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for everyone

Promoting competition and investment in fibre networks: review of the physical infrastructure and business connectivity markets

Annexes 1-25 of 26

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Contents

Annexes 1-25 of 26

A1. Regulatory framework

A1.1 This annex provides an overview of the market review process to give some additional context and understanding of the matters discussed in this document, including the legal instruments published in Annex 26.

A1.2 Market review regulation is technical and complex; and requires us to apply legislation and take into account a number of relevant recommendations and guidelines. This overview identifies some of the key aspects of materials relevant to this market review but does not purport to give a full and exhaustive account of all materials that we have considered in reaching our decisions on this market.

Market review concept

A1.3 A market review is a process by which, at regular intervals, we identify relevant markets appropriate to national circumstances and carry out analyses of these markets to determine whether they are effectively competitive. Where an operator has significant market power (SMP) in a market, we impose appropriate remedies, known as SMP obligations or conditions, to address this. We explain the concept of SMP below.

A1.4 In carrying out this work, we act in our capacity as the sector-specific regulator for the UK communications industries, including telecommunications. Our functions in this regard are to be found in Part 2 of the Communications Act 2003 (the Act).[1] We exercise those functions within the framework harmonised across the European Union for the regulation of electronic communications by the Member States (known as the Common Regulatory Framework or CRF), as transposed by the Act. The applicable rules[2] are contained in a package of five European Directives, of which two Directives are particularly relevant for present purposes, namely:

- Directive 2002/21/EC on a common regulatory framework for electronic communications networks and services (the Framework Directive); and
- Directive 2002/19/EC on access to, and interconnection of, electronic communications networks and associated facilities (the Access Directive).

A1.5 The Directives require that National Regulatory Authorities (NRAs) such as Ofcom carry out reviews of competition in communications markets to ensure that SMP regulation remains appropriate and proportionate in the light of changing market conditions.

A1.6 Each market review normally involves three analytical stages, namely:

- the identification and definition of the relevant markets (the market definition stage);

[1] Communications Act 2003, Chapter 21 [accessed 03 June 2019].

[2] The Directives were subsequently amended on 19 December 2009. The amendments have been transposed into the national legislation and applied with effect from 26 May 2011 and any references in this document to the Act should be read accordingly.

- the assessment of competition in each market, in particular whether the relevant market is effectively competitive (the market analysis stage); and
- the assessment of appropriate regulatory obligations (the remedies stage).

A1.7 These stages are normally carried out together.

Market definition

A1.8 The Act provides that, before making a market power determination[3], we must identify "the markets which in [our] opinion are the ones which in the circumstances of the United Kingdom are the markets in relation to which it is appropriate to consider whether to make such a determination" and analyse those markets.

A1.9 The Framework Directive requires that NRAs shall, taking the utmost account of the 2014 EC Recommendation[4] and SMP Guidelines[5] published by the European Commission (EC), define the relevant markets appropriate to national circumstances, in particular relevant geographic markets within their territory, in accordance with the principles of competition law.

A1.10 The 2014 EC Recommendation identifies a set of product and service markets within the electronic communications sector in which *ex ante* regulation may be warranted. Its purpose is twofold. First, it seeks to achieve harmonisation across the single market by ensuring that the same markets will be subject to a market analysis in all Member States. Second, the 2014 EC Recommendation seeks to provide legal certainty by making market players aware in advance of the markets to be analysed.

A1.11 However, NRAs are able to regulate markets that differ from those identified in the 2014 EC Recommendation where this is justified by national circumstances by demonstrating that three cumulative criteria referred to in the 2014 EC Recommendation (the three-criteria test) are satisfied and where the EC does not raise any objections.

A1.12 The three criteria, which are cumulative, are:

- the presence of high and non-transitory structural, legal or regulatory barriers to entry;
- a market structure which does not tend towards effective competition within the relevant time horizon, having regard to the state of infrastructure-based and other competition behind the barriers to entry; and
- competition law alone is insufficient to adequately address the identified market failure(s).

[3] The market power determination concept is used in the Act to refer to a determination that a person has SMP in an identified services market.
[4] Commission Recommendation of 9 October 2014 on relevant product and service markets within the electronic communications sector susceptible to *ex ante* regulation in accordance with Directive 2002/21/EC of the European Parliament and of the Council on a common regulatory framework for electronic communications networks and services (2014/710/EU) [accessed 20 May 2019].
[5] Guidelines on market analysis and the assessment of significant market power under the EU regulatory framework for electronic communications networks and services (2018/C 159/01) [accessed 20 May 2019].

A1.13 The fact that an NRA identifies the product and service markets listed in the 2014 EC Recommendation or identifies other product and service markets that meet the three-criteria test does not automatically mean that regulation is warranted. Market definition is not an end in itself but rather a means of assessing effective competition.

A1.14 The relationship between the market definitions identified in this review and those listed in the 2014 EC Recommendation is discussed in relevant parts of this document.

A1.15 The SMP Guidelines make clear that market definition is not a mechanical or abstract process. It requires an analysis of any available evidence of past market behaviour and an overall understanding of the mechanics of a given market sector. As market analysis has to be forward-looking, the SMP Guidelines state that NRAs should determine whether the market is prospectively competitive, and thus whether any lack of effective competition is durable, by taking into account expected or foreseeable market developments over the course of a reasonable period[6] in the absence of regulation based on significant market power (known as a 'Modified Greenfield Approach').[7] The SMP Guidelines clarify that NRAs enjoy discretionary powers which reflect the complexity of all the relevant factors that must be assessed (economic, factual and legal) when identifying the relevant market and assessing whether an undertaking has SMP.

A1.16 The SMP Guidelines also describe how competition law methodologies may be used by NRAs in their analysis. In particular, there are two dimensions to the definition of a relevant market: the relevant products to be included in the same market and the geographic extent of the market. Ofcom's approach to market definition follows that used by the UK competition authorities, which is in line with the approach adopted by the EC.

A1.17 While competition law methodologies are used in identifying the relevant markets *ex ante*, the markets identified will not necessarily be identical to markets defined in *ex post* competition law cases, especially as the markets identified *ex ante* are based on an overall forward-looking assessment of the structure and the functioning of the market under examination. Accordingly, the economic analysis carried out for the purpose of this review, including the markets we have identified, is without prejudice to any analysis that may be carried out in relation to any investigation pursuant to the Competition Act 1998[8] (relating to the application of the Chapter I or II prohibitions or Article 101 or 102 of the Treaty on the Functioning of the European Union[9]) or the Enterprise Act 2002.[10]

[6] The SMP Guidelines provide that the actual period used should reflect the specific characteristics of the market and the expected timing for the next review of the relevant market by the NRA – see paragraph 14.
[7] SMP Guidelines, paragraphs 13-17.
[8] Competition Act 1998, Chapter 41 [accessed 6 June 2019].
[9] Previously Article 81 and Article 82 of the EC Treaty. [accessed 11 June 2019].
[10] Enterprise Act 2002, Chapter 40 [accessed 11 June 2019].

Market analysis

Effective competition

A1.18 The Act requires that we carry out market analyses of identified markets for the purpose of making or reviewing market power determinations. Such analyses are normally to be carried out within two years from the adoption of a revised recommendation on markets, where that recommendation identifies a market not previously notified to the EC, or within three years from the publication of a previous market power determination relating to that market. Exceptionally, the three-year period may be extended for up to three additional years where the NRA notifies the EC, and it does not object.

A1.19 In carrying out a market analysis, the key issue for an NRA is to determine whether the market in question is effectively competitive. The 27th recital to the Framework Directive clarifies the meaning of that concept:

"It is essential that *ex ante* regulatory obligations should only be imposed where there is not effective competition, i.e. in markets where there are one or more undertakings with significant market power, and where national and Community competition law remedies are not sufficient to address the problem".

A1.20 The definition of SMP is equivalent to the concept of dominance as defined in competition law. In essence, it means that an undertaking in the relevant market is in a position of economic strength affording it the power to behave to an appreciable extent independently of competitors, customers, and ultimately consumers. The Framework Directive requires that NRAs must carry out their market analysis taking utmost account of the SMP Guidelines, which emphasise that NRAs should undertake a thorough and overall analysis of the economic characteristics of the relevant market before coming to a conclusion as to the existence of SMP.

A1.21 In that regard, the SMP Guidelines set out, additionally to market shares, a number of criteria that can be used by NRAs to measure the power of an undertaking to behave to an appreciable extent independently of its competitors, customers, and consumers, including:

- barriers to entry;
- barriers to expansion;
- absolute and relative size of the undertaking;
- control of infrastructure not easily duplicated;
- technological and commercial advantages or superiority;
- absence of or low countervailing buying power;
- easy or privileged access to capital markets/financial resources;
- product/services diversification (for example, bundled products or services);
- economies of scale and economies of scope;
- direct and indirect network effects;
- vertical integration;
- a highly developed distribution and sales network;
- conclusion of long-term and sustainable access agreements;

- engagement in contractual relations with other market players that could lead to market foreclosure; and
- absence of potential competition.[11]

A1.22 A dominant position can derive from a combination of these criteria which when taken separately may not necessarily be determinative.

Sufficiency of competition law

A1.23 As part of our overall forward-looking analysis, we also assess whether competition law by itself (without *ex ante* regulation) is sufficient, within the relevant markets we have defined, to address the competition problems we have identified. We consider this matter in our assessment of the appropriate remedies which, as explained below, are based on the nature of the specific competition problems we identify within the relevant markets as defined. We also note that the SMP Guidelines clarify that, if NRAs designate undertakings as having SMP, they must impose on them one or more regulatory obligations.

A1.24 In considering this matter, we bear in mind the specific characteristics of the relevant markets we have defined. Generally, the case for *ex ante* regulation is based on the existence of market failures which, by themselves or in combination, mean that the establishment of effective competition might not be possible if the regulator relied solely on *ex post* competition law powers which are not specifically tailored to the sector. Therefore, it may be appropriate for *ex ante* regulation to be used to address such market failures along with any entry barriers that might otherwise prevent effective competition from becoming established within the relevant markets we have defined. By imposing *ex ante* regulation that promotes competition, it may be possible to reduce such regulation over time as markets become more competitive, allowing greater reliance on *ex post* competition law.

A1.25 *Ex post* competition law is also unlikely in itself to bring about (or promote) effective competition, as it prohibits the abuse of dominance rather than the holding of a dominant position itself. In contrast, *ex ante* regulation is normally aimed at actively promoting the development of competition through attempting to reduce the level of market power (or dominance) in the identified relevant markets, thereby encouraging the establishment of effective competition.

A1.26 We generally take the view that *ex ante* regulation provides additional legal certainty for the market under review and may also better enable us to intervene in a timely manner. We may also consider that certain obligations are needed as competition law would not remedy the particular market failure, or that the specific clarity and detail of the obligation is required to achieve a particular result.

[11] SMP Guidelines, paragraph 58.

Remedies

Powers and legal tests

A1.27 The Framework Directive prescribes what regulatory action NRAs must take depending upon whether or not an identified relevant market has been found effectively competitive. Where a market has been found effectively competitive, NRAs are not allowed to impose SMP obligations and must withdraw such obligations where they already exist. On the other hand, where the market is found not effectively competitive, the NRAs must identify the undertakings with SMP in that market and then impose appropriate obligations.

A1.28 NRAs have a suite of regulatory tools at their disposal, as reflected in the Act and the Access Directive. Specifically, the Access Directive identifies a number of SMP obligations, including transparency, non-discrimination, accounting separation, access to and use of specific network elements and facilities, price control and cost accounting. When imposing a specific obligation, the NRA will need to demonstrate that the obligation in question is based on the nature of the problem identified, proportionate and justified in the light of the policy objectives as set out in Article 8 of the Framework Directive.

A1.29 Specifically, for each and every SMP obligation, we will explain why it satisfies the requirement in section 47(2) of the Act that the obligation is:

- objectively justifiable in relation to the networks, services, facilities, apparatus or directories to which it relates;
- not such so as to discriminate unduly against particular persons or against a particular description of persons;
- proportionate to what the condition or modification is intended to achieve; and
- transparent in relation to what is intended to be achieved.

A1.30 Additional legal requirements may also need to be satisfied depending on the SMP obligation in question. For example, in the case of price controls, the NRA's market analysis must indicate that the lack of effective competition means that the telecoms provider concerned may sustain prices at an excessively high level or may apply a price squeeze to the detriment of end-users and that the setting of the obligation is appropriate for the purposes of promoting efficiency, promoting sustainable competition and conferring the greatest possible benefits on the end-users of public electronic communications services. In that instance, NRAs must take into account the investment made by the telecoms provider and allow it a reasonable rate of return on adequate capital employed, taking into account any risks specific to a particular new investment, as well as ensure that any cost recovery mechanism or pricing methodology that is mandated serves to promote efficiency and sustainable competition and maximise consumer benefits.

A1.31 Where an obligation to provide third parties with network access is considered appropriate, NRAs must take into account factors including the feasibility of the network access, the technical and economic viability of creating networks[12] that would make the network access unnecessary, the investment of the network operator who is required to provide access[13], and the need to secure effective competition[14] in the long term.

A1.32 To the extent relevant to this review, we demonstrate the application of these requirements to the SMP obligations in question in the relevant parts of this document which set our decisions on remedies. In doing so, we also set out our assessment of how, in our opinion, the performance of our general duties under section 3 of the Act will be secured or furthered by our regulatory intervention, and that it is in accordance with the six European Community requirements in section 4 of the Act. This is also relevant to our assessment of the likely impact of implementing our decisions.

Ofcom's general duties – section 3 of the Act

A1.33 Under the Act, our principal duty in carrying out functions is to further the interests of citizens in relation to communications matters and to further the interests of consumers in relevant markets, where appropriate by promoting competition.

A1.34 In doing so, we are required to secure a number of specific objectives and to have regard to a number of matters set out in section 3 of the Act.

A1.35 In performing our duties, we are also required to have regard to a range of other considerations, as appear to us to be relevant in the circumstances. For the purpose of the Physical Infrastructure Market Review (PIMR) and Business Connectivity Market Review (BCMR), we consider that a number of such considerations are relevant, in particular:

- the desirability of promoting competition in relevant markets;
- the desirability of encouraging investment and innovation in relevant markets; and
- the desirability of encouraging the availability and use of high speed data transfer services throughout the UK.

A1.36 We have also had regard to the principles under which regulatory activities should be transparent, accountable, proportionate, consistent, and targeted only at cases in which action is needed, as well as in the interest of consumers in respect of choice, price, quality of service and value for money.

A1.37 However, Ofcom has a wide measure of discretion in balancing its statutory duties and objectives. In doing so, we take account of all relevant considerations, including responses received during our consultation process, in reaching our conclusions.

[12] Including the viability of other network access products, whether provided by the dominant provider or another person.
[13] Taking account of any public investment made.
[14] Including, where it appears to us to be appropriate, economically efficient infrastructure-based competition.

European Community requirements for regulation – sections 4 and 4A of the Act and Article 3 of the BEREC Regulation

A1.38 As noted above, our functions exercised in this review fall under the CRF. As such, section 4 of the Act requires us to act in accordance with the six Community requirements for regulation. In summary, these six requirements are:

i) to promote competition in the provision of electronic communications networks and services, associated facilities and the supply of directories;

ii) to contribute to the development of the European internal market;

iii) to promote the interests of all persons who are citizens of the EU;

iv) to take account of the desirability of Ofcom's carrying out of its functions in a manner which, so far as practicable, does not favour one form of or means of providing electronic communications networks, services or associated facilities over another (i.e. to be technologically neutral);

v) to encourage, to such extent as Ofcom considers appropriate for certain prescribed purposes: the provision of network access and service interoperability; securing efficient and sustainable competition; efficient investment and innovation; and the maximum benefit for customers of telecoms providers; and

vi) to encourage compliance with certain standards in order to facilitate service interoperability and secure freedom of choice for the customers of telecoms providers.

A1.39 We consider that the first, third, fourth, and fifth of those requirements are of particular relevance to the matters under review and that no conflict arises in this regard with those specific objectives in section 3 of the Act that we consider are particularly relevant in this context.

A1.40 Section 4A of the Act requires Ofcom, in carrying out certain of its functions (including, among others, Ofcom's functions in relation to market reviews under the CRF), to take due account of applicable recommendations issued by the EC under Article 19(1) of the Framework Directive. Where we decide not to follow such a recommendation, we must notify the EC of that decision and the reasons for it.

A1.41 Further, Article 3(3) of the Regulation establishing BEREC[15] requires NRAs to take utmost account of any opinion, recommendation, guidelines, advice or regulatory best practice adopted by BEREC.

A1.42 Accordingly, we have taken due account of the applicable EC recommendations and utmost account of the applicable opinions, recommendations, guidelines, advice and

[15] *Regulation (EC) No 1211/2009 of the European Parliament and of the Council of 25 November 2009 establishing the Body of European Regulators of Electronic Communications (BEREC) and the Office* (the BEREC Regulation) [accessed 20 June 2019].

regulatory best practices adopted by BEREC relevant to the matters under consideration in this review.

Impact assessment – section 7 of the Act

A1.43 The analysis presented in this document represents an impact assessment, as defined in section 7 of the Act.

A1.44 Impact assessments provide a valuable way of assessing different options for regulation and showing why the preferred option was chosen. They form part of best practice policy-making. This is reflected in section 7 of the Act, which means that generally Ofcom has to carry out impact assessments where there is likely to be a significant effect on businesses or the general public, or when there is a major change in Ofcom's activities. However, as a matter of policy, Ofcom is committed to carrying out and publishing impact assessments in relation to the majority of its policy decisions.[16]

A1.45 Specifically, pursuant to section 7, an impact assessment must set out how, in our opinion, the performance of our general duties (within the meaning of section 3 of the Act) is secured or furthered by or in relation to the regulation we impose.

A1.46 Ofcom is separately required by statute to assess the potential impact of all our functions, policies, projects, and practices on equality.[17] This assessment is set out in Annex 6.

Regulated entity

A1.47 The power in the Act to impose an SMP obligation by means of an SMP services condition provides that it is to be applied only to a "person" whom we have determined to be a person having SMP in a specific market for electronic communications networks, electronic communications services or associated facilities (i.e. the "services market").

A1.48 The Framework Directive requires that, where an NRA determines that a relevant market is not effectively competitive, it shall identify "undertakings" with SMP in that market and impose appropriate specific regulatory obligations. For the purposes of EU competition law, "undertaking" includes companies within the same corporate group (for example, where a company within that group is not independent in its decision making).[18]

A1.49 We consider it appropriate to prevent a dominant provider to whom an SMP services condition is applied, which is part of a group of companies, exploiting the principle of corporate separation. The dominant provider should not use another member of its group to carry out activities or to fail to comply with a condition, which would otherwise render the dominant provider in breach of its obligations.

A1.50 To secure that aim, we apply the SMP conditions to the person in relation to which we have made the market power determination in question by reference to the so-called

[16] For further information about Ofcom's approach to impact assessments, see the guidelines, Better Policy Making: Ofcom's approach to Impact Assessment [accessed 20 May 2019].
[17] Ofcom has a general duty under the 2010 Equality Act to advance equality of opportunity in relation to age, disability, sex, gender reassignment, pregnancy and maternity, race, religion or belief, and sexual orientation.
[18] *Viho v Commission*, Case C-73/95 P [1996] ECR I-5447, Judgement of the court [accessed 20 May 2019].

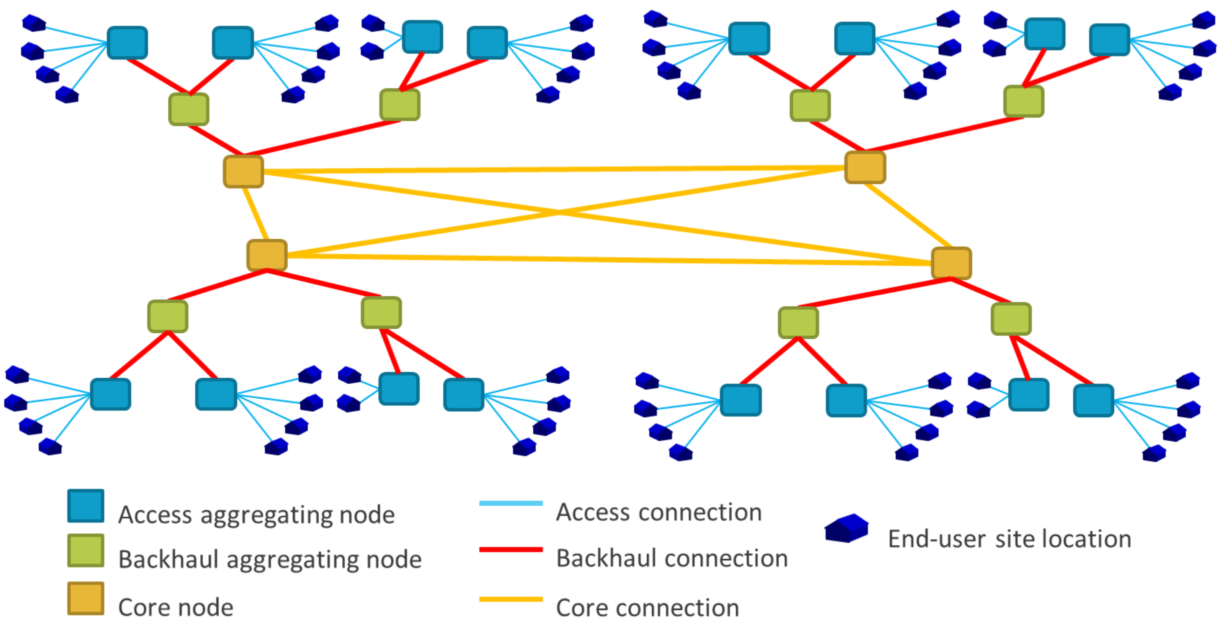
“Dominant Provider”, which we define as “[X plc], whose registered company number is [000] and any [X plc] subsidiary or holding company, or any subsidiary of that holding company, all as defined in section 1159 of the Companies Act 2006”.

A2. Background to telecoms networks

A2.1 This annex sets out an overview of network concepts in support of our analysis in this consultation.

A2.2 A communications network provides the services that enable end-users to exchange information. A network routes its communication services through its network nodes[19] and connections between them. The nodes are often located in buildings such as BT exchanges, switching centres, data centres, and telecoms providers' buildings. Figure A7.1 sets out how the nodes and connections are logically arranged in a typical network.

Figure A7.1: Illustration of logical arrangement of a communications network



Source: Ofcom

A2.3 This structure is common to the networks used to provide most voice and data communications services – such as PSTN, mobile, broadband, and leased lines.

A2.4 To enable communication between different networks, networks can be interconnected with one another.

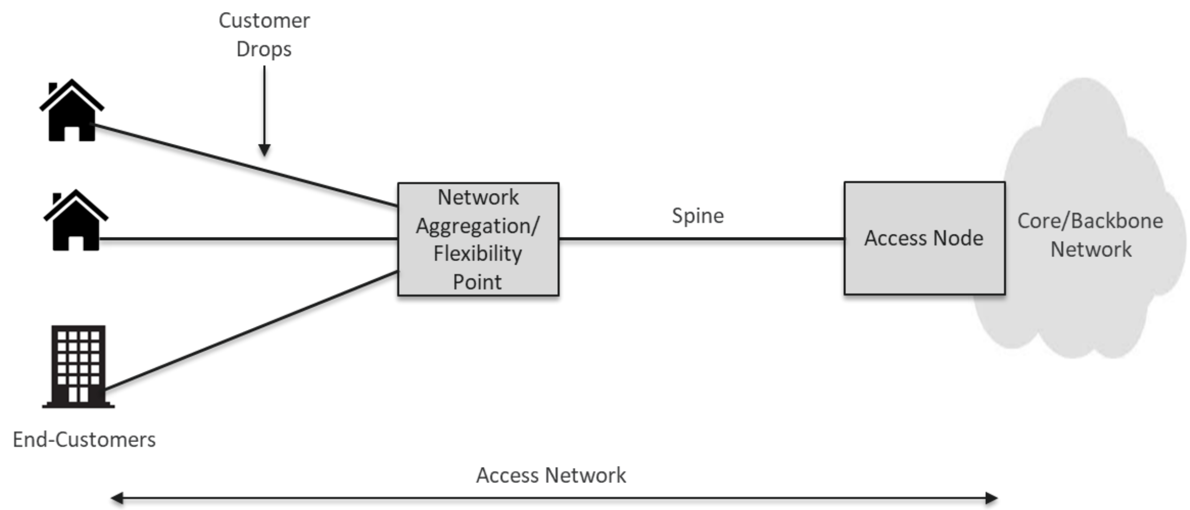
Elements of access networks

A2.5 While there are number of different types of access network, all share certain common attributes which make up the access connection between end user sites and an access aggregating node, such as customer drops, aggregation/flexibility points, spine links and

[19] Nodes and connections in this context are considered to be combinations of electronic and optical equipment. Buildings or sites in this context house the nodes.

access nodes. Figure A7.2 below illustrates how the constituent elements typically relate to one another.

Figure A7.2: Generic fixed access network



Source: Ofcom

A2.6 Customer drops, or lead-ins, are the dedicated physical bearer (or radio links in the case of wireless networks) connecting an end-customer's equipment, so-called customer premises equipment (CPE) or mobile terminals, to the network.

A2.7 Aggregation nodes or flexibility points terminate a number of customer drops and either aggregate traffic or consolidate multiple transmission bearers into a smaller number for backhaul purposes.[20]

A2.8 Spine links are transmission bearers that carry aggregated customer traffic from an aggregation node or flexibility point to an access node. Access nodes host the technology-specific equipment that controls the access network.

Common types of telecoms network

A2.9 Telecoms networks can be used to deliver a range of services and can do so using different network architectures and technologies. We set out below some of the most common contemporary telecoms networks used to deliver services. For ease of exposition, we discuss the different types of networks separately, however, we expect telecoms providers to increasingly deploy networks supplying the full range of downstream services.

A2.10 In the description below, we refer to leased lines. These are high-quality point-to-point business connectivity services which tend to be symmetric (i.e. the capacity is the same in both directions) and uncontended (i.e. the capacity is guaranteed and not subject to reduction by the presence of other communication services). These are different from other services such as consumer and business broadband connections which tend to be

[20] In some access networks, the aggregation node can also perform some of the functions of the access node (e.g. DSL-based FTTC).

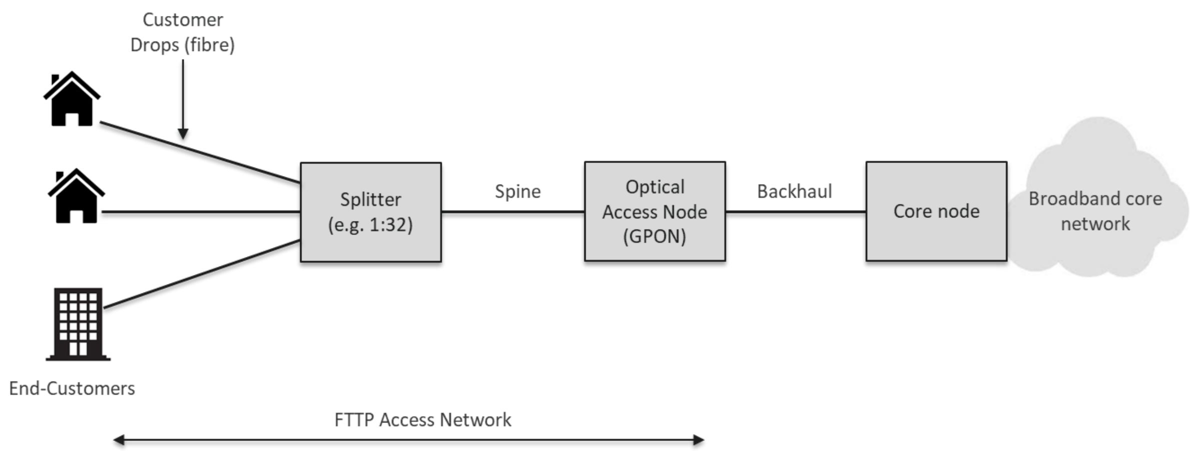
asymmetric and contended. As explained below, leased lines are used to provide business end-to-end connectivity, business access connectivity to virtual private networks (VPNs), the internet and cloud computing; mobile network connectivity (often referred to as mobile backhaul); and broadband network connectivity (often referred to as fixed broadband backhaul).

Fixed broadband networks

A2.11 Fixed broadband access networks share the common characteristic of using cables for their end-to-end transmission, with twisted-pair copper, fibre-optic and coaxial cables being the most common media types. Figure A7.3 below illustrates the key elements of a GPON-based FTTP access network.

A2.12 Fixed broadband operators use leased lines to connect from their access nodes to their backhaul and core network nodes. These network connections are referred to as 'fixed broadband backhaul'.[21] Fixed broadband operators will also connect to the internet at suitable locations to provide an end-to-end broadband service.

Figure A7.3: Generic FTTP GPON Access Network



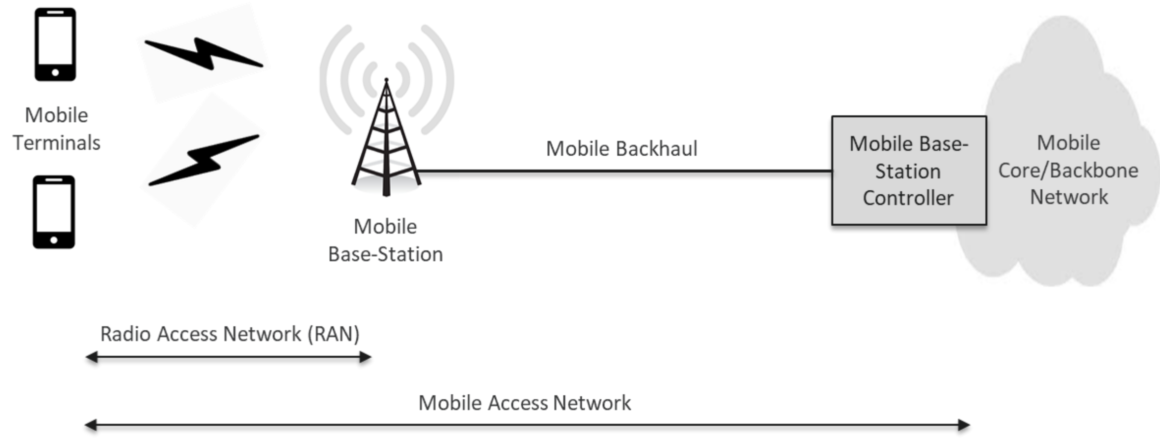
Source: Ofcom

Mobile networks

A2.13 Mobile access networks provide the wireless connectivity from an end-customer's mobile terminal device (e.g. a mobile phone) to the nearest base-station, and on via backhaul transmission links (fixed or wireless) to the mobile core network. Figure A7.4 below illustrates the generic elements of a mobile access network.

[21] Fixed broadband operators can build their own broadband networks using leased lines for backhaul and core, together with access connections owned and operated by BT. In this case, they will site their equipment to connect to BT's access network (i.e. their access aggregating node) at a BT local exchange. Alternatively, an operator may choose to build their own access connections (for example Virgin Media's network).

Figure A7.4: Generic Mobile Access Network



Source: Ofcom

A2.14 Mobile base-stations create one or more cells, geographic areas adjacent to the base station, offering connectivity for mobile devices located within the cell.

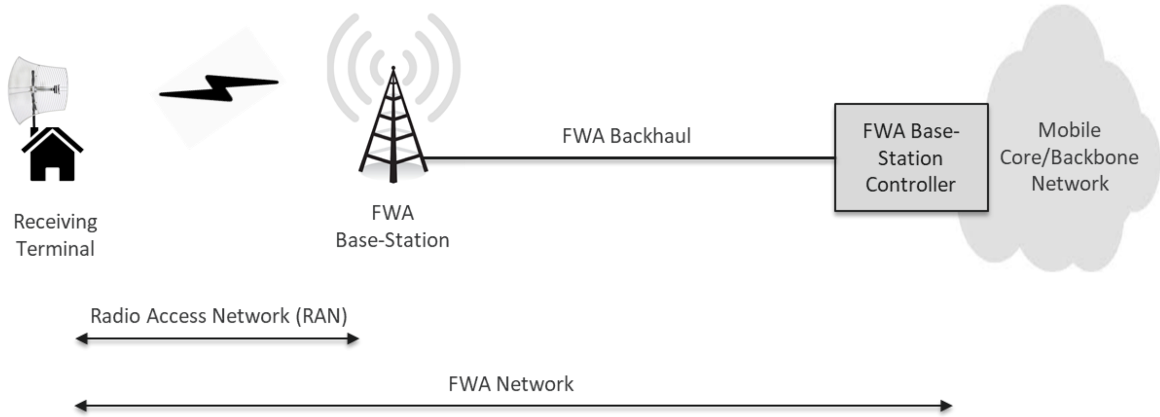
A2.15 Mobile network operators (MNOs) use leased lines to connect their base stations,[22] to their core network nodes. The term 'mobile backhaul' is often used to refer to the combination of access and backhaul connections between the mobile base station and the mobile core node. MNOs may also use leased lines to provide connectivity between their core sites to construct the networks used to support mobile services including access to the internet and other networks.

Fixed wireless access networks

A2.16 Fixed wireless access (FWA) networks share characteristics of both fixed broadband and mobile access networks. Figure A7.5: below characterises the basic elements of a FWA network.

[22] These are the radio masts that provide the communications between the mobile telephone handset and the fixed mobile network.

Figure A7.5: Generic FWA Network



Source: Ofcom

A2.17 FWA designs are still evolving, and FWA networks could take a number of forms and employ different technologies (e.g. WiMax, LTE), their architecture has similarities with mobile access networks such as a RAN, base station and backhaul transmission link.

A2.18 The key distinction between mobile access and FWA networks is that FWA does not allow for mobility of the end-customer's terminal device between cells, and in some cases within the cell.

Future wireless networks (5G)

A2.19 The topology of future 5G networks is currently unclear. However, the expectation is that there will be a greater number of cell sites, to provide greater capacity. There are many ways that these cell sites could be connected to one another and back to the core network. However, we expect that fixed/leased line connections will play a major part in providing these cell site connections.

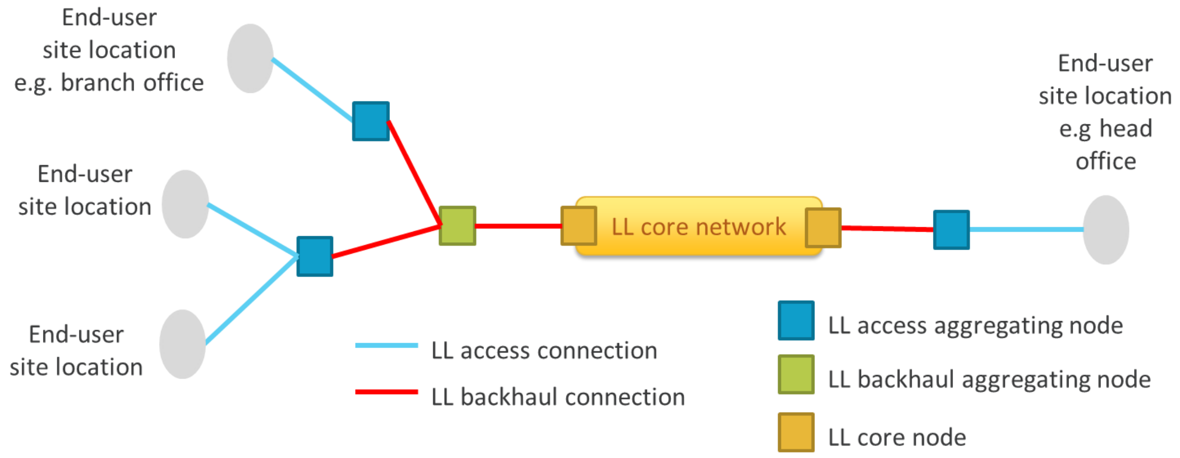
A2.20 However, in terms of the fixed network design connecting these cells, it is likely that we will see local area loops of various configurations, and these loops will need to offer connectivity to a large number of non-traditional locations (for example lamp posts).

A2.21 We are likely to see more need for connections between cells in a local area to coordinate services. Such connections may require fixed lines, though some providers are considering wireless links. There is still uncertainty about the connections between cells in a local area. Nevertheless, we still expect 5G networks to need major fixed backhaul links of the form provided today by leased lines and flexible low cost routes for such backhaul links will remain a key input in the deployment of these networks.

Business connectivity networks

A2.22 Traditionally, businesses have used leased lines to connect their sites, and sometimes to connect with other businesses. A typical end-to-end connectivity arrangement is illustrated in Figure A7.6.

Figure A7.6: Business end-to-end connectivity



Source: Ofcom

A3. Evidence on types and uses of physical infrastructure

A3.1 This annex sets out evidence in support of our market definition and SMP analysis in relation to the provision of physical infrastructure access, as set out in Section 3 of Volume 1. In the following, we outline the evidence we hold on different types and uses of physical infrastructure. More specifically, we outline:

a) use of third-party infrastructure;

b) the different types of telecoms physical infrastructure;

c) comparison of BT and Virgin Media's lead-in infrastructure; and

d) comparison of other characteristics of BT and Virgin Media's infrastructure.

Use of third-party physical infrastructure

A3.2 This evidence supports our product market definition.

A3.3 Use of other third-party physical infrastructure (both telecoms and non-telecoms) is generally limited representing a fraction of the total network deployment. This is outlined in Table A3.1 below.

Table A3.1: Use of third-party physical infrastructure by telecoms providers [✄]

Provider	Use of telecoms physical infrastructure	Use of non-telecoms physical infrastructure
[✄][23]	[✄]	[✄]
[✄][24]	[✄][25]	[✄]
[✄][26]	[✄]	[✄]
[✄][27]	[✄]	
[✄][28]	[✄]	[✄]
[✄][29]	[✄]	[✄]

23 [✄].
24 [✄].
25 [✄].
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27 [✄].
28 [✄].
29 [✄].

Provider	Use of telecoms physical infrastructure	Use of non-telecoms physical infrastructure
[✂][30]	[✂]	
[✂][31]	[✂]	[✂]

Source: see footnoted sources.

A3.4 In its report, Analysys Mason pointed to two further telecoms providers in the UK using third-party infrastructure as part of their network deployments:

a) True-speed - a rural-focussed provider offering FTTP broadband. It has used a mix of self-build, BT PIA and low voltage electricity networks to deploy to 3,000 premises (as of May 2018) and aims to cover 75,000 premises by 2021.[32]

b) ITS Technology Group – which provides full-fibre and FWA networks to serve businesses in both urban and rural areas, using a mix of self-build, re-used telecoms infrastructure and non-telecoms physical infrastructure.[33] It has partnered with various local authorities, and has more than 1,800 connections to SMEs located in business parks.[34]

A3.5 Analysys Mason also noted international examples of telecoms network being deployed using third-party infrastructure, including telecoms and non-telecoms physical infrastructure:[35]

a) SIRO (Republic of Ireland) - a joint venture between the electricity utility company Electricity Supply Board (ESB) and Vodafone for FTTP deployment using medium voltage and low voltage electricity infrastructures across the Republic of Ireland. It currently deploys to 175,000 Irish premises, and plans to deploy to 500,000 premises, representing 29% of Irish premises.[36]

b) Open Fiber (Italy) – an FTTP provider in Italy using Enel's electricity network infrastructure for fibre roll-out. It has found that 60% of Enel's infrastructure can be re-used in the fibre roll-out – finding the scope for re-use of the electricity aerial network near universal, but the scope for re-using underground network much more limited. It had rolled out FTTP infrastructure to cover 2.4 million homes by end of 2017, and planned to reach 9.5 million premises in 250 cities by 2021, using a combination of telecoms and non-telecoms physical infrastructure.[37]

[30] [✂].
[31] [✂].
[32] Analysys Mason Report, page C-2.
[33] Analysys Mason Report, page C-9.
[34] Analysys Mason Report, page C-9.
[35] Analysys Mason Report, pages C-3-C8.
[36] Analysys Mason Report pages 18-19, C3-C4.
[37] Analysys Mason Report pages 19, C4-C5.

c) Telekom Deutschland (Germany) – which has signed several agreements with local authorities and utility companies in order to expand its FTTP network. The amount and nature of non-telecoms physical infrastructure used is unclear.[38]

A3.6 While there are successful limited uses of non-telecoms infrastructure to support telecoms services (such as distribution links over power cables and beside railway lines), there have been a number of unsuccessful trials of use of non-telecoms infrastructure to deploy the final connection to customers in the UK:

a) [✂] plans to deploy an FTTP network utilising sewer networks [✂].[39]

b) [✂] investigated the feasibility of using disused water mains to house fibre cabling [✂].[40]

c) [✂] to deploy fibre in sewers [✂]. This highlighted a number of difficulties, including:

i) The complexity of negotiations and difficulty gaining access to sewers.

ii) The impact of adverse weather conditions on in-sewer deployments. Heavy rainfall can prevent entry to the sewer network, [✂].

iii) The chambers that allow breakout from the sewer network to street level can be too restrictive to provide scalable fibre access. Larger chambers may have to be built with improved access (for example, to house fibre trays/splicing equipment) at additional cost.

iv) The sewer owners ([✂]) often do not have street level concessions to host RAN equipment, so [✂] some fibre that is essentially stuck in the sewer that cannot be used [✂].

v) There are issues with 'fatbergs' and manual rerouting to avoid strategic sewers [✂].

vi) [✂] use of sewers could not be replicated in less urban areas and where small bore sewers exist.[41]

d) [✂]:

i) Trialling use of electricity pylons with [✂] highlighted that access to the pylons is not feasible in winter months, since the supply can't be shut down on half the pylon as is the case in the summer. It also highlighted the need for specialist engineers.[42]

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[38] Analysys Mason Report pages 19, C6-C8.
[39] [✂].
[40] [✂].
[41] [✂]. [✂] its experience of using the sewers to deploy fibre show that the use of alternative infrastructure is not scalable and not a substitute for ubiquitous telecoms-specific infrastructure owned by BT. [✂].
[42] [✂].

ii) It successfully trialled using a sewer duct in order to traverse a railway line [✂]. However, this trial identified the need to use a full liner in foul water pipes. It considers that, due to the higher cost, it would focus this type of use on obstacle avoidance.[43]

A3.7 We are also aware of operators' own assessments of potential non-telecoms physical infrastructure. For example, Virgin Media provided [✂] as evidence of its preliminary findings that broadly, each alternative infrastructure type has its own shortcomings that in general make the use of such infrastructure unattractive.[44]

Types of telecoms physical infrastructure

A3.8 There are different types of telecoms physical infrastructure that can be used to host fixed elements of a telecoms network.[45] The main types are ducts and chambers, and poles:

a) Ducts and chambers are used to carry cables and associated equipment underground. Underground chambers, accessible via a lid in the ground, act as points where existing cables can be accessed, and new cables can be installed.

b) Telegraph poles are used to carry cables and associated equipment overhead.

A3.9 Table A3.2 below describes the amount of these types of physical infrastructure in each operator's network:

Table A3.2: Physical infrastructure owned by BT and Virgin Media

Self-supply shares	BT	Virgin Media
Duct route length, excluding lead-ins	c.450,000km	c.[✂]km
Number of overhead poles	c.[✂]	-
Number of chambers	c.[✂]	c.[✂]

Source: Ofcom analysis; Openreach responses to WLA s135 information requests dated 27 January 2017, 16 June 2017 and 21 December 2017; Virgin Media response dated 21 September 2018 to question 5 of the s135 information request dated 30 August 2018.

A3.10 Telecoms providers that operate networks used only to provide leased lines typically provide connections using underground physical infrastructure.

Lead-in infrastructure

A3.11 Lead-ins constitute the physical link from the end-customer's premise to the flexibility point in the customer's street and are typically only tens of metres in length.

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43 [✂].

44 Virgin Media response dated 9 May 2019 to question 1 of the s135 information request dated 30 April 2019. Also, one operator ([✂]) told us that having reviewed and undertaken assessments of a broad range of potential non-telecoms physical infrastructure solutions, it concluded that such infrastructure creates extensive incremental challenges in comparison to using telecoms infrastructure. [✂]. Another operator ([✂]) has considered use of electricity poles, but [✂], due to the additional wayleaves and health and safety requirements with non-telecoms infrastructure. [✂].

45 Cables can also be directly buried in the ground.

A3.12 Broadly speaking, there are three types of lead-in:

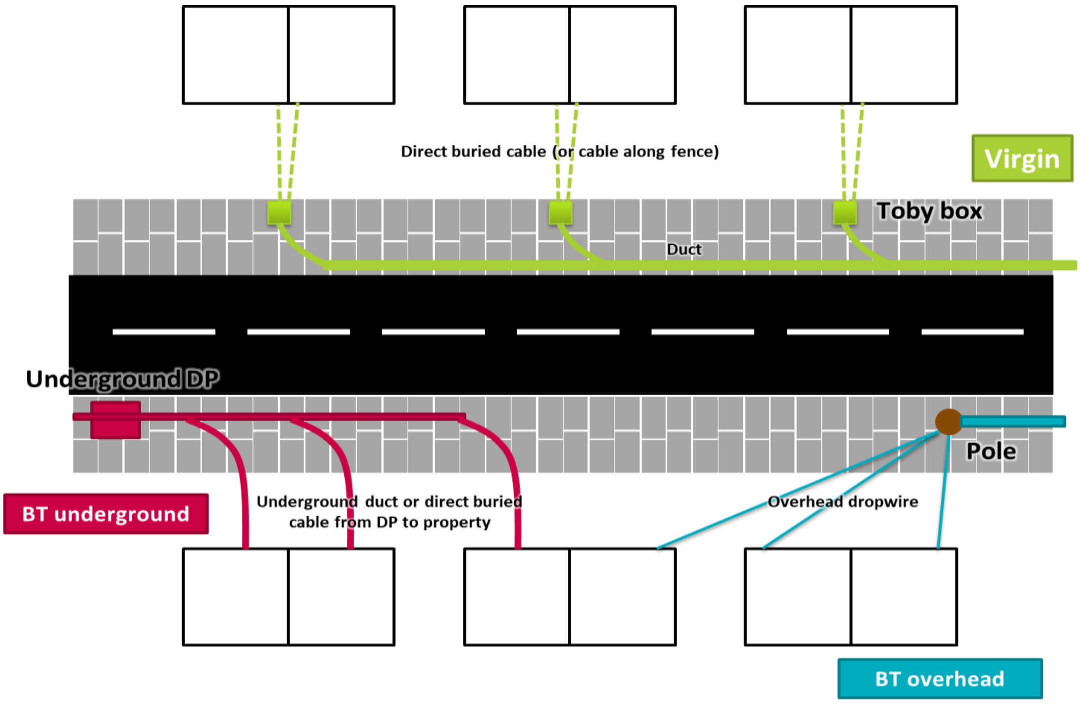
a) Overhead lead-ins in the form of dropwires attached to home from poles;

b) Underground lead-ins installed in ducts; and

c) Directly buried lead-ins.

A3.13 Figure A3.3 below illustrates what we understand to be the main types of lead-ins in BT and Virgin Media's networks.

Figure A3.3: Main types of lead-ins in BT's and Virgin Media's physical infrastructure



Source: Ofcom

BT's lead-in infrastructure

A3.14 Around 50% of BT's lead-ins are overhead using poles.[46] The remaining 50% of BT connections are underground lead-ins, running from an underground distribution point all the way to the premises.[47] The majority of BT's underground lead-ins are installed in ducts, with a small proportion (likely to be around 5% of total lead-ins) directly buried, although this varies geographically.[48]

[46] 2018 WLA Statement, Volume 3, page 29, footnote 64.

[47] Within BT's network, some premises are served by internal or external distribution points, located inside or on the facade of customer premises respectively. These are typically business premises or blocks of flats. Such distribution points are generally served by underground ducts and by definition do not require lead-in ducts beyond the distribution points.

[48] The exact number of directly buried lead-ins is unknown. The incidence of directly buried lead-ins varies between 1% in London and 8-10% in Southern England. See 2018 WLA Statement, Volume 3, page 29, footnote 64.

A3.15 We understand that most of BT's ducted lead-ins are 50mm diameter ducts, and that the majority (80%) of the cables in the 50mm lead-in duct are less than 15mm in diameter, leaving significant space within the duct.[49] We also understand that around 85-90% of BT's poles can accommodate additional equipment.[50]

A3.16 Where lead-ins are directly buried, telecoms providers would need to deploy their own lead-ins from the distribution point to the customers' premises.

Virgin Media's lead-in infrastructure

A3.17 Virgin Media's lead-ins tend to be predominantly underground ducted from a street cabinet to a termination box ('Toby box') located at ground level adjacent to the end customer's property boundary, through which the lead-in cables pass [✂]. From here, the lead-in cables are directly buried from the Toby box to the outside of the customer's premise (or cable along fence) [✂], without ducts. [✂]. As such, telecoms providers would need to deploy their own lead-ins from Virgin Media's Toby-boxes at the boundary of customers' premises.[51]

A3.18 Some of Virgin Media's Toby boxes will not have spare capacity to accommodate further cables. [✂][52]

A3.19 [✂].[53]

A3.20 New FTTP connections deployed by Virgin Media as part of its Project Lightning have primarily been built using narrow trenching techniques [✂].[54] Given the very small size of micro ducts, there is effectively no duct network for other telecoms providers to use.

A3.21 For new estates, Virgin Media works with developers to deploy a ducted access network into customer premises.[55] Overall, only a small proportion ([✂]%) of Virgin Media's lead-ins are fully ducted.[56]

[49] Smaller 25mm ducts may also be present in some parts of the BT network deployed before 1968, with little unoccupied capacity for additional cables. See 2018 WLA Statement, Volume 3, page 29, footnote 64.
[50] Around 3.3% of Openreach poles are defective and unable to have additional equipment attached to them. We assume that 12% of the remaining non-defective poles could not accommodate an additional half of the wires currently installed, based on evidence from Openreach that 7% of the current pole estate may already be at maximum capacity, and evidence from Flomatik that 12% of distribution poles could not accommodate an additional half of the wires currently installed. See 2018 WLA Statement, paragraphs A26.96-A26.97.
[51] The distance between the Toby boxes and the edge of the premises can vary. See also Analysys Mason Report, pages 13-15.
[52] Virgin Media response dated 7 September 2018 to question 13 of the s135 information request dated 30 August 2018. Virgin Media told us that [✂]; Virgin Media response dated 7 September 2018 to question 10 of the s135 information request dated 30 August 2018; Virgin Media's response to the 2018 PIMR Consultation, pages 10-11.
[53] Virgin Media response dated 26 October 2018 to question 1 of the s135 information request dated 23 October 2018.
[54] Virgin Media response dated 7 September 2018 to question 8 of the s135 information request dated 30 August 2018.
[55] Virgin Media response dated 7 September 2018 to question 8 of the s135 information request dated 30 August 2018.
[56] Virgin Media response dated 7 September 2018 to question 7 of the s135 information request dated 30 August 2018.

Illustrative comparison of the cost of using BT and Virgin Media's lead-in infrastructure

A3.22 Below, we present our illustrative estimates comparing the cost of using BT and Virgin Media's lead-ins. This supports our assessment of the strength of competition from Virgin Media in Alternative Multi-service Network areas, set out in paragraphs 3.179-3.186.

A3.23 In what follows, we also address the points made by Openreach, BT Group and Analysys Mason, which disagreed with some aspects of our assessment in the consultation.[57]

A3.24 We have compared the average costs associated with using BT and Virgin Media's lead-in physical infrastructure to connect customers, in order to understand whether one offers advantages over the other to prospective access seekers. In doing so we note that our calculation is illustrative, and not intended to provide a precise estimate of the cost difference.[58]

A3.25 For the purposes of this comparison, we assume that access seekers will be deploying a conventional GPON FTTP network using blown fibre tube (BFT), suitable mainly for the delivery of broadband services.[59]

A3.26 We describe the different types of lead-in infrastructure used in BT and Virgin Media's networks above. The mix of BT's and Virgin Media's lead in infrastructure can be summarised as follows:[60]

Table A3.4: BT and Virgin Media lead-in types[61]

	BT	Virgin Media
Overhead (poles)	50%	0%
Underground – ducted	45%	[✂]%
Underground – directly buried	5%	[✂]%

Source: 2018 WLA Statement, Volume 3, page 29, fn 64; and Virgin Media response dated 7 September 2018 to questions 7 and 8 of the s135 information request dated 30 August 2018.

[57] Analysys Mason Report, pages 13-15; BT Group's response to the 2018 PIMR and 2018 BCMR Consultations, paragraph 2.41; Openreach's response to the 2018 PIMR Consultation, paragraph 65.
[58] For example, the precise cost difference will depend on the length of lead-ins, on which there is incomplete data. Analysys Mason suggested that a field survey could be beneficial. However, any survey would need to be very significant in scale in order to be representative. Analysys Mason Report, page 12-13.
[59] This analysis focuses on the cost of connecting residential sites with broadband services. For business sites, differences in lead-in costs are likely to be smaller when compared with the value of the contract. Openreach's response to the 2018 PIMR Consultation, paragraph 66.
[60] For the avoidance of doubt, these figures relate to all of Virgin Media's infrastructure (i.e. HFC and FTTP).
[61] Analysys Mason said we had assumed a significantly higher proportion for Virgin Media's infrastructure in comparison to BT infrastructure. See Analysys Mason Report, page 15. While these figures are not precise estimates of the proportion of lead-in types, they do reflect our understanding of the mix of lead-in types based on what BT and Virgin Media have told us.

A3.27 We have identified the following key cost differences between these different lead-in infrastructure types:[62]

a) The cost of deploying the manifold, which joins blown fibre ducts from customer premises to a single upstream blown fibre duct: it costs significantly more to deploy pole-mounted manifolds than it does to deploy manifolds in underground chambers.[63] Given BT's mix of lead-ins includes poles and Virgin Media's does not, this factor alone points to BT's mix of lead-in infrastructure being more expensive than Virgin Media's.

b) The cost of provisioning the lead-in between customers' premises and manifolds: it costs less to provision a new lead-in where an existing underground lead-in is ducted than if it is directly-buried. Given BT and Virgin Media's mix of lead-in infrastructures, these factors point to BT's mix of lead-ins being less expensive than Virgin Media's.

A3.28 These costs point in opposite directions qualitatively. In order to evaluate which of these costs is likely to outweigh the other, we have carried out a simple, illustrative bottom-up calculation.

A3.29 Table A3.5 sets out our cost assumptions, for each type of lead-in infrastructure. We assume that where the existing lead-in is directly buried an access seeker would need to deploy new duct for the lead-in. In practice, the extent of additional cost will depend on how much of the lead-in is directly buried (e.g. whether it is from the distribution point in the street, or from the Toby box at the boundary of the property, and the length of the directly-buried lead-in), and the method used to deploy a new lead-in in such a case.

A3.30 We have information about FTTP deployment costs from several telecoms providers. However, as there are significant differences between these sources, we have chosen to use a single information source to ensure internally consistent estimates. [✂].[64]

Table A3.5: Assumed cost of manifold deployment and lead-in provision, by type of lead-in infrastructure

	Overhead	Underground - ducted	Underground – directly buried
Manifold deployment, per manifold	£100	£15	£15
Lead-in provision, per connection	£160	£160	£230

[62] We have not included any costs associated with enabling works (such as chamber construction and pole upgrade works undertaken during network rollout to facilitate the deployment of manifolds, or duct unblocking to facilitate lead-in provisioning). Whilst the incidence of these activities is uncertain, we do not believe their inclusion would materially alter the outcome of our analysis. [✂]. Moreover, we have not made any assumptions about capacity limitations into our calculation.
[63] As outlined below, we assume that the cost of deploying a manifold on a pole is around £100, and that the cost of deploying a manifold underground is around £15.
[64] [✂].

Source: Ofcom

A3.31 Openreach argued that it is counterintuitive for Virgin Media's lead-ins to be more expensive when its network is typically built much closer to the customer premises.[65] However, the outcome of our analysis (in terms of which of the two cost differences identified above outweighs the other) is insensitive to the average length given the high incidence of non-ducted lead-ins in the Virgin Media network, and the low incidence in the BT network.

A3.32 Analysys Mason considered that an appropriate assumption for the additional cost of deploying where the existing network was directly-buried compared to where the existing network was ducted could be £30 rather than the £70 we assume. However, this estimate is based on a different approach to estimating the cost of deploying the lead-in duct.[66] We acknowledge that the precise magnitude of the cost difference is uncertain. Our illustrative calculation was not intended to precisely quantify the cost difference – rather, it was intended to illustrate that BT is likely to have a more attractive mix of infrastructure for connecting premises. We consider that the assumptions underpinning our estimate of the cost difference are reasonable for this purpose.[67]

A3.33 Moreover, we have assumed that the cost of provisioning overhead lead-ins is the same as using underground duct whereas in practice we understand it could be quicker and/or cheaper to provision overhead lead-ins than underground lead-ins.[68] Were we to reflect this in our illustrative calculation (or in Analysys Mason's), the cost difference would be larger.

A3.34 The overall cost per premises connected (combining the manifold deployment and lead-in provisioning costs discussed in paragraph A3.27 above) will depend on the number of homes served by each manifold, and the penetration achieved by the telecoms provider. In Table A3.6 below, we first show the overall cost per premises for each type of lead-in infrastructure, across different numbers of connections per manifold, and assuming a penetration of 40%. We then combine our estimates of the overall cost per connection for each type of lead-in infrastructure with the information on BT and Virgin Media's mix of lead-in infrastructures to calculate the blended average cost of using BT and Virgin Media's lead-ins.

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[65] Openreach's response to the 2018 PIMR Consultation, paragraph 65; BT Group's response to the 2018 PIMR and 2018 BCMR Consultations, paragraph 2.41.

[66] Analysys Mason has calculated the cost based on assuming £10 of materials, and two hours of labour at £10/hour (with the hourly rate taken from Virgin Media's New Build Handbook). Analysys Mason notes that while the length of Virgin Media's lead-ins would vary, it would expect a high proportion to be short (around 1 metre) in built-up areas. Analysys Mason does not provide evidence to support this; it only provides anecdotal evidence of lead-ins which vary between less than 1 metre to around 6 metres, and acknowledges that there may be longer lead-in lengths in some areas. Analysys Mason also notes that the deployment approaches typically used on walls and across soft ground are significantly lower cost than duct deployment in the access network. See Analysys Mason report, pages 13-15.

[67] We have [✂]. As noted above, we have chosen to use a single information source to ensure internally consistent estimates. Even on Analysis Mason's assumptions, it is still more expensive to use Virgin Media's lead-in infrastructure than BT's.

[68] For example, [✂]. We also note that [✂].

Table A3.6: Overall cost per premises connected, assuming 40% penetration

	Cost per connection			Blended average cost per connection	
Number of premises per manifold at 100% penetration	Overhead	Underground – ducted	Underground – directly buried	BT	Virgin Media
1	£410	£198	£268	£307	[✄]
2	£285	£179	£249	£235	[✄]
3	£243	£173	£243	£211	[✄]
4	£223	£169	£239	£199	[✄]
5	£210	£168	£238	£192	[✄]
6	£202	£166	£236	£187	[✄]
7	£196	£165	£235	£184	[✄]
8	£191	£165	£235	£181	[✄]
9	£188	£164	£234	£179	[✄]
10	£185	£164	£234	£178	[✄]
11	£183	£163	£233	£177	[✄]
12	£181	£163	£233	£175	[✄]

Source: Ofcom

A3.35 These illustrative calculations suggest that the cost of using BT’s lead-in infrastructure is lower than the cost of using Virgin Media’s lead-in infrastructure, on average. The higher costs of deploying manifolds overhead are more than offset by the lower costs associated with provisioning lead-ins using BT’s mix of lead-in infrastructure.

A3.36 As the average number of premises per manifold would probably be comparable with BT’s copper distribution points at around [✄], this suggests that using Virgin Media’s lead-in infrastructure could be around [✄]% more expensive than using BT’s.[69]

Comparison of other characteristics of BT and Virgin Media’s infrastructure

A3.37 There are a number of other characteristics of network infrastructure that may be relevant to access seekers purchase decision. However, we have little evidence on the extent to

[69] If we were to use Analysys Mason’s assumption for the additional cost of deploying where the existing network was directly-buried (£30 rather than the £70), this would suggest that Virgin Media’s lead-in infrastructure would be around [✄]% more expensive than using BT’s. However, if we also assumed that the cost of provisioning overhead lead-ins were, for example, £30 cheaper than using underground duct, the cost difference becomes [✄]% using our £70 assumption, and [✄]% using Analysys Mason’s £30 assumption.

which these characteristics are important for access seekers, and on whether either infrastructure has an advantage in terms of those characteristics:

a) BT ducts are installed deeper and may be better installed than Virgin Media's, based on the cycle of renewal, but this is uncertain.

b) It is unclear whether either infrastructure is in a better state of repair.

c) It is unclear whether either provider has better or more accessible duct records.

d) BT offers greater pre-existing interexchange connectivity, and potentially more space within exchanges for hosting.

e) BT may have scale and scope advantages from being a UK-wide vertically integrated multi-service network operator, such as being able to maintain and adjust its physical infrastructure to facilitate access.

f) It is unclear whether either infrastructure has more capacity in its network for access seekers. In its response to the 2018 PIMR Consultation, [✂].[70] It also considered [✂].[71]

g) [✂].[72]

[70] [✂].
[71] [✂].
[72] [✂].

A4. Evidence of telecoms physical infrastructure coverage

A4.1 This annex outlines the coverage of telecoms physical infrastructure operators, and potential entry and expansion. This supports our assessment of significant market power.

Measuring coverage

A4.2 In relation to coverage of residential premises we use premises passed.

A4.3 To assess the presence of alternative infrastructure to business customer sites we consider three infrastructure indicators, each of which give an indication of the intensity of competition:[73]

a) Proportion of businesses with X rival networks within 50m.

b) Proportion of 2017 new customer ends with existing duct connections.

c) Average distance from business sites to nearest rivals.[74]

A4.4 We also consider the propensity of rival infrastructures to build when seeking to connect a customer who is not already duct connected relative to purchasing an active wholesale leased line product from BT to fulfil the connection. We refer to this as ‘build vs buy’. We calculate ‘build’ (on-net dig) as a percentage of ‘build’ (on-net dig) plus ‘buy’ (off-net) in relation to the supply of a leased line to a customer’s site outside their existing network reach.

A4.5 For assessing the direct constraint, what matters is the coverage of telecoms physical infrastructure which can be used by third party access seekers, rather than coverage that can only be used by the network infrastructure owner (for example, where cables are direct buried, or where there is no spare capacity). However, as the usability of the existing telecoms physical infrastructure is uncertain, we cannot report such adjusted figures, so instead we report total coverage.

National coverage of telecoms physical infrastructure operators

BT and Virgin Media

A4.6 BT passes nearly all [✂]% premises in the UK (excluding Hull area).

[73] All distances measured by the infrastructure indicators are radial distances. Annex 12 sets up how we measure the distances used in the Network Reach analysis and distance to nearest rivals and Annex 11 sets out our analysis of distances dug by telecoms providers in 2017. Volume 2, paragraph 6.58 explains why we use these metrics.

[74] As explained in Annex 12 we have considered the proximity of rival telecoms infrastructure providers’ networks to customer circuit ends connected in 2017 to give an insight into the distances rivals would potentially have to dig to provide leased lines to customers.

A4.7 Virgin Media passes [✂]% of premises in the UK (excluding Hull area). We show the availability of Virgin Media's network by its coverage of individual postcode sectors below.

Figure A4.1: Premises passed by Virgin Media in each postcode sector

[✂]

Source: Ofcom analysis of Connected Nations December 2018 data.

A4.8 We note that Virgin Media's coverage varies by postcode sector. As explained in paragraph 3.111, we consider Virgin Media to be present in postcode sectors where its coverage is greater than [✂]% [30-80]%. On this basis, Virgin Media is present in [✂] % of postcode sectors.

Table A4.2: Premises passed by Virgin Media in each postcode sector

[✂]

Small multi-service networks

A4.9 There are a number of other infrastructures with very low overall premises coverage, but which have sufficient coverage to be present in a small number of postcode sectors. These are outlined in the table below. We note that the majority of these instances are in [✂].[75]

Table A4.3: Premises passed by other end-to-end telecoms providers [✂]

	Hyperoptic	OFNL	Gigaclear	CityFibre	B4rn	Cablecom Gilde	Callflow	WightFibre
Proportion of UK premises passed	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%
[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]

Coverage of large business sites and mobile sites

A4.10 A number of providers have built networks which focus on connecting to large business sites and mobile sites. See Volume 2, Figure 5.3 for a map outlining these areas, and Volume 2, Table 5.4, for a table outlining the proportion of postcode sectors, and proportion of all large business and mobile base stations based on the number of rival leased line networks present.

A4.11 In addition, below we present the number of large business and mobile sites to which each individual infrastructure is within 50m in the UK excluding Hull area. This is generally low.

[75] [✂].

Table A4.4: Proportion of large business and mobile sites which can be served within 50m for each rival leased line network in the UK excluding Hull area

Virgin Media	CityFibre	Colt	Interoute	Level3	SSE	Verizon	Vodafone	Zayo
[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%

Coverage within our geographic markets

Alternative Multi-service Network areas

A4.12 BT covers almost every [✂]% premises in these areas.

A4.13 Virgin Media's network covers [✂]% of premises in these areas. The graph below shows the proportion of postcode sectors in Alternative Multi-service Network areas where Virgin Media's coverage is between a certain level.

Figure A4.5: Virgin Media coverage by postcode sector in the Alternative Multi-service Network areas

[✂]

Contiguity analysis of Virgin Media's coverage

A4.14 In paragraphs 3.163 to 3.169, we set out our view that a ubiquitous infrastructure is likely to be preferred by access seekers to alternative telecoms physical infrastructure which is not ubiquitous. In this analysis, we assess extent to which there are any sufficiently large areas of Virgin Media's coverage which are near-ubiquitous.

A4.15 We therefore group postcode sectors where Virgin Media passes over 90% of premises into contiguous clusters (i.e. geographically adjacent to each other).[76] In this analysis, we require this high level of coverage in every postcode sector to be included within a cluster. On this threshold:

[76] The way contiguity is estimated means there is a margin of error such that there may be postcode sectors included in a cluster which are close to each other, but not contiguous. This can arise from postcodes being used for premises located far apart (up to +300km, in extreme cases). These may correspond to errors in the source data. This may slightly overstate the extent to which the postcode sectors where Virgin Media covers over 90% of all postcode sectors are in contiguous clusters.

a) Openreach argued that using 90% as the threshold for assessing the contiguity of Virgin Media coverage was too high, as Virgin Media's own level of average coverage demonstrated this was not necessary.[77] However, as we explain in 3.164 and 3.165, even if it is *possible* for an access seeker to deploy to its desired number of premises using a non-ubiquitous infrastructure, using a ubiquitous infrastructure is likely to have material advantages.

b) Analysys Mason argued that we should perform a sensitivity on this threshold, for example by testing lower thresholds of premises passed.[78] However, the purpose of this analysis is to identify areas where Virgin Media has near-ubiquitous coverage. Clearly, using a lower threshold would likely increase the size of the contiguous clusters we find, but Virgin Media's coverage within these clusters would not be ubiquitous.[79]

A4.16 For the purposes of this analysis, we include postcode sectors in the HNR areas and the CLA where Virgin Media has over 90% premises coverage. This ensures that the we do not understate the contiguity of Virgin Media coverage as a result of our geographic market delineations, and that the order in which we determine the geographic market in which a particular postcode sectors lies does not affect this analysis.[80]

A4.17 We have calculated the number of premises and the proportion of those premises passed by Virgin Media in each cluster. We have also calculated the number of large business and mobile sites within each cluster, and the proportion of these within 50m of Virgin Media's network.

A4.18 Table A4.6 below shows the size and coverage available in these clusters. It shows that:

a) The majority of such areas are relatively small.[81]

b) In [✂] of these clusters which contain more than [✂] premises, the coverage of large business and mobile sites is lower than the coverage of all premises.

Table A4.6: Virgin Media coverage in clusters of postcode sectors where it passes more than 90% of premises in each postcode sector

[✂]

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[77] Openreach's response to the 2018 PIMR Consultation, paragraph 64.
[78] Analysys Mason Report, page 9. It also suggested that we should apply sensitivities to the ratio of broadband premises coverage to large business and mobile cell sites coverage – however, we do not apply any threshold based on coverage of large business and mobile cell sites in a postcode sector to identify contiguous clusters. Indeed, were we to apply a second threshold based on the coverage of large business and mobile cell sites in a postcode sector, it is likely that we would find smaller clusters.
[79] Indeed, there may be an argument for using a threshold higher than 90%. In this respect, we note that Virgin Media's coverage is greater than 95% in [✂]% of postcode sectors in the Alternative Multi-service Network area.
[80] Where Virgin Media passes more than [✂]% [30-80]% and two alternative (non-BT) infrastructures can serve within 50m of more than 65% of large business and mobile cell sites, it is defined as an HNR area or CLA. There are [✂] postcode sectors where Virgin Media passes more than 90% of premises which we define as an HNR area or the CLA.
[81] [✂]% of premises in postcode sectors where Virgin Media has over 90% coverage are in clusters of contiguous postcode sectors with less than [✂] premises. Indeed [✂]% of premises in postcode sectors where Virgin Media has over 90% coverage are in postcode sectors which are not contiguous with any other postcode sector with over 90% coverage.

Source: Ofcom analysis of Connected Nations December 2018 data

A4.19 We find [✂] where Virgin Media has contiguous high coverage which contains more than [✂] premises. However, even in [✂] we consider access seekers would find BT more attractive than Virgin Media.[82]

Figure A4.7: [✂]

[✂]

A4.20 The previous analysis seeks to find geographic areas where Virgin Media's high coverage is most contiguous. In reality, these are unlikely to match the deployment areas desired by potential access seekers. As such, we have also assessed the contiguity of Virgin Media's coverage in each of 183 urban areas (with at least 20,000 premises).[83] We find that:

a) Virgin Media's network passes some premises in [✂]% of these urban areas, on average covering [✂]% of premises within those clusters.

b) Virgin Media's network covers at least 90% of premises in [✂]. This analysis suggests that the majority of clusters found by our postcode sector contiguity analysis do not map to entire urban areas, and so may not correspond to desired deployment areas from access seekers.

Figure A4.8: Urban areas in the UK where Virgin Media passes at least 90% of premises

[✂]

Source: Ofcom analysis of Connected Nations January 2018 data

HNRs and CLA

A4.21 To assess the proximity of alternative infrastructures for the provision of leased lines connections, we consider the indicators explained in A4.3 above. We also consider the average number of rivals within 50m of large business and mobile sites, which provides a useful indication of the degree of rival infrastructure available close to customer sites in a particular geographic area.

[82] [✂] Virgin Media's coverage of large business and mobile sites [✂] is lower than its coverage of premises. [✂].

[83] We use Ordnance Survey's premises and postcodes polygons data to identify clusters of at least 20,000 premises within urban areas. We filter out non-urban areas by excluding postcode polygons that are larger than 100,00m^2. We identify 183 such clusters, which are shown in grey on the map below. This analysis is based on Connected Nations January 2018 data.

Table A4.9: Proximity of alternative infrastructures to large business sites and mobile sites

		CLA[84]	HNR areas
Average # of rival networks within 50m		4.3	2.4[85]
Proportion of businesses with X rival networks within 50m	X=0	4%	4%
	X=1	6%	12%
	X=2	9%	44%
	X=3	17%	26%
	X=4	18%	9%
	X=5	17%	4%
	X=6	14%	1%
	X=7	10%	
	X=8	3%	
	X=9	1%	
% of businesses with at least 2 rivals		90%	84%
Average distance to closest rival network		16m	21m[86]
Average distance to individual rival network closest on average		[✂][87]	n/a
Openreach's proportion of 2017 new customer ends already ducted		[✂]% [91-100]%	[✂]% [91-100]%
Rival's proportion of 2017 new customer ends already ducted		76%	57%
Rivals build vs. buy		11%	22%

Source: Ofcom's network reach analysis and circuit data analysis for Volume 2 – BCMR Statement. Annex 12 provides a more detailed description and explanation of the analysis undertaken.

Geographic coverage of individual infrastructures within HNR areas

A4.22 The majority (64%)[88] of HNR postcode sectors have a single infrastructure within 50m of at least 80% of large business and mobile sites.

A4.23 109 HNR postcode sectors (36%[89] of all HNR postcode sectors) have a single infrastructure within 50m of every large business and mobile site. In [✂] of these, [✂] is within 50m of every large business and mobile site.

A4.24 [✂] has the highest (or in some cases joint-highest) coverage of any rival infrastructure provider in the majority [✂]% of HNR postcode sectors.

A4.25 Table A4.10 below shows the proportion of large business and mobile sites in HNR areas that each alternative infrastructure can serve within 50m.

Table A4.10: Proportion of large business sites and mobile sites in HNR areas within which each infrastructure can serve within 50m

Virgin Media	CityFibre	Colt	Interoute	Level3	SSE	Verizon	Vodafone	Zayo
[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%

A4.26 Table A4.11 below shows further proximity indicators in HNR areas for [✂].

Table A4.11 [✂]

[✂]

Source: Ofcom's network reach analysis and circuit data analysis for Volume 2 – BCMR Statement.

A4.27 Table A4.12 below shows the proportion of postcode sectors where each individual infrastructure is within 50m of a given proportion of large businesses and mobile sites. This shows that [✂] have relatively ubiquitous coverage of large business and mobile sites within a material proportion of HNRs.

Table A4.12: Proportion of HNR postcode sectors where each operator is within 50m of at least X% large business and mobile sites

X%	Virgin Media	CityFibre	Colt	Interoute	Level3	SSE	Verizon	Vodafone	Zayo
[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%
[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%
[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%
[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%

Geographic coverage within the CLA

A4.28 The majority (89%) of CLA postcode sectors have a single infrastructure within 50m of at least 80% of large business and mobile sites.

[84] See BCMR Table 6.9 for CLA figures.
[85] See BCMR Table A12.26.
[86] See BCMR Table A12.25.
[87] This is [✂] network.
[88] 91% of HNR postcode sectors which contain large business or mobile sites. (There are some HNR postcode sectors which do not contain any large business or mobile sites.)
[89] 50% of HNR postcode sectors which contain large business or mobile sites.

A4.29 In 74% of postcode sectors in the CLA at least one alternative infrastructure is within 50m of all large business and mobile sites; in 52% of postcode sectors at least two alternative infrastructures are within 50m of all large business and mobile sites.

A4.30 Table A4.13 below shows the proportion of large business and mobile sites in the CLA that each alternative infrastructure can serve within 50m.

Table A4.13: Proportion of large business and mobile sites in the CLA within which each infrastructure can serve within 50m

Virgin Media	CityFibre	Colt	EU	Interoute	Level3	SSE	Verizon	Vodafone	Zayo
[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%

A4.31 Table A4.14 below shows further proximity indicators in the CLA for [✂].

Table A4.14: [✂]

[✂]

Source: Ofcom's network reach analysis and circuit data analysis for Volume 2 – BCMR Statement.

A4.32 Table A4.15 below shows the proportion of postcode sectors where each individual infrastructure is within 50m of a given proportion of large businesses and mobile sites.

Table A4.15: Proportion of CLA postcode sectors where each operator is within 50m of at least X% of large business and mobile sites

X%	Virgin Media	CityFibre	Colt	EU	Interoute	Level3	SSE	Verizon	Vodafone	Zayo
[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%
[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%
[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%
[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%	[✂]%

Potential entry and expansion

A4.33 As we explained in paragraphs 3.200 – 3.202 we noted that some operators are considering entry or expansion. This is outlined in table A4.16 below.[90]

Table A4.16: Planned full-fibre network deployments

Operator	Current/planned full-fibre network deployments
Virgin Media	Continuing to expand its network via its Project Lightning, aiming to expand its network to an additional four million premises by 2020, of which two million will be full fibre. Some of this will be infill to its existing footprint areas.[91]
CityFibre	Plans to connect five million homes to full fibre, expanding its network in 37 towns and cities where it already has fibre spine.[92]
TalkTalk	Through FibreNation, has an ambition to reach three million homes with full fibre by 2025.[93]
Hyperoptic	Plans to expand its network to reach two million homes passed by 2021 and 5 million homes passed by 2024.[94]
Gigaclear	Plans to connect 500,000 premises by 2022 in rural areas.[95]
Community Fibre	Currently focused on council homes in London, it plans to connect 500,000 premises by 2022, and more than 1 million premises by 2025.[96]
County Broadband	Plan to deploy FTTH to 30,000 premises across the East of England.[97]
Trooli (CallFlow)	Plan to cover 26,000 premises in rural Kent by mid-2019.[98]

[90] Leased line operators have also suggested that they would consider further expansion of their networks. [✂].
[91] ISP Review, 2018. *Who is Building – UK Summary of Full Fibre Broadband Plans and Investment UPDATE15.* https://www.ispreview.co.uk/index.php/2018/04/building-uk-summary-fttp-broadband-rollouts-investment.html [accessed 3 May 2019].
[92] CityFibre, 2018. CityFibre announces a £2.5bn investment plan to expand its full fibre network and unlock the UK's next generation broadband. https://www.cityfibre.com/news/cityfibre-announces-2-5bn-investment-plan-expand-full-fibre-network-unlock-uks-next-generation-broadband/ [accessed 3 May 2019] and CityFibre, 2018. CityFibre puts in place a debt package of £1.12 billion to underpin capital investment in full fibre across UK towns and cities. https://www.cityfibre.com/news/cityfibre-puts-place-debt-package-1-12-billion-underpin-capital-investment-full-fibre-across-uk-towns-cities/ [accessed 3 May 2019].
[93] TalkTalk. *TalkTalk launches new company FibreNation*. https://www.talktalkgroup.com/articles/talktalkgroup/TalkTalk-launches-new-company-FibreNation [accessed 3 May 2019].
[94] Hyperoptic, *Hyperoptic raises strategic investment from Mubadala Company and announces additions to its Senior Leadership Team* https://www.hyperoptic.com/press/posts/hyperoptic-raises-strategic-investment-from-mubadala-investment-company-and-announces-additions-to-its-senior-leadership-team/ [accessed 3 May 2019].
[95] Gigaclear, About. https://www.gigaclear.net/about [accessed 3 May 2019].
[96] https://www.ispreview.co.uk/index.php/2018/04/building-uk-summary-fttp-broadband-rollouts-investment.html/2, accessed 10 May 2019.
[97] ISP Review, 2018. Who is Building – UK Summary of Full Fibre Broadband Plans and Investment UPDATE15. https://www.ispreview.co.uk/index.php/2018/04/building-uk-summary-fttp-broadband-rollouts-investment.html [accessed 3 May 2019].
[98] ISP Review, 2018. New Full Fibre Broadband ISP Trooli Starts Rural UK Rollout in Kent. https://www.ispreview.co.uk/index.php/2018/06/new-full-fibre-broadband-isp-trooli-starts-uk-deployment-in-kent.html [accessed 10 May 2019].

WightFibre	Plans to cover 53,000 homes on the Isle of Wight by the end of 2020.[99]
Truespeed Communications	In Southwest England, plans to cover 75,000 premises by 2021, and would like to see 200,000 premises passed by 2025.[100]
Glide (previously WarwickNet and CableCom)	Plan to deploy to 200,000 premises by the end of 2020 in the Coventry and Warwickshire area.[101]
Toob	Plans to deploy to 100,000 premises in Southampton by the end of 2021, and reach 1 million UK premises within the next 10 years.[102]

[99] Wightfibre. A different kind of broadband…Gigabit Broadband. https://www.wightfibre.com/gigabit-island/ [accessed 10 May 2019].
[100] ISP Review, 2018. Truespeed CEO – We Hope to Reach 200,000 UK Premises with FTTP. https://www.ispreview.co.uk/index.php/2018/05/truespeed-ceo-we-hope-to-reach-200000-uk-premises-with-fttp.html/2 [accessed 10 May 2019].
[101] ISP Review, 2018. Who is Building – UK Summary of Full Fibre Broadband Plans and Investment UPDATE15. https://www.ispreview.co.uk/index.php/2018/04/building-uk-summary-fttp-broadband-rollouts-investment.html/2 [accessed 3 May 2019].
[102] Toob. Southampton to become a gigabit city thanks to toob's £50m full fibre investment. https://www.toob.co.uk/wp-content/uploads/2019/05/toob-press-release-Southampton-launch-8-May-2019.pdf [accessed 10 May 2019] and Toob. Toob raises £75 million to fund initial full fibre broadband rollout. https://www.toob.co.uk/wp-content/uploads/2019/05/toob-secures-75m-investment.pdf [accessed 10 May 2019].

A5. Adverse effects of the physical infrastructure access remedy

Introduction

A5.1 In Section 5 we set out that we consider that in this review period any adverse effects arising from the imposition of our physical infrastructure access remedy are not disproportionate to our overall aim since the benefits that accrue outweigh any such effects.

A5.2 In this annex, we present our detailed assessment of the potential adverse effects that we considered in order to inform our assessment of the proportionality of our remedy.

A5.3 We have considered the following potential adverse effects:

a) **Impact on dynamic efficiency**: We consider the potential for our Physical Infrastructure Access (PIA) remedy to adversely affect the investment incentives of BT and other telecoms operators.

b) **Impact on Openreach's pricing structures**: We consider the potential for the unrestricted PIA remedy to collapse the bandwidth gradient which could lead to inefficient common cost recovery.

c) **Cost of competition**: We recognise that competition could lead to some duplication of costs which could put upward pressure on industry average costs.

d) **Additional costs and resource requirements imposed on Openreach**: We consider the cost and resource required for Openreach to develop the PIA product.

e) **Impact on competitive markets**: We consider the effect of a PIA remedy on some markets which we already deem competitive.

f) **Externalities caused by our approach to network adjustment costs**: We consider whether our approach to the recovery of network adjustment costs might give rise to adverse effects.

Impact on dynamic efficiency

A5.4 In developing our PIA remedy, we have sought to enhance the investment incentives, both of BT, and of other telecoms providers. We have considered incentives to invest in both residential broadband markets and business connectivity markets.

Impact on end-to-end telecoms providers other than BT

A5.5 An effective PIA remedy will reduce the absolute costs and time required to build ultrafast broadband networks, and we expect that this will encourage competitors to invest in their own networks. We have considered what effect this will have on existing end-to-end competition (i.e. where competitors build their networks from scratch, including building their own physical infrastructure), for both broadband and business markets.

A5.6 We recognise that existing end-to-end competitors which have already deployed networks by building their own physical infrastructure may face a more competitive environment in certain areas, which could affect their ability to retain some of their customers without adjusting prices. However, at the same time, an effective PIA remedy provides these telecoms providers with opportunities to expand their networks at lower cost and more quickly, allowing them to compete in other areas where it would not be viable to deploy their own physical infrastructure. Given the higher costs and time required to build a new network from scratch, the scope for end-to-end network competition is much more limited than the scope for network competition based on PIA. Therefore, to the extent our remedy displaces some end-to-end competition, this is likely to be small, and far outweighed by the significant benefits of realising network competition based on PIA in potentially many more geographic areas.

A5.7 We observe that all existing network competitors who replied to our 2018 PIMR Consultation supported our proposals to give operators improved access to BT's physical infrastructure and some are already exploring the role that PIA can play in their network expansions.[103] This includes leased-lines-only operators, who have also generally been positive about the opportunities from unrestricted duct access. We discuss later the impact in already competitive markets.

Impact on BT's incentives to invest

A5.8 We consider that BT's SMP in physical infrastructure has been a factor in limiting network investment. As noted above, we expect that the unrestricted PIA remedy will encourage competitors to invest in their own networks. We observe that it has been competition which has previously incentivised BT to invest in upgrading its services and we expect competition, or the threat of competition, to continue to incentivise BT to invest.

A5.9 In the early 2000s, one of the factors that drove BT to increase the performance of its broadband service was the availability of cable broadband. Then, following the introduction of LLU, we saw innovation around the electronic equipment deployed and the capacity of broadband connections. Research has confirmed that promoting access to LLU led to faster broadband speeds.[104] Similarly, BT announced its rollout of superfast broadband shortly after Virgin Media's upgrade to DOCSIS 3.0.[105] Further, BT's more recent decision to invest in G.fast was in the context of Virgin Media at the time offering a maximum service speed of 200 Mbit/s, compared to 80 Mbit/s, which is the current maximum offering on BT's FTTC connections.

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[103] These include, [✂].

[104] Nardotto, M., Valletti, T., and Verboven, F., 2015. Unbundling the incumbent: evidence from UK broadband. Journal of the European Economic Association. 2015, vol.13, issue 2, 330-362.

[105] Ofcom, 2016. *Making Communications work for everyone: Initial conclusions from the Strategic Review of Digital Communications*, paragraph 4.11. https://www.ofcom.org.uk/__data/assets/pdf_file/0016/50416/dcr-statement.pdf.

A5.10 While we have seen some benefits from the network competition that already exists between BT and Virgin Media, we consider that a greater degree of network competition – in terms of the number and geographic coverage of competing networks – will drive a material change in outcomes. Greater network competition, enabled by our PIA remedy, will open up more of the value chain to more effective competition than is the case under current wholesale access remedies.

Impact on BT's cost recovery

A5.11 By allowing telecoms providers to use PIA for business connectivity services, this should have the effect of increasing the competitive pressure on BT's business connectivity wholesale active products, especially in geographies where these are currently subject to limited or weak competition. Similar to broadband markets, we expect competition, or the threat of competition, to incentivise BT to invest in upgrading its services.

A5.12 As a result of competition, Openreach might see a reduction in its leased lines volumes which could affect BT's ability to recover its costs from regulated products.[106] If BT does not have a fair opportunity to recover the costs of its previous investments, it could undermine its incentives to make future investments.

A5.13 In Annex 18 of this statement we set out our short-term projections of Openreach's leased line volumes that we anticipate may be lost to telecoms providers taking advantage of the unrestricted PIA remedy. We conclude that even the upper-bound of our projected volume losses, were they to occur, would not be large enough to affect our leased lines charge control in this market review period.

A5.14 While our short-term volume projections are small enough not to affect the leased lines charge control, over the longer term they could be more significant. However, any implications this may have for BT's cost recovery are matters that can be considered when determining the regulatory arrangements that will apply from 2021. We will consider the most appropriate approach to ensure that BT has an opportunity to recover its efficiently incurred costs as any cost recovery impacts become clearer. We set out our high level principles on how we anticipate that we might approach this in Section 7.

Impact on Openreach's pricing structures

A5.15 We have considered the impact that widespread use of the PIA remedy we are imposing (including for leased lines) could result in Openreach having to change its existing pricing structure. The current pricing structure set by Openreach involves it recovering its common costs across different services, with a higher share of common costs is recovered from higher bandwidth leased lines. 107 Higher pricing of higher bandwidth services is called the bandwidth gradient. We acknowledge that in theory a bandwidth gradient can allow a more efficient recovery of common costs relative to a flat pricing structure.

[106] Alternatively, it may reduce prices to maintain market share but with the same effect.
[107] Common costs are those costs that do not vary with output and are common to two or more products or services, which cannot be avoided except by closure of all the activities to which they are common.

A5.16 In general, when imposing wholesale access remedies in market reviews, Ofcom has given BT flexibility in setting prices in the hope that this would lead BT to recover its common costs relatively efficiently. However, taking regulatory measures in order to encourage relatively efficient pricing in circumstances where competition is absent does not imply that it is desirable to restrict (or avoid promoting) competition simply in order to preserve BT's ability to set prices flexibly. The purpose of the PIA remedy is to subject BT and the decisions it makes to substantially greater competition and contestability. We accept that the presence of effective competition will mean Openreach will have less control over pricing; that is a natural and desirable constituent of a more competitive market.

Cost of competition

A5.17 Our strategy is for everyone in the UK to enjoy fast, reliable broadband services. Over time, we would expect that most consumers and businesses will move from 'superfast' to 'ultrafast' broadband, based increasingly on competing networks. Inevitably, our strategy for competing networks will entail some duplication of costs, which could put upward pressure on average costs.

A5.18 However, a competitor using PIA to deploy a competing network will most likely deploy a full-fibre network. This is not a simple duplication of the existing network that still relies partly on a copper connection, it is a new means of offering broadband that offers a number of advantages, including much higher speeds and improved service quality.

A5.19 In any case, in this review period, we expect any impact from fixed cost duplication to be small given the natural constraints on build rates associated with mass broadband deployments and a period of familiarisation of the remedy for leased lines only operators.

A5.20 Over the longer term the impact may become more significant if BT's competitors roll out networks on a much larger scale. However, in the long-term we expect the existing copper network will anyway need to be supplemented with new technologies, such as full-fibre, and this process of network upgrade will involve simultaneous provision of the current copper network and full-fibre. There is therefore likely to be duplication of copper and full-fibre, whether PIA is used to provide the new technologies or not. The PIA remedy helps reduce the scale of fixed cost duplication by allowing new networks to use BT's ducts and poles, significantly lowering the extent of replication of fixed costs.

Additional costs and resource requirements imposed on Openreach

A5.21 Openreach incurs costs in setting up and managing the PIA product, and processing individual PIA orders. We refer to these costs as 'productisation' costs. In the 2018 WLA we decided that these costs should be recovered across all SMP products that use the physical infrastructure (including PIA).

A5.22 The vast majority of these costs can therefore be considered sunk and so not relevant for this analysis of the costs and benefits of introducing unrestricted PIA in this consultation. We do not expect BT to incur any material additional costs adapting the remedy for unrestricted use. Accordingly, we expect our current proposal would require minimal, if any additional development costs beyond those already incurred.

A5.23 We recognise our remedy includes a requirement on Openreach to make adjustments to its network where this is necessary for its physical infrastructure network to be available to telecoms providers for the purpose of deploying their own networks. In some cases, Openreach would have to undertake this work in any event to maintain its network, albeit the request under PIA may bring forward the timing of this work. Notwithstanding these cases, we recognise that the requirement could have a material impact on Openreach, both in terms of the resources required to carry out the civil works, and the costs associated with these adjustments. We already allow Openreach to recover these costs across all users of the infrastructure. With respect to the resource requirements, we recognise that over time Openreach could see a significant step up in the volume of civil works it is required to undertake or oversee. Openreach may need to expand its workforce, for example, by hiring more network planners and field engineers.

A5.24 However, we consider that the resource burden is sufficiently predictable for Openreach to manage without any significant adverse impact, for three reasons:

a) First, any increase in the requests for network adjustments for mass broadband deployments will be gradual, given the natural constraints on build rates and the time that it will take for telecoms providers to increase their roll-out to the maximum deployment rate.

b) Second, any increase in the requests for network adjustments for leased lines will be gradual as telecoms providers familiarise themselves with the remedy.

c) Thirdly, the PIA Reference Offer includes conditions for the provision of forecasts by telecoms providers in respect of their future requirements for PIA, to assist Openreach to plan its resources.

A5.25 We also observe that requests for Openreach to relieve congested sections in its infrastructure will only arise where other telecoms providers are using PIA to deploy competing networks. Therefore, the scale of the impact on Openreach is contingent on the scale of network deployment, and so is directly linked to the scale of the benefits that result from imposing the PIA remedy.

Impact on competitive markets

A5.26 As discussed in Section 5, Volume 1, in its response to the 2018 PIMR Consultation, BT Group, Colt and Openreach expressed concerns that unrestricted PIA could impact deregulated services and areas that are already competitive, in particular business connectivity services in the Central London Area (CLA).[108]

A5.27 By introducing an additional means of supplying leased lines in the CLA we expect that unrestricted PIA will result in some increase in downstream leased line competition. This

[108] BT Group’s response to 2018 PIMR Consultation, paragraphs 1.2, 1.4-1.5, 2.1-2.4, 2.22-2.25; Colt’s response to the 2018 PIMR Consultation, page 2; Openreach’s response to the 2018 PIMR Consultation, paragraphs 37-38, 70 and 126-130

may have benefits for customers through lower prices and better services. It could also be argued that this same impact is detrimental to those operators who have significant sales of service in the CLA, such as BT and Colt, and could undermine their incentives to make future investments. However, duct access will also reduce alternative operators' costs of supply, enabling them to compete better where they do not have an existing connection.

A5.28 In particular, as noted in Annex 6, we expect that some rivals may deploy in-fill network extensions using the unrestricted PIA remedy in the CLA given the high number of networks already present and high business density.[109] However, we do not consider that the impact of unrestricted PIA will render the remedy disproportionate, particularly when set against the benefits of an unrestricted remedy in other markets where BT has SMP. BT Group, Colt and Openreach did not provide evidence to the contrary.

A5.29 We have also considered the potential impact of the PIA remedy on some inter-exchange and backhaul markets, that we already consider competitive.

A5.30 With respect to inter-exchange backhaul markets, we do not consider that the remedy will have a material impact on existing competition. This is because the distances between the exchanges and the existence of competing wholesale providers of backhaul means that investment in further capacity is unlikely to be commercially attractive, so to the extent there is any impact it is likely to be minimal.

Externalities caused by our approach to network adjustment costs

A5.31 Currently, Openreach recovers network adjustment costs over all users of the infrastructure subject to a financial limit. We think this is necessary to promote competition by reducing barriers to investment in competing networks, including ensuring a level playing field with respect to the recovery of these costs.

A5.32 Under the unrestricted PIA remedy, Openreach will continue to recover network adjustment costs over all users of the infrastructure.

A5.33 We consider below whether our approach to the recovery of network adjustment costs might give rise to adverse effects which are disproportionate compared to our objectives. We have considered the following potential adverse effects:

a) The risk of promoting inefficient entry;

b) The risk of encouraging inefficient network adjustments;

c) The risk of distorting competition;

d) The financial impact on Openreach; and

e) The impact on consumers.

[109] In Annex 6 we also set out that bespoke network extensions will be limited and, while using unrestricted PIA for mass roll-out could begin in this review period in any area, its main competition impact is likely to be beyond the timeframe of this review period.

A5.34 In general, as noted above, the impact of our approach to cost recovery is likely to be limited within this market review period given the natural constraints on build rates associated with mass broadband deployments and the learning curve that builders of leased lines go through as they familiarise themselves with the remedy.

A5.35 In the longer term, we recognise that the impact of our approach is likely to be more significant. However, any requests for network adjustments will only arise where other telecoms providers are using PIA to deploy competing networks. Therefore, the scale of any impacts is contingent on the scale of network deployment, and so is directly linked to the scale of the benefits that result from imposing the PIA remedy. As a result, we consider that any adverse impacts are more likely to be justified by significant benefits to consumers in the longer term from greater network competition. In any event, we also have the flexibility to modify aspects of the PIA remedy in the future, in light of evidence and experience.

Risk of promoting inefficient entry

A5.36 We recognise that our approach to cost recovery may result in competing network build occurring in circumstances where the build would not be profitable if access seekers had been charged for the network adjustments and such build may not be productively efficient.

A5.37 However, we are requiring BT to provide access to its physical infrastructure with the aim of promoting competition and investment in rival networks, in the context of BT's substantial incumbency advantages. Our approach to the recovery of network adjustment costs is necessary to support this objective. We anticipate significant dynamic benefits to consumers where actual network competition emerges, which are not taken into account in the profit evaluations of potential entrants. This means that even if our approach does entail some degree of productive inefficiency, that does not mean our approach is inappropriate.

A5.38 While the dynamic benefits we expect to arise as a result of promoting greater network competition cannot be readily or reliably quantified, we consider it likely that they will far exceed the likely costs of network adjustments. We have also introduced a financial limit to provide a greater degree of certainty around the costs of network adjustments.

Risk of encouraging inefficient network adjustments

A5.39 We recognise that there is a risk that telecoms providers may have a weaker incentive to minimise requests for network adjustments than under any approach where they faced some cost of network adjustments. However, we do not consider this to be a significant risk, as the ability for telecoms providers to obtain inefficient adjustments is limited by the network access obligation. This is due to the following reasons:

a) Openreach is only required to make network adjustments that are necessary, feasible, and where making the adjustment is more efficient than it would be for the telecoms provider to build its own network asset to circumvent the unusable section of Openreach's infrastructure.

b) Openreach can also suggest alternative, more efficient routings, and has the flexibility to choose the most efficient solution to meet its obligation. This also enables Openreach to take into account its own future requirements, potentially avoiding the need for further adjustments at a later date.

A5.40 We recognise that by imposing a financial limit on the network adjustment costs to recover across all users of the infrastructure, Openreach could have a reduced incentive to keep costs under the financial limit, to dissuade telecoms providers from requesting network adjustments. However, by setting the financial limit at a level which should include the cost of all adjustments other than those that are exceptionally high cost, and because there are some limitations on Openreach's ability to inflate costs, we are of the view that this will not be an issue in the majority of circumstances. We also consider that the risk of setting the financial limit too low is outweighed by the risk of no financial limit. In addition, we have reserved direction making powers to adjust the financial limit if it proves necessary.

Risk of distorting competition

A5.41 We have considered if our approach to network adjustments costs would distort Openreach's competitive position, compared to other network providers which did not face the same obligation.

A5.42 We have previously estimated that the impact of recovering network adjustment costs (including those to support BT's own deployments) over all users of infrastructure to be around 14 pence per line per year on average, which would amount to a very small increase in Openreach's prices.[110] We set out in Section 7, Volume 1, that extending the requirement for Openreach to make network adjustments for leased lines only deployment would cost around £[✂] (£0.24m – £1.3m). We consider these costs are immaterial, representing less than 0.2% of Openreach's physical infrastructure cost base.

A5.43 These small increases in prices are unlikely to affect Openreach's ability to compete, particularly given its SMP. However, the impact of our decision and objective of the unrestricted PIA remedy is that other telecoms providers will be able to compete more effectively with Openreach.

Financial impact on Openreach

A5.44 We recognise that our approach requires Openreach to recover additional costs of network adjustments over all products that use the physical infrastructure. However, we do not consider that this approach transfers significant risk to Openreach.

[110] WLA 2018, Volume 3, paragraph 4.89.

A5.45 When regulating prices, we seek to ensure that Openreach has an opportunity to recover its efficiently incurred costs, including a return which reflects the associated risks of the investment. The fact that the physical infrastructure is a shared asset supporting a range of products lowers the risk associated with investment required to undertake network adjustments. We expect Openreach to have a customer base over which to recover these costs for the foreseeable future. Even if Openreach loses significant volumes of downstream customers to competing networks built using PIA, Openreach will still be able to recover these costs from charges for PIA users.

Impact on consumers

A5.46 We recognise that an increase in the costs Openreach recovers over products which use its physical infrastructure will increase the costs to be recovered by users other than of the competing telecoms provider. However, this needs to be weighed against the significant benefits to consumers in the longer term from innovation (including innovation to increase efficiency and lower costs), choice, stronger incentives to price keenly to attract customers and higher quality of service, which will benefit a wide group of consumers.

A5.47 Where costs are incurred, we consider there to be little risk of the costs being incurred without these benefits to consumers arising. This is because the chances of the services deployed using PIA of being withdrawn after deployment are small. Sunk costs account for a large part of the business case of network deployment, meaning that even if revenues are lower than expected, it is likely that ongoing costs would be able to be recovered and the service would continue to be provided. Even if the particular telecoms provider had to exit, we consider that it is likely that another provider could take over and run the service at a profit.

A6. Implications of the unrestricted PIA remedy for the BCMR

A6.1 As set out in Volume 1, we require BT to provide unrestricted access to its ducts and poles (i.e. the unrestricted PIA remedy)[111] everywhere in the UK, excluding the Hull Area, no later than one month after the publication of this Statement.[112]

A6.2 This decision reflects our finding in the Physical Infrastructure Market Review that BT has significant market power in the market for physical infrastructure access, which is fundamental in the delivery of telecoms services.[113]

A6.3 This annex sets out our view on the impact of unrestricted PIA on wholesale business connectivity markets over the period of this market review (i.e. to 31 March 2021). The annex is structured as follows:

- our approach to considering unrestricted PIA in the 2018 BCMR Consultation and stakeholder responses;
- potential impact of unrestricted PIA on BT's competitive advantage;
- implications of unrestricted PIA for the CI Access services market; and
- implications of unrestricted PIA for the CI Inter-exchange connectivity market.

A6.4 In summary, our view is that unrestricted PIA has the potential to significantly reduce BT's competitive advantage in the CI Access and CI Inter-exchange connectivity markets over time by supporting the expansion of network competition (although BT still may have a time and, to a lesser degree, cost advantage where fibre already exists). However the speed and scale of this impact is likely to depend – in part – on how it is used.

A6.5 We remain of the view that the availability of unrestricted PIA will not have such a material impact so as to alter our market definition finding in the CI Access services market in this review period. However, we conclude that unrestricted PIA may have greater implications for BT's market power in the CI Access services market for the CLA and High Network Reach areas in the rest of the UK. As set out in Volume 2, Section 6, in summary, we find:

- No SMP in the CLA, where the presence of unrestricted PIA is one of the factors underlying our findings;
- SMP in HNR areas in the rest of the UK, notwithstanding the presence of unrestricted PIA. However, this finding is finely balanced and we reflect this in our remedy assessment by imposing lighter remedies (See Volume 2, Section 10);
- SMP in BT Only and BT+1 areas notwithstanding the presence of unrestricted PIA.

[111] The term "unrestricted PIA" we are using in this statement is equivalent to the terms "unrestricted DPA" and "uDPA" which we used in the 2018 BCMR Consultation. We have decided to use a different terminology now to distinguish the concept of having access to BT's ducts and poles (DPA) from the PIMR remedy that requires BT to offer a product to provide access to its ducts and poles without usage restrictions (unrestricted PIA).
[112] As set out in Volume 1, we have not extended the PIMR to the Hull Area and so do not impose unrestricted PIA in the Hull area. As a consequence this annex, and our market assessment of the Hull Area, does not include a consideration of the impact of unrestricted PIA.
[113] For more details see Volume 1, Section 5

A6.6 We also remain of the view that unrestricted PIA will have no material impact on market definition in the CI Inter-exchange connectivity markets and, similar to our consultation position, we still consider that unrestricted PIA will have no material impact on our SMP assessment in the CI Inter-exchange connectivity markets for this review period.

Approach to considering unrestricted PIA in the 2018 BCMR Consultation and stakeholder responses

Proposed approach

A6.7 In the 2018 BCMR Consultation, we did not adjust our proposed market analysis (geographic market definition and SMP assessment) to reflect the availability of unrestricted PIA, given our expectation, at the time, that this proposed remedy was unlikely to be in widespread use within the period of the review.[114] However, we took account of the potential impact of unrestricted PIA in our approach to remedies, given our expectation that there was a reasonable prospect that this remedy might provide limited support to competition in some areas within the period of this review.[115]

Stakeholder responses

A6.8 Twelve stakeholders provided comments on the proposed unrestricted PIA remedy in the context of the BCMR.[116] We have grouped their comments in four areas:

- Ofcom's proposed approach to reflecting unrestricted PIA in the SMP assessment.
- Ofcom's proposed approach understates the impact of unrestricted PIA.
- Ofcom's proposed approach overstates the impact of unrestricted PIA.
- Take-up and timescales of unrestricted PIA.

Ofcom's proposed approach to reflecting unrestricted PIA in the SMP assessment

A6.9 In the 2018 BCMR Consultation, given our expectation that the usage of a duct access remedy was unlikely to be widespread in the relevant geographic markets within this review period, we did not adjust our proposed SMP assessment to reflect the availability of unrestricted PIA.[117] Three stakeholders broadly agreed with our proposal (IIG, TalkTalk, and Vodafone). However, BT Group and Openreach disagreed. We discuss these stakeholders' views on this area in Volume 2, Section 6.

[114] 2018 BCMR consultation, volume 1, paragraphs 5.8 (geographic market definition) and 6.74 (SMP assessment).
[115] 2018 BCMR consultation, volume 1, paragraphs 10.8 to 10.12 (approach to remedies).
[116] BT Group, Colt, Gamma, Three, IIG, Openreach, Sky, TalkTalk, UKCTA, Virgin, Vodafone and [✂].
[117] 2018 BCMR Consultation, paragraph 6.74.

Ofcom's proposed approach understates the impact of unrestricted PIA [118]

A6.10 BT Group and Openreach argued that Ofcom's proposed market definition and SMP findings for the CI Access services and CI Inter-exchange connectivity markets were wrong because they ignored the material impact of unrestricted PIA on competition during this review period. Their main arguments are:

- telecoms providers will be able to use unrestricted PIA from launch (one month following the PIMR Statement) and therefore this will have a material impact over this review period (BT Group);[119]
- unrestricted PIA increases rivals' ability and incentive to deploy fibre. It allows them to deploy their own fibre more cheaply, rapidly and in more locations than only using their own physical infrastructure (BT Group[120] and Openreach[121]);
- this is likely to increase the competitive constraint on BT in many areas, as reducing deployment costs means that telecoms providers will find it more profitable to serve customers that are much further away from their network (BT Group[122] and Openreach[123]); and
- unrestricted PIA would have implications for our proposed geographic market definition, SMP findings and remedies (BT Group).[124]

A6.11 BT Group added that unrestricted PIA would facilitate two models of network competition, namely: [125]

- "tactical network build": targeting high-value individual sites such as data centres, MNO backhaul and large corporate sites; and
- "strategic network build": scale build of FTTP covering residential and business customers over an area.

A6.12 Both BT Group[126] and Openreach[127] argued that the impact of unrestricted PIA would be greater for VHB services. BT Group also argued that the impact would be greater where it is used to provide multiple circuits. [128]

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[118] BT Group have also argued that mixed usage PIA is will have an impact on our market definition and SMP findings (BT Group's response to the 2018 PIMR and 2018 BCMR Consultations, Alix Partners report, paragraph 1.14) . However, we do not consider that mixed usage PIA is likely to exert any additional constraints on Openreach over and above those imposed by unrestricted PIA given that unrestricted PIA will be available no more than one month after the publication of this Statement.
[119] BT Group's response to the 2018 PIMR and 2018 BCMR Consultations (Alix Partners report), paragraph 12
[120] BT Group's response to the 2018 PIMR and 2018 BCMR Consultations, paragraph 1.14; and BT Group's response to the 2018 PIMR and 2018 BCMR Consultations (Alix Partners report), paragraph 2, 10, 13 and 9-21.
[121] Openreach's response to the 2018 BCMR Consultation, paragraphs 25 and 145.
[122] BT Group's response to the 2018 PIMR and 2018 BCMR Consultations, paragraph 1.14; and BT Group's response to the 2018 PIMR and 2018 BCMR Consultations (Alix Partners report), paragraph 2, 10 and 9-21.
[123] Openreach's response to the 2018 BCMR Consultation, paragraphs 25 and 145.
[124] BT Group's response to the 2018 PIMR and 2018 BCMR Consultations (Alix Partners report), paragraphs 16-22
[125] BT Group's response to the 2018 PIMR and 2018 BCMR Consultations, paragraph 3.37.
[126] BT Group's response to the 2018 PIMR and 2018 BCMR Consultations, paragraph 3.32.
[127] Openreach's response to the 2018 BCMR Consultation, page 31 paragraph 145.
[128] BT Group's response to the 2018 PIMR and 2018 BCMR Consultations (Alix Partners report), paragraph 14.

Ofcom's proposed approach overstates the impact of unrestricted PIA

A6.13 Three, Hyperoptic, IIG, Sky, TalkTalk and Vodafone made the following points in support of their view that we had overstated the impact of unrestricted PIA in the CI Access services and CI Inter-exchange connectivity markets:

- the product is not yet finalised, and there is no guarantee there will not be an appeal of the PIMR statement, so there should not be an automatic presumption that unrestricted PIA will have an impact in the short to medium term (Hyperoptic);[129]
- even if BT does not appeal the remedy, it will not be introduced soon enough to have a material impact during this review period (TalkTalk); [130]
- the network extension costs faced by rivals, even with unrestricted access to BT's ducts and poles, have been understated (Vodafone and Sky); [131]
- the economics of unrestricted PIA for single site installations in the CI Access services market are challenging (Vodafone);[132]
- unrestricted PIA will not bring effective competition to the CI Inter-exchange connectivity market (at least in the short to medium term) as infrastructure providers are likely to focus their deployment on more lucrative access tails rather than invest substantial sums in deploying fibre over large distances for inter-exchange connectivity (Three);[133] and
- Ofcom provides little argument to substantiate why unrestricted PIA is unsuitable for IEC (Virgin Media).[134]

Take-up and timescales of unrestricted PIA

A6.14 Some stakeholders agreed with our view that take-up of unrestricted PIA is unlikely to be material over this review period:[135]

- Openreach accepted that in this market review period, although PIA volumes will grow rapidly, they are still likely to remain at relatively modest levels[136]; and
- Virgin Media, TalkTalk and [✂] considered that take-up of PIA will be modest or insignificant over the review period.[137]

A6.15 Conversely, BT Group argued that our proposals understated the take-up of unrestricted PIA during this review period and that we had not provided detailed evidence to support our view that take-up will be limited. They argued that we ignored the following factors: [138]

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[129] Hyperoptic response to the 2018 BCMR Consultation, page 7.
[130] TalkTalk's response to the 2018 BCMR Consultation, paragraph 2.108.
[131] Vodafone's response to the 2018 BCMR consultation, part 1, paragraph 1.10, and part 2, paragraphs 4.12-4.43. Sky's response to the 2018 BCMR Consultation, paragraph 12.
[132] Vodafone's response to the 2018 BCMR consultation, part 3, paragraph 3.1.4.
[133] Three's response to the 2018 BCMR consultation, paragraph 4.6.
[134] Virgin Media's response to the 2018 BCMR consultation, page 17.
[135] The views on take-up set out in the Annex are based on BCMR and PIMR responses.
[136] Openreach response to the 2018 PIMR Consultation, paragraph 172.
[137] Virgin Media response to the 2018 PIMR Consultation, page 23; TalkTalk's response to the 2018 PIMR Consultation, paragraph 6.2; and [✂].
[138] BT Group's response to the 2018 PIMR and 2018 BCMR Consultations (Alix Partners report), paragraph 9, and BT Group's response to the 2018 PIMR and 2018 BCMR Consultations, paragraphs 3.8-3.41.

- unrestricted PIA provides telecoms providers with strong incentives to get high value customers quickly;
- [✂];
- active engagement of telecoms providers in mixed usage PIA implementation meetings suggests high degree of interest and readiness; and
- Openreach has already seen a ramp up of demand for PIA in the last few quarters and business-only providers have started to register to take the service.

Impact of unrestricted PIA on BT’s competitive advantage

A6.16 Unrestricted PIA will be available no later than one month after the publication of this Statement,[139] and we consider that over time it will have an impact on network competition. This remedy goes directly to the source of BT’s competitive advantage by allowing rival telecoms providers to access BT’s ducts and poles on regulated terms and combine them with their own network to reach final customers.

A6.17 In this sub-section we assess the likely impact of unrestricted PIA on BT’s competitive advantage over this review period. We set out our views as follows:

- BT’s ubiquitous network is the main source of its competitive advantage in the CI Access services and CI Inter-exchange connectivity markets.
- Unrestricted PIA reduces BT’s competitive advantage in the provision of these services.
- There are a range of different use cases for unrestricted PIA in terms of facilitating network extensions for the provision of leased lines.
- The impact in this review period depends on take-up: while it is uncertain, we expect take-up volumes in this review period to be modest and most likely to be in areas with high network density.

BT’s ubiquitous network is the main source of its competitive advantage

A6.18 BT is the only network operator in the UK with a national network, and this gives it several advantages over potential rivals in terms of time and cost to supply. We now set out the specific details of its competitive advantage in relation to CI Access services and CI Inter-exchange connectivity.

CI Access customers

A6.19 As set out in Volume 2, Section 6, we consider that BT’s ubiquitous network gives it an advantage over other operators in the provision of access circuits as in the vast majority of cases it has a physical infrastructure connection (fibre or duct) to customer sites. This gives it a significant cost and time advantage when it is fibre or duct connected, while other operators need to extend their network.

[139] As set out in Volume 1, Section 5.

A6.20 In summary, this is based on the following evidence:

- BT is more likely to be duct connected: BT had existing duct connections to [✂]% 81%-90% of its 2017 new customer ends in the UK excluding the Hull Area, compared to 46% across all rivals, collectively.[140]
- The cost advantage is significant even at short dig distances. For example, our indicative cost model estimates that where BT has an existing duct connection but not fibre, its cost to connect a customer will be around £1,700 lower than an operator who needs a 10m network extension (see Figure A6.1 overleaf).[141] This cost advantage is around one-quarter of the revenue of a three-year contract for a 1 Gbit/s EAD LA circuit.
- Duct activity increases the time to supply: for Openreach 2017 new connections, the Mean Time To Provide an Access order was around [✂] where new duct was required. This is compared to [✂] where Openreach had existing duct but no fibre and [✂] where Openreach had a fibre connection to a building).[142] This time to provide disadvantage is likely to occur as soon as any dig is required by a rival but not by BT, even for comparatively short dig distances (as illustrated by Figures A6.2 and A6.3).
- BT's competitive advantage is also reflected in rivals' digging behaviour: Openreach's rivals were unlikely to build to connect customers' sites that were not already duct connected to their networks. Collectively, they only built for 9% of connections not already connected to their networks, meaning that 91% of the time they instead purchased wholesale access products from Openreach; where rivals did dig, distances were very short with a median distance of just 14 metres.

A6.21 The scale of the advantage increases with the length of network extensions:

- **Cost advantage**: as illustrated in Figure A6.1 overleaf, the costs of network extensions where duct is required increase with distance at a materially faster rate than where duct already exists. For example, a 100m extension where new duct is required is more than four times the cost of a 10m extension, whereas when duct and tubing is already in place, the cost of extension is less than double for 100m compared to 10m. This means that the cost disadvantage for a new entrant is even greater for longer distances.

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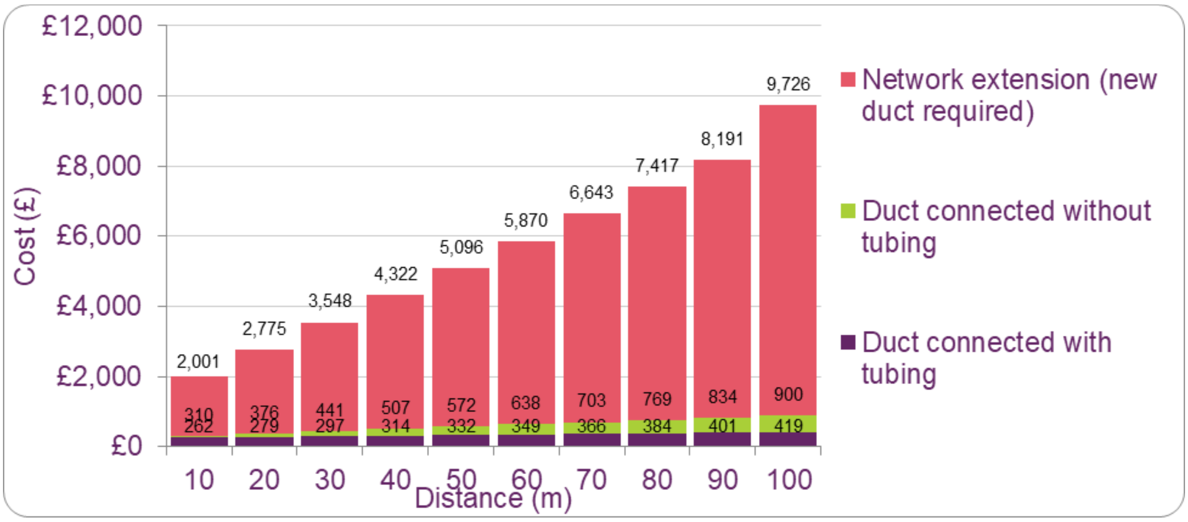
[140] Openreach response to the 1st BCMR s.135 notice.

[141] The analysis is based on Openreach's costs for the physical infrastructure required to extend its network (set out in Annex 10). This is calculated by comparing a cost of £262 for BT (as it is usually duct-connected with tubing) vs. a cost of £2,001 for a rival (assuming it needs to extend its network to reach the customer). We note that this may well understate Openreach's cost advantage for the reasons set out in Volume 2, Section 5 (e.g. because BT will also be better placed to compete due to customer convenience).

[142] This evidence is based on information about the time it takes Openreach to provide different types of leased line Ethernet orders (all orders, orders with duct work, and 'quick wins'), and the relationship between time-to-provide and dig distance. We collected this information from Openreach via our s.135 powers (see Annex 11 for further details). Based on Ofcom analysis of the BCMR s.135-1 and BCMR s.135-21 Notices.

Figure A6.1: Infrastructure costs for different distance scenarios



Source: Ofcom analysis. Physical infrastructure costs are based on Openreach's ECCs.[143]

- **Time advantage**: The charts below suggests that the time taken to provide a leased line circuit tends to increase with the length the network extension. This is particularly the case for shorter distance extensions that only require blown fibre with greater fluctuation for long circuits. This is based on Openreach's orders that were delivered in 2017 (our analysis is set out in Annex 11).

Figure A6.2: MTTP in working days by length of fibre for connections only requiring blown fibre [✂]

Figure A6.3: MTTP in working days by dig distance

[✂]

A6.22 Based on the above, we consider that BT has a competitive advantage in all areas of the UK (except the Hull Area).

A6.23 The scale of this advantage varies across the different geographic markets depending on the density and proximity of rival infrastructure. As set out in Volume 2, Section 6, BT's competitive advantage is highest in BT Only areas, where networks are much further away from customer sites (over 1km). Conversely, the scale of the advantage is lowest in the CLA due to the higher density and proximity of rival infrastructure. [144]

[143] We include ECCs on survey, blown fibre tubing, blown fibre, digging a duct under a footway, digging a duct under a carriage way, new footway box, break through external wall(s) at the customer premises. See Annex 10 for more details. As set out in Annex 10, results are only indicative as we recognise that rivals' costs may be different from Openreach's (they are likely to be higher e.g. as Openreach may benefit from bulk discounts) and cost may vary from one circuit to another. However, we consider results are a reasonable proxy as we are interested in estimating the likely scale of costs incurred rather than a precise quantification of that cost.

[144] As discussed in Volume 2,Section 6.

CI Inter-exchange services customers

A6.24 We note that BT also has a number of competitive advantages over other telecoms providers in the CI Inter-exchange connectivity services market, as discussed in Volume 2, Section 8. Unlike other providers, it is present at all BT exchanges, so it is able to provide a ubiquitous inter-exchange connectivity service, and do so relatively quickly and at comparatively low incremental cost (particularly where unused fibre exists). This is important for inter-exchange connectivity which is in effect connecting access services with competitive backhaul provision, and so there can be large distances involved. Moreover, BT's greater route diversity and lower reliance on other non-BT telecoms providers for inter-exchange connectivity also offers it additional competitive benefits which stem from its ubiquitous network.

A6.25 In order for rivals to compete in the CI Inter-exchange connectivity market, they need their own fibre network, to have a substantial footprint[145], and have the capacity to offer a wholesale CI inter-exchange connectivity service to other telecoms providers (as per the PCO definition set out in Volume 2, Section 8). Where a provider does not already meet these criteria, it is likely to require material investment and take considerable time to achieve, which reinforces BT's competitive advantage.

A6.26 If it met these criteria but was not present at a particular BT exchange, a PCO would need to extend its network from an existing network node to the exchange in order to be able to provide a backhaul or core fibre service (and therefore provide a competitive constraint). As BT will generally already have physical infrastructure connections to each of its exchanges, it has a significant cost and time advantage:

- There are likely to be significant costs associated with connecting to an exchange, even where distances are relatively short. For example, as illustrated by Figure A6.1 previously, a 10m network extension where new duct is built could cost approximately £2,000, compared to approximately £250-300 when duct is already in place.
- The need to dig is likely to materially increase time to supply, particularly in comparison to BT which is generally already connected. For example, BT was able to supply a new CI inter-exchange connectivity circuit on average in approximately [✂] in 2017 where it already had fibre in place (i.e. no duct or fibre work was required), or approximately [✂] days when it had duct and only needed to blow fibre (combined these accounted for the significant majority (approximately [✂]%) of new connections in 2017).[146] This compares to an average time to provide of [✂] for an access circuit in 2017 where new duct was required (we consider an access circuit is a relevant comparator for provision by a rival operator since, as described above, we would

[145] Note, contrary to Three's argument, we do not consider rival providers need to be able to offer a ubiquitous service in order to compete in inter-exchange connectivity, given customers can (and in many instances are) multi-source to fulfil their backhaul requirements. This is discussed further in Volume 2, Section 8.
[146] Based on Ofcom analysis of BCMR s.135-21 Notice. The data on digging distances presented is consistent with our approach to dig variables described in Annex 12.

expect them to extend their network from an existing node to a BT exchange, and so the distances and locations of build could be more comparable to an access circuit than a complete inter-exchange connectivity circuit between two BT exchanges[147]). As noted in the 2018 Cartesian report, when it comes to purchasing fibre services, telecoms providers decisions are affected by the risk of delay.[148]

- As with access, we would expect the costs and time to supply to depend on the individual circumstances, but will likely increase with the distance from the BT exchange.

A6.27 Based on this we consider that BT has a competitive advantage in CI inter-exchange connectivity services, but the scale of this advantage varies by exchange depending on presence of PCOs. As set out in Volume 2, Section 8, we consider this competitive advantage is highest at BT Only exchanges as there are no existing rivals, and in the majority of cases we expect the costs and time associated with entry are a material barrier (in part due to the longer distances from rival networks to BT Only exchanges than to other BT exchanges). We consider the advantage to be low at BT+2 exchanges as there are already two rivals present who also have a substantial footprint and the capacity to supply a wholesale backhaul service (and indeed this contributes to our no SMP finding).

Unrestricted PIA reduces the cost and time of network rollout

A6.28 As set out above, laying new duct is both costly and time-consuming, making replicating BT's access network uneconomic in the vast majority of the country. This is supported by the minimal evidence of rival network build in 2017 (~2% of all new access connections with a median build distance of under 15m).[149]

A6.29 The ability to use BT's duct and poles will significantly reduce the cost of network build. The possible scale of this impact is indicated by Figure A6.1 previously, which compares an indicative estimate of the costs of network extensions when a provider needs to build new duct itself and when they do not (i.e. the necessary duct is already present).

A6.30 In addition to reducing the costs of network build, unrestricted PIA also reduces the time to provide a service relative to digging. For example, the mean time to provide an access circuit where existing duct can be used (and so work is limited to blowing fibre) is [✂], compared to [✂] where new duct needs to be built. Therefore, BT's competitive advantage in terms of time or costs to supply will be materially lower where unrestricted PIA can be used (particularly where BT does not already have fibre).

A6.31 However, it is important to note that there still remains a time disadvantage using unrestricted PIA relative to where fibre is already available. In 2017, new Openreach access

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[147] We note in any event that the average time to provide an inter-exchange circuit when new duct was required was [✂] than for an Access circuit at [✂] working days, but this is still materially longer than where infrastructure already exists.
[148] Cartesian, 2018. Business Connectivity Market Assessment (non-confidential version), paragraphs 7.25-7, [accessed 20 May 2019].
[149] See Annex 11.

connections for sites with existing fibre were on average provisioned in [✂], whereas sites which had existing duct but needed fibre work had longer lead times – [✂] on average.[150] We also note that the time to supply will be longer when providers have access to a BT duct for the first time. In this case, it is necessary for fibre tubing to be installed, which increases the time to supply – [✂] on average.[151]

A6.32 This time disadvantage relative to when fibre is already available is unsurprising, given the need to actually deploy cabling in BT's duct, and the associated wayleaves and traffic management which can still be needed when using unrestricted PIA.[152] For example, we note that a material minority ([✂]%) of Openreach's 2017 completed orders (Access and IEC) where only blown fibre or the splice of existing fibre was required had traffic management and/or wayleaves, whereas a [✂] proportion ([✂]%) where access cabling/tubing was required in existing duct had traffic management and/or wayleaves.[153]

A6.33 We consider that the above implications of unrestricted PIA for costs and times to provide are also relevant for inter-exchange connectivity services, where a provider is looking to extend its network by connecting its network to a BT exchange (and then use its own existing network for onward backhaul or core connectivity). This is because, as set out above, such network extensions could look similar to access circuits in terms of the distance and location of build required. To the extent a provider was looking to replicate the entire route between two BT exchanges, we note the distances would typically be much longer than an access circuit. Although our analysis suggests the times to provide could be [✂][154], we would expect the costs to be even greater in total given the longer distances (see discussion above).

A6.34 Overall we are of the view that unrestricted PIA has the potential to significantly reduce BT's competitive advantage in access and inter-exchange connectivity over time by supporting the expansion of network competition (although there may still be a time and (to a lesser degree) cost disadvantage relative to where fibre already exists).[155] However the speed and scale of this impact is likely to depend – in part – on how it is used.

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[150] Our analysis is set out in detail in Annex 11 and is broadly consistent across the different geographic markets defined.

[151] Based on Openreach Quality of Service data, see Annex 11.

[152] For example, if there is still a need to lay some new duct to connect the rival's network to BT, or if network engineers need access to a manhole in a road to lay cables in a duct.

[153] These proportions are based on Openreach's provision order categories. [✂] We also note that Openreach's Technical Report on QoS explained that [✂]. Openreach, 12 December 2018, *A Statistical Analysis of the feasibility of meeting the Upper Percentile MSL* (confidential). Openreach provided a summary of the report as part of its non-confidential response to the BCMR Consultation (Openreach's response to the 2018 BCMR Consultation (quality of service), Annex 1).

[154] The average time to provide for inter-exchange connectivity orders that required digging of new duct was approximately [✂] working days in 2017 compared to approximately [✂] working days when fibre needed to be blown or [✂] working days where the duct and fibre was already in place. Based on Ofcom analysis BCMR s.135-21 Notice.

[155] There are a number of factors that potentially hinder the deployment of competitive networks, and these are being addressed in various forums, most notably the OTA-facilitated Passives Industry Working Group (P-IWG). One specific issue complicating the deployment of networks through private land by telecoms providers other than Openreach is the need to secure wayleaves – note that Openreach already have wayleaves for their existing network infrastructure, which can be re-used for deployment of their full-fibre networks. Wayleaves are not an issue specific to PIA, nor indeed to

The impact of unrestricted PIA varies by the type of network extension

A6.35 For the purposes of this assessment we have identified three types of network extensions that could impact on leased lines, for which unrestricted PIA could be used by rivals, namely:

- mass network rollout;
- network infill; and
- Bespoke network extensions.

A6.36 We consider that the impact of unrestricted PIA on the costs and time to supply leased lines is likely to vary for each of these use cases, particularly in the short term. We now set out our views on each.

Mass network rollout

A6.37 In a mass network rollout, telecoms providers would use unrestricted PIA to build network across an area where they do not have network coverage. In this case, issues with time to supply driven by wayleaves and traffic management can largely be dealt with in the planning stage for covering an area. In particular, once permissions are received, multiple premises can be passed in a time and cost-efficient way. This reduces the impact of needing such permissions on network build.

A6.38 Under a proactive mass network rollout, the network is constructed to pass premises, with the final connection only made once an order has been received. Although there is still some work to connect the end customer, this is significantly less than when there is no existing network passing the premises (see discussion on bespoke network extensions below), and critically the telecoms provider is more likely to be able to give certainty to the end customer as to when a circuit can be delivered. For example, in its response to the PIMR, Vodafone said:

- "For FTTH networks, the aim is to pass homes while minimising the work for connecting each additional new end customer and providing better certainty for delivery to a target timescale when an order is taken."[156]; and
- "Enterprise focused networks aim to build to business parks or office blocks, leaving as little work to be done to connect as practical. Initial build may be done around the business park if permission from the owner is obtained. When connecting sites that are ultimately won, additional costs to bring the connectivity from the ring to the customer site are incurred."[157]

A6.39 As set out above, we would expect unrestricted PIA to reduce the costs of network extension compared to laying new duct. In particular, it is likely to reduce the cost of

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telecommunications infrastructure, and are outside Ofcom's remit. A number of recent and current initiatives seek to streamline the processes relating to wayleaves, including the Digital Economy Act 2017 (which permits wayleaves entered into from December 2017 to be shared by multiple access seekers); an Openreach information service advising CPs of the post-DEA2017 wayleaves they hold; and ongoing initiatives by DCMS' Barrier Busting Taskforce.

[156] Vodafone's response to the 2018 BCMR Consultation, part 3, paragraph 2.20.

[157] Vodafone's response to the 2018 BCMR Consultation, part 3, paragraph 2.21.

passing premises as part of a proactive mass network rollout We also note that where the mass network rollout is passing multiple premises, the costs can potentially be spread across multiple end customers, further lowering the effective cost per circuit/customer.

Infill

A6.40 This type of deployment is similar to the mass network rollout described above. Under infill deployment, telecoms providers would use unrestricted PIA to fill gaps between areas where they already have network coverage. Proactively passing multiple premises in existing gaps can have similar benefits to mass rollout in terms of wayleaves and traffic management.

A6.41 Unrestricted PIA will allow telecoms providers to fill gaps in their coverage at a significantly lower cost than laying new duct. Once the network extension is laid, premises passed can be connected at relatively low cost and with greater certainty over delivery timescales (as with mass network rollout, albeit on a more limited scale).

Bespoke network extensions

A6.42 The third use case for unrestricted PIA is for bespoke, dedicated, single site installations over longer distances. This would involve providing a single extension to connect a premises to its network using unrestricted PIA in cases where the existing network does not currently 'pass' or is not near to the premises. As such, it is likely to involve a longer 'customer-specific' extension than mass rollout or network infill, where more of the deployment is intended to be shared across multiple customers and the final connection to an individual customer is over a short distance (as described above).

A6.43 As Vodafone stated in its PIMR response "the economics of [unrestricted PIA] for single site installations are challenging" and although we would expect some usage of unrestricted PIA for this purpose, this is likely to be limited as operators prioritise mass network rollout/infill.

A6.44 BT Group's response to our consultation argued that in the case of "tactical network build" (which we consider is analogous to our definition of bespoke network extensions), the impact of unrestricted PIA would be greater for VHB services. Based purely on costs to supply and current prices, we expect some individual CI Access and Inter-exchange connectivity leased lines, particularly VHB circuits, could be replaced by rival providers using unrestricted PIA (particularly over shorter distances). For inter-exchange connectivity, the contestable revenues may be more attractive than for an access circuit (depending on specific demand at a given exchange).

A6.45 This view that some leased lines could be replaced was also supported by the Alix Partners modelling set out in BT Group's response to the consultation, which was based on Openreach's excess construction charges and the current structure and level of mixed usage PIA charges.

A6.46 However, looking only at costs and prices fails to take into account the time taken to deploy the fibre and fibre tubing for these types of extensions and the resultant competitive disadvantage that entails, as well as the opportunity cost of the resources needed for bespoke network extensions.

A6.47 Unlike the mass rollout scenario, the customer-specific part of a bespoke network extension is likely to be much longer as existing network is not already passing the premises. As illustrated above, where the work is required over longer distances, lead times are likely to be longer. This could be, for example, because traffic management and wayleaves are more likely to be required for longer circuits (as discussed in Annex 11), leading to delay. These differences in lead times may also reflect a difference in the complexity of orders, which also requires resource costs that are not captured in the cost model described above. In addition, unlike the case with a mass network rollout or an infill deployment, these resource costs are not shared across multiple customer orders, increasing the cost per order for single network extensions.

A6.48 The high resource costs for bespoke network extensions also gives rise to an opportunity cost. A telecoms provider can choose to deploy network planning resources for a mass network rollout or for a single individual order. The information we have had from both some rival telecoms providers and BT suggests that mass rollouts are prioritised. For example, Openreach delivers FTTP through two methods, mass rollout and Fibre on Demand. Mass rollout of FTTP was reported by BT to pass 13,000 premises a week, whereas Fibre on Demand has an order quota of 20 to 100 orders per month across the UK.[158] This use of a quota suggests that Openreach prioritises its resources for mass rollout. CityFibre's response describes its strategy when entering a city is to ultimately build a city-wide full fibre network.[159]

A6.49 We also understand from BT Group's response that it recognises that unrestricted PIA is more likely to be used for mass rollout and network infill than for single site installations. It mentioned that the impact of unrestricted PIA could be greater where it is used to provide multiple circuits.[160]

A6.50 In summary, although unrestricted PIA will be used for some bespoke network extensions, the evidence on lead times suggests that they will remain challenging and resource intensive. As such, we expect rivals to remain at a significant disadvantage for these types of connections in this review period compared to a provider which is already fibre-connected, and that they are likely to prioritise mass rollout or infill.

Potential impact over this review period

A6.51 The potential impact of unrestricted PIA on business connectivity services in this market review period will depend on two factors, namely how quickly it is used and where it is likely to happen.

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[158] BT Group plc, Q3 2018/19 trading update, slide 7 [accessed 20 May 2019].
Fibre on Demand is an Openreach product that enables telecoms providers order FTTP for individual customers who are within a Fibre to the Cabinet (FTTC) exchange area and are served by a FTTC enabled cabinet, see: Fiber to the Premises (FTTP) on Demand, Openreach [accessed 11 June 2019].
[159] CityFibre' response to the 2018 BCMR and 2018 BT RFR Consultations, paragraph 3.2.2
[160] BT Group's response to the 2018 PIMR and 2018 BCMR Consultations (Alix Partners report), paragraph 14.

Unrestricted PIA will take time to have an impact

A6.52 Using unrestricted PIA to extend networks will likely take some time, both in terms of the necessary planning and physically carrying out the work. As such, we would expect the actual provision of leased lines using unrestricted PIA to be relatively low in this review period.

A6.53 As set out in Volume 1, Section 7, we consider that the overall loss of Openreach leased lines because of unrestricted PIA is likely to be modest over the market review period. This is based on Openreach's own forecasts which indicate a loss of around [✂] (1,000 – 5,000) leased lines under mixed usage PIA and a further [✂] (1,000 – 5,000) leased lines under unrestricted PIA for two-year period from 2019/20 to 2020/21. Openreach inventory data indicates it has a total of around [✂] leased lines.[161]

A6.54 Most respondents who commented on this issue, including Openreach, agreed with this conclusion and although BT Group disagreed with this, it did not present evidence that would suggest that Openreach's forecasts are too low.

A6.55 We therefore do not expect use of unrestricted PIA for bespoke network extensions at scale during this review period.

Initial take-up is likely to be in areas with higher network density

A6.56 As mentioned above, we expect that the main impact of unrestricted PIA will be to encourage network deployment in the form of mass network rollout and infill extensions rather than bespoke network extensions.

A6.57 This, combined with the time it is likely to take for providers to start using unrestricted PIA, means, as argued by Openreach, its impact in this review period is most likely to be in areas with higher network density already:

- While mass rollout could begin in this review period in any area, its main impact is likely to be beyond the timeframe of this review period given the time it takes to plan and build the network from scratch (even with unrestricted PIA).
- We consider that unrestricted PIA could have a greater impact in this review period for network infill, by virtue of there already being network nearby, meaning time to supply will be shorter. Network infill is relevant for areas with existing network density.
- To the extent bespoke network extensions occur (which we think is limited, for the reasons described above), they are relevant for all areas but most likely targeted at shorter circuits and/or where distances to alternative existing networks are shorter (which is more likely in areas with greater network density).

A6.58 We now set out our view of the implications of this expected use of unrestricted PIA for our specific CI Access services and CI Inter-exchange connectivity market analyses, as well as our remedies package.

[161] Openreach's response to the 1st BCMR s.135 Notice.

Implications of unrestricted PIA for the CI Access services market

A6.59 In the 2018 BCMR Consultation, we proposed to find that BT has SMP in the supply of CI Access services in the whole of the UK, except for the Central London Area (CLA) and the Hull Area. That is, we proposed to find that BT has SMP in the following geographic markets:

- BT Only areas in the UK;
- BT+1 areas in the UK;
- each of the Metro Areas;[162] and
- High Network Reach areas in the rest of the UK.[163]

A6.60 We considered that the availability of unrestricted PIA is unlikely to affect the geographic market definition or the SMP findings as its use is likely to be on a limited scale over the review period.

A6.61 We have reconsidered our views on the implications of unrestricted PIA on our market analysis for CI Access services in light of stakeholder comments. As set out above, BT and Openreach argued that we understated the impact of unrestricted PIA in our market analysis (geographic market definition and SMP findings). However, we note that other stakeholders considered that the impact of unrestricted PIA was overstated.[164]

A6.62 We have taken the availability of unrestricted PIA into account in our CI Access services geographic market definition and SMP assessment, consistent with the modified greenfield approach. As set out in the following paragraphs, we consider that unrestricted PIA will have no material impact on the geographic market definition in this review period. However, we conclude that unrestricted PIA will have implications for the degree of competitive constraints in the CLA and HNR areas in the rest of the UK. We reflect this in our conclusions on SMP.

Implications for the CI Access services geographic market

A6.63 As set out in Volume 2, Section 5, we define geographic markets based on the presence of rival infrastructure. We measure the presence of rival infrastructure using the network reach analysis.[165] The first step in analysing network reach is to define the measured distance over which rival networks are likely to be sufficiently close to competitively serve

[162] Defined as High Network Reach postcode sectors in each of Birmingham, Bristol, Edinburgh, Glasgow, Leeds and Manchester.
[163] Defined as High Network Reach postcode sectors outside the CLA, Metro Areas and the Hull Area.
[164] Three, IIG, Sky, TalkTalk, UKCTA, and Vodafone.
[165] The network reach analysis calculates, for each postcode sector in the UK, the number of telecoms providers supplying leased lines other than BT that have network within the buffer distance of the large business sites and mobile base stations in that postcode sector. This allows us to identify postcode sectors that are likely to have sufficiently homogeneous conditions of competition.

customers. We refer to this as the "buffer distance". We consider a 50m buffer distance to be appropriate assumption for our analysis.

A6.64 BT Group argued that unrestricted PIA leads to a much longer buffer distance, which will have a material impact on the size of the geographic markets we define. It argued that the appropriate assumption on buffer distance is a minimum of 300m. It added that this is likely to result in many postcode sectors being appropriately reclassified from BT Only and BT+1 to HNR areas, particularly in light of our sensitivity analysis which shows that increasing the buffer distance from 50m to 100m more than doubles the number of postcode sectors classified as HNR areas.[166]

A6.65 We disagree with BT Group as our analysis of the buffer distance takes into account potential bespoke network extensions and, as set out above, we do not expect unrestricted PIA to have a material impact on this type of network extension over this review period.

A6.66 Therefore, we do not consider that the availability of unrestricted PIA will have a material impact on the length of the buffer distance over this review period.

Implications for the CI Access services market SMP assessment

A6.67 BT Group argued that we considered the competitive impact of unrestricted PIA to a "limited extent" in our SMP assessment and that we should reconsider our SMP assessment. In its view, if we were to do so, we would find that materially more areas will tend towards being effectively competitive over this review period. It suggested that "Ofcom should place greater weight on the impact of [unrestricted PIA] on actual and potential competition rather than the historic market shares that do not reflect the competitive constraints on BT over the review period. This is particularly the case in HNR Metro and other HNR areas where telecoms providers already have a material degree of network presence which is located closer to customer sites."[167]

A6.68 We agree with BT Group that the availability of unrestricted PIA may have an impact on the strength of competition faced by BT in the CLA and HNR areas in the rest of the UK over this review period. This is because network infill extensions are likely to be a particular feature in the CLA and HNR areas in the rest of the UK. This means that, as a result of unrestricted PIA, BT's advantage from having control of infrastructure and being closer to customer sites is likely to be lessened somewhat in the CLA and HNR areas in the rest of the UK:[168]

- In the CLA we consider it reasonable to expect that at least some rivals may use unrestricted PIA for network infill extensions during the review period. This is due to the high number of networks already present (four rival networks within 50m) and the high density of valuable customers.

[166] BT Group's response to the 2018 PIMR and 2018 BCMR Consultations (Alix Partners report), paragraph 16, first bullet.
[167] BT Group's response to the 2018 PIMR and 2018 BCMR Consultations (Alix Partners report), paragraph 90.
[168] Bespoke network extensions using unrestricted PIA may occur in any of the relevant geographic markets, but similar to our view on buffer distance, we do not expect this to be on a material scale to affect our SMP findings.

- Network infill may also occur in HNR areas in the rest of the UK. These areas have two networks within 50m, but notably lower existing telecom provider coverage than the CLA. We expect that during this review period, unrestricted PIA may be used for infill in some, but probably not all, HNR areas. However, at this stage it is difficult to identify exactly where it will be deployed, and plans are likely to change and develop during the period.
- In BT Only and BT+1 areas, some mass rollout and infill is likely to occur, but it is difficult to predict exactly where, and it is unlikely to be on a material scale in this review period. This is supported by Virgin Media:

  "While the number of [telecoms providers] using PIA and their usage is likely to increase and accelerate, the resulting volumes will still be de minimis in the context of BT's current market position."[169]

A6.69 Based on the above, we consider it appropriate to reflect the impact of unrestricted PIA in our SMP assessment. As set out in Volume 2, Section 6, our SMP finding is based on our assessment of evidence on the following criteria in the round:

- market shares and market share trends;
- control of infrastructure not easily duplicated;
- economies of scale and scope;
- barriers to entry and expansion;
- absence of potential competition; and
- absence of or low countervailing buyer power.

A6.70 We take into account the potential impact of unrestricted PIA as part of our assessment of potential competition. We set out our analysis and findings in Volume 2, Section 6. In summary, based on evidence in the round, we find:[170]

- No SMP in the CLA, where the presence of unrestricted PIA is one of the factors underlying our findings;
- SMP in HNR areas in the rest of the UK, notwithstanding the presence of unrestricted PIA. However, this finding is finely balanced and we reflect this in our remedy assessment by imposing lighter remedies (See Volume 2, Section 10);
- SMP in BT Only and BT+1 areas, notwithstanding the presence of unrestricted PIA.

Implications of unrestricted PIA for the CI Inter-exchange connectivity market

A6.71 In the 2018 BCMR Consultation, we proposed to find that BT has SMP in the supply of CI inter-exchange connectivity services from BT Only and BT+1 exchanges. We considered that the availability of unrestricted PIA was unlikely to affect these conclusions as usage was likely to be on a limited scale, but took it into account in designing our remedies.

[169] Virgin Media's response to the PIMR Consultation, page 24.
[170] We consider that our analysis of these factors applies to a notional VHB Access market, as discussed in Annex 14.

A6.72 We have reconsidered the implications of unrestricted PIA on our market analysis for CI Inter-exchange connectivity services in light of stakeholder comments summarised above, where BT and Openreach argued that we understated the impact while other stakeholders argued we had overstated it.

A6.73 We set out our analysis and findings in the following order:

- unrestricted PIA will have no impact on market definition; and
- similar to our consultation position, we consider that unrestricted PIA will have no material impact on our SMP assessment for this review period.

Implications for CI Inter-exchange connectivity market definition

A6.74 Our market definition for CI Inter-exchange connectivity services is set out in Volume 2, Section 7. As we describe there, our market definition is based on an analysis of the level of competition at each individual exchange.

Implications for the CI Inter-exchange connectivity SMP assessment

A6.75 Our assessment of the competitive conditions in the CI Inter-exchange connectivity markets is based predominantly on a test of presence, and in particular, the number of PCOs who are actively providing a wholesale service at each exchange. We consider that potential rival networks which are close to BT exchanges but are not currently connected provide some constraint on BT at BT Only and BT+1 exchanges, but we consider it to be significantly weaker than presence. As set out in Volume 2, Section 8, this is because of the high barriers to entry in terms of time to provide and cost of supply at these exchanges, as well as the often more limited demand for backhaul (particularly in the case of most BT Only exchanges).

A6.76 We recognise that where networks are already close to a BT exchange and there is material demand for backhaul, unrestricted PIA could reduce the barriers to entry such that a rival is willing to invest.[171] Where this is the case, it may provide constraints on BT's behaviour. We consider this is most likely where the distances between existing network nodes and BT exchanges are shorter, and so is more likely in BT+1 exchanges where distances are shorter (although could include some BT Only exchanges as set out in Volume 2, Section 12). We also recognise that where demand for backhaul is particularly high (e.g. NGA handover exchanges), the distances rival providers might be willing to cover with a bespoke network extension could be longer than in the CI Access services market.

A6.77 However, even where unrestricted PIA reduces the barriers to entry at BT Only and BT+1 exchanges with material demand for backhaul, we still consider that BT will have a competitive advantage in this review period.

[171] Openreach argued it its consultation response that DPA would reduce network build costs and make it economic to build further (Openreach's response to the 2018 BCMR Consultation, page 40, paragraphs 38-40).

A6.78 This advantage is because connecting a network node to a BT exchange is likely to have many characteristics of a bespoke network extension, as it is likely to involve a network which does not 'pass' an exchange[172] using unrestricted PIA for a single extension to connect to its network. Although bespoke build for inter-exchange connectivity is possible, particularly where existing networks are close to a BT exchange, it is costly and involves delay compared to where BT already has fibre (as described above). Additionally, some build is still likely to be required even with unrestricted PIA, as some work will be needed to join the two networks together (e.g. build from the rival's network to the BT duct or handover point). This could further increase the cost and complexity of the extension, strengthening BT's competitive advantage.

A6.79 In principle, there may be some exchanges which are located in areas where they could be connected to network nodes as part of infill network extensions (and potentially as part of mass rollout in the medium to long term). However, as well as the general uncertainty around where infill extensions could occur in this review period (described above), the specific exchanges which could be affected would need to be located close to end customer premises in HNR areas of the CI Access services market (such that the connection could be included in infill) and have sufficient demand for backhaul in order to justify the connection. We note that to affect our inter-exchange connectivity SMP assessment, the extension would also need to be met by a PCO, and not all networks included in our assessment of density in the CI Access services market meet this criterion. Therefore, while possible in principle, we consider there is significant uncertainty about whether infill extensions expected in this review period could affect our SMP assessment for CI Inter-exchange connectivity. This means, combined with the fact that the maximum number of exchanges which could be affected is very small (there is only one BT Only exchange and four BT+1 exchanges in HNR areas and the CLA, which is where we expect infill could occur in this review period), we have not sought to reflect this in our SMP assessment.

A6.80 We note that an alternative use of unrestricted PIA to compete in CI Inter-exchange connectivity could be to replicate the complete connection between two BT exchanges. However, we consider this is even less likely in this review period, since as well as being a bespoke network extension, such connections tend to cover longer distances, and so practical and financial barriers to using unrestricted PIA are likely to be higher. This view is echoed by Three which, as noted above, argued that infrastructure providers are likely to focus their deployment on more lucrative access tails than invest substantial sums in deploying fibre over large distances.

A6.81 Virgin Media argued that we had not substantiated why unrestricted PIA is unsuitable for inter-exchange connectivity. We consider that a rival seeking to use unrestricted PIA for inter-exchange connectivity would still be at a competitive disadvantage in this review period, particularly where their network is further away from the exchange. This means, combined with the more favourable conditions for mass rollout and infill in access networks (and the need to prioritise resources), we do not expect bespoke network extensions using unrestricted PIA to be on a material scale for inter-exchange connectivity

[172] For example, is not close to the point where it could connect to an External Cablelink product.

services in this review period, such that it affects our SMP analysis. In the longer term however, we recognise this may change as extensions to connect existing network to exchanges could in some circumstances form part of more mass rollout/infill planning (reducing some of the time and cost disadvantages discussed above).

Implications of unrestricted PIA for remedies

A6.82 While we do not expect unrestricted PIA to materially affect our market analysis for CI Access services or CI Inter-exchange connectivity in this review period, we are of the view that it has the potential to have a material impact on competition in the longer term (as set out above and in Volume 2, Section 10). This, combined with our desire to further the interests of consumers by promoting competition from rival infrastructure providers, means we think it is appropriate to adjust our remedies so as not to undermine incentives for rival investment. We set out how we have done this in Volume 2, Section 10, but in summary:

- We have limited the scope of the dark fibre remedy to areas where investment is unlikely. Where there is significant uncertainty, we have adopted a cautious approach and not imposed dark fibre, so as not to undermine infrastructure based competition in this review period.
- We are imposing lighter remedies in HNR areas in the rest of the UK (outside of the CLA) to reflect existing and greater expected future levels of competition, in part because we expect infill using unrestricted PIA to occur in some of these areas. Specifically, in these areas BT is not subject to quality of service standards and only subject to a fair and reasonable pricing requirement (as opposed to a charge control).
- We have adopted flat pricing of active remedies to provide a sufficient degree of protection for access-based competition and good incentives for alternative infrastructure investment while competition, based on unrestricted PIA, develops.

A7. Product dynamics

A7.1 In this annex, we analyse the product dynamics in the business connectivity markets and how these affect prices and competition. We first look at the evolution of volumes and costs since 2009 and then go on to assess how these trends interact with regulation and BT's pricing incentives, to explain market outcomes.

A7.2 We use the analysis in this annex to help inform our proposals on market definition and significant market power (SMP) assessment for Contemporary Interface (CI) services.

A7.3 Only Openreach commented on our analysis of product dynamics, particularly in relation to aspects used to inform our hypothetical SMP assessment for VHB access (Annex 14 of Volume 2). We consider their comments where relevant further below.

Volume and cost trends

A7.4 Bandwidth demand is growing rapidly driven by new applications such as cloud computing, video conferencing, and smartphone use. Industry forecasts suggest that bandwidth demand will increase by a factor of 3 between 2016 and 2021, growing at a rate of around 24% per annum.[173]

A7.5 To meet their increasing bandwidth needs, leased line customers migrate to higher bandwidth products. This has manifested itself in the changing distribution of leased line volumes by bandwidth over time (see Figure A7.1). In 2010, <10 Mbit/s lines represented nearly all of BT's leased line volumes, they now only represent c.20%.[174] Over this time, 100 Mbit/s has become the most popular speed, accounting for around 60% of BT's leased line volumes, while 1 Gbit/s lines have increased in popularity and now represent around 15% of BT's leased line base.

A7.6 In addition, demand for very high bandwidth (VHB) circuits – which we define as circuits offering speeds above 1 Gbit/s – is expected to accelerate during this review period, driven mainly by mobile and fixed network backhaul customers, due to the move to fifth generation mobile technology (5G) and the transition from copper to fibre broadband respectively. Demand for VHB circuits from enterprises is also expected to grow, although it will remain low relative to the demand from mobile and fixed network backhaul customers.

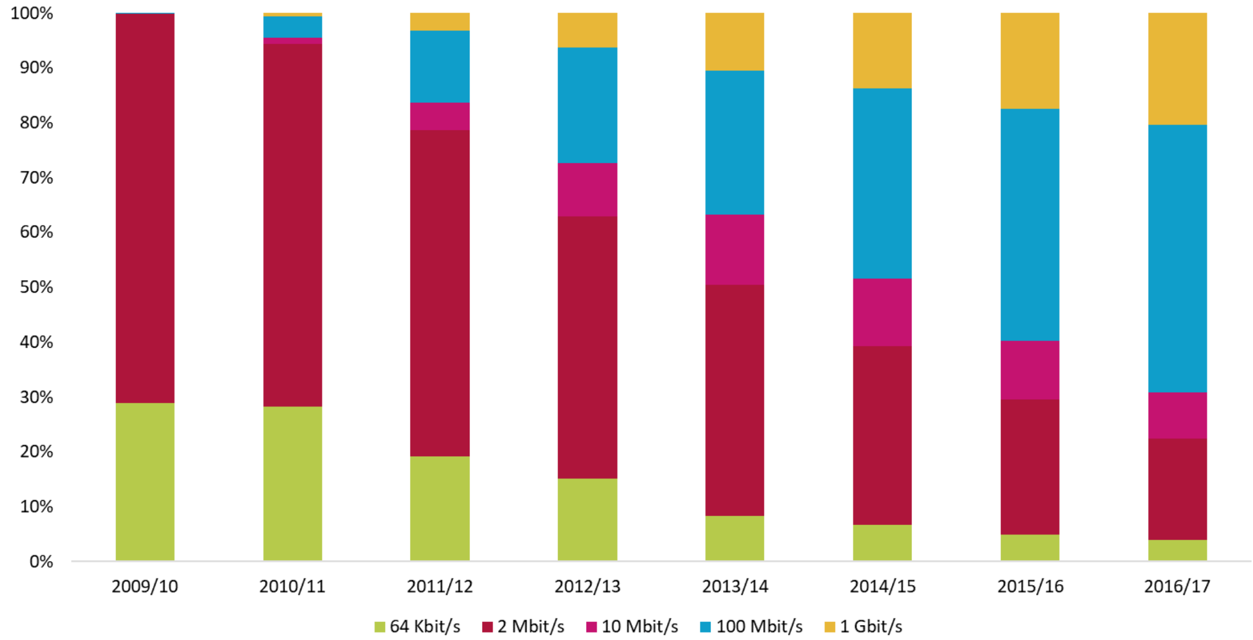
A7.7 This is confirmed by the information received from MNOs and by the research we commissioned on large enterprises[175], which found that:

[173] Cisco, June 2017. *VNI Complete Forecasts Highlights* [accessed 21 May 2019].
[174] Ofcom analysis based on BT's Regulatory Financial Statements (RFS).
[175] Cartesian, 2018. Business Connectivity Market Assessment [accessed 20 May 2019].

- Mobile Network Operators (MNOs) expect traffic to grow exponentially with 5G, and therefore demand for 10 Gbit/s services is likely to increase in the next three to five years;[176] and
- demand for 10 Gbit/s from large enterprises[177] is growing, with some enterprises already requesting 100 Gbit/s.

A7.8 This trend is consistent with a product lifecycle where demand for a particular bandwidth is low at the beginning (when early adopters take up the product) then increases as the product becomes mass-market and late adopters begin to take it up. At some point, as leased line customers continue to migrate upwards and new higher bandwidth services are launched, demand for the product falls.

Figure A7.1: Distribution of BT business connectivity circuits by bandwidth



Source: Ofcom based on BT's Regulatory Financial Statements (RFS) volumes data for rental Tradition Interface (TI) and CI services (excluding services above 1 Gbit/s). 64 Kbit/s and 2 Mbit/s volumes reflect TI local ends and were adjusted (divided by a factor of 2) to convert to circuits.

[176] Over the next 5 years (2019-23), we understand from MNOs that the rollout of 5G will mostly involve upgrading sites to 10 Gbit/s services (MNO responses to the 23rd BCMR s.135 notice). The research we commissioned with Cartesian found that 10 Gbit/s and multiple 10 Gbit/s links are likely to become the norm for MNOs in the next three to five years. This is in line with Vodafone's response that for the rollout of 5G, "individual sites will need multiple gigabit links, and in some cases above 10 Gbit/s" (Vodafone's response to the 2018 BCMR Consultation, part 2, paragraph 2.17). However, Openreach disagreed with these research findings and commented that "the exact demands [*of MNOs*] is unclear" (Openreach's response to the 2018 BCMR Consultation, page 121, paragraph 7). Our view based on the evidence gathered is that we can expect an increase in demand from MNOs for 10 Gbit/s services during this review period.

[177] Defined as organisations with 250 or more employees in the UK. These organisations come from a variety of sectors including for example public administration, education and financial services.

A7.9 Trends in the business connectivity markets also indicate that equipment costs are declining over the product cycle by 4.9 to 7.3% per year.[178] On an absolute basis, these costs are relatively constant across Ethernet services for bandwidths of 1 Gbit/s and below (see Section 3 of Volume 2 for more detail). For bandwidths above 1 Gbit/s, equipment costs are higher, around triple the costs for lower bandwidths based on our analysis of BT's Regulatory Financial Statements (RFS).[179]

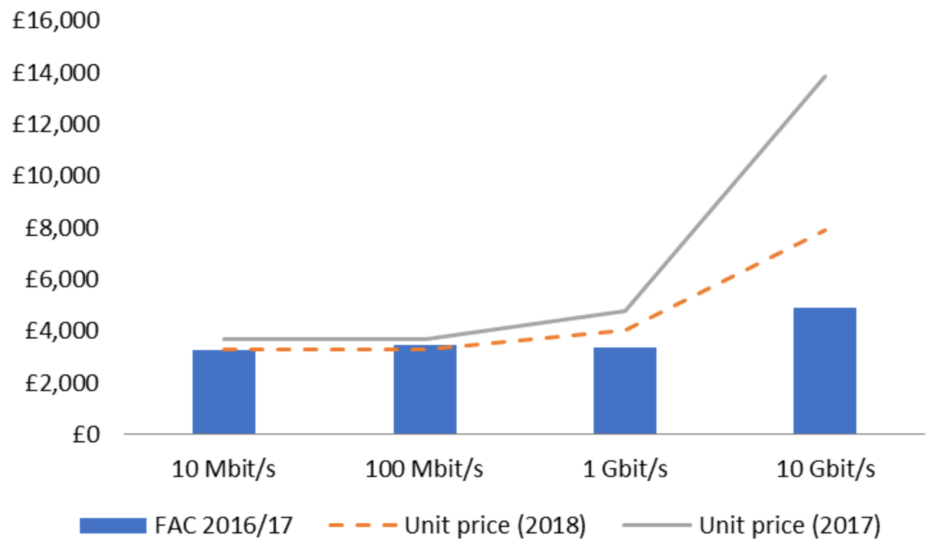
A7.10 The equipment cost differential between 1 Gbit/s and 10 Gbit/s has been declining over time. In the 2016 BCMR we noted that the equipment costs underlying the 10 Gbit/s service had reduced considerably with the introduction of Openreach's 10 Gbit/s Ethernet Access Direct (EAD) service and, as a result, the cost differential between 1 Gbit/s and 10 Gbit/s had narrowed.[180] Since then, BT's RFS suggests equipment costs for 10 Gbit/s EAD have reduced further by nearly half.[181] As technology for 10 Gbit/s continues to evolve, it is reasonable to assume that this cost gap will continue to narrow in the future.

The bandwidth gradient

A7.11 Historically, BT's charges have followed a bandwidth gradient, which means that charges increase with bandwidth. This bandwidth gradient has been greater than equipment cost differentials alone, also reflecting differences in willingness to pay, price discrimination (though to some extent constrained by competition), and differences in regulation.[182]

[178] BT response dated 11 November 2014 to the 4th 2016 LLCC s.135 notice.
[179] We have updated estimates from BT's 2016/17 RFS to reflect the changes announced as part of BT's 2017/18 Change Control Notification [accessed 20 May 2019].
[180] 2016 BCMR, paragraph 4.181.
[181] In the 2016 BCMR we estimated equipment costs for 10 Gbit/s EAD of [✂]. We have now updated our estimate of these costs and have come down to [✂] based on BT's 2017/18 flat file (for service SD163).
[182] For charge-controlled products, the bandwidth gradient can also reflect efficient common cost recovery where products with a higher willingness to pay make greater contributions to common costs, allowing fewer common costs to be recovered from lower bandwidth products. This is less important for non-charge-controlled products as higher charges for these products do not reduce the amount of common costs to be recovered by charge controlled products.

Figure A7.2: EAD prices and fully allocated costs



Source: Ofcom based on BT's 2016/17 RFS and Openreach's price list as at April 2018. Costs and prices are stated on a Total Cost of Ownership (TCO) basis and include rental, connection and main link costs/charges. Connection costs/charges are spread over a three-year period and discounted using an 8% Weighted Average Cost of Capital (WACC). For main link costs/charges, we assume a 5km link distance. As in our indicative dig distance cost analysis (Annex 10 of Volume 2), we have removed operating costs and overheads associated with Ethernet electronics based on 2017/18 RFS cost data which splits out the costs for EAD equipment. In our view, the allocation of these costs (operating costs and overheads) do not reflect the underlying incremental costs of the service but rather BT's cost allocation rules.

A7.12 Since 2009, BT's Ethernet services of 1 Gbit/s and below have been subject to price controls which require charges to reflect costs in aggregate. BT has historically set prices for services above 1 Gbit/s (which were not subject to price regulation) with a greater premium above cost.

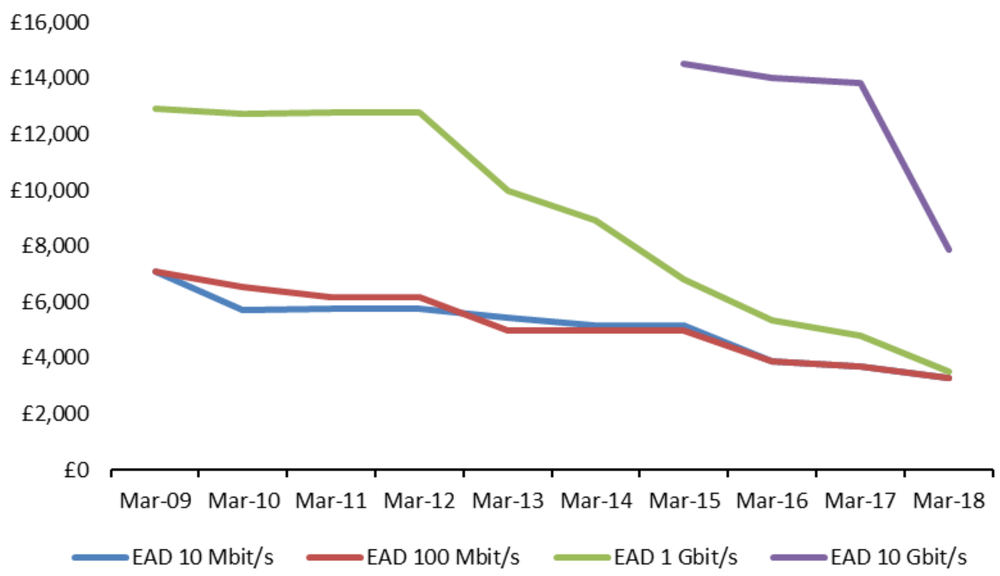
A7.13 For example, as at March 2017, we estimate that whereas EAD 100 Mbit/s prices were 2% below Fully Allocated Cost (FAC), EAD 1 Gbit/s prices were 32% above FAC and those for EAD 10 Gbit/s were [✂]% 100-150% above FAC.[183] This differential has reduced significantly since April 2018, when BT reduced EAD 10 Gbit/s charges by nearly 40% (see Figure A7.2). [184]

A7.14 Over time, we find that BT's Ethernet prices are declining and the price gap across bandwidths is narrowing, making the bandwidth gradient flatter and more cost reflective

[183] Ofcom analysis based on BT's 2016/17 RFS and Openreach's price list as at March 2017.
[184] In their response to our consultation, Virgin Media also suggest that developments in the market since the 2016 BCMR point towards a narrowing between 1 Gbit/s and 10 Gbit/s services.

(see Figure A7.3). This is likely due to a combination of price regulation, upward migration, falling equipment costs and competition from alternative networks.[185]

Figure A7.3: Evolution of EAD charges – Annualised Total Cost of Ownership (TCO)[186]



Source: Ofcom based on Openreach's price list as at October 2018.

Impact on evolution of prices

A7.15 Upward migration may impact the evolution of prices as relative charges across bandwidths affect decisions to migrate. The lower the incremental charges for high bandwidths (relative to lower bandwidths), the sooner lower bandwidth customers will migrate to more profitable higher bandwidth products. This means that, independent of competitive pressure from other operators, BT may find it profitable to reduce the relative charge for high bandwidth services if it encourages enough customers from lower bandwidths to migrate and pay higher charges. The loss from lower margins from existing high bandwidth customers could be more than offset by the gain from the additional customers upgrading their service, provided that customers migrate in sufficient numbers.

A7.16 This is supported by internal pricing documents from Openreach which indicate that:

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[185] Openreach argued that Ofcom's statement that the bandwidth gradient is flattening is "misleading" as this reflects the lifecycle of pricing for these products, and that above 1 Gbit/s, "a substantial gap remains in price". (Openreach's response to the 2018 BCMR Consultation, page 121, paragraph 7). Firstly, we do not think that our statement is misleading, as we explain that this is due to a combination of reasons, one being upward migration which is consistent with product dynamics and lifecycle. Also, while we note that the price differential between 1 Gbit/s and 10 Gbit/s services has reduced significantly since April 2018, we acknowledge that it still remains high.

[186] The annualised TCO includes rental, connection, and main link charges. Connection charges are spread over a three-year contract term and discounted based on a 8% WACC. For Main link charges we assume a 5km link distance.

- [✂].[187] This means that the revenue loss from a price cut on 1 Gbit/s would be partially offset by the gain from additional migration from 100 Mbit/s. This is not true for a price cut on 100 Mbit/s where potential migration from lower bandwidths would be minimal given the small 10 Mbit/s volumes.
- Expected demand growth for VHB services in the next five years, mainly from MNO and fixed network backhaul customers, and the presence of competition, partly explain Openreach's decision to cut its EAD 10 Gbit/s price and introduce OSA Filter Connect with a 30%[188] discount over its standard Optical Spectrum Access (OSA) product.[189]

A7.17 Given Openreach's low VHB volumes ([✂] circuits), relative to its 1 Gbit/s volume base ([✂] circuits), it is plausible that the gain from additional migration from 1 Gbit/s (caused by the cut in VHB charges) more than compensates for the loss from lower margins on existing VHB customers. This appears to be confirmed by Openreach's commercial assessment of its VHB price cut, which shows that [✂].[190]

A7.18 Openreach's internal pricing documents also suggest that competition plays a role in shaping these price trends. Notably, the size of BT's recent VHB price cuts may be influenced by the presence of competition. In its pricing documents, Openreach have provided evidence for this by highlighting [✂].[191] However, the size of the price cut (nearly 40%) also suggests that it is likely that competition was previously insufficiently robust so as to force BT to reduce its prices earlier.

Impact on competition and service shares

A7.19 Also, our analysis shows that the bandwidth gradient affects competition and service shares in the market.

A7.20 In theory, the higher BT's prices, the greater scope for competition as this affects the incentives for network extensions (also described in Section 4 of Volume 2). Other operators base their build/buy decisions on a comparison between BT's prices and the cost of construction and adding their own equipment: the higher BT's charges for operators to extend their networks to connect customers. Note that, if we assume that other operators face similar equipment prices to Openreach, this greater competitive distance is driven by the premium BT charges above costs.

A7.21 Given the historically high charges for VHB it is unsurprising that BT has a lower service share for VHB than for lower bandwidths, where charges are closer to the underlying costs. This is illustrated in Table A7.4 below.

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[187] Openreach response dated 20 April 2018 to Question 5 of the 8th BCMR s.135 notice. See document entitled *Leased Line Charge Control Ethernet Prices for April 2018.*
[188] We set out our analysis of the discount in Annex 14 of Volume 2.
[189] Openreach response dated 20 April 2018 to Question 4 of the 8th BCMR s.135 notice. See document entitled *New pricing and product launches for VHB portfolio*, page 6.
[190] Openreach response dated 20 April 2018 to Question 4 of the 8th BCMR s.135 notice. See document entitled *Product Proposals: Ethernet & Optical Response to Dark Fibre*, slide 7.
[191] Openreach response dated 20 April 2018 to Question 4 of the 8th BCMR s.135 notice. See document entitled *New pricing and product launches for VHB portfolio*, page 2.

Table A7.4: Ofcom estimates of BT service shares

Service	2008 BCMR	2013 BCMR	2016 BCMR	This statement
TI Low bandwidth (<8 Mbit/s)	89%	88%	89%	n/a
CI services of 1 Gbit/s and below	73%	74%	57% (affected by same data issues described in Annex 12)	[✂]% (71%-80%)
CI services >1 Gbit/s and WDM	39%	57%	30% (affected by same data issues described in Annex 12)	[✂]% (51%-60%)

Source: 2016 BCMR. BT service shares in the UK excluding Hull Area for TI Low bandwidth and excluding Hull Area and West East and Central London Area plus (WECLA+) for Alternative Interface Symmetric Broadband Origination (AISBO) and Contemporary Interface Symmetric Broadband Origination (CISBO) services.

A7.22 However, steady migration to higher bandwidths, together with BT's recent price cut and its impact on network extensions, means that it is reasonable to anticipate that BT's service share for VHB will increase.

Implications for our competition assessment

A7.23 The analysis above suggests that prices for higher bandwidth products tend to reduce over time and become more cost reflective. This is relevant when thinking about competition in the long term, and what competitive prices are for market definition purposes.

A7.24 The analysis also suggests that the relationship between BT's prices and competition may be circular. On the one hand a lack of competition results in the ability to charge significantly above costs. On the other, the higher BT's prices (relative to costs), the more attractive it may be for alternative operators to extend their networks and compete in the market. This means that service shares for higher bandwidth services (where BT's prices have historically been higher and above costs) may understate BT's market power.

A8. CI Access services market definition: demand-side substitution analysis

A8.1 In this annex we assess the extent to which customers see different Contemporary Interface (CI) Access services as substitutes from the demand side.

A8.2 Demand-side substitution arises when customers switch to alternative products in response to changes in their relative prices. We have used the SSNIP[192] test (as outlined in Volume 2, Section 4) to assess the boundaries of the CI Access services product market from the demand side.

A8.3 The overarching question is whether enough customers would switch to an alternative service in response to a SSNIP (typically of 5-10%) on the focal product, such that the SSNIP would become unprofitable. As part of our assessment we have also conducted a critical loss analysis. This analysis estimates the switching rate necessary to make the SSNIP unprofitable, i.e. the critical loss. It then asks whether the proportion of customers that would switch in response to a SSNIP would exceed this critical loss.

A8.4 We present our analysis and findings on demand-side substitution for CI Access services in the following order:

- our summary of stakeholder responses to our consultation proposals;
- our approach to assessing demand-side substitution, including our critical loss analysis for assessing the SSNIP test and the focal products to which we apply the test;
- our SSNIP analysis for each focal product; and
- our conclusion on demand-side substitution.

Summary of stakeholder responses

A8.5 In the 2018 BCMR consultation, we proposed that our demand-side substitution analysis indicated the following:

- 10 Mbit/s services are constrained by 100 Mbit/s services;
- 100 Mbit/s services are constrained by 1 Gbit/s services;
- there is a possible break between 1 Gbit/s and VHB services, although the evidence is ambiguous;
- EFM and asymmetric broadband services are not close demand substitutes for CI Access services; and
- dark fibre is not a close demand substitute for low bandwidth CI Access services (1 Gbit/s and below) but could be one for VHB services.

A8.6 Six consultation respondents commented on our demand-side substitution analysis. The main comments were in relation to our approach to assessing demand-side substitution and our SSNIP analysis and findings.

[192] Small but Significant Non-transitory Increase in Price.

Our approach to assessing demand-side substitution

A8.7 Only Openreach and TalkTalk commented on our approach to assessing demand-side substitution. Their comments were mainly in relation to our critical loss analysis for assessing the SSNIP test, and the focal products and relevant price to which we apply the test.

A8.8 Openreach's main arguments were that:

- it is not clear why Ofcom is relying on calculations of critical loss as this is a departure from past approaches;[193] and
- the focal products are elements of a much wider network which has not been considered as part of our demand-side substitution analysis.[194]

A8.9 TalkTalk argued that our approach to demand-side substitution is "flawed" as our SSNIP analysis is based on "existing (distorted) market prices" rather than competitive prices. Based on this, TalkTalk argued that our analysis of VHB services is subject to a form of 'cellophane fallacy'.[195]

SSNIP analysis and findings

A8.10 A number of stakeholders commented on our SSNIP analysis and findings. We consider comments for each focal product below.

SSNIP at 10 Mbit/s

A8.11 IIG and Openreach agreed with our finding that 10 Mbit/s is constrained by 100 Mbit/s. Openreach argued that it is "evident" with a SSNIP that 10 Mbit/s is not "an economic market in its own right".[196] IIG argued that 10 Mbit/s and 100 Mbit/s are "clear substitutes".[197]

SSNIP at 100 Mbit/s

A8.12 Openreach argued that the extent to which a SSNIP on 100 Mbit/s induces switching to 1 Gbit/s is not as high as Ofcom suggests.[198] Openreach argued that there is "potentially" a break between 100 Mbit/s and 1 Gbit/s.[199]

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[193] Openreach's response to the 2018 BCMR Consultation, page 86, paragraph 30.
[194] Openreach's response to the 2018 BCMR Consultation, page 85, paragraph 24.
[195] TalkTalk's response to the 2018 BCMR Consultation, paragraph 2.14.
[196] Openreach's response to the 2018 BCMR Consultation, page 86, paragraph 31.
[197] IIG's response to the 2018 PIMR, 2018 BCMR and 2018 BT RFR Consultations, paragraph 4.3.1.
[198] Openreach's response to the 2018 BCMR Consultation, page 87, paragraph 32.
[199] Openreach's response to the 2018 BCMR Consultation, page 86, paragraph 31.

SSNIP at 1 Gbit/s

A8.13 IIG agreed with our SSNIP findings that 10 Gbit/s is unlikely to defeat a SSNIP at 1 Gbit/s.[200]

A8.14 Openreach argued that there is a break between 1 Gbit/s and 10 Gbit/s.[201] Openreach also argued that Ofcom has not "explicitly" acknowledged that 1Gbit/s is its own economic market, because there are either no or weak incentives to switch down to 100 Mbit/s or up to 10 Gbit/s in response to a SSNIP.[202]

A8.15 TalkTalk argued that by using current prices rather than competitive prices, Ofcom had overestimated the competitive constraint imposed by 1 Gbit/s on 10 Gbit/s.[203]

A8.16 Vodafone acknowledged that evidence for demand-side substitution is limited because 10 Gbit/s prices are not set at the competitive level and that the number of customers switching between 1 Gbit/s and 10 Gbit/s is low.[204]

A8.17 Openreach argued that Ofcom does not demonstrate the results would be different if 1 Gbit/s and 10 Gbit/s prices were set at the FAC level.[205]

A8.18 Also, Openreach argued that Ofcom has not recognised that the October 2018 price reduction[206] in 1 Gbit/s would further widen the price differential between 1 Gbit/s and 10 Gbit/s.[207]

SSNIP at 10 Gbit/s

A8.19 TalkTalk argued that by using current prices rather than competitive prices, Ofcom had underestimated the competitive constraint imposed by 10 Gbit/s on 1 Gbit/s.[208]

Substitution to asymmetric broadband, Ethernet in the first mile (EFM) and dark fibre

A8.20 IIG[209], TalkTalk[210] and Vodafone[211] agreed that asymmetric broadband and EFM do not impose a competitive constraint on our focal products.

A8.21 SSE suggested that FTTP (asymmetric broadband) should be included in future market definitions as it is a viable substitute for services at 1 Gbit/s and below.[212] BT Group also

[200] IIG's response to the 2018 PIMR, 2018 BCMR and 2018 BT RFR Consultations, paragraph 4.3.1.
[201] Openreach's response to the 2018 BCMR Consultation, page 87, paragraph 34.
[202] Openreach's response to the 2018 BCMR Consultation, page 87, paragraph 33.
[203] TalkTalk's response to the 2018 BCMR Consultation, paragraph 2.17.
[204] Vodafone's response to the 2018 BCMR Consultation, part 2, paragraphs 1.9-1.10.
[205] Openreach's response to the 2018 BCMR Consultation, page 87, paragraph 34.
[206] Openreach EAD Price list [accessed 16 May 2019].
[207] Openreach's response to the 2018 BCMR Consultation, page 87, paragraph 35.
[208] TalkTalk's response to the 2018 BCMR Consultation, paragraph 2.17.
[209] IIG's response to the 2018 PIMR, 2018 BCMR and 2018 BT RFR Consultations, paragraph 4.3.3.
[210] TalkTalk's response to the 2018 BCMR Consultation, paragraphs 2.22-2.31.
[211] Vodafone's response to the 2018 BCMR Consultation, part 2, paragraph 1.1.3.
[212] SSE's response to the 2018 BCMR Consultation, page 2.

pointed out that services at 1 Gbit/s and below are increasingly becoming competitive at the wholesale level from FTTP providers.[213]

A8.22 IIG agreed that dark fibre is not likely to impose a constraint on low bandwidth services, however noted their members have seen that "some wholesale customers of VHB circuits are more likely to use dark fibre as a substitute".[214] Openreach argued that the relevance of dark fibre entry is not obvious as Ofcom does not consider it "in the context of the relevant timeframe".[215]

A8.23 We consider stakeholder comments in more detail below, with the exception of some comments in relation to our approach to assessing demand-side substitution, which we consider in more detail in Volume 2, Section 4.

Our approach

A8.24 We have used the SSNIP framework (as outlined in Volume 2, Section 4) to assess the boundaries of the CI Access services product market from the demand side. The overarching question is whether enough customers would switch to an alternative service in response to a SSNIP (typically of 5-10%) on the focal product, such that the SSNIP would become unprofitable.

A8.25 As part of our assessment we have conducted a critical loss analysis. This analysis estimates the switching rate necessary to make the SSNIP unprofitable, i.e. the critical loss. It then asks whether the proportion of customers that would switch in response to a SSNIP would exceed this critical loss. If enough customers would switch, the evidence would point to a wider market encompassing the focal product as well as the candidate substitute. If an insufficient number of customers would switch, the evidence would support a narrower market that includes the focal product exclusively.

Focal products

A8.26 To perform the SSNIP test we need to decide what the starting point of the analysis is, i.e. the focal product. The general practice is to start from the narrowest possible product market (the focal product) and assess whether the market could be broader to include additional substitutes.

A8.27 We apply our SSNIP analysis to the following focal products which account for 99%[216] of Openreach's wholesale leased line volumes:

- 10 Mbit/s
- 100 Mbit/s
- 1 Gbit/s

[213] BT Group's response to the 2018 PIMR and 2018 BCMR Consultations, paragraphs 3.19-3.22.
[214] IIG's response to the 2018 PIMR, 2018 BCMR and 2018 BT RFR Consultations, paragraph 4.3.3.
[215] Openreach's response to the 2018 BCMR Consultation, page 95, paragraph 78.
[216] Ofcom analysis based on Openreach's response to Question A of the BCMR s.135-1 Notice on circuit data and new adds for share, network reach for competitor intensity, future roll out plans.

- 10 Gbit/s

A8.28 We do not consider bandwidths of 2.5 Gbit/s, 40 Gbit/s and 100 Gbit/s explicitly in our analysis given their minimal volumes. However, we expect these bandwidth products to face similar competitive conditions to those for 10 Gbit/s. We refer to these services collectively as very high bandwidth (VHB) services in our analysis.

Relevant price

A8.29 To implement the SSNIP analysis we need to determine the price to which we apply the SSNIP. We have used Openreach's price list to inform this price and have taken the minimum price available for each focal product under the assumption that this better reflects competition in the market (i.e. this is the price that is likely to place the strongest constraint within and across different bandwidths).

A8.30 Given that we are interested in distinguishing between access and inter-exchange connectivity, we base our assessment on the charges for Openreach's Ethernet Access Direct Local Access (EAD LA) services (rather than on Openreach's standard EAD services which include Main Link charges capturing inter-exchange costs). These are also the most popular Openreach CI Access services for each of the focal products analysed, except for 10 Gbit/s where OSA is the most popular service, albeit on the back of a low volume base.

A8.31 For each focal product we consider the wholesale charge for the following two scenarios:

- an existing customer – who only needs to pay a migration charge to switch from the focal product to the candidate substitute; and
- a new customer – who needs to pay a connection charge to purchase either the focal product or the candidate substitute.

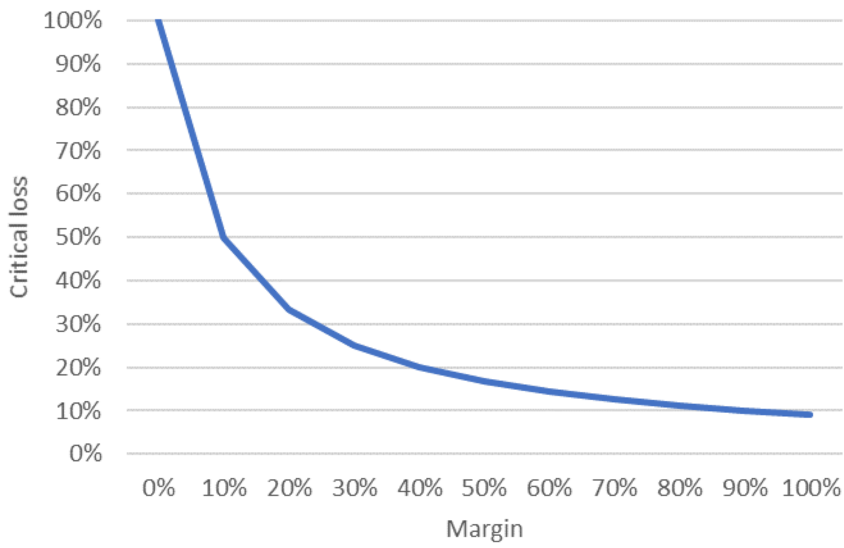
Critical loss

A8.32 The critical loss threshold or break-even critical loss is the amount of switching needed to render a SSNIP unprofitable.[217] This is determined by two factors: the price increase and the margin.

A8.33 For any given increase in price, the higher the margin the less switching is required to render a SSNIP unprofitable. Therefore, for a given price increase, we only need to know the margin to know the critical loss. The figure below shows the relationship between the margin and critical loss for a 10% price increase.

[217] In its response, Openreach argued that it is not clear why Ofcom is relying on calculations of critical loss as this is a departure from past approaches (Openreach's response to the 2018 BCMR Consultation, page 86, paragraph 30). The EC Guidelines state that "assessing demand- and supply-side substitution provides a way of measuring the 'critical loss' of sales (rendering a relative price increase unprofitable) and consequently of determining the scope of the relevant market" (European Commission Guidelines on market analysis and assessment of SMP, paragraph 30 [accessed 9 May 2019]). Therefore, as part of our assessment, we use the critical loss analysis to estimate the switching rate necessary to make a SSNIP unprofitable, i.e. the critical loss.

Figure A8.1: Relationship between the critical loss and the assumed margin for a 10% SSNIP



Source: Ofcom based on the standard critical loss formula.[218]

Intertemporal switching, migration, and the relevant assessment period

A8.34 Switching in response to the SSNIP may not occur immediately as leased line customers are typically tied to minimum contract periods. We therefore need to consider the time horizon over which we ascertain the impact of a SSNIP on customer switching.

A8.35 The EC SMP Guidelines are silent on the exact time horizon of a SSNIP, stating that additional products should be included if they would restrain sufficiently pricing "in the short term".[219] Office of Fair Trading (OFT) guidance[220] emphasises substitution within a year, while previous issues of the Federal Trade Commission/Department of Justice guidelines referred to a two-year period over which substitution responses take place.[221]

A8.36 In general, we consider that the most relevant time horizon is likely to be that which the hypothetical monopolist considers when making its pricing decisions. Internal pricing documents from Openreach suggest that pricing decisions are assessed by considering the impact of pricing proposals on revenues and costs over a medium-term period of [✂] years.[222]

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[218] Harris, B.C. and Simons, J.J., 1989. *Focusing Market Definition: How Much Substitution is Necessary?* Research in Law and Economics, 12, pp. 207-26, 1989.
[219] As outlined in Volume 2, Section 4 – Our approach to product market definition.
[220] OFT, 2004. Market Definition Guidelines [accessed 16 May 2019].
[221] In addition to the previous guidelines, more recent guidelines from 2010 refer to entry being rapid enough to make unprofitable overall the actions causing those effects [accessed 16 May 2019].
[222] Openreach response to Question 4 of the BCMR s.135-8 Notice. See document 'New pricing and product launches for VHB portfolio', pages 19-20, and slide deck entitled 'Product Proposals: Ethernet & Optical Response to Dark Fibre', slides 13-14.

A8.37 Contract periods can also provide an indication of how long the effects of a price change may take to fully materialise. This is consistent with what the Tribunal said in the BCMR Judgment: “the duration and frequency of renewal or change of leased line contracts by customers” is “highly relevant as regards the appropriate duration of a SSNIP analysis”.[223] For CI Access services, contract durations typically range from one year to five years, with the median duration being one year for wholesale contracts and three years for retail contracts.[224] This suggests that most switching decisions are likely to happen within a short time period (no more than three years) after the price increase.

A8.38 In addition to the time horizon of analysis, the profile of switching may affect the profitability of the SSNIP.[225] In the BCMR Judgment, the Tribunal suggested that the critical loss threshold may be impacted by the profile of switching and migration occurring because of a SSNIP and that this could be more accurately accounted for by considering a discounted cash flow approach. Although we recognise that this is the ideal approach for assessing the effects of a SSNIP we do not consider that it would have a material impact on the standard critical loss thresholds given the short timeframes involved for the likely switchers. We have therefore not explicitly modelled the profile of switching when assessing the profitability of the SSNIP.

Relevant margin

A8.39 The margin is the difference between the original, pre-SSNIP revenue obtained from the diverted sales, and the avoided cost associated with providing those sales (expressed on a per customer basis).

A8.40 To inform this margin we have considered the following evidence:

- Openreach’s Fibre First business case, which provides information on the net cash margin impact of the loss of Ethernet sales because of FTTP.[226] According to Openreach, these lost sales would mainly be 10 Mbit/s and 100 Mbit/s circuits. This evidence suggests an average margin of [✂for low bandwidth Ethernet services.[227]
- BT’s 2016/17 RFS, which provides a breakdown of operating and capital costs for Openreach’s CI Access services. We consider that operating costs are more likely to be

[223] BCMR appeal judgment, paragraphs 312 and 313.

[224] Ofcom analysis based on Openreach and BT Group’s response to the BCMR s.135-1 Notice on circuit data and new adds for share, network reach for competitor intensity, future roll out plans.

[225] Openreach argued that in the context of demand-side switching, we have not considered that the focal products are elements of a much wider network. In its view, it is “highly implausible” that any network operator would pay more by upgrading their access links to a higher bandwidth in response to a SSNIP “in excess of the demand from the rest of their network”, as otherwise “the bandwidth will just sit idle” (Openreach’s response to the 2018 BCMR Consultation, page 86, paragraph 30). Openreach does not provide any evidence where this has been the case. Our view is that switching decisions are likely to vary on a case by case basis for each network operator. Also, some operators may find it profitable to pay more for a higher bandwidth (in response to a SSNIP), even if in excess of their network demand, as bandwidth demand is growing rapidly and it is unlikely that high bandwidth products are likely to “just sit idle”.

[226] This net cash impact is the difference between the forgone revenues and the avoidable costs from the lost sales.

[227] Openreach’s response to Question 3 of the BCMR s.135-8 Notice on FTTX, EFM and CI services.

avoidable, therefore we estimate the margin by taking the difference between the reported revenue (adjusted by Openreach's April 2018 prices) and the reported operating cost for Openreach's EAD LA products. This suggests a margin of [✂] depending on the bandwidth.[228]

A8.41 Table A8.2 summarises this evidence. It suggests that the margin increases as the bandwidth gets higher. We have used these margins to inform the critical loss in our analysis (these are reported in the last column of the table). We consider the margin for 10 Gbit/s to be conservative as it may overstate the margin that would occur in a competitive market.

Table A8.2: Evidence on margin by bandwidth and the critical loss threshold

Focal product	BT's 16/17 RFS adjusted by Openreach's April 2018 prices	Openreach Fibre First business case	Range	Critical loss threshold
10 Mbit/s	[✂]%	[✂]%	[✂]%	[✂]%
100 Mbit/s	[✂]%		[✂]%	[✂]%
1 Gbit/s	[✂]%	N/A	[✂]%	[✂]%
10 Gbit/s	[✂]%	N/A	[✂]%	[✂]%

Source: Ofcom analysis based on Openreach and BT data. We have assumed that the margin coming from the Openreach Fibre First business case relates mainly to 10 Mbit/s and 100 Mbit/s leased lines.

SSNIP analysis

A8.42 We present our SSNIP analysis for each focal product in turn below. For each focal product, we carry out our analysis by first assessing substitution to the next higher bandwidth (which we consider the closest substitute). We then consider substitution to the nearest lower bandwidth where relevant.[229]

A8.43 For 100 Mbit/s, 1 Gbit/s and 10 Gbit/s we also assess substitution to asymmetric broadband, Ethernet in the first mile (EFM) and dark fibre. We do not consider this for 10 Mbit/s as our analysis of 100 Mbit/s already captures the possible constraints from these alternative services, given the minimal difference in charges between 10 Mbit/s and 100 Mbit/s services.

A8.44 Table A8.3 summarises the candidate substitutes considered for each focal product.

[228] BT 2016/17 RFS and supplementary AFIs.
[229] Openreach argued that "it is not sufficient to test that each link in the chain is constraining in both directions" but that whether "there are groups of products within the chain which are worth monopolising" should be established for a chain to be possible. Also, Openreach argued that the possibility of combining 100 Mbit/s and 1 Gbit/s into one "overall chain of substitution is not sufficiently evidenced" (Openreach's response to the 2018 BCMR Consultation, page 81, paragraph 2). However, we note that these arguments are irrelevant to our analysis, as we do not propose or look to establish whether there is a chain of substitution in our assessment of demand-side substitution.

Table A8.3: Candidate substitutes considered for each focal product

Focal Product	10 Mbit/s	100 Mbit/s	1 Gbit/s	10 Gbit/s
10 Mbit/s		✓		
100 Mbit/s	✓		✓	
1 Gbit/s		✓		✓
10 Gbit/s			✓	
Ethernet in the first mile (EFM)		✓	✓	
Asymmetric broadband		✓	✓	
Dark fibre		✓	✓	✓

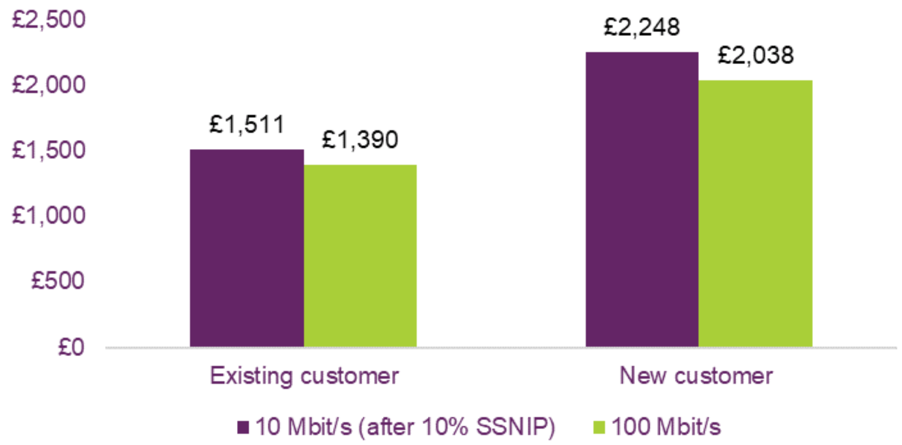
SSNIP at 10 Mbit/s

A8.45 Figure A8.4 shows the comparison between the price of 10 Mbit/s (after a 10% SSNIP) and the price of 100 Mbit/s for the two scenarios.

A8.46 It shows that a 10 Mbit/s customer would save £121 per annum by upgrading to 100 Mbit/s, with the additional benefit of getting 10 times more bandwidth. This upgrade would not require changing the underlying equipment, so we have only factored in the relevant migration charge.

A8.47 Likewise, a new customer would save £210 per annum by choosing to purchase a 100 Mbit/s circuit as oppose to a 10 Mbit/s circuit. The larger saving for this customer reflects the additional savings on connection charges.

Figure A8.4: Price comparison between 10 Mbit/s (after 10% SSNIP) and 100 Mbit/s – annualised total cost of ownership (£)[230]



Source: Ofcom analysis based on Openreach prices for EAD Local Access as of October 2018.

A8.48 Given the price and bandwidth differentials, we consider that a SSNIP at 10 Mbit/s is likely to result in significant substitution to 100 Mbit/s (in excess of 20%), rendering the SSNIP unprofitable.

A8.49 IIG and Openreach agreed with our finding that 10 Mbit/s is constrained by 100 Mbit/s. IIG's view is that 10 Mbit/s and 100 Mbit/s are "clear substitutes". [231] Similarly, Openreach indicated that it is "evident" that 10 Mbit/s is not "an economic market in its own right". [232] No stakeholders disagreed with our findings.

A8.50 Therefore, we conclude that 10 Mbit/s and 100 Mbit/s are close demand substitutes.

SSNIP at 100 Mbit/s

Substitution to 1 Gbit/s

A8.51 Figure A8.5 shows the price comparison between the price of 100 Mbit/s (after a 10% SSNIP) and the price of 1 Gbit/s for the two scenarios.

A8.52 It shows that a 100 Mbit/s customer would find it cheaper to stay at 100 Mbit/s than to upgrade to 1 Gbit/s.[233] For new customers the choice between 100 Mbit/s and 1 Gbit/s is much more marginal as the price differential for these customers is only £42 per year.

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[230] Prices are stated on a Total Cost of Ownership (TCO) basis and include rental and connection charges. Connection charges are spread over a three-year period by calculating the annuity which, when considered over the three-year period, is equivalent to the upfront connection charge on a NPV basis. To calculate this annuity we assume a 8% discount rate or Weighted Average Cost of Capital (WACC).

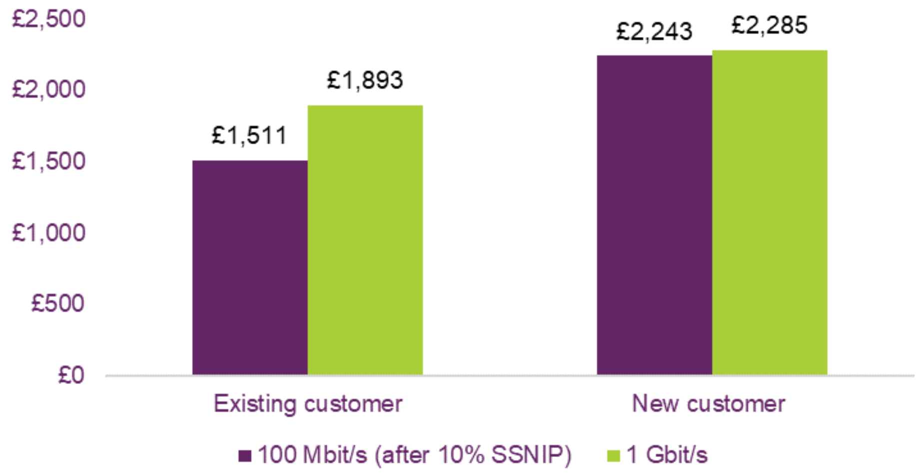
[231] IIG's response to the 2018 PIMR, 2018 BCMR and 2018 BT RFR Consultations, paragraph 4.3.1.

[232] Openreach's response to the 2018 BCMR Consultation, page 86, paragraph 31.

[233] The price differential may vary in the future depending on whether the existing customer has an old or new equipment. This is because, since 2017, Openreach uses the same boxes for 100 Mbit/s and 1 Gbit/s and thus a change of equipment would not be required in this case (albeit an engineer visit may still be required). Openreach's response to question 5 of the BCMR s.135-8 Notice on FTTX, EFM and CI services, see document entitled "Leased Line Charge Control Ethernet Prices for April 2018", dated 26/02/18, page 3.

Therefore, the benefit of getting 10 times more bandwidth at little extra cost is likely to make 1 Gbit/s more attractive for new customers.

Figure A8.5: Price comparison between 100 Mbit/s (after 10% SSNIP) and 1 Gbit/s – annualised total cost of ownership (£)[234]



Source: Ofcom analysis based on Openreach prices for EAD LA as of October 2018.

A8.53 Even existing 100 Mbit/s customers could still find it attractive to switch to 1 Gbit/s if they value having additional bandwidth enough. The BDRC 2016 study indicates that bandwidth need is the most important factor affecting customers' decision to migrate,[235] suggesting that customers may consider moving to a higher bandwidth only when they require the additional bandwidth. However, the study also identifies changes in relative prices as a factor (albeit a less important one) for migration decisions, indicating that customers also factor value-for-money considerations into their migration decisions.

A8.54 Openreach argued that there is "potentially" a break between 100 Mbit/s and 1 Gbit/s.[236] However, evidence from an Openreach pricing document[237] shows that demand for 1 Gbit/s may be sensitive to the relative prices between 100 Mbit/s and 1 Gbit/s. According to this document:

- [✂];[238]
- [✂];[239]

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[234] Prices are stated on a Total Cost of Ownership (TCO) basis and include rental and connection charges. Connection charges are spread over a three-year period by calculating the annuity which, when considered over the three-year period, is equivalent to the upfront connection charge on a NPV basis. To calculate this annuity we assume a 8% discount rate or Weighted Average Cost of Capital (WACC).
[235] BDRC, 2016. *Business Connectivity Market Review: High bandwidth connections,* Figure 31 [accessed 20 May 2019].
[236] Openreach's response to the 2018 BCMR Consultation, page 86, paragraph 31.
[237] Leased Lines Charge Control Ethernet Prices for April 18 document submitted by Openreach in response to Question 5 of the BCMR s.135-8 Notice on FTTX, EFM and CI services.
[238] LLCC 2017/18 Phase 2 Price reductions document submitted by Openreach in response to Question 5 of the BCMR s.135-8 Notice on FTTX, EFM and CI services, page 12.
[239] Leased Lines Charge Control Ethernet Prices for April 18, page 3.

- [✂].[240]

A8.55 The document therefore suggests that a lower 1 Gbit/s price may encourage migration from 100 Mbit/s, and our view is that this migration could be substantial if the price differential between 100 Mbit/s and 1 Gbit/s is low enough ([✂]).[241]

A8.56 Based on this evidence, we consider that a 10% SSNIP at 100 Mbit/s is likely to result in substitution to 1 Gbit/s in excess of 20%, rendering the SSNIP unprofitable. We conclude that 100 Mbit/s and 1 Gbit/s services are close demand substitutes.

Substitution to 10 Mbit/s

A8.57 We consider that substitution from 100 Mbit/s to 10 Mbit/s is highly unlikely for several reasons. First, bandwidth demand is constantly increasing, so customers are more likely to consider switching to a higher bandwidth than to a lower bandwidth, particularly if switching to a lower bandwidth means losing 90% of the bandwidth.

A8.58 For 100 Mbit/s customers whose bandwidth need exceeds 10 Mbit/s, trading down to 10 Mbit/s is unlikely to be an option as they would be reluctant to reduce their bandwidth demand to get a 10% cost saving.

A8.59 For 100 Mbit/s customers with a bandwidth need below 10 Mbit/s (numbers of which are shrinking), switching to 10 Mbit/s, although an option, may not be a straightforward choice as they may value the additional bandwidth. For these customers, staying at 100 Mbit/s would also prevent them from having to migrate back to 100 Mbit/s later when their bandwidth need exceeds 10 Mbit/s, which could happen relatively soon given the rate at which bandwidth demand is growing (see Annex 7 of Volume 2).

A8.60 Therefore, we consider that a SSNIP at 100 Mbit/s is unlikely to result in substitution to 10 Mbit/s exceeding the critical loss of [✂], thus we conclude that there is an asymmetric relationship in the substitution between 10 Mbit/s and 100 Mbit/s services.

Substitution to EFM

A8.61 Similar to substitution to 10 Mbit/s, substitution from 100 Mbit/s to EFM is likely to be limited by the slower speeds offered by the latter service. EFM can support speeds up to around 35 Mbit/s, but this is dependent on how close the customer is to the exchange. Data from BT suggests that the average speed of an EFM connection is closer to c.10 Mbit/s.[242]

[240] Leased Lines Charge Control Ethernet Prices for April 18, page 6.

[241] In its response, Openreach argued that the document does not support our "assertion of substantial migration" and that we had not "characterised" the document correctly (Openreach's response to the 2018 BCMR Consultation, page 91, paragraphs 52-54). However, based on the document, we remain of the view that if the price differential between 100 Mbit/s and 1 Gbit/s is low enough, then this could encourage substantial migration from 100 Mbit/s.

[242] BT response to Question A1 of the BCMR s.135-1 Notice on circuit data and new adds for share, network reach for competitor intensity, future roll out plans.

A8.62 Migration analysis conducted by Openreach in 2015 shows that at that time very few EAD leased line customers ([✂ %]) who ceased their service, and were identified as possible migrations, ended up migrating to EFM.[243] This is despite EFM services being priced considerably lower than EAD leased lines. This is also consistent with the results from the Cartesian 2018 study which suggests that businesses perceive "copper-based circuits (EFM) …to be less reliable" than fibre leased lines.[244]

A8.63 In addition, our recent engagement with telecoms providers suggests that EFM is considered a legacy service and will be gradually replaced, mainly with FTTX[245] based asymmetric broadband.

- [✂] said that it considers EFM as a legacy technology and that it only uses it for new connections on a limited basis where suitable FTTX or fibre-based Ethernet services cannot be provided.[246]
- [✂] stated that it will use FTTX where possible ahead of EFM, although different coverage across the country will dictate uptake.[247] It also said that FTTP offers the opportunity to migrate EFM customers to a fibre-based solution as the copper platform approaches the end of its life and fibre is preferred to copper.[248]
- [✂] said that it has intentions to migrate its EFM circuits to FTTX in the long-term due to platform lifecycle and market evolution to ultrafast FTTC and FTTP.[249]

A8.64 This is consistent with the volume forecasts submitted by telecom providers indicating that EFM volumes will decline by c.32% over the next four years, while FTTC volumes will triple.

A8.65 Based on this evidence, we consider that it is highly unlikely that more than [✂] of 100 Mbit/s customers would switch to EFM in response to a 10% SSNIP. We also received no objections from stakeholders in response to these findings. Consequently, we conclude that switching to EFM is unlikely to defeat a SSNIP at 100 Mbit/s, indicating that EFM and 100 Mbit/s are not close demand substitutes.

Substitution to asymmetric broadband

A8.66 Substitution from 100 Mbit/s to asymmetric broadband is also bounded by the lower quality and limited coverage of the latter service.

A8.67 In relation to asymmetric broadband, upload speeds are dependent on the technology used. For example, for FTTC services, the maximum upload speed that can be delivered is 20 Mbit/s. Migration patterns suggest that few leased line customers consider FTTC as an

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[243] Openreach response to Part 3 of the BCMR s.135-15 Notice
[244] Cartesian, 2018. Business Connectivity Market Assessment [accessed 16 May 2019].
[245] FTTX means a connection of Fibre-to-the-Cabinet (FTTC) or Fibre-to-the-Premises (FTTP).
[246] [✂].
[247] [✂]
[248] [✂]
[249] [✂] response dated 20 April 2018 to Question 1 of the BCMR s.135-6 Notice on the impact of EFM/FTTx as a constraint on 100Mb/s services.

alternative service.[250] Openreach's 2015 migration analysis shows that at that time a small proportion ([✄ %]) of the Openreach EAD leased line ceases identified as possible migrations were identified as having migrated to FTTC.[251]

A8.68 However, with the ongoing and future rollout of ultrafast technologies like FTTP, higher upload speeds will be available, and therefore asymmetric broadband may become more of a substitute for CI Access services in the future. In their response, SSE claimed that FTTP is a viable substitute for services at 1 Gbit/s and below.[252] BT Group also stated that services at 1 Gbit/s and below are increasingly becoming competitive at the wholesale level from FTTP providers.[253]

A8.69 While we acknowledge that ongoing and future FTTP deployments will narrow the speed gap between asymmetric broadband and CI Access services, we remain of the view that take up of FTTP is likely to be low among CI Access customers for two reasons. First, we expect that FTTP coverage is likely to be limited for businesses over the course of this review period. This is further supported by our engagement with telecoms providers which suggests that FTTP rollout will have little impact on the demand for leased lines over the course of this market review period.[254] Second, leased lines are high quality point-to-point connectivity services that tend to be symmetric (i.e. the capacity is the same in both directions) and uncontended (i.e. the capacity is guaranteed and not subject to reduction). While FTTP may be a good substitute for some leased line customers, for others it is likely to be a weak substitute for CI Access services due to its quality limitations.[255]

A8.70 In TalkTalk's view, an FTTP network "does not have the features businesses generally seek".[256] TalkTalk stated that it does not anticipate FTTX to have a significant impact on the demand for Ethernet leased lines services in the next 3-5 years due to the following factors:

- "Customer bandwidth requirements evolution – existing Ethernet Leased Line customers will continue to see their bandwidth and network performance

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[250] Our meetings with telecoms providers also indicate limited coverage to be a barrier for the take-up of FTTC. Our Connected Nations 2017 report found that FTTC is available to 84% of small businesses, while only available to 74% small businesses in business parks and trading estates (Ofcom, 2017. Connected Nations 2017 Report [accessed 20 May 2018]). Verizon suggested an even lower average coverage rate of (49%) for larger businesses (Verizon email sent by [✄] on 14 May 2018).

[251] Openreach response to Part 3 of the BCMR s.135-15 Notice on TI services, see document entitled 'Ethernet Migration Analysis Update', page 2.

[252] SSE's response to the 2018 BCMR Consultation, page 2.

[253] BT Group's response to the 2018 PIMR and 2018 BCMR Consultations, paragraphs 3.19-3.22.

[254] TalkTalk response to Question 1 of the BCMR s.135-6 Notice; BT response to Question 1 of the BCMR s.135-6 Notice; "PIR and Inflight Review", p.4; and Vodafone response to Question 1 of the BCMR s.135-6 Notice on the impact of EFM/FTTx as a constraint on 100Mb/s services.

[255] However, we note that telecoms providers can mitigate some of these disadvantages, for example, by over dimensioning the backhaul capacity to reduce contention or by applying traffic management methods to deliver lower error rates comparable to those of leased lines.

[256] TalkTalk's response to the 2018 BCMR Consultation, paragraph 2.29.

requirements evolve and grow - beyond the service levels of the initial contended broadband FTTP offerings"; and

- "Limited availability (coverage and business-specific) FTTP service – almost all FTTP rollouts are being targeted at residential areas and therefore we expect coverage of commercial premises to lag. In the next 3 years at least, premises coverage will not be significant enough to materially impact volumes".[257]

A8.71 BT expects most FTTP volumes to come from existing copper broadband customers. It stated that [✂].[258]

A8.72 Vodafone said that they do not see "customers migrate from Ethernet leased lines 100 Mbit/s or higher to FTTX in like for like circumstances. A change from Ethernet to FTTX would occur if there were a change in circumstances such as customers might change if an office location was reduced to a lower number of employees / if floor space taken at a location was reduced".[259]

A8.73 In addition, it considered that asymmetric broadband and leased lines should be seen more as complements rather than substitutes. Vodafone explained that it uses broadband (ADSL and FTTC) "as an access mechanism to connect small sites with a low assured bandwidth requirement cost effectively onto a wide area network" or as a "backup connection to Ethernet leased lines or broadband lines". While it uses Ethernet when "a customer site exceeds the smaller levels of demand to access the internet; needs equivalent download and upload speeds due to uploading, publishing or transfer large amounts of data and needs a rapid repair time due to the business-critical status of the services being downloaded and uploaded".[260]

A8.74 We consider that this evidence in the round suggests that substitution from 100 Mbit/s to FTTC is unlikely to exceed [✂] in the event of a SSNIP. While we acknowledge that FTTP may be more of a demand-side substitute for CI Access services than FTTC, we remain of the view that take up of FTTP is likely to be low among CI Access customers during this review period due to its limitations in terms of quality and coverage. Therefore, we conclude that asymmetric broadband and 100 Mbit/s services are unlikely to be demand substitutes.

Substitution to dark fibre

A8.75 Dark fibre is another option leased line customers have to satisfy their connectivity needs. With dark fibre, however, customers need to install the equipment and manage the

[257] TalkTalk response to Question 1 of the BCMR s.135-6 Notice on the impact of EFM/FTTx as a constraint on 100Mb/s services.
[258] BT response dated 20 April 2018 to Question 1 of the BCMR s.135-6 Notice on the impact of EFM/FTTx as a constraint on 100Mb/s services. PIR and Inflight Review, p. 4.
[259] Vodafone response to Question 1 of the BCMR s.135-6 Notice on the impact of EFM/FTTx as a constraint on 100Mb/s services.
[260] Vodafone response to the BCMR s.135-6 Notice on the impact of EFM/FTTx as a constraint on 100Mb/s services.

network themselves. This is likely to limit the demand for dark fibre as few customers are likely to have the willingness and skills to do this. This should not be a problem though for wholesale customers who are used to managing networks.

A8.76 Pricing data from telecoms providers suggests that dark fibre prices are high relative to 100 Mbit/s prices. We analysed the pricing of CityFibre's existing dark fibre contracts and estimate that the total cost of ownership (TCO) of these contracts ranges from [✂][261] on an annualised basis, with a median TCO of [✂]. This excludes the costs of installing and managing the electronics. Once these costs are included, the cost of dark fibre rises to £[✂] for the median contract. This compares against a TCO of £2,285 for a 1 Gbit/s EAD LA service.

A8.77 There are also non-price factors that are likely to limit the extent to which CI Access services customers may see dark fibre as a close substitute. These are:

- the need for customers to light the fibre and manage the network themselves;
- the limited footprint of dark fibre networks, which means that duct works are likely to be needed to connect a new customer; and
- the time to connect a customer site when duct works are required and the inconvenience of this for customers. The evidence suggests that it may take around five months ([✂]) for duct works to be completed and this could be a source of significant disruption for customers (see Annex 11 of Volume 2).

A8.78 This is consistent with the BDRC 2016 study which suggests that few low bandwidth customers see dark fibre as an alternative service, with only 3% of respondents using connections of 100 Mbit/s or less saying that they would consider dark fibre.[262] This is also in line with the dark fibre research we conducted as part of the BCMR 2016 indicating that dark fibre circuits are not used for bandwidths below 1 Gbit/s.[263] IIG also agreed that dark fibre is not likely to impose a constraint on low bandwidth services.[264]

A8.79 Therefore, the evidence suggests that few 100 Mbit/s customers (less than 10%) would switch to dark fibre in the event of a SSNIP, making it highly unlikely that substitution to dark fibre would defeat a SSNIP at 100 Mbit/s. We also received no objections from stakeholders in response to these findings. Hence, we conclude that dark fibre and 100 Mbit/s CI Access services are not close demand substitutes.

SSNIP at 1 Gbit/s

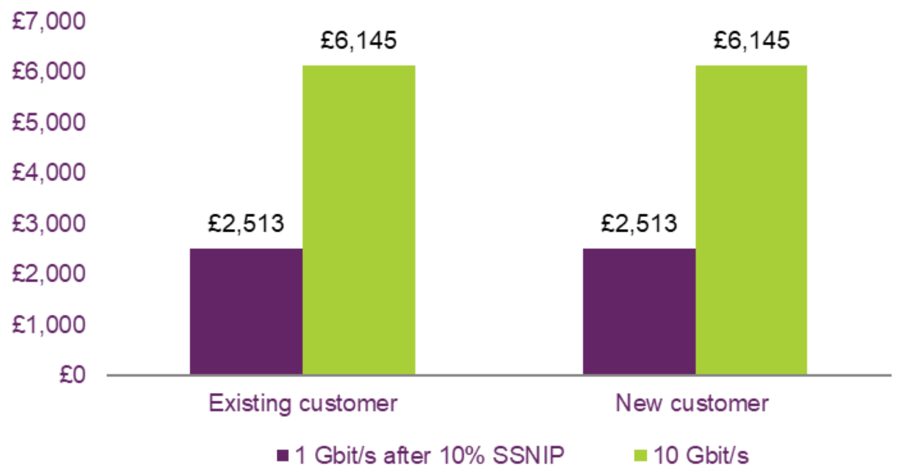
Substitution to 10 Gbit/s

A8.80 Figure A8.6 shows the comparison between the price of 1 Gbit/s (after a 10% SSNIP) and the price of 10 Gbit/s for the two scenarios. We note that given that migration from 1

[261] Annualised 3-year TCO calculation based on CityFibre's 2017 dark fibre connections. The TCO includes rental and connection charges. Connection charges were spread over a three-year contract term and discounted based on an 8% WACC.
[262] BDRC 2016, Figure 34a and 34b.
[263] BCMR 2016, Figure 4.5.
[264] IIG's response to the 2018 PIMR, 2018 BCMR and 2018 BT RFR Consultations, paragraph 4.3.3.

Gbit/s to 10 Gbit/s requires replacing equipment, price differentials look identical for the two scenarios.

Figure A8.6: Price comparison between 1 Gbit/s (after 10% SSNIP) and 10 Gbit/s – annualised total cost of ownership (£)[265]



Source: Ofcom analysis based on Openreach prices for EAD LA as of October 2018.

A8.81 The figure shows that a 1 Gbit/s customer would find it considerably cheaper to stay at 1 Gbit/s than to upgrade to 10 Gbit/s. This is similar for a new customer.

A8.82 Vodafone suggested that evidence for demand-side substitution is limited because 10 Gbit/s prices are not set at the competitive level.[266] TalkTalk argued that by using current prices rather than competitive prices, Ofcom had overestimated the competitive constraint imposed by 1 Gbit/s on 10 Gbit/s.[267] Both TalkTalk[268] and Openreach[269] argued that we had not demonstrated the results would be different if 1 Gbit/s and 10 Gbit/s prices were set at the FAC level. Also, Openreach's view is that there is a break between 1 Gbit/s and 10 Gbit/s.[270]

A8.83 As mentioned in Section 4 of Volume 2, we acknowledge the price differential between 1 Gbit/s and 10 Gbit/s suggests there is a break, although we note this may be influenced by current high 10 Gbit/s prices. Despite this, even if we assume that price differentials were to reflect cost differentials in a competitive market, we consider that the cost differentials

[265] Prices are stated on a Total Cost of Ownership (TCO) basis and include rental and connection charges. Connection charges are spread over a three-year period by calculating the annuity which, when considered over the three-year period, is equivalent to the upfront connection charge on a NPV basis. To calculate this annuity we assume a 8% discount rate or Weighted Average Cost of Capital (WACC).

[266] Also, Vodafone stated that the number of customers switching between 1 Gbit/s and 10 Gbit/s is low (Vodafone's response to the 2018 BCMR Consultation, part 2, paragraphs 1.9-1.10).

[267] TalkTalk's response to the 2018 BCMR Consultation, paragraph 2.14.

[268] TalkTalk's response to the 2018 BCMR Consultation, paragraphs 2.16-2.17.

[269] Openreach's response to the 2018 BCMR Consultation, page 87, paragraph 34.

[270] Openreach's response to the 2018 BCMR Consultation, page 87, paragraph 34.

between 1 Gbit/s and 10 Gbit/s (see Annex 7 of Volume 2) are such that substitution to 10 Gbit/s may not be sufficient to defeat a SSNIP on 1 Gbit/s. For example, as at March 2017, we estimated that EAD 1 Gbit/s prices were 32% above FAC and those for EAD 10 Gbit/s were [✂] 100-150% above FAC.[271]

A8.84 Therefore, we consider that it is unlikely that a significant number of 1 Gbit/s customers (more than 12%) would switch to 10 Gbit/s in response to a SSNIP. IIG agreed with our findings that 10 Gbit/s is unlikely to defeat a SSNIP at 1 Gbit/s.[272]

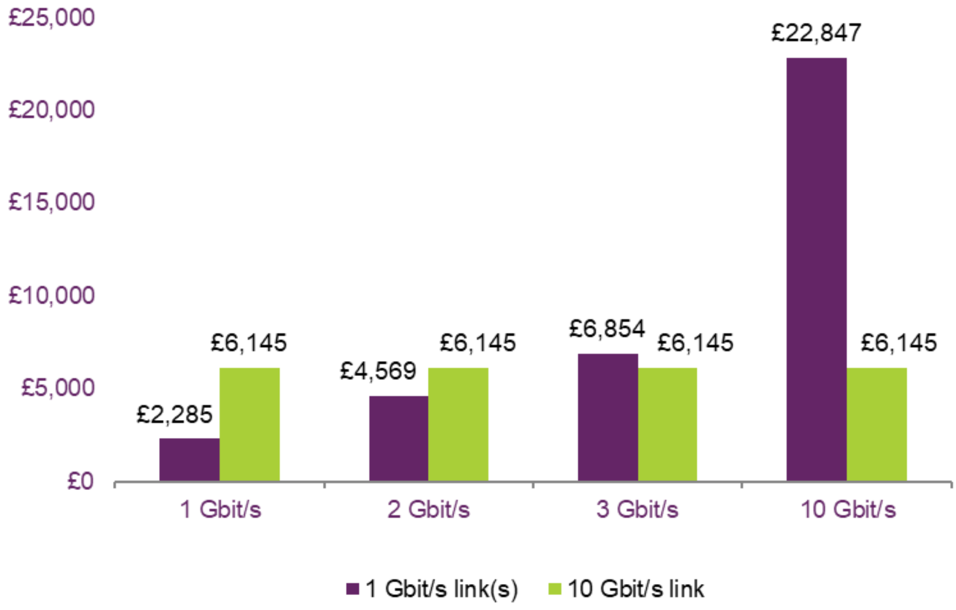
A8.85 In the 2016 BCMR we identified customers with multiple 1 Gbit/s circuits as the most likely to switch to 10 Gbit/s in response to a SSNIP at 1 Gbit/s.[273] This was because the decision to migrate for these customers was finely balanced as they were already indifferent between purchasing two 1 Gbit/s circuits (in the same route) or a single 10 Gbit/s circuit, i.e. the price of 10 Gbit/s was found to be almost equivalent to two times the price of 1 Gbit/s.

A8.86 However, we note the price differential between 1 Gbit/s and 10 Gbit/s has widened after Openreach's recent price cut in EAD 1 Gbit/s charges (as of October 2018). Therefore, the decision to migrate is now more finely balanced for customers indifferent between purchasing three 1 Gbit/s circuits (in the same route) or a single 10 Gbit/s circuit. This can be seen in figure A8.7 below.

A8.87 Based on the above, we conclude that demand-side substitution to 10 Gbit/s is unlikely to defeat a SSNIP at 1 Gbit/s, hence pointing at 1 Gbit/s and 10 Gbit/s not being close demand substitutes.

[271] Ofcom analysis based on BT's 2016/17 RFS and Openreach's price list as at March 2017.
[272] IIG's response to the 2018 PIMR, 2018 BCMR and 2018 BT RFR Consultations, paragraph 4.3.1.
[273] BCMR 2016, paragraph 4.152.

Figure A8.7: Price comparison between 1 Gbit/s and 10 Gbit/s by bandwidth demand – annualised total cost of ownership (£)



Source: Ofcom analysis based on Openreach prices for EAD LA as of October 2018.

Substitution to 100 Mbit/s

A8.88 For the same reasons that 100 Mbit/s customers are unlikely to switch back to 10 Mbit/s in the event of a SSNIP, 1 Gbit/s customers are unlikely to trade down to 100 Mbit/s in response to a 10% price increase, or at least not in sufficient numbers to render a SSNIP unprofitable. Again, we conclude there is an asymmetric substitution relationship between 100 Mbit/s and 1 Gbit/s.

Substitution to asymmetric broadband and EFM

A8.89 We have established that substitution to asymmetric broadband and EFM is unlikely to sufficiently constrain the price of 100 Mbit/s to be considered in the same product market. We consider that substitution from 1 Gbit/s to asymmetric broadband and EFM is even less likely given the larger bandwidth differential involved. For example, FTTP is likely to impose a weaker constraint on 1 Gbit/s than on 100 Mbit/s. Therefore, we would not expect substitution to asymmetric broadband and EFM to defeat a SSNIP at 1 Gbit/s. Consequently, we conclude that EFM and asymmetric broadband are not close demand substitutes of 1 Gbit/s services.

Substitution to dark fibre

A8.90 We consider that dark fibre is likely to be more attractive for 1 Gbit/s customers than for 100 Mbit/s customers. Pricing of dark fibre looks more competitive when compared to 1 Gbit/s charges, although 1 Gbit/s charges are still lower than the dark fibre price for the median contract, £2,285 compared to [✂] on a total cost of ownership basis.

A8.91 In addition, the dark fibre research we conducted as part of the 2016 BCMR uncovered that a non-negligible proportion of dark fibre customers (more than 20%) use dark fibre for 1 Gbit/s circuits.[274] However, the question is whether a sufficient number of 1 Gbit/s customers ([✂] would switch to dark fibre in the event of a SSNIP.

A8.92 The evidence suggests that this is unlikely for the following reasons:

- non-price factors including the time required to dig to a new customer site[275] and the need for customers to light and manage the dark fibre circuit is likely to deter 1 Gbit/s customers from switching; and
- a small proportion of leased line customers of 1 Gbit/s or below (8%) say they consider dark fibre as an alternative service.[276]

A8.93 However, we recognise that CityFibre has been successful in offering dark fibre services to typical 1 Gbit/s customers and that the low dark fibre volumes could be a reflection of the limited availability of dark fibre as a result of the two main network providers (Openreach and Virgin Media) not supplying the service. Nevertheless, the evidence is ambiguous and customers may need time to adapt before they are able to switch from CI Access services to dark fibre in response to a small price increase.

A8.94 Based on this evidence we consider that substitution to dark fibre is unlikely to be enough ([✂]) to render a SSNIP at 1 Gbit/s unprofitable, and therefore conclude that these services are not close demand substitutes.

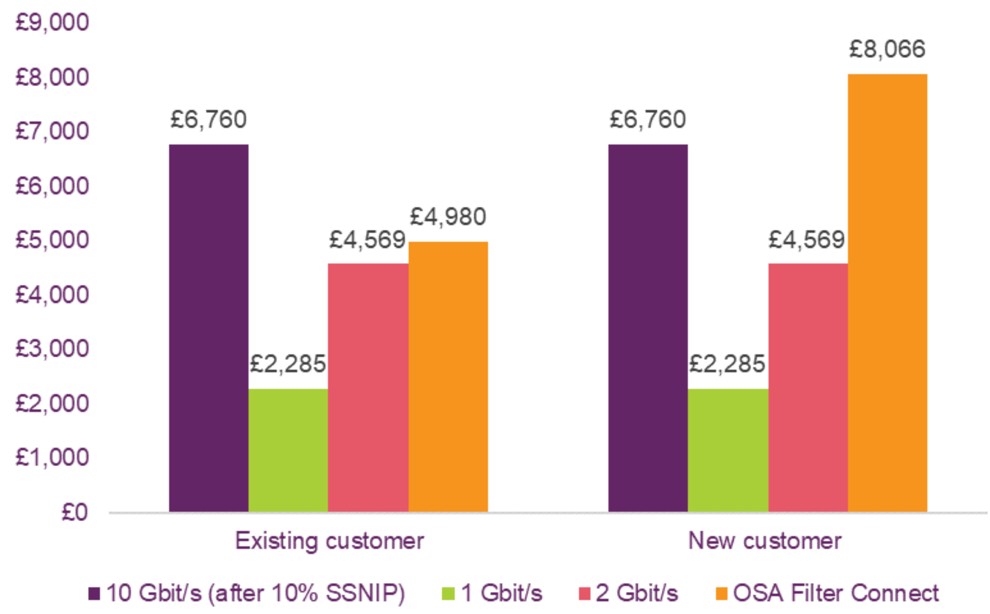
SSNIP at 10 Gbit/s

Substitution to 1 Gbit/s

A8.95 Figure A8.8 shows the price comparison between the price of 10 Gbit/s (after a 10% SSNIP) and the price of 1 Gbit/s and multiple 1 Gbit/s for the two scenarios.

[274] BCMR 2016, Figure 4.5.
[275] Openreach argued that the relevance of dark fibre entry is not obvious as Ofcom does not consider it "in the context of the relevant timeframe" (Openreach's response to the 2018 BCMR Consultation, page 95, paragraph 78). We consider timeframe by considering the inconvenience faced by customers from waiting to be connected by a supplier.
[276] BDRC 2016, Figure 34a and 34b.

Figure A8.8: Price comparison between 10 Gbit/s (after 10% SSNIP), 1 Gbit/s, multiple 1 Gbit/s and wavelength division multiplex – annualised total cost of ownership (£)[277]



Source: Ofcom analysis based on Openreach prices for EAD LA as of October 2018 and proposed prices for the OSA Filter Connect product (single fibre variant) as of March 2018.[278]

A8.96 Figure A8.8 shows that 10 Gbit/s customers with a bandwidth demand of less than 2 Gbit/s would find it cheaper to switch to 1 Gbit/s or multiple 1 Gbit/s. Nevertheless, we focus our analysis on 10 Gbit/s customers requiring between 1 and 2 Gbit/s (which we refer to as 2G customers)[279] as we do not expect customers requiring 1 Gbit/s or less to take 10 Gbit/s (for these customers, 1 Gbit/s would be a cheaper option even before the SSNIP). For 2G customers switching to multiple 1 Gbit/s would represent an annual cost saving of £2,191 (or a 32% discount over the 10 Gbit/s price).

A8.97 We consider that this cost saving is unlikely to be sufficient to encourage enough 2G customers to switch from 10 Gbit/s to 1 Gbit/s in response to a SSNIP for two reasons. First, these customers are likely to place some value on having additional bandwidth (i.e. by switching to multiple 1 Gbit/s, 2G customers would lose 80% of their current bandwidth). Second, bandwidth demand is growing rapidly so 2G customers are unlikely to switch to 1 Gbit/s only to switch back to 10 Gbit/s later (when their bandwidth need exceeds 2 Gbit/s) and pay the associated 10 Gbit/s connection charges again.

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[277] Prices are stated on a Total Cost of Ownership (TCO) basis and include rental and connection charges. Connection charges are spread over a three-year period by calculating the annuity which, when considered over the three-year period, is equivalent to the upfront connection charge on a NPV basis. To calculate this annuity we assume a 8% discount rate or Weighted Average Cost of Capital (WACC).
[278] Openreach, 2018. [OSA Filter Connect available from 3 April 2018] [accessed 16 May 2019].
[279] This is consistent with the way the Tribunal referred to multi-circuit customers.

A8.98 We conclude therefore that substitution to 1 Gbit/s is likely to be insufficient to render a SSNIP at 10 Gbit/s unprofitable.[280] Together with our substitution analysis from 1 Gbit/s to 10 Gbit/s, this analysis suggests that demand-side substitution between 1 Gbit/s and 10 Gbit/s is likely to be weak in both directions.

Substitution to dark fibre

A8.99 We consider that dark fibre is most appealing to 10 Gbit/s customers for a number of reasons:

- dark fibre prices look attractive when compared to current 10 Gbit/s prices ([[✂] compared to £6,145 on a total cost of ownership basis);
- evidence from Openreach internal documents suggest that Openreach's 10 Gbit/s prices compete against dark fibre;[281] and
- previous dark fibre research suggests that most dark fibre circuits (70 to 80%) are used for VHB.[282]

A8.100 This evidence is consistent with consumer research indicating that 20% of VHB customers consider dark fibre as an alternative service, compared to 8% for lower bandwidth customers.

A8.101 Nevertheless, non-price factors may limit the extent to which 10 Gbit/s customers would switch to dark fibre in response to a SSNIP. Similar to our analysis of substitution from 100 Mbit/s and 1 Gbit/s to dark fibre, 10 Gbit/s customers are likely to be reluctant to install the equipment and manage the network themselves as well as to wait for the dark fibre supplier to extend its network to connect their buildings.

A8.102 However, IIG mention that its members have seen that "some wholesale customers of VHB circuits are more likely to use dark fibre as a substitute" and suggest that "a significant number of wholesale customers of VHB circuits have the technical competence to add equipment and manage the service".[283] Therefore, there may be some customers that have the technical capabilities to use dark fibre, however, there are still other non-price factors (i.e. current footprint of dark fibre) which may limit the extent to which 10 Gbit/s customers could switch to dark fibre in response to a SSNIP.

A8.103 The evidence is thus ambiguous on whether a sufficient number of 10 Gbit/s customers (more than [✂]) would switch to dark fibre in the event of a SSNIP to render the price increase unprofitable.

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[280] TalkTalk argued that by using current prices rather than competitive prices, Ofcom had underestimated the competitive constraint imposed by 10 Gbit/s on 1 Gbit/s (TalkTalk's response to the 2018 BCMR Consultation, paragraph 2.17). As set out further above, we still find that cost differentials between 10 Gbit/s and 1 Gbit/s are such that substitution to 1 Gbit/s may not be sufficient to defeat a SSNIP on 10 Gbit/s.
[281] Openreach, 2018. *New pricing and product launches for VHB portfolio*. Submitted by Openreach in response to the BCMR s.135-8 Notice on FTTX, EFM and CI services.
[282] BCMR 2016, Figure 4.5.
[283] IIG's response to the 2018 PIMR, 2018 BCMR and 2018 BT RFR Consultations, paragraph 4.3.3.

Conclusions on demand-side substitution

A8.104 Our SSNIP analysis above suggests that there is an asymmetric relationship in the substitution across leased lines of different bandwidths up to 1 Gbit/s. In these instances, we find that higher bandwidth CI Access services are a close substitute to the next lower bandwidth service, but not the other way around. We also find that EFM, asymmetric broadband and dark fibre are not strong enough demand substitutes for these services to defeat a potential SSNIP on either 100 Mbit/s or 1 Gbit/s.

A8.105 Our analysis shows that there is a possible break between 1 Gbit/s and VHB services as price differentials between these services remain high, though these differentials may be distorted by BT's high VHB prices.

A8.106 Dark fibre appears to place a stronger constraint on VHB than on lower bandwidths, but we consider the evidence to be inconclusive as to whether substitution to dark fibre would be enough to defeat a SSNIP on VHB.

A8.107 Our demand-side substitution analysis above does not capture the fact that network operators are able to supply the full range of bandwidths, and hence the candidate substitute may be supplied by the incumbent supplier. We take this into account in our analysis of supply side substitution in Section 4 of Volume 2, where we conclude that telecoms providers can seamlessly switch to different bandwidths once they connect the customer site. This leads to our decision that there is a single market for CI Access services at all bandwidths.

A9. Assessment of mobile backhaul

A9.1 Mobile network operators (MNOs) are significant buyers of leased lines. We estimate that they currently use over [✂] leased line circuits and require leased line coverage across a wide geographic area. MNOs use leased lines to connect their mobile base stations to a point of aggregation in their core networks. This can be done using a mix of access and backhaul connections.[284]

A9.2 This annex focuses on the use of Contemporary Interface (CI) Access[285] leased lines purchased by MNOs to connect to mobile base stations. For convenience, we refer to these CI Access connections as "mobile backhaul" in this annex.[286] We have examined if there are significant differences in competitive conditions in the supply of mobile backhaul connections to base stations compared to other services in the CI Access market. If we were to find significant differences in the conditions of competition, it might be appropriate to define separate markets. The analysis in this annex takes into account responses to our consultation on this issue and reflects further evidence gathered following our consultation.

A9.3 We have concluded that mobile backhaul is part of the CI Access services market, rather than a separate product market, on the basis of homogeneity of competitive conditions. Even if we were to define a separate market for MNO backhaul, the resultant SMP assessment would be similar to those for all CI Access customers.

A9.4 We set out our analysis and findings in the following order:

- our summary of stakeholder responses to our consultation proposals;
- our approach to defining product markets for different customer types;
- our assessment of competitive conditions for MNO and enterprise customers;
- our hypothetical SMP assessment if we were to define a separate MNO market; and
- our conclusion on mobile backhaul market definition.

Summary of stakeholder responses

A9.5 In the 2018 BCMR consultation, we proposed to define a single market for CI Access services which would include both MNO and enterprise customers. This finding is based on similarity of competitive conditions. Although we found some differences between purchasers of mobile backhaul and enterprise customers, we concluded that in both cases,

[284] As shown in Section 3 of Volume 2, Figure 3.2.
[285] Network operators have historically been significant buyers of traditional interface circuits. However, some of the mobile network operators no longer have any traditional interface circuits remaining, while others confirmed that they would migrate to Ethernet services by the end of the review period.
[286] In this annex, we refer to CI Access leased lines purchased by MNOs as 'mobile backhaul' mainly for convenience. However elsewhere in the document, unless otherwise stated, by 'mobile backhaul' we are referring to the purchase of access leased lines and/or inter-exchange leased lines for backhaul and/or core connections which, when combined, connect mobile base stations to a point of aggregation in their core networks.

competition is primarily determined by the proximity of rival networks to the customer site. As part of our assessment, we also proposed to exclude microwave backhaul links from the CI Access services market.

A9.6 Overall, 6 consultation respondents commented on our market definition proposal. CityFibre, Zayo and IIG agreed with our proposal that "circuits used for mobile backhaul form part of the overall CI Access market" and that there is "no separate product market".[287] On the other hand, Openreach, Passive Access Group (PAG) and Vodafone argued that there is a separate market for MNOs.

CityFibre and Zayo agreed but they raised some concerns

A9.7 CityFibre and Zayo agreed with our proposal. However, they disagreed that mobile backhaul and other CI Access services face similar competitive conditions, due to concerns around the terms on which BT provides mobile backhaul downstream. These can be summarised as follows:

- CityFibre's concerns are that BT's downstream businesses may be [✂].[288]
- Zayo argued that BT's (and potentially Virgin Media's) pricing makes it difficult for MNOs to choose other suppliers without suffering financial consequences.[289]
- IIG argued that "Ofcom should undertake an investigation of BT's pricing strategy" for provision of mobile backhaul downstream.[290]

Openreach argued that MNOs have buyer power and microwave is a substitute

A9.8 Openreach said that mobile backhaul is "very different from business access", and at the minimum, a separate analysis for mobile backhaul in terms of competitive conditions is required in future reviews.[291] Its main arguments were that we should have undertaken a sensitivity analysis on mobile backhaul as a separate market, and that we had not examined switching costs in the right context as "MNOs are often able to exercise countervailing buyer power".[292]

A9.9 Openreach did not agree with our proposal, given that our analysis suggested microwave is widely used by MNOs. They argued that under the modified greenfield approach (MGA), "Ofcom should allow for microwave to form some competitive constraint on pricing of fibre connections".[293]

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[287] CityFibre's response to the 2018 BCMR and 2018 BT RFR Consultations, paragraph 4.2; Zayo's response to the 2018 BCMR and 2018 BT RFR Consultations, paragraph 3.1.1; and IIG's response to the 2018 PIMR, 2018 BCMR and 2018 BT RFR Consultations, paragraph 4.4.5.
[288] CityFibre's response to the 2018 BCMR and 2018 BT RFR Consultations, paragraph 7.1.19.
[289] Zayo's response to the 2018 BCMR and 2018 BT RFR Consultations, paragraph 3.1.3.
[290] IIG's response to the 2018 PIMR, 2018 BCMR and 2018 BT RFR Consultations, paragraph 4.4.9.
[291] Openreach's response to the 2018 BCMR Consultation, page 96, paragraph 83.
[292] Openreach's response to the 2018 BCMR Consultation, pages 95-96, paragraph 80, 85-86.
[293] Openreach's response to the 2018 BCMR Consultation, page 96, paragraph 87-88.

Vodafone argued that MNOs have different demand and supply side characteristics

A9.10 Vodafone was the only MNO who disagreed with our proposal that mobile backhaul is in the CI Access services market.[294] PAG also disagreed with our proposal.[295] They both argued that mobile backhaul is a separate market due to differences in the demand and supply requirements of MNOs and enterprise customers.

A9.11 Vodafone's arguments are that in relation to the demand side: [296]

- MNOs represent a small number of purchasers with large and more specific demands;
- the product demanded by MNOs is different as they require dark fibre rather than active services. MNOs have the capability to manage their own networks and use the same active services as enterprise customers only because they have no other option; and
- "MNOs have a particular urgent need for dark fibre due to the timing of the 5G rollout which is already underway".

A9.12 Vodafone added that in relation to the supply side: [297]

- our analysis of geographic markets relies on prospects of market entry upstream. However, this is less likely to happen for mobile backhaul because there is no economic rationale for deploying duplicate fibre at mobile base stations, as the fibre cannot be redeployed (i.e. sold to another customer at a future date);
- it is challenging to find alternative suppliers at a given mobile base station and even if found, it is rare that they offer terms equal or more preferential than BT;
- MNO sites are more likely to be in remote areas, meaning that prospective suppliers need more coverage than they would to supply enterprise customers; and
- the CMA in its BT/EE merger analysis had assumed regulatory remedies including access to dark fibre would address a number of risks to MNOs.[298] [299]

A9.13 We note that Vodafone argued for a national geographic market for MNO as well as enterprise customers.[300] We address this argument in Section 5 of Volume 2. In this annex, we only address points that may be relevant to variation in competitive conditions between MNOs and enterprise customers.

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[294] BT/EE, Telefónica and Three did not have any comments on our proposed market definition.
[295] PAG's response to the 2018 BCMR consultation, paragraphs 22-23.
[296] Vodafone's response to the 2018 BCMR Consultation, part 2, paragraph 2.2.
[297] Vodafone's response to the 2018 BCMR Consultation, part 2, paragraph 2.3-2.5.
[298] Vodafone's response to the 2018 BCMR Consultation, part 2, paragraph 2.4.
[299] CMA, 2016. A report on the anticipated acquisition by BT Group plc of EE Limited [accessed 16 January 2019].
[300] Vodafone's response to the 2018 BCMR Consultation, part 2, paragraph 2.7.3 and letter from Vodafone (Emma Reynolds) to Ofcom (Jonathan Oxley) dated 21 December 2018.

MNOs’ views on the requirement of dark fibre remedy for 5G rollout

A9.14 As mentioned above, in support of its view that there is a separate product market for MNOs, Vodafone argued that MNOs need dark fibre over this review period to support 5G rollout. It considered that there are technical benefits of having direct access to fibre and in the absence of dark fibre, it is unsure how they could achieve an increase in mobile backhaul capacity cost effectively, [✂].[301]

A9.15 While the other MNOs did not comment on our proposed product market definition, they commented on the need for a dark fibre remedy over this review period.

- Similar to Vodafone, Telefónica argued that MNOs needed dark fibre to support the rollout of 5G. Telefónica argued that Ofcom had not considered the impact of its proposed remedies on the rollout of 5G.[302] They considered that MNOs would face significant charges in excess of the cost of supply for active 10 Gbit/s services, and such costs could result in a slower 5G rollout and higher prices for consumers.
- Also, Vodafone argued that EE will be able to “secure backhaul in-house, with no cash outflow for BT Group”,[303] and that EE’s “competitive advantage in mobile backhaul” may damage competition for consumers by slowing the pace and spread of 5G by other MNOs.[304]
- On the other hand, Three appeared to agree with our proposal, noting that the “imposition of a dark fibre remedy in the inter-exchange market should be prioritised over a nationwide dark fibre remedy”, and therefore provided no arguments against our proposed remedies in the CI Access services market (which would cover MNO backhaul).[305] BT Group (which includes EE) did not have specific comments on our proposed remedies for mobile backhaul.

A9.16 In light of stakeholder comments, we have gathered information on the 5G rollout plans of MNOs using our statutory powers. We have used this information to inform our overall assessment.

A9.17 We consider these comments from stakeholders in more detail in the relevant sub-sections below.[306] As part of our response, we have expanded on our product market definition assessment. We have also added a sub-section to set out our hypothetical SMP assessment for mobile backhaul were it to be defined as a separate market.

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[301] Vodafone’s response to the BCMR s.135-26 Notice, note entitled “5G rollout and mobile backhaul”.
[302] Telefónica’s response to the 2018 BCMR Consultation, paragraph 9-11.
[303] Vodafone’s response to the 2018 BCMR Consultation, part 1, paragraph 2.14.
[304] Vodafone’s response to the 2018 BCMR Consultation, part 1, paragraph 2.15.3.
[305] Three’s response to the 2018 BCMR Consultation, paragraph 1.1.
[306] Our conclusions on CI Access product market definition and SMP findings can be found in Volume 2, Sections 4 and 6 respectively.

Approach to defining markets for different customer groups

A9.18 As set out in Section 4 of Volume 2, we conclude that there is a single market for CI Access services at all bandwidths.[307] The following paragraphs set out our approach to assess whether we should define separate markets for different customer groups using CI Access services; namely MNOs and other CI Access customers (we refer to the latter as enterprise customers).

Potential for price discrimination

A9.19 In relation to demand-side analysis, the Commission suggests the possibility of defining narrower product markets on the demand side where there are distinct groups of customers and if such groups of customers are subject to price discrimination:

> "The extent of the product market might be narrowed in the presence of distinct groups of customers. A distinct group of customers for the relevant product may constitute a narrower, distinct market when such a group could be subject to price discrimination. This will usually be the case when two conditions are met: (a) it is possible to identify clearly which group an individual customer belongs to at the moment of selling the relevant products to him, and (b) trade among consumers or arbitrage by third parties should not be feasible".[308]

A9.20 The conditions for price discrimination are likely to be met for each individual customer in the CI Access services market. First, it is possible for a supplier to identify each individual customer based on their location. This is unique for each customer, even among MNOs and enterprise customers. Second, there is no potential for trade or arbitrage among leased lines customers, as each connection is unique, i.e. a connection to a customer at a given location cannot be used for connecting a customer in a different location.

A9.21 Therefore, on a strict demand-side basis, each leased line customer in principle could belong to a distinct product market.

We aggregate customers based on similarity of competitive conditions[309]

A9.22 Defining a separate market for each individual customer would be intractable. First, there are many hundreds of thousands of customers, and it would be unmanageable to find separate product markets (or impose remedies) for each. Second, analysing each individual customer would not produce meaningful results for the SMP assessment.

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[307] MNOs use and are supplied the same leased line service as other CI Access customers. Therefore, our assessment of demand-side substitution and supply-side substitution between CI Access services at different bandwidths, as set out in Section 4 and Annex 8 of Volume 2, applies to services used by all types of customers, including MNOs.

[308] Commission notice of 9 December 1997 on the definition of relevant market for the purposes of Community competition, page 7, paragraph 43 [accessed 11 June 2019].

[309] This is similar to our approach for geographic market definition as set out in Volume 2, Section 5.

A9.23 To make the analysis more tractable, we aggregate together customers that face similar competitive conditions. This can streamline the subsequent SMP analysis, by avoiding the need to review many very similar markets. Even if services are not demand-side or supply-side substitutes, it can be appropriate to analyse services as constituting part of the same market if competitive conditions in the supply of the two services are sufficiently homogeneous.[310]

A9.24 This is consistent with the relevant guidelines. For example, the OFT/CC Merger Assessment Guidelines suggest that "there are circumstances where Authorities may aggregate several narrow relevant markets into one broader one", such as when "the same firms compete to supply different products and the conditions of competition are the same for each product".[311]

We consider whether competitive conditions are sufficiently different for MNO and enterprise customers

A9.25 For leased line customers there is a continuum of demand as purchasing requirements vary across different customers. Some customers require just a single leased line; others such as Ofcom connect a handful of sites across the UK; whereas major retailers, public sector organisations and MNOs require thousands of circuits.[312] MNOs are at the higher end of this range. For example, our analysis suggests that Vodafone and Telefónica combined had over [✂] sites as of December 2017.[313] Vodafone noted that the Experian data of enterprise customers suggested the largest customers (for example Tesco and Boots) may have between 2000 and 3000 sites nationally.[314]

A9.26 The key question for our product market assessment is whether there are groups of customers for which the competitive conditions are sufficiently different from other customers such that the customer group is its own separate market. We consider potential differences for two groups of customers within the CI Access services market: MNOs and other CI Access enterprise (including public sector) customers.

Our approach to assessing variations in competitive conditions

A9.27 As set out in Section 5 of Volume 2, we consider that the strength of competition faced by BT is primarily determined by the presence of rival infrastructure. Therefore, our analysis of variations in competitive conditions focuses on the extent to which the ability of a nearby network to compete for a given MNO site is different from its ability to compete for a given enterprise site.

[310] This is consistent with the purpose of market definition, which is to structure and inform the assessment of whether a particular market is characterised by effective competition or should be subject to *ex ante* regulation. The EU regulatory framework recognises that market definition is not an end in itself but is a prerequisite for assessing the degree of an undertaking's market power.
[311] See for example, OFT/CC Merger Assessment Guidelines 2010, page 33, paragraph 5.2.17 [accessed 20 May 2019].
[312] We note that not all sites will be necessarily served by leased lines but they are an indication of the likely variations in the demand for leased lines.
[313] Based on Vodafone and Telefónica's response to the 5th BCMR s.135 Notice.
[314] Vodafone submission to Ofcom, "Mobile Backhaul", follow on material from 5 March 2018 meeting.

A9.28 In particular, we consider whether the ability to compete for each customer group may vary due to the following factors:

- **Level of presence of rival infrastructure and BT's advantage:** If there are more dense networks close to one customer group, this may suggest that they are facing more competition. We also consider the extent to which BT's ubiquitous network may give it a significantly greater advantage when competing for one group of customers.
- **Differences in demand-side characteristics for purchasing CI Access services**: As noted above, there is a continuum of demand for leased line services: the mere presence of variations in demand characteristics is not evidence in itself of variation in competitive conditions. We need to consider whether the differences are likely to mean that one group of customers is likely to face a significantly different level of competition and hence have different market outcomes (e.g. cheaper prices).
- **Demand-side substitution to microwave links:** Each mobile base station is connected to a mobile network node either by a leased line connection or by microwave radio. The latter is not is not as widely available to enterprise customers. If MNOs consider microwave links to be a demand-side alternative to CI Access services, this would mean that BT will face stronger competition for MNO customers.
- **MNO requirement for dark fibre**: We consider Vodafone's argument that product demanded by MNOs is different as they require dark fibre rather than active services and that MNOs have a particular urgent need for dark fibre during this review period to support their 5G rollout plans.[315]

Assessment of potential variations in competitive conditions

A9.29 Below, we set out our assessment for each of the factors mentioned in the previous paragraph. We then present our overall conclusion.

Presence of rival infrastructure

A9.30 As set out in Section 6 of Volume 2, we consider that BT has a competitive advantage when competing for CI Access customers as it is usually closer to customer sites. We have explained that:

- BT has by far the largest and the only ubiquitous network in the UK;
- BT's ubiquitous network gives it an advantage over other operators as it will more often have a physical infrastructure connection (fibre or duct) to customer sites; and

[315] As part of this assessment we also consider the arguments made by other MNOs on the need for dark fibre over this review period.

- This gives BT a significant cost[316] and time[317] advantage when it is fibre or duct connected while rivals are not.

A9.31 We consider that BT's advantage applies to both enterprise customers and MNOs. This is because the competitive advantage relates to connecting a customer at a particular location and BT is best placed to deliver at most locations. For example:

- Telefónica told us [✂]; and[318]
- Vodafone also told us that [✂][319]

A9.32 We consider that the scale of BT's competitive advantage and the ability of rival networks to compete for nearby customer sites is broadly similar for MNO and enterprise customers. We set out our analysis of and findings in the following order:

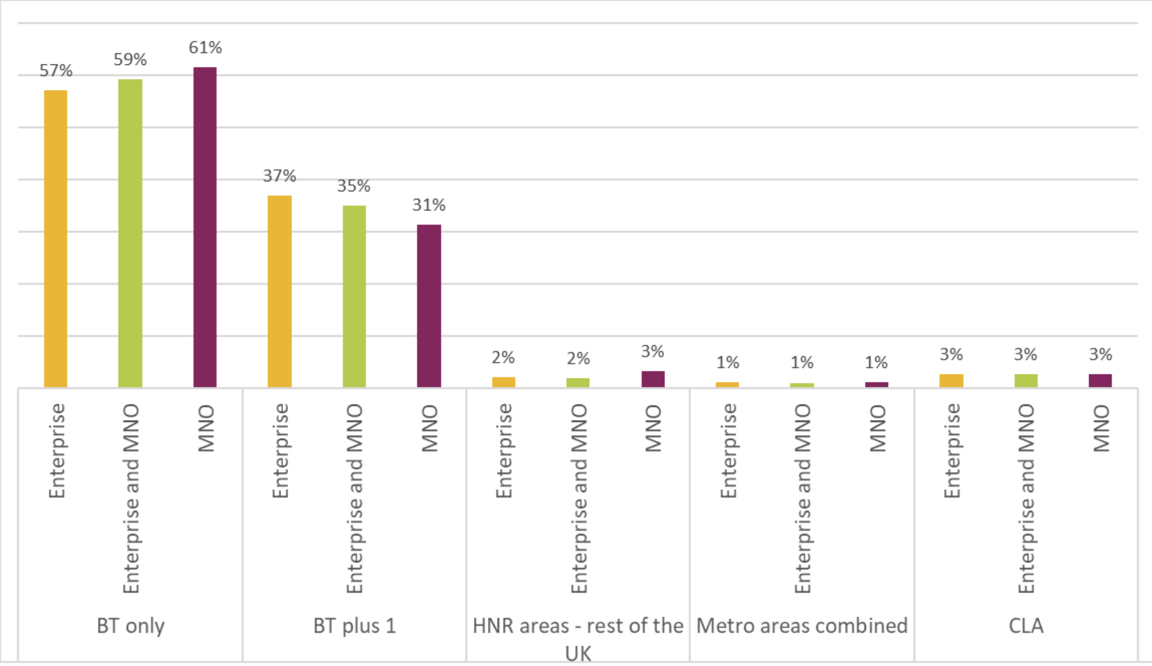
- The geographic distribution of sites and the presence of rival networks is broadly similar for both customer types.
- While MNOs need wider coverage, they can use multiple suppliers.
- The incentives to build to MNO and enterprise customers are broadly similar.

The geographic distribution of sites and presence of rival networks is broadly similar

A9.33 We have compared the distribution of mobile sites with those of all CI Access customers. Figure A9.1 below presents the proportion of sites in each geographic market for enterprise only, MNO only, and MNO and enterprise together.

[316] BT more commonly has existing duct connection to a customer site whereas rivals typically need to extend their network to reach a site. A supplier with a network that is closer to the customer has a significant cost advantage over one that is further away. The competitive advantage from having an existing duct (or fibre) connection compared to a rival that needs to dig is significant even at short distances.
[317] BT has an advantage compared to rivals as it is able to supply faster due to its greater proximity and customers face greater inconvenience choosing a telecoms provider located further away; for example, due to greater uncertainty over the time taken to extend the network.
[318] Telefónica meeting with Ofcom, 15 March 2018.
[319] Vodafone's response to the BCMR s.135-23 Notice on MNO backhaul and 5G rollout plans. We note Vodafone's argument which we cover in Volume 2, Section 5. Our analysis applies to both MNO and enterprise customers. We also consider the arguments for a national market for MNOs in specific later in this Section.

Figure A9.1: Distribution of customer sites by geographic market (%)[320]



Source: Ofcom analysis based on 2017 new connections data and MNO inventory data.

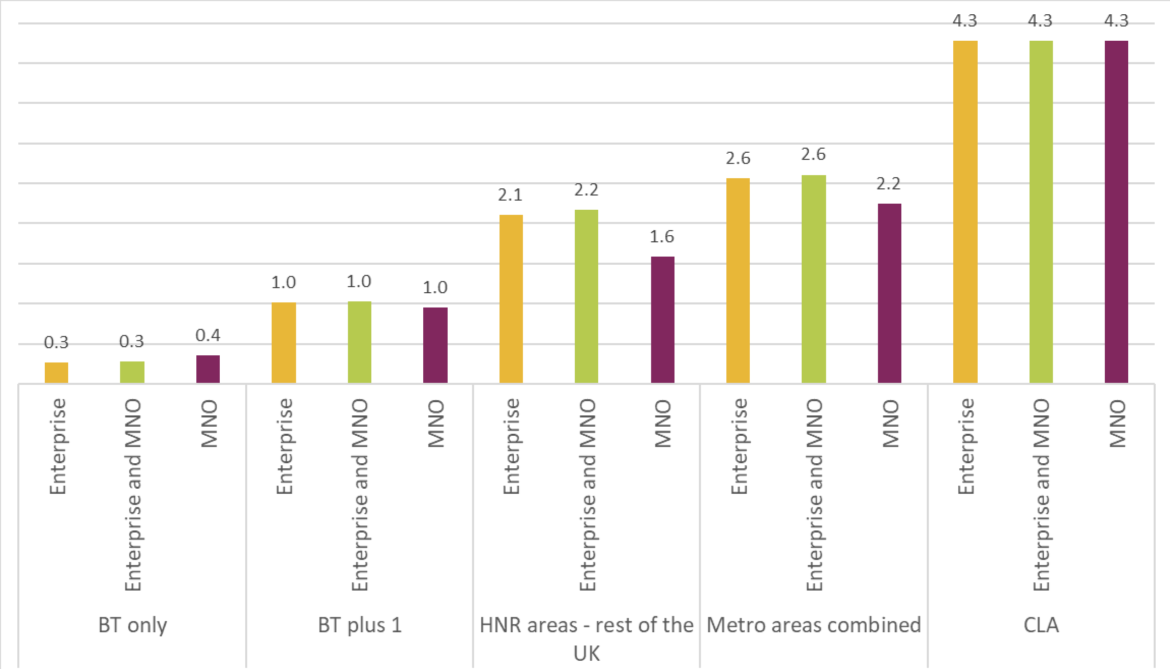
A9.34 Results show that MNO and enterprise customers have a broadly similar geographic distribution across our geographic markets. The majority of MNO and enterprise sites are in BT Only areas (61% and 57%, respectively), followed by BT+1 areas (31% v. 37% for enterprise), and the remainder of their sites in High Network Reach (HNR) areas (7% v. 6% for enterprise).[321] This indicates that the distribution of MNO sites is similar to that of CI Access customers as a whole, although weighted more towards BT Only sites.

A9.35 However, although a higher proportion of MNO sites are in BT Only areas, in absolute terms, the number of enterprise sites in BT Only areas far exceeds the number of MNO sites (71,000 vs. [✂]), suggesting that this distinction in terms of relative distribution may be overstated.

A9.36 Additional analysis (Figure A9.2) shows the average number of operators other than BT within 50m of each of MNO and enterprise sites in each geographic market. It shows that the network reach for MNO and enterprise sites are similar within the different geographic markets. Although MNO sites have proportionately more networks within reach in BT Only areas than enterprise sites, and proportionately fewer in BT+1 and HNR areas, the differences in both cases are relatively small.

[320] Results are based on geographic markets defined for each customer group, therefore the size of each geographic market varies by customer group.
[321] This includes the CLA, Metro Areas and other HNR areas in the rest of the UK.

Figure A9.2: Average number of rival networks within 50m buffer distance[322] [323]



Source: Ofcom analysis based on 2017 new connections data and MNO inventory data. Annex 12 provides a more detailed description and explanation of the analysis undertaken.

MNOs need wider geographic coverage

A9.37 Vodafone argued that mobile base stations are more likely to be geographically remote compared to enterprise sites. Therefore, prospective suppliers need even greater coverage to supply MNOs.

A9.38 We recognise that some mobile base stations are in particularly remote areas which can be difficult to reach, both for Openreach and rival networks. Data submitted by Openreach for its Quality of Service work indicated that over the period 2011 to 2018 [✂] of MNO orders were in “highly rural” areas compared with [✂] other orders.[324] Although this shows that a higher proportion of mobile circuits were in highly rural areas, in absolute terms, the number of enterprise orders in such areas far outweighed that of MNOs.

A9.39 We acknowledge that, in those remote areas, the Openreach network is likely to be significantly closer than any other network such that customers face limited options for supply whether they are an MNO or an enterprise customer.

A9.40 By itself, the fact that a (slightly) higher proportion of mobile circuits may be in rural or BT Only areas does not necessarily lead to a difference in competitive conditions between

[322] As set out in Section 5 of Volume 2, network reach provides a useful indication of the degree of rival infrastructure available close to customer sites in a particular geographic area. It calculates, for each postcode sector in the UK, the number of operators other than BT that have network within 50m of the business sites in that postcode sector.
[323] Results are based on geographic markets defined for each customer group, therefore the size of each geographic market varies by customer group.
[324] Openreach response to the BCMR Consultation on Quality of Service, Annex 1, Technical Report page 29.

mobile and non-mobile circuits. Mobile and enterprise customers in BT Only areas may be similarly dependent on BT and may have a similar choice of supplier in HNR areas.

A9.41 However, competitive conditions could be different for MNOs and enterprise customers if MNOs needed a single supplier to achieve wide coverage and were not able to split purchases to use rival suppliers in areas where they are present. This could mean national based competition as BT would be able to leverage its competitive advantage from the uncompetitive areas to the more competitive areas. In other words, a potential competitor would need to extend its network to uncompetitive areas in order to win the customer.

A9.42 However, based on the evidence set out below, we find that although BT has an advantage from nationwide coverage, MNOs are able to split their purchases as they can and do use other networks. Again, this suggests that the presence of rival infrastructure is the key determinant of competition.

Despite the need for wider coverage, MNOs have the ability to use multiple providers

A9.43 Our service share analysis shows that BT has high service shares in the provision of CI Access services to MNO customers in all geographic markets. The main observations are that:

- all mobile network operators use at least BT and Virgin Media. Other suppliers used include [✂], among others (Table A9.3); and
- BT's share of supply is highest in BT Only areas, in common with the CI Access services market as a whole. However, BT's share for MNO customers compared to enterprise customers is much higher in the CLA and Metro Areas (Table A9.4).

Table A9.3: Telecoms providers' share of supply to mobile network operators

	MBNL, EE, Three	Telefónica	Vodafone*	Total
BT[325]	[✂]%	[✂]%	[✂]%	[✂]%
Virgin Media	[✂]%	[✂]%	[✂]%	[✂]%
Other	[✂]%	[✂]%	[✂]%	[✂]%

Source: Ofcom analysis based on the 5th BCMR s.135 notice to MNOs.

**[✂]*

[325] Openreach and BT Wholesale combined service share.

Table A9.4: BT's share of supply by geographic market

	BT share of supply to MNOs only (based on MNO inventory)	BT's market share in CI Access (based on new connections)
BT Only	[✂]%	[✂]%
BT + 1	[✂]%	[✂]%
HNR Rest of UK	[✂]%	[✂]%
Metros combined	[✂]%	[✂]%
CLA	[✂]%	[✂]%

Source: Ofcom analysis based on the 1st and 5th BCMR s.135 Notice.

A9.44 While this evidence on service shares suggests that MNOs do not use a single supplier, it may also suggest that they have been more reliant on BT compared to enterprise customers. In particular, BT's higher service shares in the CLA and Metro Areas for MNOs may reflect reliance on BT for a wide coverage across low network reach and HNR areas.

A9.45 However, there is some evidence that this may not be the case in future. First, we note that service shares for MNO customers and all CI Access customers are not directly comparable. MNO service shares are based on circuit inventory, which reflect historic activity, while CI Access service shares are based on 2017 new connections, which reflect more recent activity. We could not present comparable service shares due to data limitations.[326]

A9.46 Second, notwithstanding this reservation, while service shares suggest that historically, MNOs relied more on BT, this may change over this review period. We note that:

- BT's share of supply to MNOs has fallen from [✂]% in 2014 to [✂]% in 2017.[327]
- There is indication that MNOs do switch suppliers. For example, in its response, [✂].[328]
- MNOs are more likely to consider using multiple providers with the rollout of 5G. For example, we understand that [✂].[329] We also understand that [✂].[330]

A9.47 Telefónica, Three and Vodafone have told us they prefer to buy services from a limited number of suppliers. This is because there are costs associated with managing supply chains such as developing systems to handle each supplier's processes.

A9.48 Despite the cost implications, Telefónica have told us that [✂].[331] Also, evidence suggests MNOs do or at least have the ability to use multiple suppliers. Our analysis for the consultation suggested that all MNOs use at least BT and Virgin Media, among others, for their connectivity needs.

[326] We set these out in Volume 2, Annex 12.
[327] Ofcom analysis based on the MNO inventory.
[328] [✂].
[329] [✂].
[330] [✂].
[331] Telefónica's response to the BCMR s.135-28 Notice.

A9.49 Overall, we consider that the evidence suggests that BT's ubiquitous national network gives it an advantage for supplying MNOs: in BT Only areas, BT may be the only available supplier; in BT+1 and HNR areas, others may be available, but BT's coverage is more extensive and its presence in other areas also gives it an advantage in winning contracts. This means that BT still has a high share of supply in more competitive areas, but in those areas MNOs do use other suppliers for some of their sites [✂]. This suggests an overall picture for MNOs which is similar to enterprise customers in the same locations.

The incentives for network extensions are broadly similar

A9.50 Vodafone argued that supply to MNOs is less competitive as there is no economic rationale for duplicate fibre at mobile base stations as the redundant fibre cannot be redeployed to another customer in the same way as it could for an enterprise customer.[332] This could suggest that suppliers may have weaker incentives to enter the market for mobile backhaul.

A9.51 However, we note that, when assessing where to extend their network to a given site, most suppliers typically base their decision on whether the extension will be profitable for that contract alone and do not take into account the possibility of future contracts which they may or may not win.[333] It is also true that the incumbent supplier has an advantage when competing for subsequent contracts, but this is equally true for enterprise and MNO sites. In BT Only areas, distances to rival networks are longer, so such extensions may be less likely to cost in, but we note that in BT+1 and HNR areas our analysis suggests that MNO sites and enterprise sites have a similar number of rival networks within reach.

Other demand characteristics do not suggest significant variations in competitive conditions

A9.52 We agree with Vodafone and Openreach that there may be some differences in demand characteristics for CI Access services between MNO and enterprise customers. However, we disagree that they are likely to lead to significant variations in competitive conditions.

A9.53 This is based on our assessment for each of the following demand characteristics, which we present below in turn:

- type of bandwidth demanded;
- volume of circuits purchased; and
- volume and time commitment.

[332] Vodafone's response to the 2018 BCMR Consultation, part 2, paragraph 2.3.1.
[333] See for example [✂].

Bandwidth demanded

A9.54 In its response, Vodafone argued for a separate market because – unlike enterprise customers – MNOs require high bandwidth services to deliver 5G services.[334] Based on its analysis, Vodafone suggested that MNOs will move from demanding 1 Gbit/s to 10 Gbit/s services, whereas enterprise customers will move from demanding 100 Mbit/s to 1 Gbit/s services.[335]

A9.55 First, even if there were material differences in bandwidth requirement, we do not consider that this is likely to have a material impact on competitive conditions. As set out in Section 4 of Volume 2 (and in further detail in Annex 11), evidence on actual digging behaviour shows that telecoms providers rarely extend their networks to supply leased lines at any bandwidth, and when they do dig, the dig distance is similar across all bandwidths. Hence, we consider that competitive conditions are broadly similar for different bandwidths. In other words, the competitive conditions when competing for a CI Access customer tend not to differ depending on the bandwidth purchased.

A9.56 Second, our analysis shows that both MNO and enterprise customers will use a mix of VHB and lower bandwidth services over this review period. Historically, enterprise customers bought more VHB CI Access services than MNO customers.[336] However, MNO demand for 10 Gbit/s services is likely to increase during this review period to support the rollout of 5G.[337] We are aware that demand for 10 Gbit/s services from large enterprises is also growing, with some enterprises already requesting 100 Gbit/s.[338] Therefore, this suggests there may be a subset of enterprise customers with similar bandwidth needs to MNOs in the near future.

A9.57 It may be argued that VHB are higher value services, hence VHB suppliers are likely to face more competition due to buyer power or sponsoring entry, or less competition due to there being a more limited choice of suppliers. However, we do not consider this to be the case to any material extent for the same reasons set out below in the following analysis of volume of MNO purchases.

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[334] Vodafone’s response to the 2018 BCMR Consultation, part 2, paragraph 2.8

[335] Vodafone’s response to the BCMR S.135-23 Notice on MNO backhaul and 5G rollout plans.

[336] We estimate that VHB services accounted for 2.6% of CI Access customer ends purchased by enterprise customers and 0.2% of those purchased by MNO customers in 2017. This is based on the MNO and CI Access circuit inventory as of December 2017, and on customer ends where bandwidth information was available and assuming customer ends with unknown “on-net” classification were provided “on-net”. We have concerns around the reliability of CI Access inventory data. For details see Annex 12.

[337] For example, we understand from [✂] that approximately [✂]% of their sites that are likely to be upgraded to 5G during this review period will require 10 Gbit/s services. [✂].

[338] Cartesian, 2018. Business Connectivity Market Assessment [accessed 14 May 2019]

Volume of MNO purchases

A9.58 Mobile network operators tend to purchase the same leased line services as enterprise customers.[339] However, MNOs have a greater number of sites across the UK and, therefore, require more circuits to connect to all of these sites.

A9.59 For example, our analysis suggests that Vodafone and Telefónica combined have over [✂] sites while MBNL, EE and Three together have over [✂] sites (as of December 2017).[340] No single enterprise customer has demand on a similar scale. Within enterprise customers there are a range of customer types – some small customer may require just one or two circuits, whereas large enterprises can require hundreds or low thousands of sites. For example, Vodafone noted that the Experian data of enterprise customers suggested the largest customers (e.g. Tesco and Boots) may have between 2000 and 3000 sites nationally.[341] Vodafone suggested that “MNO demand is typically six times the size of an extra-large Enterprise customer.”[342] Although the ratio of sites per customer is higher for MNOs we find that, overall, enterprise customers account for a higher number of total sites (approximately 134,000) when compared to MNOs (approximately [✂]).

A9.60 Nevertheless, while some enterprise customers may have few sites, others may require coverage in some geographies at a level of similar intensity to MNOs. For example, the Northern Ireland Department of Finance awarded a tender for approximately 2000 public sector sites scattered across urban and rural areas in Northern Ireland in a single contract in 2018.[343] Within Northern Ireland, these sites number more than all MNO base stations put together.

Larger volumes may lead to more competition due to buyer power

A9.61 The large volume requirements of MNOs compared to most other CI Access customers may potentially lead to more competition for their contracts due to:

- More buyer power: the higher volumes may give them the ability to negotiate bespoke deals. Virgin Media and BT Group have both said they have separate teams to manage relationships with MNOs, and other purchasers of backhaul. In response to the consultation, Openreach argued that MNOs are able to exercise countervailing buyer power to acquire the terms they need.[344]
- Sponsoring entry: Mobile backhaul requirements could also be an important source of demand to enable other telecoms providers building leased line infrastructure to gain entry or scale. Openreach noted that MNOs “are actively considering alternative network providers including [✂] which could co-fund competitor network

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[339] Vodafone disagrees with our view and argues that MNOs only purchase active leased lines because they have no other choice (as MNOs want to purchase a dark fibre product). We address Vodafone’s point later in this Annex.
[340] Based on MNO responses to the 5th BCMR s.135 Notice, Question B12, dated February 2018.
[341] Vodafone submission to Ofcom, “Mobile Backhaul”, follow on material from 5 March 2018 meeting.
[342] Vodafone’s response to the 2018 BCMR Consultation, part 2, paragraph 2.6.12.
[343] See NI public sector shared network, Project title: ID868122 [accessed 11 June 2019].
[344] Openreach’s response to the 2018 BCMR Consultation, page 96, paragraph 85-86.

expansion”.[345] CityFibre have also said [“MNOs are one of only two predominant anchor tenant options[346] for competitive [telecoms providers] entering new towns and cities. An anchor tenant must have sufficiently large requirement for business connectivity circuits within that town or city, from which additional connections can then be provide to other customers”].[347] For example, CityFibre’s expansion in Hull to supply MBNL with dark fibre is an example of this.[348]

Larger volumes may lead to less competition due to more limited choice of suppliers

A9.62 On the other hand, the large MNO volumes may potentially lead to less competition compared to enterprise customers in light of BT’s advantage. BT (as both the incumbent supplier and owner of a ubiquitous network) will have a significant advantage in being able to supply all or most of the necessary sites at a much lower cost and more quickly than a rival telecoms provider which needs to build to the sites. For example, Vodafone argued that it is difficult to find alternative suppliers to a site, and even if found, it is rare that they can offer equal or more preferential terms to BT.[349] Hence, the volumes MNOs require may limit their choice of supplier as BT may have an advantage in winning mobile backhaul contracts.

A9.63 Therefore, it is not clear whether the large volumes purchased by MNOs are likely to lead to variations in competitive conditions. Overall, the evidence suggests that the volume purchased by MNOs may contribute to more as well as less competition.

A9.64 The requirement for wide coverage by MNOs may mean the supply of mobile backhaul is less competitive, as MNOs have a limited number of providers to choose from relative to enterprise customers. However, evidence suggests that the need for wide coverage does not necessarily mean that MNOs can only rely on BT. Instead, MNOs are able to consider alternative providers for their supply of mobile backhaul in different areas, based on the availability of rival networks. Although MNOs may prefer to use few suppliers, the evidence suggests that they can, and in some cases do, purchase from multiple suppliers other than BT.

Volume and time commitments

A9.65 MNOs have historically been subject to some minimum volume commitments in their contracts with BT and this, together with the typical length of contracts, may imply that switching providers for MNOs is more difficult than for enterprise customers. [✂].[350]

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[345] Openreach response to Question 4 of the 8th BCMR s.135 notice, document entitled “Product Proposals: Ethernet & Optical Response to DF”, dated 12 October 2017.
[346] The other option being the local authority.
[347] CityFibre submission to Ofcom, 31 May 2018.
[348] CityFibre, 2015. *CityFibre provides dark fibre connectivity to Purebroadband's wireless network in Hull* [accessed 11 June 2019].
[349] Vodafone’s response to the 2018 BCMR Consultation, part 2, paragraph 2.3.2.
[350] [✂].

Time commitments

A9.66 MNOs are typically subject to contract terms of five to ten years. For example, Vodafone mentioned that typical contract terms for mobile backhaul last for [✄] years,[351] but [✄].[352] Therefore, the contract term proposed by suppliers may act as a potential demand-side barrier to switching for MNOs.

A9.67 As a comparison, contract durations for CI Access customers typically range between one year and five years.[353] However, there are exceptions to this. For example, the Northern Ireland public sector tender referred to previously has a contract term of between seven and nine years.[354]

A9.68 The very nature of long-term contracts can make MNOs more attractive to suppliers. BT Group, in its response, mentioned that the "large-scale long-term commercial agreements can drive fierce price competition given the 'all or nothing' nature of such transactions".[355] For example, rivals may be more willing to absorb Excess Construction Charges (ECCs) to connect a customer site if they can win a longer-term contract.

A9.69 Therefore, the evidence on the length of contracts is mixed. While it may imply that the ability to switch providers for MNOs is more difficult than for enterprise customers, it may also contribute towards a more competitive supply of mobile backhaul.

Volume commitments

A9.70 While historically MNOs have been subject to some minimum volume commitments with BT, we noted [✄]. Nevertheless, [✄] experience with [✄].

A9.71 In their responses, CityFibre and Zayo indicated that [✄].[356] Based on this, CityFibre and Zayo disagreed that mobile backhaul and other CI Access services face similar competitive conditions. Zayo pointed to the BT/EE merger analysis, in which the CMA indicated that "durations and volume commitments in existing contracts with BTW make large scale switching difficult [*for MNOs*] in the short to medium term".[357]

A9.72 We note that CityFibre and Zayo have been unable to provide evidence to substantiate their concerns that BT's (and potentially Virgin Media's) pricing makes it difficult for other infrastructure providers to compete for mobile backhaul. Regardless of this, we believe their concerns are downstream of the market we are analysing rather than in our upstream analysis of competition for wholesale leased line services.

351 Vodafone's response to the BCMR s.135-23 Notice on MNO backhaul and 5G rollout plans.
352 [✄].
353 See Volume 2, Annex 8.
354 Contract award notice, section II.1.4 [accessed 20 May 2019].
355 BT Group's response to the 2018 PIMR and 2018 BCMR Consultations, paragraph 3.15.
356 We understand from [✄].
357 Zayo's response to the 2018 BCMR and 2018 BT RFR Consultations, paragraph 3.1.4.

Microwave links are not in the same market

A9.73 Each mobile base station is connected to a network aggregation node either by a leased line connection or by a microwave radio. In some rural areas, microwave backhaul can be a lower cost alternative to fibre based backhaul and is widely used by mobile network operators (see Table A9.5).

Table A9.5: Microwave links as a proportion of all mobile leased line circuits[358]

	MBNL, EE, Three[359]	Telefónica	Vodafone
Total access circuits	[✂]	[✂]	[✂]
% Microwave	[✂]	[✂]	[✂]

Source: Ofcom analysis based on the 5th s.135 notice to mobile network operators

A9.74 We disagree with Openreach that microwave is in the same market as leased line backhaul.[360] The fact that it is widely used by MNOs, does not in itself show that microwave would impose some competitive constraint the supply of CI Access services to MNO customers.

A9.75 For microwave to impose an effective competitive constraint on mobile backhaul, there must be a sufficient number of sites at which if a hypothetical monopolist were to raise the price of circuits for mobile backhaul by a small amount, MNOs would substitute fibre for microwave links such that a Small but Significant Non-transitory Increase in Price (SSNIP) would be unprofitable.

A9.76 We do not consider that microwave links could act as a substitute for leased line mobile backhaul services, thus a SSNIP on a CI leased line is likely to be defeated. Microwave links are a poor substitute for Ethernet leased lines because of their:

- ability to support only lower capacity links compared to fibre based backhaul;
- requirement for line of sight connectivity;
- significantly lower transmission range than fibre-based backhaul links; and
- higher risk of failure because microwave antennas are exposed.

A9.77 We believe that the growth in mobile data use and corresponding increase in bandwidth requirements will make microwave an even less viable substitute compared to CI leased lines, as microwave is more limited in its ability to support higher capacities and only viable for a limited proportion of sites.

A9.78 In addition, the evidence we have gathered post consultation suggests that microwave is only likely to be used by MNOs for 5G rollout in areas where it is not cost-effective or practical to use fibre.[361] We understand from MNOs as part of their 5G rollout plans that

[358] The total number of circuits include all microwave, fibre and copper circuits. [✂].
[359] MBNL (Mobile Broadband Network Limited) is a joint venture company owned by H3G and EE.
[360] Openreach's response to the 2018 BCMR Consultation, page 96, paragraph 87-88.
[361] MNO responses to the BCMR s.135-23 Notice on MNO backhaul and 5G rollout plans.

microwave (as opposed to fibre) will only be used as a last resort, for example at sites where fibre is not available or ECCs are too high.

A9.79 We therefore remain of the view that microwave links do not constrain the provision of CI Access services to MNO customers, with the result that these services are not in the same market.

MNOs demand a different ‘product’: dark fibre requirement

A9.80 In their response to our product market proposal, Vodafone and Openreach disagreed with our view that MNOs use the same products as enterprise customers. Vodafone argued that MNOs have the capability to manage their own networks and that they use the same active services as enterprise customers only because they have no other option. It considers that in a proper functioning market, MNOs would be supplied dark fibre (not active services like enterprise customers).[362] Openreach also argued that MNOs have the potential to use a mixture of passive and active services with bespoke terms.[363]

A9.81 Vodafone added that MNOs need an extension of the dark fibre remedy for mobile backhaul in the CI Access services market for 5G rollout.[364] From a technical point of view, Vodafone argued that MNOs require dark fibre connectivity to deliver the full benefits of 4G and 5G services and, in relation to costs, that they could not achieve an increase in mobile backhaul capacity cost effectively, [✂].[365]

A9.82 While Telefónica did not argue for a separate market, it also argued that MNOs need dark fibre to support 5G rollout. It argued that MNOs would face significant charges in excess of the cost of supply for active 10 Gbit/s services, and such costs could result in a slower 5G rollout and higher prices for consumers.[366]

A9.83 We recognise that MNOs have the knowledge and capability to manage their own networks and therefore, would use dark fibre access where available. However, Vodafone has not provided evidence to support its view that absent regulation, MNOs but not enterprise customers, would purchase dark fibre as a product. In fact, Vodafone[367] and TalkTalk[368], in their responses, argued that competition based on dark fibre access would be the best approach for the entire CI Access services market.

A9.84 In addition, evidence suggests that the demand for dark fibre is not only limited to MNO customers. In the 2016 BCMR, based on an information request to dark fibre end users, we found that dark fibre was sold to customers not only within the Communication and IT

[362] Vodafone’s response to the 2018 BCMR Consultation, part 2, paragraph 2.2.2-2.2.4 and 2.6.8-2.6.9.
[363] Openreach’s response to the 2018 BCMR Consultation, page 96, paragraph 81.
[364] Three instead argued for an expansion of dark fibre in the inter-exchange connectivity market. We consider their arguments in Volume 2, Section 12.
[365] Vodafone’s response to the BCMR s.135-26 Notice, note entitled “5G rollout and mobile backhaul”.
[366] Telefónica’s response to the 2018 BCMR Consultation, paragraph 9-11.
[367] Vodafone’s response to the 2018 BCMR Consultation, paragraph 1.1.5, 1.18.
[368] TalkTalk’s response to the 2018 BCMR Consultation, paragraph 4.43.

sector but also sectors such as Media and Broadcasting, Education and Research (mostly universities) and Finance and Local Government.[369]

A9.85 Furthermore, contrary to Vodafone's argument, we note that CI Access services at 1 Gbit/s and below were deregulated in the 2016 BCMR in the CLA. Even in the absence of regulation, MNOs tend to purchase a mix of both dark fibre and active services.

A9.86 However, we consider Vodafone's argument that "MNOs have a particular urgent need for dark fibre due to the timing of the 5G rollout which is already underway". Therefore, below, we look at whether dark fibre would be an appropriate and proportionate remedy for the CI Access services required by MNOs in this review period.[370]

- First, we outline the rollout plans of MNOs.
- Second, we consider the technical and commercial benefits associated with dark fibre relative to active services for 5G rollout, in light of Vodafone and Telefónica's arguments.
- Third, we consider the implications for competition and investment of making dark fibre available in access services in this review period.

A9.87 In summary, we conclude that, dark fibre access for mobile backhaul would not be appropriate and proportionate as a remedy in this review period. As discussed in Volume 2, Section 10, our view is that the imposition of dark fibre in areas where there may be competitive build with unrestricted PIA would risk undermining investment and our strategic objective to promote network-based competition. Although dark fibre is desirable for 5G rollout, it is not essential and the areas where the 5G rollout will be concentrated in this review period are those with most network competition and so where the case for dark fibre is weakest.

5G rollout

A9.88 Following recent auctions undertaken by Ofcom to release spectrum for 4G mobile and 5G services, MNOs have confirmed they will be in the process of upgrading sites to support the rollout of 5G during this review period.[371] As a consequence of this, MNOs will increasingly be demanding 10 Gbit/s services.

A9.89 The timing and location of sites likely to be upgraded to 5G varies by each MNO. However, the following rollout plans have been publicly announced:

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[369] 2016 BCMR Statement, Volume I, Paragraph 4.287.

[370] Separate to this, Vodafone pointed to the CMA's decision on the BT/EE merger that regulatory remedies including access to dark fibre would provide protection against a number of competition risks identified by the CMA. We note that these risks were identified in relation to the downstream retail mobile market. Therefore, we have not considered the conclusions arising from the CMA's merger analysis in our upstream remedy assessment for leased line services. However, we note that the CMA found no evidence to suggest that downstream BT is causing harm to mobile operators based on the existing regulation at that time.

[371] MNO responses to the BCMR s.135-23 Notice on MNO backhaul and 5G rollout plans.

- EE is to roll out 5G across 16 UK cities in 2019. The rollout will first start in London, Edinburgh, Cardiff, Belfast, Birmingham and Manchester.[372]
- Telefónica's rollout of 5G is expected to begin in 2019. The rollout will first start in London, Edinburgh, Cardiff and Belfast.[373]
- Three's rollout of 5G is expected to begin in 2019.[374]
- Vodafone will rollout 5G in 19 towns and cities across the UK in 2019.[375] Trial sites have gone live in Manchester, Bristol, Cardiff and Liverpool.

A9.90 Based on further information obtained using our statutory information gathering powers, we estimate in aggregate that approximately [✂]% of MNO sites (mobile base stations) are likely to be upgraded in the next 5-years (2019-23), and therefore, we expect a smaller proportion during this review period (2019-21).[376]

Technical benefits of dark fibre for 5G rollout

A9.91 While we agree with Vodafone that dark fibre may have some technical benefits, we do not consider it to be essential to support 5G rollout over this review period.

Very high bandwidth

A9.92 Vodafone argued that "individual sites will need multiple gigabit links, and in some cases above 10 Gbit/s" driven by, for example, data consumption "growing by more than 50% per year".[377]

A9.93 Based on the rollout plans of MNOs, we are aware of at least one mobile operator planning to rollout using 10 Gbit/s Ethernet (active services) for the majority of its fixed backhaul links, while in contrast, another is planning to [✂].[378] This suggests that, in practice, Ethernet and WDM (wave division multiplexing) is sufficient for providing the required 10 Gbit/s backhaul capacity for the initial 5G rollout.

Synchronisation and fronthaul solutions for small cells

A9.94 Vodafone identified that "5G architectures utilising fronthaul"[379] could demand accuracy of around +/-260ns" which is lower than for 3G and 4G networks which "have sync accuracy requirements of +/-1.5µs". [380] This "fronthaul" type of architecture is also laid out in a white

[372] EE, 2018. *It's official: EE to launch 5G across 16 UK cities in 2019* [accessed 11 June 2019].
[373] ISPReview.co.uk, 2019. *O2 name first UK cities to benefit from 5G mobile rollout in 2019* [accessed 11 June 2019].
[374] Three, 2018. Three UK continues 5G network preparation [accessed 11 June 2019].
[375] Vodafone, 2019. *Vodafone to launch 5G in 19 cities during 2019* [accessed 11 June 2019].
[376] MNO responses to the BCMR s.135-23 Notice on MNO backhaul and 5G rollout plans.
[377] Vodafone's response to the 2018 BCMR Consultation, part 2, paragraph 2.17.
[378] Ofcom, 2019. Information provided by Mobile Network Operators in response to the BCMR s.135-23 Notice.
[379] Fronthaul is typically a direct fibre link from a mobile base station to baseband unit as part of a centralised radio access network (C-RAN) architecture. This can be likened to a number of leased line dark fibre access circuits being terminated at an aggregation node located, for example, between a BT exchange and the base stations to provide localised aggregation. See, for example, Ericsson, 2015. Centralized RAN and Fronthaul [accessed 26 February 2019].
[380] Vodafone's response to the 2018 BCMR Consultation, part 2, paragraph 2.13-2.14.

paper by Ericsson,[381] which identifies dark fibre or WDM technology as the ideal link for fronthaul which have more demanding latency and bandwidth requirements.

A9.95 While dark fibre or WDM is key for deploying such architectures in the future and provides technical flexibility, Ofcom considers that initial deployment will be targeted at upgrading existing sites.[382]

Ultra-Reliable Low-Latency Communication (URLLC) services

A9.96 We note that it is possible that dark fibre could give an advantage in providing URLLC services. However, this is less certain because the standards for these services are not expected to be released until the end of 2019 at the earliest[383,384,385] and are unlikely to be commercially available to until at least 2021. Therefore, this is unlikely to be relevant to this market review period.

Private networks/network slicing

A9.97 Vodafone's response describes the use of providing separate wavelengths carried over an optical fibre to allow, for example, network sharing.[386]

A9.98 Ofcom considers that this is not necessarily a requirement for initial deployment of 5G and that existing solutions exist today. For example, Ethernet can provide "some rudimentary capability",[385] managed optical WDM services (such as Openreach's OSA Filter Connect) could be used in some cases, and unrestricted PIA is available should an MNO wish to construct its own solution.

Commercial benefits of dark fibre for 5G rollout.

A9.99 Telefónica argued that in the absence of dark fibre, each MNO could face significant charges in excess of the cost of supply of around £10-12m,[387] over the review period.

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[381] Ericsson, 2015. Centralized RAN and Fronthaul [accessed 26 February 2019].
[382] As part of our BCMR s.135-23 notice, MNOs provided a list of sites that they plan to upgrade to 5G over the next five years. We matched these sites with a list of all MNO sites as of December 2017 (based on their response to our s.135-5 notice) to determine which fall within our product market. We found a match for 93% of sites.
[383] 3GPP, 2018 - Release 16 update [accessed 12 March 2019].
[384] 3GPP, 2018 - Study on enhancement of Ultra-Reliable Low-Latency Communication (URLLC) support in the 5G Core network (5GC) [accessed 12 March 2019].
[385] 3GPP, 2018 - 3GPP Release 15 final freeze delayed by three months [accessed 18 March 2019].
[386] Vodafone's response to the 2018 BCMR Consultation, part 2, paragraph 2.24.
[387] This estimate of "overpayment" is based on Telefónica's assumption that each MNO upgrades over 3,000 sites by the end of March 2021. Based on this, Telefónica note that as EE is wholly owned by BT, there is no "overpayment" as such, but that other MNOs "would face significant overcharges" (Telefónica's response to the 2018 BCMR Consultation, paragraph 9-11). Similarly, Vodafone commented that EE will be able to "secure backhaul in-house, with no cash outflow for BT Group" (Vodafone's response to the 2018 BCMR Consultation, part 1, paragraph 2.14). Vodafone also argued that EE's "competitive advantage in mobile backhaul" may damage competition for consumers by slowing the pace and spread of 5G by competitors (Vodafone's response to the 2018 BCMR Consultation, part 1, paragraph 2.15.3). First, we note that we have decided that BT is required to provide network access on fair and reasonable charges in HNR areas, and is subject to a charge control at current charges in other markets in which it has SMP. Therefore, our view is that the protection offered by our price control remedies is sufficient to address any risks of a margin squeeze by BT on VHB active services. Second, to the extent that any costs in excess of supply may have an impact on the rollout of 5G, we do not expect that MNOs will only rely on active services to provide the required 10Gbit/s backhaul capacity but will seek alternative services

According to Telefónica, this could result in a slower network rollout for 5G and higher prices for consumers.[388] Similarly, Vodafone mentioned they were unsure on how they could achieve an increase in mobile backhaul capacity cost effectively, [✂].[389]

A9.100 We recognise that a regulated dark fibre access product would reduce the cost incurred by MNOs to upgrade circuits to 10 Gbit/s services but consider that, if it were available at cost or close to cost, it might adversely affect the mass rollout of rival networks in areas where infrastructure based competition could be economic. We consider this below.

Impact on investment incentives

A9.101 As set out in Volume 2, Section 10, there is a risk that access to dark fibre in competitive or potentially competitive areas could negatively affect current and future network investments. As such, dark fibre access in these areas would undermine our objective to stimulate competition higher up the value chain in rival infrastructure and the dynamic benefits which that will bring, particularly in the context of our unrestricted PIA remedy.

A9.102 We consider that this view applies equally to MNO and enterprise customers. For example, CityFibre has identified MNOs as an ‘anchor tenant’, whose custom can facilitate expansion into an area, such as its contract with MBNL in Hull. In addition, Three noted that “the access tails of the [mobile] backhaul network are more attractive to infrastructure providers using a PIA remedy than inter-exchange lines, as there is a larger market for these lines (they are more numerous than inter-exchange lines) and access tail line lengths are much shorter, reducing the costs to operators of deploying their own fibre.”[390]

A9.103 Against this, we have to consider the potential benefits of an earlier introduction of dark fibre in the CI Access services market. We consider that the case for introducing dark fibre, whether for mobile or enterprise customers, in HNR or BT+1 areas is very weak as it risks undermining our strategic objective of promoting infrastructure based competition. We have also considered whether to introduce dark fibre for MNOs in BT Only areas during this review period. Our analysis suggests that in this review period, the benefit of introducing dark fibre in BT Only areas would be small and, in our view, not sufficient to outweigh the risk of potentially deterring investment. In particular, we do not believe that the absence of dark fibre in this review period is likely to have a substantial impact on the rollout of 5G because:

- As noted in Volume 2, Section 10, infrastructure competition using unrestricted PIA is likely to be viable in some BT Only areas though not in others, and we are looking to

in markets where possible. We also expect only a small proportion of total MNO sites to be upgraded to 5G during this review period (based on MNO responses to the BCMR s.135-23 Notice).

[388] Based on the total number of mobile subscribers in the UK, we estimate that there could be a price increase of c.£0.50 per year per subscriber, if MNOs were to upgrade all their circuits to 10 Gbit/s during this two-year review period and pass through costs to consumers. Derived based on an annualised five-year TCO calculation including rental and connection charges. Connection charges were spread over a five-year contract term and discounted based on a 8% WACC.

[389] Vodafone’s response to the BCMR s.135-26 Notice, note entitled “5G rollout and mobile backhaul”.

[390] Three’s response to the BCMR Consultation, paragraph 1.2 page 3.

identify those areas as part of our 2021 review, when we will consider again the case for dark fibre in CI Access markets.

- We only expect around [✂]% of total MNO sites ([✂]) to be upgraded to 5G during this review period (2019-21).[391]
- Evidence suggests that the majority of these sites will be in [✂], and a smaller proportion in [✂].[392]
- Also, Telefónica's view is that the [✂].[393] Similarly, Three indicated in an internal document that [✂].[394] This suggests that dark fibre is not essentially critical during this review period.
- Evidence from Openreach on the rollout of 4G is consistent with MNOs rolling out first in urban areas and expanding to rural areas in later years.[395]

A9.104 Therefore, we remain of the view that it is not appropriate at this time to mandate dark fibre access in CI Access, including for MNOs. Three agreed with our view that "dark fibre in both access and inter-exchange connectivity may discourage investment".

We conclude that competitive conditions support a single market

A9.105 We have decided to include mobile backhaul within the CI Access market rather than define a separate market for this customer group. Our analysis of competitive conditions suggests that mobile backhaul is unlikely to be more competitive than other CI Access services (as claimed by Openreach) or less competitive (as claimed by Vodafone).

A9.106 As with enterprise customers, the most important factor in determining BT's competitive advantage is proximity. The competitive advantage from having an existing connection compared to a rival who needs to extend their network is significant. The competitive advantage from having a closer network to the customer will give the provider a cost advantage as it will require a shorter network extension. Therefore, at an individual site, either an enterprise site or mobile radio base station, the competitive conditions are similar regardless of the customer.

A9.107 Our analysis suggests that BT has a broadly similar advantage in providing circuits to MNOs as they do with enterprise CI Access customers. For example, on average, there is a similar number of rival networks to both customer groups. Furthermore, as discussed earlier,

[391] As part of our BCMR s.135-23 notice, MNOs provided a list of sites that they plan to upgrade to 5G over the next five years. We matched these sites with a list of all MNO sites as of December 2017 (based on their response to our BCMR s.135-5 notice) to determine which fall within our product market. We could not find a match for around 7% of the total sites due to missing matching identifiers or sites being built since December 2017. For these sites that do not match, we know some will fall within our product market and some will not, so we create a lower bound by excluding these unmatched sites and an upper bound by including them.

[392] Based on our analysis of MNO responses to our BCMR s.135-23 notice.

[393] Telefónica's response to the BCMR s.135-28 Notice.

[394] Three's response to the BCMR s.135-25 Notice.

[395] See Annex 1 to Openreach's response on Quality of Service, pages 28-29.

MNOs and enterprise CI Access customers have broadly the same geographic distribution and generally rely on the same set of suppliers for their connectivity needs.

A9.108 We recognise that if MNOs needed a single supplier to achieve wide coverage this could mean national based competition and therefore a separate product market. However, although Telefónica, Three and Vodafone have said they prefer to source from a limited number of suppliers, they can and do use multiple telecoms providers for their mobile backhaul needs where others have infrastructure presence and are able to offer leased line services.

A9.109 We acknowledge that there are other differences in the demand requirements of MNOs and enterprise customers. However, we do not consider they lead to significant variations in competitive conditions to justify a separate market for mobile backhaul.[396] In addition, we find that some differences in demand characteristics are not necessarily unique to MNOs compared to enterprise customers as there is a continuum of demand from leased line customers.[397]

A9.110 We find that microwave links do not constrain the provision of CI Access services to MNO customers, with the result that these services are not the same market as CI Access services to MNOs.

A9.111 We do not consider that the products consumed by MNOs are different to enterprise customer. We recognise the arguments in favour of dark fibre for MNOs over this review period in light of the 5G rollout. However, we remain of the view that dark fibre is currently not appropriate in access within this review period, including for MNOs.

Hypothetical SMP assessment[398]

A9.112 We have undertaken a hypothetical SMP assessment in response to Openreach’s argument that we should have undertaken a sensitivity analysis on mobile backhaul as a separate market.

A9.113 Our analysis is based on considering the SMP criteria set out in Volume 2, Section 6. In particular, for each geographic market we consider the evidence on service shares and network reach results (set out above in Table A9.4 and Figure A9.2). We also consider that

[396] Overall, we find the evidence for each demand-side characteristic to be mixed, for example, MNOs’ large volume requirements may give them the ability to negotiate bespoke deals and their importance in sponsoring entry may mean there is more competition for their contracts. However, the volumes MNOs require may also limit their choice of supplier and as a result of the size of BT’s network and the economies of scale it can achieve, it may have an advantage in winning mobile backhaul contracts.

[397] For example, we recognise that MNOs are likely to be at one end of this continuum of demand, but we have identified customers within the CI Access services market other than MNOs which require coverage across urban and rural areas, high capacity leased lines or commit to long-term contracts (e.g. public sector sites).

[398] Our analysis shows that the geographic markets will be broadly similar if we were to define mobile backhaul as a separate market. For example, with our base case scenario, we find that 59%, 35% and 6% of postcode sectors in the UK (excluding Hull) are in BT Only, BT+1 and BT+2 areas, respectively. If we were to define mobile backhaul as a separate market, we find that 61%, 31% and 7% of postcode sectors in the UK (excluding Hull) are in BT Only, BT+1 and BT+2 areas, respectively. (Figures may not add up to 100% due to rounding).

our assessment of the following criteria for CI Access customers in Volume 2, Section 6, also applies to MNOs:

- BT has a significant advantage across the UK due to its proximity to customer sites compared to rivals (we have also discussed this above in relation to MNOs).
- BT benefits from economies of scale and scope from the ubiquity of its network, and high sunk costs and switching costs (among other factors) are likely to give rise to barriers to entry and expansion in the wholesale leased lines markets, making it more difficult for rivals to compete with BT for the supply of CI Access services.
- There is likely to be insufficient countervailing buyer power to constrain BT's position as a supplier of CI Access services. This is mainly because there are limited alternative suppliers and customer volumes are not large enough to impose a credible threat on BT.

A9.114 We also take into account the potential impact of unrestricted PIA as part of our assessment of potential competition. We set out our views on the potential impact of PIA on CI Access services over this review period in Volume 2, Annex 6. In short, we consider that:

- In the CLA, it is reasonable to expect that at least some rivals may use unrestricted PIA for network infill extensions during the review period. This is due to the high number of networks already present (four rival networks within 50m) and the high customer density.
- In HNR areas, we expect that during this review period, unrestricted PIA may be used for infill for some, but probably not all, of these HNR areas. However, at this stage it is difficult to identify exactly where it will be deployed.
- For BT Only and BT+1 areas, the impact of PIA is unlikely to be on a material scale in this review period.

A9.115 We set out our analysis and finding for the different geographic markets below. Overall, our analysis suggests that even if we were to define a separate market for mobile backhaul, our resulting SMP findings would not be different to the CI Access market as a whole.

SMP in BT Only and BT+1 markets

A9.116 If we were to define a separate MNO market for the provision of CI Access services, BT would have SMP in the BT Only and BT +1 geographic markets.

A9.117 This is driven by BT's very high service shares of [✂]% and [✂]% in BT Only and BT+1 areas respectively, which supports an SMP finding. According to the EC SMP Guidelines, a share in excess of 50% is itself evidence of a dominant position, save in exceptional circumstances.

A9.118 This finding is further supported by the very limited availability of rival infrastructure close to mobile sites, high barriers to entry and expansion, limited buyer power and the limited prospects for potential competition even in the presence of an unrestricted PIA remedy.[399]

SMP in Metro Areas and High Network Reach areas in the rest of the UK

A9.119 Even if we were to define a separate market for MNO backhaul, we would find that BT has SMP in High Network Reach areas in the rest of UK and each of the Metro Areas.

A9.120 This is mainly driven by BT's high service share of over [✂]% in both markets, which again is above the 50% threshold of presumed dominance. This is further supported by evidence on BT's competitive advantage from proximity, the high barriers to entry and expansion and limited buyer power.

A9.121 However, we consider that our SMP finding in these areas is finely balanced over this review period, in light of the following evidence:

- the presence of two rival networks, on average, within 50m of mobile site;
- the availability of unrestricted PIA remedy. As set out in Annex 6, we expect that, during this review period, unrestricted PIA maybe used for infill for some, but probably not all, of these HNR areas. However, at this stage it is difficult to identify exactly where it will be deployed; and
- evidence suggesting that MNOs are starting to move away from BT over this review period.

A9.122 As discussed in Volume 2, Section 10, we reflect this in our remedy assessment by imposing lighter remedies in these areas.

No SMP in the CLA

A9.123 Even if we were to define a separate market for MNO backhaul, we would still find that BT does not have SMP in the CLA.

A9.124 We note that BT's share of [✂]% is above the 50% level at which dominance can be presumed (subject to other factors).

A9.125 However, we believe that over this review period there is likely to be sufficient infrastructure in the CLA so as to exert strong competitive constraints on BT for the following reasons:

- density of rival infrastructure in the CLA is an order of magnitude greater than all other areas. On average, there are four rival networks within 50m of a mobile site;
- some rivals may use unrestricted PIA for network infill extensions during the review period given the high number of networks already present and the high customer density; and
- there is evidence suggesting that MNOs are starting to move away from BT over this review period.

[399] On average, there are less than two rivals within 50m of mobile sites in both markets (0.4 in BT Only and 1.0 in BT+1).

Conclusion

A9.126 We consider competitive conditions between MNOs and enterprise customers to be sufficiently homogeneous. Therefore, we do not define a separate market for this customer group, and include mobile backhaul within the CI Access market.

A9.127 We find that, even if we were to define a separate market for this customer group, the resultant SMP would still be similar to those for the CI Access services market as a whole.

A10. Indicative dig distance cost model

A10.1 This Annex sets out the background, structure, assumptions, and results of the indicative dig distance cost model. We use this model to analyse an indication of the distance a rival to Openreach may be willing to dig to serve a customer site to which the rival does not have an existing connection.

A10.2 We characterise this model as "indicative" because it requires a number of cost and revenue inputs which can vary widely from customer site to customer site, and from provider to provider. Hence, there is no single set of costs and/or revenue inputs we could use for the model and its results are indicative. As set out in Volume2, Section 5, this model is one of several tools we use to understand the competitive conditions in different geographic areas.

A10.3 This annex is structured as follows. We:

- summarise stakeholder responses to our consultation model;
- provide some background to our statement model;
- present the structure and assumptions of our statement model; and
- discuss the results of our statement model.

Stakeholder responses to our consultation model

A10.4 A number of stakeholders (BT Group[400], Openreach[401], Sky[402], Virgin Media[403], Vodafone[404], UKCTA[405], and [✂][406]) suggested that, in principle, an indicative dig distance cost model is a reasonable approach to examine how a hypothetical rival to Openreach makes a build vs buy decision.

A10.5 However, some of these stakeholders (Vodafone, Sky, and UKCTA) raised concerns that, in their view, led the model to **overstate the indicative dig distance**. These include concerns that:

- Using Openreach's Excess Construction Charges (ECCs) as a proxy for rivals' network extension costs is wrong because rivals face higher costs than Openreach (Vodafone[407], Sky[408], and UKCTA[409]). In light of its experience undertaking network extensions, Vodafone argued the model did not account for some costs (i.e.

[400] BT Group's response to the 2018 PIMR and BCMR Consultations, paragraph 1.13.
[401] Openreach's response to the 2018 BCMR consultation, page 101, paragraph 24.
[402] Sky's response to the 2018 BCMR consultation, paragraph 12.
[403] Virgin Media's response to the 2018 BCMR Consultation, pages 7-8.
[404] Vodafone's response to the 2018 BCMR consultation, part 2, paragraph 4.1.
[405] UKCTA's response to the 2018 BCMR consultation, paragraph 10.
[406] [✂].
[407] Vodafone's response to the 2018 BCMR consultation, part 1, paragraph 1.10.
[408] Sky's response to the 2018 BCMR consultation, paragraphs 12a and 12b.
[409] UKCTA's response to the 2018 BCMR consultation, paragraph 10.

wayleaves, in-building wiring, traffic management, and minimum labour charge), understated some costs (i.e. survey, blown fibre, duct under a footway, duct under a carriageway, and break through external wall(s)), and overstated one cost (new footway box).[410] Vodafone was also of the view that our assumptions for the proportion of duct that runs under a footway (90%) and the proportion of duct that runs under a carriageway (10%) were not representative of what a rival would face in reality. This is because the first operator to roll out network (generally Openreach) will deploy new duct under the footway as this is more cost effective than digging up the carriageway and, hence, operators rolling out network later on will use the carriageway a higher percentage of the time due to the footway being full.[411]

- Using April 2018 EAD LA prices is wrong as prices have fallen since then and, consequently, the potential revenues to a rival from network extensions.[412]
- Assuming rivals only need to match BT's prices to encourage BT customers to switch provider is wrong as rival providers usually need to offer significant discounts.[413]
- Ofcom has failed to understand the scale of the time delay and disruption caused by civil works to extend existing network to new business customers, even when customers are in close proximity to the existing network.[414]

A10.6 On the other hand, Openreach and Virgin Media raised concerns that, in their view, led the model to **understate the indicative dig distance**. These include concerns that:

- assuming rivals consider a three-year payback period is wrong as, in reality, they consider longer terms;[415] and
- assuming rivals make their build vs buy decision on the basis of providing a single leased line (Openreach[416]) and ignoring the potential for future upgrades (Openreach[417] and Virgin Media[418]) is wrong as, in reality, rivals consider multiple lines and the potential for future upgrades.

A10.7 The following sections set out the background, structure, assumptions and results of our statement model. We address stakeholder comments in the course of our explanation.

Background to our statement model

A10.8 Leased lines are services provided using physical network infrastructure. When a telecoms provider wants to supply a leased line to a new customer, it needs to connect that customer's sites to its network infrastructure. Some of the customer's sites might be located outside of the telecoms provider's network coverage area and the supplier might therefore need to extend the reach of its network by undertaking civil engineering works.

[410] Vodafone's response to the 2018 BCMR Consultation, part 2, paragraphs 4.12-4.43.
[411] Vodafone's response to the 2018 BCM Consultation, part 2, paragraph 4.43.
[412] Vodafone's response to the 2018 BCMR consultation, part 2, paragraph 4.8.
[413] Vodafone's response to the 2018 BCMR consultation, part 1, paragraph 3.10.5.
[414] Vodafone's response to the 2018 BCMR consultation, part 1, paragraph 3.10.2.
[415] Openreach's response to the 2018 BCMR consultation, page 101, paragraph 26.
[416] Openreach's response to the 2018 BCMR consultation, page 101, paragraph 27.
[417] Openreach's response to the 2018 BCMR consultation, page 101, paragraph 27.
[418] Virgin Media's response to the 2018 BCMR consultation, page 8.

A10.9 The costs of civil engineering works associated with extending physical network infrastructure are largely sunk, common to most fixed telecommunications services and represent a significant proportion of the total cost of provisioning for a new customer as explained in more detail in Section 3 of Volume 2.

A10.10 When deciding whether to extend its network to reach a new customer, a telecoms provider will compare the costs it will incur to the revenues it expects to earn and to the costs of any available alternative means of supplying the customer without incurring the costs of digging. The most likely alternative is to purchase a regulated service from Openreach. Telecoms providers are often faced with a decision to either build their own network or buy wholesale services from Openreach on regulated terms (or sometimes on commercial terms from networks other than Openreach). We have undertaken a cost modelling exercise to estimate an indicative breakeven dig distance for telecoms providers.

A10.11 This modelling exercise requires a number of cost and revenue inputs which can vary widely from customer site to customer site, and from provider to provider. Hence, there is no single set of cost and/or revenue inputs we could use for the model and its results are indicative. These inputs include:

- the costs of the civil engineering works associated with extending the physical network infrastructure;
- assumptions around a number of factors that impact costs. For instance, the number of new footway boxes and the type of surface under which the new duct will run;[419]
- the costs of the electronic equipment necessary to offer an active service;
- the expected revenues;
- assumptions around a number of factors that impact revenues. For instance, the bandwidth and prices of the services provided, the number of new end customers, the length of the contracts with these new end customers, and the discount factor applied to streams of revenues in the future; and
- the costs of any alternative means of supplying the customer without incurring the costs of digging.

A10.12 The following section sets out our approach to modelling dig costs and the indicative dig distance for a range of scenarios and leased line services in our statement model.

Structure and assumptions of the statement model

A10.13 The statement model uses a bottom-up approach to estimate the maximum average route distance from a telecoms provider's nearest network flexibility point to an end-customer's premises that it would be economic for the telecoms provider to serve, such that it would break even (on a net present value basis) over the average life of a leased line service contract.

[419] Some surfaces are relatively inexpensive to dig – e.g. a stretch of land without any existing infrastructure – while other surfaces are relatively expensive to dig – e.g. a stretch of land covered by a carriageway.

A10.14 The model calculates the indicative dig distance for three leased line services: 100 Mbit/s, 1 Gbit/s and 10 Gbit/s. We have not modelled a 10 Mbit/s service as the revenues and costs of this service are almost identical to those of 100 Mbit/s.

A10.15 In conducting this analysis, we have focused on a build/buy comparison, i.e. a comparison of build costs with Openreach's wholesale charges for leased lines. Most network operators (e.g. Vodafone, Virgin Media and Colt) explained to us that when they supply a premises to which they did not have an existing connection, they would only extend their network if they could do so at a lower cost than they would incur by purchasing a wholesale leased line product from Openreach (or another provider).[420] This therefore means that an assumption based on an individual circuit and over an average contract term provides a reasonable indication of how close competitors need to be located to a customer premises in order to be an effective competitor.

Revenue assumptions

A10.16 To model the revenues of each leased line service, we use the wholesale charges for the equivalent Openreach Ethernet Access Direct Local Access (EAD LA) leased line service, as summarised in Table A10.1 below. We have reflected the latest prices (as of October 2018) in this statement.[421]

Table A10.1: Modelled leased line services and key revenue assumptions[422]

Service	Connection (one-off)	Rental (annual)
EAD LA 100 Mbit/s	£1,850	£1,374
EAD LA 1 Gbit/s	£1,850	£1,620
EAD LA 10 Gbit/s	£5,565	£4,146

Source: Openreach price list as of October 2018.

A10.17 As explained in Section 4 of Volume 2, EAD LA products are the most popular for the various bandwidths considered, except for 10 Gbit/s (though this is on a low volume base). Using EAD LA charges also has the advantage that these charges exclude inter-exchange costs, allowing the analysis to focus on the access elements of the network.

A10.18 We disagree with Vodafone's view that assuming rivals only need to match BT's prices to encourage BT customers to switch provider is wrong as providers usually need to offer significant discounts.[423] While we recognise that rivals may offer discounts to encourage BT

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[420] We note that some network operators (CityFibre and Zayo) instead base their build decisions on the retail value of the contract. However, these are a minority.

[421] This addresses the point raised by Vodafone that the April 2018 EAD LA prices we used in the BCMR Consultation had fallen and, consequently, the potential revenues to a rival from network extensions are lower. See Vodafone's response to the 2018 BCMR consultation, part 2, paragraph 4.8.

[422] The main change since the 2018 BCMR Consultation is a 16.9% fall in the annual rental charge for EAD LA 1 Gbit/s services. Other charges (connection and rental charges) either remained the same or fell by less than 1.5% compared to the Consultation.

[423] Vodafone's response to the 2018 BCMR consultation, part 1, paragraph 3.10.5. We note that this seems to be inconsistent with a comment made by Vodafone in the context of connectivity provision. [✂] ([✂]).

customers to switch provider, we are of the view that for the purpose of the model (i.e. to provide an *indication* – rather than a precise reflection – of the dig distance a hypothetical rival to Openreach may be willing to dig), not modelling discounts is reasonable as discounts can vary widely from provider to provider. Also, providers may compete on factors other than price (e.g. quality of service).

Network assumptions

A10.19 For each leased line service, we modelled four network scenarios, each reflecting a different assumed level of pre-existing, dedicated physical network connectivity between the closest network flexibility point and the end-customer premises. Table A10.2 below characterises these scenarios.

Table A10.2: Network scenarios modelled

	Fibre connected	Duct connected with tubing	Duct connected without tubing	Network extension (new duct required)
Existing telecoms provider Infrastructure	Trench, duct, footway boxes, tubing, fibre cable	Trench, duct, footway boxes, tubing	Trench, duct, footway boxes	None
Incremental telecoms provider Infrastructure Required	None	Fibre cable	Tubing, fibre cable	Trench, duct, footway boxes, tubing, fibre cable

Source: Ofcom analysis

A10.20 We have assumed the following incremental network elements:

- a survey by the network operator of the actual or proposed route when duct connected, or new duct required;[424]
- blown fibre cable when duct connected, or new duct required;
- blown fibre tubing when duct connected but no tubing in place or new duct required;
- clearance of duct blockages when new duct required;
- trenching and ducting when new duct required, assuming a mix of 90% of the new duct route built under the footway and 10% under the carriageway;
- new footway boxes every 100m when new duct is required, with a final footway box installed outside the end-customer's premises; and
- active equipment at both ends of the leased line across all scenarios.

[424] To clarify a point raised by Vodafone (Vodafone's response to the November 2018 BCMR Consultation, part 2, paragraph 4.41), it is worth noting that the model assumes one survey fee as per Openreach's ECCs.

Model assumptions

Passive and active costs assumptions

A10.21 In order to derive an estimated total cost per metre for each scenario, we split the costs into passive infrastructure costs, which are typically distance-dependent, and costs associated with active equipment, which are not dependent on distance (with the exception of the lasers).

A10.22 Our passive costs are informed by Openreach's Excess Construction Charges (ECCs)[425] and Physical Infrastructure charges, which reflect Openreach's network extension costs. These are Openreach charges to wholesale customers for network extensions.

We disagree with Vodafone[426], Sky[427], and UKCTA[428] with regards to their view that using Openreach's ECCs as a proxy for rivals' network extension costs is wrong because rivals face higher costs than Openreach.

A10.23 We have gathered evidence that suggests network extensions costs vary widely from customer site to customer site, and from provider to provider. Hence, there are no 'typical' network extensions costs. For instance:

- Network extension costs vary widely depending on the location of customers' sites. This reflects a range of cost variables such as the surface type (e.g. block paving has higher reinstatement costs), wayleave costs, construction permits (including lane closures, parking bay suspensions, etc.), restrictions on the time of works (e.g. a higher labour rate for night work), traffic management, and contract (e.g. construction firms offer volume discounts).[429]
- Network extensions costs may vary widely depending on the cost structure of the provider incurring them. For example, this reflects the different ways in which a provider may incur network extensions costs.[430]

[425] Openreach's Excess Construction Charges cover the additional costs of either providing additional service or dealing with situations where the cost of providing service is more than the Openreach price list. See: https://www.openreach.co.uk/orpg/home/products/serviceproducts/excessconstructioncharges/excessconstructioncharges.do [accessed 14 May 2019].
[426] Vodafone's response to the November 2018 BCMR consultation, part 1, paragraph 1.10.
[427] Sky's response to the November 2018 BCMR consultation, paragraphs 12a and 12b.
[428] UKCTA's response to the November 2018 BCMR consultation, paragraph 10.
[429] For instance, Openreach's Excess Construction Charges indicate that depending on the surface type the cost of digging and laying new duct varies widely from about £30 per metre (soft surface) to £116 per metre (carriageway). See tab "ECC" of the indicative dig cost model (Annex 16). Additionally, the costs in terms of time to provide also vary widely as discussed in Annex 11.
[430] We understand that network operators tend to hire subcontractors to do the labour associated with network extensions. However, the way in which network operators are charged for this can vary. For example, Vodafone pays a minimum cost below which the subcontractor will not arrive on site regardless of the extent of the network extension (Vodafone's response to the 2018 BCMR Consultation, part 2, paragraphs 4.14-4.18). However, other providers may not be charged in this way.

A10.24 As mentioned above, there is no single set of costs we could use for the model that would represent all situations and, hence, we cannot calculate a precise figure that reflects the dig distance a hypothetical rival may be willing to dig for all cases. This explains why, as we mentioned in the 2018 BCMR Consultation,[431] the purpose of the model is to provide an *indication* – rather than a precise reflection – of the dig distance a hypothetical rival to Openreach may be willing to dig.

A10.25 Our active costs are based on Openreach's annual depreciation of the unit fully allocated cost (FAC) for the Ethernet Electronics Capital cost (i.e. cost component CO487). This cost covers the cost of the equipment and its installation and excludes other operational costs e.g. maintenance costs.[432]

A10.26 Our assumptions for both passive and active costs for each network scenario are presented in Table A10.3 overleaf.

A10.27 Active costs are derived for each leased line service by multiplying the cost of Ethernet Electronics equipment and their installation by the asset life used in BT regulatory accounts, which is around five years.

A10.28 Note that the passive and active costs we have considered in our analysis do not include a return on capital employed explicitly. This is because our discounted cash flow (DCF) analysis captures this return implicitly through the application of a discount rate i.e. the Weighted Average Cost of Capital (WACC).

A10.29 As a separate point, we disagree with Vodafone's view that we failed to understand the scale of the time delay and disruption caused by civil works to extend existing network to new business customers, even when customers are in close proximity to the existing network.[433] As set out in Section 5 of Volume 2, one of the tools we use to understand the competitive conditions in different geographic areas is the time delay and disruption associated with civil works.

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[431] 2018 BCMR Consultation, paragraph 6.25 and footnote 126.
[432] By excluding other operational costs, the distances resulting from the model are likely to be to some extent overstated across all scenarios and products.
[433] Vodafone's response to the 2018 BCMR consultation, part 1, paragraph 3.10.2.

Table A10.3: Costs assumptions[434]

Category	Unit	£ excluding VAT	Source
Survey	£ per survey	244.52	Openreach's Excess Construction Charges
Blown fibre tubing	£ per metre	3.83	Openreach's Excess Construction Charges
Blown fibre	£ per metre	1.74	Openreach's Excess Construction Charges
Duct under a footway	£ per metre	66.54	Openreach's Excess Construction Charges
Duct under carriageway	£ per metre	119.22	Openreach's Excess Construction Charges
Footway box[435]	£ per box	761.62	Openreach's Excess Construction Charges
Break through customer site walls	£ per break	220.83	Openreach's Excess Construction Charges
Blockage clearance	£ per blockage	577.60	Openreach's Physical Infrastructure charges for Ancillary Activities
100 Mbit/s Ethernet Electronics equipment and installation	Annual depreciation per circuit (£)	306.00	BT's 2017/18 RFS
1 Gbit/s Ethernet Electronics equipment and installation	Annual depreciation per circuit (£)	285.00	BT's 2017/18 RFS
10 Gbit/s Ethernet Electronics equipment and installation	Annual depreciation per circuit (£)	795 to 1,193[436] [✂]	BT's 2017/18 flat files

Source: Ofcom analysis

Assessment period and economic dig distance calculation

A10.30 We have modelled the revenues and costs over a three-year period i.e. the payback period. We consider three years to be a reasonable period for assessing the economic dig

[434] Compared to the 2018 BCMR Consultation, three cost items increased in value ("Blockage clearance" by 7.66%, "Duct under a footway" by 5.20%, and "Duct under a carriageway" by 2.71%) and one cost item feel in value ("Footway box" by 10.95%). All other cost items changed less than 1%.

[435] We use the cost of a small footway box (£855.23) rather than a medium (£1,487.14) or large one (£2,656.91) to have a conservative estimate of the costs. This is also the reason why we have not included the cost of a new carriageway box.

[436] For the model results discussed below, we have taken the midpoint between these numbers.

distance.[437] In our meetings with telecoms providers (see Annex 11), it was suggested that build vs buy decisions are assessed by considering the costs over the duration of the contract and the evidence from the circuit inventory data submitted by telecoms providers indicates that this is typically three years, i.e. the median contract length of a leased line customer is approximately three years. Nevertheless, we have produced results for longer payback periods as a sensitivity, including five years.

A10.31 We disagree with Openreach's view that it is wrong to assume rivals consider a three-year payback period as in reality they consider longer terms.[438] Some rivals may indeed consider longer payback periods for some contracts or will consider a probability weighting of a contract being renewed. For an indicative model, however, we think it is reasonable to assume that rivals would be more likely to make a build vs buy decision based on the stream of revenues contracted with the end customer. As mentioned above, the median contract length of a leased line customer is approximately three years.[439]

A10.32 Similarly, we are of the view that for an indicative model it is reasonable to assume that rivals are more likely to make their build vs buy decision on the basis of providing a single leased line and ignoring the potential for future upgrades. This aligns with the view presented in stakeholder meetings.[440]

A10.33 To calculate the indicative dig distance, we discount the annual revenues and annual costs over the pay-back period by applying a 8.0% discount rate to be consistent with our estimate of the pre-tax nominal WACC for active leased lines.[441] The breakeven distance is such that the total discounted revenues equal the total discounted costs. We then estimate the indicative route dig distance: the maximum average distance from a telecoms provider's nearest network flexibility point to an end-customer's premises following the layout of streets and other infrastructure at which it would be economically viable for the provider to dig given our assumptions. We also estimate the indicative *radial* dig distance: the straight-line distance from a provider's nearest network flexibility point to an end-customer's premises at which it would be economically viable for the provider to dig. Overall, some stakeholders argued we understated network extension costs and others argued we understated the potential revenue from network extensions. We are of the view that our indicative model provides a reasonable balance between these conflicting views.

Results of the statement model

A10.34 This section sets out the outputs of our modelling for the scenarios for which additional infrastructure is required.

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437 To clarify a point raised by Vodafone (see Vodafone's response to the 2018 BCMR Consultation, part 2, paragraph 4.38), the five-year equipment cost is included in the three-year assessment.

438 Openreach's response to the 2018 BCMR Consultation, page 101, paragraph 26.

439 We also model a 5-year payback period as a sensitivity.

440 See for example [✂].

441 In the BCMR Consultation we used a 9% discount rate to be broadly consistent with the Other UK telecoms WACC assumed in the 2018 WLA Charge Control which would be applicable to leased lines. Annex 21 sets out our latest view of the appropriate WACC for leased lines.

A10.35 Table A10.4 below suggests that the costs of serving a customer are significantly higher when a network extension is needed to connect the customer (e.g. £2,062 for a 10-metre distance) compared to when a duct connection already exists (e.g. between £262 and £309 for a 10-metre distance, depending on the availability of fibre tubing).

Table A10.4: Passive costs by route distance (£)

Distance	Duct connected with tubing	Duct connected without tubing	Network extension (new duct required)
10 metres	262	310	2,001
20 metres	279	376	2,775
30 metres	297	441	3,548
40 metres	314	507	4,322
50 metres	332	572	5,096
60 metres	349	638	5,870
70 metres	366	703	6,643
80 metres	384	769	7,417
90 metres	401	834	8,191
100 metres	419	900	9,726
200 metres	593	1,555	18,226
500 metres	1,115	3,520	43,724
1000 metres	1,985	6,796	86,221
2000 metres	3,725	13,348	171,215

Source: Ofcom analysis.

A10.36 Table A10.5 and Table A10.6 below present our indicative dig distances. These are shown for our base case assumption of a three-year payback period, as well as for a five-year payback period as a sensitivity. As expected, they show that the indicative dig distance is higher where the connection needs to be dug than where the customer site is already duct connected. It also shows that the indicative dig distance increases with bandwidth.

Table A10.5: Indicative route dig distances (metres)[442]

Service	Duct connected with tubing	Duct connected without tubing	Network extension (new duct required)
Three-year payback			
EAD LA 100 Mbit/s	2,241	595	38
EAD LA 1 Gbit/s	2,696	716	48
EAD LA 10 Gbit/s	6,832	1,814	131
Five-year payback			
EAD LA 100 Mbit/s	3,449	916	65
EAD LA 1 Gbit/s	3,986	1,058	77
EAD LA 10 Gbit/s	8,379	2,225	166

Source: Ofcom analysis.

A10.37 Given that our network reach analysis is based on the radial distance between telecoms providers' networks and customers' sites, we have converted the route distances (in Table A10.5 above) into radial distances (in Table A10.6 below). This conversion involves dividing each given route distance by 1.4. We have used similar conversion factors in previous work[443] based on applying Pythagoras' theorem.[444]

Table A10.6: Indicative radial dig distances (metres)

Service	Duct connected with tubing	Duct connected without tubing	Network extension (new duct required)
Three-year payback			
EAD LA 100 Mbit/s	1,601	425	27
EAD LA 1 Gbit/s	1,926	511	34
EAD LA 10 Gbit/s	4,880	1,296	94
Five-year payback			
EAD LA 100 Mbit/s	2,463	654	46
EAD LA 1 Gbit/s	2,847	756	55
EAD LA 10 Gbit/s	5,985	1,589	118

Source: Ofcom analysis.

[442] Compared to the 2018 BCMR Consultation, the indicative dig distances when a network extension (new duct) is required have remained the same for EAD LA 100 Mbit/s, decreased significantly for EAD LA 1Gbit/s, and decreased slightly for EAD LA 10Gbit/s. This is mainly the net effect of two opposing factors. The reduction in EAD LA prices (see Table A10.1) had the effect of reducing the NPV of the stream of revenues expected from network extensions and, therefore, led to a reduction in the indicative dig distances. And the reduction in the WACC discount factor had the effect of increasing the NPV of the stream or revenues expected from network extensions and, therefore, led to an increase in the indicative dig distances.

[443] For instance, footnote 29 of the 2017 WLA Consultation mentions that "telephone lines tend to follow the layout of streets, rather than travel in straight radial lines from exchanges to street cabinets and onto customer premises, the derived radial distances are converted into route distances that follow the typical rectilinear pattern of streets by applying a conversion factor (typically in the range 1.2 – 1.4)" [accessed 20 May 2019].

[444] Pythagoras' theorem states that for a right-angled triangle, the square of the hypotenuse (the side opposite the right angle) is equal to the sum of the squares of the other two sides.

A11. Network extensions and their impact on competition in the CI Access market

A11.1 This annex sets out evidence on telecoms providers' network extensions in the UK (excluding the Hull Area). This is used to inform the product market definition and significant market power (SMP) assessments set out in Sections 4, 5 and 6 of Volume 2.[445]

A11.2 This annex focuses on historic evidence and so does not reflect the potential impact of unrestricted PIA on the CI Access markets which we consider in Annex 6 and in our assessment of the geographic markets and SMP.

A11.3 We present three types of evidence:

- **Empirical evidence on the impact of network extension on lead times**: this includes evidence on the importance of lead times to customers when choosing a supplier and evidence on the impact of network extensions on lead times. This is based on two pieces of research we commissioned from third parties (BDRC-Continental and Cartesian) and on Openreach's responses to s.135 notices.
- **Qualitative evidence on build vs. buy strategy:** this section presents qualitative evidence on how providers decide whether to build (i.e. extend their network by building new duct) or buy (i.e. buy an active wholesale leased line product from another provider) to supply a leased line to a customer's site beyond their existing network reach. This is based on information we gathered at the meetings we held with leased line providers.
- **Empirical evidence on the incidence and dig distances of network extensions**: this covers evidence on how often telecoms providers had to extend their networks to connect new customers; the build vs buy decision for Openreach's rivals; and how far providers usually dug. This is based on providers' responses to statutory information requests issued under section 135 of the Communications Act 2003.

A11.4 To summarise, this evidence suggests that:

- lead times are important for leased line customers to the extent that having an existing connection to the customer site is one of the main factors considered by customers when choosing a provider;
- network extensions significantly increase lead times;
- building new duct takes longer if wayleaves and/or traffic management are required;
- lead times increase as the distance (dig or fibre blown) of the connection increases;
- the longer the dig or fibre blown, the more likely wayleaves and/or traffic management are required;
- build-only providers (those with a strong preference to build, consistent with their business strategy) tend to build when it is profitable to do so and, collectively, account for approximately 2% of 2017 connections;

[445] The evidence in this annex also informs our hypothetical SMP assessment for VHB (Annex 14).

- build vs buy providers (those without a strong preference for either option) tend to build when it is less costly than to buy and, collectively, account for approximately 33% of 2017 connections;
- Openreach accounted for the vast majority [✂]% of the [✂] network extensions undertaken by all providers in 2017. Out of the [✂] network extensions not undertaken by Openreach, Virgin accounted for [✂]% and CityFibre for [✂]%;
- Openreach had existing duct for the [✂] of the customer ends it connected in 2017 ([✂]%) 81% - 90%. It only extended its network for [✂]% of the customer ends it connected in 2017;
- Openreach's rivals had existing duct for a lower proportion of the customer ends they connected in 2017 (46%) when compared to Openreach. They only built for 5% of the customer ends they connected in 2017;
- Openreach's rivals were unlikely to build to connect customers' sites that were not already connected to their networks. Collectively, they only built for [✂] connections (10% of the [✂] connections not already connected to their networks);
- four providers accounted for 99% of the [✂] digs that took place in 2017 ([✂);
- providers tend to dig short distances. Close to 80% of digs involved a distance of 50m or less ([✂]% of [✂] Openreach digs, and [✂]% of [✂] rival digs), and close to 90% of digs involved a distance of 100m or less ([✂]% of [✂] Openreach's digs, and [✂]% of [✂] rivals' digs);
- a minority of digs were long distance, suggesting a low propensity of rivals to dig when they are located further away. About 15% of digs involved a distance above 100m ([✂]% of [✂] Openreach digs, and [✂]% of [✂] rival digs);
- the vast majority of long distance digs by Openreach's rivals were carried out by build-only providers (i.e. CityFibre, euNetworks and Zayo) as their business strategy is to build. Out of the [✂] rival digs above 100m, build-only providers collectively accounted for 78%, and CityFibre individually accounted for 56%; and
- for Openreach, the median dig distance was [✂] 0-25 metres compared to a mean distance of [✂] metres; while for Openreach's rivals the median was 14 metres compared to a mean of [✂] metres. We consider that the median rather than the mean provides a better indication of the distance to which operators are most likely to extend their network for the reasons set out in paragraph A11.42.

Empirical evidence on the impact of network extensions on lead times

Evidence on the importance of lead times

A11.5 This evidence is based on the results of the 2016 BDRC-Continental study[446] and the 2018 Cartesian study.[447] It indicates that:

[446] BDRC-Continental, 2016 [accessed 20 May 2019].
[447] Cartesian, 2018, Business Connectivity Market Assessment [accessed 20 May 2019].

- having an existing connection to the customer site is one of the main factors considered by customers when choosing a provider;
- long and uncertain lead times are some of the key problems faced by customers on the provisioning of fixed services;
- longer-than-expected lead times may be associated with monetary costs to the customer; and
- a longer dig distance is likely to imply longer lead times.

2016 BDRC-Continental study for Ofcom

A11.6 We commissioned BDRC-Continental to interview 241 business customers (not resellers) of high bandwidth leased line services (i.e. Ethernet leased line services of more than 50 Mbit/s speeds or WDM-based leased line services) to explore:

- their requirements and preferences from high bandwidth leased line services;
- their willingness to switch and the possible barriers to doing so;
- the choice of suppliers; and
- market trends.

A11.7 This study found the following with regard to lead times:

- more than half of respondents (51%) indicated that one of the reasons they had chosen their leased line supplier was because it already had a connection to their site. This reason was more likely to be mentioned by respondents who buy leased line services of speeds higher than 100 Mbit/s (61% of respondents who buy WDM connections; 60% of respondents who buy Ethernet leased lines over 1 Gbit/s; and 61% of respondents who buy Ethernet leased lines at 1 Gbit/s and below but more than 100 Mbit/s) compared to respondents who buy lower speeds (43% of respondents who buy Ethernet leased lines at 100 Mbit/s and below but more than 50 Mbit/s).[448] This evidence indicates that already having a connection to the customer site is an important factor on end-users' choice of supplier;
- two in five respondents (41%) indicated they had experienced an obstacle when they migrated from a slow bandwidth connection (e.g. an Asymmetric Digital Subscriber Line (ADSL), Integrated Services Digital Network (ISDN), or analogue leased line connection[449]) to a high bandwidth connection (i.e. any service with bandwidth above 50 Mbit/s).[450] The most frequent obstacle was "time taken to deliver service/long delay in installation" (9% of those migrating indicated they experienced this obstacle); followed by "Other criticism of provider – e.g. poor communication, poor customer service" (8%); and "Lead time for the new service up and running" (6%).[451] This

[448] BDRC-Continental, 2016, Figure 23 (Important selection criteria for HBW supplier) and Figure 24 (Important selection criteria for HBW supplier) [accessed 20 May 2019].
[449] BDRC-Continental, 2016, Figure 28 (What HBW line replaced).
[450] BDRC-Continental, 2016, Page 14 (Migration).
[451] BDRC-Continental, 2016, Figure 32 (Obstacles when migrating).

evidence indicates that lead times can be an obstacle when end-users migrate to higher bandwidth leased lines; and

- almost half (44%) of the respondents who experienced at least one obstacle when migrating to higher bandwidth leased lines indicated that there were costs associated with the main obstacle they experienced (14% indicated a cost of £1,000 to £4,000; 13% indicated a cost of £5,000 to £9,000; and 17% indicated a cost of >£10,000).[452] This evidence suggests that lead times may be associated with monetary costs given that "time taken to deliver service/long delay in installation" and "lead time for the new service up and running" were the most frequent and third most frequent obstacles experienced by end-users, respectively.

2018 Cartesian study for Ofcom

A11.8 We commissioned Cartesian to interview 75 executives in technology and procurement roles of UK large businesses, with responsibility for business connectivity; 16 senior personnel in Communication Service Providers (CSPs), with insight into the business connectivity supply chain; and 6 senior representatives of UK mobile network operators and mobile access infrastructure providers, with insight into mobile backhaul connectivity.

A11.9 This study explored four areas:

- how UK large businesses use communication services;
- how satisfied UK large businesses are with their communication services;
- how UK large businesses see their communication needs evolving over the next five years; and
- how UK large businesses design their business connectivity supply chain.

A11.10 This study found the following with regards to lead times:

- on a scale from 1 (lowest) to 10 (highest satisfaction score), the provisioning of fixed services was the most prevalent area of dissatisfaction (with a mean score of 5.3), particularly for fibre leased lines;[453] and
- the key problems associated with the provisioning of fixed services include long lead times, delays, uncertain delivery deadlines and a lack of communication from the service provider. Wayleaves, the supplier's organisational structure and lack of a seamless migration process were perceived as the main contributing factors.[454]

Evidence on the impact of network extensions on the extent of lead times

A11.11 The main findings from the evidence presented in this section include:

- network extensions significantly increase lead times;
- building new duct takes longer if wayleaves and/or traffic management are required;
- lead times increase as the distance (dig or fibre blown) of the connection increases; and

[452] BDRC-Continental, 2016, Figure 32 (Cost of main obstacle when migrating).
[453] Cartesian, 2018, page 7.
[454] Cartesian, 2018, page 7.

- the longer the dig or fibre blown, the more likely wayleaves and/or traffic management are required.

A11.12 The evidence in this section includes information about the average number of working days excluding customer delay that it takes Openreach to complete an order (i.e. the "Mean Time To Provide" or MTTP) and, when available, whether each order required wayleaves and/or traffic management. We present the evidence separately for Openreach 2017 new connections,[455] and for all Openreach provision categories in 2017.[456]

MTTP evidence based on Openreach 2017 new CI Access connections

A11.13 In order to assess the impact on lead times of different levels of infrastructure build, we have categorised each Openreach 2017 new CI Access connection into one of four types of connection according to the extent of infrastructure Openreach needed to build. Table A11.1 presents these types of connection.

[455] This is an expansion of the Openreach 2017 new connections data we presented in the BCMR Consultation (based on Openreach's response to the 1st BCMR S.135 notice). Openreach provided this new MTTP data in response to the 21st BCMR S.135 notice. In Annex 12 we discuss how we processed this new MTTP data (see Annex 12).

[456] Ofcom analysis of 12th BCMR s.135 Notice, Openreach Ethernet KPI reports, 10th 2016 BCMR s.135 Notice, and 12th 2016 BCMR s.135 Notice.

Table A11.1: Types of 2017 new connection according to the extent of infrastructure Openreach needed to build

Type of connection	Description	Duct required which was present	Fibre required which was present
justconnect	This refers to a new connection where all the duct required and all the fibre required were already present. Hence, Openreach just needed to connect the customer.	All	All
justbf	This refers to a new connection where all the duct required and none of the fibre required were already present. Hence, Openreach just needed to blow fibre through the existing duct.	All	None
digandbf (or partial build)	This refers to a new connection where some of the duct required was present and none of the fibre required was present. Hence, Openreach needed to dig and build part of the duct required and blow fibre down the whole route of duct (i.e. existing duct and new duct).	Some	None
justdig (or full build)	This refers to a new connection where none of the duct required and none of the fibre required were present. Hence, Openreach needed to dig and build all the duct required and blow fibre down the whole route of duct.	None	None

A11.14 We have analysed the MTTP across the four types of connection, whether wayleaves and/or traffic management were required, by the length of duct built or fibre blown, and for each geographic market. We have found that:

- building new duct takes longer than blowing fibre, and blowing fibre takes longer than making a connection where there is an existing fibre connection (i.e. network extensions significantly increase lead times);
- building new duct takes longer if wayleaves and/or traffic management are required;
- lead times increase as the distance (dig or fibre blown) of the connection increases;
- the longer the dig or fibre blown, the more likely wayleaves and/or traffic management are required; and
- inter-exchange and access connections have a broadly similar MTTP.[457]

[457] However, as inter-exchange circuit ends are more often found in less built-up areas than access ends, inter-exchange circuit ends are less likely to require wayleaves or traffic management and therefore have a slightly lower MTTP.

A11.15 Figure A11.2 below shows the MTTP for all order types jointly (i.e. *allorders*), *justconnect* orders, *justbf* orders, and for *digandbf* and *justdig* orders jointly (i.e. *build*). This evidence suggests that the more extensive the building of infrastructure, the greater the MTTP.

Figure A11.2 MTTP in working days by order type for CI Access circuits

[✂]

** build category comprises both digandbf and justdig.*

Source: Ofcom analysis of Openreach's response to the 1st and 21st BCMR s.135 notices.

A11.16 Figure A11.3 below shows that wayleaves and/or traffic management create a very substantial delay in the provision of new circuits, increasing mean provision time from [✂] to [✂] days. Additionally, we find that longer dig distances almost always require wayleaves and/or traffic management, whereas shorter digs require them far less often.[458]

Figure A11.3 MTTP in working days for all CI Access circuits by requirement of wayleaves (W) and/or traffic management (T)

[✂]

Source: Openreach's response to the 1st and 21st BCMR s.135 notice.

A11.17 Figure A11.4 below shows there is a linear relationship between the length of fibre blown and the MTTP for connections up to 4km long. Above this length of blown fibre, there is a wide fluctuation of MTTP which is known as heteroskedasticity, reflecting the many factors affecting the installation of infrastructure for a circuit that is significantly long.

Figure A11.4: MTTP in working days by length of fibre for connections only requiring blown fibre[✂]

Source: Openreach's response to the 1st and 21st BCMR s.135 notice.

A11.18 Figure A11.5 below shows there is much greater variation and heteroskedasticity in MTTP for connections requiring digs as the dig distance increases. This supports our view that the greater the level of infrastructure build required, the greater likelihood of delay and variability in MTTP.

Figure A11.5: MTTP in working days by dig distance [✂]

Source: Openreach's response to the 1st and 21st BCMR s.135 notices.

A11.19 Broadly, the MTTP evidence based on Openreach 2017 new connections indicates that MTTP increases with a greater extent of infrastructure build, the distance of the circuit, and the requirement of wayleaves and/or traffic management. This complements the evidence that shows that delay and variability in the estimated MTTP contributes to

[458] As volumes are low for longer circuits, we do not present the exact data on this. However, as volumes are sufficiently large for shorter circuits, we are confident in our finding of a positive correlation between circuit length and probability of wayleaves/traffic management.

customers being wary of switching to a rival provider that would have to build, as was found in the studies mentioned above.

A11.20 The data provided by Openreach shows that, excluding customer-caused delay, months can be added onto the MTTP if wayleaves and/or traffic management are required. When digging is required, Openreach, even with its typically short distances required, often takes many months and – in the worst cases – over a year to provide a new connection.

MTTP evidence based on Openreach provision categories in 2017

A11.21 To expand on the MTTP evidence based on Openreach 2017 new connections described above, in this sub-section we present MTTP evidence based on Openreach's provision categories in 2017. In broad terms, these two pieces of evidence are consistent as both indicate network extensions significantly increase lead times.

A11.22 When planning the provision of a leased line, Openreach categorises orders according to its expectation of the works required to deliver the circuit into one of seven provision categories.[459] Below, we look into the MTTP of four of these provision categories[460] where a higher category number denotes a higher level of works is needed to connect the customer:

- **Category 1.1 orders (or 'quick win' orders)** – these are orders which need no Excess Construction Charges, no duct work (new or clearance), splice only where fibre exists and with a fibre blow of up to 600m either way from the central point externally, or 150m internally to connect to desired NTE location.
- **Category 1.2 orders (or blown fibre orders)** – these are orders with no requirement to build the network as spine (customer node & network node) and Cable Junction (CJ) capacity is seen to exist. The only requirement on a category 1.2 from the external provision team will be a blow and/or splice. The external blow will be over 600m or over 150m internal blow to connect to desired NTE location.
- **Category 2.1 orders (or cabling orders)** – Within this category there is a requirement for Cabling/Tubing activities, before Blow & Splice, anywhere from the node up to the termination point. As a result, Rod & Tube activities will exist on the job but there will not be the requirement for new duct Provision within this category.
- **Category 2.2 orders (or duct work orders)** – Within this category there is a requirement for Cabling/Tubing activities, before Blow & Splice, anywhere from the node up to the termination point. As a result, DRT or RTC activities will exist on the job and new duct Provision will be needed within this category.

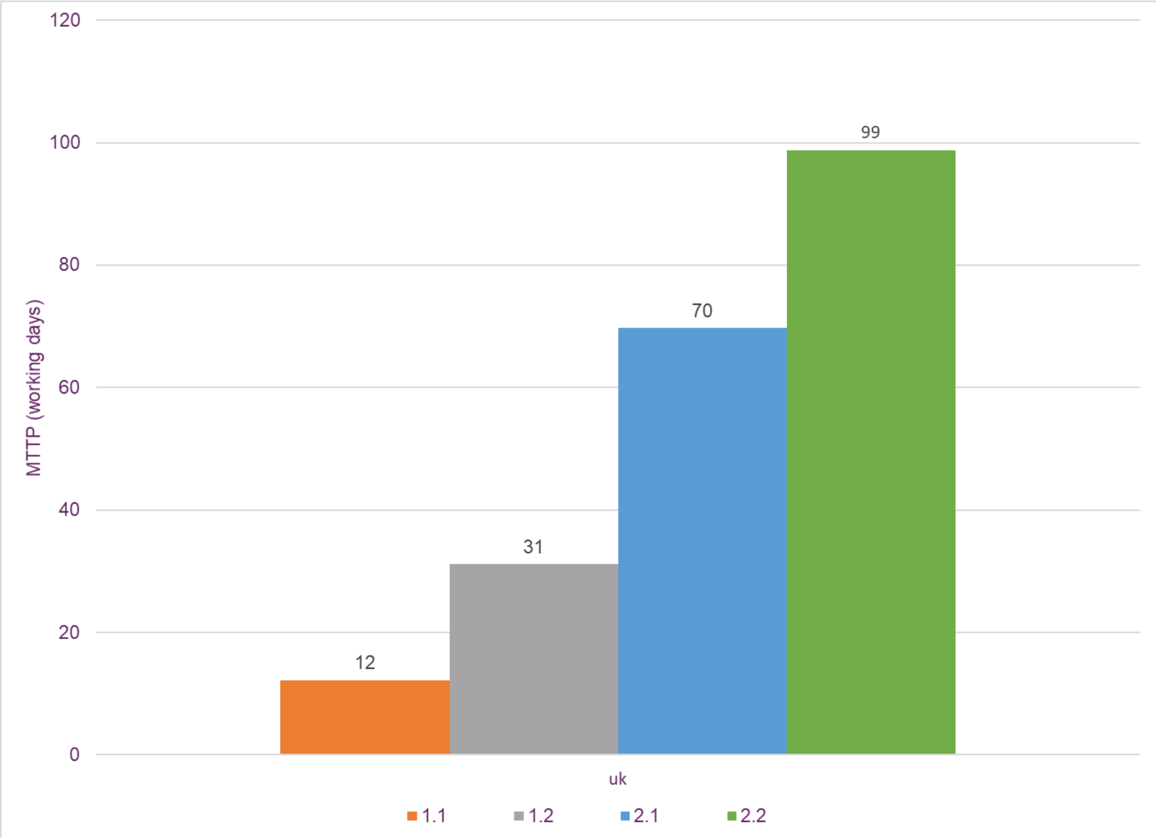
[459] When planning the provision of a leased line, Openreach categorises orders according to its expectation of the works required to deliver the circuit into one of seven provision categories: 1.1 or 'Quick Wins', 1.2, 2.1, 2.2, 3, 4.1, and 4.2. These categories may not always reflect all the works required for completed orders because the categorisation (i) does not take into consideration factors that may lengthen the delivery time or make it more "complex" to deliver (e.g. wayleaves), (ii) is registered at the beginning of the delivery process and not subsequently changed, and (iii) only applies for "Provide" order types and usually only for EAD products. Source: Openreach response dated 22 May 2018 to the 12th BCMR s.135 notice.
[460] We do not consider the other three categories because they relate to spine and core connectivity which are typically related to inter-exchange connectivity rather than CI Access.

A11.23 Figure A11.6 below shows the MTTP in 2017 for the four Openreach provision categories described above. This data shows that:

- the MTTP was significantly higher (on average 99 working days) for orders that involved duct work (category 2.2) compared to the other three provision categories (between 12 and 70 working days). This duct work includes both cases of constructing new duct and instances where existing duct needed to be repaired or cleared of blockages. Assuming these times are similar to the times faced by the industry overall, the higher MTTP associated with duct work means that operators who extend their networks to supply a leased line have a significantly longer lead time compared to the average for all orders.
- the MTTP for cabling orders is associated with a lower (on average 70 working days) compared to orders that required duct work (on average 99 working days), but significantly higher than either quick win orders (on average 12 working days) or when just blown fibre is required (on average 31 working days).
- the MTTP was significantly longer for orders that involved duct work (on average 99 working days) compared to the orders Openreach categorised as quick wins (on average 12 working days)– the latter are the orders we use as a proxy for orders for which Openreach already had a fibre connection.[461] This comparison suggests that operators who extend their networks to supply a leased line are likely to experience significantly longer lead times compared to operators that already have a fibre connection to the customer's site.
- The analysis also shows that where there is existing duct, the time to supply will be longer if cabling needs to be installed compared to where there is cabling already in place (on average 70 vs 12 to 31 working days).

[461] In our view, quick wins are a good proxy for orders for which Openreach already had a fibre connection given that they capture orders for which Openreach expected:
•no Excess Construction Charges (i.e. the additional costs Openreach charges customers to provide additional service or to deal with situations where the cost of providing service is more than the Openreach price list);
•no duct work (neither new duct nor instances where existing duct needed to be repaired or cleared from blockages); and
•potentially, but not necessarily, limited splice (splice only where fibre exists and with a fibre blow of up to 600m either way from the central point externally, or 150m internally to connect to desired Network Termination Equipment location).

Figure A11.6: Mean Time To Provide (MTTP) for 2017 Openreach orders categorised as provision category 1.1, 1.2, 2.1, and 2.2.



Source: Ofcom analysis of 12th BCMR s.135 Notice, Openreach Ethernet KPI reports, 10th 2016 BCMR s.135 Notice, and 12th 2016 BCMR s.135 Notice.

Qualitative evidence on build vs buy strategy

A11.24 This section presents qualitative evidence on how providers other than Openreach decide whether to build (extend their network) or buy (buy an active wholesale leased line product from another provider) to supply a leased line to a customer's site that is not currently connected to their network.

A11.25 This section is based on the views expressed by providers verbally or in writing in the context of several one-to-one meetings we held with them between March and June 2018.

A11.26 In broad terms, there are two distinct groups of providers:[462]

- build-only providers (i.e. CityFibre, euNetworks, and Zayo) have a strong preference to build as that is their business strategy. They either do not to make a build vs buy decision or rarely do so.
- build vs buy providers (i.e. Vodafone, Colt, Surf, [✂], Verizon, MS3, [✂], KCOM, [✂], SSET, and Virgin Media) do not have a strong preference for either option.

[462] We identified these groups based on information we gathered at the meetings we held with leased line providers.

A11.27 Build-only providers tend to build only when it is profitable to do so, otherwise they would usually decide not to serve the customer's site. For instance, Zayo indicated that it usually considers the Net Present Value, Return On Investment, and payback period in the round when deciding whether to build or use another means for deploying fibre for long term utilisation and ownership. Zayo only leases dark fibre as a last resort for deployment of time critical network extensions supporting complex customer connectivity solutions.[463]

A11.28 Collectively, build-only providers accounted for approximately 2% of 2017 connections, while build vs buy providers accounted for approximately 33% of 2017 connections.[464]

A11.29 Build vs buy providers tend to build when it is less costly than to buy and take into consideration different factors in this decision. These factors may include: the net present value of the expected revenues and costs of each option over a payback period equal to the customer's contract length (usually three years), and lead times.

A11.30 Build vs buy providers may still build where it is economically better to buy for a single circuit, but would usually do so in the context of network rollout programmes (e.g.) rather than in the context of incremental extensions for individual sites.

A11.31 The points below provide an indication of how [✂] makes its build vs buy decision,[465] and the importance given by [✂] to lead times:[466]

- [✂].
- [✂].
- [✂].
- [✂].
- [✂] indicated that the lead times associated with build and buy are important.
- [✂] mentioned that supplying a leased line service to a new customer's site can take (i) *days* when the site is already connected to [✂] network (e.g. three to four days); (ii) *weeks* when [✂] buys an active wholesale leased line product from another provider (usually when the customer's site is connected to another provider's network but not to [✂]); or (iii) *a month or more* when [✂] digs and installs a new duct to extend its network to reach the customer's site (usually when the customer's site is not connected to any network).

Empirical evidence on the incidence and dig distances of network extensions

A11.32 We analyse the CI Access circuits connected by telecoms providers in 2017 in the UK to estimate how often providers usually dig and the distances they typically dig to extend

[463] Ofcom notes from meeting with Zayo on 23 May 2018.
[464] We based this observation on information we gathered at the meetings we held with leased line providers and data we collected under s.135 requests. We explain this further in footnote 153 in Table A11.6.
[465] Ofcom notes from meeting with Vodafone on 1 March 2018 and Vodafone letter to Ofcom dated 19 April 2018.
[466] Ofcom notes from meeting with [✂] on 14 May 2018.

their network to new customers' sites. We use this to inform our SMP assessment of CI Access circuits in Section 5 of Volume 2.[467]

A11.33 We present the distances telecoms providers dug to connect their networks to customers' sites as *radial* distances (i.e. the straight-line distance between networks and sites ignoring the layout of streets and other infrastructure), as opposed to *route* distances (i.e. the actual distance providers dug to connect networks and sites following the layout of streets and other infrastructure). This allows for a like-for-like comparison between the distances presented in this section and our 50m *radial* buffer distance.[468]

A11.34 We converted route distances into radial distances by dividing each given route distance by 1.4. We have used similar conversion factors in previous work.[469]

A11.35 The main findings from this analysis include:

- Openreach accounted for [✂]% of the [✂] network extensions done by all providers in 2017. Out of the [✂] network extensions not done by Openreach, Virgin Media accounted for [✂]% and CityFibre accounted for [✂]%;
- Openreach had existing duct for the [✂] of the customer ends it connected in 2017 ([✂]%) 81% - 90%. It only extended its network for [✂]% of the customer ends it connected in 2017;
- Openreach's rivals had existing duct for a lower proportion of the customer ends they connected in 2017 (46%) when compared to Openreach. They only built for 5% of the customer ends they connected in 2017;
- Openreach's rivals were unlikely to build to connect customers' sites that were not already connected to their networks. Collectively, they only built for [✂] connections (10% of the [✂] connections not already connected to their networks);
- four providers accounted for 99% of the [✂] digs that took place in 2017 ([✂]);
- providers tend to dig short distances. Close to 80% of digs involved a distance of 50m or less ([✂]% of [✂] Openreach digs, and [✂]% of [✂] rival digs), and close to 90% of digs involved a distance of 100m or less ([✂]% of [✂] Openreach's digs, and [✂]% of [✂] rivals' digs);
- a minority of digs were long distance, suggesting a low propensity of rivals to dig when they are located further away. About 15% of digs involved a distance above 100m ([✂]% of [✂] Openreach digs, and [✂]% of [✂] rival digs);
- the vast majority of long distance digs by Openreach's rivals were carried out by build-only providers (i.e. CityFibre, euNetworks and Zayo) as their business strategy is to

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[467] This evidence and its breakdown by bandwidth also informs Annex 14 (SMP assessment for VHB).

[468] Section 5 of Volume 1 discusses our 50m radial buffer distance in detail.

[469] For instance, footnote 29 of the 2017 WLA Consultation mentions that "telephone lines tend to follow the layout of streets, rather than travel in straight radial lines from exchanges to street cabinets and onto customer premises, the derived radial distances are converted into route distances that follow the typical rectilinear pattern of streets by applying a conversion factor (typically in the range 1.2 – 1.4)" [accessed 20 May 2019].

build (out of the [✂] rival digs above 100m, build-only providers collectively accounted for 78%, and CityFibre individually accounted for 56%); and

- for Openreach, the median dig distance was [✂] 0-25 metres compared to a mean distance of [✂] metres; while for Openreach's rivals the median was 14 metres compared to a mean of [✂] metres. We consider that the median rather than the mean provides a better indication of the distance to which operators are most likely to extend their network for the reasons set out in paragraph A11.42.

A11.36 This analysis is based on the datasets we collected from 16 providers (CityFibre[470], Colt[471], eir[472], euNetworks[473], Fibrespeed[474], Interoute[475], KCOM[476], [✂][477], MS3[478], Openreach[479], SSE[480], Surf[481], Verizon[482], Virgin Media[483], Vodafone[484], and Zayo[485]) which we processed as described in Annex 12.[486] This data identifies:

- each leased line and dark fibre connection made in 2017 and whether it was connected on-net or off-net (responses to question C1);
- for each on-net connection, whether it was connected using an existing fibre connection (i.e. no need to blow fibre) (C1 viia), it was connected using existing duct but not fibre (C1 viib), or digging was required (i.e. no existing duct or fibre) (C1 viic); and
- for each on-net connection that involved digging, the actual distance dug (C2 viii), the distance between the newly connected building and the nearest flexibility point (C2 ix), the interface delivered (C2 x), the bandwidth delivered (C2 xi), and the cost of connecting to the building (C2 xii).

Incidence of network extensions and build vs buy decision

A11.37 Table A11.7 below presents the number of CI Access circuits ends connected in 2017 in the UK, their breakdown by how they were connected, and an indicator of the likelihood of build vs buy. This information is presented for the four providers with the highest number of digs in 2017 (Openreach, CityFibre, Virgin Media, and Vodafone) and Openreach's rivals

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[470] CityFibre response dated 17 January 2018 to the 1st BCMR s.135 notice.
[471] Colt response dated 17 January 2018 to the 1st BCMR s.135 notice.
[472] eir's response dated 28 January 2019 to the 19th BCMR s.135 notice.
[473] euNetworks's response dated 17 January 2018 to the 1st BCMR s.135 notice.
[474] Fibrespeed response dated 19 January 2018 to the 1st BCMR s.135 notice.
[475] Interoute response dated 17 January 2018 to the 1st BCMR s.135 notice.
[476] KCOM response dated 17 January 2018 to the 1st BCMR s.135 notice.
[477] [✂].
[478] MS3 response dated 17 January 2018 to the 1st BCMR s.135 notice.
[479] Openreach response dated 18 January 2018 to the 1st BCMR s.135 notice.
[480] SSE response dated 17 January 2018 to the 1st BCMR s.135 notice.
[481] Surf response dated 17 January 2018 to the 1st BCMR s.135 notice.
[482] Verizon response dated 17 January 2018 to the 1st BCMR s.135 notice.
[483] Virgin response dated 17 January 2018 to the 1st BCMR s.135 notice.
[484] Vodafone response dated 17 January 2018 to the 1st BCMR s.135 notice.
[485] Zayo response dated 18 January 2018 to the 1st BCMR s.135 notice.
[486] In Annex 12 (under the 'Dig variables' heading) explain how we processed the raw circuit ends data we received in response to s.135 notices to inform our analysis of the empirical evidence on the incidence and dig distances of network extensions. We note that (i) we classified as 'on-net duct connected' the circuit ends with missing information on type of connection; and (ii) we allocated digs randomly for customer-to-customer circuit ends.

grouped together (CityFibre, Virgin Media, Vodafone, euNetworks, Colt, Zayo, Surf, KCOM, MS3, Interoute, [✂], SSE, Verizon, and Fibrespeed).

Table A11.7: CI Access circuit ends connected in 2017 in the UK (excluding the Hull Area) – Type of connection and likelihood of build vs. buy[487] [488]

	Openreach[489]	Other providers (total)[490]	CityFibre	Virgin Media	Vodafone
a) CI Access circuit ends connected in 2017	[✂]	[✂]	[✂]	[✂]	[✂]
b) on-net duct-connected (i.e. no need to build)	[✂] (81% - 90%)	[✂] (46%)	[✂] (41% - 50%)	[✂] (71% - 80%)	[✂]
c) on-net not duct-connected (i.e. build)	[✂] (11% - 20%)	[✂] (5%)	[✂]	[✂]	[✂]
d) off-net (i.e. buy)	0 (0%)	[✂] (50%)	[✂]	[✂]	[✂]
e) Likelihood of build vs buy [c / (c + d)]	Does not apply	9%	[✂]	[✂]	[✂]

Source: Stakeholder responses to the 1st BCMR s.135 notice.

A11.38 This evidence indicates that:

- Openreach completed [✂] network extensions in 2017 which represents [✂]% of the [✂] network extensions done by all providers in 2017. Out of the [✂] network extensions not done by Openreach, Virgin Media accounted for [✂] ([✂]%), while CityFibre accounted for [✂] networks extensions ([✂]%).
- Openreach had existing duct for the [✂] of the customer ends it connected in 2017. Openreach had a total of [✂] customer ends, of which [✂]% 81% - 90% already had

487 Annex 12 (under the 'Dig variables' heading) explain how we processed the raw circuit ends data we received in response to s.135 notices to inform our analysis of the empirical evidence on the incidence and dig distances of network extensions. We note that (i) we classified as 'on-net duct connected' the circuit ends with missing information on type of connection; and (ii) we allocated digs randomly for customer-to-customer circuit ends.

488 In some columns the total number of CI Access circuit ends connected in 2017 (row a) is higher than the sum of the number of circuits that were on-net duct-connected (row b), on-net not duct-connected (row c), and off-net (row d). This is because for a minority of circuits we could not identify the type of connection.

489 For Openreach the number of CI Access circuit ends connected in 2017 that were fibre connected was [✂], which is equivalent to [✂]% of Openreach's [✂] CI Access circuit ends connected in 2017. In comparison, for Openreach's rivals the proportion of fibre-connected ends was less than [✂%] of the [✂] CI Access circuit ends they connected in 2017 (we were unable to estimate the exact figure for rivals due to data limitations).

490 As mentioned in the section on Qualitative evidence on build vs buy strategy above, we have classified providers other than Openreach into one of two groups: build-only providers (i.e. CityFibre, euNetworks, and Zayo) and build vs buy providers (i.e. [✂]). We have made this classification based on the information gathered at the meetings we held with leased lines providers. However, we also considered how many of a given provider's 2017 connections were done off-net (i.e. they bought the connection from another provider) as per their responses to the 1st BCMR s.135 notice. Build-only providers made [✂] connections in 2017 (2% of all 2017 connections), of which on average 7% were done off-net. Build vs buy providers made [✂] connections in 2017 (33% of all 2017 connections), of which on average 43% were done off-net.

duct in place. Openreach only extended its network (i.e. built) for [✂] customer ends or [✂]% of the customer ends it connected in 2017.

- Openreach's rivals had existing duct for a lower proportion of the customer ends they connected in 2017 when compared to Openreach. Collectively, they connected a total of [✂] customer ends, of which only 45% already had duct in place. They only built for [✂] customer ends or 5% of the customer ends they connected in 2017.
- Openreach's rivals were unlikely to build to connect customers' sites that were not already connected to their networks. Collectively, they only built for [✂] connections (10% of the [✂] connections not already connected to their networks). At an individual level, Vodafone built for only [✂]% of the connections not already connected to its network, while Virgin did so for [✂]% of the connections not already connected to its network. We categorised CityFibre as a build-only provider as it does not make a build vs buy decision.
- Four providers accounted for 99% of the [✂] digs that took place in 2017 ([✂]).

A11.39 Table A11.8 below presents this information broken down by bandwidths.

Table A11.8: CI Access circuit ends connected in 2017 in the UK (excluding the Hull Area) by bandwidth – Type of connection and likelihood of build vs. buy

	Openreach	Other providers (total)	CityFibre	Virgin Media	Vodafone
		10 Mbit/s			
a) CI Access circuit ends connected in 2017	[✂]	2,415 (100%)	[✂]	[✂]	[✂]
b) on-net duct-connected (i.e. no need to build)	[✂]	1,092 (46%)	[✂]	[✂]	[✂]
c) on-net not duct-connected (i.e. build)	[✂]	45 (2%)	[✂]	[✂]	[✂]
d) off-net (i.e. buy)	[✂]	1,237 (52%)	[✂]	[✂]	[✂]
e) Likelihood of build vs buy [c / (c + d)]	Does not apply	4%	[✂]	[✂]	[✂]
		100 Mbit/s			
a) CI Access circuit ends connected in 2017	[✂]	15,099 (100%)	[✂]	[✂]	[✂]
b) on-net duct-connected (i.e. no need to build)	[✂]	5,668 (38%)	[✂]	[✂]	[✂]
c) on-net not duct connected (i.e. build)	[✂]	439 (3%)	[✂]	[✂]	[✂]
d) off-net (i.e. buy)	[✂]	8,846 (59%)	[✂]	[✂]	[✂]
e) Likelihood of build vs buy [c / (c + d)]	Does not apply	5%	[✂]	[✂]	[✂]
		1 Gbit/s			
a) CI Access circuit ends connected in 2017	[✂]	5,381 (100%)	[✂]	[✂]	[✂]
b) on-net duct-connected (i.e. no need to build)	[✂]	3,234 (61%)	[✂]	[✂]	[✂]

c) on-net not duct-connected (i.e. build)	[✂]	304 (6%)	[✂]	[✂]	[✂]
d) off-net (i.e. buy)	[✂]	1,794 (34%)	[✂]	[✂]	[✂]
e) Likelihood of build vs buy [c / (c + d)]	Does not apply	14%	[✂]	[✂]	[✂]
		VHB			
a) CI Access circuit ends connected in 2017	[✂]	660 (100%)	[✂]	[✂]	[✂]
b) on-net duct-connected (i.e. no need to build)	[✂]	527 (80%)	[✂]	[✂]	[✂]
c) on-net not duct-connected (i.e. build)	[✂]	17 (3%)	[✂]	[✂]	[✂]
d) off-net (i.e. buy)	[✂]	116 (18%)	[✂]	[✂]	[✂]
e) Likelihood of build vs buy [c / (c + d)]	Does not apply	13%	[✂]	[✂]	[✂]
		Dark fibre			
a) CI Access circuit ends connected in 2017	[✂]	894 (100%)]	[✂]	[✂]	[✂]
b) on-net duct-connected (i.e. no need to build)	[✂]	498 (56%)	[✂]	[✂]	[✂]
c) on-net not duct-connected (i.e. build)	[✂]	389 (44%)	[✂]	[✂]	[✂]
d) off-net (i.e. buy)	[✂]	7 (1%)	[✂]	[✂]	[✂]
e) Likelihood of build vs buy [c / (c + d)]	Does not apply	98%	[✂]	[✂]	[✂]

Source: Stakeholder responses to the 1st BCMR s.135 notice.

Dig distances

A11.40 Table A11.9 below presents the distances providers dug to extend their network to new customers' sites in 2017 as radial distances. This information is presented for the four providers with the highest number of digs in 2017 (Openreach, CityFibre, Virgin Media, and Vodafone) and Openreach's rivals grouped together (CityFibre, Virgin Media, Vodafone, euNetworks, Colt, Zayo, Surf, KCOM, MS3, Interoute, [✂], SSE, Verizon, and Fibrespeed).

Table A11.9: CI Access circuit ends connected in 2017 in the UK (excluding Hull) – Radial dig distances for on-net circuits without duct connected

Dig Distance (metres)	Openreach	Other providers (cumulative total %)	CityFibre	Virgin Media	Vodafone
0 to 25	[✂]	[✂]	[✂]	[✂]	[✂]
0 to 50	[✂]	[✂]	[✂]	[✂]	[✂]
0 to 75	[✂]	[✂]	[✂]	[✂]	[✂]
0 to 100	[✂]	[✂]	[✂]	[✂]	[✂]
Any distance	[✂]	[✂]	[✂]	[✂]	[✂]
Mean	[✂]	[✂]	[✂]	[✂]	[✂]
Median	[✂] 0-25	14	[✂] 0-25	[✂] 0-25	[✂] 0-25

Source: Stakeholder responses to the 1st BCMR s.135 notice.

A11.41 This evidence indicates that:

- providers tend to dig short distances. Close to 80% of digs involved a distance of 50m or less ([✂]% of [✂] Openreach's digs, and [✂]% of [✂] rivals' digs), and close to 90% of digs involved a distance of 100m or less ([✂]% of [✂] Openreach's digs, and [✂]% of [✂] rivals' digs);
- a minority of digs were long distance, suggesting a low propensity of rivals to dig when they are located further away. About 15% of digs involved a distance above 100m ([✂]% of [✂] Openreach's digs, and [✂]% of [✂] rivals' digs);
- the vast majority of long distance digs by Openreach's rivals were carried out by build-only providers (i.e. CityFibre, euNetworks and Zayo) as their business strategy is to build (out of the [✂] rivals' digs above 100m, build-only providers collectively accounted for 78%, and CityFibre individually accounted for 56%);[491] and
- for Openreach, the median dig distance was [✂] 0-25 metres compared to a mean distance of [✂] metres; while for Openreach's rivals the median was 15 metres compared to a mean of [✂] metres.

[491] As mentioned in the section on Qualitative evidence on build vs buy strategy, build-only providers have a strong preference to build.

Table A11.10: CI Access circuit ends connected in 2017 in the UK (excluding the Hull Area) by bandwidth – Radial dig distances for on-net not duct connected

	Openreach	Other providers (total)	CityFibre	Virgin Media	Vodafone
10 Mbit/s					
0 to 25	[✂]	[✂]	[✂]	[✂]	[✂]
0 to 50	[✂]	[✂]	[✂]	[✂]	[✂]
0 to 75	[✂]	[✂]	[✂]	[✂]	[✂]
0 to 100	[✂]	[✂]	[✂]	[✂]	[✂]
Any distance	[✂]	[✂]	[✂]	[✂]	[✂]
Mean	[✂]	[✂]	[✂]	[✂]	[✂]
Median	[✂]	[✂]	[✂]	[✂]	[✂]
100 Mbit/s					
0 to 25	[✂]	[✂]	[✂]	[✂]	[✂]
0 to 50	[✂]	[✂]	[✂]	[✂]	[✂]
0 to 75	[✂]	[✂]	[✂]	[✂]	[✂]
0 to 100	[✂]	[✂]	[✂]	[✂]	[✂]
Any distance	[✂]	[✂]	[✂]	[✂]	[✂]
Mean	[✂]	[✂]	[✂]	[✂]	[✂]
Median	[✂]	[✂]	[✂]	[✂]	[✂]
1 Gbit/s					
0 to 25	[✂]	[✂]	[✂]	[✂]	[✂]
0 to 50	[✂]	[✂]	[✂]	[✂]	[✂]
0 to 75	[✂]	[✂]	[✂]	[✂]	[✂]
0 to 100	[✂]	[✂]	[✂]	[✂]	[✂]
Any distance	[✂]	[✂]	[✂]	[✂]	[✂]
Mean	[✂]	[✂]	[✂]	[✂]	[✂]
Median	[✂]	[✂]	[✂]	[✂]	[✂]
VHB					
0 to 25	[✂]	[✂]	[✂]	[✂]	[✂]
0 to 50	[✂]	[✂]	[✂]	[✂]	[✂]
0 to 75	[✂]	[✂]	[✂]	[✂]	[✂]
0 to 100	[✂]	[✂]	[✂]	[✂]	[✂]
Any distance	[✂]	[✂]	[✂]	[✂]	[✂]
Mean	[✂]	[✂]	[✂]	[✂]	[✂]
Median	[✂]	[✂]	[✂]	[✂]	[✂]
Dark fibre					
0 to 25	[✂]	[✂]	[✂]	[✂]	[✂]
0 to 50	[✂]	[✂]	[✂]	[✂]	[✂]
0 to 75	[✂]	[✂]	[✂]	[✂]	[✂]
0 to 100	[✂]	[✂]	[✂]	[✂]	[✂]
Any distance	[✂]	[✂]	[✂]	[✂]	[✂]
Mean	[✂]	[✂]	[✂]	[✂]	[✂]
Median	[✂]	[✂]	[✂]	[✂]	[✂]

Source: Stakeholder responses to the 1st BCMR s.135 notice.

A11.42 We consider that the median rather than the mean provides a better indication of the distance to which operators are most likely to extend their network. This is because mean dig distances are skewed by the minority of very long distances dug. In our view, these long-distance digs are likely to be exceptional and not representative of what providers would be more generally willing to dig. We note that the majority of long-distance digs are carried out by build-only providers, i.e. providers who have a strong preference to build and either do not make a build vs buy decision or rarely do so. The small number of long-distance digs for build vs buy providers may also be exceptional and explained by situations when the total contract value of an unusually large contract justifies the dig, when the provider is digging for an anchor tenant, rollout programmes, and situations where it was less costly to build than to buy because dig costs in that area were unusually low.

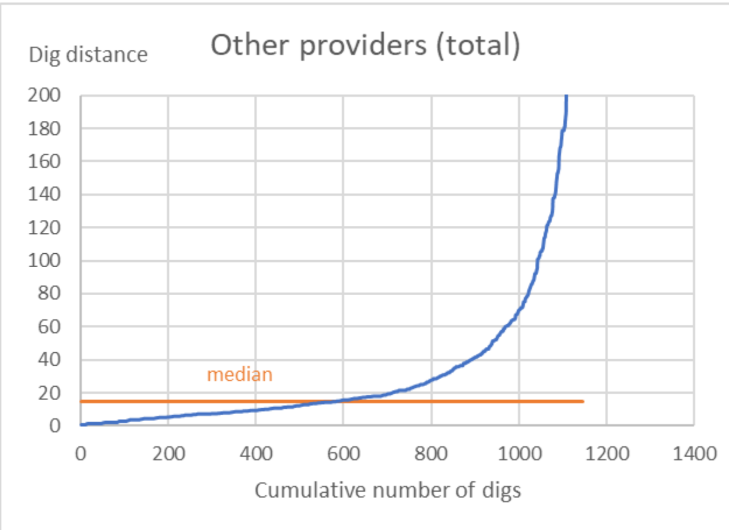
A11.43 Table A11.10 presents this information broken down by bandwidths.

A11.44 Figure A11.11 below shows the cumulative distribution of the radial distances dug by providers in 2017.

Figure A11.11: CI Access circuit ends connected in 2017 in the UK (excluding Hull) for selected providers – Distribution of dig distances[492]

Openreach[✂]

Other providers (total)



CityFibre [✂]

Virgin Media [✂]

Vodafone [✂]

Source: Responses to BCMR s.135 notices (see paragraph A11.26)

[492] For some providers the number of digs reported in Figure A11.10 is slightly smaller than that reported in Tables A11.6, A11.7, A11.8, and A11.9 above. This is because Figure A11.10 excludes instances in which providers have informed a dig but failed to inform the associated dig distance.

A11.45 This evidence supports the point that for a relatively small proportion of customer ends providers had to dig unusually long distances, which suggests that the median (rather than mean) is a more representative measure of the distance providers tend to dig.

A12. Approach to data processing

A12.1 In this annex, we explain our approach to cleaning the data, including the physical network infrastructure data and the leased lines data, obtained from telecoms providers under our statutory information gathering powers. We use these data sets to perform our network reach and service share analyses.

A12.2 We also explain the different methodologies we use in these analyses, as well as that of classifying geographic markets in the UK based on the level of competition. We then outline results from these analyses which relate to the base case scenario, where a buffer distance of 50m is applied.[493]

A12.3 The data used in our analyses is comprised of:

- postcode data;
- physical network infrastructure data;
- network sites data;
- business locations data; and
- leased lines data.

A12.4 Since the 2018 BCMR Consultation we have made several updates to our network reach and service share analyses. These are explained in further detail in this annex. These updates include:

- we now use a dataset of 2018 postcodes;
- eir's physical network infrastructure, network sites and leased line circuits have been added;
- we now use a more recent dataset of business locations; and
- the postcode uplift for those customer ends with an unknown postcode is now applied to all telecoms providers.

Postcode data

A12.5 In the 2016 BCMR, geographic market areas were defined with individual postcode sectors using Dotted Eyes as our data source. This data source was updated in 2017 by Miso[494] for the 2018 BCMR Consultation, providing the locations of postcodes, postcode sectors and

[493] Refer to Annex 11 for detail in determining the buffer distance that is used.
[494] Miso is a division of Dotted Eyes Ltd offering mapping data and software.

their associated polygons.[495] For this statement, we have updated this dataset to postcodes as of September 2018.[496]

A12.6 This postcode data is used to determine the locations of businesses and network sites for our network reach analyses, as well as the locations of exchanges in our inter-exchange analysis and a small number of circuit ends in our leased lines data.

Physical network infrastructure data

A12.7 We asked telecoms infrastructure providers to supply digital maps of their duct networks. Coordinates of these duct networks were extracted where possible and used to map the network infrastructure of each provider.

A12.8 To supplement this data, we also asked telecoms infrastructure providers to supply the easting and northing location details[497] of all their flexibility points.[498] These are points where existing physical links can be accessed to connect an end-user premises and from which telecoms infrastructure providers would consider extending their network to provide services to additional end-user premises. Examples of flexibility points include buildings where fibre terminates on an Optical Distribution Frame or underground chambers where fibre can be accessed, such as where ducts meet at a junction. This allowed us to map the network infrastructure of providers where duct maps were not available or usable.

Responses to our approach to using flexibility points and duct network data

A12.9 Openreach agreed with our use of actual duct networks and our methodology to measure the extent of a network based on the location of an operator's duct.[499] Openreach raised the concern that the use of fibre flexibility points for some providers[500] rather than duct

[495] The polygons for each postcode and postcode sector represent the geographic coverage of the postcode or postcode sector. When verifying the postcode and postcode sector polygons in Northern Ireland, we found that the polygon shapes in the Miso data differed when compared to those created by Ofcom from another data source, Ordnance Survey. This is due to Miso's manual creation of Thiessen polygons from postcode points in their source data.
For polygons in Northern Ireland this other data source is used. Postcode polygons in Great Britain were consistent between the two sources of polygons. Since the 2018 BCMR Consultation we have corrected an error with the easting and northing coordinates of Northern Ireland's postcode centroids. This fix had only a small effect on our geographic market definitions, with eight and 53 additional postcode sectors being classified as HNR and BT+1 respectively, and 186 less BT Only sectors.

[496] In addition to geographic postcode, there are also some non-geographic postcodes where a business moves location but retains their previous postcode. We have not adjusted our analysis for non-geographic postcodes because of the low materiality of these postcode locations to our geographic market assessment.

[497] Eastings and northings provide the coordinates of any given location in the UK in metres east and north of an origin just to the south-west of the Isles of Scilly.

[498] In many cases flexibility point data was provided as eastings and northings. Where data was provided as latitude and longitude we converted this to eastings and northings (using software called MapInfo), and where data was provided as postcodes we used our postcode data to convert to eastings and northings of the postcode centroid.

[499] Openreach's response to the 2018 BCMR Consultation, paragraph 20, page 100.

[500] Providers with flexibility points and network sites: CityFibre, Colt, Eir, EU Networks, Fibrespeed, Interoute, KCOM, CenturyLink, MS3, Openreach, Sky, SSE, Surf, TalkTalk Verizon, Virgin Media, Vodafone and Zayo.

network will lower the estimated coverage of rival networks[501] and understate the true "footprint" of these operators,[502] suggesting that we use a longer reach distance for those operators.[503] We are using flexibility points in conjunction with duct networks for all telecoms providers where available, and in cases where duct network is unavailable this is due to the limited extent of the operator's duct network.

A12.10 Vodafone said [✂][504] We have extracted duct route coordinates and supplemented these with flexibility points to reflect the behaviour of some providers digging out to a customer along any part of their network. This is in line with our conservative approach by tending towards greater rival competition to Openreach.

Network sites data

A12.11 We requested from each provider a list of network sites, which we defined as locations in the telecoms provider's network where it had installed transmission equipment that is used for leased lines and which is capable of serving more than one business customer. Network sites are distinct from flexibility points in that the former are buildings where a telecoms provider has telecom equipment that allows for the transmission, switching, routing and/or aggregation of traffic[505], whereas the latter are physical locations from which a provider can extend its copper, fibre or coax network. Therefore, although a network site can serve as a flexibility point, the reverse is normally not true.

A12.12 For each network site, we requested address details (or geographic coordinates where no postal address was available), a brief description of the nature of the site and whether it coincides with a customer site.

A12.13 Using these details of each network site we filtered out sites that were out of scope, such as those labelled as test sites, those associated with out of scope products, those that are inactive, and those coinciding with customer sites.

Business locations and mobile sites data

A12.14 To carry out our network reach analyses, we require data on UK business size and locations. For the 2016 BCMR and 2018 BCMR Consultation we used Market Location as our source of UK business information, where we extracted the locations of businesses which employed 250 or more employees.[506] This formed a list of large businesses and their corresponding postcodes. We have updated this data source to its 2018 version for this statement, with a comparison of the number of large business sites in each version shown in Table A12.1.

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[501] Openreach's response to the 2018 BCMR Consultation, paragraph 118c, page 26.
[502] Openreach's response to the 2018 BCMR Consultation, paragraph 21, page 100.
[503] Openreach's response to the 2018 BCMR Consultation, paragraph 22, page 100.
[504] [✂]
[505] For example, a telecoms provider's own network equipment rooms, the common equipment room in a multi-tenant building, or an end-customer equipment room from which you serve other customers.
[506] This number of employees is at a national level.

Table A12.1: Comparison of the number of large business sites in each business sites data set

Year data was obtained	Number of business sites with 250 or more employees
2014	164,329
2018	138,128

Source: Market Location's 2016 and 2018 Business Connectivity Report

A12.15 Our intention was to use circuit inventory data in our access network reach analysis but, as detailed in the leased lines data section below, we are unable to use the inventory data due to quality concerns. There are insufficient volumes in the new connections data to use as an effective weight in our network reach analysis due to the geographic granularity required. This contrasts with our service share analysis which is calculated over larger geographic areas, so the smaller volumes in the new connections data are sufficient. We also considered using Ordnance Survey as a data source, which provides the exact coordinates of business sites rather than their address. However, this dataset does not provide information on the number of employees of a business, which we use to filter for large businesses. Consequently, there would be a loss of accuracy in identifying an appropriate sample of business sites likely to demand leased lines. We consider that using this alternative dataset would not allow us to adequately implement our methodology.

A12.16 Mobile sites require leased lines as well as large businesses. The Mobile Network Operator (MNO) inventory data, an output of the leased lines data discussed below, contains all leased lines and dark fibre products used by mobile network operators. Using this data, we determine the locations of MNOs' cell sites by identifying those postcodes where a leased line used by an MNO terminates. These locations of the circa 26,000 mobile sites are added to those of large businesses for our access network reach analysis.

Responses to our use of business location data

A12.17 Openreach argued that we are understating the likely presence of rival infrastructure with our notional database for potential demand[507] and said that BT had previously raised concerns that this selection is not representative of leased line demand as it is skewed towards companies and organisations that have a large number of small sites such as retail companies.[508] Our threshold of 250 or more employees database includes businesses with a large number of sites and employees that may not require leased lines, just as it misses companies with fewer employees that do require leased lines. Openreach argued that there is a probability that at least one-third of our dataset of 138 thousand sites have no relevance to this market review and will bias the findings to find rival infrastructure providers with lower coverage than is usually the case.[509] Openreach did not produce

[507] Openreach's response to the 2018 BCMR Consultation, page 26, paragraph 118a.
[508] Openreach's response to the 2018 BCMR Consultation, page 98, paragraph 5.
[509] Openreach's response to the 2018 BCMR Consultation, page 99, paragraph 12.

evidence to validate this number and support its argument. We also think that Openreach's evidence is unlikely to take into account those smaller sized businesses that do require leased lines. We consider that large business sites are a reasonable proxy for those businesses that demand leased lines.[510] We also note that service shares in any given area are unaffected by the choice of dataset for network reach.

A12.18 Openreach believed that using actual and plausible future real connections would result in a smaller error of coverage rather than a theoretical geographic site demand database which includes many thousands of sites that are currently served by broadband services.[511] It was also suggested by Openreach that a consistent approach for demand should be adopted, with geographic demand for mobile base stations uses only existing fibre-connected sites.[512] Our intention was to use customer sites in conjunction with mobile base stations. However, given our data quality concerns with the inventory data[513] and new connections having insufficient volumes to provide effective weightings in our network reach analysis due to the geographic granularity required, we have used large business sites.[514]

A12.19 Openreach argued that a low proportion of new build to total large business sites in the data suggests that the CI access market demand has been largely built to already.[515] We disagree with Openreach on this point because, as shown in Table A12.2 below, the number of orders completed by Openreach annually has risen slightly since 2015 and we see no reason why a sudden decline would occur.

Table A12.2: Comparison of the number of large business sites in each business sites data set

Year	Number of orders completed by Openreach
2015	[✂]
2016	[✂]
2017	[✂]

Source: Ofcom analysis based on Openreach's response to the 12th BCMR s.135, 10th 2016 BCMR s.135 notice and 12th 2016 BCMR s.135 notice.

510 The Tribunal indicated that Ofcom was not wrong to use this approach (see paragraph 421 of the BCMR Judgement [accessed 20 May 2019]). And, we consider that it takes into account future demand from businesses that do not currently use leased lines.
511 Openreach's response to the 2018 BCMR Consultation, page 99, paragraph 14.
512 Openreach's response to the 2018 BCMR Consultation, page 100, paragraph 15.
513 Refer to Annex 12, paragraph A12.21 for detail of our concern.
514 In Annex 10, paragraph A10.222 of the 2016 BCMR Statement we looked at a sensitivity using inventory data instead of large business sites and found the CLA boundary remained largely unchanged.
515 Openreach's response to the 2018 BCMR Consultation, page 99, paragraph 13.

Leased lines data

A12.20 We requested data from each telecoms provider on all live leased lines they supply and purchase.[516] We then collated and cleaned this data to generate the following three datasets:

- the inventory dataset, containing all live leased lines and dark fibre products supplied by telecoms providers;
- the MNO inventory dataset, containing all live leased lines and dark fibre products used by MNOs; and
- the connections dataset, containing all leased lines and dark fibre products connected by telecoms providers in 2017.

A12.21 We have used the inventory dataset for calculating service shares in the Hull Area. Due to data quality issues affecting large parts of the UK other than the Hull Area, we have not relied on the inventory dataset and have instead used the connections dataset to analyse service shares in those other areas. However, we have performed sensitivity analysis using the inventory dataset.[517]

A12.22 We have used the MNO inventory dataset alongside the business locations data to carry out the network reach analysis.

Responses to our approach to using leased lines data

A12.23 Responses to the consultation acknowledge the difficulties faced with some of the data submitted by providers but some responses, Openreach[518] in particular, also stated specific concerns about the leased lines data we used and our approach in using this information.

A12.24 Openreach also expressed concern that the lack of key competitor information on circuit locations means that Ofcom is unable to complete a sense check using actual circuit connections.[519] Openreach considers that it "[has] been penalised in the formulation of geographic markets and in the related SMP assessment due to the inability of a major competitor to provide reliable data." Openreach made it clear that reliable information from this major provider ought to be assured for future market reviews.

A12.25 Additionally, Openreach submitted specific concerns about Virgin Media's data and how we had treated these issues.[520] For instance, Openreach was concerned that we had not cross-checked potentially mis-classified Virgin Media on-net circuits (which are actually off-net) against its own circuit database which had been provided in full.

A12.26 We were unable to undertake this check because of missing information in Virgin Media's data, notably missing postcodes, which prevented us from having a common point of

[516] Stakeholder responses to questions A1, A2, C1 and C2 of the 1st BCMR s.135 notice, questions A1 and A2 of the 5th BCMR s.135 notice, and questions A1 and A2 of the 19th BCMR s.135 notice.
[517] See Annex 13.
[518] Openreach's response to the 2018 BCMR Consultation, page 26, paragraph 118.b.
[519] Openreach's response to the 2018 BCMR Consultation, page 26, paragraph 118.b.
[520] Openreach's response to the 2018 BCMR Consultation, page 112, paragraph 21.

reference between Virgin Media's and Openreach's data. Furthermore, our approach of including circuits with missing on-net information ensures that we are taking the upper bound of Virgin Media's customer ends; this means that Openreach's market shares are effectively a lower bound in this regard. This is congruent with our overall conservative approach to the SMP assessment. Therefore, we do not agree with Openreach that it has been "penalised" in the SMP assessment because of complications with Virgin Media's data.

A12.27 Openreach expressed concerns with our approach in rectifying issues in the Virgin Media data, arguing that "there could be a systematic reason why postcodes were not recorded for some circuits and this could easily distort reported market shares".[521] Moreover, Openreach stated that we ought to have included margins of error for the assumptions used in both the inventory and new connections data which affect service shares.[522] We acknowledge that there could be a reason why some circuits were missing key information and that there is a risk that proportionally reallocating them to circuits containing that piece of information (e.g. postcode or on-net/off-net classification) might not accurately reflect reality. Nonetheless, we consider our approach is reasonable because not performing this reallocation process would essentially exclude these circuits with missing key information and, by default, increase Openreach's service shares. By reallocating these circuits to those with known classifications, we consider we are taking a conservative approach in assessing Openreach's service shares by presenting a lower bound.[523]

A12.28 UKCTA argued that our approach of including self-supply providers (those with their own network but without wholesale business) overestimates competition because these providers are not a like-for-like alternative for access seekers to Openreach's network.[524] We disagree with UKCTA, as such providers have made a decision to build network infrastructure out to a customer over buying from a wholesale supplier. This places a competitive constraint on BT, therefore we include self-supply providers in our assessment of competitive conditions.

A12.29 SSE supported our use of 2017 connections but considered it important that upgrades are included within in the assessment.[525] We confirm that upgrades are included in our analysis and were included consistently across all providers.

Data collation

A12.30 To collate the responses from all telecoms providers, we created a list of common variables based on the information requested. This required us to rename and generate additional variables based on the data provided by each telecoms provider. In some cases, this was as simple as changing a variable name from 'technology' to 'interface'. However, in other

[521] Openreach's response to the 2018 BCMR Consultation, page 112, paragraphs 23-24.
[522] Openreach's response to the 2018 BCMR Consultation, page 112, paragraph 23.
[523] Note that we have reallocated all circuits missing postcodes for all providers.
[524] UKCTA's response to the 2018 BCMR Consultation, paragraph 13.
[525] SSE's response to the 2018 BCMR Consultation, page 5, question 6.1.

cases it involved extracting information from one variable to generate another, based on rules described by the telecoms provider that supplied the data.

A12.31 To identify the access portion of the telecommunications network, we converted each telecoms provider's datasets from circuits to circuit ends.

A12.32 Following this, there were some data anomalies specific to each telecoms provider that we needed to address. For example, for those telecoms providers who responded with a list of orders rather than active circuits, we dropped all orders that were classed as administrative changes.[526] This was to avoid overestimating the number of circuits supplied by these telecoms providers.[527] Through this process, for two telecoms providers, we dropped 16,120 circuit ends from the inventory dataset [✂] and 4,962 circuit ends from the connections dataset [✂].

A12.33 Another telecoms provider-specific anomaly that we had to deal with at this stage related to the quality of Virgin Media's data, which will be discussed in more detail later in this annex. Virgin Media's data contained a significant number of blank or invalid entries for some of the key variables needed for the service share analysis. We have therefore attempted to address this by matching Virgin Media's 2017 circuit sales with those of purchasers, where we had data. We were able to do this for [✂]'s 2017 circuit purchases.[528] As this provider's circuit purchases from Virgin Media should equal Virgin Media's circuit sales to the provider, we matched these two datasets to identify information included in the provider's response but missing from Virgin Media's. This matching exercise allowed us to fill in missing values in Virgin Media's data for 227 circuit ends. We could not do the same for any of Virgin Media's other customers, as we either had no data or no unique identifier to carry out such matching.

A12.34 Following this, a matching exercise between the different datasets submitted by each telecoms provider had to be carried out on an individual basis. While some variables were required for both the inventory and the connections datasets, they might have only been provided in the inventory data (i.e. they were missing from the connections data). In these cases, we matched the responses based on a unique ID, which, depending on the telecoms provider, might have been an order number, a circuit ID, or a site ID.

A12.35 After having carried out all the steps described above, we obtained raw datasets containing 1,005,574 observations in the inventory dataset, 92,079 in the MNO inventory dataset, and 167,496 in the connections dataset.

Data cleaning

A12.36 Due to differences in telecoms providers' internal systems and the complexity of the data requested, the way information was reported for each variable varied widely across telecoms providers. We therefore had to make sure that information was recoded in a

[526] Classifications such as "[✂]".

[527] This was only possible in cases where the telecoms provider included some sort of order type variable indicating whether the order was a new order or an administrative change.

[528] Provided in response to the 5th BCMR s.135 Notice.

consistent manner for the variables used in our analysis. Below, we describe the steps that we undertook to clean the data, which we applied consistently throughout the inventory dataset, the MNO inventory dataset and the connections dataset.

CI products

A12.37 We looked for key words of products, interfaces, and physical links that we wanted to exclude. We then flagged these exclusions via the dummy variable "*productmarket*", which takes on a value of 'one' if the product does belong to the CI markets, and 'zero' otherwise. We assumed that any circuits in our dataset not flagged for exclusion are part of a relevant CI product market.[529]

A12.38 We have excluded the following categories of circuits:

- circuits classed as analogue, PDH/SDH[530], time division multiplex (TDM), radio base station (RBS), KiloStream, and MegaStream on the basis that these are Traditional Interface (TI) circuits;[531]
- Cablelink circuits, as these are only used for access to network equipment within a BT exchange or to connect to infrastructure close to a BT exchange, which means that they are not end-to-end access or inter-exchange circuits;
- leased lines used for specialist applications such as CCTV, Broadcast, and Street Access;[532]
- business-grade connectivity services provided over Ethernet in the first mile (EFM) and asymmetric broadband, captured by the digital subscriber line (DSL) category;[533]
- wavelength division multiplex (WDM) bearers, as the presence of wavelengths would lead to double counting of circuits; and
- circuits transmitted via radio, as these are not included in any of the relevant markets for this BCMR.

A12.39 The full rationale behind the exclusions of these circuits is set out in the CI Access product market definition, which can be found in Section 4 of Volume 2. Since the 2018 BCMR Consultation, the set of excluded categories has been reviewed and updated to exclude circuits classified as using copper wires in the physical link. Though we updated the list of excluded circuits, this did not affect how many circuits were excluded across all providers.

A12.40 The result of this process is that 14.85% of circuit end observations are excluded from the CI markets in the inventory dataset, 61.19% in the MNO inventory dataset, and 3.81% in the connections dataset (Table A12.3). We therefore reduced the number of observations

[529] In this process, we had to make some assumptions. For example, we assume that circuits labelled "Private line" are TDM circuits, which fall outside the scope of this BCMR (this is about 1,127 circuit ends in the inventory dataset and 12 ends in the new connections dataset).
[530] Plesiochronous / synchronous digital hierarchy.
[531] In the MNO inventory dataset, we have also excluded managed connectivity products based on TI (MEAS E1X15, MEAS E1X2, MEAS E1X25 and MEAS E1X7).
[532] See Section 4 of Volume 1, paragraph 4.15.
[533] See Section 4 of Volume 1, paragraphs 4.34, 4.37, and 4.77.

to 856,285 in the inventory dataset, 35,737 in the MNO inventory dataset, and 161,119 in the new connections dataset.

Table A12.3: CI products identification

Circuit end observations*	Inventory[534]	MNO inventory	Connections
All products	1,010,588	92,079	167,813
Non-CI products	152,921 (15.13%)	56,342 (61.19%)	6,597 (3.93%)
CI products	857,668 (84.87%)	35,737 (38.81%)	161,216 (96.07%)

Source: Ofcom's analysis of the stakeholder responses to the 1st and 5th BCMR s.135 notices

**At this stage of data processing, a circuit end may be captured by more than one observation where it is supplied by one telecoms provider to another. In this case, the circuit end will be classified as "on-net" for the telecoms provider who supplies it using their own network and as "off-net" for the purchasing telecoms provider.*

Dark fibre

A12.41 To flag dark fibre circuit ends, we standardised the dark fibre field using regular expressions. We generated a "*df*" variable to take on a value of 'one' if that circuit end belongs to a dark fibre circuit, 'zero' otherwise. We also carried out an additional step where we used a combination of the dark fibre variable and the customer name to identify dark fibre circuits sold to other telecoms providers in the dataset, which are flagged via the '*dfcp'* variable. These circuits appeared in our data twice: once as a passive circuit for the telecoms provider who leased the circuit, and again as an active circuit for the telecoms provider who purchased it. We therefore removed one of these from service share analysis to avoid double counting. The numbers of circuit ends removed from the inventory dataset and the connections data set are summarised in Table A12.4 below. This step does not result in any changes in the MNO inventory dataset.

Table A12.4: Dark fibre identification

Circuit end observations*	Inventory	Connections
CI products	857,668	161,216
Dark fibre supplied to other telecoms providers	4,385 (0.51%)	387 (0.24%)
CI excluding dark fibre supplied to other telecoms providers	853,283 (99.49%)	160,829 (99.76%)

Source: Ofcom's analysis of stakeholder responses to the 1st and 5th BCMR s.135 notices
**At this stage of data processing, a circuit end may be captured by more than one observation where it is*

[534] Excluding MNO inventory.

supplied by one telecoms provider to another. In this case, the circuit end will be classified as "on-net" for the telecoms provider who supplies it using their own network and as "off-net" for the purchasing telecoms provider.

On-net

A12.42 We carried out a similar exercise to standardise the on-net field: we used regular expressions to recode the variable to take on a value of 'one' when that circuit end is on-net and 'zero' for off-net. For circuit ends with missing on-net classification, we followed a conservative approach and included them as on-net in our service share analysis (to the extent we were able to identify their geographic location – see below). The results of this step are summarised in Table A12.5. On-net classification is not relevant for the MNO inventory dataset, which we only use to determine the locations of MNO cell sites.

Table A12.5: On-net and off-net circuit ends

Circuit end observations	Inventory	Connections
CI excluding dark fibre supplied to other telecoms providers	853,283	160,829
On-net	725,298 (85.00%)	137,585 (85.55%)
Off-net	86,863 (10.18%)	16,564 (10.30%)
Unclassified	41,122 (4.82%)	6,680 (4.15%)
CI wholesale (on-net and unclassified)	766,420 (89.82%)	144,265 (89.70%)

Source: Ofcom's analysis of stakeholder responses to the 1st and 5th BCMR s.135 notices

A12.43 About 97% of the unclassified circuit ends in the inventory dataset and 99% in the connections dataset are due to Virgin Media's missing data; this represents about 26% of Virgin Media's circuit ends in the inventory dataset and 25% in the connections dataset.[535] Under our approach explained above, all of these circuit ends will be included in further analysis leading to the calculation of service shares. However, many of them may in fact be off-net and should therefore be excluded. This means there is a risk that Virgin Media's volumes and services shares are overstated.

[535] After the application of the additional cleaning steps described below, some circuit ends with missing on-net classification as well as known on-net classification are removed from the datasets. The resulting share of Virgin Media's circuit ends with missing on-net classification decreases to about [✂] of the connections dataset but increases to about [✂] of the inventory dataset.

Postcode

A12.44 To determine the geographic location of each circuit end, we need to have a valid postcode. Therefore, we cleaned the postcode field and validated the list of postcodes of our raw dataset by matching it with the list of postcodes provided by Miso. The objective of this was to flag incorrect postcodes and postcodes that are no longer in use or outside the UK, as we are unable to allocate circuit ends with such postcodes into a geographic market. We did this both by postcode and by postcode sector, as some postcodes may be invalid but still belong to a valid postcode sector. With missing postcodes, we refer to both completely blank entries and to observations for which information was provided but did not match the UK postcode format. With invalid postcodes we refer to postcodes that matched the UK postcode format but were not matched to the Miso postcode list, while valid postcodes had both the required format, and were matched to the Miso list.

A12.45 In the connections dataset, a significant proportion of circuit ends with a missing postcode are [✂] circuit ends that do not represent a customer end. This is because some types of order[536] only relate to one customer end per circuit or because some products[537] only have one customer end per circuit. Circuit ends that do not represent a customer end are not relevant to our analysis of the CI Access market. To exclude them, we have applied a set of rules provided by [✂] which identifies the number of relevant customer ends per circuit based on the order type and product. This way, we removed a total of 5,444 irrelevant circuit ends with a blank postcode from the connections dataset.

A12.46 The results of postcode validation, after the removal of irrelevant circuit ends with a blank postcode from the connections dataset, are presented in Table A12.6 for our three datasets.

[536] E.g. change of address.
[537] E.g. Internet Protocol Virtual Private Network.

Table A12.6: Missing and invalid postcodes and postcode sectors for CI wholesale circuit ends

	Inventory	MNO inventory	Connections
CI wholesale (on-net and unclassified), of which:	766,420	35,737	138,821
Missing postcode	59,886 (7.81%)	178 (0.50%)	10,487 (7.55%)
Invalid postcode	1,664 (0.22%)	612 (1.71%)	354 (0.26%)
Valid postcode	704,870 (91.97%)	34,676 (97.03%)	127,980(93.28%)
Missing postcode sector	19,888 (2.59%)	187 (0.52%)	3,608 (2.63%)
Invalid postcode sector	3,065 (0.40%)	300 (0.84%)	253 (0.18%)
Valid postcode sector	743,467 (97.01%)	35,250 (98.64%)	133,335 (97.19%)

Source: Ofcom's analysis of stakeholder responses to the 1st and 5th BCMR s.135 notices

A12.47 About 72% of the missing and invalid postcode sectors in the connections dataset are due to Virgin Media's missing data; this represents about 22% of Virgin Media's circuit ends. With postcode sector missing or invalid, we cannot classify the circuit ends into the relevant geographic market. Given that Virgin Media is the largest rival to BT, there is a risk of materially understating BT's service shares in those markets. We have sought to address this issue by assuming that Virgin Media's customer ends with missing and invalid postcode sectors follow the same distribution as Virgin Media's customer ends with valid postcode sectors, using this to apply an uplift to those Virgin Media customer ends with valid postcode sectors (see the section "Blank postcode sector uplift" below, starting at A12.73).

A12.48 For this statement, we have updated the analysis to use 2018 postcodes data. In all instances, a 2017 postcode is replaced by a 2018 postcode.

Network sites

A12.49 Another crucial step of data cleaning is to determine whether a circuit terminates at a customer or network site. This is because we only want to include circuit ends that belong to the access portion of the network for access service shares calculations. This means that we needed to identify and exclude all the circuit ends that correspond to BT exchanges, KCOM exchanges, data centres[538] and other network sites.[539]

A12.50 As we asked telecoms providers to identify whether each circuit end terminates in a customer site or network node, we first standardised their responses through the "*endtype*" variable.[540] We searched for key words such as "exchange", "pop", or "data

[538] For the reasons outlined in Volume 2, Section 7 we treat the vast majority of data centres as equivalent to network sites.
[539] MNO base stations are treated as customer sites.
[540] This variable describes whether each end is a customer site or a network node.

centre" to generate four variables that indicate whether that circuit end is located at a BT exchange, data centre, the telecoms provider's own network site, or another telecoms provider's network site.

A12.51 However, as some telecoms providers were not able to fully answer this question or provided ambiguous classifications, we needed to find other ways of identifying network sites for blank or invalid entries. Therefore, we matched our dataset with three lists of postcodes: one containing all postcodes belonging to data centres,[541] one containing all BT exchange postcodes, and finally one containing all other network sites postcodes as identified by all the telecoms providers in our dataset.[542]

A12.52 We then combined the output of the "*endtype"* variable and the result of the postcode match into five single variables (*btexchange*, *kcomexchange*, *dc*, *ownnetworksite*, *othernetworksite).*[543] We assumed that a single postcode corresponds to a BT exchange or a data centre if it is identified by either the "*endtype"* variable or the postcode match. The approach we took for other types of network sites was slightly different. As we recognised that the list of network sites we used for matching may overstate the actual number of network sites, we only used the result of the postcode matching if the "*endtype*" variable was left blank by the telecoms provider. This ensured that whenever a circuit end is flagged as a customer site, it was treated as one regardless of whether its postcode also matches a network site.

A12.53 The results of the network site identification process are provided in Table A12.7 below. This table shows that to define the CI Access market to be used for our service shares analysis we exclude around 52% of all circuit ends in the inventory data, around 27% in the MNO inventory, and around 50% in the connections dataset, as we identified these as network sites.[544]

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541 This list was compiled based on online information via the data centre map and individual data centre websites.

542 The lists of BT exchanges and network site postcodes were provided in response to Section B of our BCMR s135-1 Notice.

543 These are indicator variables which identify whether the circuit terminates in a BT exchange, a data centre, the telecoms provider own network site, or another telecoms provider network site (respectively).

544 A network site can be either a BT exchange, a data centre, the telecoms provider's own network site, or another telecoms provider's network site. Depending on the telecoms provider's definition of network site, the same postcode can be classified as more than one type of network site (e.g. a data centre and an own network site) but is only counted once in excluding network sites.

Table A12.7: Network sites and customer sites by dataset[545]

	Inventory	MNO inventory	Connections[546]
CI wholesale (on-net and unclassified), of which:	767,420	35,737	136,407
Network sites	397,706 (51.89%)	9,527 (26.7%)	72,379 (52.14%)
Customer sites	350,169 (45.69%)	26,210 (73.3%)	61,148 (44.83%)
Unknown*	18,545 (2.42%)	-	2,880 (2.11%)

Source: Ofcom's analysis of stakeholder responses the 1st and 5th BCMR s.135 Notices
**Circuit ends with missing postcodes where the data provider has not identified the circuit end type*

A12.54 For about 2% of the circuit ends in the inventory dataset and about 4% of the circuit ends in the connections dataset, we could not apply either of the above methods of classifying them as network sites or customer sites, as both "*endtype*" and "*postcode*" are missing. Most notably, about 22% of Virgin Media's circuit ends in the connections dataset and 4% of its circuit ends in the inventory dataset cannot be classified using the above rules. Some of these circuit ends may be located at the various type of network sites that we would be able to identify if we could use a postcode match. In the absence of postcode information, for the purposes of calculating service shares, we have assumed that the distribution of network sites and customer sites is the same as for Virgin Media's circuit ends with known postcodes.

A12.55 Table A12.8 below provides the result of network site identification process by telecoms provider for the inventory and connections datasets. As seen from the table, we exclude around [✂] of Openreach's circuit ends in the inventory data (53.11% in the connections) because these terminate in network sites.

545 Since 2018 BCMR Consultation we have received more accurate postcode information for a very small number of data centres, translating to more network site matches.

546 Owing to the methodology of the blank postcode sector uplift explained later in this annex, we use the ratio of customer ends to network ends in each provider's data with known locations and apply this ratio to the connections with unknown locations. This removes network sites from circuits with unknown postcodes. Hence, the number of CI Wholesale is lower than in previous tables.

Table A12.8: Network sites and customer sites by telecoms provider and dataset [✂]

	Inventory			Connections		
Telecoms Provider	**Network Sites**	**Customer Sites**	**Unknown***	**Network Sites**	**Customer Sites**	**Unknown***
CityFibre	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]
Colt	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]
eir	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]
euNetworks	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]
Fibrespeed	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]
Interoute	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]
KCOM	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]
CenturyLink	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]
MS3	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]
Openreach	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]
SSE	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]
Surf	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]
Verizon	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]
Virgin Media	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]
Vodafone	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]
Zayo	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]

Source: Ofcom's analysis of stakeholder responses to the 1st BCMR s.135 notice.

**Circuit ends with missing postcodes where the data provider has not identified the circuit end type*

A12.56 Table A12.9 below shows the effect of network site exclusions to shares of circuit end supplied by each telecoms provider. As seen from the table, the exclusion of network sites only has a minor impact on Openreach's share: it decreases from [✂]% (61%-70%) to (61%-70%) in the inventory data and from [✂]% (71%-80%) to 71%-80% in the connections data.

Table A12.9: Shares before and after network site exclusion, by telecoms provider and dataset

	Inventory		Connections	
Telecoms Provider	Before exclusion of network sites	After exclusion of network sites	Before exclusion of network sites	After exclusion of network sites
CityFibre	[✂]	[✂]	[✂]	[✂]
Colt	[✂]	[✂]	[✂]	[✂]
eir	[✂]	[✂]	[✂]	[✂]
euNetworks	[✂]	[✂]	[✂]	[✂]
Fibrespeed	[✂]	[✂]	[✂]	[✂]
Interoute	[✂]	[✂]	[✂]	[✂]
KCOM	[✂]	[✂]	[✂]	[✂]
CenturyLink	[✂]	[✂]	[✂]	[✂]
MS3	[✂]	[✂]	[✂]	[✂]
Openreach	[✂]	[✂]	[✂]	[✂]
SSE	[✂]	[✂]	[✂]	[✂]
Surf	[✂]	[✂]	[✂]	[✂]
Verizon	[✂]	[✂]	[✂]	[✂]
Virgin Media	[✂]	[✂]	[✂]	[✂]
Vodafone	[✂]	[✂]	[✂]	[✂]
Zayo	[✂]	[✂]	[✂]	[✂]

Source: Ofcom's analysis of stakeholder responses to the 1st BCMR s.135 notice.

A12.57 In Volume 2, Section 7, we set out our conclusion that it is appropriate to presume connections to data centres are competitive. One of the supporting claims for this statement is shown in Table A12.10 below. The table shows that BT's share of supply of new connections to all data centres ([✂%] 20-30%), and carrier neutral data centres specifically ([✂%] 11-20%), is not indicative of dominance.

Table A12.10: Share of circuit ends terminating in data centres by telecoms provider (column totals, CI wholesale, excluding off-net ends)

	Inventory		Connections	
Telecoms Provider	Data Centres	Carrier Neutral Data Centres	Data Centres	Carrier Neutral Data Centres
CityFibre	[✂]	[✂]	[✂]	[✂]
Colt	[✂]	[✂]	[✂]	[✂]
eir	[✂]	[✂]	[✂]	[✂]
euNetworks	[✂]	[✂]	[✂]	[✂]
Fibrespeed	[✂]	[✂]	[✂]	[✂]
Interoute	[✂]	[✂]	[✂]	[✂]
KCOM	[✂]	[✂]	[✂]	[✂]
CenturyLink	[✂]	[✂]	[✂]	[✂]
MS3	[✂]	[✂]	[✂]	[✂]
Openreach	[✂]	[✂]	[✂]	[✂]
SSE	[✂]	[✂]	[✂]	[✂]
Surf	[✂]	[✂]	[✂]	[✂]
Verizon	[✂]	[✂]	[✂]	[✂]
Virgin Media	[✂]	[✂]	[✂]	[✂]
Vodafone	[✂]	[✂]	[✂]	[✂]
Zayo	[✂]	[✂]	[✂]	[✂]

Source: Ofcom's analysis of stakeholder responses to the 1st BCMR s.135 notice.

Bandwidth

A12.58 We requested information on both the bearer bandwidth and the bandwidth sold, and while we standardised both variables, we used the bandwidth sold to define the bandwidth categories used for our service share analysis. This is because prices are typically based on the bandwidth sold rather than bearer bandwidth.[547] The process implemented to standardise these variables used regular expressions to identify the number provided in the bandwidth field. We started with the assumption that the number is provided in Mbit/s. However, when the unit of measurement is provided, we identified this and made the appropriate conversions to Mbit/s. Following these steps, there was missing bandwidth sold information for 30,485 (8.32%) customer ends in the inventory

[547] In addition, most telecoms providers only supplied this information.

dataset, 134 (0.51%) in the MNO inventory, and 512 (0.79%) in the connections dataset for the CI access wholesale market services (excluding off-net ends).

Dig variables

A12.59 To inform our analysis of digging behaviour contained in Annex 11, we asked telecoms providers to indicate whether each on-net circuit end in the connections dataset was connected using existing fibre, existing duct, or if digging was required. In addition, for the connections that involved digging, we asked telecoms providers to supply a series of statistics such as the actual distance dug, the distance from the closest flexibility point, and the total cost of connecting to the building. After recording their responses, some processing was required for these variables. This derives from two issues:

- the data has been converted from circuits to circuit ends; and
- dig statistics have been provided at the circuit level.

A12.60 This means that even though we do not know which end of the circuit involved digging, the format of our dataset and the data being provided at the circuit level would lead to us finding that whenever there was digging, it always happened at both ends of the circuit. Doing so may overstate the amount of actual digging and skew the statistics around the distances dug and costs of digging. To address this issue, we generated a list of new variables (*dig1, distance1, flexdistance1, totalcost1)*[548] where we allocate all the dig statistics to the access end of the circuit. This means that whenever the circuit begins and terminates in an access site we randomly allocate the dig statistics, with a chance of doing so for the wrong end. However, we estimate that the instances of customer-to-customer digs to be less than 5% of all digs in the connections dataset, and we therefore work with the random allocation of digs.

A12.61 Using the connections dataset, we then carry out some additional steps to create a separate dataset to inform our analysis of digging behaviour contained in Annex 11. We first remove all circuit ends that do not fall within the CI Access services market. Second, for the purposes of this analysis only, we remove all circuits ends with missing on-net classifications and recode the dig variable so that all off-net circuits with a positive dig variable are treated as connections that did not involve digging. We use this approach when analysing the time to provide (TTP) Openreach's 2017 new connections.

Openreach's time to provide data

A12.62 Since the consultation, we received information about Openreach's TTP and the prevalence of wayleaves and traffic management. We only included on-net circuits that are in both the CI Access services and CI Inter-exchange connectivity services product markets.

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[548] These variables describe, respectively: whether digging was required, the actual distance dug for connections involving digging, the distance between the newly connected building and the nearest flexibility point, and the total cost of connecting to the building.

Openreach's circuits were matched to the geographic markets determined in our geographic market definition; circuits that did not match[549] were dropped, as were circuits in the Hull Area.

A12.63 Openreach provided two variants of the time to provide data: with and without customer caused delay. Though we have regard for customer delays in analysing the time to provide a new circuit in our QoS assessment, for this analysis we only use the TTP that excludes customer caused delay.

A12.64 Openreach made us aware of limitations of the data such as the upward rounding in steps of 100m of the length of fibre blown owing to the way Openreach is billed for the fibre it uses. There is also upward rounding to the nearest metre in the length of duct built. Additionally, based on the assumption that where duct work is required at least an equal length of fibre must be installed, we adjusted the length of fibre blown to match the length of duct built in instances where the length of fibre was less than the length of duct. It is possible that more blown fibre is required than duct built in instances where part of the circuit has existing duct, however the length of fibre blown cannot be less than the length of duct built.

A12.65 In order to show the TTP for each connection type, we generated variables for each build type:

- *justdig* – this refers to a new connection where digging was required and there was no existing duct. Openreach provided information that digging was required and we infer that the circuit did not contain any existing duct because the length of fibre installed is no longer than the length of duct installed;
- *digandbf* – where a dig is required but the length of fibre installed is longer than the length of duct built, we infer that there was some existing duct and so fibre needed to be blown; this is in addition to the digging required for the remaining section of the circuit;
- *justconnect* – this refers to a new connection where all the duct and fibre required were already present;
- *justbf* – this refers to a new connection where duct was already present so Openreach only needed to blow fibre through the existing duct; and
- *allorders* – is an aggregation of all order types – used to compare results.

A12.66 The information on digging, the length of fibre blown, TTP, wayleaves, and traffic management are provided on a circuit basis but, as explained in A12.31-32, we work on a circuit end basis. Therefore, to avoid overstating the amounts of these variables which could skew the statistics around the distances dug and TTP, we generate new variables that allocated the statistics to the access end of the circuit, as explained above in A12.60. The outputs from this analysis are shown in Annex 11 on digging behaviour.

[549] i.e. these circuits either had missing or invalid postcodes/postcode sectors.

A12.67 We then add in the relevant geographic areas and network reach buckets, as defined below, to calculate a series of statistics related to the dig variables. In doing so, we make the assumption that all circuits classed as on-net that did not involve digging were already duct connected, regardless of whether the "*existingductonly*" and "*existingductandfibre*" variables were filled in or not.[550] Most telecoms providers did not provide complete answers regarding these variables, as they were unable to comment on the infrastructure of newly connected circuits that did not involve digging. For example, the variable "*existingductonly*" is missing 58,852 observations (32.96%), while the variable "*existingductandfibre*" has 58,423 (32.72%) missing values. [✄][551] We therefore find it reasonable to assume that if digging was not required to connect an on-net circuit, duct was already in place. Similarly, we assume that all on-net circuits that had to be connected through digging required new duct to be put in place.

Output datasets

A12.68 We use a combination of the circuit's contract start date and the source of the data to define our three datasets of interest: the inventory dataset to be used for the Hull Area service shares analysis and sensitivities, the MNO inventory dataset to be used in our network reach analysis, and the connections dataset to be used for our service shares analysis. As we are only interested in the CI Access services market, we filter these three datasets to exclude any circuit ends that are not part of the relevant product market: BT exchanges, data centres, network sites, dark fibre circuits sold to any telecoms providers in our dataset, and off-net ends. We are therefore left with 368,714 customer ends in the inventory dataset, 26,210 in the MNO inventory, and 64,028 in the connections dataset.

A12.69 After having carried out all the steps described above, some information is still missing for our key variables of interest. These are presented in Table A12.11 overleaf.

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[550] These variables describe, respectively: whether the circuit was connected using existing duct but not fibre, and whether the circuit was connected using existing duct and fibre.

[551] [✄].

Table A12.11: Missing key variables

	Inventory		Connections*	
	All	Virgin Media	All	Virgin Media
CI Access, of which:	368,714	[✄]	64,028	[✄]
Unknown if on-net or off-net	31,702 (8.60%)	[✄] 30-40%	743 (1.16%)	[✄] 0-10%
Missing or invalid postcode	41,097 (11.15%)	[✄] 11-20%	4,978 (7.77%)	[✄] 20-30%
Missing or invalid postcode sector	21,350 (5.79%)	[✄] 0-10%	2,966 (4.63%)	[✄] 20-30%
Missing bandwidth	302,244 (8.70%)	[✄] 20-30%	459 (0.79%)	[✄] 0-10%

Source: Ofcom circuit data analysis
**After excluding Virgin Media's circuit ends with missing postcodes in the connections data set that have not been identified as relevant customer ends based on the classification rules provided by Virgin Media*

A12.70 As the second largest supplier of leased lines, Virgin Media's data is key to reliably estimating service shares. However, Virgin Media has pointed out various issues affecting the accuracy of its inventory data. The data submitted by Virgin Media may include inactive circuits. [✄] Also, the same circuit may be included more than once, [✄][552] Overall, Virgin Media has identified about [✄].[553] We therefore have serious concerns regarding the accuracy of the inventory data and believe that using it for service shares analysis could materially overstate the number of circuit ends provided by Virgin Media.

A12.71 Virgin Media's connections dataset is not subject to the issues described above, as the data is taken from a [✄] different database. However, it contains a significant proportion of missing postcodes. As described above, we have addressed this issue by applying the same geographic distribution as the customer ends with known postcode information. This uplift is described in more detail below. This dataset also contains a proportion of circuit ends with missing on-net classification. For these, we took a conservative approach and included them in our analysis, as described above.

A12.72 We therefore decided to use the connections dataset for our service share analysis. However, we still use the inventory dataset for service shares analysis in the Hull Area, as Virgin Media is a smaller player in this area (it supplies [✄] CI Access circuit ends in the Hull Area, which are about [✄]% 0-10% of all circuit ends terminating in the Hull Area), meaning that the quality of its data would have a negligible impact. We also use the inventory dataset for some of our sensitivity analysis (see Annex 13), though noting that it is likely to overstate Virgin Media's service share.

[552] Virgin Media response to 1st BCMR s.135 notice.
[553] Information provided by Virgin Media in connection with its response to the 1st BCMR s.135 notice in a meeting between Ofcom and Virgin Media on 4 April 2018.

A12.73 The extent of missing on-net/off-net information in Virgin Media's inventory data [✂] 30-40% of its circuit ends classified as CI Access based on the above rules), as well as the possibility of duplicate and ceased circuits being included, means there is a risk of Virgin Media's inventory service shares being overstated and, consequently, BT's service shares understated. Virgin Media's circuit ends with missing on-net/off-net classification are likely to include a proportion of circuit ends that are in fact delivered off-net and should be excluded from the CI Access services market. However, based on the information provided, we are unable to identify those circuit ends. The inventory service shares provided in Annex 13 should therefore be interpreted having regard to the potential understatement of BT's service shares.

A12.74 Another limitation is the extent of missing bandwidth information in the inventory data, which makes any analysis of VHB inventory service shares unreliable. There are 10,109 circuit ends identified as VHB, compared to 32,243 circuit ends with missing bandwidth. The latter are likely to include a proportion of VHB circuit ends that are not currently classified as such. Much of the missing bandwidth is due to Virgin Media's inventory data. However, 24,568 (76%) of the circuit ends with missing bandwidth are also missing on-net/off-net information, while 2,665 (26%) of the circuit ends identified as VHB are missing on-net/off-net information. In Virgin Media's inventory data, [✂] circuit ends are identified as VHB, of which [✂] (70%) are missing on-net/off-net information. Due to the large scope for error, we consider there is a high risk that any VHB service shares calculated based on the inventory data would be distorted.

Response to our approach to missing bandwidth information

A12.75 Openreach highlighted that proportional uplifting was not done for circuits with missing bandwidths.[554] We included these circuits in our analysis as "unknown" bandwidth instead of being proportionally re-assigned to circuits with known bandwidths. We acknowledge that with more time, there could be improvements made to the analysis. We present total service shares except when specifically assessing VHB (sometimes including dark fibre circuits where appropriate). The volume of circuits with unknown bandwidths is low (0.8% of all new connections) and we therefore do not uplift these circuits with missing bandwidths because there would be little, or no material change to our findings.

CI Access network reach analysis

A12.76 Business and mobile site customers require a physical network (most commonly using optical fibre) to be able to receive connectivity services.

A12.77 To determine how many networks are close enough to businesses and mobile sites to be able to supply them competitively, we need to know the location of businesses and mobile sites, and the location of networks. We obtained business site locations from Market Location and gathered mobile site and network location information from telecoms infrastructure providers who own or have access to physical network infrastructure.

[554] Openreach's response to the 2018 BCMR Consultation, paragraph 16, page 123.

A12.78 From these sets of data, we were able to conduct our access network reach analysis which assesses the extent to which Openreach's (and KCOM's in the Hull Area) competitors have laid their own networks in different parts of the UK to serve the needs of business consumers and mobile cell sites.[555]

A12.79 We recognise that there is a measurement inaccuracy that can occur for all postcodes in the UK when assessing the distance between large business sites and mobile base stations (at the postcode centroid) and rival network infrastructure (flexibility points and duct network). However, we do not consider it proportionate to assess all postcodes in a detailed manner, and additionally we have already reflected this inaccuracy in our choice of the buffer distance. All else being equal, the degree of measurement inaccuracy reduces with the size of the postcode though we recognise that there can be issues where very large structures e.g. railways stations or St Paul's Cathedral constitute an entire postcode so that the network appears to be outside the 50m buffer distance even if the building is fibre-connected. We have reason to believe the CLA is more prone to this type of measurement inaccuracy.

A12.80 In this review, the focus of our analysis in the access network is on the percentage of large businesses and mobile sites within a buffer distance of rival telecoms providers. For this measure we consider the number of rival telecoms network infrastructure within a buffer distance of 50m of each large business and mobile site. For each postcode sector, we translate this to a cumulative figure looking at the percentage of large businesses and mobile sites within a buffer distance of zero or more rival telecoms infrastructure providers, one or more rival telecoms infrastructure providers, etc. out of all large businesses and mobile sites in the postcode sector.

A12.81 For postcode sectors without any large business or MNO sites located within their boundaries (see Table A12.14 below), we nominally assign each postcode within the postcode sector a large business/mobile site for the purposes of our geographic market classification. This ensures that rival telecoms providers' network infrastructure in areas where we do not identify the presence of leased line consumers is taken into consideration in our assessment of geographic competition in the CI Access services market.

A12.82 For example, a postcode sector with 50% of its large business and MNO sites within 50m of two or more rival telecoms infrastructure providers, 75% within 50m of one or more rival telecoms infrastructure providers, and 100% within 50m of zero or more rival telecoms infrastructure providers, will be classified as BT+1 rival telecoms infrastructure providers since at least 65%[556] of its large business and MNO sites are within one or more rival telecoms infrastructure providers.

[555] In this BCMR we find that BT has SMP in the UK (excluding the CLA and Hull Area), where Openreach has access to network infrastructure such as ducts and fibre, whereas downstream BT does not.

[556] The threshold we apply in geographically classifying postcode sectors.

Responses to our approach to the network reach buffer distance

A12.83 SSE argued that connections to an existing fibre cable would normally be done at a splice point which could be a few hundred metres away from the building location, despite the duct running outside the building.[557] However, SSE agreed that this was the most sensible approach given that the location of all supplier splice points is not easily accessible.[558]

Responses to our use of postcode sector

A12.84 Openreach argued that "postcode sectors are too large to be used in these areas. This is likely an even more acute issue for VHB services".[559] As we explain in Volume 2, Section 5, postcode sectors are the appropriate geographic unit because they provide the most usable level of granularity. We disagree with Openreach's view that smaller units would be better because there are 1.75 million unique postcodes in the UK which would lead to excessive granularity and we do not consider that it would give rise to a materially different analysis.

A12.85 In addition, Openreach stated that 8% of all sectors have no large business sites. The assumption of a business site in every single postcode within the postcode sector cannot be correct and is a "totally unrealistic distribution of sites". Openreach asserts that "[g]iven that Ofcom has data on actual sites that purchase CI services this should have been used in preference to assuming businesses are spread across all postcodes, many of which will be solely residential".[560] We assume that there is a business site in every postcode because we cannot accurately attribute businesses' locations within these postcode sectors. This approach avoids biasing any particular area of a postcode sector and instead aims to reflect the network that is present in the whole sector. Moreover, the area covered by a postcode tends to be small in densely populated and business regions which reduces the risk of measurement error when treating business presence at postcode centroids.

A12.86 TalkTalk found that our approach in using postcode sectors creates uncertainty because this geographic unit lacks the granularity to model precise distances to premises.[561] Nonetheless, TalkTalk generally agreed with our use of postcode sectors as the appropriate geographic unit, noting this approach "has been used in previous business connectivity market reviews, and is well-understood, and tractable".[562]

A12.87 We agree with TalkTalk that the use of postcode sectors is tractable and reasonable. The Tribunal did not rule against this approach.[563] The distance to large business sites and mobile base stations is calculated for each postcode in the UK before being aggregated to the postcode sector, so postcode-level granularity is achieved in our analysis.

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[557] SSE's response to the 2018 BCMR Consultation, page 3, question 5.1.
[558] SSE's response to the 2018 BCMR Consultation, page 3, question 5.1.
[559] Openreach's response to the 2018 BCMR Consultation, page 27, paragraph 125.
[560] Openreach's response to the 2018 BCMR Consultation, page 100, paragraph 19.
[561] TalkTalk's response to the 2018 BCMR Consultation, paragraph 2.56.
[562] TalkTalk's response to the 2018 BCMR Consultation, paragraph 2.83.
[563] BCMR Judgment, paragraph 425 [accessed 20 May 2019].

Geographic access market classification methodology

UK excluding the Hull Area

A12.88 The demand and supply of leased lines in the CI Access services market is geographically diverse. In the 2016 BCMR we recognised this diversity by finding that no provider had SMP in the Central London Area (CLA), while in the Temporary Conditions we found that no provider had SMP in either the CLA or the Central Business Districts (CBDs) of Birmingham, Glasgow and Leeds.

A12.89 In this BCMR, we recognise that the CLA (as defined in 2016 BCMR) is different to the rest of the UK, resulting in this geographic area being separated out from the classification process.

A12.90 For the rest of the UK excluding the Hull Area, we reflect this geographic leased line diversity in the CI Access market by classifying areas, specifically postcode sectors, into varying levels of competitiveness.

A12.91 This involves applying a threshold of 65% to the cumulative percentage of large businesses and mobile sites within a buffer distance of 50m of rival telecoms infrastructure providers. Performing this process on each postcode sector in the UK excluding the Hull Area separates it into the following areas of competition:

- the CLA;
- postcode sectors where only BT is present (BT Only);
- postcode sectors where BT plus a rival telecoms infrastructure provider is present (BT+1); and
- postcode sectors where BT plus at least another two rival telecoms infrastructure providers are present, known as High Network Reach (HNR) areas.

Our considerations on the CLA boundary

A12.92 We have considered whether the CLA boundary should expand to include those HNR postcode sectors that are contiguous with the boundary. This is set out in Volume 2, Section 5.

A12.93 We have also considered whether to shrink the CLA boundary. We looked into whether to include the 23 postcode sectors now classified by our network reach analysis as BT Only or BT+1 in the same market as the High Network Reach postcode sectors in the CLA (i.e. define a single market for the CLA). We have decided to continue to include them in the CLA to ensure regulatory consistency, as the CLA has been deregulated in previous market reviews. We do not think it is appropriate to risk re-regulating these postcode sectors and then de-regulating them again in the future, particularly in light of the following considerations:

- They are all contiguous to or even surrounded by High Network Reach postcode sectors. We therefore consider there is potential for incremental network build into these sectors. This is supported by the evidence on the average distance to the nearest rivals in these 23 postcode sectors collectively. On average, the four nearest rivals are 28m, 51m, 67m and 82m away from customers connected in 2017.[564] While, on average, rival proximity is lower than the High Network Reach sectors in the CLA, it is greater than the proximity to rival networks in High Network Reach areas in the rest of London or in other areas of the UK (particularly for the third and fourth nearest rival networks);

- The low network reach result may be an anomaly as some of these postcode sectors are located in the heart of the CLA and the underlying dataset indicates a low number of business sites and mobile base stations in some of those postcode sectors. This is further supported by the evidence on the distance to nearest rivals discussed above; and
- The number of postcode sectors is small, so will not have a material effect on our analysis and findings for the CI access market.[565] We consider it appropriate and practical for these postcode sectors to remain in the existing CLA.

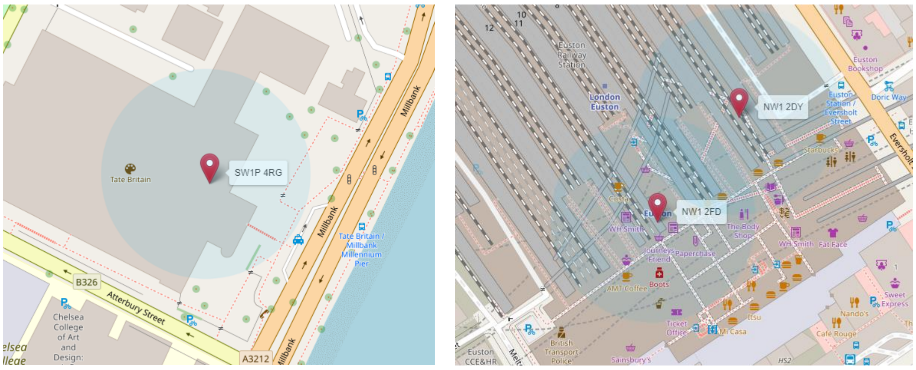
A12.94 We have examined these 23 sectors in detail, which further reinforces our view that the majority of these sectors are an anomaly and are not genuinely low network reach sectors. We consider that the low network reach results are largely driven by the following:

- As we assume businesses and mobile base stations are at the centre of the postcode, this introduces measurement inaccuracy to a majority of these 23 sectors due to the presence of large structures and/or landmarks. When a large structure or landmark covers the 50m radial distance from the postcode centroid, such that it is not possible to find network infrastructure in the area, the analysis is tended toward finding low network reach. Large structures/landmarks included: St. Paul's Cathedral, Euston station and St. Pancras station. Examples of this can be seen in Figure A12.12. We consider network reach results from these postcodes are not indicative of actual competitive conditions in the area.
- This effect is compounded by the low number of large business sites and mobile base stations in some of those postcode sectors. We find a low number of large business sites and mobile base stations tends to correspond to a large structure(s) and/or landmark(s) present in the sector. Combined with the measurement inaccuracy discussed above, this leads to a low network reach finding in these particular sectors.

[564] While more than 65% of the business sites and mobile base stations in these 23 postcode sectors are within coverage of zero or one rival network, the average distance of the second nearest rival to customers connected in 2017 is less than 50m.

[565] We do not consider that this will have a material impact on our SMP analysis and findings for the CLA. They are a small proportion of the postcode sectors in the CLA (around 8%) and hence will not have a significant impact on the results we get for the CLA in the SMP analysis.

Figure A12.12: Examples of large structures/landmarks covering the 50m radial distance from the postcode centroid of postcodes: SW1P 4RG, NW1 2DY and NW1 2FD.

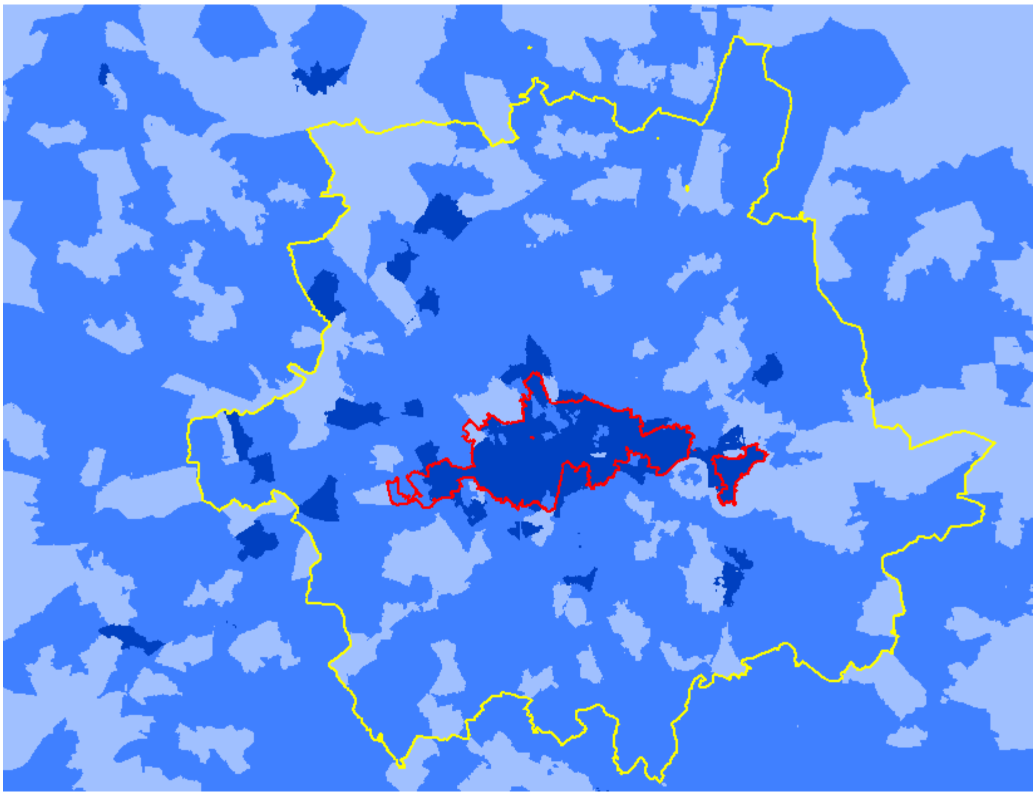


Source: Maps generated from © OpenStreetMap contributors https://www.openstreetmap.org/

A12.95 TalkTalk argued that, due to higher costs of network extension in the CLA, shorter buffer distances are appropriate for the CLA.[566] We do not consider it proportionate to define a separate buffer distance for the CLA and consider that 50m is still appropriate. This is particularly in light of the results showing that the presence of large structures within the CLA. In addition, TalkTalk did not provide evidence to support its view and even if costs may be higher for the CLA, demand and value of sites are also higher. Lastly, as mentioned in Volume 2, Section 5, the indicative cost model is only one input in the choice of the buffer distance and the other pieces of evidence do not point to any material difference to justify defining a separate buffer distance for the CLA. Figure A12.13 shows the CLA (red) inside Greater London (yellow), with postcode sectors classified as HNR (dark blue), BT+1 (blue) and BT Only (light blue).

[566] TalkTalk's response to the 2018 BCMR Consultation, paragraph 2.117.

Figure A12.13: Map of network reach in the CLA and rest of London



Source: Ofcom Network Reach Analysis

Our considerations of HNR areas outside the CLA

A12.96 The distribution of this separation of postcode sectors in the UK excluding the Hull Area into areas of competition is shown in Table A12.14. Approximately 8% of postcode sectors do not have a large business or mobile site within their boundaries, with 54% of these being classified as BT Only.

Table A12.14: The number of postcode sectors with no large business/mobile sites in the UK excluding the Hull Area

Areas of competition	Number of postcode sectors with no large business/mobile sites	Number of postcode sectors
CLA	4	275
BT Only	410	5,906
BT+1	260	3,489
HNR areas	88	304
UK excluding the Hull Area	762	9,974

Source: Ofcom analysis of stakeholder responses to the 1st and 5th BCMR s.135 notices.

A12.97 We next consider the potential for competition in metropolitan areas outside of the CLA which have been classified as HNR areas by looking at the top six postcode areas ranked by customer ends connected in 2017.

A12.98 This results in six metropolitan areas being identified as potential geographic markets: Birmingham, Bristol, Edinburgh, Glasgow, Leeds and Manchester.

Table A12.15: The number of postcode sectors and large business/mobile sites within each geographic market in the UK excluding the Hull Area

Geographic Market	Number of postcode sectors	Number of large business and mobile sites
CLA	275	4,229
Birmingham	10	359
Bristol	10	301
Edinburgh	21	604
Glasgow	20	601
Leeds	14	410
Manchester	34	608
Combined metropolitan areas	109	2,883
HNR areas (inc. Metro Areas)	304	5,438
UK exc. the Hull Area BT+1	3,489	62,250
UK exc. the Hull Area BT Only	5,906	85,789
UK exc. the Hull Area	9,974	157,706

Source: Ofcom analysis of Miso postcode information, Market Location business information, and stakeholder responses to the 1st and 5th BCMR s.135 notices.

Table A12.16: The percentage of large businesses and mobile sites within 50m of rival telecoms providers for each geographic market in the UK excluding the Hull Area

Geographic Market	Percentage of large businesses and mobile sites within 50m of rival telecoms infrastructure providers		
	No rivals	1 rival	2 or more rivals
CLA	4%	6%	90%
Birmingham	8%	10%	81%
Bristol	3%	7%	90%
Edinburgh	4%	14%	82%
Glasgow	2%	7%	91%
Leeds	3%	7%	90%
Manchester	4%	5%	90%
Combined metropolitan areas	4%	9%	87%
HNR areas (inc. Metro Areas)	4%	12%	84%
UK exc. the Hull Area BT+1	16%	70%	15%
UK exc. the Hull Area BT only	77%	19%	4%
UK exc. the Hull Area	48%	39%	13%

Source: Ofcom analysis of stakeholder responses to the 1st and 5th BCMR s.135 notices.

Response to our approach to geographic market classification

A12.99 BT Group suggested that the geographic markets associated with a (properly defined) VHB market and the (separate) lower bandwidth market (i.e. 1 Gbit/s and below) are also likely to be distinct, reflecting how different demand characteristics drive different build incentives.[567] Our geographic market definitions are based on leased line demand, using large business sites and mobile base stations data.[568] The volume of new connections are used in identifying large city clusters outside the CLA, but we do not consider that separating VHB and lower bandwidth circuits would have a material effect on the ranking of the Metro Areas.

[567] BT Group's response to the 2018 PIMR and 2018 BCMR Consultations, paragraph 3.12.
[568] 99.7% of circuits connecting mobile base stations are lower bandwidth, so we do not consider separating these out would have a material effect in defining geographic markets.

The Hull Area

A12.100 The Hull Area is recognised as a separate geographic market. We do not further separate it into competitive levels but consider it as a whole.

Table A12.17: The number of postcode sectors and large business/mobile sites within the Hull Area

Geographic Market	Number of postcode sectors	Number of large business and MNO sites
The Hull Area	59	999

Source: Ofcom analysis of stakeholder responses to the 1st and 5th BCMR s.135 notices.

Table A12.18: The percentage of large businesses and mobile sites within 50m of rival telecoms infrastructure providers for each geographic market in the Hull Area

Geographic Market	Percentage of large businesses and mobile sites within 50m of rival telecoms infrastructure providers		
	No rivals	1 rival	2 or more rivals
The Hull Area	80%	18%	2%

Source: Ofcom analysis of stakeholder responses to the 1st and 5th BCMR s.135 notices.

Dark fibre adjustment

A12.101 We recognise that CityFibre's dark fibre connections are primarily used in providing circuits at 1 Gbit/s and below.[569] To cater for this when it comes to customer end volumes based on bandwidth, we assign 95% of CityFibre's dark fibre circuits to bandwidths 1 Gbit/s and below[570], and the remaining 5% are assigned to the 10 Gbit/s bandwidth.

A12.102 Other telecoms providers' dark fibre circuits are completely assigned to the 10 Gbit/s bandwidth.

[569] See Annex 14.

[570] Split evenly between the 10 Mbit/s, 100 Mbit/s, and 1 Gbit/s bandwidths.

Blank postcode sector uplift

Table A12.19: The volume of circuit ends with blank postcode sector

Provider	Circuit ends	Blank postcode circuit ends
CityFibre	[✂]	[✂] [✂%] 1-10%
Colt	[✂]	[✂] [✂%] 1-10%
eir	[✂]	[✂] [✂%] 11-20%
Interoute	[✂]	[✂] [✂%] 1-10%
KCOM	[✂]	[✂] [✂%] 1-10%
CenturyLink	[✂]	[✂] [✂%]
Openreach	[✂]	[✂] [✂%] 0-2%
Virgin Media	[✂]	[✂] [✂%] 21-30%
Vodafone	[✂]	[✂] [✂%] 1-10%
Total	**64,028**	**2,817**[571]

Source: Ofcom analysis of stakeholder responses to the 1st and 5th BCMR s.135 notices.

A12.103 For the 2018 BCMR Consultation, we found that, as shown in Table A12.19 above, a material proportion of Virgin Media's new connection customer ends do not have an associated postcode or postcode sector. This means we cannot classify these customer ends into a geographic market using the above described methodology, since we do not know where in the UK these customer ends are located. We have applied the below methodology to all providers where new connections customer ends did not have an associated postcode or postcode sector.

A12.104 We account for this material proportion of customer ends, which would otherwise be excluded from our subsequent analyses due to their unknown locations, by uplifting the provider's customer ends with known locations (i.e. those customer ends with associated postcodes and postcode sectors).

A12.105 This uplifting process works by:

- using the ratio of customer ends to network ends in the provider's new connection circuit ends with known locations, we identify the volume of circuit ends that are customer ends among those circuit ends with unknown locations; and
- we then distribute these identified customer ends with unknown locations among those customer ends with known locations based on the latter's existing geographic distribution.

571 Note that we have excluded network sites from this analysis and so, in contrast to the ~5k circuit ends with blank postcode sectors, we have a lower figure.

A12.106 Applying this process results in the volume of the provider's customer ends with known locations, uplifted using customer ends with unknown locations, to be used for subsequent analyses.

Response to our approach to the blank postcode uplift

A12.107 We appreciate Openreach's view that there could be a knock-on effect if there is a non-random distribution of circuits with missing/invalid postcodes that could affect service shares in HNR and metro areas.[572] Openreach notes the scale of the issue and it is because of the scale that it would be difficult to investigate a potential reason that resulted in particular postcodes being omitted in the time available for this market review. In the absence of evidence to suggest a particular reason causing postcodes to be omitted in the data sent to us by providers, we consider our approach to be reasonable and avoids biasing any geographic area when reassigning these circuits.

Service share analysis

Wholesale service shares

A12.108 Our service share analysis looks at the shares of different types of leased lines that telecoms infrastructure providers supply.

A12.109 The focus of our service share (market share) analysis is on the CI Access services market, so it is based on circuit ends terminating at customer sites, while those terminating at telecoms providers' network sites are excluded.

A12.110 A telecoms infrastructure provider's wholesale service share is calculated as the proportion of a telecoms infrastructure provider's customer ends of all telecoms infrastructure providers customer ends. For example, if a provider has four out of ten customer ends in an area, then that provider's service share in that area is 40%.

UK excluding the Hull Area

A12.111 In the UK excluding the Hull Area, wholesale service shares are calculated using 2017 customer end connections.

A12.112 Table A12.20 below shows the wholesale service shares for each geographic market we identify above and for each bandwidth grouping.

[572] Openreach's response to the 2018 BCMR Consultation, paragraph 56, page 117.

Table A12.20: Number of new customer end connections in 2017 and Openreach's wholesale market service shares (%), by geographic market

Geographic Market	Number of new customer end connections in 2017			Openreach Wholesale Service Share (%)		
	All bandwidths[573]	LB	VHB inc. DF	All	LB	VHB inc. DF[574]
CLA	7,837	7,338	469	[✂] (61%-70%)	[✂] (61%-70%)	[✂] (21%-30%)
Birmingham	283	273	8	[✂] (51%-60%)	[✂] (51%-60%)	-
Bristol	279	274	4	[✂] (61%-70%)	[✂] (61%-70%)	-
Edinburgh	466	446	18	[✂] (51%-60%)	[✂] (51%-60%)	-
Glasgow	424	416	7	[✂] (61%-70%)	[✂] (61%-70%)	-
Leeds	326	319	7	[✂] (51%-60%)	[✂] (61%-70%)	-
Manchester	479	463	13	[✂] (61%-70%)	[✂] (71%-80%)	-
Combined metropolitan areas	2,257	2,191	58	[✂] (61%-70%)	[✂] (61%-70%)	-
HNR areas inc. Metro Areas	3,972	3,820	137	[✂] (61%-70%)	[✂] (61%-70%)	[✂] (51%-60%)
UK exc. the Hull Area BT+1	21,039	20,393	554	[✂] (61%-70%)	[✂] (61%-70%)	[✂] (51%-60%)
UK exc. the Hull Area BT only	30,747	29,931	755	[✂] (81%-90%)	[✂] (81%-90%)	[✂] (51%-60%)
UK exc. the Hull Area	63,594	61,482	1,915	[✂] (71%-80%)	[✂] (71%-80%)	[✂] (41%-50%)

Source: Ofcom analysis of telecoms providers' responses to the 1st and 5th BCMR s.135 Notices.

The Hull Area

A12.113 In the Hull Area, wholesale service shares are calculated using the inventory of customer ends.

A12.114 Table A12.21 below shows the wholesale service shares for each geographic market we identify above and for each bandwidth grouping.

[573] This includes 2,017 new customer end connections with unknown bandwidths.

[574] Note that the VHB (inc. DF) service shares for the Metro Areas are not presented here due to the low number of VHB (inc. DF) new customer end connections in 2017.

Table A12.21: Number of customer ends and KCOM's wholesale market service shares (%) in the Hull Area

Geographic Market	Number of customer ends			KCOM Wholesale Service Share (%)		
	All bandwidths[575]	LB	VHB (inc. DF)	All	LB	VHB (inc. DF)
The Hull Area	1,627	1,541	32	[✂]	[✂]	[✂]

Source: Ofcom analysis of telecoms providers' responses to the 1st and 5th BCMR s.135 Notices.

Retail service shares

The Hull Area

A12.115 In the Hull Area, we also consider the service share of the retail leased lines market. This is achieved by considering the customer of a wholesale leased line, compared with the supplier as in wholesale service shares, where that customer is also a telecoms provider, and determining the share of leased lines for each.

Table A12.22: Telecoms providers' retail market service shares (%) in the Hull Area

BT	CityFibre	Colt	Interoute	KCOM	CenturyLink
[✂]	[✂]	[✂]	[✂]	[✂]	[✂]
MS3	**Openreach**	**SSE**	**Verizon**	**Virgin**	**Vodafone**
[✂]	[✂]	[✂]	[✂]	[✂]	[✂]

Source: Ofcom analysis of stakeholder responses to the 1st and 5th BCMR s.135 notices

[575] This includes 2,017 new customer end connections with unknown bandwidths.

Retail CI Access service shares

The Hull Area

A12.116 In the Hull Area, we also consider the service shares of the retail CI Access services market. This is achieved by considering the retail purchases of KCOM's wholesale leased lines – a subset of those considered in retail service shares.

A12.117 In effect, service shares in the retail CI Access market measure the retail shares of telecoms providers who purchase CI access leased lines from KCOM in the Hull Area.

Table A12.23: Telecoms providers' retail CI Access services market service shares (%) in the Hull Area

BT Wholesale	Colt	Interoute	KCOM	CenturyLink	SSE	Virgin Media	Vodafone
[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]

Source: Ofcom analysis of stakeholder responses to the 1st and 5th BCMR s.135 notices.

Distance to rival telecoms infrastructure providers' networks

CI Inter-exchange connectivity market

A12.118 In the CI Inter-exchange connectivity services market, we consider the average and median distances from BT exchanges to rival telecoms infrastructure providers' networks to give an insight into the distances PCOs would potentially have to dig to connect to a BT exchange.

A12.119 Each PCO's distance to a BT exchange is ranked by their closeness, with averages and medians for these different rankings then calculated. These are shown in Table A12.24 below for each presence classification at a BT exchange.[576]

Table A12.24: The average and median distance from BT exchanges to PCOs for each BT exchange presence

Presence at BT exchange	Average distance (m) to:		Median distance (m) to:	
	1st closest rival	2nd closest rival	1st closest rival	2nd closest rival
BT Only	5,988	12,360	2,737	5,888
BT+1	130	1,312	25	334
BT+2 or more	24	62[577]	21	35

Source: Ofcom analysis of stakeholder responses to the 1st and 5th BCMR s.135 notices.

[576] In BT+1 exchanges, the first closest rival is connected to the exchange either directly, within the exchange, or via an external cablelink if it within 100m of the exchange. Together with the use of postcode centroid as a measurement, this means that the distance to an already connected telecom providers is not zero.
[577] This average excludes a single exchange where a separate datasource suggests the distance to the nearest flexpoint is over 30km. With this outlier included, the average distance is 130m.

CI Access services market

A12.120 In the CI Access services market, we have considered the proximity of rival telecoms infrastructure providers' networks to customer circuit ends connected in 2017 to give an insight into the distances rivals would potentially have to dig to provide leased lines to customers.

A12.121 Each rival's distance to a customer's 2017 connected circuit end is ranked by their closeness, with averages for these different rankings then calculated. The average distances to the four closest rival telecoms infrastructure providers are shown in Table A12.25 below.

Table A12.25: The average distance from customer's circuit ends connected in 2017 to rival telecoms infrastructure providers for each geographic market in the UK excluding the Hull Area

Geographic Market	Average distance (m) to:			
	1st closest rival	2nd closest rival	3rd closest rival	4th closest rival
CLA	16.3	25.5	34.3	46.7
Birmingham	17.2	27.2	51.4	80.9
Bristol	17.6	48.0	81.1	167.0
Edinburgh	20.5	39.4	134.7	306.2
Glasgow	15.4	27.0	59.8	125.5
Leeds	17.8	25.8	40.7	92.9
Manchester	17.8	29.9	54.7	105.0
Combined metropolitan areas	17.8	32.7	73.4	154.6
HNR areas (inc. Metro Areas)	21.0	38.8	94.4	234.4
UK exc. the Hull Area BT+1	58.2	332.5	861.4	2,087.1
UK exc. the Hull Area BT Only	1,145.6	2,632.7	4,824.9	8,235.9
UK exc. the Hull Area	585.5	1,408.4	2,663.3	4,750.4

Source: Ofcom analysis of stakeholder responses to the 1st and 5th BCMR s.135 notices.

Further access market analyses

Average number of rival telecoms infrastructure providers

A12.122 The average number of rival telecoms infrastructure providers within a buffer distance of large businesses and mobile sites is an informative metric as it informs a large business/mobile site in an area that, on average, it will be within a buffer distance of a certain number of rival telecoms infrastructure providers.

Table A12.26: The average number of rival telecoms infrastructure providers within a buffer distance of 50m of large businesses and mobile sites for each geographic market in the UK excluding the Hull Area

Geographic Market	Average number of rivals within 50m
CLA	4.3
Birmingham	2.7
Bristol	2.9
Edinburgh	2.2
Glasgow	2.6
Leeds	2.7
Manchester	2.8
Combined metropolitan areas	2.6
HNR areas (inc. Metro Areas)	2.4
UK exc. the Hull Area BT+1	1.0
UK exc. the Hull Area BT Only	0.3
UK exc. the Hull Area	0.8

Source: Ofcom analysis of stakeholder responses to the 1st and 5th BCMR s.135 notices.

Table A12.27: The average number of rival telecoms infrastructure providers within a buffer distance of 50m of large businesses and mobile sites for each geographic market in the Hull Area

Geographic Market	Average number of rivals within 50m
The Hull Area	0.2

Source: Ofcom analysis of stakeholder responses to the 1st and 5th BCMR s.135 notices.

Circuit density

A12.123 As already mentioned, the demand and supply of leased lines in the UK is geographically diverse. To further highlight this, we have considered the average number of customer ends connected in 2017 per square kilometre in each of our identified geographic markets, shown in Table A12.28 below.

Table A12.28: The average number of customer ends connected in 2017 per square kilometre for each geographic market in the UK excluding the Hull Area

Geographic Market	Circuit density (per sq km)
CLA	275.3
Birmingham	149.7
Bristol	60.2
Edinburgh	30.0
Glasgow	60.3
Leeds	131.4
Manchester	65.3
Combined metropolitan areas	58.0
HNR areas (inc. Metro Areas)	31.2
HNR areas (exc. Metro Areas)	19.4
UK exc. the Hull Area BT+1	1.8
UK exc. the Hull Area BT Only	0.2
UK exc. the Hull Area	0.3

Source: Ofcom analysis of stakeholder responses to the 1st and 5th BCMR s.135 notices.

A13. Geographic sensitivity analysis

A13.1 In this annex, we present the impact of varying the main parameters used in the network reach analysis on the results of our geographic analysis and CI Access service shares. We also present service shares based on inventory data.

A13.2 In our base case, we calculate network reach using a 50m buffer distance and 65% network coverage threshold as set out in Volume 2, Section 5. In this annex, we test the sensitivity of our results by using both a 25m and 100m rather than 50m buffer distance and using both a 50% and 80% rather than 65% network coverage threshold. In Annex 9, we examine our results based on calculating network reach of mobile sites only rather than both large business and mobile sites.

A13.3 Openreach, in its response to the consultation, noted that the coverage threshold/buffer distance had a significant impact on the classification of postcode sectors: increasing the buffer distance increases the number of High Network Reach (HNR) postcode sectors.[578]

A13.4 Openreach also commented on the change of coverage thresholds for some HNR areas and said that for some cities, changes were not in the direction expected.[579]

Size of areas with similar levels of rival network coverage

A13.5 Tables A13.1 and A13.2 show the impact of changing the buffer distance and the network coverage threshold on the size of areas with similar levels of rival network coverage, measured by the numbers of postcode sectors and customer ends connected in 2017.

Table A13.1: Postcode sectors with similar levels of rival network coverage

	Number (share[580]) of postcode sectors								
	Buffer distance = 25m			Buffer distance = 50m			Buffer distance = 100m		
Network coverage threshold	***50%***	***65%***	***80%***	***50%***	***65%***	***80%***	***50%***	***65%***	***80%***
BT Only[581]	6,922 (69%)	8,230 (83%)	9,004 (90%)	4,914 (49%)	5,912 (59%)	7,007 (70%)	3,992 (40%)	4,600 (46%)	5,368 (54%)
BT+1 rival network	2,785 (28%)	1,554 (16%)	845 (8%)	4,306 (43%)	3,506 (35%)	2,535 (25%)	4,238 (42%)	4,154 (42%)	3,691 (37%)
HNR areas	267 (3%)	190 (2%)	125 (1%)	754 (8%)	556 (6%)	432 (4%)	1,744 (17%)	1,220 (12%)	915 (9%)
Total UK excl. the Hull Area	**9,974 (100%)**	**9,974 (100%)**	**9,974 (100%)**	**9,974 (100%)**	**9,974 (100%)**	**9,974 (100%)**	**9,974 (100%)**	**9,974 (100%)**	**9,974 (100%)**

Source: Ofcom network reach analysis

[578] Openreach's response to the consultation, Annex F, paragraphs 29-30.
[579] Openreach's response to the consultation, Annex F, paragraphs 31-34.
[580] Percentages presented in this table may not add up to exactly 100% due to rounding.
[581] Defined as postcode sectors where no more than a proportion of large business sites corresponding to the network coverage threshold have a rival network to BT within the buffer distance.

Table A13.2: Customer ends connected in 2017 in postcode sectors with similar levels of rival network coverage

	Number (share[582]) of customer ends connected in 2017								
	Buffer distance = 25m			Buffer distance = 50m			Buffer distance = 100m		
Network coverage threshold	***50%***	***65%***	***80%***	***50%***	***65%***	***80%***	***50%***	***65%***	***80%***
BT Only[583]	39,304 (62%)	49,064 (77%)	54,636 (86%)	22,721 (36%)	30,941 (49%)	40,051 (63%)	15,168 (24%)	19,447 (31%)	25,830 (41%)
BT+1 rival network	17,729 (28%)	9,845 (15%)	6,344 (10%)	26,889 (42%)	21,379 (34%)	14,478 (23%)	24,734 (39%)	25,450 (40%)	22,959 (36%)
HNR areas	6,562 (10%)	4,687 (7%)	2,615 (4%)	13,985 (22%)	11,276 (18%)	9,066 (14%)	23,694 (37%)	18,699 (29%)	14,807 (23%)
Total UK excl. the Hull Area	**63,595 (100%)**	**63,595 (100%)**	**63,595 (100%)**	**63,595 (100%)**	**63,595 (100%)**	**63,595 (100%)**	**63,595 (100%)**	**63,595 (100%)**	**63,595 (100%)**

Source: Ofcom network reach and circuit data analysis

A13.6 The analysis above shows that the geographic definition is sensitive to the choice of buffer distance used. A shorter buffer distance would result in us defining fewer areas as having high network reach, and a wider buffer distance would result in us defining larger areas as having high network reach.

A13.7 These results are to be expected, as shortening the buffer distance means that fewer rival networks will be identified as sufficiently proximate to the customer, whereas increasing the buffer distance means that more distant networks will be identified as sufficiently proximate to the customer. This will decrease the proportion of customers with higher network reach in any given postcode sector when the buffer distance is shortened and increase the proportion when the buffer distance is widened.

A13.8 Similarly, changing the network coverage threshold also affects the geographic definition in the way we would expect. A lower network coverage threshold of 50% would increase the size of the HNR areas, while a higher network coverage threshold of 80% would reduce the size of the HNR areas.

BT service shares in HNR areas

A13.9 Table A13.3 presents the impact of changing the buffer distance and the network coverage threshold on BT service shares of customer ends connected in 2017 in HNR areas. We focus on HNR areas to address the concern that these areas would be considered competitive if we had used different parameters.

[582] Percentages presented in this table may not add up to exactly 100% due to rounding.
[583] Defined as postcode sectors where no more than a proportion of large business sites corresponding to the network coverage threshold have a rival network to BT within the buffer distance.

Table A13.3: BT service shares of customer ends connected in 2017 in HNR areas

HNR area	BT service share of customer ends connected in 2017								
	Buffer distance = 25m			Buffer distance = 50m			Buffer distance = 100m		
Network coverage threshold	*50%*	*65%*	*80%*[584]	*50%*	*65%*	*80%*	*50%*[585]	*65%*	*80%*
CLA	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]
Birmingham	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]
Bristol	[✂]	[✂]	n/a*	[✂]	[✂]	[✂]	n/a*	[✂]	[✂]
Edinburgh	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]
Glasgow	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]
Leeds	[✂]	[✂]	n/a*	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]
Manchester	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]
Other HNR areas	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]

Source: Ofcom network reach and service share analysis
**Results are presented for the Metro Areas, where each set of assumptions may result in a different set of Metro Areas*

A13.10 We note Openreach's comments that for some cities the changes in service shares between changing parameters are not always in the direction expected. The size of some individual Metro Areas are not large and often contain a small number of customer ends, so caution needs to be exercised in drawing conclusions on individual service shares as the buffer distance and coverage threshold are varied. We note that BT's service shares of 2017 new customer ends in each of the different HNR areas are consistently above 50% for these sensitivities, and so, subject to the other factors we take into consideration, consistent with SMP.[586]

BT service shares based on inventory data

A13.11 We have based our service share analysis on customer ends connected in 2017, because the inventory of circuits suffers from severe data limitations (see Annex 12). These limitations mean that, using the same methodology for calculating service shares as we have used for customer ends connected in 2017, Virgin Media's service share based on the inventory of circuits would likely be overstated and BT's service share understated.

A13.12 We have used the inventory data to calculate service shares as a sensitivity analysis, as these provide a likely lower bound for BT's service shares. The results are presented in Table A13.4.

[584] In this scenario, Liverpool and Southend-on-Sea are identified as Metro Areas with shares of [✂] and [✂] respectively.
[585] In this scenario, Reading is identified as a Metro Area with a share of [✂].
[586] BT's service shares are also consistent with SMP in each of these sensitivities when using inventory data.

Table A13.4: BT service shares of leased lines inventory

	BT service share of leased lines inventory								
	Buffer distance = 25m			Buffer distance = 50m			Buffer distance = 100m		
Network coverage threshold	***50%***	***65%***	***80%***[587]	***50%***	***65%***	***80%***	***50%***[588]	***65%***	***80%***
CLA	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]
Birmingham	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]
Bristol	[✂]	[✂]	n/a*	[✂]	[✂]	[✂]	n/a*	[✂]	[✂]
Edinburgh	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]
Glasgow	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]
Leeds	[✂]	[✂]	n/a*	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]
Manchester	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]
Other HNR areas	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]
BT+1	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]
BT Only	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]	[✂]

Source: Ofcom network reach and service share analysis

**Results are presented for the Metro Areas, where each set of assumptions may result in a different set of Metro Areas*

A13.13 BT's service shares of leased lines inventory are consistently somewhat lower compared to those based on customer ends connected in 2017. This may be partly explained by the poor quality of Virgin Media's inventory data which is likely to overstate Virgin Media's volumes and, consequently, understate BT's service shares in some areas (see Annex 12). Nevertheless, we find that BT's inventory service shares are above 40% in every geographic area (including under the buffer distance and network coverage threshold sensitivities) and so are compatible with our findings that BT has significant market power.

[587] In this scenario, Liverpool and Southend-on-Sea are identified as Metro Areas with shares of [✂] and [✂] respectively.
[588] In this scenario, Reading is identified as a Metro Area with a share of [✂].

A14. CI Access: hypothetical SMP assessment for VHB Access

A14.1 In Section 4 of Volume 2 we set out our decision to define a single product market for Contemporary Interface (CI) Access services at all bandwidths. In reaching our conclusions we explain why we considered that very high bandwidth (VHB) Access services were not a separate relevant product market.[589] We explained in our assessment that the evidence is ambiguous with respect to the presence of a separate VHB market from the demand side, but there is evidence from the supply side that led us to define a single product market for CI Access services across all bandwidths. We explained our finding that leased line suppliers are equally able to supply all bandwidths and to switch between these at low cost and quickly, pointing to a single market on the supply side.[590]

A14.2 In this annex we conduct a hypothetical SMP assessment for VHB Access circuits only, as a sensitivity analysis. We examine whether BT would have SMP in the market for VHB circuits used for access, if we were to define it as a separate product market.

A14.3 We conclude that, were we to define a separate VHB Access product market, we would find BT to have SMP in the same geographic markets addressed in Section 6 of Volume 2, (where we find BT to have SMP for CI Access Services in the whole of the UK except the Central London Area and Hull Area).

Summary of stakeholder responses

A14.4 The majority of respondents agreed with our proposed single product market definition and SMP findings for CI Access services and did not comment on the specific SMP findings in a notional VHB Access product market.[591]

[589] We refer to circuits above 1 Gbit/s as very high bandwidth (VHB). The main VHB products in BT's leased line portfolio used for access connections are EAD 10Bit/s, OSA, OSA Filter Connect.
[590] This finding differs from the approach we took in the Temporary Conditions. In the Temporary Conditions, we determined that BT had significant market power (SMP) in lower bandwidth Contemporary Interface Symmetric Broadband Origination (CISBO) services in certain geographic areas. We explained that in light of the exceptional circumstances and urgency we were taking a conservative approach to the market analysis (Ofcom, 2017, Business Connectivity Market Review Temporary Conditions, paragraph 2.5 [accessed 20 May 2019]). We explained that for the purposes of the Temporary Conditions we were making no finding in relation to BT's SMP in VHB CISBO services. (We also made no finding on whether BT had SMP in the Central London Area BCMR 2016 Temporary Conditions, Paragraphs 2.95-2.97). Yet that we would consider these issues as we addressed the remitted matters (Ofcom, 2017, Business Connectivity Market Review Temporary Conditions, Paragraph 1.15).
[591] See our summary of stakeholder responses in Section 4 and Section 6 of Volume 2.

A14.5 BT Group and Openreach disagreed with our proposal to find BT to have SMP for a notional VHB market in the UK except the CLA and Hull Area.[592] Openreach said we had not demonstrated BT has SMP for VHB access circuits "except perhaps in very few geographic areas".[593] BT Group considered that "Ofcom has not made the case that Openreach has SMP in HNR Metro areas [for all CI Access services including VHB] nor in additional areas for the VHB segment".[594]

A14.6 The main arguments underlying their views are:

- The **geographic markets** for VHB services are likely to be different from other CI Access services due to different build incentives as telecoms providers will tend to extend their networks for longer distances for the higher value VHB sites.[595] Both argue further that this will be facilitated "even more so in the VHB segment given the removal of the usage restrictions" on PIA, which will enable "high value business customers to be targeted."[596]
- Ofcom understated the level of competition faced by BT by ignoring the material impact of **unrestricted PIA** on competition during this review period.[597] We summarise and address this argument in full in Annex 6.
- The **data underlying the service share analysis** (i.e. using 2017 new connections) have several shortcomings and is particularly problematic for VHB services.[598] We address general arguments against the data we use in the service share analysis in Section 6 of Volume 2 and Annex 12. To the extent there are additional points for VHB services we cover them here.
- Customers of VHB products tend to have more **countervailing buying power** compared to other bandwidths. This is because they "tend to be sophisticated and well-funded" and buy products as part of "long-term commercial agreements", which "can drive fierce price competition."[599]
- "The **pricing and margins** on VHB do not support Ofcom's conclusion of SMP"[600] They argue that price reductions for VHB circuits in recent years demonstrate that there is a high level of competitive pressure in the VHB market segment. Moreover, even though "there remains a margin between prices and costs" this "is not inconsistent with a

[592] Openreach's response to 2018 BCMR Consultation, Annex G and BT Group's response to the 2018 PIMR and 2018 BCMR Consultations, paragraphs 3.1-3.9, 3.24-3.25 and 3.28-3.31.
[593] Openreach's response to 2018 BCMR Consultation, Annex G, page 120, paragraph 2.
[594] BT Group's response to the 2018 PIMR and 2018 BCMR Consultations, page 28, paragraph 3.31.
[595] Openreach's response to 2018 BCMR Consultation, Annex G, page 120, paragraph 1 and BT Group's response to the 2018 PIMR and 2018 BCMR Consultations, page 26, paragraphs 3.24-3.25.
[596] BT Group's response to the 2018 PIMR and 2018 BCMR Consultations, page 28, paragraph 3.32
[597]Openreach's response to 2018 BCMR Consultation, page 9, paragraph 25 and BT Group's response to the 2018 PIMR and 2018 BCMR Consultations, pages 29-30, paragraphs 3.39-3.41.
[598] Openreach's response to 2018 BCMR Consultation, Annex G, page 122, paragraph 13
[599] BT Group's response to the 2018 PIMR and 2018 BCMR Consultations, page 24, paragraphs 3.13-3.15.
[600] Openreach's response to 2018 BCMR Consultation, Annex G, page 120, paragraph 1.

competitive market: a bandwidth gradient is commonly used (by Openreach and rivals) to recover fixed and common costs efficiently."[601]

Geographic market for a notional VHB CI Access market

A14.7 We consider the relevant geographic markets for VHB Access to be the same as those defined in Section 5 of Volume 2 for CI Access services.[602] The SMP assessment in Section 6 of Volume 2 applies to our hypothetical VHB Access market.

A14.8 We do not repeat our assessment here, but we respond to Openreach and BT Group's arguments that geographic markets for VHB services are distinct to other CI Access services. We understand their argument to be that we should use a longer buffer distance[603] for VHB services as competitors will be willing to extend their networks a longer distance due to VHB services being more profitable than lower bandwidth circuits (which is further reinforced in the presence of an unrestricted PIA remedy).

Network extensions are short for both VHB and non-VHB services

A14.9 Both BT Group and Openreach argued that since VHB circuits are higher value, competitors will be willing to extend their network longer distances to serve VHB customers compared to lower bandwidth services. As a result, BT Group[604] contended that "The geographic markets associated with these product markets are also likely to be distinct" as "network rivals will tend to dig further – extending geographic boundaries – to reach higher value customers." Similarly, Openreach concluded that "the geographic markets for all CI services have no relevance for VHB services".[605]

A14.10 We disagree with BT Group and Openreach in this respect. We acknowledge in Section 5 of Volume 2 that our indicative dig cost model suggests that it is profitable to extend networks for longer distances for VHB services due to their higher value.[606] However, we also note that this is only one of several pieces of evidence we consider and does not solely determine our buffer distance.

[601] BT Group's response to the 2018 PIMR and 2018 BCMR Consultations, page 27, paragraph 3.29

[602] Namely, we define the following relevant geographic markets for our notional VHB access market: BT Only areas; BT+1 areas; the Central London Area (CLA); High Network Reach areas of each of Birmingham, Bristol, Edinburgh, Glasgow, Leeds and Manchester (Metro Areas); all other High Network Reach areas (taken together); and the Hull Area.

[603] We define the buffer distance as the measured distance over which rival networks are likely to be sufficiently close to competitively serve customers.

[604] BT Group's response to the 2018 PIMR and 2018 BCMR Consultations, page 26, paragraph 3.24.

[605] Openreach's response to 2018 BCMR Consultation, page 123, paragraph 15.

[606] For example, in Section 5 of Volume 2 we mention that evidence from our indicative dig cost model suggests that telecoms providers would not find it profitable to dig further than 27m radial distance for a 100 Mbit/s circuit, 34m radial distance for a 1 Gbit/s circuit and 94m for VHB services at current prices. This is using a typical three-year payback period. The breakeven distance increases with the payback period used. For a 5-year period, the breakeven distance is 46m for a 100Mbit/s circuit, 55m for a 1 Gbit/s circuit and 119m for a VHB circuit. See Annex 10.

A14.11 As set out in Section 5 of Volume 2, all the evidence taken together suggests that network extensions are likely to be quite short (less than 50m), which applies for all CI Access services, including VHB services. In particular:

- The indicative dig cost model does not account for the time taken to provide a circuit, which suggests much shorter distances. This is because irrespective of the bandwidth of the circuit, extending a network to connect a customer is time-consuming, which places the rival at a competitive disadvantage. Hence, the actual dig distance for VHB Access circuits is likely to be much shorter than the estimated indicative dig cost distances.
- This is consistent with evidence on actual digging behaviour for circuits at all bandwidths where we find that network extensions are infrequent and median dig distances were less than 25m. This is broadly similar for VHB and other CI Access services.[607] Therefore, even though VHB Access circuits may be higher value this has not translated into competitors extending their network longer distances or a higher proportion of these circuits.

Unrestricted PIA is unlikely to have a material impact on network extensions

A14.12 BT Group and Openreach argue that using the same geographic markets for VHB and other CI Access services does not adequately account for the availability of unrestricted PIA, which will give rivals cheaper deployment options over longer distances. According to BT Group, this remedy provides "the scope for rapid DPA take-up to support tactical build… particularly focused on the VHB segment." [608]

A14.13 We disagree with BT Group and Openreach as we consider that our analysis of the likely impact of unrestricted PIA on bespoke network extensions applies equally to VHB and non-VHB services. In Annex 6 we consider the impact of unrestricted PIA for all bandwidths. We agree that over time unrestricted PIA will have a material impact on network competition. However, over the course of this review it is our assessment that bespoke network extensions using unrestricted PIA to target individual customers will not be utilised at scale and so unrestricted PIA is unlikely to materially affect the buffer distance of circuits for any bandwidth. Therefore, even with unrestricted PIA, the buffer distance used as part of our geographic analysis for a VHB Access market does not change.

A14.14 In summary, based on factors affecting the deployment of circuits of all bandwidths and evidence on actual dig behaviour, the same network reach analysis applies to a notional VHB market, even after taking into account unrestricted PIA. The relevant geographic markets for VHB Access are the same as those we outline in Section 5 of Volume 2.

[607] Our analysis of 2017 new connections shows that where telecoms providers (other than Openreach) did not have an existing connection to the customer site, they chose to buy from a wholesale leased line supplier the vast majority of the time, only extending their network in 3% of cases for VHB services and 3% for other CI Access services. In addition, the median dig distances were short for VHB and lower bandwidth circuits are considered separately, (less than [✂] for both). The full analysis is set out in Annex 11.

[608] BT Group's response to the 2018 PIMR and 2018 BCMR Consultations, page 30, paragraph 3.41

Approach to undertaking an SMP assessment in a notional VHB Access market

A14.15 In Section 6 of Volume 2 we set out the criteria relevant to our SMP assessment, which is based on the European Commission (EC) SMP Guidelines. Most of the assessment in Section 6 of Volume 2 is relevant to this hypothetical assessment of SMP for VHB Access circuits. We do not repeat our assessment of the criteria in this annex, but summarise the relevant arguments that inform our conclusions. We then set out the additional factors that are relevant for a hypothetical SMP assessment for VHB Access services.

A14.16 In Section 6 of Volume 2, we explained that:

- BT has a significant **competitive advantage from being closer to customer sites** compared to rival networks. BT's ubiquitous network gives it an advantage over other operators as it will more often have a physical infrastructure connection (fibre or duct) to customer sites. This gives BT a significant cost[609] and time[610] advantage when it is fibre- or duct-connected while rivals are not.
- BT benefits from **economies of scale and scope** from the ubiquity of its network, and high sunk costs and switching costs (among other factors) are likely to give rise to barriers to entry and expansion in the wholesale leased lines markets, making it more difficult for rivals to compete with BT for the supply of CI Access services.
- There is likely to be **insufficient countervailing buyer power** to constrain BT's position as a supplier of CI Access services because there are limited alternative suppliers and customer volumes are not large enough.
- We also take into account the **potential impact of unrestricted PIA** as part of our assessment of potential competition. In short, we consider that it is reasonable to expect that at least some rivals may use unrestricted PIA for network infill extensions in the CLA and to a lesser extent in HNR areas during the review period. For BT Only and BT+1 areas, the impact of unrestricted PIA is unlikely to be on a material scale in this review period. We set out our views in detail in Annex 6. [611]

A14.17 We consider that our analysis of these factors applies to a notional VHB market.

[609] BT more commonly has existing duct connection to a customer site whereas rivals typically need to extend their network to reach a site. A supplier with a network that is closer to the customer has a significant cost advantage over one that is further away. The competitive advantage from having an existing duct (or fibre) connection compared to a rival that needs to extend their network is significant even at short distances.

[610] BT has an advantage compared to rivals as it is able to supply faster due to its greater proximity and customers face greater inconvenience choosing a telecoms provider located further away; for example, due to greater uncertainty over the time taken to extend the network

[611] BT Group and Openreach raised concerns in relation to the impact of unrestricted PIA on our SMP findings for CI Access services and VHB services. These are covered and addressed in Annex 6 and we do not repeat them here. In short, they argued that we considered the competitive impact of unrestricted PIA to a "limited extent" in our SMP assessment and that we should reconsider our SMP assessment. In response, we have revised our assessment and we are of the view that the availability of unrestricted PIA may have an impact on the strength of competition faced by BT in the CLA and other HNR areas over this review period.

A14.18 We disagree with BT Group that there is intense competition for VHB services due to buyer power.[612] BT Group considers that VHB customers "tend to be sophisticated and well-funded" and "tend to issue tenders or engage in a dedicated search" which lends towards "long-term contracts and partnerships."[613] They consider that these differences in contractual negotiations "can drive fierce price competition" in the VHB market segment.

A14.19 BT Group did not provide evidence to show that CI Access VHB customers have sufficient countervailing buyer power. It provided five examples of competitive supply arrangements, at least three of which are connections between network nodes, such as data centres and the core network of MNOs, rather than to supply customers in the CI Access market.[614] In terms of enterprise customers, most enterprise VHB customers purchase a range of circuits, mainly 1 Gbit/s and below, so are not 'VHB customers' per se.

A14.20 Even if some VHB purchasers were to have better contractual negotiations compared to CI Access customers who purchase primarily lower bandwidth circuits, this does not mean that they exercise *enough* buyer power to constrain BT in the VHB segment, given the lack of alternatives to BT. BT Group provided some examples to show that BT has lost some VHB customers outside the CLA.[615] However, even a firm with market power can lose some sales to its competitors. This is not evidence that VHB customers are able to obtain competitive prices from BT.[616] If anything, evidence (set out later in this Annex) suggests that BT is able to extract higher margins from VHB customers compared to lower bandwidth customers.

A14.21 We continue to consider that our view that CI Access customers have insufficient countervailing buying power also holds specifically in the VHB segment:

- As with customers at lower bandwidths, VHB customers often have limited access to alternative suppliers to BT. Since there is not access to a range of alternative suppliers both now and in the near future, this is likely to constrain countervailing buying power;
- even where there are alternative network providers, BT has other advantages that will limit the countervailing buying power of customers. BT's margins on VHB services, which we present below, provide further evidence of this lack of buying power; and
- even if some VHB customers in areas where there are alternative network providers were able to exercise buyer power effectively, this is unlikely to benefit customers without buyer power.[617]

A14.22 In the rest of this Annex, we consider additional factors that are relevant to conducting our hypothetical SMP assessment with respect to VHB Access circuits. These are:

- service shares for VHB Access circuits by geographic market;

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[612] BT Group's response to the 2018 PIMR and 2018 BCMR Consultations, pages 24-25, paragraph 3.13-3.19
[613] BT Group's response to the 2018 PIMR and 2018 BCMR Consultations, page 24, paragraph 3.13
[614] BT Group's response to the 2018 PIMR and 2018 BCMR Consultations, page 24, paragraph 3.16
[615] BT Group's response to the 2018 PIMR and 2018 BCMR Consultations, pages 25-26, paragraph 3.18.
[616] BT Group considers that mobile backhaul customers in particular have countervailing buyer power. However, as set out in Annex 9, our assessment of MNO backhaul customers does not support this.
[617] Where BT is able to offer selective discounts to purchasers with buyer power, those without buyer power would not benefit, and in fact, would likely face higher prices. Where BT is not able to offer lower prices only to purchasers with (potential) buyer power, it will be less inclined to decrease prices in response to the threat of a single purchaser.

- BT's incumbency advantage when competing for VHB customers; and
- evidence on pricing and margins of VHB circuits.

A14.23 We also note that VHB circuits are currently not commonly used for access connections and therefore, the total number of VHB Access circuits under consideration in this Annex is small (see below).

A14.24 We will first consider VHB Access circuits only and then extend our analysis to include dark fibre circuits as it is reasonable to expect a proportion of these are used for VHB.

Market context

A very small proportion of VHB circuits are used for Access connections

A14.25 We distinguish between access and inter-exchange CI services in our market analysis. We have also explained that in general, to aggregate data, backhaul links transport more communication services and have greater capacity than access links (see Section 3 of Volume 2).

A14.26 At present and over this review period the vast majority of VHB connections will be used for inter-exchange backhaul[618], which we consider in our assessment of the inter-exchange connectivity market in Section 7 of Volume 2. Our analysis shows that VHB Access customer ends, which are the focus of this annex, amount to around 2% of all VHB circuit ends in the UK excluding the Hull Area.[619]

A14.27 This is consistent with the evidence from market research and from Openreach. The qualitative research undertaken for the 2018 Cartesian report showed that businesses typically used VHB connections to connect to data centres, while connections between headquarters, regional offices and local offices tended to use lower bandwidth leased lines and in the case of regional and local offices potentially business broadband products.[620] In its internal documents, Openreach noted that VHB circuits are important for mobile and fixed backhaul, but for business and corporate customers "10 Gbit/s has a restricted use case typically limited to head office locations with significant bandwidth needs."[621] This is consistent with other evidence submitted by Openreach, which explained that "in the national market we only provide a very small number of [business access] sites [✂] with

[618] This does not include connections used for backhaul by MNOs, which is a CI Access service.
[619] Ofcom analysis based on responses to 1st and 5th BCMR s.135 notices.
[620] Cartesian 2018 Study, Business Connectivity Market Assessment, figure 11, p23 [accessed 20 May 2019].
[621] Openreach's response to Question 4 of the 8th BCMR s.135 notice dated 20 April 2018, document entitled "Ethernet & Optical Response to DF", dated 1 September 2017, p61.

10 Gbit/s and above. These circuits are mostly driven by a small segment of VHB networks typically around [✂]. These networks are heavily data centre driven”.[622] [623]

The volume of VHB Access connections is small but growing fast

A14.28 VHB Access accounts for a small proportion of all CI Access circuits. This is shown in Table 14.1 below, which presents the number of customer ends for CI Access and VHB Access services. The table shows our estimates of customer ends based on new connections in 2017 and based on total circuit inventory as of December 2017. Due to data limitations from one major provider, and the very small number of VHB circuits, we have particular concerns over the reliability of the circuit inventory data for VHB (see Annex 12).[624]

Table A14.1: Number of CI and VHB Access customer ends in the UK excluding the Hull Area (2017)

Customer end type	New Connections in 2017	Circuit Inventory as of Dec. 2017*
Number of CI Access customer ends	63,595	355,199
Number of VHB Access customer ends	1,628	9,453
Proportion of VHB Access out of CI Access customer ends	3%	3%

Source: Ofcom analysis based on 1st and 5th BCMR s.135 notices.
** Based on customer ends where bandwidth information was available and assuming customer ends with unknown “on-net” classification were provided “on-net”. We have concerns around the reliability of circuit inventory data. For details see Annex 12.*

A14.29 The table shows that there are fewer than 10,000 VHB Access customer ends in the UK excluding the Hull Area, which accounts for only 3% of CI Access customer ends. Though the number of VHB Access circuits is growing, this growth is from a small base. Therefore, VHB Access circuits are expected to continue to be a small proportion of CI Access connections over this review period.

[622] This information was provided in evidence submitted in the appeal of the 2016 BCMR - First Witness statement, Mark Logan (BT), paragraph 53-54, p10
[623] In the case of an access connection e.g. from a head office to a data centre, the head office site would be included in our analysis of access customer ends, but the data centre end would not be as we treat it as equivalent to a network site.
[624] This is for the following reasons: Virgin Media inventory data may include inactive circuits and the same circuit may be included more than once. In addition, a large proportion of Virgin Media’s inventory data has missing information for key variables. Notably, for [✂] 20-30% of Virgin Media’s customer ends classified as CI Access there is missing information on the bandwidth supplied and for 73% of the customer ends classified as VHB Access there is no information on whether it supplied the circuit using its own network (on-net) or by purchasing a wholesale product from a third party (off-net). Our estimates are based on information for which bandwidth information was available and we assume that any circuit with missing on-net classification is provided on-net. Given the small volume of VHB Access customer ends, our estimates will be sensitive to any assumptions we make in interpreting Virgin Media’s data (see Annex 12).

A14.30 Annex 7 sets out our view on the product dynamics in the business connectivity markets and how they affect prices and competition. Here we summarise our views in relation to VHB services. [625]

A14.31 The demand for VHB services is evolving, driven by growing demand for bandwidth among leased line customers. This is consistent with an early product lifecycle where demand is low at the beginning (when early adopters take up the product) then increases as the product becomes mass-market and late adopters begin to take it up. Demand is expected to accelerate during this review period, driven mainly by mobile customers due to the move to fifth generation mobile technology (5G). Demand for VHB circuits from enterprises is also expected to grow, albeit it will be lower than the demand from MNOs. This is confirmed by the information received from MNOs and by the research we commissioned on large enterprises[626], which found that:

- MNOs expect traffic to grow exponentially with 5G, and therefore demand for 10 Gbit/s services is likely to increase in the next three to five years; [627] and
- demand for 10 Gbit/s from large enterprises[628] is growing, with some enterprises already requesting 100 Gbit/s.

Trends in prices and profit margins

A14.32 In addition to growing volumes, the prices and profit margins for VHB services are falling over time. BT has historically set prices for VHB services (which were not subject to price regulation) with a greater premium above cost compared to lower bandwidth services. Over time, we find that BT's VHB prices are declining and the price gap across bandwidths is narrowing, making the bandwidth gradient flatter and more cost reflective. This is likely due to a combination of price regulation, upward migration, falling equipment costs and competition from alternative networks, as discussed in Annex 7.

A14.33 We consider that the relationship between BT's prices and competition may be circular. On one hand, a lack of competition results in the ability to charge significantly above costs. On the other, the higher BT's prices (relative to costs), the more attractive it is for alternative operators to make network extensions and compete in the market. This means that service shares for VHB Access services may understate BT's market power. We also note that BT's prices will be affected by technological development, with new products often priced at a

[625] Openreach's comments on VHB product dynamics are summarised and addressed in Annex 7.
[626] Cartesian 2018 Study, Business Connectivity Market Assessment [accessed 20 May 2019].
[627] Over the next 5 years (2019-23), we understand from MNOs that the rollout of 5G will mostly involve upgrading sites to 10 Gbit/s services (MNO responses to the 23rd s.135 notice). The research we commissioned with Cartesian found that 10 Gbit/s and multiple 10 Gbit/s links are likely to become the norm for MNOs in the next three to five years. This is in line with Vodafone's response that for the rollout of 5G, "individual sites will need multiple gigabit links, and in some cases above 10 Gbit/s" (Vodafone's response to the 2018 BCMR Consultation, part 2, paragraph 2.17). However, Openreach disagreed with these research findings and commented that "the exact demands [*of MNOs*] are unclear" (Openreach's response to the 2018 BCMR Consultation, page 121, paragraph 7). Our view based on the evidence gathered is that we can expect an increase in demand from MNOs for 10 Gbit/s services during this review period.
[628] Defined as organisations with 250 or more employees in the UK. These organisations come from a variety of sectors including for example public administration, education and financial services.

high premium but then coming down in price as that bandwidth becomes mainstream, and new higher capacity products emerge.

Assessment of SMP criteria

A14.34 In this sub-section we set out:

- service shares for VHB circuits by geographic market;
- BT's incumbency advantage for VHB customers;
- evidence on pricing and margins of VHB circuits; and
- our extended analysis to include dark fibre.

Service shares

Service shares based on new customer ends connected in 2017 is the better measure for a forward-looking analysis of market power for VHB

A14.35 We do not expect historical service shares based on circuit inventory to reflect the competitive conditions for VHB services over this review period. The competitive conditions for any product during an introductory phase can be materially different from those for the same product during growth or maturity stages.

A14.36 In this case, we consider that inventory service shares could materially understate BT's true competitive position. The low VHB Access volumes, steady migration to higher bandwidths, growing demand from mobile network operators and BT's pricing strategies since 2015 for VHB services, mean we anticipate that BT's service share for VHB Access connections will increase over this review period compared to its historical service shares.

A14.37 Evidence suggests that BT started focusing on winning business for VHB services over the last few years and has radically changed its service offering, partially in response to the growing demand for these services. In particular:

- prior to September 2015, BT had a limited range of wavelength division multiplex (WDM) products for access services. In March 2015, an optical spectrum access (OSA) 10 Gbit/s circuit cost over £30,000 p.a.;[629]
- in September 2015 BT launched the Ethernet Access Direct (EAD) 10 Gbit/s service at nearly half the wholesale charge of its previous single service 10 Gbit/s Ethernet product (c.£16,000 p.a.);[630]
- in April 2018, BT reduced the price of its leading VHB products. For example, the price of EAD local access (EAD LA) 10 Gbit/s fell by nearly 40% to just under £7,000 p.a.; and

[629] 2016 BCMR, Figure 4.1.
[630] 2016 BCMR, page 90.

- BT also introduced OSA Filter Connect at a price around 30% cheaper than its standard OSA 10 Gbit/s product.[631] This product includes a 10 Gbit/s circuit, but also allows the purchaser to upgrade bandwidth at very low incremental cost.

A14.38 We consider that service shares based on new connections in 2017 are a better measure than inventory service shares for a forward-looking SMP assessment for VHB Access services.[632] As the volume of VHB Access services is growing from a small base, new connections will better reflect market dynamics compared to inventory service shares. New connections focus on the most recent activity at a time when BT is launching products which better address this market and at prices which better reflect BT's lower cost of supply. The launch of EAD 10 Gbit/s in September 2015 resulted in BT having more competitive pricing. This is reflected by the fact that BT has higher service shares of new connections in 2017 compared to inventory service shares, as shown by our analysis later in this annex.

A14.39 Therefore, we disagree with Openreach, which suggested that "there is no reason to conclude [data on 2017 connections] would be more representative of future demand than current inventory".[633] This is consistent with the Commission's guidance, which mentions that:

> "[…] the Commission will interpret market shares in the light of the relevant market conditions, and in particular of the dynamics of the market and of the extent to which products are differentiated. The trend or development of market shares over time may also be taken into account in volatile or bidding markets."[634]

Although 2017 new connections are a better indicator, they may understate BT's position

A14.40 While service shares based on 2017 new connections are a better proxy of competition going forward than inventory shares, they may still understate BT's competitive position over this review period. As our estimates are based on 2017 data, they do not reflect the impact of BT's more recent price reduction in October 2018 and its launch of the OSA Filter Connect product. We would expect BT's service shares to increase during this review period in response to the price reductions and OSA Filter Connect, particularly in light of the anticipated growing future demand. Unlike BT, rivals do not have ubiquitous networks and more commonly need to extend their networks to connect a new customer. BT's lower charges for VHB services will make it less profitable for rivals to extend their networks and will also make the distance over which it is profitable to extend the network much shorter.

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[631] Our analysis is set out below when we discuss VHB pricing.
[632] Customer ends refer to leased lines circuit ends terminating at customer premises. Our approach to estimating service shares is explained in Annex 12.
[633] Openreach's response to 2018 BCMR Consultation, Annex F, page 109, paragraph 3
[634] European Commission's Guidelines on market analysis and the assessment of significant market power under the EU regulatory framework for electronic communications networks and services, page 12, paragraph 54.

A14.41 Based on the above, our service share analysis is based on 2017 new connections, taking into consideration that they are likely to understate BT's competitive position over this review period.

A14.42 As we explain in Section 6 of Volume 2, we disagree with Openreach that using 2017 new connections data is flawed and may overstate its service shares. We do not repeat their arguments and our responses here. We note that Openreach argued that the concerns with using 2017 connections data "apply with particular force for VHB".[635] However, it has not provided evidence to substantiate this claim.

A14.43 Below, we present inventory service shares for transparency, but we do not put weight on them in our hypothetical SMP assessment for VHB Access services. In addition to our view that they are not a good proxy of future competitive conditions, we do not believe that results are reliable due to significant data limitations, which we discuss in more detail below when presenting the results.

New connections service shares

A14.44 The table below presents the number of VHB Access connections and BT's service shares based on the new customer ends connected in 2017.

[635] Openreach's response to 2018 BCMR Consultation, Annex G, page 122, paragraph 13

Table A14.2: Number of circuits and BT VHB service shares (2017 new connections)[636]

	BT Only	BT + 1	High Network Reach Metro Areas	Other High Network Reach areas	CLA
Number of CI access customer ends in 2017	30,747	21,038	2,257	1,716	7,838
Number of VHB access customer ends in 2017	671	497	53	65	342
Proportion of VHB circuits compared to all CI access customer ends	2%	2%	2%	4%	4%
BT service share CI access for all bandwidths	[✂]% (81%-90%)	[✂]% (61%-70%)	[✂]% (61%-70%)	[✂]% (71%-80%)	[✂]% (61%-70%)
BT service share VHB customer ends	[✂]% (61%-70%)	[✂]% (51%-60%)	[✂]% (61%-70%)	[✂]% (61%-70%)	[✂]% (31%-40%)
Share of BT's largest rival in VHB customer ends (i.e. Colt in the CLA, Virgin Media elsewhere)	[✂]% (11%-20%)	[✂]% (21%-30%)	[✂]% (21%-30%)	[✂]% (21%-30%)	[✂]% (31%-40%)

Source: Ofcom analysis based on stakeholder responses to the 1st and 5th BCMR s.135 notices.
Note: dark fibre circuits are not included in these results but are included in Table A14.6 below.

A14.45 The number of VHB circuits in the Metro Areas that we have defined as being separate geographic markets is very small (amounting to less than 50 customer ends in each Metro Area in 2017). The small number of circuits means that service shares by individual Metro Area would not be meaningful. Therefore, we have presented results on an aggregated basis. Even in the aggregated Metro Areas and HNR areas in the rest of the UK the total number of VHB circuits is small and therefore the evidence should be treated with some caution.

A14.46 The service share results presented in Table A14.2, support our assessment of SMP for the notional VHB Access services in each of the relevant geographic markets. The analysis shows that:

[636] These geographic markets and resulting indicators are based on a network reach of 50m. See Section 4 of Volume 2 for an explanation of why we also consider that this is the appropriate distance for VHB circuits.

- BT has a high service share of over [✁%] 60% for VHB Access circuits in each of the BT Only, BT+1, Metro Areas and High Network Reach areas in the rest of the UK markets. It is also followed at a distance by Virgin Media with service share below 30%. Our SMP assessment takes account of a number of different factors, absent other evidence this high service share would support a finding of SMP in VHB Access circuits in these areas, were we to define it as a distinct market.[637] While BT's service shares are lower than those in the market for CI Access services at all bandwidths, they are still consistent with the threshold for presuming SMP. We also expect BT's service shares of new connections over this review period to be even higher following the reduction in wholesale charges for its leading VHB products in 2018; and
- BT has the second highest service share in the CLA of [✁%] 31%-40% after Colt [✁%] 31%-40%, consistent with a finding of no SMP in VHB Access circuits in this area.

Inventory service shares

A14.47 We explained in Section 6 of Volume 2 that we cannot present reliable estimates of service shares based on circuit inventory due to issues with Virgin Media's data. For transparency, we present the main service share results in the table below.

Table A14.3: Number of circuits and BT VHB service shares (inventory)[638]

	BT Only	BT + 1	HNR Metro Areas	Other HNR areas	CLA
Number of VHB Access customer ends in 2017	3,876	3,493	267	320	1,498
BT service share	[✁]% (41%-50%)	[✁]% (41%-50%)	[✁]% (31%-40%)	[✁]% (51%-60%)	[✁]% (21%-30%)
Share of BT's largest rival (i.e. Colt in the CLA, Virgin Media elsewhere)	[✁]% (31%-40%)	[✁]% (41%-50%)	[✁]% (41%-50%)	[✁]% (21%-30%)	[✁]% (21%-30%)

Source: Ofcom analysis based on stakeholder responses to the 1st and 5th BCMR s.135 notices.
Note: Based on customer ends where bandwidth information was available and assuming customer ends with unknown "on-net" classification were provided "on-net". We have concerns around the reliability of circuit inventory data. For details see Annex 12.
Note: dark fibre circuits are not included in these results.

[637] We note that the number of VHB Access customer ends in the Metro Areas combined and in the HNR Areas in the rest of the UK is small (less than 80 customer ends). While service share results are only indicative due to the small volume, they look reasonable as they are broadly consistent with service share results in the other geographic markets.
[638] The geographic markets and resulting indicators, presented in Table A14.2, are based on a network reach of 50m. See Section 4 of Volume 2 for an explanation of why we consider that this is the appropriate distance for VHB circuits as well.

A14.48 Taken at face value, the results for inventory service shares may not appear consistent with an SMP finding in BT+1 areas and HNR Metro Areas, and possibly also BT Only areas. Indeed, Openreach[639] note that "the BT service shares using the inventory data are in fact dramatically lower than for 2017 connections." However, as set out earlier, BT's historical service shares are not a good indicator for the competitive dynamics over this review period as they would materially understate BT's competitive position.

A14.49 In addition, we consider that inventory service shares for VHB Access services are highly unreliable. In particular, the quality of Virgin Media's inventory data is particularly problematic for VHB Access services (See Annex 12 for details). Virgin Media inventory data may include inactive circuits and the same circuit may be included more than once. In addition, a large proportion of the inventory data has missing information for key variables. Notably, for [✂%] 20-30% of Virgin Media's customer ends classified as CI Access, there is missing information on the bandwidth supplied and for 73% of the customer ends classified as VHB Access there is no information on whether it supplied the circuit using its own network (on-net) or by purchasing a wholesale product from a third party (off-net).

A14.50 Given the low volumes of VHB Access connection, the results would be overly sensitive to any assumptions we made to interpret the inventory data (i.e. the margin of error would be very high). Due to these limitations we do not place weight on the VHB Access service shares calculated using inventory data.

A14.51 This is supported by the service share results presented in Table 14.3 above. For example, the results suggest that BT has the highest service share relative to its largest competitor in VHB Access services in Other HNR areas. This is counter-intuitive as we would expect BT to have a higher service share in BT Only and BT+1 areas. This further reinforces our view that inventory data is an unreliable indicator of actual historic service shares.

A14.52 We disagree with Openreach that inventory service shares for VHB services overstate BT's shares. Openreach contended that in our service share calculations we have not accounted for "missing bandwidth circuits from Virgin Media", which may lead us "potentially over-estimating BT's service share".[640] However, we note that the other limitations with the inventory data may mean that we are under-estimating BT's service share.[641] The overall effects of these limitations on service shares is unclear. Therefore, we continue to consider them to be unreliable.

BT's incumbency advantage for customers upgrading to VHB

A14.53 We consider that BT will also have an incumbency advantage which means that it will be better placed to win some of the VHB customers over this review period. In 2017 BT had a high service share of lower bandwidth circuits: 73% in the market for 1 Gbit/s links. This is

[639] Openreach's response to 2018 BCMR Consultation, Annex G, page 123, paragraph 16.
[640] Openreach's response to 2018 BCMR Consultation, Annex G, page 123, paragraph 16
[641] Virgin Media inventory data may include inactive circuits and the same circuit may be included more than once and missing information on whether it supplied the circuit using its own network (on-net) or by purchasing a wholesale product from a third party (off-net). Our analysis assumes that all circuits with missing on-net/off-net classification were supplied on-net, which will tend to overstate Virgin Media's share.

important because, as the market for VHB expands, new VHB customers will increasingly be those migrating from lower bandwidths. For example, as we set out in Annex 9, we expect that a large share of these customers will be MNOs migrating from 1Gbit/s links to VHB circuits.

A14.54 The migration of existing lower bandwidth customers and the expansion of the VHB market segment is likely to benefit large incumbent operators, such as BT. This is because incumbent providers have a material advantage in competing for such circuits as they do not incur any build costs and so can supply the circuit quicker and at lower costs than rivals who need to extend their network. This is supported by evidence we present in Section 6 of Volume 2 which shows that there are costs of switching supplier that may act as an entry barrier to place rivals at a disadvantage to BT.

A14.55 This further supports our view that the VHB shares that we present here may understate the true VHB service share of BT during this review period.

Prices and margins

Pricing of VHB services

A14.56 Under the Temporary Conditions, CI access services at 1 Gbit/s and below were regulated, whereas VHB services were not.

A14.57 BT's ability to set prices of VHB circuits above competitive levels is an indicator of market power. In April 2018, BT reduced the price of its leading VHB products (OSA and EAD 10 Gbit/s) by 30-40%. Notwithstanding the reduction, BT's prices for VHB circuits are still substantially above its costs.

Table A14.4: BT pricing for selected access connections, before and after 1 April 2018

Access Connection type	3 Yr TCO (£)	
	Price before 1 April 2018	Price after 1 April 2018
EAD 1Gbit/s	£8,790	£7,725*
EAD 10 Gbit/s 12 Month	£28,490	£18,040
OSA 12 month[642]	£70,599	£49,453

*Source: Openreach calculations set out in internal document excerpt *Ofcom analysis*[643]
Note: The 1 Gbit/s and 10 Gbit/s prices are based on local access variants where a mainlink circuit is not required, whereas the OSA quoted above includes a mainlink circuit.

A14.58 We reviewed two of Openreach's internal pricing documents, which we obtained using our statutory information gathering powers.[644] The documents suggest that VHB price reductions were mainly motivated by:

- concerns that pricing of VHB was not competitive against the prices charged by other telecoms providers for similar bandwidths. Openreach was concerned that it was at risk of losing significant business if no changes were made, particularly in certain parts of the UK and in the fixed backhaul business; and
- providing a path for MNOs to upgrade their bandwidth from 10 Gbit/s to multiples of 10 Gbit/s without the high costs of additional bandwidth, and concerns about losing business to other telecoms providers and the subsequent impact on its position if this happened. In its internal documents Openreach notes [✂].[645,646] Openreach states: "[✂]."[647]

A14.59 Openreach argued that the paper indicates that they do not have market power but is rather trying to keep up with market leaders.[648] We acknowledge that the internal pricing documents do suggest that the reasons for the price reductions indicate that BT faced

[642] OSA 3000 pre April 2018 price cut compared to OSA filter connect product no main link.
[643] Openreach response dated 20 April 2018 to Question 4 of the 8th BCMR s.135 notice, document entitled "New pricing and product launches for VHB portfolio", dated 21 January, page 21. Ofcom analysis to calculate the 3-year TCO for a EAD 1 Gbit/s for the price after April 2018 is different to other TCO prices presented elsewhere to ensure a consistent methodology with the rest of Openreach's analysis
[644] Openreach response dated 20 April 2018 to Question 4 of the 8th BCMR s.135 notice. The first is a document to Openreach Board entitled "Product Proposals: Ethernet & Optical Response to DF", dated 12 October 2017. The second is a document to Openreach Commercial Policy and Pricing Board (CPB) entitled "New pricing and product launches for VHB portfolio", dated 21 January.
[645] Openreach response dated 20 April 2018 to Question 4 of the 8th BCMR s.135 notice, document entitled "Product Proposals: Ethernet & Optical Response to DF", dated 12 October 2017, p2.
[646] Openreach response dated 20 April 2018 to Question 4 of the 8th BCMR s.135 notice, document entitled "New pricing and product launches for VHB portfolio", dated 21 January, p6.
[647] Openreach response dated 20 April 2018 to Question 4 of the 8th BCMR s.135 notice, document entitled "New pricing and product launches for VHB portfolio", dated 21 January, p6.
[648] They contend that the paper itself states 'We are no longer competitive in the VHB market and at risk of losing significant business if we do not make these changes' quoting that £26m of annual revenue was at risk (Openreach's response to 2018 BCMR Consultation, Annex G, page 124, paragraph 21).

competition for VHB circuits, though we note that much of its concern related to circuits falling within the inter-exchange connectivity market rather than the access market given the volumes of VHB in inter-exchange connectivity compared to access.

A14.60 Openreach[649] has also argued that prices for VHB services are set to reflect a product life cycle with "a price above FAC" being consistent with this "dynamic". Yet we consider that reducing prices, even if this is in line with a product life cycle, to meet competition does not contradict a finding of BT having market power. A telecoms provider with market power would still face some level of competition and is expected to respond to it, particularly in an evolving market where customer needs are changing and demand is growing from a small base. In addition, as mentioned above, the relationship between BT's prices and competition may be circular, i.e. the level of both demand and competition for VHB services may have been driven in part by BT's high prices.

A14.61 In addition, as part of the impact assessment in these internal documents, Openreach considered that the price reductions would reduce the risk of Ofcom imposing a dark fibre remedy, and reduce the negative financial impact to BT in the event Ofcom did impose a dark fibre remedy. For instance,

- one of the internal documents stated "[✂]";[650] and
- in the financial impact assessment, Openreach considered that [✂].[651]

A14.62 Therefore, we consider it likely that BT's price reductions were in part driven by a desire to reduce the risk of dark fibre being imposed as a regulatory remedy, or minimise its impact, in addition to being a response to competitive pressures. We consider that this is consistent with a point made in another Openreach strategy document which stated that proposals to introduce new products – which formed part of the same package of proposals as the price reductions – would [✂].[652] This further supports our view that the internal documents do not contradict our finding that BT has SMP.

A14.63 We have also compared BT's prices for VHB services across different geographic areas. The intensity of competition should be reflected in lower prices and therefore we would expect areas with more competition to have lower wholesale charges. This is reflected in Openreach's internal documents, in which it stated "[✂]"[653]

[649] Openreach's response to 2018 BCMR Consultation, Annex D, pages 85-86, paragraph 26.
[650] Openreach response dated 20 April 2018 to Question 4 of the 8th BCMR s.135 notice, document entitled "Product Proposals: Ethernet & Optical Response to DF", dated 12 October 2017, p2.
[651] Openreach response dated 20 April 2018 to Question 4 of the 8th BCMR s.135 notice, document entitled "New pricing and product launches for VHB portfolio", dated 21 January, p5. See also document entitled "Product Proposals: Ethernet & Optical Response to DF", dated 12 October 2017, p2 where Openreach states that "[✂]".
[652] Openreach stated that "[✂]". Openreach response dated 20 April 2018 to Question 4 of the 8th BCMR s.135 notice, document entitled "Openreach Strategy – presentation to the Board", dated 14 November 2017, slide 13
[653] Openreach response dated 20 April 2018 to Question 4 of the 8th BCMR s.135 notice, document entitled "Product Proposals: Ethernet & Optical Response to DF", dated 12 October 2017, p4

A14.64 Another internal document also suggests that Openreach [✂]. It said: "[✂]" It defines the Metro Areas as the CLA, London Periphery and the CBDs, as defined in the 2016 BCMR. In addition, the document says: [✂].[654]

A14.65 We recognise that competitive pressure may be higher in the Metro Areas compared to the BT Only and BT+1 Access areas, though this alone is not conclusive evidence that there is no SMP in these areas.

Margins on VHB services

A14.66 The table below shows BT's estimates of its payback period, i.e. the time it takes for the revenue from providing a product to breakeven with the cost of providing the product, for some of its product portfolio; and the margin earned on each product.

Table A14.5: Payback period and margin for VHB products compared to 1 Gbit/s

	Payback period (months)		3 year margin (%)[655]	
Product	pre April 2018	post April 2018	pre April 2018	post April 2018
EAD 1Gbit/s	[✂]	-[656]	[✂]	-
EAD 10 Gbit/s 12 Month	[✂]	[✂]	[✂]	[✂]
EAD 10 Gbit/s 60 Month	[✂]	[✂]	[✂]	[✂]
OSA 12 month[657]	[✂]	[✂]	[✂]	[✂]
OSA 60 month	[✂]	[✂]	[✂]	[✂]

Source: BT calculations set out in internal document[658]
Note: BT has not based this on RFS

A14.67 We make the following observations based on the table above, which we consider are consistent with BT having market power for VHB circuits:

[654] Openreach response dated 20 April 2018 to Question 4 of the 8th BCMR s.135 notice, document entitled "Product Proposals: Ethernet & Optical Response to DF", dated 12 October 2017, p12.
[655] These margins are based on Openreach's internal assessment and not based on the RFS methodology. It is not possible to do a like for like comparison with RFS margins.
[656] BT does not set out its assumptions for the payback period at the new 1 Gbit/s EAD LA price on a like for like basis. However, the reduction in the 1 Gbit/s EAD LA price resulting in the 3-year TCO falling from £8,790 to £7,725 suggests that at a minimum the payback period on a like for like basis will be the same as pre April 2018, and is more likely to be higher. Conversely the margin is likely to a minimum the same, and more likely to be lower
[657] OSA 3000 pre April 2018 price cut compared to OSA filter connect product no mainlink.
[658] Openreach response to Question 4 of the 8th BCMR s.135 notice dated 20 April 2018, document entitled "New pricing and product launches for VHB portfolio", dated 21 January, p21

- the payback period is significantly lower and the three-year margin is much higher for the VHB products (EAD 10 Gbit/s and the OSA products) compared to the regulated 1 Gbit/s product. This is also true for the prices introduced in April 2018, despite that these have decreased by 30-40%;
- before BT restructured its pricing in April 2018, the payback period of the OSA product was [✂]; and
- the payback period for BT is much shorter than both the average duration of a typical contract, and the assumptions BT makes in its analysis.[659] [✂].[660]

A14.68 We have also noted that BT may find it profitable to reduce the relative charge for VHB services if it encourages enough customers from lower bandwidths to migrate and pay higher charges. This is because the loss from lower margins from existing high bandwidth customers could be more than offset by the gain from the additional margin from customers upgrading their service, provided that customers migrate in sufficient numbers. This is supported by internal pricing documents from Openreach, see Annex 8.[661]

Service shares including dark fibre circuits

A14.69 Extending the analysis to include dark fibre circuits, we find that BT would still have SMP on VHB circuits.

A14.70 In Section 4 of Volume 2 we explained that dark fibre is likely to be a demand-side substitute for VHB Access circuits for at least some users. The largest operators, BT and Virgin Media, do not sell dark fibre to end customers. The largest suppliers of dark fibre are CityFibre and Zayo, accounting for [✂]% of all dark fibre access circuits, based on 2017 connections data.

A14.71 Telecoms providers that supply dark fibre have told us that they are unable to observe the bandwidths being used over the circuit. Therefore, to estimate VHB service shares, it is necessary to determine whether dark fibre circuits are being used as 1 Gbit/s and below active circuits or as VHB active circuits.

A14.72 Evidence shows that dark fibre use is not limited to VHB Access services. For example, for the 2016 BCMR we asked users about the types of connection speeds they have over their dark fibre. Out of a sample of 120 dark fibre circuits, 23% of circuits were used for 1 G bit/s.[662]

[659] For example, it calculates the 3-year TCO, 3-year margin and 3-year and 5-year cash contribution, net present value and internal rate of return in its internal documents.
[660] This information was provided in evidence submitted in the appeal of the 2016 BCMR, Second Witness statement Mark Logan (BT), 16 January 2016.
[661] We note that Openreach argued that "the migration hypothesis of VHB services" is "without any evidence" and "was largely rejected by the CAT as lacking in any evidence." However, we have provided evidence in Annex 8 that it may be profitable for BT to reduce the relative charges for VHB. Moreover, we note that the evidence considered by the CAT in 2016 was in relation to demand side substitution and so is not as relevant for our SMP assessment.
[662] Ofcom analysis 2016 based on sample of dark fibre users. See 2016 BCMR, page 113.

A14.73 Moreover, there is also evidence that CityFibre competes for customers of all bandwidths, and many of its customers are unlikely to be using VHB over dark fibre:

- CityFibre has submitted to Ofcom that [✂][663];
- [✂]% of CityFibre's access customers are in the public sector, which overall use very little VHB services;[664] and
- CityFibre competes primarily in smaller cities and towns, where the use of VHB services is currently very limited.[665]

A14.74 Zayo customers are more likely to be VHB users. For example, they are more likely to be located in London and more likely to be in the banking and finance sector where there is higher propensity to use VHB services[666].

A14.75 We have conducted our sensitivity analysis assuming that 5% of CityFibre's customers use dark fibre for VHB services,[667] and all other telecoms providers using dark fibre use it for VHB circuits. Given that not all dark fibre circuits by other providers will be used for VHB, this assumption is likely to overstate true VHB usage.

A14.76 Customers using dark fibre as a substitute for active WDM products may also use multiple wavelengths over a single fibre. Ideally, we should count a WDM service, carried over a single physical fibre provided from one location to another, as a single circuit rather than as wavelengths. However, the data we received from some telecoms providers does not distinguish between the physical bearer and where an additional wavelength had been provided. Therefore, for consistency we also adjust the dark fibre circuits where used for VHB services by the typical number of wavelengths on VHB circuits. We assume that the number of wavelengths per circuit is either one or two and we present results for both assumptions.[668]

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[663] CityFibre submission to Ofcom, dated 17th March 2015, page 5.
[664] Data based on 2017 new connections shows that across all providers public sector organisations typically use VHB 4%, compared to 96% for bandwidths equal to or less than 1Gbit/s.
[665] The rise of the Gigabit city, CityFibre - see list of 40 cities, [accessed 11 Juney 2019].
[666] Based on data in 2017 new connections.
[667] As noted, CityFibre uses dark fibre to compete for all bandwidths and around 3% of CI Access circuits are VHB Access.
[668]We note that Openreach suggested that "the average" number of wavelengths per circuit "could well be greater than two and the shares then would be lower than computed." However, [✂]. We note this may be an overestimate of the number of wavelengths because it assumes all dark fibre circuits use WDM technology whereas some may use Ethernet electronics, more akin to a 10 Gbit/s EAD for example. On the other hand, this may be an underestimate because the previous [✂] was not as easily scalable as dark fibre using WDM electronics.

Table A14.6: VHB service shares including dark fibre[669]

	BT Only	BT + 1	HNR Metro Areas	Other HNR Areas	CLA
Number of VHB customer ends	671	497	53	65	342
Number of CityFibre dark fibre customer ends (total)	[✂]	[✂]	[✂]	[✂]	[✂]
Number of dark fibre customer ends (assumed to be VHB)	[✂]	[✂]	[✂]	[✂]	[✂]
BT service share VHB circuits including dark fibre	[✂]% (51%-60%)	[✂]% (51%-60%)	[✂]% (51%-60%)	[✂]% (51%-60%)	[✂]% (21%-30%)
BT service share including dark fibre and two wavelengths per circuit	[✂]% (51%-60%)	[✂]% (41%-50%)	[✂]% (41%-50%)	[✂]% (41%-50%)	[✂]% (11%-20%)

Source: Ofcom analysis based on stakeholder responses to 1st and 5th BCMR s.135 notices.

A14.77 As shown in the table above, except for CityFibre, the use of dark fibre for VHB access circuits is very limited, and a high concentration of the use is in the CLA area.

A14.78 Including dark fibre in our service share assessments does not have a material impact on our conclusions because:

- BT has a high service share for VHB circuits in each of the BT Only and BT+1 access areas, which is consistent with it having market power in VHB circuits in these areas;
- in the High Network Reach areas and the Metro Areas, the service shares are also high, potentially indicating SMP, but the low number of circuits means this evidence needs to be treated with caution; and
- BT has a service share of [✂]% less than 30% in the CLA, which is consistent with BT not having market power in VHB circuits in this area.

A14.79 In terms of inventory service shares (including dark fibre), BT has a service share of less than 40% in each of the relevant geographic markets, which is sometimes lower than Virgin Media's service share.[670] However, we do not place weight on these results for the same reasons set out earlier when discussing inventory service shares excluding dark fibre.

[669] Assumes 5% CityFibre dark fibre circuits are VHB.
[670] For transparency, we present a breakdown of the inventory service shares including dark fibre for each geographic market: BT Only (34%), BT+1 (33%), HNR Metro Areas (28%), Other HNR Metro Areas (38%) and CLA (14%). This is in response to Openreach's argument that we didn't present them (Openreach's response to 2018 BCMR Consultation, Annex G, page 123, paragraph 18), however we still consider them unreliable.

Conclusions

A14.80 On the basis of the analysis set out in this annex, we conclude that if we were to find that VHB Access circuits were in a separate market to lower bandwidth products in the CI Access market (i.e. 1 Gbit/s and below) (which is not our decision for the reasons set out in Section 4 of Volume 2), we would find that BT has SMP in each of the following geographic markets:

- BT Only areas in the UK;
- BT+1 areas in the UK;
- HNR Metro Areas; and
- Other HNR areas in the rest of the UK.

SMP in BT Only and BT+1 markets

A14.81 Our conclusion that BT would have SMP in BT Only and BT+1 markets is based on the evidence on BT's very high service shares, BT's incumbency advantage and evidence on VHB prices and margins.

A14.82 This finding is further supported by the evidence set out in Section 6 of Volume 2 on the very limited availability of rival infrastructure, high barriers to entry and expansion, limited buyer power and the limited prospects for potential competition even in the presence of an unrestricted PIA remedy.[671]

SMP in Metro Areas and other High Network Reach areas in the rest of the UK

A14.83 Our conclusion that BT would have SMP in the Metro Areas and other High Network Reach areas in the rest of the UK is driven by BT's high service share, BT's incumbency advantage and evidence on VHB prices and margins. It is further supported by the evidence in Section 6 of Volume 2 on BT's competitive advantage from proximity, the high barriers to entry and expansion and limited buyer power.

A14.84 However, as set out in Section 6 of Volume 2, we consider that our SMP finding in these areas is finely balanced in light of the evidence on the presence of rival networks and the availability of unrestricted PIA remedy.[672]

No SMP in the CLA

A14.85 Our conclusion that BT would not have SMP in the CLA is supported by evidence on BT's service share in the CLA and our view that over this review period there is likely to be sufficient infrastructure in the CLA so as to exert strong competitive constraints on BT for the following two reasons:

[671] On average, there are less than two rivals within 50m of mobile sites in both markets (0.2 in BT Only and 1 in BT+1).
[672] As set out in Annex 6, we expect that during this review period, unrestricted PIA maybe used for in-fill for some, but probably not all, of these HNR areas. However, at this stage it is difficult to identify exactly where it will be deployed

- density of rival infrastructure in the CLA is an order of magnitude greater than all other areas. On average, there are four rival networks within 50m of a customer site; and
- some rivals may deploy infill network extensions during this review period using the unrestricted PIA remedy in the CLA given the high number of networks already present and high customer density.

A15. Inter-exchange connectivity

A15.1 As explained in Volume 2, Section 8, in order to assess significant market power (SMP) in inter-exchange connectivity, we have looked at Principal Core Operator (PCO) presence at BT exchanges.

A15.2 To identify the number of PCOs present at BT exchanges we have looked at purchases of external cablelink variants at BT exchanges.[673]

A15.3 In this annex, we explain how we have undertaken our presence test, noting the actions we took prior to and post consultation. We also outline relevant stakeholder comments and our response to them. Finally, at the end of this section, we detail the results of our analysis.

Information request to Openreach

A15.4 On 1 February 2018, we sent a statutory information request to Openreach which requested data on sales of two products, Cablelink External and Bulk Transport Link (BTL).[674] We requested confirmation of which customer was purchasing which product, including the number of each product, at which exchange.

A15.5 On 22 February 2018, Openreach responded to our request. It provided a list of customers that had purchased an external cablelink variant. There were two variants included: "BT Cablelink" and "Cablelink External". Openreach also provided information on BTL purchases which demonstrated that volumes of BTL have declined to a point where it is no longer a relevant constraint on Openreach's activities in inter-exchange connectivity.[675] It also provided a list of purchases of Cablelink Internal (1-3)[676] and Cablelink Cell Sites variants.

[673] In order for a non-BT network to connect to a BT exchange, it needs to purchase an external cablelink variant. These products can be purchased both by the PCO (e.g. Virgin Media) or by a non-PCO telecoms provider that wants an inter-exchange connectivity service from the exchange (e.g. TalkTalk). In both instances, we request confirmation as to the underlying network providing the service. This is why purchases of external cablelink variants are a good indicator of PCO presence at BT exchanges.

[674] The Cablelink External product is a fibre cable connection which allows telecoms providers to connect network equipment within an exchange to fibre from outside the exchange. In contrast, BTL is a high capacity link that enables telecoms providers to transport multiple backhaul circuits from an exchange without needing to install their own equipment at the exchange.

[675] The data showed that there were [✂] BTL links nationwide.

[676] We decided not to look at these links as they helped to identify reseller relationships but did not further help to identify fibre providers present at the BT exchange. It would also require telecoms providers to identify activity relating to approximately [✂] data points, which we considered disproportionate given that it would not enhance our analysis of presence at BT exchanges.

Information requested from other telecoms providers

A15.6 On 13 April 2018, we sent a further 21 statutory information requests to the largest providers and buyers of inter-exchange connectivity services.

A15.7 In addition to asking questions aimed at helping us to better understand competitive conditions in the CI Inter-exchange connectivity services market (e.g. each telecoms provider's wholesaling policy, what factors affect their buying decisions), we also asked telecoms providers to verify the purchases of external cablelink variants provided by Openreach and confirm what it was using these products for.[677]

Further information gathering pre-consultation

A15.8 In August 2018, we identified some inconsistencies between the initial results of our analysis and the analysis we undertook for the 2016 BCMR.

A15.9 The inconsistencies primarily related to Vodafone's presence at BT exchanges. Specifically, the initial results appeared to potentially under-represent Vodafone's presence at BT exchanges. Having identified the issue, we sought further information from Vodafone, which confirmed its fibre presence at 114 additional exchanges.[678]

A15.10 To understand what might have caused the issue and determine whether other telecoms providers were affected, we obtained further information from both BT Group and Openreach. Openreach identified two possible reasons for the problem:

- at some exchanges, Vodafone may have purchased another pre-Cablelink legacy product, "BT Egress - External" [679], which may not have appeared in our initial analysis of Vodafone's presence at BT exchanges; and
- Vodafone may have received some cablelink external variants from BT Enterprise. We since established that [✂].

A15.11 On 14 September 2018, we sent a statutory information request to BT in order to confirm which telecoms providers it was supplying with an external cablelink variant or BT Egress - External. The information we received showed that BT was supplying [✂] with external cablelink variants and [✂] with "BT Egress - External".

A15.12 We noted in our Consultation document that we intended to send further statutory information requests to purchasers of "LLU Egress - External" and those telecoms providers that receive external cablelink variants from BT Enterprise and other non-Openreach BT entities. We stated that the evidence received in those responses might change the number of BT exchanges subject to regulation.[680]

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[677] As part of this request, we also asked telecoms providers about their activities at data centres.
[678] Vodafone provided this information as an update to its response to the 3rd BCMR s.135 notice.
[679] On 10 September, Openreach provided an update to its response to the 2nd BCMR s.135 notice, listing its sales of BT Egress/LLU Egress – External to other telecoms providers. The volumes were relatively small (compared to sales of other external cablelink variants), with only [✂] to a number of telecoms providers that had informed our assessment of PCOs presence at BT exchanges inclusive of [✂]. Information relating to "BT Egress"/ "LLU Egress – External" can be found here: LLU Contract RANF PART IV [accessed 15 May 2019].
[680] Ofcom, 2018. Business connectivity market review, Annexes 1-22, page 132, paragraph A15.13 [accessed 20 May 2019].

Stakeholder comments

A15.13 Only Openreach and Vodafone commented on the accuracy of our classification of BT exchanges.

A15.14 Openreach argued that our identification of certain exchanges as BT Only did not reflect the data it had supplied to us. It noted that there were 162 exchanges that we had designated as BT Only, where it had sold external cablelink variants to third parties. It further noted that in some cases these might be connecting into non-PCO networks, but it doubted that this was the case in all instances.[681]

A15.15 Openreach further noted that as it is unable to count the number of PCOs at an exchange, it could not comment on the accuracy of our BT+2 findings. It argued that given the apparent scale of errors for BT Only, it had concerns over the validity of our findings for BT+2 as well.[682]

A15.16 Openreach was also unsure as to why 13 exchanges, which had been de-regulated at the Temporary Conditions, on the basis of a higher threshold (i.e. BT+2 Direct or BT+3 Direct/Indirect), should now not be found not competitive at a lower threshold (i.e. BT+2 Direct/Indirect).[683]

A15.17 Vodafone noted that the Chelsea exchange is now closed and therefore should not be on the list of competitive exchanges.[684]

Our assessment of stakeholder comments

A15.18 We have undertaken a thorough and careful assessment of presence at BT exchanges in order to classify them as BT Only, BT+1 and BT+2 or more.[685] As part of this, we have also reviewed the list of 162 exchanges queried by Openreach and have detailed the reasons for our findings below.[686] There are four scenarios where we have changed our presence classification of BT exchanges:

- As we noted in our consultation[687], Openreach's sales of "BT Egress - External" and BT Enterprise's (and other BT entities') resale of all external cablelink variants had not been included in our analysis. This was because the information had not been provided to us in time for us to include it in our analysis before consultation. We have now

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[681] Openreach's response to the 2018 BCMR Consultation, page 12, paragraph 36.
[682] Openreach's response to the 2018 BCMR Consultation, page 39, paragraph 35.
[683] Openreach's response to the 2018 BCMR Consultation, page 41, paragraph 51.
[684] Vodafone's response to the 2018 BCMR Consultation, part3, paragraph 1.19.1.
[685] We note that we sent formal information requests to 29 telecoms providers (inclusive of BT), capturing in excess of 99% of all sales of external cablelink variants.
[686] As part of this process, we sent additional information requests to a few small purchasers of external cablelink variants at BT Only exchanges (i.e. Net Support, Novosco, and Updata).
[687] 2018 BCMR Consultation, Annexes, paragraph A15.13.

integrated the information from Openreach and BT (other) sales and this has resulted in a change in presence classification of 27 out of the 162 exchanges.

- At a number of exchanges, Virgin Media stated it was purchasing an external cablelink variant to connect into Openreach's network. In our assessment, this would not count as non-Openreach PCO presence. We asked Openreach if it was possible that Virgin Media could purchase external cablelink variants to connect into an Openreach product. Openreach considered it unlikely.[688] Subsequently, we contacted Virgin Media, which confirmed that it was providing backhaul from these exchanges via its own network.[689] We have now integrated the information into our assessment and this has resulted in a change in presence classification of 21 out of the 162 exchanges.
- Our review process identified a few anomalies in KCOM's responses to our statutory information requests. We discussed this issue with KCOM[690] and KCOM provided a further clarification to our statutory information requests.[691] This resulted in increasing CityFibre presence in 2 out of the 162 exchanges.
- [✂] This has resulted in a change in presence classification in 1 out of the 162 exchanges.

A15.19 As a result of these updates, our presence classification has changed in 50 of the 162 exchanges. 49 of these BT Only exchanges have been reclassified as BT+1, and 1 of these exchanges has been reclassified as BT+2.[692]

A15.20 We note that these changes have mechanically flowed through our model, meaning that there have been adjustments to our presence test at additional BT+1 and BT+2 or more exchanges.[693]

A15.21 In the remaining 112 exchanges, we have not changed our presence classification. We have not changed our findings for the following reasons[694]:

- There were a number of exchanges where a telecoms provider is paying for an external cablelink variant, but no service is being provided (over either a PCO or other non-BT network). We have been informed by telecoms providers that this happens because the annual rental charge (c£7/annum) is significantly less than the costs involved in ceasing the circuit (e.g. engineer time and cost).[695] We do not consider this scenario represents PCO "presence". Our rationale for why we do not think it is a sufficient constraint is set out in Volume 2, Section 8.[696]
- There were a number of exchanges where the external cablelink variant had been ceased prior to 31 December 2017 or did not exist.

[688] Meeting with Openreach on 25 February 2019 at Ofcom.
[689] VM response 2 April 2019 to the 3rd s135 notice (clarification).
[690] Meeting with KCOM on 25 February 2019 via telephone.
[691] KCOM response dated 25 February 2019 to the third and twentieth BCMR s135 notice (clarification).
[692] Note that the change in presence classification in one exchange from BT Only to BT+2 means that only 50 exchanges have been affected, even though A15.18 lists 51 incidences of changes in presence.
[693] Specifically, changes are not just limited to the BT Only exchanges where there were purchases of external cablelink variants.
[694] It is worth noting that at a number of exchanges, more than one of these reasons could be applicable.
[695] See for example [✂].
[696] See in particular paragraphs 8.37 to 8.41.

- Finally, there were a number of exchanges where the external cablelink variant was connecting into a non-PCO network.

A15.22 We have also reviewed the 13 BT exchanges from the 2016 Temporary Conditions that we proposed to re-regulate in our Consultation. Our findings are as follows:

- four BT exchanges (i.e. the Basildon, Accrington, York and Stafford exchanges) have already been re-classified as BT+2 or more, in light of the data update to our presence analysis and so will not be re-regulated; and
- in the remaining nine BT exchanges (i.e. the Basford, Forest Hill, Lee Green, Weybridge, Kensal Green, Aycliffe, Lincoln, Stratton St Margaret and Winchester exchanges), we have found that PCO presence has decreased since the 2016 BCMR.[697] Therefore, we continue to classify these as BT+1 for the purposes of our SMP assessment, as we consider this appropriately reflects the competitive conditions in these exchanges for this review period.[698]

A15.23 We welcome Vodafone's comment and have removed the Chelsea exchange from the list of competitive exchanges.[699]

The results of our analysis

A15.24 As in the 2016 BCMR, we have only counted presence where it is from a PCO.

A15.25 In summary, we have identified 4,269 exchanges as BT Only, 733 as BT+1 and 571 as BT+2 or more.[700]

A15.26 We have provided a detailed list of exchanges that we have decided to regulate and not regulate in Schedule 8 to the legal instrument. This includes information on whether BT is required to provide access to dark fibre at a given BT Only exchange. It also provides further detail on the regulation that applies for multiple MDF IDs that are co-located within one exchange building. Finally, in Schedule 8 we also note we also note the changes that have occurred since the Temporary Conditions. We do this by noting the exchanges we have decided will not be subject to regulation and those we have decided to re-regulate.

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[697] This is due to a reduction in the number of telecoms providers that we still consider to be PCOs at the exchange in question.
[698] We note in Volume 2, Section 11, that in some of these exchanges BT may not face an EOI requirement.
[699] We note for the purpose of our analysis, we had asked for information accurate as of 31 of December 2017. The Chelsea exchange closed in 2018.
[700] [✂].

A16. Indicative dig distance cost model

A16.1 As explained in more detail in Annex 10, we have prepared an Excel model to inform our understanding of the competitive conditions in different geographic areas. This model uses a bottom up approach to estimate the maximum average route distance from a telecoms provider's nearest network flexibility point to an end-customer's premises that it would be economic for the telecom provider to serve, such that it would break even (on a net present value basis) over the average life of a leased line service contract.

A16.2 The Excel workbook used for this model can be found here: https://www.ofcom.org.uk/__data/assets/file/0025/149263/indicative-dig-distance-cost-model.xlsm.

A17. Dark fibre implementation

A17.1 In Volume 2, Section 12, we set out our requirement that BT provide dark fibre access (DFA) for inter-exchange connectivity circuits from certain BT Only exchanges. This annex sets out the timeline for implementation of the dark fibre remedy.

Table A17.1: Summary of the dark fibre remedy implementation obligations

Obligation	Summary
Reference Offer	Publish a Reference Offer no later than six weeks after the BCMR conditions come into force.[701] Specified minimum requirements for the RO (as set out in Volume 2, Section 12). Service Level Agreements (SLAs) to be agreed and finalised as part of industry negotiations regarding product specification within the Reference Offer prior to publication. Service Level Guarantees (SLGs) to be agreed and finalised as part of industry negotiations and inserted within the published Reference Offer no later than 1 January 2020.
Soft launch	No later than six weeks after the BCMR conditions of this Statement come into force, provide access to dark fibre (in line with SLAs), but no requirement for automated EMP systems.[702]
Full launch	Launch DFA product with full parity to EAD services, including automated EMP systems by 1 January 2020. SLGs come into force on same date.
Quality of service	QoS standards apply from Year Two of the review period (April 2020 to March 2021). Key Performance Indicators (KPIs) defined in Direction. Reporting requirements to come into effect from soft launch (i.e. no later than six weeks after the BCMR conditions come into force) as agreed with Ofcom.

A17.2 We require BT to publish a Reference Offer (RO) for dark fibre access for inter-exchange connectivity from BT Only exchanges. The minimum requirements for the RO are set out in Volume 2, Section 12 and are broadly the same as those we imposed in the 2016 BCMR

[701] Annex 26, Schedule 3, Part 3.
[702] EMP (Equivalence Management Platform) is used to coordinate orders made to Openreach for existing products (Ethernet Access Direct, TDM Backhaul Services, Ethernet Backhaul Direct) and in future will incorporate DFA products. This system is relied upon to meet no undue discrimination obligations and EOI requirements.

(but subsequently withdrew), recognising the alignment between the DFA remedy design and EAD services including any reliance on radial and route distance limits associated with EAD products.[703]

A17.3 We have made some changes to the timetable for implementation of dark fibre that we proposed in our consultation. The timetable that we are now imposing is summarised in Table A17.1 on the previous page. As set out at Volume 2, Section 12 – paragraphs 12.244 onwards – we have decided to require a two-stage launch. The RO and any associated contractual documents must be consistent with this timetable.

Background

Previous dark fibre product developments

A17.4 In the 2016 BCMR, we concluded that BT would need some time to develop a dark fibre product and that it would need to negotiate some aspects of the product design with other telecoms providers. We therefore required BT to publish a final RO on 1 December 2016 (seven months after publication of the 2016 BCMR) and to launch the dark fibre product on 1 October 2017 (17 months after publication of the 2016 BCMR).

A17.5 In the 2017 Dark Fibre Consultation, we considered that most of the preparatory work for the launch of the dark fibre product had already been completed. In particular, industry had already worked with BT for 15 months following the publication of the 2016 BCMR to develop the detailed technical and operational aspects of the dark fibre product. This included the dark fibre RO, which BT published in December 2016 (December 2016 RO).[704] As a result, our view was that BT would be able to conclude those activities which it needed to undertake before launching the previously proposed dark fibre product within one month.[705]

A17.6 In responding to the 2017 Dark Fibre Consultation, Openreach commented that our proposed launch date of one month following the publication of the final statement was “simply not achievable”.[706]

A17.7 Openreach highlighted that following the Tribunal’s ruling, all preparation for the original Dark Fibre Access product was suspended and up until that point there had been “very limited model office testing undertaken”.[707] Openreach outlined several tasks that would have to be completed prior to launch, such as:

- upgrading systems to reflect changes to relevant products and retraining staff;[708]

[703] 2016 BCMR, Volume 1, paragraphs 9.177 to 9.182.
[704] Openreach’s 2016 Dark Fibre Access Reference Offer.
[705] In this previous consultation we proposed that use of the dark fibre remedy would be restricted to supplying services that are at 1 Gbit/s or below. See 2017 Dark Fibre Consultation, paragraph 3.55.
[706] Openreach’s response to the 2017 Dark Fibre Consultation, paragraph 490 to 500.
[707] Openreach’s response to the 2017 Dark Fibre Consultation, paragraph 494.
[708] Openreach’s response to the 2017 Dark Fibre Consultation, paragraph 496.

- updating the RO in line with the new remedy design, involving negotiations with industry; and
- testing the EMP systems developed for dark fibre orders to suit both Openreach and industry.[709]

A17.8 Other telecoms providers were more supportive of the implementation timeline proposed in the 2017 Dark Fibre Consultation. TalkTalk supported launch within a month of the conditions coming into force and stated that it would seek to use dark fibre from launch.[710] Vodafone also agreed with the proposal to require Openreach to provide the dark fibre product shortly after the conditions come into force. It also noted that the majority of contractual issues had already been concluded and the remaining outstanding issues could be resolved swiftly.[711]

A17.9 The proposed implementation arrangements set out in our 2018 BCMR Consultation were based on these previous product developments.

Our proposals

A17.10 In our 2018 BCMR Consultation, we proposed a DFA remedy design based on EAD fibre circuits to allow implementation of the remedy within one month of publication of a Final Statement. We set out our proposed implementation timeline in Annex 17 to the 2018 BCMR Consultation, as follows[712]:

- RO published within one month of publication of a Final Statement;[713]
- SLAs and SLGs negotiated in line with the RO and included in the RO, but to come into force four months after Final Statement; and
- launch access to dark fibre within one month of Final Statement.

A17.11 We proposed Quality of Service standards to come into effect from 1 April 2020 (the start of year two of the market review), with reporting requirements to come into effect from launch.

Stakeholder responses

A17.12 We received limited comments from stakeholders relating to our proposed DFA implementation timeline. In summary, the comments we received related to the following topics:

- Openreach argued a lack of clarity as to the anchor product, to which parity was required when providing a DFA product, would cause delays to implementation[714] –

[709] BT's response to the 2017 Dark Fibre Consultation, paragraphs 13 to 21.
[710] TalkTalk's response to the 2017 Dark Fibre Consultation, paragraphs 3.61 to 3.65.
[711] Vodafone's response to the 2017 Dark Fibre Consultation, page 23.
[712] See Table A17.1 in 2018 BCMR Consultation, Volume 1.
[713] The legal instrument expressed this as "one month after the date on which this Condition enters into force".
[714] Openreach's response to 2018 BCMR Consultation, Annex C, page 77, paragraph 12-15.

either clarity would need to be given in our statement or a longer implementation timeline permitted to agree the new product specifications.

- SSE stated that providers seeking network access will be ready to take up DFA within the proposed timeline[715], highlighting familiarity with "own-use" services[716] based on the provision of dark fibre services by other suppliers of fibre networks.
- Openreach[717] and Virgin Media[718] stated they needed adequate time for negotiations of the RO, in light of potential changes required to align the RO with the scope of the DFA remedy, and one month was not sufficient.
- Openreach submitted that it would be unable to complete the necessary systems development within the proposed timeline for launch of the DFA remedy.[719]

A17.13 We address these points in turn below.

Parity with EAD

A17.14 Openreach queried the intended anchor product for the new dark fibre remedy.[720] It highlighted the clarity found in the 2016 BCMR Final Statement that linked DFA to EAD services, and asked us to confirm that EAD remained the intended anchor product for the dark fibre remedy.

A17.15 Openreach also noted that systems associated with EAD products have developed since December 2016 when the DFA implementation process was suspended. Furthermore, EAD products are not restricted in terms of use across market segments and such restrictions on scope were not envisaged when developing the DFA remedy in 2016.

A17.16 For these reasons, Openreach's comments on the need for clarity as to the intended anchor product feed into both the initial RO negotiation and systems developments. Openreach submitted that one month was insufficient and the timeline would become more protracted where the anchor product was not made clear, or if an anchor product other than EAD was selected.

Publication and negotiation of the Reference Offer

A17.17 Virgin Media highlighted the difference in scope between previous DFA remedy designs and our proposals, and suggested RO negotiations might take longer than one month to complete.[721]

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[715] SSE's response to the 2018 BCMR Consultation, answer to Q.12.5, page 11.
[716] This phrase is used by SSE to refer to dark fibre services which involve providers other than the incumbent using their own equipment to light the fibre supplied as part of the incumbent's network.
[717] Openreach's response to 2018 BCMR Consultation, Annex C, pages 76-77, paragraphs 8-11.
[718] Virgin Media's response to 2018 BCMR Consultation, page 18.
[719] Openreach's response to 2018 BCMR Consultation, Annex C, page 77, paragraphs 12-15.
[720] Openreach's response to 2018 BCMR Consultation, Annex C, page 77, paragraphs 12-15.
[721] Virgin Media's response to 2018 BCMR Consultation, page 18.

A17.18 Openreach also stated that one month does not provide sufficient time to complete negotiations, based on its previous experience. It considered other providers would want to consider and understand any new proposals and raise comments or concerns with Openreach in order to agree an RO prior to making any orders.

A17.19 Openreach indicated that it would be possible to publish a RO within the proposed timescales but highlighted the risks of imposing terms on other providers. It warned that if negotiations are given insufficient time, there is a risk of disputes.

A17.20 Openreach suggested that four months after publication of the Final Statement is a reasonable time period in which to conclude industry negotiations on the RO.[722]

Systems development

A17.21 In light of the obligation for parity between DFA and wholesale active products, which means DFA is provided in accordance with the same systems and processes, in the same manner and within the same or shorter period of time[723], Openreach said it would need more time to achieve parity through systems developments.[724] Openreach set out various features of the proposed DFA remedy, which it suggested it and industry would need to consider when completing an EMP system for processing DFA orders.[725] It indicated systems developments are necessary for the following:

- order journey, including system testing;
- geography, termination options and migrations;
- billing system for separate cease charges; and
- assurance, including review of SLGs.

A17.22 Openreach explained that major systems developments are implemented in batches across an annual work plan split across multiple release cycles. Release cycles are given number references such as 'R4100'. The release cycles are predetermined, with the first three in the review period being July, September and November 2019.[726]

A17.23 Openreach said it would implement the changes required as a result of BCMR 2019 at the earliest available release cycle. [✂]it aimed to include all developments in one release cycle, it indicated that the lead time for the July release, and the possible need to implement other developments not connected to the launch of DFA, meant it was likely some systems developments would have to be delayed to the September release.[727]For these reasons, Openreach suggested a two-stage implementation process.[728] Openreach told us that while it could not launch DFA in the time we had proposed, it could "trial dark fibre with industry from mid-August" with a soft launch, before full implementation in October 2019 based on our final statement being published in April 2019.

[722] Openreach's response to 2018 BCMR Consultation, Annex C, page 76.
[723] See Condition 2.4 of the legal instrument, Annex 26, Schedule 3, Part 3.
[724] Openreach's response to 2018 BCMR Consultation, Annex C, page 74, paragraph 5.
[725] Openreach's response to 2018 BCMR Consultation, Annex C, pages 75-76.
[726] Openreach's response to 2018 BCMR Consultation, Annex C, page 74; Openreach's response to s.135-26, [✂].
[727] Openreach's response to BCMR s.135-26 Notice, slides presented at meeting dated 25 February 2019, page 4.
[728] Openreach's response to 2018 BCMR Consultation, Annex C, page 74, paragraph 5.

A17.24 During any soft-launch period, Openreach indicated there will be opportunity to test the ordering journey and complete RO negotiations with other providers. It said it would use any later release cycles, prior to full launch, to finalise EMP systems. Openreach suggested it would be able to complete this within six months of the Final Statement.

Our reasoning and decisions

Parity with EAD

A17.25 As discussed in Volume 2, Section 12, Openreach requested greater clarity as to the links between DFA remedy and EAD fibre products, arguing that any lack of clarity would delay negotiations (and consequently agreement of a suitable RO).[729] We confirm that the DFA remedy design is based on EAD services and we require parity with wholesale active EAD services when implementing the DFA product.

Publication and negotiation of the Reference Offer

A17.26 Similar to our position in the 2017 Dark Fibre Consultation, in our 2018 BCMR Consultation we said that it would not be necessary for BT to make significant changes to the dark fibre product to reflect its implementation in the CI Inter-exchange connectivity services market.

A17.27 Openreach has shown in its response to our consultation that it has considered the December 2016 RO for its previous iteration of the DFA product. It has identified areas of the RO that may require amendments to align it with the scope of the DFA remedy that we are imposing, as set out in Volume 2, Section 12.

A17.28 We envisage that the additional clarity offered in this statement will reduce the need for amendments to the existing RO. However, we acknowledge some minor amendments are likely to be considered necessary by industry given this DFA remedy is targeted at inter-exchange connectivity.

A17.29 We agree that some industry engagement will be beneficial to establishing a fit-for-purpose RO. We recognise the potential risks associated with any negotiations, both in terms of poor outcomes as a result of timeframes being too short and of protracted negotiations that delay implementation. We have taken this into account in reaching our decision as set out below.

A17.30 When making our proposals, we not only considered the progress made in the 2015/16 negotiations but also the agreement reached with stakeholders. It is not in the interests of providers who wish to use dark fibre to delay implementation of the DFA remedy, and any protracted negotiations favours the incumbent who holds SMP and is subject to network access conditions. In reaching a decision, we need to ensure sufficient time is given to the process, so BT provides other parties with adequate opportunity to comment, while at the same time any negotiations are time limited to reduce unnecessary delay.

[729] Openreach's response to the 2018 BCMR Consultation, Annex C, page 77, paragraphs 12-15.

Considering specific RO amendments

A17.31 As set out in Volume 2, Section 12, we consider large parts of the December 2016 RO can be retained as previously agreed with industry. However, we acknowledge that the industry may need to consider changes to the following provisions:

- **Termination locations**: the previous RO had multiple options for termination, some of which related to circuits in what we have now defined as the CI Access services market (where the dark fibre remedy will not apply) .
- **Cessation charges**: the previous RO was based on a product which was priced on an active-minus basis and cessation charges were incorporated into the rental price. However, we have set a separate charge for cessation charges (see Volume 3, Section 4). While systems developments may be necessary to implement billing for cessation charges, we consider only minor amendments to the RO will be necessary.
- **Migration**: Given the scope of the DFA remedy, providers may want to migrate only part of an existing active circuit (i.e. the section between a BT Only exchange and another BT exchange, but not any other part of the circuit) to DFA. The RO will need to provide a suitable mechanism for migration of existing circuits and sections of existing circuits.

A17.32 The focus of any RO amendments must be to achieve alignment between the RO and the DFA remedy imposed in this review. We would expect that any changes to the previously agreed RO, which are unrelated to the change in scope of the remedy, would be minimal.

Our decision on the deadline for RO publication

A17.33 Based on the above, we have decided to increase the period for RO negotiations by two weeks. This means that BT must publish the RO no later than six weeks after the BCMR conditions come into force.

Launch date

A17.34 In light of Openreach's comments, we considered two options for the launch timeframe of DFA:[730]

- delay the introduction of the DFA remedy until the necessary systems development work is complete, extending the implementation period to six months rather than one month as set out in our consultation; and
- maintain a shorter timeframe[731] for the provision of DFA, with a manual 'soft launch' shortly after the BCMR conditions enter into force and full launch (including a fully automated EMP system for provision of services) somewhat later.

A17.35 As discussed in Volume 2, Section 12, we have decided to adopt a two-stage implementation process, with soft launch no later than six weeks after the BCMR

[730] As set out in Volume 2, Section 12, the option of not imposing the requirement for reasonable access to dark fibre during this review period was considered. Here we are focusing on the effective implementation of a DFA remedy.
[731] In this Annex we consider whether the original one-month timeframe set out in the consultation is feasible or whether the minimum steps necessary to prepare for a soft launch of the DFA remedy require a longer period.

conditions come into force, and full launch by 1 January 2020. In the following paragraphs we set out what we require BT to do during the soft-launch period and after full launch.

A17.36 Openreach indicates that there would be some restrictions on the use of dark fibre during soft launch, that would be removed after full launch, and suggests this is down to the EMP systems not being fully developed at this earlier stage. We consider this restriction to be process based, and therefore acceptable, as opposed to indicative of DFA products including sub-quality fibre causing detriment to telecoms providers. We have decided that the lack of parity does not prevent other providers beginning to place orders for reasonable access to dark fibre and Openreach providing such services within a soft-launch period.

A17.37 In relation to BCMR 2016, we considered a similar two-stage process and at that time we decided that BT should focus its attention on a full launch (and other providers seeking access to dark fibre), and therefore a soft launch was not considered appropriate. The reasons we gave indicated risks associated with poor customer experiences prior to full launch if access was established based on partially manual ordering processes.

A17.38 By adopting a two-stage implementation process, we acknowledge there is a risk that work generated by any interim ordering process could distract from implementing an effective remedy by the full launch deadline.

A17.39 We note that during the BCMR 2016 implementation period, when a dark fibre product was initially imposed, there were extensive negotiations taking place relating to the RO and other design elements for this new remedy, which were spread across 12 months. The risks associated with this implementation period are different because of progress made in 2016 and subsequent take up of dark fibre products offered by other suppliers,[732] as reflected in the response from SSE, which highlights the progress industry has made in relation to dark fibre products.[733] This suggests that a soft-launch period is likely to be less disruptive during the 2019 BCMR implementation period than it would have been after the 2016 BCMR.

A17.40 We consider the advantages of a soft-launch period are clear, as it allows other providers to place initial orders for dark fibre sooner than would be the case if they had to wait for Openreach to complete the work it needs to do for a full launch.

A17.41 We have therefore decided to provide additional time to enable Openreach to undertake systems development, while maintaining a launch date for access to dark fibre shortly after the BCMR conditions come into force.

A17.42 We recognise that the processes used to provide access to dark fibre during the soft-launch period are unlikely to be the same as EAD product ordering processes. However, we are imposing a no undue discrimination obligation and an EOI requirement on BT from the

[732] Openreach has not launched a dark fibre product given the DFA remedy did not take effect during the 2016 BCMR period.

[733] SSE's response to 2018 BCMR Consultation, page 11.

start of the review period,[734] meaning the fibre elements must have equivalence whether fibre is used for active or passive network access.

A17.43 Openreach indicated alternative ordering processes can be used during a soft-launch period for systems development and testing.[735] We recognise there will be additional risks associated with a staged approach to full automation, such as potential issues when merging manual orders into the EMP systems after full launch. We consider the number of orders processed during the soft-launch period is unlikely to be significant enough to justify a longer delay to launching the DFA product and limiting access to dark fibre during this two-year review period.[736]

A17.44 By setting a clear deadline for full launch we are giving Openreach additional time to complete the work needed to prepare its ordering systems. This may involve the use of multiple release cycles[737], potentially including R4150 September 2019 and R4200 November 2019, as well as providing scope for testing and training.

A17.45 Looking at the timeline proposed by Openreach in its consultation response, we consider it proportionate to set the deadline for full launch as 1 January 2020.

Quality of service

A17.46 As discussed in Volume 2, Section 15, we have decided to impose a direction requiring BT to provide quality of service information in the form of KPIs in relation to Ethernet products. We said these would include dark fibre provided for inter-exchange connectivity. We need this information to monitor performance outcomes as between active and passive remedies and as a complement to our measures to address potential discriminatory behaviour.

A17.47 We proposed that the KPI data should be made available when the dark fibre product becomes available. We retain the view that there is no reason why the provision of KPI data immediately from launch should pose any difficulty for Openreach. We are therefore making a direction requiring BT to provide QoS information in the form of KPIs as soon as orders begin to be processed, including during the soft-launch period.

A17.48 As discussed in Volume 2, Section 15, we are also imposing QoS standards on these inter-exchange dark fibre circuits in year two of the market review (from 1 April 2020), including them alongside the other Ethernet products covered by the QoS standards. This will be approximately nine months after soft launch and three months after full launch of the DFA remedy.

[734] See Volume 2, Section 11 on General remedies.
[735] Openreach's response to BCMR s.135-26 Notice, slides presented at meeting dated 25 February 2019, page 3.
[736] See Volume 2, Section 12 on take up of dark fibre.
[737] See Openreach's response to 2018 BCMR Consultation, Annex C, page 74.

A18. Cost modelling for active services

A18.1 In Section 2 of Volume 3 we set out our decision to cap prices for CI access and inter-exchange services at 1 Gbit/s and below with a flat nominal (i.e. CPI-CPI) control. We explain that, to inform our assessment of how best to implement flat pricing, we undertook some modelling to understand the likely evolution of efficient costs of the relevant services over this review period. This allows us to understand how setting a CPI-CPI cap compares with a cost-based charge control, similar to the one currently in place for these services, which would normally require prices to align with our estimate of fully allocated costs (FAC) by the end of the review period.

A18.2 The purpose of the modelling is to understand the broad implications of keeping prices flat on BT's cost recovery, ensuring our decision strikes a reasonable balance between protecting consumers and allowing BT to recover efficiently incurred costs. The modelling is not intended to provide a precise level for the value of 'X' as it would were we to set a CPI-X FAC-based charge control; therefore, we did not consider it would be proportionate to consult on the values of the specific input parameters used in the modelling presented in the 2018 BCMR Consultation.

A18.3 Consistent with the approach adopted in the Consultation, we use the 2016 LLCC top-down model as a starting point and largely follow forecasting methodologies established in previous leased lines and the 2018 WLA charge controls. We refer to this model as the 'CI model'.

A18.4 Our analysis shows that prices are likely to be broadly aligned to costs as of April 2019 (the expiry of the latest set of charge controls). Further, our modelling suggests that a CPI-CPI charge control could lead to BT recovering around £15 to £25m more over the review period than if we set the control on a FAC basis, which is lower than our provisional conclusion in the Consultation.[738]

A18.5 If we consider a wider range for key input parameters (as we typically would when creating scenarios as part of setting a cost-based charge control), the over-recovery could be greater, in the order of up to £80m, and under-recovery of costs is also possible, in the order of up to £40m.[739]

A18.6 A control at CPI-CPI therefore falls within the range of outcomes of our modelling, although on balance, some modest over-recovery by BT is the more likely outcome compared a cost-based control to align with FAC. As explained in Section 2 of Volume 3, we do not consider that any potential over-recovery of costs by BT will outweigh the benefits of maximising incentives to invest.

A18.7 This annex sets out the details of how we have modelled costs using the CI model. We have taken the same approach to modelling as we did in the Consultation. Where new

[738] In the Consultation the range was £50m to £65m. The change in our estimates from the Consultation reflects the impact of updating some of the input parameters and correcting for some modelling errors.
[739] In the Consultation, we indicated possible over-recovery of anything up to £135m or under-recovery of up to £10m.

information has become available which we consider could materially impact the results of the modelling and our policy decision, we have updated the model to account for it. However, we considered that it would be disproportionate to update every single input parameter in the CI model as we are not setting a charge control that targets a precise level of costs (and hence we do not require a precise 'X' value).

A18.8 A number of stakeholders commented on whether keeping prices flat is more appropriate than setting a cost-based charge control. We address these comments in Volume 2 and 3.

A18.9 Some stakeholders also commented on the levels of estimated over-recovery for BT, including comments on the specific input assumptions we used. We have considered whether we should alter our modelling approach in light of these comments. Where stakeholders have noted modelling errors, we have made appropriate changes to the model. However, where stakeholders commented on the specific input assumptions, we conclude that these comments simply highlight that there is a degree of uncertainty around each input parameter (which we acknowledged in the Consultation) and that the broad ranges for the input parameters used in the Consultation remain appropriate.[740]

A18.10 In this annex we set out:

- the overall modelling approach we have taken;
- the details of certain key assumptions in the model; and
- the outputs of the model and the implications for BT's cost recovery.

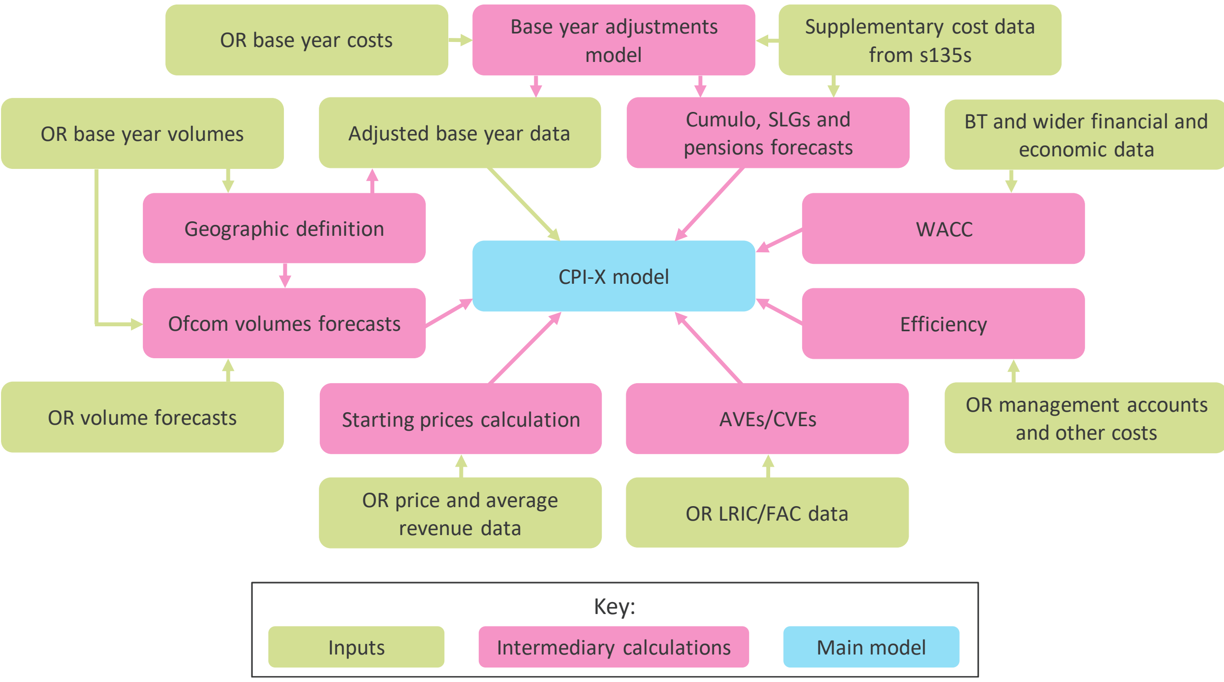
Overall approach to cost modelling

A18.11 The objective of our modelling exercise is to forecast how the efficient costs of providing the active services at 1 Gbit/s and below might evolve over the charge control period. We have structured our model as illustrated in Figure A18.1 below.

A18.12 No stakeholder has commented on our overall modelling approach. The approach described below is exactly the same as the one set out in the Consultation.

[740] Where a stakeholder has raised a comment on an input which we have decided not to update, we have noted that a stakeholder has responded and referenced their response, however, we have not sought to respond to each specific point raised by the respondent.

Figure A18.1: The CI model structure



Note: in this Figure 'OR' refers to Openreach. Other acronyms are described later in this annex.

Approach to modelling

A18.13 Consistent with previous reviews, we have built our model using a top-down cost modelling approach based on cost data from BT's regulatory financial reporting systems. The top-down modelling approach is an accounting approach that forecasts how BT's efficiently incurred costs may change over time relative to the base year. We have used the 2016 LLCC Model as our starting point and have updated it to take into account market developments as outlined in the rest of this annex.

Cost standard

A18.14 Our typical approach to setting charge controls on BT has been to allow it to recover the incremental costs of provision plus an appropriate allowance for the recovery of common costs.[741] This is based on forward-looking costs plus some relevant sunk costs, such as the cost of duct.

A18.15 As in previous Business Connectivity Market Reviews (2004, 2009, 2013 and 2016) and other charge controls using top-down models (WLA and, until recently, WBA), we consider Current Cost Accounting (CCA) Fully Allocated Cost (FAC) to be the most appropriate standard for estimating the cost of providing leased line services.

A18.16 The use of a CCA FAC approach values BT's assets on the basis of their current replacement costs. We consider that a CCA FAC approach has the advantages of being transparent and

[741] Common costs are those which arise from the provision of a group of services, but which are not incremental to the provision of any individual service.

practicable to implement as BT's costs are known and are based on its Regulatory Financial Statements (RFS) which are publicly available to stakeholders each year. We consider that current costs give better signals for efficient investment and entry than historical costs. Using BT's costs also has the benefit of leading to consistent cost recovery decisions, both over time and between other regulated markets. We therefore use BT's CCA FAC as the cost standard in our model.

Key steps in our cost modelling

A18.17 Our modelling approach consists of four key steps:

a) First, we calculate the base year costs for the relevant services. These costs use BT's RFS as a starting point, with some adjustments.

b) Second, we forecast costs for each year until the end of the charge control period. We forecast operating and capital costs starting from the base year, taking into account our volume forecasts, efficiency assumptions, input price changes, asset volume and cost volume elasticities (AVEs and CVEs), as well as our view of the appropriate forward-looking weighted average cost of capital (WACC).

c) Third, we forecast revenues in each year until the end of the charge control, absent a charge control over the forecast period.

d) Finally, we compare revenues and costs for the 1 Gbit/s and below active services basket[742] to assess the effect of setting a CPI-CPI control rather than a CCA-FAC-based charge control.[743]

A18.18 We describe each of the steps and key assumptions used in more detail below.

Base year costs

A18.19 The first step of a top-down model is to establish the relevant costs in the base year for the charge control. These base year costs are based on regulatory accounting data provided by BT.[744] We use BT's 2017/18 RFS costs as the starting point for our base year. We then adjust the data to reflect our view of BT's efficiently-incurred costs. These adjustments are discussed in detail in Annex 19.

A18.20 In the Consultation we used BT's 2016/17 RFS costs for the base year. We stated that, although the 2017/18 RFS had been published, we did not have sufficient time to obtain the relevant data from Openreach and perform the necessary adjustments and checks to make the data usable in our model. We noted our intention to update the base year data to use the 2017/18 RFS in this statement. The base year costs are also a critical input into

[742] Please note, in the legal instrument we refer to this basket as the 'Ethernet (1 Gbit/s and below) Services Basket'.
[743] We have corrected for an error in the Consultation model where the costs and revenues being compared were not expressed in the same price base, with revenues expressed in 2018/19 prices being compared with costs expressed in 2016/17 prices. For this statement, both revenues and costs are estimated consistently in 2018/19 prices, explaining to some degree why our estimates of over-recovery have reduced.
[744] Stakeholders did not comment on our approach to base year costs.

inter-exchange dark fibre prices and hence, we have decided it is appropriate to update the CI model for new base year data.

Forecasting costs

Overall approach

A18.21 BT's costs consist of operating and capital costs (opex and capex). We forecast each of these cost types separately. We have taken a similar approach to forecasting costs as in the 2016 BCMR.[745]

A18.22 While we are ultimately interested in service-level costs, our cost forecasts are calculated at a network component level. We consider that this is more robust than forecasting at a service level as BT's services are made up of a common pool of network components such as lengths of fibre or Ethernet electronics costs. By forecasting how the costs of these 'building blocks' are expected to change, we can build up the costs of each service. This allows our forecasts to, for example, account for economies of scale due to volumes growth of multiple services all of which make use of a single component; these economies of scale might be missed were we to treat each service as separate.

A18.23 We forecast costs in each year until the end of the charge control period. We do this in two steps after we have established the base year costs:

a) First, we forecast costs assuming volumes remain constant in all years. This takes into account changes in input prices and expected efficiency gains.

b) Second, we add the effects of our volume forecasts. We use AVEs and to estimate the impact of changes in volumes on costs.

Geographic definition

A18.24 In Section 5 of Volume 2 we set out our geographic market definitions. These do not align precisely with the geographic definitions as set out in the Temporary Conditions, which were themselves different to those in the 2016 BCMR. Generally, we have separated the CLA from the rest of the UK, but the exact boundaries used and any other definitions such as the central business districts of other major cities have changed between publications.

A18.25 For the purposes of setting a charge control, we are most concerned with the boundary between areas where the charge control is in force (regardless of whether this is further subdivided in the SMP market assessment) and areas that are not charge controlled. Table A18.2 below shows changes in these areas since 2016.

[745] 2016 BCMR, Volume 2, paragraphs A26.26-A26.49. Stakeholders did not comment on our overall approach to forecasting costs.

Table A18.2: Summary of the new and previous geographic market definitions

	2016 BCMR	Temporary Conditions	2019 BCMR
Charge-controlled areas	London Periphery Rest of the UK	London Periphery The CBDs of Bristol and Manchester Rest of the UK	BT Only areas in the UK BT+1 areas in the UK
Non-charge-controlled areas	CLA	CLA The CBDs of Birmingham, Leeds and Glasgow	CLA Each of the HNR Metro Areas Other HNR areas

Note: in the 2017/18 RFS, costs are reported separately for two areas: 'Rest of the UK' and 'Combined Geographic' (which includes London Periphery and the Central Business Districts of Bristol and Manchester). While the name 'Central London Area' is used both in the 2016 BCMR Statement and this statement, the exact set of postal sectors covered in this document for this area is slightly changed from the set in 2016 (see Section 5 of Volume 2 for further details).

A18.26 To ensure our modelling is consistent with our latest definitions, we have adjusted base year costs and volumes to reflect only those circuits in relevant geographic areas.[746] We have updated the inputs that go into our geographic adjustment from those used at the time of the Consultation to align with the new data sets being used.[747] The mechanics of the adjustments we make to the base data costs and volumes have not changed from the Consultation.

A18.27 We have approached this adjustment in five steps:

- **Step 1:** We have identified circuits by geography under each of the geographic definitions in the Temporary Conditions and under the definitions in Section 5 of Volume 2. We have done this by using the Openreach Circuit Inventory Database which contains geographic data for all Openreach leased lines.
- **Step 2:** We have identified those circuits in areas where we are making a change in geographic definition as to whether that circuit is or is not in a charge-controlled area. These are:
  - the circuits which were in the Rest of the UK, the London Periphery or the CBDs of Bristol and Manchester which are now in BT+2 areas – these are circuits that were subject to charge controls but will not be under our new definitions; and
  - the circuits which were in the CLA or the CBDs of Birmingham, Leeds and Glasgow which are now in BT Only or BT+1 areas – these are circuits that were not subject to charge controls but will be under our new definitions.

[746] Stakeholders did not comment on our approach to geographic adjustments.
[747] See Annex 12 for the updates to the geographic data sets since the Consultation.

- **Step 3:** We have calculated the proportion of circuits that have been reclassified (i.e. number of reclassified circuits in an area divided by total circuits in that area). We have done this for each of the areas for which we have aggregated data from BT: the Combined Geographic Area (comprising the London Periphery and the HNR areas of Bristol and Manchester); the Rest of the UK; and CISBO Residual (comprising the CLA and the HNR areas of Birmingham, Leeds and Glasgow).[748] These three areas are the areas we use in our base year data. Each service has a variant of the base year data with its own costs, volumes and revenues for each of the three areas.
- **Step 4:** To capture the reclassification of circuits, we move circuit volumes between the CISBO Residual (which includes all circuits that are not charge controlled) and the Rest of the UK (which includes all circuits which are charge controlled). We have moved all volumes out of the Combined Geographic Area, with around a third moving into CISBO Residual and the remainder moving into the Rest of the UK. For each service, this results in up to three net movements:
  - from the Combined Geographic area into the CLA;
  - from the Combined Geographic Area into the Rest of the UK; and
  - between the CLA and the Rest of the UK.

  Step 5: When moving volumes between areas, we must also move the associated costs of the reclassified circuits. BT does not hold data on a more granular basis than the three areas we have used, so we are unable to identify the actual costs of the circuits we are reclassifying. For the purposes of this analysis, we have assumed that the average unit cost of service volumes moving from the CLA and the Combined Geographic Area is equal to the average unit cost of the service in the original area. This may be different from the average unit cost of the equivalent service in the destination area. We consider this assumption is appropriate because the Combined Geographic Area and CLA are smaller areas with greater homogeneity than the Rest of the UK, which covers a high proportion of the country with a range of business densities from large towns to rural areas. Furthermore, the areas that are being redefined are likely to be parts of the country with greater business density; areas which have either seen greater competition in the last few years or that were previously defined as competitive (and are now at the more competitive end of the spectrum in the Rest of the UK). Therefore, we consider that using the unit costs of circuits in these smaller and more homogenous areas is a better proxy for the unit costs of circuits in redefined areas than are the unit costs of circuits in the Rest of the UK.

[748] We do not hold data disaggregated at the level of each of the individual geographic markets listed in Table A18.2. We have therefore performed our analysis at the greatest level of disaggregation available to us, which are the data split as shown in the 2017/18 RFS.

Key modelling assumptions

Volume forecasts

A18.28 Volume forecasts are required for our top-down cost model, driving both cost and revenue forecasts. Due to the presence of fixed costs, changes in volumes are likely to affect unit costs.

A18.29 As we are forecasting the costs and revenues of Openreach's regulated CI services, on a service-by-service basis, we base our volume forecasts initially on Openreach's own forecasts. We consider that Openreach's forecasts of service volumes provide the best starting point for our forecasts. We have checked these forecasts against those of other telecoms providers and adjusted them where we believe it is appropriate to do so (see below).

A18.30 At the time of the Consultation, our volume forecasts used actual 2016/17 service volumes as a starting point. As part of the 2017/18 base data update, we obtained the 2017/18 actual service volumes and updated our modelling accordingly.[749]

A18.31 To assess whether the volume growth rates used in the Consultation remained appropriate, we requested updated volume forecasts from Openreach.[750] We compared these forecasts to those used to inform the Consultation assumptions and concluded that there is not a material enough change between the forecasts to have a material impact on our estimated range of potential cost under or over-recovery.

A18.32 Therefore, we have updated our model for the 2017/18 actual service volumes and applied the same growth rates as in the Consultation to the updated 2017/18 base year volumes.[751]

A18.33 The growth rates we use are derived from forecast volume data received from Openreach.[752] This data provide us with two sets of volumes forecasts:

a) a short-run forecast covering 2017/18 and 2018/19, broken down by individual service; and

b) a long-run forecast covering 2019/20 to 2021/22, broken down only by broad bandwidth categories and technology.

A18.34 Neither forecast breaks services down by geography with both sets of data providing forecasts across all geographic areas.

Adjustments to Openreach's forecasts

A18.35 We have identified some areas where we consider adjustments are needed to Openreach's forecasts to make them appropriate for use in our CI model:

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[749] Openreach response dated 12 December 2018 to question 21 of the 11th LLCC s.135 notice.
[750] Openreach response dated 12 December 2018 to question 21 of the 11th LLCC s.135 notice.
[751] Vodafone had a number of comments in relation to our volumes modelling inputs. These comments can be found in their response to the Consultation (leased lines charge control), paragraph 6.43-6.45.
[752] Openreach response dated 2 March 2018 to question 11 of the 1st LLCC s.135 notice.

- an adjustment to account for volumes in Northern Ireland;
- adjustments to convert the more aggregated long-run forecasts into suitable service-level growth rates;
- a bespoke forecast of main links;
- an adjustment to reflect our new geographic definitions; and
- an adjustment to reflect the potential impact on volumes of the PIA remedy.

Northern Ireland adjustment

A18.36 While the base year volumes data from BT's RFS do include Northern Ireland volumes, Openreach's volume forecasts do not. We have adjusted the volumes in our modelling to avoid inconsistencies between the base year data and the forecast series.

Converting the more aggregated long-run forecasts into suitable service-level growth rates

A18.37 Openreach's long-run forecast aggregates services into broad categories, with all services within a given category receiving the same growth rate. We have adjusted the growth rates for some services, which we consider should have a different growth rate to the rest of the category they have been included with:

- we assume a lower growth rate for 10 Mbit/s services compared to 100 Mbit/s services;
- we assume lower growth rates for WES/BES services compared to EAD services at the same bandwidth, given the planned closure of the legacy WES/BES platform by mid-2020; and
- we assume higher growth for LA services compared to their non-LA equivalents, consistent with historical trends.

A18.38 In each case, we change the growth rates of both the adjusted services and the remaining services within a category such that the total volume growth of each broad service category remains in line with Openreach's original forecast.

Main links forecast

A18.39 Openreach's forecasts do not include forecasts for main link services. We have set the growth rate for these services at the same rate as the services which use them. We have based this on a mapping of such services provided by Openreach. We consider this is a reasonable predictor for the growth of main link services because they are always purchased alongside other services and the average main link length per circuit appears to have remained relatively constant over the past five years.

Impact of the PIA remedy

A18.40 In the 2018 WLA we relaxed usage restrictions on BT's PIA product to allow 'mixed usage'. Our relaxation of the usage restrictions allowed telecoms providers to use BT's ducts and poles (through the PIA remedy) to deploy local access networks offering both broadband and non-broadband services, provided the primary purpose of the network deployment is the delivery of broadband services. Furthermore, in Volume 1 we set out our decision to give unrestricted access to Openreach's network of underground ducts and poles.

A18.41 Unrestricted access will allow telecoms providers to use PIA to provide business connectivity in more circumstances than with the current mixed usage arrangements. Additional use of PIA products may increase competitive pressure on some of Openreach's wholesale active products. Consequently, Openreach may see a reduction in its future volumes of leased lines services.

A18.42 We consider that only new external connections, as opposed to existing circuits, would use PIA. This is because existing circuits are likely to be subject to contractual obligations in the short-term and there are also likely to be other costs associated with any active circuit migration. Costs could be both financial (e.g. the cost of blowing fibre), and non-financial (e.g. end customers would likely face service downtime when switching to the new service).

A18.43 We consider that if a telecoms provider did try to migrate an existing customer, the disruption caused may result in the customer switching provider. Even if an existing customer was prepared to accept the migration of an existing service, we would expect it to try and obtain a large price reduction. This would limit telecoms providers' incentives to seek to migrate existing active services to services deployed using PIA. Therefore, we have assumed that telecoms providers will use PIA in this review period for new leased lines, rather than to replace existing lines.

A18.44 We have considered a range for the volumes of new circuits that could be cannibalised in 2019/20 and 2020/21. At the lower bound of our range, no Openreach new connections would be lost to other telecoms providers in either year. At the higher bound of our range, 45% to 50% of Openreach's new external 100 Mbit/s and 1 Gbit/s EAD LA connections would be cannibalised by PIA and almost all of its external 10 Gbit/s EAD LA connections. This reflects our expectation that it will be more economically viable to use PIA over shorter distances and for higher-bandwidth circuits. Overall, we expect that this high scenario will amount to c.12,000 connections each year.[753] We consider this gives a wide enough range to capture all reasonable possible volume losses.

A18.45 We note that PIA will also be available for inter-exchange connectivity. However, as discussed in Annex 11, we do not expect use of PIA for inter-exchange connectivity at material scale over this review period.

Bandwidth-level rentals forecasts

A18.46 Having made the above adjustments to Openreach's service-level volume forecasts, we have constructed two scenarios to represent our upper and lower-bound service volume forecasts. In producing these scenarios, we have captured two key factors that we believe have the most material impact on the growth of service volumes in the basket of active services at 1 Gbit/s or lower:

- exogenous volumes growth, i.e. if more or fewer customers are buying leased lines overall; and

[753] As explained in Annex 6, actual expected take up over the 2 years is expected to be [✂] so the high scenario is an extreme case to identify the maximum possible impact.

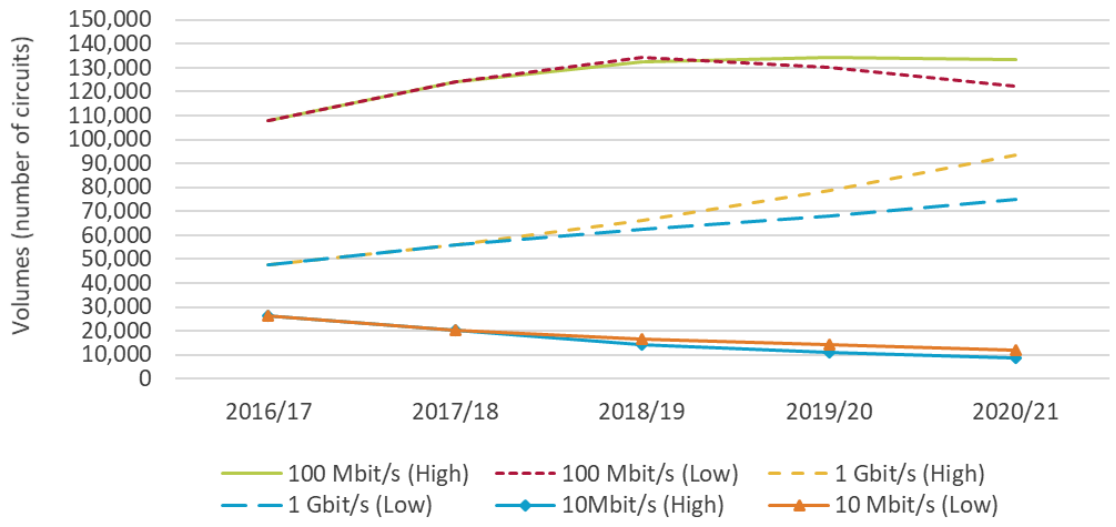
- changes in the average bandwidth demanded, i.e. if customers tended to purchase higher- or lower-bandwidth services when purchasing a leased line.

A18.47 Greater exogenous volumes growth would tend to decrease unit costs as fixed and common costs are spread over a wider base. This would then produce a larger (absolute) value of X from our modelling as prices would need to fall faster to be in line with costs at the end of the period. The reverse is true for lower exogenous volumes growth.

A18.48 If the average bandwidth demanded rises, with customers purchasing more 1 Gbit/s services and fewer 10 Mbit/s and 100 Mbit/s services, total costs would increase as higher-bandwidth services tend to cost more. However, volumes also affect revenue forecasts, and the ultimate effect on the value of X depends on the balance between the cost and revenue effects. As higher bandwidth services also tend to have higher returns, total revenue would rise faster than total costs if average bandwidth demanded rises. This would then produce a larger value of X. The reverse would be true if average bandwidth demanded were to fall.

A18.49 We have produced our 'high case' forecast by assuming that there is both some greater generalised demand for leased lines and some increase in the average bandwidth demanded. Both of these factors lead to larger (absolute) values of X and so work in combination to create an upper bound for values of X as a result of volumes changes. Similarly, our 'low case' combines lower generalised demand for leased lines with a decrease in average bandwidth demanded to generate a lower bound. These forecasts are shown in Figure A18.3 below.

Figure A18.3: Ofcom's high and low volume forecasts, by bandwidth for the 1 Gbit/s and below ethernet basket in charge controlled-areas



Source: Actual and Forecast rental volumes for the ethernet basket from the Ofcom volume forecast model

A18.50 Overall, we forecast the bulk of circuits to remain as 100 Mbit/s and 1 Gbit/s over the review period, with the former experiencing lower growth from a higher starting volume and the latter experiencing higher growth from a lower starting volume. We forecast strong growth in circuits above 1 Gbit/s[754], though as the starting volume of these circuits is much lower in the base year, they will remain a minority of circuits over the forecast period. In our low-case scenario, circuits up to 100 Mbit/s are forecast to be higher than in our high-volumes scenario because the effect of there being greater demand for lower bandwidth services dominates the generalised lower demand for leased lines.

A18.51 We have also checked these forecasts against forecasts provided by other telecoms providers for their own use of leased lines. We are satisfied that our forecasts sit within the range of these forecasts, though they are towards the lower end. We consider this is reasonable as, being the largest provider of leased lines, we would expect lower growth rates for Openreach than we might see for a smaller telecoms provider due to the maturity of its market position.

Efficiency

A18.52 As part of our cost forecasting, we take a view on the cost savings (efficiency) we expect BT to achieve over the review period. In the Consultation, we considered several sources of evidence and used our judgement to produce an appropriate set of efficiency rate assumptions.

A18.53 Having considered all the evidence in the round, we use a range of 4% to 7% per annum for our operating cost efficiency target, and our analysis indicates that BT can achieve the higher end of this range. For the capital cost efficiency target, we use a range of 3% to 6% per annum. These are the same ranges as the ones we used in the Consultation.

A18.54 We consider that the evidence and analysis we used to support our assumptions in the Consultation continue to provide an appropriate basis to inform our modelling, since it is unlikely that there is significant new information available which would materially affect the efficiency ranges. We use several sources of evidence to inform our efficiency assumptions, including historical data and forecast data sources. Our chosen efficiency assumptions reflect the different weights we give to each source of evidence that we have reviewed, as explained in more detail below.

A18.55 We did not consider that a full update of the efficiency analysis was proportionate given the cross-check nature of our CI model.

Operating costs

A18.56 Consistent with the methodology described in the 2016 BCMR Statement and 2018 WLA Statement, to arrive at our operating cost efficiency targets we have:

- Analysed changes in component costs via sets of ‘pairwise’ comparisons over the historic period 2013/14 to 2017/18 using BT regulatory accounting information from

[754] Not shown in Figure A18.3 (which only includes forecasts of service volumes within the 1 Gbit/s and below basket) but our forecasts cover all bandwidths, to ensure a consistent set of forecasts for each service.

Openreach.[755] Consistent with how we have modelled costs, cumulo and Service Level Guarantee (SLG) costs have been removed from this analysis.

- Analysed both historical and forecast BT divisional management accounting information for the relevant BT divisions[756] over the historic period 2013/14 to 2017/18 and forecast period up to 2020/21.[757] Consistent with how we have modelled costs, cumulo and SLG costs have been removed from this analysis.
- Reviewed information originating from outside BT. This included various benchmarking studies undertaken for BT[758] together with various telecoms specific and economy wide studies.[759]
- Reviewed other public information about BT's cost performance such as public statements made by BT.

A18.57 We continue to consider that our regulatory cost analysis provides an important source of evidence[760] and attach a relatively high weight to it in forming our efficiency assumptions. This analysis is consistent with the way we model costs and covers the same services. We estimate the average annual cost saving achieved between 2012/13 and 2016/17 was a compound annual growth rate (CAGR) of 7.2%.

A18.58 We consider our analysis of Openreach and BT Technology's historical and forecast internal management accounting data should also provide relevant and reliable evidence for forming our efficiency assumptions for this review period. This analysis provides a view of both the relevant divisions recent efficiency achievements and its forecast internal efficiency and cost transformation targets out to 2020/21. This analysis suggested CAGR efficiency of 5.7% p.a. has been achieved historically for our relevant services and forecast CAGR efficiencies of 5.1% p.a. are expected. When adjusted to look over a consistent time period, the results are similar to those from our regulatory cost analysis and again we attach a relatively high weight to this analysis in forming our efficiency assumptions.

A18.59 In recent charge controls we have taken the view that benchmarking data and other external studies can provide a potentially informative source of evidence. However, we have had concerns about all the studies we considered. These generally related to consistency with our modelling approach, notably the treatment of changes in volumes, and consistency with the range of costs to which we apply our efficiency estimates. We continue to have these concerns and so currently give these studies no weight in our analysis.

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[755] Openreach response dated 9 May 2018 to question 2 of the 3rd s.135 notice.
[756] The relevant BT divisions for this charge control are Openreach and BT Technology.
[757] Openreach response dated 9 May 2018 to section 2 of the 3rd LLCC s.135 notice; Openreach response dated 2 July 2018 to section 3 of the 7th LLCC s.135 notice; Openreach response dated 23 May 2018 to question 14 of the 3rd LLCC s.135 notice. The methodology for this analysis is the same as described in the 2018 WLA Statement, paragraphs A17.48-A17.78.
[758] Two separate benchmarking studies were provided by Openreach both related to very niche parts of the BT business and the costs from which made up a very small portion of our base data cost pool. Openreach response dated 9 May 2018 to question 15 of the 3rd LLCC s.135 notice.
[759] ONS, April 2017. *Multi-factor productivity estimates: Experimental estimates to 2015*; IMF 2016, Country Report No. 16/58, United Kingdom: Selected Issues. https://www.imf.org/external/pubs/ft/scr/2016/cr1658.pdf; OBR, Economic and fiscal outlook supplementary economy tables – November 2017, Table 1.6. http://budgetresponsibility.org.uk/efo/economic-fiscal-outlook-november-2017/ [accessed 31 January 2018].
[760] 2018 WLA Statement, paragraph A19.119.

A18.60 Our review of public statements by BT confirmed that it has reduced costs through its cost transformation programmes and it believes there are still significant opportunities to do so going forward, at a similar rate to those achieved in the past. Identified cost transformation initiatives include activities that span the relevant services. These statements provide qualitative evidence that cost savings will continue to materialise in relation to the relevant services. This gives us more confidence in using evidence from historical data for BT as an indication of what rates may be achievable in the future.

A18.61 Having considered all the evidence, we use a range of 4% to 7% per annum for our operating cost efficiency target within the CI model and our analysis indicates that BT can achieve the higher end of this range. We have sought to identify a challenging but achievable target, which while not easy to meet, is nevertheless capable of being exceeded.

Capital costs

A18.62 We have assessed efficiency on capital expenditure separately from that on operating costs. Consistent with the methodologies described in the 2018 WLA Statement, for each different capital cost category for both Openreach and TSO, we have calculated historical cost saving rates and then combined these together based on the relevant weights for our relevant services. The distinct categories we have considered are:

- Capitalised pay [✂]% (30% to 40%) in 2016/17[761] – the capitalisation of pay costs for BT employees.[762]
- Civil engineering [✂]% (0% to 10%) in 2016/17[763] – costs for work undertaken by external third parties to complete civil engineering activity.[764]
- Contract equipment, Stores and other [✂]% (50% to 60%) in 2016/17[765] – we understand that these cost categories contain the electronics equipment along with other costs which cannot be mapped onto one of the previous categories.

A18.63 Our analysis of these categories suggests historical annual average cost savings of 3% to 6% between 2014/15 and 2016/17 with a CAGR in the middle of this range. Our cost savings estimates for different types of capital expenditure are weighted to reflect both the mix of capital expenditure for the relevant services and the relative contribution of each Relevant Division to capital expenditure on the relevant services.

Asset volume elasticities (AVEs) and cost volume elasticities (CVEs)

Overall approach to calculating AVEs/CVEs

A18.64 We would expect changes in the volume of a service provided to impact the costs associated with providing that service. However, where fixed or common costs are

[761] Openreach response dated 3 August 2018 to question 1 of the 8th s.135 notice.
[762] The methodology for this analysis is the same as described in the 2018 WLA Statement, paragraphs A19.149-A19.152.
[763] Openreach response dated 3 August 2018 to question 1 of the 8th s.135 notice.
[764] The methodology for this analysis is the same as described in the 2018 WLA statement, paragraphs A19.153-A19.156.
[765] Openreach response dated 3 August 2018 to question 1 of the 8th s.135 notice.

incurred, costs may not change by the same proportion as volumes. Therefore, when we forecast costs, we need to appropriately reflect the underlying relationship between forecast changes in service volumes and changes in the number of assets and costs of providing those services.

A18.65 We convert forecast changes in service volumes to changes in network component volumes using usage factors. The impact the change in these forecast network component volumes have on forecast costs (before considering the impact of inflation or cost savings) is determined by AVEs and CVEs.

A18.66 In the Consultation, we adopted the same methodology to calculate AVEs and CVEs as in the 2016 BCMR Statement and 2018 WLA Statement.[766] We use the same approach for this statement.[767]

A18.67 As discussed above, we have updated the base data from the 2016/17 RFS to the 2017/18 RFS. One of the impacts of updating the base year data is that there is now a different set of network components.[768] As explained below, we calculate AVEs and CVEs at a network component level and so we have updated our modelling since the Consultation to ensure there is a consistent set of AVEs and CVEs for this new component set. We have used LRIC to FAC ratios as a proxy for AVEs and CVEs based on BT's LRIC model outputs.

A18.68 Given we forecast pay and non-pay operating costs separately in the model, we need to estimate separate CVEs for pay and non-pay operating costs. We therefore apply separate pay and non-pay CVEs for each component we are forecasting.[769] This is consistent with the approach we adopted in the 2014 FAMR, 2016 BCMR and 2018 WLA.

A18.69 AVEs can be calculated in the same manner as CVEs (i.e. separately for each component). We calculate AVEs using the same approach that we adopted in the 2016 BCMR and 2018 WLA by weighting together LRIC to FAC ratios for each cost category within each super-component by the gross replacement costs (GRCs) of that cost category.[770] We have excluded cumulo costs and SLG payments when calculating non-pay CVEs as these are forecast separately to other non-pay costs in the CI model.

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[766] See Annex 18 of the 2018 WLA Statement.

[767] Stakeholders did not comment on the overall approach to AVEs/CVEs. Openreach had one comment with respect to our assumption on the AVE for the EAD Fibre component, which we discuss later in this section.

[768] It is often the case that new network components are required to be introduced or existing network components revoked, as directed by Ofcom within the reporting statements.

[769] Or to be more precise super-component specific; BT's LRIC model does not contain information on individual components, but rather for super-components which may be an amalgamation of several individual components. Therefore, references below to component information in relation to BT's LRIC model should strictly be taken as referring to super-components, rather than components.

[770] BT defines a 'cost category' within its LRIC model as a "Grouping of costs into unique cost labels by identical cost driver for use in the LRIC model." See page 33 of BT, 2016, *Long Run Incremental Cost Model: Relationships & Parameters*. https://www.btplc.com/Thegroup/RegulatoryandPublicaffairs/Financialstatements/2016/LRICModelRelationshipsandParameters2015-16.pdf.

Cross checks and adjustments

A18.70 We generally expect that the relationship between component volumes and costs is, as a maximum, equi-proportionate (i.e. a 10% increase in volume for a component leads to a maximum increase of 10% in cost for that component). We also expect that the relationship is, as a minimum, zero (i.e. an increase in volumes for a component should not lead to a decrease in total cost for that component). We have therefore checked that all the estimated CVEs and AVEs are between zero and one. In previous charge controls we had identified some ratios that lay slightly outside this range. However, our checks on the ratios using 2017/18 data identified no exceptions.

Adjustment to non-pay CVE for Openreach Admin Fee component

A18.71 As in the 2018 WLA Statement, we set the non-pay CVE for the component Openreach Admin Fee (CO801) to one. This is because the Openreach Admin Fee costs are attributed to service revenues[771] and so we would expect that, in the long run, changes to these costs (after removing inflation) are likely to be closely correlated to changes in revenues and hence, to changes in service volumes.

Adjustment to AVE for Access Fibre cost category

A18.72 We make an adjustment to the AVE for access fibre similar to, and for the same reasons as, the one we made in the 2016 BCMR Statement.[772] Access fibre costs are used by a number of Ethernet components and are an important element of the Ethernet basket cost stack. Using BT's LRIC model outputs and our standard methodology, the estimated AVE for access fibre costs used by the EAD Fibre component is very low ([✂]), representing very little volume elasticity of costs.

A18.73 We consider that our standard approach of using BT's LRIC model outputs is likely to understate the AVE in this case, as we consider that the decremental approach used in BT's LRIC model approach is not suitable for estimating the access fibre elasticity. We consider costs are likely to respond differently to volume increases than to volume decreases; while volume increases would be likely to require an increase in the footprint of the network, volume decreases would be unlikely to result in assets being removed. Instead, we would expect less intensive use of existing assets.

A18.74 In the Consultation we used an AVE for access fibre of between 0.6 and 0.8. This range referred to our estimate of the adjusted AVE for access fibre costs used by the EAD Fibre component and not to the overall AVE for the EAD Fibre component (which is a weighted average across all cost categories it uses including access fibre). We presented a range for confidentiality reasons. Using our point estimate of [✂] for the AVE of access fibre costs used by the EAD Fibre component resulted in an estimate of the overall AVE for the EAD

[771] See the description of the base LICENCEFEE in BT's 2017 AMD, page 47.
[772] See paragraphs A32.119-A32.136 of the 2016 BCMR Statement.

Fibre component of [✂]. We used this value across all our scenarios for cost modelling for active services.[773]

A18.75 We have updated our estimate of the AVE of access fibre costs used by the EAD Fibre component for the statement, since we have had to update all the AVEs and CVEs (as explained above) using 2017/18 data.[774] We have also adjusted the historical GRC of these access fibre costs, which is an input to our estimate of the AVE of these costs, to reflect our revised approach to fibre asset indexation as set out in Annex 19. Our adjustment results in a revised AVE of [✂] (0.4 to 0.6) for access fibre costs used by the EAD Fibre component and overall AVE for the EAD Fibre component of [✂] (0.4 to 0.6).

Dynamic AVEs/CVEs

A18.76 If the same set of component AVEs and CVEs are used to forecast the impact of changes in volumes on costs in each year of the charge control period (i.e. 'static' AVEs and CVEs), then this assumes that fixed and common costs are a constant proportion of total costs throughout the review period. Forecast changes in volumes would therefore result in forecast changes in the level of fixed and common costs. This may be a reasonable simplifying assumption if volume growth is likely to be low over the charge control period.

A18.77 However, as volumes are forecast to change quite significantly, then this approach will assume significant change in costs that should be fixed. To ensure that this does not occur, we have implemented 'dynamic' AVEs and CVEs which allow our elasticity assumptions to vary year-on-year and maintain a fixed level of fixed and common costs across all years. This is the same approach taken in the 2016 LLCC model. In the presence of rising volumes, our AVEs/CVEs will grow over time, representing the smaller proportion of total costs that fixed and common costs represent over time. The reverse is true when volumes are falling.

Input price inflation

A18.78 In our model, costs in each year are adjusted using our estimates of the impact of inflation, changes in volumes and cost savings (efficiency). In this subsection, we describe the inflation assumptions we have used for the different cost items. We consider pay operating cost inflation, non-pay operating cost inflation, and asset price inflation separately.

A18.79 Our approach to forecasting inflation is consistent with that adopted in both the 2016 BCMR Statement and the 2018 WLA Statement. In summary:

- **Pay operating cost inflation.** We have considered a range of evidence when setting our pay cost inflation assumptions, including historical and forecast BT data and external pay cost indices. We adopt a pay cost inflation rate within our forecasts of 2.8% per annum across the forecast period.

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[773] Openreach stated in paragraph 95 of its response to the 2018 BCMR Consultation (LLCC) that we had incorrectly left the higher AVE for the EAD Fibre component out in our modelling for the high costs scenario (and instead used the same AVE as in the low costs scenario). As explained in the main text, the range of 0.6 to 0.8 referred to our estimate of the adjusted AVE for access fibre costs used by the EAD Fibre component and not to the overall AVE for the EAD Fibre component. Further, this range was presented for confidentiality reasons rather than to reflect high or low scenarios. We therefore disagree with Openreach that a different AVE should be used in the high costs scenario.

[774] Openreach response dated 5 December 2018 to question 24 of the 11th LLCC s135 notice.

- **Non-pay operating cost inflation.** To estimate non-pay cost inflation assumptions that reflect the cost mix for the services in the top-down model, we have weighted separate inflation estimates for energy, accommodation and all other non-pay costs. We adopt a non-pay cost inflation rate within our forecasts of 2.1% per annum across the forecast period.
- **Asset price inflation.** We adopt asset price change assumptions that ensure duct and copper assets are valued consistently with how they are revalued for current cost accounting (CCA) purposes in BT's RFS (i.e. an indexed historical methodology using the Retail Price Index (RPI)). The geometric mean of the OBR's RPI forecast between 2017/18 and the final year of the review period, 2020/21, is 3.3% per annum. We assume that all other asset prices, including those for fibre assets, stay constant in nominal terms. We explain our rationale for the indexation of fibre assets in Annex 19.

A18.80 These assumptions are the same as the ones we used in the Consultation.[775] These inflation inputs would have to change significantly, beyond reasonable expectations, to have a material impact on the estimates of cost over and under-recovery from our CI model. Therefore, we do not consider it would be proportionate to update these inputs for the statement.

WACC

A18.81 The CI model requires an estimate of the appropriate forward-looking weighted average cost of capital (WACC) for active leased lines services. The WACC is also an important input to our estimates of inter-exchange dark fibre prices and we have received extensive comments from BT Group and TalkTalk on our WACC assumptions.

A18.82 We have updated our WACC analysis from the Consultation. We estimate a pre-tax nominal WACC of 8.0% for active leased lines services (unchanged from the Consultation). We therefore remain of the view that a range of 7% to 9% is still appropriate for the purposes of the CI model.[776] We explain our estimation of the WACC, along with our responses to stakeholder comments, in Annex 21.

Costs forecast separately

Cumulo

A18.83 Cumulo rates are the non-domestic rates BT pays on its rateable assets (primarily passive assets such as duct, fibre, copper and exchange buildings) in the UK. It is called a 'cumulo'

[775] Stakeholders did not comment on our inflation assumptions.

[776] When creating scenarios as part of setting a cost-based charge control we would normally use low and high sensitivities of around ± one percentage point around our central estimate of the WACC.

assessment because all the rateable assets are valued together. They are usually calculated by multiplying a Rateable Value (RV) for the property by a 'rate in pound'.[777]

A18.84 RVs are specific to each property and are assessed by the relevant rating authority in each nation, for example, the Valuation Office Agency (VOA) in England and Wales. They are reassessed every few years, with the latest reassessment in England, Wales and Scotland in 2017, and in Northern Ireland in 2015. The next reviews will take place in 2020 in Northern Ireland, 2021 in England and Wales, and 2022 in Scotland.[778]

A18.85 Within the CI model we include recovery of an appropriate share of BT's forward looking cumulo costs. From 1 April 2017 the rating authorities reassessed BT's cumulo RVs at a significantly higher level. These RVs will remain in place until the end of the review period, except in Northern Ireland, and will increase BT's cumulo costs significantly starting from 2017/18 and the next few years. Our standard approach to modelling operating costs would not capture these large increases and so we have forecast them separately.

A18.86 In the Consultation we proposed to adopt the same two step approach to forecasting these costs as in the 2018 WLA Statement. We forecast BT's total cumulo costs and then we attributed these across all BT's services.[779] As discussed below, the only change we made in the CI model compared to the approach used for modelling in the 2018 WLA Statement has been how we treat net replacement costs (NRCs) when attributing cumulo costs to TI and Ethernet services. We describe this change below.

A18.87 We have corrected an error in how we had used our cumulo forecasts within the CI model[780] and also updated the attribution of our forecast cumulo costs across components.[781] Otherwise, we follow the same approach and use the same forecasts of cumulo costs as in the Consultation. We are not aware of any changes in rating policy, practice, or law that would trigger a change in our assumptions. There have been no changes to the published rateable values for BT's cumulo rating list entries in England, Scotland and Wales or Northern Ireland since the Consultation.

[777] Rates in the pound are set centrally by each nation and are the same for all ratepayers in a nation. By rate in the pound (sometimes also called the rate poundage) we mean the standard non-domestic rating multiplier. For an introduction to how rates liabilities are calculated see https://www.gov.uk/introduction-to-business-rates [accessed 20 February 2018]. Northern Ireland is different in that the rate poundage in each of the 11 districts is made up of two separate rates: a regional rate poundage that is the same in each district and a district rate poundage that is different for each district.

[778] Openreach response dated 10 September 2018 to question 13 of the 10th LLCC s.135 notice.

[779] See Annex 21 of the 2018 WLA Statement.

[780] In paragraph 95 of its response to the 2018 BMCR Consultation (LLCC), Openreach pointed out that we had used the 2016/17 cumulo costs in all years in the model instead of the cumulo costs which we had forecast over the charge control period. We have corrected the model so that it now correctly uses the forecast cumulo costs.

[781] Consistent with our rational for updating AVEs/CVEs the new set of network components has required us to update the cumulo attribution model.

Forecasts of BT's cumulo rates costs

A18.88 As in the 2018 WLA Statement, we have forecast BT's cumulo rates costs by taking BT's latest published RVs, estimating the impact of two material changes in circumstances[782] (for MPF growth and VULA rollout), applying assumptions about rates in the pound, and estimating the impact of the English transition scheme.[783]

A18.89 As a result of the 2017 revaluation in England, Wales and Scotland the RVs increased from £201m as at 31 March 2017 to £602m from 1 April 2017.[784]

A18.90 For the Consultation, BT told us that the material changes in circumstance (MCC) regime had not yet been agreed with the rating authorities.[785] BT's RVs have not changed since those we reported in the 2018 WLA Statement. We have forecast BT's RVs over the charge control period using the same assumptions as we used in the 2018 WLA Statement. We have assumed that BT's future RVs will not be reduced because of the UK Government's recent legislation that grants 100% business rate relief on new full-fibre infrastructure for a 5-year period from 1 April 2017. Overall, we forecast that BT's cumulo RV will increase by c.£70m by the end of 2020/21.

A18.91 We have used the rates in the pound published for 2017/18 and 2018/19 and have forecast them forward as we did in the 2018 WLA Statement by indexing by CPI, consistent with recent government announcements in England, Scotland and Wales. The resulting forecast rates in the pound are again very similar to those we presented in Table A21.4 of the WLA Statement.

A18.92 We have again estimated the effect of the English transition scheme. The scheme is complex, but essentially limits increases on a ratepayer's bill, measured using the final RV in England in the previous rating list. Our calculations suggest that the large increase to BT's English RV means that BT's cumulo rate payments in England will be subject to these transition rules until 2019/20, but not in 2020/21.

A18.93 Overall, we have forecast BT's cumulo costs almost to quadruple from around £96m in 2016/17 to around £349m in 2020/21, in a profile that is very similar to the forecasts in the 2018 WLA Statement.

Attributions of BT's cumulo costs

A18.94 Our approach to the attribution of BT's cumulo costs is the same as that in the 2018 WLA Statement. We consider that this approach is reasonable and note that the core methodological approach of profit weighted net replacement costs (PWNRC) was defended

[782] Once assessed and, absent any appeals, RVs generally stay constant unless there have been 'material changes in circumstance' (MCC). Historically BT's RVs have changed fairly regularly as a result of MCCs.
[783] *Rating and Valuation, England The Non-Domestic Rating (Chargeable Amounts) (England) Regulations 2016 SI No. 1265*, Part 2, http://www.legislation.gov.uk/uksi/2016/1265/pdfs/uksi_20161265_en.pdf.
[784] See Table A21.1 in the 2018 WLA Statement.
[785] Openreach response dated 10 September 2018 to question 13 of the 10th LLCC s.135 notice.

successfully at appeal to the Competition Commission in 2012/13.[786] The only change we have made in this control is to include forecasts for NRCs of rateable assets for leased line services (both Ethernet and TI).

A18.95 Our attribution method has three steps:

a) Attribute cumulo costs between GEA and non-GEA services in proportion to their shares of the cumulo RV. The GEA Services' RV is calculated assuming each FTTC connection has an RV of £18 and every other GEA connection an RV of £20. The non-GEA services RV is what remains.

b) Attribute the cumulo costs apportioned to GEA services across relevant GEA components using the PWNRC methodology.

c) Attribute the cumulo costs apportioned to non-GEA services across relevant non-GEA components using the PWNRC methodology.

A18.96 In implementing this methodology, we have started from BT's 2017/18 cumulo attribution model, rather than the 2016/17 cumulo attribution model we used in the Consultation.

A18.97 We have modified the approach used in the 2018 WLA Statement when generating NRCs for the rateable assets for some components. We do this to better forecast the split between TI and Ethernet services, which we had held constant as a simplifying assumption in the 2018 WLA.

A18.98 For Ethernet services we have used the forecast growth in component NRCs from the CI model in the same way we used forecast growth in component NRCs from the 2018 WLA charge control model to drive attributions to non-GEA WLA services. For TI services we have assumed component NRCs reduce at a rate consistent with the average reduction in these NRCs over the last four years.

A18.99 Lastly, we have identified some components that are shared to a significant extent between different markets; notably Sales and Product Management, Ofcom Licence Fee and Openreach Project Services. We have forecast NRCs for these components by weighting the forecast NRC growth rate for each component across the markets that it is shared between. We have then attributed a proportion of the forecast cumulo for each of these components to Ethernet services, based on the split of the component's NRC between Ethernet and other services.

[786] Competition Commission, 2013, *British Telecommunications Plc v Office of Communications Case 1193/3/3/12 British Sky Broadcasting Limited and TalkTalk Telecom Group Plc v Office of Communications Case 1192/3/3/12 Determinations,* paragraphs 11.97-11.98, and 11.112. https://www.catribunal.org.uk/sites/default/files/1192-93_BSkyB_CC_Determination_270313.pdf. Under the PWNRC methodology BT's cumulo costs are attributed across the rateable assets in proportion to the share of the net replacement costs (NRC) of the asset multiplied by the return for that asset (the profit weight).

Service Level Guarantee (SLG) costs

A18.100 We have removed SLG costs from the 2017/18 base data and then added our forecasts of SLG costs back into our total operating cost for each year in the model. Our treatment of SLG costs is similar to our treatment of BT's cumulo costs, except that SLG costs also form part of the costs for dark fibre services. The modelling approach we have used in relation to SLG costs is the same as in the Consultation.[787]

A18.101 We have adopted the following approach to calculating SLGs:

a) As discussed in Annex 19, we note that the SLG payments in both 2016/17 and the early parts of 2017/18 are atypical. This was largely due to Openreach working to clear the tail of older provision orders which tended to be more complex and had higher SLG payments.[788] Due to this, we have not relied on 2017/18 RFS data and instead have estimated a steady-state level of SLGs costs in 2018/19 from recent payment levels and used this estimate as the base from which we forecast payments in the future.[789]

b) We then forecast this base cost using:

i) Our forecast growth rate for connections volumes – we would expect more connections overall to lead to more connections that incur an SLG payment;

ii) An assumption of rental price changes, as SLG payments are a function of monthly rental prices[790]; and

iii) The expected impact from the year two change in the Certainty QoS standard – as with higher Certainty QoS standards, we would expect fewer connections to incur an SLG payment and so lower total SLG payments to be made. We consider that the QoS standards imposed for the charge control period are achievable.

Revenue forecasting

A18.102 We need to forecast revenues in each year until the end of the review period. These forecasts are based on two inputs: the charges for each service that we expect to be in place during the period; and the volumes of each service.

A18.103 In forecasting revenues, we project revenues to the final year of the review period (2020/21) by applying our volume forecasts for each year of the period to the prices at the beginning of the period (i.e. by assuming prices would remain constant over the period in

[787] As discussed in Annex 19, the base case SLG costs have been updated, but our method for forecasting our base year SLG costs has remained the same. Stakeholders did not comment on our approach to SLG costs.
[788] Openreach response dated 3 July 2018 to question 14 of 7th LLCC s.135 notice.
[789] Openreach response dated 17 September 2018 to question 17 of 7th LLCC s.135 notice, Openreach response dated 12 December 2018 to question 19 of 11th LLCC s.135 notice and Openreach response dated 6th March 2019 to question 8 of 12th LLCC s.135 notice.
[790] We note that this introduces an endogenous element to our calculations, as forecast rental prices are an output of the model. We ran the model to get an initial output (assuming no rental price change for the SLG forecast) and then used this output to inform the input assumption of rental prices for SLG forecasts in final runs of the model.

nominal terms). We then compare the projected revenues and costs in the final year of the period to work out the value of X.

A18.104 We have explained how we have produced our volume forecasts above. Our approach to forecasting service level prices is described below.

Prices

A18.105 We have calculated start prices by calculating a weighted average price for each service using price information for the 6 months from 1 April 2018 to 30 September 2018 and 6 months from 1 October 2018 to 31 March 2019.[791] We then make an adjustment to account for the EAD 100 Mbit/s connection special offer that was run from 1 April 2018 to 30 September 2018, and a final adjustment to prices of services included in the current ethernet basket to ensure that the total revenue for 2018/19 satisfies compliance with our current charge control.

A18.106 For the Consultation, we did not have sufficient time to robustly take account of the price changes that occurred on 1 October 2018. As start prices used within our model should reflect the full prior year weighted average charges (see Section 2 of Volume 3), we thought it was appropriate to update the start prices we used in the Consultation to reflect our latest estimates of average prices for financial year 2018/19.[792]

A18.107 In the 2016 BCMR we allowed BT to include certain types of discounts to reach compliance.[793] We therefore need to account for the level of discounts offered on each service when calculating our starting prices. We are aware that this information will not be reflected in the data we received from Openreach, as this data relates to the prices listed in Openreach's official price list which does not include the net effect of any relevant discounts.

A18.108 Eligible discounts are factored into Openreach's compliance for the temporary conditions ethernet basket. We have therefore captured the impact of discounts on starting prices (other than for the 100 Mbit/s connection offer) within the adjustment we make to ensure basket compliance. We note that our approach to pick up discounts through the compliance adjustment will not pick up specific services that were discounted, but rather apply a flat rate across all services to meet the compliance. However, we do not consider this would have a material impact and so consider it to be an acceptable modelling simplification.[794]

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[791] Openreach response dated 19 March 2019 to question 1 of the 12th LLCC s.135 notice.

[792] Openreach commented in paragraph 95 of its response to the 2018 BCMR Consultation (LLCC) that our approach for calculating start prices in the Consultation materially overstated prices as we did not reflect the actual published prices. We agree and have updated to include these prices in the Statement.

[793] Annex 9, paragraph 9.35. https://www.ofcom.org.uk/__data/assets/pdf_file/0025/81934/business_connectivity_market_review_draft_statement_volume_two.pdf.

[794] From investigations made since the Consultation, we do not believe discounts made in prior years would be a reliable estimation for future discounts so have not used the comparison to RFS approach used at the time of the Consultation.

Outputs of the model

A18.109 First, our analysis shows that we expect prices to be broadly aligned to cost by the end of the current review period. Table A18.4 below shows that returns in this market have declined significantly (broadly consistent with the trajectory forecast in the 2016 LLCC) and we are not expecting a material gap between returns and the cost of capital by the end of the current review period. The forecast ROCE for the final year of the current control is below the WACC of 9.8% assumed in the 2016 BCMR Statement and within our estimated WACC range of 7 to 9% for the end of this review period.

Table A18.4: Outturn and forecast revenues, costs and ROCE, 2016/17 to 2018/19

Parameter	2016/17	2017/18	2018/19
Revenue	£587.3m	£560.6m	£511.5m
Total CCA operating costs	£401.0m	£380.1m	£386.7m
Return	£186.3m	£180.5m	£124.8m
MCE	£1,511.0m	£1,453.2m	£1,550.1m
ROCE	12.3%	12.4%	8.0%

Note: This table shows the outputs of our model in 2018/19 real terms based on the geographic and product definitions for the CI Ethernet and WDM services up to and including 1 Gbit/s in charge-controlled areas and include the adjustments we have made to the base year costs.[795] This is a different basis of preparation to the definitions on which BT's 2016/17 and 2017/18 RFS have been prepared.

A18.110 Our modelling allows us to assess the potential implications of our CPI-CPI control for active services at 1 Gbit/s and below on BT's cost-recovery. The assumptions we have made in each of these scenarios are provided in Table A18.5 below. If we consider a reasonably wide range for key input parameters, then our modelling suggests that the value of 'X' could in the range of between -6.75% and +0.75%. For comparison, the near-term forecast from the OBR is of CPI between 1.9% and 2.0%.[796]

[795] The numbers will not match the tables within Annex 19 as the base year adjustment annex does not take account for our geographic adjustments.

[796] OBR, *Economic and Fiscal Outlook March 2019,* Table 3.10. https://obr.uk/efo/economic-fiscal-outlook-march-2019/ [accessed 25 April 2019].

Table A18.5: Low and high-cost scenario parameters assumed

Parameter	Low-cost scenario	High-cost scenario
Volumes	Higher exogenous growth Greater demand for higher bandwidth services Low impact of PIA	Lower exogenous growth Greater demand for lower-bandwidth services High impact of PIA
Efficiency	Opex: 7.0% Capex: 6.0%	Opex: 4.0% Capex: 3.0%
WACC	7.0%	9.0%
Impact of dark fibre	No impact modelled	No impact modelled
Resulting value of '-X' for the CPI-X formula	**-6.75%**	**+0.75%**

A18.111 We have calculated this range without modelling any migration from active circuits to the inter-exchange dark fibre remedy. As the dark fibre remedy only covers inter-exchange circuits from certain BT Only exchanges, it is likely to affect only a small proportion of total Openreach circuits even if take-up is high in those areas. As such, we would expect any impact on the value of X to be small and not to change any of the conclusions we have drawn from this modelling.

A18.112 Were we setting a cost-based CPI-X control, we would usually expect values of X closer to the middle of the range to be more likely than those close to the limits of the range. This is because the limits of the range are produced by applying the effects of multiple changes in input assumptions which all work in tandem to produce a more extreme result.

A18.113 Therefore, we expect that, compared to a cost-based CPI-X control, a flat nominal CPI-CPI cap is most likely to lead to some over-recovery to BT (of around £15 to £25m), with over-recovery of up to £80m. Under-recovery of up to £40m is also plausible, but we consider it less likely.

A19. Base year adjustments

A19.1 In Section 4 of Volume 3 we set out our approach to setting the price for inter-exchange dark fibre services and in Annex 18 we set out details of the model that we use to estimate the evolution of efficient costs of the relevant active services. In this annex, we set out the adjustments we make to our base year data used as the input for inter-exchange dark fibre prices and for our cost modelling of active services.

A19.2 In the Consultation, we used BT's 2016/17 RFS costs as a starting point for our base year, but stated our intention to update our base year data with BT's 2017/18 RFS for the Statement. Therefore, we use BT's 2017/18 published RFS cost data as the starting point for our base year. As in the Consultation, we then make several adjustments to ensure that these costs form an appropriate base which can be used to estimate the dark fibre prices and as an input into our forecasting model.

A19.3 In considering whether to adjust the base year data, we must exercise regulatory judgement based on our understanding of BT's accounting data. Specifically, we have reviewed the 2017/18 base year cost data provided by BT and considered whether it:

- contains any identifiable errors or inappropriate accounting methodologies;
- includes any 'one off' costs that should be excluded; and
- is likely to reflect BT's efficiently incurred costs which should be present in the 2017/18 base year.[797]

A19.4 We have also considered known changes to future costs post 2017/18 that have occurred and made adjustments where the changes reflect our expectation of actual efficiently incurred costs that BT faces.

A19.5 We received no responses to our consultation proposals in relation to our base year data and associated adjustments. The adjustments we have decided to make to the base year data therefore reflect our proposals unless otherwise stated.

A19.6 In March 2019, we commissioned Cartesian Ltd to provide an external review of our base year adjustments and inter-exchange dark fibre models. Cartesian completed its work in April 2019. A letter outlining the scope of its work, its approach and findings is published alongside the Statement. We have considered the issues raised by the external review in finalising our models.

A19.7 Table A19.2 sets out the changes that we have made to BT's 2017/18 data. The impacts reflect changes to costs of a subset of CISBO services at 1 Gbit/s and below in the revised 'Rest of UK' and 'Combined Geographic' markets as defined in the Temporary Conditions[798] (these services are referred to as the 'Relevant Services'). Table A19.1 shows how these

[797] In the past we would have also needed to check that previous regulatory decisions had been implemented. However, the change control process now ensures that this is done annually.

[798] Ofcom, 2017. *Business Connectivity Markets: Temporary SMP conditions in relation to business connectivity services.* https://www.ofcom.org.uk/__data/assets/pdf_file/0019/108019/BCMR-Temporary-Conditions.pdf.

costs reconcile to the 2017/18 RFS. In Annex 18 we describe our approach to adjusting base year data to reflect the new geographic market definitions defined in Volume 2.

Table A19.1: Reconciliation from RFS to pre-adjusted Ethernet Basket[799]

	Operating costs (opex)[800] (£m)	CCA Depreciation (£m)	Mean Capital Employed (MCE) (£m)
2017/18 RFS Low bandwidth CISBO Markets[801]	235	234	1,932
Remove Exempt Ancillaries	-10	-	-
Remove TRCs	-1	-2	-26
Remove ECCs not captured in the EAD connection price	-10	-10	-188
2017/18 Ethernet Basket	214	222	1,718

A19.8 In the remainder of this annex we set out the details of each of the base year adjustments that feed into our active services cost model and dark fibre prices. For each adjustment, we set out an explanation and the associated calculation.

[799] Numbers in Table A19.1 are shown to the nearest £m, as reported in the RFS. In subsequent tables, we round to one decimal point to show greater level of granularity.
[800] All opex numbers disclosed in this annex do not include costs relating to Other CCA adjustments, CCA depreciation or Holding gains/losses.
[801] Combining Rest of UK and Combined Geographic markets.

Table A19.2: Summary of adjustments to our base year model on Relevant Services (£m)

	Operating costs (opex) (£m)	CCA Depreciation (£m)	Mean Capital Employed (MCE) (£m)
2017/18 RFS total unadjusted	213.6	221.9	1,717.9
Remove cumulo costs[802]	-19.4	-	-
Increase restructuring charges and property provision costs for smoothed 4-year average	0.3	-	-
Remove EE integration costs	-0.1	-	-
Decrease pensions service costs	-0.8	-	-
Fibre CCA revaluation	0.2	-21.0	-76.7
Replace Excess Construction Charges (ECCs)	35.8	-3.9	-86.5
Remove service level guarantee (SLG) payments	-28.0	-	-
Remove Openreach repayment works	-	-1.4	-38.2
2017/18 revised total	201.6	195.6	1,516.6

Source: Ofcom figures calculated from analysis on BT data

Removal of cumulo costs

Explanation of the adjustment

A19.9 BT's cumulo rate costs are the non-domestic rating costs BT pays on its rateable network assets. As explained in Annex 18, the rating authorities increased BT's cumulo rating assessment significantly, with effect from 1 April 2017. This has resulted in BT facing significantly higher cumulo costs going forward compared to the costs BT incurred in our base year, 2017/18.[803]

A19.10 Due to the large increase in BT's rates bill, we have forecast cumulo costs separately in our active services cost model. This is consistent with the approach taken in the 2018 WLA

[802] The removal of all cumulo costs is the first adjustment made to the 2017/18 base data. All other adjustments below have been made excluding cumulo.

[803] Although the rate changes take effect from the 1 April 2017 the increase is phased in resulting in the 2017/18 costs not capturing the full impact of the cost increase.

Statement and the approach we proposed in the Consultation. Our approach to the treatment of BT's cumulo rates is described in Annex 18, where we also explain that our efficiency assumption is not applied to these costs. To avoid double-counting cumulo costs, we have therefore removed all cumulo costs from our base year data before adding back our forecasts of cumulo costs for the Relevant Services within the CI model. The treatment of cumulo costs in calculating the base year dark fibre prices is explained in Annex 20.

Calculation of the adjustment

A19.11 BT's cumulo costs amounted to a £19.4m impact on operating expenditure (opex) for the Relevant Services in 2017/18.[804] We have removed these costs from the base year.

Adjustments arising from the review of BT's Annual Reports

A19.12 We have reviewed both the attribution and magnitude of the specific items BT records within its annual report and accounts to determine whether adjustments to our base data are required.[805] We make base data adjustments for three items based on this review:

- restructuring charges;
- property rationalisation provision; and
- EE acquisition and integration costs.

A19.13 Below, we consider the restructuring charges and property rationalisation together, and then EE acquisition and integration costs.

Inclusion and smoothing of restructuring charges and property rationalisation provision costs

Explanation of the adjustment

A19.14 Restructuring costs are associated with changes in BT's organisational structure that result in employee redundancies (with costs from redundancies known as leaver payments).

A19.15 Property rationalisation provision costs relate to BT's strategy of consolidating its office space to enable the mothballing and subletting of buildings. The cost associated with this rationalisation is treated as a provision. BT makes an annual assessment of the size of the balance sheet provision and its net movement. This assessment includes an element of judgement with regard to the level of future costs and savings.

A19.16 As part of our review of BT's Statutory Financial Statements for 'one off' items, we identified that in 2016/17 BT incurred no costs in relation to property rationalisation and restructuring, but incurred high costs in 2017/18[806], indicating that both types of cost display high volatility, as shown in Table A19.3 below.

[804] Openreach response dated 5 December 2018 to question 2 of 11th LLCC s.135 notice.
[805] BT Group plc 2018 Annual Report and Form 20F, page 222, note 8.
https://www.btplc.com/Sharesandperformance/Annualreportandreview/pdf/2018_BT_Annual_Report.pdf.
[806] BT Group plc 2017 Annual Report and Form 20F, page 189.

Table A19.3: Restructuring and property rationalisation provision costs (£m)

Cost type	2014/15	2015/16	2016/17	2017/18
Restructuring costs	315	-	-	241
Leaver payments[807]	8	109	86	50
Property rationalisation costs	45	29	-	28

Source: BT Group Plc Annual report & Form 20-F 2016, 20-F 2017 and 20-F 2018

A19.17 As in the 2018 WLA Statement, we consider that leaver payments, restructuring costs and property rationalisation provision costs are forward looking and efficiently incurred if they produce future efficiency benefits and reduce future property related costs (and we are not aware of any information suggesting these costs may be inefficient). We therefore include these costs in the base year.

Calculation of the adjustment

A19.18 For the purposes of modelling our base year costs, we smoothed these costs over a four-year period. This is due to the continued variability of these costs, the amount of discretion that BT has in this process and the lack of transparency of the calculation. This is consistent with the approach we took in the 2018 WLA Statement.

A19.19 We asked BT to provide a breakdown for the Relevant Services for the restructuring and property rationalisation provision costs for[808]:

- 2014/15 and 2015/16 for each historic RFS CISBO market as published in BT's 2015/16 RFS;
- 2015/16 and 2016/17 for each historic RFS CISBO market as published in BT's 2016/17 RFS; and
- 2016/17 for each Revised RFS CISBO Market.

A19.20 BT also provided network component costs for both the restructuring costs and property rationalisation provision cost for each service and network component within each of the Revised RFS CISBO Markets for 2017/18.[809] We combine the four years of data, using both the published and restated numbers in each year's RFS to ensure that we reflect changes in market definitions, to produce a smoothed four-year average. We then replace the 2017/18 base year opex data with our smoothed calculation. The impact on our base year data amounts to a £0.3m increase in respect to operating costs for the Relevant Services in 2017/18.

[807] Included in operating expenditure before specific items.
[808] Openreach response dated 6 June 2018 to question 11a of the 5th LLCC s.135 notice.
[809] Openreach response dated 12 December 2018 to question 9 of the 11th LLCC s.135 notice.

Adjustment for EE integration costs

Explanation of the adjustment

A19.21 In the Consultation we investigated EE integration costs, identified as a specific item within BT's annual report and accounts. This investigation identified that some of these costs were being allocated to the Relevant Services. We proposed that no costs associated with the EE integration should be included in our base data and therefore proposed to remove them.

A19.22 Since the Consultation was published, we have again investigated the EE integration costs which appear as a specific item within BT's 2018 Annual accounts.[810] Consistent with our proposal, we have removed all costs relating to EE integration.

Calculation of the adjustment

A19.23 Openreach provided us with its estimate of the EE integration costs that had been allocated to the Relevant Services. These costs amounted to £93k opex for the Relevant Services in 2017/18.[811] We have removed these costs from the base year by applying a proportional reduction based on total operating costs on all services.

A19.24 The way we have adjusted for EE integration costs has changed from the approach described in the Consultation where Openreach provided the estimate split by service and network component. The magnitude of EE integration costs in the starting base data has significantly reduced, rendering the adjustment less material, and as such we made a less complicated adjustment.

Adjustment reflecting the increase in pension service costs

Explanation of the adjustment

A19.25 In early 2018 BT entered into new agreements with the trade unions on pension arrangements.

A19.26 On 5 February 2018, BT announced that it had agreed with the Prospect union to close the BT Pension Scheme (BTPS) to managers from 31 May 2018. It also agreed to make some changes to the contribution rates for all managerial staff in the BT Retirement Saving Scheme (BTRSS).[812]

A19.27 On 19 March 2018, BT announced that it had agreed with the Communication Workers Union (CWU) to also close the BTPS to all team members from 31 May 2018.[813] In addition, BT stated that it would:

[810] BT Group plc 2018 Annual Report and Form 20F, page 222.
[811] Openreach response dated 12 December 2018 to question 6 of 11th s.135 notice.
[812] https://www.btplc.com/News/#/pressreleases/bt-to-close-defined-benefit-pension-scheme-for-10000-managers-2405030 [accessed 21 May 2019].
[813] https://www.btplc.com/News/#/pressreleases/bt-announces-closure-of-its-defined-benefit-pension-scheme-2451910 [accessed 21 May 2019].

- continue to work with the CWU to introduce a 'hybrid' pension scheme that includes defined benefit and defined contribution elements, with an aim to have this set up by 1 April 2019; and
- be improving the BTRSS for all members, beyond the current level.

A19.28 In light of these changes to BT's pension schemes, we do not consider it is appropriate to use the 2017/18 pension costs as a basis for estimating the efficient level of costs for the Relevant Services as the 2017/18 costs will reflect the new pension arrangements for only a part of the financial year. Our decision to adjust pension costs is consistent with the approach we took in the 2018 WLA Statement.[814]

Calculation of the adjustment

A19.29 To assess what BT's actual pension service costs may be for the charge control period, and what is an appropriate level for the base year, we have obtained BT's estimates of the ongoing pension service charge for the three years from 2018/19 to 2020/21 which covers the period up to the end of the charge control.[815]

A19.30 Given that the BTRSS and BTPS schemes closed on 1 June 2018 and 30 June 2018 respectively, the costs provided by BT for 2018/19 include an element of the costs of the old arrangements. As we do not consider that these costs are an appropriate basis for determining the ongoing costs of the scheme, we do not include any costs from the previous scheme in our forecasts. We have used the 2019/20 pension expense amount as that will be the first full year under the new deal.

A19.31 The ongoing pension charges, provided by BT in response to a statutory information request, include an element of transition costs that it estimates will account for £[✂] or [✂]% of the annual P&L charge for BT Group in 2019/20.[816] We have accounted for these costs in our adjustment as they are necessary to implement the new scheme.

A19.32 The costs provided by BT do not make allowances for some recent developments, i.e. BT's announcement relating to the removal of c.13,000 ([✂])[817] roles or the hiring of c.6,000 ([✂])[818] employees across engineering, customer service and cyber security areas. As BT was unable to provide updated information on pension costs in relation to these developments, we reduce the 2019/20 future pension cost of £[✂] by the proportion [✂] (c.7,000/105,800) to reflect these developments.[819]

A19.33 BT provided us with the 2017/18 pension costs[820] within BT as a whole and for each service and network component combination separately.[821]

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[814] 2018 WLA Statement, paragraphs A12.30-A12.46.
[815] Openreach response dated 12 December 2018 to question 8 of the 11th LLCC s.135 notice.
[816] Openreach response dated 12 December 2018 to question 8 of the 11th LLCC s.135 notice.
[817] Openreach response dated 17 May 2018 to question 5 of the 4th LLCC s.135 notice, Openreach response dated 25 June 2018 to questions 43 of the 7th LLCC s.135 notice.
[818] Openreach response dated 10 September 2018 to questions 9 of the 10th LLCC s.135 notice.
[819] 105,800 is the number of full time equivalent employees. BT 2018 annual accounts page 43.
[820] Excluding member contributions to be consistent with the forecast pension costs provided by BT.
[821] Openreach revised response dated 19 December 2018 to question 7 of the 11th LLCC s.135 notice.

A19.34 We have adjusted the pension costs within the base year data of £[✂] by uplifting the cost for each Relevant Service and network component combination. We have uplifted the cost by the ratio between BT's forecast 2019/20 pension expense, adjusted for the developments above £[✂], and the 2017/18 current pension expense £[✂].

A19.35 Table A19.4 below sets out the 2017/18 ongoing pension charge, alongside the cost we are including within our base year.

Table A19.4: Estimated P&L costs of the pension deal for BT Group

	Total BT pension service charge (£m)[822]	Relevant Services pension operating charge (£m)
2017/18 Cost[823]	[✂]	[✂]
BT forecast 2019/20 pension expense	[✂]	[✂]
BT forecast 2019/20 pension expense adjusted for 'recent developments'	[✂]	[✂]

Source: Ofcom analysis of BT data

A19.36 We have made an adjustment to the 2017/18 base year costs to decrease the pension costs by the difference between the costs currently in the base year £[✂] and the forecast pension expense in 2019/20 for the Relevant Services, adjusted for 'recent developments' £[✂]. This results in a decrease in the pension costs of £0.8m.

Adjustments for changes proposed by BT in its 2018 Change Control Notice (CCN)

Explanation of the adjustment

A19.37 In the Consultation we made a number of adjustments to reflect the fact that BT had proposed several changes for the 2017/18 RFS within its 2018 Change Control Notification. As we are using data from the 2017/18 RFS as our starting position for our base year data, all these adjustments are already incorporated in the raw 2017/18 data. Therefore, we no longer need to make any further adjustments to our base year data to reflect the CCN adjustments proposed by BT in its 2018 CCN.

[822] Service charge relating to employees who currently receive benefits in the BTPS and BTRSS and excluding employee contributions paid through salary sacrifice arrangements.
[823] Openreach revised response dated 19 December 2018 to question 7 of the 11th LLCC s.135 notice.

Adjustment for fibre CCA indexation

Explanation of the adjustment

Background

A19.38 As set out in Annex 18 and Section 4 of Volume 3, we consider that estimating the cost of both active and inter-exchange dark fibre services based on BT's CCA costs is transparent, practicable to implement and provides better signals for efficient investment than historic costs. We do not consider that BT's current approach to calculating the CCA value of its fibre assets is appropriate and hence, we have adjusted the value of these assets in line with the approach we proposed in the Consultation.

A19.39 Up to 2016/17, BT valued its fibre assets within its RFS using an absolute valuation methodology.[824] However, within its 2017/18 RFS, BT changed the methodology to an indexed historic approach, using CPI as the inflation index.

A19.40 In the 2016/17 RFS, within our statement on BT's Regulatory Financial Statements 2017, we noted that the valuation of fibre required further review ahead of the next year's RFS. Having reviewed the results of BT's analysis into the previous methodology, we agree that there were issues with the previous absolute valuation methodology, both in 2016/17 and potentially in earlier years.

A19.41 BT proposed the change in the 2018 CCN and the methodology change was made for the 2017/18 RFS. Within the CCN, BT noted: "Historically the valuation of Fibre assets was based on an absolute valuation. We have performed a review of the methodology due to the historically high level of 'Other CCA adjustments', which highlighted that the increasing complexity of the Fibre network is not fully reflected in the absolute valuation model".[825]

Our review of the evidence

A19.42 We obtained the analysis BT performed to support its move to a historic indexed approach using CPI[826] and have used this as a starting point for our own analysis into the appropriate methodology for the CCA valuation for fibre assets.

A19.43 BT's analysis examined a range of scenarios using different indexes and concluded that indexing by CPI produced NRC estimates that were in the middle of the range of NRC values produced by the different scenarios.

A19.44 We accept that an indexed historic approach is a reasonable approach for estimating the CCA value of BT's fibre assets. Compared to the absolute valuation methodology, it has some advantages in terms of reducing complexity and increasing stability and is unlikely to lead to a major loss of reliability.

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[824] See BT's AMD 2016/17. https://www.btplc.com/Thegroup/Policyandregulation/Governance/Financialstatements/2017/AMD2016-17.pdf.
[825] BTs 2018 CCN, Section 3.10, page 23.
[826] Openreach response dated 17 May 2018 to questions 2 of the 4th LLCC s.135 notice.

A19.45 However, we do not believe that CPI is the right index to use for indexing fibre assets. We have considered the supporting analysis provided by BT, as well as other evidence, and on balance, we consider that keeping valuations flat in nominal terms (i.e. indexing by 0%) is more consistent with this evidence. We explain our reasoning below.

A19.46 BT's analysis sought to identify what the best index might be by considering several different options for indexing. It indexed historical capex for these different cost categories. Most options resulted in NRCs close to the value under a 'flat nominal' approach (i.e. HCA cost). However, indexing all capex components (pay, stores and other) by the General Buildings Cost Index (GBCI) produced noticeably higher values. Indexing all cost components by CPI produced a value between HCA and the value indexed by GBCI, which was a key justification used by BT for choosing CPI.

A19.47 We do not consider that GBCI is an appropriate index for revaluing fibre assets. This is for two main reasons:

- First, when considering the use of GBCI for revaluing ducts and copper in the 2014 FAMR[827], we noted that there would be cost savings if the network was to be rebuilt on a planned basis over a short period. We referred to this as the 'national discount' principle. We consider such a discount would apply also in the case of rebuilding BT's fibre network. However, this discount is not reflected in the GBCI index, so an indexed historic valuation approach that used GBCI would overvalue the fibre assets.
- Second, the GBCI index is based on a cost model of an average building and reflects changes in the costs of labour, materials and plant costs. We consider it likely that the mix of costs reflected in this index will be very different to that required to install fibre. As we explain below, this is predominantly labour costs in some form and the fibre itself, with, for example, no civil engineering activity and little plant costs.

A19.48 As such, we do not consider that indexation by GBCI would provide a good basis for indexation. Removing this from BT's results significantly weakens the case for adopting CPI as the index. Openreach analysis of the direct costs included in BT's Access Fibre shows that pay makes up c.44%, stores c.24% and 'other' c.33% of the relevant capital expenditure.[828] We understand that stores relate mainly to the costs of fibre and that 'other' is primarily contractors and third-party costs. If we assume that the bulk of the other costs are also labour or stores costs then this suggests that BT's capitalised fibre costs are predominantly a mix of pay and stores, say c.65% pay and c.35% stores.

A19.49 BT's analysis referred to two indices on fibre cable costs: a UK and a US index. We consider that both provide relevant evidence on stores costs. In the UK, the ONS publishes a 'Fibre Optic Cables' index on the costs required to manufacture (but not install) fibre back to

[827] Ofcom, 2014. *Fixed Access Market Review*, paragraph A5.62-A5.69. https://www.ofcom.org.uk/__data/assets/pdf_file/0021/46326/annexes.pdf.
[828] Openreach response dated 17 May 2018 to question 2 of the 4th LLCC s.135 notice.

2011.[829] There has only been a very small increase of just 3.3% in the index over the last six years. In the US, a 'Fibre Optic Cable Manufacturing' index goes back to 2004 and shows a reduction in fibre prices, with these remaining broadly flat since 2014.[830] As fibre costs have remained fairly stable since 2004, it suggests there is little reason to index this element of BT's historical capex.

A19.50 BT's analysis used various indices for capitalised pay costs. However, when not using a general index such as CPI or GBCI, it usually applied a UK index of average earnings with 2% efficiency, consistent with how it had revalued fibre planning costs in the past.[831] BT did not justify the use of 2% efficiency. Our efficiency analysis, discussed in Annex 18, has estimated savings in pay costs, after considering the impact of inflation and changes in volumes, to be much higher at around 6% per annum. It therefore seems likely that efficiency gains would more than offset the effects of pay inflation, again suggesting little justification to index the capitalised pay element of this capex.

A19.51 There may be some fibre installation costs that have risen in recent times. We have identified two potential areas: the time that it takes engineers to travel to and from fibre installation jobs may have increased because of increased traffic congestion; and traffic management costs. However, we do not consider that either of these should make up a significant proportion of the cost base. Furthermore, any increase in travel times will have been captured as part of our efficiency analysis of pay costs.

Our approach

A19.52 On balance, we do not consider the evidence supports either an upward or downward revaluation of fibre assets to arrive at a reasonable proxy for their CCA valuation. We note that this is consistent with our approach to forecasting fibre asset values in previous leased lines charge controls.[832] It is also consistent with the assumptions used in the 2018 WLA bottom-up model used to estimate the cost of GEA services.[833]

A19.53 Given this conclusion, we do not agree with BTs current approach to revalue its fibre assets in the 2017/18 RFS using a CPI indexation approach.

A19.54 Since the evidence we have does not support a revaluation of fibre assets from that of HCA, we have adjusted the 2017/18 base data to use an opening value consistent with HCA valuation. We consider that this is a better proxy for CCA valuation and therefore is a more

[829] ONS Fibre Optic Cables index. https://www.ons.gov.uk/economy/inflationandpriceindices/timeseries/jv7b [accessed 13 September 2018].
[830] Federal Reserve Bank of St. Louis Fiber Optic Cable Manufacturing index. https://fred.stlouisfed.org/series/PCU3359213359210 [accessed 23 April 2019].
[831] See BT's 2016/17 AMD.
[832] 2016 BCMR and 2018 WLA.
[833] 2018 WLA, Annex 29, page 29, Figure 27. This assumption was based on BT's Chief Engineers model where BT was assuming fibre costs would increase at 0% p.a.

appropriate basis on which to estimate dark fibre costs and to forecast fibre costs in the CI model.

Calculation of the adjustment

A19.55 BT provided us with the impact of using HCA valuation instead of a CPI valuation on the 2017/18 operating costs and MCE for each service and network component combination separately. 834 The impact of our approach is to increase HCA operating expenditure (excluding depreciation) by £0.2m, decrease CCA depreciation by £21.0m and decrease MCE by £76.7m for the Relevant Services.

Adjustment for ECCs

Explanation of the adjustment

A19.56 BT's current treatment of ECCs within the 2017/18 RFS is to capitalise all costs relating to both the fixed fee ECC cost recovered from connection services and the ECC costs recovered against the separate additional ECCs.[835]

A19.57 We do not agree with capitalising ECC costs. Instead, we consider that the costs should be expensed in the same period that the revenue is recognised. Therefore, for both fixed fee ECC and other ECC costs, where the revenue is recognised either in the connection fee or as an upfront additional charge, we treat these costs as an operating cost in the year they are incurred.

Calculation of the adjustment

A19.58 All costs included in our starting base year data that relate to ECCs[836] are captured by BT's network components CE104 'Ethernet Excess Construction' and CE106 'Ethernet Excess Construction Capex'.[837] We have removed all costs within these Network components relating to MCE and the associated depreciation from the base year data. This part of the adjustment has been done as the final adjustment to the base year data to ensure any MCE or depreciation costs from adjustments that flow through to the two ECC network components are removed.[838]

A19.59 BT provided us with estimates of the capital expenditure attributable to ECC fixed fee revenues and capital expenditure attributable to other ECCs for 2017/18. This information

[834] Openreach response dated 15 December 2018 to question 5 of 11th LLCC s.135 notice.
[835] Openreach response dated 4 June 2018 Question 12 of the 5th LLCC s.135 notice.
[836] Excluding overheads allocated to ECCs.
[837] CE106 was a new component introduced in the 2017/18 RFS.
[838] We have not adjusted overhead operating costs that are allocated to ECCs as consider these costs are appropriate to be recovered.

was provided for each of the revised CISBO RFS markets, broken down by capitalised pay and other capital expenditure.[839]

A19.60 BT also provided a breakdown of its ECC revenues in 2017/18, split by fixed fee and other, in each of the revised CISBO RFS markets.[840]

A19.61 We have allocated the estimates of capital expenditure by market to the ECC services based on the ECC revenue by service in 2017/18.

A19.62 We have treated all capitalised pay in BT's estimates as pay operating costs and all other capitalised costs as non-pay operating costs in our adjusted base year data.

A19.63 The impact of the above adjustments is to increase HCA operating expenditure (excluding depreciation) by £35.8m, decrease CCA depreciation by £3.9m and decrease MCE by £86.5m for the Relevant Services.[841]

Adjustment for SLG Payments

Explanation of the adjustment

A19.64 Under SLG schemes, Openreach pays compensation to customers if it fails to meet agreed performance criteria – such as time taken to complete an installation – as set out in the SLAs.[842] These SLG payments are part of BT's operating costs.

A19.65 In previous leased line charge controls we have allowed BT to recover an appropriate forward-looking estimate of these costs. We have decided to continue to include these costs in the base year, but to adjust 2017/18 base year provision SLG costs as we do not consider them to be reflective of the efficient level of cost.[843] We discuss our base year adjustment below and we discuss how SLG costs have been forecast in Annex 18.

A19.66 In the 2016 LLCC we also did not rely on SLG costs in either of the base years (2013/14 for the Consultation and 2014/15 for the Statement). This is because they represented a period of poor performance and we expected BT's Quality of Service (QoS) to improve over the period of the charge control.[844] In the 2016 BCMR Statement, we used BT's actual cash SLG payments in 2011 as a proxy for the efficient level of SLG payments.[845] However, we do not consider the 2011 costs to be an appropriate basis for estimating the base year SLG costs in this review period. We do not think it is appropriate to rely on data that relates to demand levels, procedures and rental prices from seven years ago.

[839] Openreach response dated 12 December 2018 to question 12 of the 11th LLCC s.135 notice.
[840] Openreach response dated 12 December 2018 to question 11 of the 11th LLCC s.135 notice.
[841] Removing this MCE does not prevent BT from recovering its costs as these costs have already previously been recovered through the EAD connection charges.
[842] For example, see page 84 of BT's 2017/18 AMD.
[843] We have reviewed the repair SLG costs and do not consider there to be an issue with the level of repair SLG costs.
[844] 2016 BCMR Statement, Annex 27, paragraph A27.100.
[845] 2016 BCMR Statement, Annex 27, paragraph A27.109.

A19.67 SLG costs were significantly higher in 2016/17 than in previous years and they remained at a similar level in 2017/18. Openreach told us that the increase in 2016/17 and 2017/18 resulted from two factors. The first was an accounting change under which SLG payments for circuit provisions, where the customer completion date had not yet been achieved but known payments under the SLG terms and conditions were already due, were accrued from 2016/17. Previously these SLG costs had only been booked to the general ledger as they came through for payment. The second and larger change was because Openreach worked on a large tail of older provision orders which had been in Openreach's work stack for a long time. These tended to be more complex jobs to fulfil and increased the risk of missing delivery dates and hence incurred higher SLG payments.[846] We therefore consider that SLG costs in 2016/17 and the early parts of 2017/18 are atypical. The analysis below confirms this to be the case.

A19.68 The starting point of our analysis for provision SLG costs is data from Openreach that splits Ethernet SLG costs incurred on provision services by month, in the years 2015/16, 2016/17 and 2017/18 and part of 2018/19.[847] This data is summarised in Figure A19.5 below.

Figure A19.5: SLG payments by month over the last 3-4 years

A19.69 Figure A19.5 shows that payments increased rapidly from June 2016 to a peak in December 2016, before reducing slowly with some evidence that they started to level off from December 2017. This is also consistent with QoS data that suggests performance has started to stabilise. The current level of payments will also reflect revised Openreach procedures following the 2017 deemed consent investigation.

[846] Openreach response dated 3 July 2018 to question 14 of 7th LLCC s.135 notice.
[847] Openreach revised response dated 17 September 2018 to question 17 of 7th LLCC s.135 notice, Openreach response dated 12 December 2018 to question 19 of 11th LLCC s.135 notice and Openreach response dated 6th March 2019 to question 8 of 12th LLCC s.135 notice.

A19.70 However, there are certain other factors that need to be considered when coming to a final view of what provision SLG payments might be.

A19.71 First, we note that there are unresolved negotiations between Openreach and industry, regarding both what the level of SLG reimbursements should be in the future[848] and contract changes proposed by Openreach as part of a broader package of changes to Ethernet provision.[849] We have not made any adjustments to reflect these discussions as they are not finalised.

A19.72 Second, we change the required QoS standards for this review period, as set out in Section 15 of Volume 2. These would come into force next year and therefore may affect the level of SLG payments over the review period.

A19.73 We have considered the possible impacts, both direct and indirect, that each of the QoS standard changes may have and adjusted our base SLG cost for the certainty standard.[850] We assume that the net impact of the changes to the other QoS standards on future SLG costs will be minimal. We consider this is a reasonable assumption as we believe that the impacts of these other changes would be small and would offset each other.

Calculation of the adjustment

A19.74 There are several factors that could affect SLG payments going forward and SLG costs in 2017/18 will not necessarily be a good reflection of what they should be in the future, consistent with our revised QoS standards. We have therefore:

- Estimated the current annual run rate using the cash payments made over the 4 months up to January 2019.
- In the Consultation, we scaled this annualised number down by a ratio 15/17 to reflect our proposed changes to the Certainty standard. The reason for this adjustment was the actual percentage of orders Openreach provided on time for the last four months up to March 2018 averaged 83%, but the new certainty standard we proposed required the average for the first year of the review period to be at least 85%.[851] However, we consider this adjustment is no longer required since Openreach has been achieving the new required standard of 85% over the four months to January 2019, and our decision on the Certainty standard reflects our consultation proposal.

A19.75 We have included an operating cost of £13.4m as the 2017/18 base efficient level of SLG costs to be forecast forward over the charge control period. The impact of our adjustment is to reduce operating expenditure by £28.0m for the Relevant Services.[852]

[848] http://www.offta.org.uk/updates/otaupdate2018July.htm [accessed 1 November 2018].
[849] https://www.openreach.co.uk/orpg/home/updates/briefings/ethernetservicesbriefings/ethernetservicesbriefingsarticles/eth05518.do [accessed 1 November 2018].
[850] The required percentage of orders to be provided on time based on the actual completion date quoted.
[851] Openreach's average of 83% on time means that the SLG cost data we had was for 17% of orders being provided late. Given the proposed MSL would only allow 15% to be late and subsequently incur SLGs, we needed to reduce the cost by 15/17.
[852] Total SLG costs pre-adjustments for our Relevant Services amount to £41.6m.

Adjustment for Openreach repayment works

Explanation of the adjustment

A19.76 Openreach's repayments programme is made up of two sub-programmes: repayment alterations and repayment damages. Repayment alterations relate to pre-planned jobs, where work is requested by external parties (e.g. local authorities) to alter the Openreach network due to building, redevelopment, utilities or transport projects such as HS2. Repayment damages relate to the repair of the Openreach network caused by third party damage and reported via the Openreach damage control unit.[853] The charges billed for these two programmes are made up of the direct cost of the damage or alteration works and the relevant overheads.[854]

A19.77 Within BT's RFS, repayments work activity that is capitalised is attributed to the same network components that contained the original (now altered) asset, and so in some cases the costs will have been attributed to regulated markets.[855] The revenues are however wholly attributed to the Openreach residual market. We believe that revenues should be matched to costs and therefore have made an adjustment to reattribute any capitalised repayment work costs previously attributed to regulated markets to the Openreach residual market.

A19.78 The methodology for attributing repayments works costs within BT's RFS has been in place since the creation of Openreach (January 2006). To reattribute these costs, we therefore need to consider the cumulative impact back to 2006.

Calculation of the adjustment

A19.79 Openreach provided information which showed the gross book value (GBV) and the associated full year depreciation of repayment assets that have been added to the fixed asset register by class of work (CoW) for each year since 2009/10. Openreach also provided the accumulated depreciation for the repayment assets and associated GBV by network component and CoW that were added to the fixed asset register from 2009/10.[856]

A19.80 We have calculated the average in-year depreciation and GBV additions over the period 2009/10 to 2017/18 and assumed that these will provide a reasonable proxy for the annual in-year depreciation and GBV additions over the period 2006/07 to 2009/10.

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[853] Openreach response dated 3 August 2018 to question 13 of the 8th LLCC s.135 notice.

[854] For the avoidance of doubt, the overheads do not include items that previous court decisions have ruled as too remote from Repayment works such as corporate overheads and senior management costs.

[855] Openreach capitalise an asset where improvements on the old can be identified. Capitalising the value of the new asset less the value of the old asset that is being improved.

[856] Openreach response dated 19 December 2018 to question 13 of the 11th LLCC s.135 notice. Data was requested from financial year 2006/07 however Openreach were unable to provide data pre-2009/10 due to the data not being available in their Orbit Capital Reporting system.

A19.81 We need to make three adjustments to remove the appropriate share of repayment works costs from the relevant regulated services. We need to adjust GRCs, NRCs, and the 2017/18 in-year depreciation. We assume for simplicity that there is no difference between GRC and GBV, and so there is also no difference between NRC and NBV.[857]

A19.82 For each of these three adjustments, we first calculate the total impact for each network component. We then identify what proportion is relevant to the Relevant Services by using component volumes data.[858] We explain each of the adjustments in turn.

A19.83 We have adjusted the accumulated GRC by removing the total additions as provided by Openreach over the period 2009/10 to 2017/18 and add our estimate (as calculated above) of the additions over the period 2006/07 to 2009/10. We have attributed the GRC (or GBV) additions over the years 2006/07 to 2009/10 period to network components in the same way that total GBV additions over the period 2009/10 to 2017/18 have been attributed.

A19.84 We have adjusted the accumulated NRC by firstly removing the total accumulated depreciation as provided by BT over the period 2009/10 to 2017/18. We have calculated the accumulated depreciation associated with assets added over the period 2006/07 to 2009/10 using our estimates of the GBV additions over this period and by assuming that these have been depreciated on the same basis as the 2009/10 to 2017/18 additions.[859] We have attributed the accumulated depreciation for assets pre-2009/10 to network components in the same way that total accumulated depreciation over the period 2009/10 to 2017/18 has been attributed.

A19.85 Finally, we have adjusted the 2017/18 depreciation to remove the in-year depreciation associated with all of the additions going back to 2006/07 to 2017/18. This total depreciation by CoW has been assigned to components using the same ratio as the accumulated depreciation by component for each CoW.

A19.86 This reduces CCA depreciation by £1.4m and MCE by £38.2m for the Relevant Services.

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[857] This will slightly underestimate the adjustment as some repayments works activity is associated with duct, which would be revalued each year in BT's RFS using RPI as the measure of asset price inflation.
[858] Openreach response dated 18th December 2018 to question 17 of the 11th LLCC s.135 notice. This data shows total volumes by component and what proportion relate to the Relevant services.
[859] We assume that assets are on average added to the fixed asset register mid-year, i.e. they only incur half of the annual depreciation charge in the year they are added.

A20. Inter-exchange dark fibre pricing

A20.1 In Section 4 of Volume 3 we provide an overview of how we set starting charges for inter-exchange dark fibre services. This includes a description of the cost standard that we use (forward-looking fully allocated costs), and the services that we set starting charges for (connection, rental and main link services and selected ancillary services). We also set out an overview of our methodology, which is:

- to estimate the costs of the main inter-exchange dark fibre services by estimating the costs of each of the following elements:
  - costs relating to the passive infrastructure required for an inter-exchange dark fibre circuit, such as duct and fibre ('element A');
  - other costs required for, but not specific to, an inter-exchange dark fibre circuit, such as costs associated with staff working in customer contact centres handling provision and repair enquiries ('element B'); and
  - costs that are specific to an inter-exchange dark fibre circuit, such as those relating to its unique network terminating equipment ('element C').
- to calculate the costs of elements A and B with reference to the relevant costs for EAD 1 Gbit/s services as reported in BT's RFS, and the costs of element C using a similar methodology to that Openreach used when preparing its final Reference Offer for dark fibre services in 2016.

A20.2 In this annex we summarise our proposals, review stakeholder comments and then explain in detail how we have decided to estimate each of elements A, B and C, including how we:

- classify the costs of the network components[860] within the cost stack for EAD services as being either active, passive or shared;
- use the costs of passive components to estimate element A;
- use the costs of shared components to estimate element B;
- use alternative data on costs specific to inter-exchange dark fibre services to estimate element C; and
- exclude the costs of non-domestic rates (NDRs) in elements A, B or C as these will be paid by the telecoms provider that lights the fibre.

A20.3 We then provide starting charges for the main inter-exchange dark fibre services based on costs from BT's 2017/18 RFS (using our calculation of WACC as set out in Annex 21 and after making the base year cost adjustments outlined in Section 4 of Volume 3 and Annex 19). Finally, we set out our decisions for the pricing of two ancillary services that are specific to inter-exchange dark fibre services: a cessation charge and a right when tested (RWT) charge.

[860] BT allocates costs to components which represent 'discrete parts of [its] network' such as Ethernet Electronics, Ethernet Access Direct Fibre and Sales Product Management. Component costs are then attributed to services using usage factors. See page 201 of BT's 2018 AMD.

Classification of components

Our proposals

A20.4 We proposed to classify the components used to provide EAD services in BT's RFS as being either active, passive or shared and to use the costs of these components as inputs to our calculation of starting charges for inter-exchange dark fibre services.

A20.5 We presented indicative starting charges based on BT's 2016/17 RFS, but said we would update the calculations in this statement using BT's 2017/18 RFS. In the 2017/18 RFS, BT introduced some new components and removed or redefined others, and so we provided our proposed classification of the components in both BT's 2016/17 and 2017/18 RFS.

Stakeholder responses

A20.6 Openreach broadly agreed with our proposed classification of each of the components used to provide EAD services as active, passive or shared.[861] However, Openreach disagreed with our proposal not to include any costs of active components in the cost stack for inter-exchange dark fibre services. Openreach considered that it would still incur various overheads included in the Ethernet Electronics component (such as procurement, vehicles and general overheads) if providing an inter-exchange dark fibre service instead of an EAD service.[862] It suggested that these overheads should be included in our estimate of the unit FAC of the patch panel in element C of the cost stack.[863]

A20.7 [✂] asked for greater clarity on the reasons for differences in main link charges between inter-exchange dark fibre services and EAD services. We address this below when discussing shared costs and non-domestic rates (NDRs).[864]

A20.8 No other stakeholders commented on our proposed classification of components.

Our reasoning and decisions

A20.9 We classify the components used to provide EAD services in BT's 2017/18 RFS as relating either only to the active or passive elements of an EAD circuit or as being 'shared' between the active and passive elements. Table A20.1 below shows our classification of the components used to provide EAD services in BT's 2017/18 RFS. This is as set out in the Consultation with one exception; we have corrected a typographical error which classified SLG Ethernet Provision as an active component whereas it should have been classified, as SLG Ethernet Assurance had been, as a shared component.

A20.10 Active components relate to the active elements of an EAD circuit and do not appear to include any costs relevant to an inter-exchange dark fibre circuit. These include:

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861 Openreach's response to the 2018 BCMR Consultation (LLCC), paragraph 28.
862 Openreach's response to the 2018 BCMR Consultation (LLCC), paragraphs 43-44.
863 Openreach's response to the 2018 BCMR Consultation (LLCC), paragraphs 70-71.
864 [✂]

- EAD Electronics Capital, which covers the direct costs associated with the dedicated electronic equipment supporting an EAD service. These costs were included within the costs of the Ethernet Electronics component in BT's 2016/17 RFS.
- Ethernet Electronics Current, which covers the overheads associated with the electronic equipment used to provide various Ethernet services including EAD. These costs were included within the costs of the Ethernet Electronics component in BT's 2016/17 RFS.
- Ethernet Monitoring Platform, which covers costs associated with a platform that performs remote diagnostic testing and reconfigurations of EAD and OSA circuits. These costs were included within the costs of the Ethernet Electronics component in BT's 2016/17 RFS.

A20.11 We acknowledge Openreach's concern that some overheads included in the Ethernet Electronics Current component may still be incurred if providing an inter-exchange dark fibre service instead of an EAD service. We respond to this point below when we discuss our approach to estimating the unit FAC of the patch panel in element C of the cost stack.

A20.12 Passive components relate to the passive elements of an EAD circuit and so may include costs that are relevant to an inter-exchange dark fibre circuit. These include:

- Ethernet Main Links, which covers costs associated with providing connectivity between BT exchanges where the ends of an Ethernet circuit are in different BT exchange areas.
- Routing and Records, which covers costs associated with the physical verification and initial recording of routings within the network.
- EAD Fibre, which covers costs associated with the duct and fibre used to provide an access segment between a served location and its local BT exchange for EAD services.
- Ethernet Excess Construction, which covers costs associated with the construction of additional duct and fibre when there is no existing BT infrastructure connecting a served location to its local BT exchange. As discussed in Section 3 of Volume 3, we have, since 2014, directed BT to exempt EAD orders from ECCs below a threshold charge and to recover the resulting loss of revenue by including a balancing charge in the connection price. This component covers the capital employed (except in-year capital expenditure) and depreciation relating to ECCs incurred on Ethernet services.
- Ethernet Excess Construction Capex, which covers in-year capital expenditure relating to ECCs incurred on Ethernet services. These costs were previously included in the costs of the Ethernet Excess Construction component in BT's 2016/17 RFS.

A20.13 Shared components relate to both the active and passive elements of an EAD circuit and so may include costs that are relevant to an inter-exchange dark fibre circuit. These include:

- Openreach Sales Product Management, which covers the costs of staff who work in the Sales Product Management division of Openreach;
- Openreach Systems & Development (Ethernet), which covers the development costs for Openreach Ethernet products which are predominantly related to software such as ordering, billing and task allocation systems;

- Openreach Service Centre Assurance (Ethernet) and Openreach Service Centre Provision (Ethernet), which covers the costs of staff working in Openreach customer contact centres who deal with enquiries and complaints relating to repairs and provisions respectively;
- SLG Ethernet Assurance and SLG Ethernet Provision, which cover costs associated with Service Level Guarantee (SLG) payments made to customers if Openreach fails to meet contractually agreed timescales for repair and provision activities respectively. These costs were included in the Openreach Service Centre Assurance and Provision (Ethernet) components in BT’s 2016/17 RFS;
- Ofcom Administration Fee (Openreach), which covers the costs of the Network and Services Administrative Charges that Ofcom charges BT; and
- Revenue Receivables, which cover part of the working capital for a service. Revenue Receivables costs are an estimate of the amounts that service users (whether BT Group’s downstream businesses or other providers) owe to Openreach for each service based on Openreach’s standard payment terms.

Table A20.1: Classification of components used to provide EAD services in BT's 2017/18 RFS

Component	Classification	Component used by:		
		EAD Connections	EAD Rentals	EAD Main Link Rentals
Ethernet Electronics Current	Active		✓	
EAD Electronics Capital	Active		✓	
Ethernet Monitoring Platform	Active		✓	
Ethernet main links	Passive			✓
Routing and Records	Passive	✓		
Ethernet Access Direct Fibre	Passive		✓	
Ethernet Excess Construction	Passive	✓		
Ethernet Excess Construction Capex	Passive	✓		
Openreach sales product management	Shared	✓	✓	✓
OR Systems & Development - Ethernet	Shared	✓	✓	✓
OR Service Centre - Assurance (Ethernet)[865]	Shared	n/a	n/a	n/a
OR Service Centre - Provision (Ethernet)	Shared	✓		
SLG Ethernet Assurance	Shared		✓	
SLG Ethernet Provision	Shared	✓		
Ofcom Administration Fee - Openreach	Shared	✓	✓	✓
Revenue Receivables	Shared	✓	✓	✓

[865] In BT's 2016/17 RFS, which we used in the Consultation, some OR Service Centre – Assurance (Ethernet) costs were attributed to EAD rental services. In BT's 2017/18 RFS, this component was split into two components (OR Service Centre – Assurance (Ethernet) and SLG Ethernet Assurance) with OR Service Centre – Assurance (Ethernet) costs no longer being attributed to any EAD services.

Passive infrastructure costs ('element A')

Our proposals

A20.14 For each main inter-exchange dark fibre service (i.e. connection, rental, main link), we proposed to include in element A of the cost stack the unit FAC of any passive components used to provide the corresponding EAD service that we considered would also be required to provide inter-exchange dark fibre services.

A20.15 We proposed to include the full unit FAC of the Ethernet Main Links and Routing and Records components and to not include the unit FAC of the EAD Fibre component. We also proposed not to include the unit FAC of the Ethernet Excess Construction or Ethernet Excess Construction Capex components as we considered that, for most inter-exchange dark fibre circuits, little (if any) extra construction work would be required.

A20.16 Finally, we proposed that the unit FAC of element A for a two-fibre circuit should be twice that of a one-fibre circuit as we did not consider that the unit FAC of any of the passive costs included would vary with the number of fibres provided.

Stakeholder responses

A20.17 Openreach agreed with our proposals to include the unit FAC of the Routing and Records component and to not include the unit FAC of the EAD Fibre component in the cost stack for inter-exchange dark fibre services.[866]

A20.18 Openreach and BT Group considered that the unit FAC of the Ethernet Main Links component would be relatively higher for an inter-exchange dark fibre circuit than for an EAD circuit. Openreach and BT Group noted that telecoms providers may substitute multiple existing active circuits on an inter-exchange route for a single inter-exchange dark fibre circuit and that this posed a risk of under-recovery of main link common costs. Openreach analysed its inventory of active circuits on inter-exchange routes from BT Only exchanges and found that there were, on average, 1.48 active circuits per telecoms provider per route. Openreach and BT Group argued that the unit FAC of the Ethernet Main Links component should therefore be uplifted by a factor of 1.48 to ensure the same absolute contribution to common costs for EAD and inter-exchange dark fibre services.[867]

A20.19 Openreach disagreed with our proposal not to include the unit FAC of the Ethernet Excess Construction and Ethernet Excess Construction Capital components in the cost stack for inter-exchange dark fibre services. These correspond to the balancing charge included in the connection price for EAD circuits. It stated that this would not be appropriate as capacity constraints may require Openreach to install new fibre cable to provide an inter-

[866] Openreach's response to the 2018 BCMR Consultation (LLCC), paragraph 30.
[867] Openreach's response to the 2018 BCMR Consultation (LLCC), paragraphs 34-35; BT Group's response to the 2018 PIMR and 2018 BCMR Consultations, paragraph 5.35.

exchange dark fibre circuit.[868] Openreach considered that it should be able to levy an ECC to recover any construction costs in full if a balancing charge was not included in the inter-exchange dark fibre connection price.[869]

A20.20 Vodafone agreed with our approach to estimating passive infrastructure costs for inter-exchange dark fibre services.[870]

A20.21 No other stakeholders commented on our approach to estimating passive infrastructure costs for inter-exchange dark fibre services.

Our reasoning and decisions

A20.22 For each inter-exchange dark fibre service, we include in element A of the cost stack the unit FAC of any passive components used to provide the corresponding EAD service that we consider would also be required to provide inter-exchange dark fibre services. We discuss our approach to estimating the costs for each of the following components having taken account of stakeholder responses:

- Ethernet Main Links;
- Routing and Records;
- EAD Fibre; and
- Ethernet Excess Construction and Ethernet Excess Construction Capex.

A20.23 As in the Consultation, we consider that the unit FAC of element A for a two fibre circuit should be twice that of a one fibre circuit as we do not consider that the unit FAC of any of the passive costs we have included will vary with the number of fibres provided.

Ethernet Main Links

A20.24 We acknowledge Openreach's concern that telecoms providers may substitute multiple active circuits on a route between BT exchanges for a single inter-exchange dark fibre circuit. In such instances, our proposal to set the unit contribution from inter-exchange dark fibre services to main link common costs equal to that for active services could, all other things equal, create a risk of under-recovery of main link common costs due to the net decrease in circuit volumes on a route.

A20.25 However, we consider that this risk of under-recovery of main link common costs would be, at least partially, offset by demand for new inter-exchange dark fibre circuits which do not substitute for existing active circuits. These new circuits would represent entirely new contributions to the recovery of main link common costs.

A20.26 Further, to the extent that the impact of this new demand did not fully offset that of aggregation, we consider that any resulting under-recovery is likely to be small due to the limited scope of the remedy (inter-exchange connectivity from certain BT Only exchanges and a two-year charge control period). In addition, our approach to pricing of active

[868] Openreach's response to the 2018 BCMR Consultation (LLCC), paragraph 30.
[869] Openreach's response to the 2018 BCMR Consultation (LLCC), paragraph 42.
[870] Vodafone's response to the 2018 BCMR Consultation, part 3, paragraph 6.72.

services is, on balance, expected to result in some cost over-recovery for BT (as set out in Section 2 of Volume 3), which would likely offset any potential under-recovery from inter-exchange dark fibre services.

A20.27 For these various reasons, we consider that estimating the likely change in common cost allocations between active and dark fibre services would be both disproportionate and unnecessary for this review period.

A20.28 We therefore adopt our consultation proposal and include in element A of the inter-exchange dark fibre main link service the full unit FAC of the Ethernet Main Links component that is attributed to the EAD main link service. We do not uplift that as Openreach and BT Group suggested.

Routing and Records

A20.29 As in the Consultation, we include in element A of the inter-exchange dark fibre connection service the full unit FAC of the Routing and Records component that is attributed to the EAD connection service. We consider that the activities making up the costs for this component would be the same whether Openreach provided an EAD or inter-exchange dark fibre circuit.

EAD Fibre

A20.30 As in the Consultation, we do not include the costs of the EAD Fibre component that are attributed to the EAD rental service in element A of the inter-exchange dark fibre rental service. Both ends of an inter-exchange dark fibre circuit will be in BT exchanges and so it will not require any duct and fibre other than that connecting the BT exchanges. The costs of that duct and fibre are included in element A of the cost stack within the Ethernet Main Links component. This contrasts with most EAD circuits where one or more of the ends will be in a customer premises, and so duct and fibre is required to connect the customer premises to its local BT exchange.

Ethernet Excess Construction & Ethernet Excess Construction Capex

A20.31 We still consider that for most inter-exchange dark fibre circuits, little (if any) extra construction work would be required as the infrastructure supporting connectivity between BT exchanges is already in place. However, we recognise there may be instances where network build is required to provide an inter-exchange dark fibre circuit. For instance, the fibres in the cables connecting two BT exchanges may be fully utilised or there may be no existing network between two BT exchanges.

A20.32 We asked Openreach how it currently recovers the cost of installing network between exchanges when this is required to provide EAD services. Openreach stated that it does not raise ECCs against the cost of installing network between exchanges when providing EAD services as it considers such network to be common network and therefore ECCs do not apply.[871]

A20.33 Openreach's current approach appears to be consistent with our view set out in the Consultation that any other fibres within a new cable installed by Openreach to provide an inter-exchange dark fibre circuit could then be used by both BT and other telecoms providers. We therefore do not consider it appropriate to load costs of installing the new fibre cable on the telecoms provider that places the first order on a route.

A20.34 Openreach noted that there had been a "small number of cases" where the network build cost to provide an EAD service was sufficiently high (e.g. "£800k for a single EAD circuit") that it offered to proceed only on the basis that the purchasing telecoms provider paid an amount designed to make Openreach's investment in that new common network viable. Openreach stated that none of these orders had progressed to delivery.[872]

A20.35 We recognise that in some instances the cost of network build may be prohibitively high. For example, there may be no existing direct network route between two BT exchanges as opposed to a lack of spare capacity. As set out in Section 12 of Volume 2, Openreach is not required to dig additional duct to form a new direct route in such scenarios. However, Openreach will be required to consider all alternative options for providing a route between those BT exchanges, such as routing the circuit via an intermediate BT exchange to which both are connected.

A20.36 As in the Consultation, we therefore do not to include the costs of the Ethernet Excess Construction or Ethernet Excess Construction Capex components that are attributed to the EAD connection service in element A of the inter-exchange dark fibre connection service.

Other costs not specific to inter-exchange dark fibre services ('element B')

A20.37 For each inter-exchange dark fibre service, we include in element B of the cost stack an appropriate proportion of the unit FAC of any shared components used to provide the corresponding EAD service. Below we summarise our proposals, review stakeholder responses and then explain our decisions for each of the following components:

- Openreach Systems and Development (Ethernet);
- Service Centre – Provision (Ethernet) and SLG Ethernet Provision;
- Service Centre – Assurance (Ethernet) and SLG Ethernet Assurance;
- Openreach Sales and Product Management;
- Ofcom Administration Fee; and
- Revenue Receivables.

A20.38 As noted in the Consultation, some or all the costs of these components can be viewed as being common with active Ethernet services or indeed common with other non-Ethernet services. We acknowledge that our proposed treatment of these costs could be taken to

[871] Openreach response dated 6 March 2019 to question 12 of the 12th LLCC s.135 notice.
[872] Openreach response dated 6 March 2019 to question 12 of the 12th LLCC s.135 notice.

imply a reattribution of common costs and this may lead to lower costs in the long run for active Ethernet services. However, we consider that the impact of any such implicit reattribution will be relatively low over the course of this two-year charge control.

A20.39 As for the passive components we have discussed above, we consider that the unit FAC of shared components for a two-fibre circuit should be twice that of a one fibre circuit as we do not consider that the unit FAC of any of the costs of shared components we have included will vary with the number of fibres provided.

Openreach Systems and Development (Ethernet)

Our proposals

A20.40 We proposed to include 91% of the unit FAC of the Openreach Systems and Development (Ethernet) component based on Openreach data on systems expenditure supporting Ethernet services between 2015/16 and 2017/18. This indicated that 91% of systems expenditure would be relevant to providing dark fibre services with the remaining 9% being specific to active services (such as the ordering system for electronic equipment).

Stakeholder responses

A20.41 Openreach agreed with our proposed approach to estimating Openreach Systems and Development (Ethernet) costs for inter-exchange dark fibre services.[873]

A20.42 Vodafone commented on our approach to estimating the costs of all shared components in general. It considered it difficult to assess whether our proposals attributed an appropriate proportion of shared costs to passive elements of circuits based on what it considered to be a "limited amount of data remaining in the Consultation". However, it said that the costs of all shared components apart from the Ofcom Administration Fee were primarily driven by "the complexity and nature of active products" and stated that "the idea that passive services would consume anywhere like the same level of these costs as active services is not in line with our understanding of the cost drivers of these services".[874]

A20.43 No other stakeholders commented on our proposed approach to estimating Openreach Systems and Development (Ethernet) costs for inter-exchange dark fibre services.

Our reasoning and decisions

A20.44 Openreach Systems and Development (Ethernet) costs are attributed to Ethernet connection, rental and main link services based on service volumes.[875]

A20.45 Our proposed approach to estimating Openreach Systems and Development (Ethernet) costs was similar to that used by Openreach when setting and then updating launch prices

[873] Openreach's response to the 2018 BCMR Consultation (LLCC), paragraph 30.
[874] Vodafone's response to the 2018 BCMR Consultation, part 3, paragraph 6.72.
[875] Costs are attributed to connection services based on the number of circuits ordered during the year and to rental and main link rental services based on the number of rentals during the year (main link rental volumes are measured in kilometres, so the usage factor is based on the average circuit length).

for DFA services in December 2016 and August 2017 respectively to comply with the dark fibre remedy we proposed in the 2016 BCMR Statement.

A20.46 Following the Consultation, we asked Openreach to provide an update of its analysis of systems expenditure for Ethernet services covering the more recent three-year period from 2015/16 to 2017/18 inclusive. In this update, Openreach identified expenditure not only on systems specific to active services (as in its previous analysis relating to DFA), but also on systems specific to Openreach's access network (i.e. the local ends connecting BT exchanges to customer premises). This analysis suggests that the proportion of systems expenditure specific to active services and/or Openreach's access network, and therefore not relevant to providing inter-exchange dark fibre services, is 23%.[876]

A20.47 We therefore have decided to include 77% of the unit FAC of the Openreach Systems and Development (Ethernet) component that is attributed to each EAD service within the unit FAC of element B of its corresponding inter-exchange dark fibre service.

A20.48 In relation to Vodafone's general concern about our approach to estimating the costs of shared components for inter-exchange dark fibre services, we note that Vodafone did not comment on the specific cost drivers we identified for each of these shared components or our analysis of the expected differences in the levels of these cost drivers between EAD and inter-exchange dark fibre services. We also consider that our description of our approach as well as the data presented in the Consultation (after redacting confidential Openreach data) was sufficient to form a view of the appropriateness of our proposals.

Openreach Service Centre – Provision (Ethernet) and SLG Ethernet Provision

Our proposals

A20.49 In BT's 2016/17 RFS, the Openreach Service Centre – Provision (Ethernet) component included both the costs of staff working in customer contact centres handling provisioning enquiries as well as provisioning SLG payments. When estimating indicative starting charges in the Consultation based on BT's 2016/17 RFS we proposed to include the full unit FAC of this component (after adjusting the base year data to reflect our view of an efficient level of SLG payments).

A20.50 We noted that in BT's 2017/18 RFS the costs of staff working in customer contact centres and the costs of provisioning SLG payments were separated into two components: Openreach Service Centre – Provision (Ethernet) and SLG Ethernet Provision. We proposed to include the full unit FAC of the Openreach Service Centre – Provision (Ethernet) and SLG Ethernet Provision components (after adjusting the latter for the reason above) when updating our starting charge calculations using BT's 2017/18 RFS.

[876] Openreach response dated 13 March 2019 to question 14 of the 12th LLCC s.135 notice.

Stakeholder responses

A20.51 Openreach agreed with our proposed approach to estimating Openreach Service Centre – Provision (Ethernet) and SLG Ethernet Provision costs for inter-exchange dark fibre services.[877]

A20.52 No other stakeholders commented on our proposed approach to estimating Openreach Service Centre – Provision (Ethernet) or SLG Ethernet Provision costs for inter-exchange dark fibre services.

Our reasoning and decisions

A20.53 In BT's RFS, Openreach Service Centre – Provision (Ethernet) costs are attributed to Ethernet connection services based on service volumes.

A20.54 As in the Consultation, we do not consider there would be material differences in the number of provisioning-related calls made per circuit to Openreach customer contact centres (or the activities involved in handling such calls) between EAD and inter-exchange dark fibre services.[878] We therefore adopt our consultation proposal by including in the unit FAC of element B of the inter-exchange dark fibre connection service the unit FAC of the Openreach Service Centre – Provision (Ethernet) component that is attributed to the EAD connection service.

A20.55 In BT's 2017/18 RFS, SLG Ethernet Provision costs are attributed to Ethernet connection services based on service volumes.

A20.56 As assumed implicitly in the Consultation, we do not expect the number of provisioning SLG failures per circuit to materially differ between EAD and inter-exchange dark fibre services. However, provisioning SLG payments for EAD circuits are currently a function of the rental price of the EAD circuit whose installation has been delayed. Although contractual SLG arrangements for inter-exchange dark fibre services will be determined by future negotiations between Openreach and other telecoms providers, we consider it to be a likely starting position for negotiations that SLG payments for these services will also be proportional to rental charges, and therefore, we consider it is appropriate to update the cost assumptions used in the Consultation to reflect this.

A20.57 Should Openreach and its customers agree a higher level of SLGs to reflect a shared pre-estimate of the costs telecoms providers may face, we consider that, over the course of this short review period, such additional payments are unlikely to be material in the context of the expected over-recovery of costs for active services.

A20.58 We have therefore updated our cost estimates on this basis and have adjusted the unit FAC of the SLG Ethernet Provision component based on the difference in rental charges

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[877] Openreach's response to the 2018 BCMR Consultation (LLCC), paragraph 30.

[878] This is consistent with the discussion of these costs in the 2016 BCMR Statement as part of our guidance for how dark fibre prices should be set. See paragraphs A23.70-A23.71.

(including main link charges) between an inter-exchange dark fibre service and EAD service. We adjust for differences in rental charges using the ratio of the sum of unit costs across rental and main link[879] services (31%) as a proxy for rental prices. These unit costs exclude the costs of SLG Ethernet Provision, as well as those of other components we estimate based on relative prices (e.g. Ofcom Administration Fee and Revenue Receivables as discussed below).

A20.59 We therefore include in the unit FAC of element B of the inter-exchange dark fibre connection service 31% of the unit FAC of the SLG Ethernet Provision component that is attributed to the EAD connection service.

Openreach Service Centre - Assurance (Ethernet) and SLG Ethernet Assurance

Our proposals

A20.60 In BT's 2016/17 RFS, the Openreach Service Centre – Assurance (Ethernet) component included both the costs of staff that work in customer contact centres and handle repair enquiries as well as the costs of repair SLG payments. When estimating indicative starting charges in the Consultation based on BT's 2016/17 RFS, we proposed to include 26% of the unit FAC of this component based on analysis of fault volume data for EAD circuits.

A20.61 We estimated the expected reduction in faults per circuit for inter-exchange dark fibre services relative to EAD services by classifying EAD faults as relating either to active or passive elements of circuits based on the clear code submitted by the Openreach engineer upon resolution. We proposed to classify 6% of 'right when tested' (RWT) faults (one of the main categories of EAD faults) as passive based on Openreach's December 2016 DFA Final Reference Offer which stated that a telecoms provider would not be charged for a RWT fault if its RWT faults made up less than 6% of its total reported faults. We classified clear codes that did not directly relate to either active or passive elements as 'other' and attributed such faults to active and passive elements of EAD circuits based on the split of active and passive faults.

A20.62 We noted that in BT's 2017/18 RFS the costs of staff working in customer contact centres and the costs of repair SLG payments were separated into two components: Openreach Service Centre – Assurance (Ethernet) and SLG Ethernet Assurance. We proposed to include 26% of the unit FAC of each of these components when updating our starting charge calculations using BT's 2017/18 RFS.

Stakeholder responses

A20.63 Openreach considered that we overestimated the expected reduction in faults per circuit for inter-exchange dark fibre services relative to EAD services and hence, underestimated the unit FAC of the Openreach Service Centre – Assurance (Ethernet) and SLG Ethernet Assurance components for inter-exchange dark fibre services. This was due to our proposed approach to classifying RWT faults as relating to either active or passive elements

[879] To calculate the main link unit cost we assume an average circuit distance of 7.1km, see page 241 of BT's 2018 AMD.

of active circuits. It stated that the 6% threshold for RWT faults in its DFA Final Reference Offer was intended to represent an allowed small margin of diagnostic error for telecoms providers and not to indicate the proportion of RWT faults on active circuits that related to passive elements.[880] Openreach suggested that, in the absence of better data on the proportion of RWT faults that related to passive elements of circuits, RWT faults should be attributed to active and passive elements in the same way as we proposed to attribute faults under clear codes we classified as 'other'.[881]

A20.64 No other stakeholders commented on our proposed approach to estimating Openreach Service Centre – Assurance (Ethernet) or SLG Ethernet Assurance costs for inter-exchange dark fibre services.

Our reasoning and decisions

A20.65 In BT's 2017/18 RFS there are no costs reported in the Openreach Service Centre – Assurance (Ethernet) component.[882] We therefore discuss our decision in relation to the costs of the SLG Ethernet Assurance component only.

A20.66 In BT's 2017/18 RFS, SLG Ethernet Assurance costs are attributed to Ethernet connection services based on service volumes.

A20.67 As in the Consultation, we consider that the appropriate framework for estimating the unit costs of this component for dark fibre rental services is to consider the relative number of faults per circuit likely to be incurred on a dark fibre circuit relative to an EAD circuit.

A20.68 We have updated our analysis of the number of reported EAD faults split by clear code to now cover the two-year period between November 2016 and October 2018 (rather than April 2016 to March 2018). We classify fault clear codes as relating either directly to the passive or active elements of an EAD circuit or as not relating directly to either ('other'). We assume that if BT provided inter-exchange dark fibre services:

- the number of active faults per circuit would be zero by definition; and
- the frequency of passive faults per circuit would be equal to that for EAD services.

A20.69 A relatively large proportion ([✂]%) of reported EAD faults are classified as RWT. For EAD services, we understand that this relates primarily to instances where BT's remote diagnostic testing using the EAD electronic equipment indicates that there is no apparent fault relating to BT's EAD service and that the fault may be the telecoms provider's responsibility (e.g. related to the telecoms provider's network or the electronic equipment that the telecoms provider has connected to the EAD electronic equipment).

A20.70 If a telecoms provider purchases an inter-exchange dark fibre circuit, it can carry out this remote diagnostic testing itself (Openreach will not be able to undertake any remote diagnostic tests). As a result, we consider that many faults on inter-exchange dark fibre services that might otherwise have been cleared as RWT (had Openreach provided an EAD

[880] Openreach's response to the 2018 BCMR Consultation (LLCC), paragraphs 49-50.
[881] Openreach's response to the 2018 BCMR Consultation (LLCC), paragraph 55.
[882] See page 97 (Appendix 1 – Network Activity Statements) of BT's 2017/18 RFS.

service) will no longer be reported to Openreach. In the Consultation, we used the 6% threshold outlined in Openreach's DFA Final Reference Offer (below which a RWT fault would not be subject to a RWT charge) as the basis for estimating this expected reduction in RWT faults for inter-exchange dark fibre services relative to EAD services.

A20.71 We accept that this threshold was probably intended to represent an allowable small margin of diagnostic error for telecoms providers, rather than an estimate of the proportion of faults cleared as RWT that were in fact related to passive elements of circuits (e.g. intermittent passive faults). In the absence of better data on the expected reduction in RWT faults, in our updated analysis we classify the RWT clear code as 'other' (i.e. not directly related to either the passive or active elements of an EAD circuit) and attribute faults to active and passive elements of circuits in the same way as we proposed for all 'other' clear codes in the Consultation and as explained below.

A20.72 Our classification of clear codes is shown in the table below, alongside the proportion of EAD faults accounted for by each clear code between November 2016 and October 2018.[883]

Table A20.2: Split of reported EAD faults by clear code (November 2016 to October 2018)

Clear code	Classification	% of EAD faults
Card replaced / reseat	Active	3%
Chassis change / reseat	Active	8%
Customer kit / customer damage	Active	8%
Customer kit no engineers dispatched	Active	2%
External fibre	Passive	15%
Internal Fibre	Passive	9%
Fault not found	Other	0%
Cancelled	Other	5%
Matters beyond our reasonable control (MBORC)	Other	3%
Provision fault	Other	2%
Right when tested (RWT)	Other	44%

A20.73 The data suggests that [✂]% of reported EAD faults related to active elements of the service, [✂]% to passive elements and that [✂]% did not directly relate to either. It is unclear how many of these 'other' faults would continue to be reported if BT provided inter-exchange dark fibre circuits in place of EAD circuits. As in the Consultation, we attribute these faults between active and passive elements pro-rata to the split of active

[883] Openreach's responses dated 14 September 2018 to question 22 of the 10th LLCC s.135 notice (October 2016 to March 2018) and 12 December 2018 to question 27 of the 11th LLCC s.135 notice (April 2018 to October 2018). Data refers to faults for standard (i.e. non-Local Access) EAD circuits.

and passive faults. This approach suggests that 48% of reported EAD faults are related to active elements of the service while 52% are related to passive elements.

A20.74 As a result, we estimate an expected reduction of 48% in faults per circuit for inter-exchange dark fibre services relative to EAD services. The decrease relative to our consultation estimate of 74% is mainly driven by our change in approach to estimating the expected reduction in RWT faults. We consider that RWT faults are likely to decrease by more than our updated assumption of 48%, but perhaps not by as much as our consultation assumption of 94%. However, as the unit FAC of SLG Ethernet Assurance for the EAD rental service is 0.71, our approach to estimating the expected reduction in RWT faults does not have a material impact on the overall starting charges we are setting for inter-exchange dark fibre services.

A20.75 As assumed implicitly in the Consultation, we do not expect the number of repair SLG failures per circuit to materially differ between EAD and inter-exchange dark fibre services. However, repair SLG payments for EAD circuits are currently a function of the rental price of the EAD circuit whose repair has been delayed. As discussed above, although contractual SLG arrangements for inter-exchange dark fibre services are yet to be determined, we consider it a likely starting point that SLG payments for these services will also be proportional to rental charges. We have updated our cost estimates on this basis by adjusting the unit FAC of the SLG Ethernet Assurance component based on the difference in rental charges (including main link charges) between an inter-exchange dark fibre service and EAD service. We adjust for differences in rental charges using the same approach as outlined above for SLG Ethernet Provision.

A20.76 We therefore include 16% (52% multiplied by 31%) of the unit FAC of the SLG Ethernet Provision component that is attributed to the EAD connection service within the unit FAC of element B of the inter-exchange dark fibre rental service.

Openreach Sales Product Management

Our proposals

A20.77 We proposed to adjust the unit FAC of the Openreach Sales Product Management component to reflect the relative prices of EAD and inter-exchange dark fibre services. In BT's RFS, Openreach Sales Product Management costs are attributed initially based on a survey of staff time allocated to product groups (e.g. all Ethernet products) and then based on service revenues within these product groups (e.g. between EAD and EBD). We assumed that inter-exchange dark fibre services would share staff with Ethernet products. We therefore estimated Openreach Sales Product Management unit costs by comparing the total costs for our services with those for our EAD reference products as a proxy for the relative prices.

Stakeholder responses

A20.78 Openreach disagreed with our proposal to adjust the unit FAC of the Openreach Sales Product Management component to reflect the relative price of EAD and inter-exchange dark fibre services (and hence revenues). It said that BT would attribute the costs of the Openreach Sales Product Management team in its RFS to inter-exchange dark fibre services, not based on revenues but on how Directors apportioned time to their teams.[884]

A20.79 Openreach estimated it would recover around £50,000 over the two-year charge control period based on our proposed unit FAC of the Openreach Sales Product Management component. However, Openreach said inter-exchange dark fibre services would require support from at least four full-time equivalent staff, costing around £500,000 over the two-year charge control period, and that the unit FAC should be uplifted appropriately.[885] It argued that, at a minimum, we should use the approach from its DFA Final Reference Offer pricing which assumed the unit cost for dark fibre services would be 20% of that for EAD services based on a survey of Directors in the Openreach Sales Product Management team.[886]

A20.80 No other stakeholders commented on our proposed approach to estimating Openreach Sales Product Management costs for inter-exchange dark fibre services.

Our reasoning and decisions

A20.81 In BT's RFS, Openreach Sales Product Management costs are attributed to connection, rental and main link services based on a survey of staff in the Openreach Sales Product Management team. This survey splits each team member's full-time equivalent (FTE) hours between Ethernet services and various other services (e.g. LLU MPF, LLU SMPF, PSTN). The survey is not however sufficiently granular to identify time relating to each individual Ethernet service. The surveyed FTE hours are therefore split between Ethernet services using revenue and volume data.[887]

A20.82 We asked Openreach to explain how it estimated the proportion of Openreach Sales Product Management costs that should be removed under the 'active minus' pricing approach it used to set prices for dark fibre services within its DFA Final Reference Offer. We also asked for any updated analysis Openreach had undertaken on this proportion since publishing its DFA Final Reference Offer.

A20.83 Openreach explained that, for its DFA Final Reference Offer pricing, it looked at the proportion of Sales Product Management team resources that was allocated to Ethernet services in 2015/16 and asked Directors responsible for these resources to estimate the likely split of time between Ethernet and DFA services in a world where the latter were introduced.[888] Openreach updated this analysis in August 2017 when preparing launch prices for DFA services which suggested a split of 81% and 19% between Ethernet and DFA services respectively.[889]

[884] Openreach's response to the 2018 BCMR Consultation (LLCC), paragraph 56.
[885] Openreach's response to the 2018 BCMR Consultation (LLCC), paragraphs 59-61.
[886] Openreach's response to the 2018 BCMR Consultation (LLCC), paragraph 62.
[887] See page 246 of BT's 2017 AMD.
[888] Openreach response dated 14 September 2018 to question 20a of the 10th LLCC s.135 notice.
[889] Openreach response dated 14 September 2018 to question 20b of the 10th LLCC s.135 notice.

A20.84 In the Consultation, we did not use the approach adopted by Openreach to support its DFA launch pricing. We assumed that BT would attribute Openreach Sales Product Management costs to inter-exchange dark fibre services in its RFS based on service revenues relative to total revenues for Ethernet services (as is currently the case for the attribution to each service within the group of all Ethernet services). Our proposal to include in the unit FAC for each inter-exchange dark fibre service an amount proportional to the unit FAC for the corresponding EAD service, adjusted to reflect price differences (and hence revenues), would be consistent with this attribution methodology.

A20.85 We accept though, that once inter-exchange dark fibre services are introduced, BT is likely to have some staff providing support for these services. BT is then likely to attribute Openreach Sales Product Management costs to inter-exchange dark fibre services in it RFS by asking Directors, as it does now, to identify the proportion of their team's time spent supporting inter-exchange dark fibre services. The attribution may well not be based on revenues.

A20.86 We therefore consider it appropriate to revise our approach to estimating unit contributions to Openreach Sales Product Management costs from inter-exchange dark fibre services. We consider that there are two options (noting that any estimate of the costs required to support a new product will necessarily be highly uncertain):

- estimate a total annual Openreach Sales Product Management cost for inter-exchange dark fibre services and convert this to a unit cost based on volume forecasts; or
- assume a 19% split of Openreach Sales Product Management costs between active Ethernet services and dark fibre services as Openreach did in its DFA launch pricing based on Directors' views of the likely split of time between Ethernet and dark fibre services in a world where the latter were introduced.

A20.87 While there is uncertainty in both options, we have decided to adopt the second option for the following reasons:

- For the first option, the only estimate of the total cost we have is Openreach's annual cost of around £250,000 based on inter-exchange dark fibre services requiring support of at least four full-time equivalent staff. This may not be unrealistic, but it is difficult to verify and carries a risk of gaming as it was specifically produced by Openreach to influence the level of the inter-exchange dark fibre charge control. In addition, there is uncertainty as to the likely demand for inter-exchange dark fibre services over the charge control period, and we have not explicitly forecast service volumes for dark fibre. Any estimated unit costs derived from Openreach's estimate of total cost would therefore be potentially unreliable and would not be calculated in a way that is consistent with the current attribution of Openreach Sales Product Management costs.
- The second option has the advantage of being derived using a methodology which is consistent with how Openreach Sales Product Management costs would be attributed in BT's RFS. However, this estimate was based on the introduction of the dark fibre remedy from the 2016 BCMR Statement. It could be argued that the unit cost may be lower as the inter-exchange dark fibre remedy is significantly more limited in scope than the previous dark fibre remedy. On the other hand, the unit cost may be higher

for the inter-exchange dark fibre remedy as any fixed costs may need to be recovered from volumes that are likely to be lower than for the previous dark fibre remedy.

A20.88 We therefore include in the unit FAC of element B of each inter-exchange dark fibre service 19% of the unit FAC of the Openreach Sales Product Management component that is attributed to the corresponding EAD service.[890]

Ofcom Administration Fee (Openreach)

Our proposals

A20.89 We proposed to adjust the unit FAC of the Ofcom Administration Fee (Openreach) component to reflect the relative prices of EAD and inter-exchange dark fibre services. We considered that this approach would be consistent with BT's approach to attributing the costs of Ofcom Administration Fee (Openreach) in its RFS which is based on service revenues.

Stakeholder responses

A20.90 Openreach argued that our proposal to adjust the unit FAC of the Ofcom Administration Fee (Openreach) component to reflect the relative price of EAD and inter-exchange dark fibre services would result in under-recovery of these costs. It considered that each inter-exchange dark fibre circuit would substitute for an existing EAD circuit, so that the total amount recovered across all EAD and inter-exchange dark fibre circuits would be less than the amount currently recovered across EAD circuits (as the contribution per inter-exchange dark fibre circuit would be relatively lower than per EAD circuit due to the lower price).[891]

A20.91 No other stakeholders commented on our proposed approach to estimating Ofcom Administration Fee (Openreach) costs for inter-exchange dark fibre services.

Our reasoning and decisions

A20.92 In BT's RFS, the cost of the Ofcom Administration Fee (Openreach) is attributed to connection, rental and main link services based on revenue. Our starting point is then, as in the Consultation, that the unit contribution to the recovery of this fee for inter-exchange dark fibre services relative to EAD services should reflect relative prices.

A20.93 We have not made the adjustment that Openreach suggested. Openreach's view that a lower unit contribution for inter-exchange dark fibre services relative to EAD services will result in under-recovery (when summed across all EAD and inter-exchange dark fibre services) assumes that all demand for inter-exchange dark fibre circuits will represent substitution from existing EAD circuits. As discussed above in relation to Ethernet Main

[890] We estimate that recovery of Openreach Sales Product Management costs from inter-exchange dark fibre services would be roughly £37,500 over two years if using volume forecasts consistent with those used by Openreach (Openreach's response to the 2018 BCMR Consultation (LLCC), paragraph 59). To the extent that this represented cost under-recovery we expect our approach to pricing of active services at 1Gbit/s and below (as set out in Section 2 of Volume 3) to result in some cost over-recovery, which could offset any potential under-recovery from inter-exchange dark fibre services.
[891] Openreach's response to the 2018 BCMR Consultation (LLCC), paragraphs 63-65.

Links, we agree that some demand for inter-exchange dark fibre circuits will be substitutional but there is likely to be some entirely new demand.

A20.94 To the extent that our approach results in reduced cost recovery, we consider that will be small due to the limited scope of the inter-exchange dark fibre remedy. Finally, we expect our approach to pricing of active services at 1 Gbit/s and below (as set out in Section 2 of Volume 3) to result in some cost over-recovery, which could offset any potential under-recovery from inter-exchange dark fibre services.

A20.95 As in the Consultation, we therefore adjust for price differences using the ratio of unit costs for each inter-exchange dark fibre service and its corresponding EAD service (we assume the ratio of unit costs will be a good proxy for the ratio of prices). These unit costs exclude the costs of the Ofcom Administration Fee (Openreach) component as well as those of other components we treat in this manner (Revenue Receivables as discussed below). Following this approach, we include 24% of the Ofcom Administration Fee (Openreach) EAD unit costs for connection services, 5% for rental services and 90% for main link services.

Revenue Receivables

Our proposals

A20.96 We proposed to adjust the unit FAC of the Revenue Receivables component to reflect the relative prices of EAD and inter-exchange dark fibre services. We considered that this approach would be consistent with BT’s approach to attributing the costs of Revenue Receivables in its RFS which is based on service revenues.

Stakeholder responses

A20.97 Openreach agreed with our proposed approach to estimating Revenue Receivables costs for inter-exchange dark fibre services.

A20.98 No other stakeholders commented on our proposed approach to estimating Revenue Receivables costs for inter-exchange dark fibre services.

Our reasoning and decisions

A20.99 In BT’s RFS, Revenue Receivables costs are attributed to connection, rental and main link services based on revenue. We adopt our consultation proposal and include in the unit FAC of element B of each inter-exchange dark fibre service, an amount that is based on the unit FAC of the Revenue Receivables component which is attributed to the corresponding EAD service, adjusted to reflect price differences.

A20.100 This approach will reflect the relatively lower debtors on dark fibre services compared to EAD services due to the lower price. We use the same approach to reflecting price differences as described above for the Ofcom Administration Fee (Openreach) component.

Costs specific to inter-exchange dark fibre services (‘element C’)

A20.101 For each inter-exchange dark fibre service, we include in element C of the cost stack an estimate of the unit FAC of the following costs that we have identified as being specific to inter-exchange dark fibre services (i.e. not currently incurred by Openreach when providing EAD services):

- patch panel costs; and
- initial testing / birth certificate costs.

A20.102 We first discuss the labour rates we use which are common to our estimation of both patch panel and initial testing costs. We then discuss the specific assumptions for patch panel and initial testing costs in turn.

Labour rates

Our proposals

A20.103 Both patch panel and initial testing costs involve engineers of different grades performing activities as part of the provisioning process for inter-exchange dark fibre circuits. We needed labour rate assumptions for ‘less qualified’ and ‘more qualified’ engineers required to perform these activities and proposed to base these on TRC rates published in BT’s RFS. As these appeared to reflect direct costs only, we proposed to apply an uplift to account for indirect and support costs and obtain FAC labour rate assumptions. We used the 37% uplift that we adopted in the 2016 BCMR Statement when estimating overheads for Ethernet TRCs.[892] We said we would use 2017/18 labour rates and update the FAC uplift assumption when setting starting charges in this statement.

Stakeholder responses

A20.104 No stakeholders commented on our proposed labour rate assumptions.

Our reasoning and decisions

A20.105 Both patch panel and initial testing costs involve engineers performing activities as part of the provisioning process for dark fibre circuits. To estimate these costs, we need to make assumptions about labour rates. We also apply these assumptions when estimating ancillary charges specific to dark fibre services later in this annex.

A20.106 Openreach explained that, when it estimated costs specific to dark fibre services in its DFA Final Reference Offer, it used LRIC labour rates for two engineering grades with different skillsets; we refer to these as ‘less qualified’ and ‘more qualified’ engineers.

[892] See paragraph 8.96 of 2016 BCMR Statement, Volume 2, where we discuss our approach to estimating overheads for Ethernet TRCs as BT was not able to provide sufficiently granular data.

A20.107 As in the Consultation, we use the direct labour rates published in BT's RFS for TRCs as a proxy for these labour rates. We use the TRC Total Direct Cost per hour for TRCs relating to Fixed Access markets as a proxy for the less qualified engineer pay rates which in 2017/18 was £37.50 per hour.[893] Similarly, we use the TRC Total Direct Cost per hour for Ethernet TRCs as the proxy for the more qualified engineer pay rates which in 2017/18 was £50.77.[894]

A20.108 As we are adopting a FAC cost standard, these labour rate assumptions should include contributions to indirect and support costs. Following the Consultation, we have updated our FAC uplift assumption by asking Openreach to provide a breakdown of Fixed Access and Ethernet TRCs in BT's 2017/18 RFS by direct labour costs (e.g. wages, pension), other labour costs (e.g. vehicles, tools, engineer managers), and general overheads (e.g. office buildings).

A20.109 This data indicates that the 'Total Direct Cost per hour' figures for Ethernet and Fixed Access TRCs in BT's 2017/18 RFS reconcile to the sum of the attribution of direct labour and other labour costs but do not include BT's attribution of general overheads which equate to an uplift of roughly 20%.[895] This is lower than the 37% uplift we used in the Consultation, which was based on analysis performed for the 2016 BCMR Statement to estimate general overheads for Ethernet TRCs as BT had not previously been able to provide data on its attribution of overheads to TRCs for Ethernet services. We have decided to apply an uplift of 20% which produces FAC pay rates of £45.00 per hour for the less qualified engineer and £60.92 per hour for the more qualified engineer.

Patch panel

Our proposals

A20.110 A patch panel would be the point of handover from Openreach to the purchasing telecoms provider for dark fibre services (the point of handover for EAD services is the active electronic equipment). We proposed to estimate the unit FAC of a patch panel based on the direct cost of the equipment as well as the cost of the labour required to install it. We considered that our FAC labour rate assumption included contributions to all material overheads that would be attributed to patch panels except for accommodation. However, we did not consider that the patch panel would trigger any incremental accommodation costs beyond those that the purchasing telecoms provider would already be paying for through co-mingling charges for its rack space within the BT exchange.

A20.111 We converted the FAC per patch panel, which given its multiple ports could support multiple inter-exchange dark fibre circuits, to a FAC per circuit using a port utilisation assumption. We proposed to include this in the rental charge using our asset life and

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[893] See Appendix 3.1 of BT's 2017/18 RFS. https://www.btplc.com/Thegroup/Policyandregulation/Governance/Financialstatements/2018/RegulatoryFinancialStatements2018.pdf [✂].
[894] See Appendix 3.5 of BT's 2017/18 RFS. [✂]
[895] Openreach response dated 13 March 2019 to questions 10a and 10b of the 12th LLCC s.135 notice.

WACC assumptions. We proposed that the FAC per circuit would be twice as much for a two fibre circuit as for a one fibre circuit due to using two ports rather than one.

Stakeholder responses

A20.112 Openreach considered that our proposals underestimated the per circuit FAC of a patch panel for two reasons:

- First, Openreach argued that it was not appropriate to use the port utilisation rate of 50% which supported its DFA Final Reference Offer pricing. It considered that the scope for filling patch panels would be relatively lower for the proposed inter-exchange dark fibre remedy as it applied only in a subset of the Rest of UK where the concentration of demand would be lower than the Rest of UK as a whole. Openreach also considered that two inter-exchange dark fibre circuits would be sufficient for a telecoms provider to supply nearly unlimited capacity on a given route, whereas for access DFA services, a circuit would have been required for each customer premises in the exchange area. Openreach considered that average utilisation of one or two ports (4%-8%) per patch panel would be reasonable over this charge control period and suggested using a mid-point of 6%.[896]
- Second, Openreach argued that our estimate accounted for the incremental cost of the patch panel and the FAC of the labour required to install it, but not the fixed and common costs associated with the patch panel itself.[897] Openreach considered that roughly £100 of overheads included in the Ethernet Electronics component (such as procurement costs, vehicle costs and general overheads) were not specific to the electronic equipment and would still be incurred if providing an inter-exchange dark fibre service with a patch panel in place of electronic equipment. In addition, as discussed above in relation to Ethernet Main Links, Openreach argued that this figure should be multiplied by a factor of 1.48 to reflect the potential for telecoms providers to substitute multiple EAD circuits on a route for a single inter-exchange dark fibre circuit.[898]

A20.113 Vodafone expressed a concern that we may have directly used Openreach's patch panel cost estimates, supporting its DFA Final Reference Offer pricing which reflected a blended cost across access and backhaul scenarios. Vodafone noted that only the backhaul scenario would be appropriate for estimating the cost of inter-exchange dark fibre services. It also considered that, as the underlying cost drivers for patch panels had not changed since Openreach's DFA Final Reference Offer pricing, it would not be appropriate to include any additional types of cost that were not included in Openreach's DFA Final Reference Offer pricing.[899]

[896] Openreach's response to the 2018 BCMR Consultation (LLCC), paragraphs 67-69.
[897] Openreach's response to the 2018 BCMR Consultation (LLCC), paragraphs 70-71.
[898] Openreach's response to the 2018 BCMR Consultation (LLCC), paragraphs 43-46.
[899] Vodafone's response to the 2018 BCMR Consultation, part 3, paragraph 6.73.

Our reasoning and decisions

A20.114 The handover point for BT's EAD service to the purchasing telecoms provider is the EAD Network Termination Equipment (NTE) installed at each of the two served locations.[900] The EAD NTE is the electronic equipment that lights the fibre and provides an active service. The purchasing telecoms provider can then connect its own equipment to the NTE via either an Ethernet or optical interface.

A20.115 To provide inter-exchange dark fibre services, Openreach would need to install some form of passive NTE to hand over the service to the purchasing telecoms provider. We include the unit FAC associated with this NTE in element C of the cost stack for the inter-exchange dark fibre rental service.

A20.116 Openreach's DFA Final Reference Offer specified that the NTE for the DFA service would be an optical patch panel installed at each of the served locations. It specified that Openreach would connect the unlit fibre to a port on the patch panel using an optical interface and that the purchasing telecoms provider would then connect its own equipment to the other side of this port using an optical interface. The DFA Final Reference Offer noted that four variants of patch panel would be available depending on the served location.[901]

A20.117 We asked Openreach to explain how it had estimated the incremental costs of installing patch panels within its DFA Final Reference Offer and for any updated analysis it had undertaken subsequently. Openreach explained that its approach was to[902]:

- estimate the costs of installing a patch panel as the sum of the equipment cost of the patch panel plus the labour costs, assuming the work would be undertaken by a less qualified engineer;
- calculate a cost per circuit by applying long-term utilisation assumptions depending on whether the patch panel was installed at a BT exchange or customer's premises; and
- convert this to an annual cost per circuit by assuming the costs would be capitalised over an assumed life.

A20.118 For its August 2017 pricing update, Openreach also planned to include some indirect and support costs, basing these estimates on a proportion of the incremental costs for the Ethernet Electronics component.[903]

A20.119 As in the Consultation, we adopt a similar methodology, except that we estimate a fully allocated unit cost per patch panel as the sum of the equipment cost and the FAC of the labour required to install it. In relation to Vodafone's concern, we do not use a blended

[900] The NTE installed by BT at each of the served locations as part of the EAD service is available in two variants. If the served location is a BT exchange, then the NTE is likely to be a modular chassis capable of supporting multiple circuits (this will be located within the telecoms provider's cabinet located in a Licensed Area within the BT Exchange). If the served location is a customer premises, then the NTE is likely to be a standalone unit to support a single circuit.

[901] Pages 11-14 of DFA Final Reference Offer: Technical Specification, 2016. https://www.openreach.co.uk/orpg/home/products/darkfibreaccess/darkfibreaccess/downloads/DFAfinalreferenceoffertechnicalspecifications011216.pdf.

[902] Openreach response dated 14 September 2018 to question 18a of the 10th LLCC s.135 notice.

[903] Openreach response dated 14 September 2018 to question 18b of the 10th LLCC s.135 notice.

cost across access and backhaul scenarios as used by Openreach for its DFA Final Reference Offer pricing.

A20.120 With respect to Openreach's concern about recovery of common costs, we do not agree that our estimates only include the incremental costs of installing the patch panel. We continue to consider that our FAC labour rate assumption includes sufficient contributions to all material overheads that would be attributed to a patch panel, with the exception of accommodation costs which we discuss separately below. We do not consider that the level of contribution to these overheads from inter-exchange dark fibre services should be equal to that for EAD services as suggested by Openreach. This is because if dark fibre services were included in BT's RFS, then most of these overheads would be attributed based on previously allocated costs.[904] Previously allocated costs for patch panels would predominantly reflect depreciation and mean capital employed. As the equipment costs of a patch panel (on an annual, per circuit basis) are significantly cheaper than Ethernet electronics, we would expect a patch panel to attract significantly lower overheads.

A20.121 We also do not adopt Openreach's suggestion that our estimate of patch panel overheads should be uplifted by a factor of 1.48 to reflect potential substitution of multiple active circuits for a single inter-exchange dark fibre circuit. Our arguments here are similar to those outlined above in response to the same argument that Openreach made in relation to Ethernet Main Link common costs. We do not think that cost recovery is likely to be a material issue here.

A20.122 We have reviewed our approach to estimating accommodation costs as this is the only "overhead" category which we do not consider to be adequately captured within our uplift from direct to FAC labour costs. We note that some accommodation costs are currently recovered from the Ethernet Electronics Current and EAD Electronics Capital components (over and above those included in co-mingling charges) and that we did not propose to include an allocation of these costs in the Consultation. Accommodation costs are allocated in BT's RFS based on utilised space.[905] We therefore include in the unit FAC of a patch panel a contribution to accommodation costs based on those attributed to the Ethernet Electronics and EAD Electronics Capital components for the EAD rental service, adjusted to reflect differences in the amount of rack space occupied by a patch panel compared to EAD electronic equipment.[906] This results in the inclusion of an additional £35.78 of accommodation costs per circuit per year.

[904] See for example Table 2.7 of Annex 28, 2016 BCMR Statement, which shows that c70% of AG112 costs (corporate costs) and a significant proportion of the other major overhead cost categories were allocated using previously allocated costs in our 2016 decision.

[905] Page 262 of BT's 2017/18 AMD.

[906] We calculated the unit FAC of accommodation costs within the Ethernet Electronics and EAD Electronics Capital components attributed to the EAD 1Gbit/s Rest of UK rental service in BT's 2017/18 RFS using data from pages 41 and 98 of BT's 2017/18 RFS as well as Additional Financial Information schedule 3 provided annually by BT to Ofcom alongside BT's RFS. We expect the type of patch panel Openreach would use for inter-exchange dark fibre services would occupy 1 rack-unit (RU). For example, see: Huber & Suhner 24 Port SC Single Mode Simplex Fibre Optic Patch Panel available from RS at https://uk.rs-online.com/web/p/fibre-optic-patch-panels/1442457/ [accessed 7 May 2019]. There are two main variants of

A20.123 We have also reviewed our patch panel utilisation assumptions. We acknowledge Openreach's view that the scope for filling patch panels is likely to be relatively lower for the inter-exchange dark fibre remedy than the previous dark fibre remedy set out in the 2016 BCMR Statement. Demand is likely to be less concentrated as a result of more limited geographic scope (certain BT Only exchanges as opposed to the Rest of UK previously) and use (backhaul only compared to a mix of access and backhaul previously).

A20.124 We previously assumed an average utilisation of twelve ports per telecoms provider's patch panel. We agree that this seems high as it implies an average of six two-fibre circuits which would be capable of providing nearly unlimited capacity to six other BT exchanges. In the absence of any robust data with which to estimate average port utilisation for inter-exchange dark fibre patch panels, we consider than an average port utilisation over the charge control period of two inter-exchange dark fibre circuits per patch panel is more reasonable. This assumes that on average a telecoms provider uses inter-exchange dark fibre services to connect a BT Only exchange to either two other BT exchanges with single fibre circuits or to one other BT exchange with a dual fibre circuit.

A20.125 With the exception of the accommodation cost and utilisation assumption, we adopt the other assumptions proposed in the Consultation. We therefore assume that an inter-exchange dark fibre circuit requires the installation of a 24-port patch panel in the telecoms provider's racks located within each of the BT exchanges. We assume that a patch panel costs £120[907] and that each patch panel would take three hours to install, which includes splicing work.[908] We use our estimate of the FAC labour rate for a less qualified engineer of £45.00 per hour.

A20.126 These assumptions generate a FAC of installing two patch panels which we need to convert to a cost per circuit per year (at which point we can then add the £35.78 contribution per circuit per year to accommodation costs).

A20.127 Assuming average port utilisation over the charge control period of two inter-exchange dark fibre circuits per patch panel results in a FAC per circuit (excluding accommodation) of £255. We include these costs, consistent with Openreach's pricing proposals, within the inter-exchange dark fibre rental service. We assume these costs would be capitalised and depreciated over an assumed life of seven years. We believe that these port utilisation assumptions imply that the unit patch panel costs of a two-fibre dark fibre circuit should be twice those of a one-fibre dark fibre circuit.

EAD electronic equipment supporting different maximum numbers of circuits and occupying either 1RU or 5RU. It is unclear which of these a telecoms provider would currently select if purchasing an inter-exchange EAD circuit from a BT Only exchange. To be cautious, we assume that a telecoms provider would currently purchase the smaller 1RU EAD electronic equipment. Our estimate of patch panel accommodation costs is therefore equal to the accommodation costs within the Ethernet Electronics and EAD Electronics Capital components attributed to the EAD 1Gbit/s Rest of UK rental service.

[907] Prices of patch panels similar to those we believe Openreach would install are generally around £160. For example, see Huber & Suhner 24 Port SC Single Mode Simplex Fibre Optic Patch Panel available from RS at https://uk.rs-online.com/web/p/fibre-optic-patch-panels/1442457/ [accessed 7 May 2019]. We assume that Openreach will be able to negotiate lower costs than this because of its buying power resulting in an assumption of £120 per unit. The assumption we have made here is [✂].

[908] [✂]

A20.128 The above assumptions result in a cost of £47.48 per fibre per annum. Finally, we add the annual per circuit contribution to accommodation costs to arrive at a final cost of £83.26 per fibre per annum. The table below outlines the derivation of this cost, which we include in element C of the cost stack for the inter-exchange dark fibre rental service.

Table A20.3: Calculation of per circuit unit FAC for patch panels

Item	Assumption
Cost of a patch panel	£120.00
Number of patch panels	2
Installation time per patch panel	3 hours
Installation resource cost (FAC)	£45.00 per hour
FAC per two patch panels (excluding accommodation)	£510.00
Average number of ports utilised per patch panel	2
FAC per circuit (excluding accommodation)	£255.00
Asset life of patch panel	7 years
WACC	7.1%
FAC per circuit per year (excluding accommodation)	£47.48 per year
Accommodation cost per circuit per year	£35.78 per year
FAC per circuit	£83.26 per year

Initial testing

Our proposals

A20.129 Initial testing costs would be incurred when providing an inter-exchange dark fibre circuit as, given the lack of electronic equipment, the circuit needs to be manually tested by an Openreach engineer to confirm the performance of the line before handover. We proposed to estimate the unit FAC of this initial testing by combining our FAC labour rate assumption with activities and associated timings supporting Openreach's estimate of the cost of this element (which Openreach referred to as the 'birth certificate') in its DFA Final Reference Offer. We proposed that the unit FAC for a two-fibre circuit would be the same as that for one fibre circuit as we considered it should be possible for an engineer to carry out tests on both circuits simultaneously with no additional travel time and negligible additional setup and diagnostic effort.

Stakeholder responses

A20.130 Openreach agreed that our estimate of initial testing costs for single fibre circuits captured the right activities and was reasonable. However, it considered that initial testing costs for two fibre circuits should be twice those for single fibre circuits. Openreach argued it would not be cost effective over the charge control period to equip engineers with two testing units. It stated that initial testing for two fibre circuits would therefore require travelling to and from the other end of the circuit two times (at two hours per round trip) as well as two sets of setup and diagnostic time (at 0.5 hours per circuit).[909]

A20.131 Vodafone observed that based on the activities and timings associated with initial testing it appeared to be "a very laborious, time consuming process" and that several telecoms providers had concerns regarding the level of this cost at the time of Openreach's DFA Final Reference Offer. Vodafone noted that as both ends of the proposed remedy would be at BT exchanges, in contrast to DFA where at least one end was likely to be at a customer's premises, the process should be "quicker, smoother, and less time consuming".[910]

Our reasoning and decisions

A20.132 Openreach's DFA Final Reference Offer specified that a dark fibre circuit needs to be tested on installation by an engineer to confirm the performance of the line before handover, as well as to generate a record to which future repair tests for that circuit could be compared (the 'birth certificate'). The equivalent test within the installation process for an EAD circuit can be performed using the electronic equipment.

A20.133 We asked Openreach to explain how it estimated the incremental costs associated with this initial testing in its DFA Final Reference Offer pricing. We also asked for any updated analysis it had undertaken on the costs associated with initial testing since publishing its DFA Final Reference Offer.

A20.134 Openreach explained that its DFA Final Reference Offer pricing assumed that a dark fibre circuit would require an additional [✂] (two to four) hours of installation time by a less qualified engineer compared to that required for an active EAD circuit. The tasks involved were as follows[911]:

- switch on a light source at one end of the circuit;
- travel to other end of circuit;
- perform an Optical Time Domain Reflectometer (OTDR) test; and
- travel back to first end of circuit and remove the light source.

A20.135 Openreach assumed that the labour costs associated with these activities would be capitalised, depreciated over [✂] years and recovered from the dark fibre rental service. In preparing updated prices in August 2017 for the expected launch of dark fibre services, Openreach updated its analysis to reflect 2016/17 rather than 2015/16 labour rates, but did not make any changes to the installation time assumptions.[912]

A20.136 We consider that this initial testing is a legitimate additional cost specific to a dark fibre circuit. We also consider that the activities and timings provided by Openreach are

[909] Openreach's response to the 2018 BCMR Consultation (LLCC), paragraphs 72-78.
[910] Vodafone's response to the 2018 BCMR Consultation, part 3, paragraph 6.73.
[911] Openreach response dated 14 September 2018 to question 18a of the 10th LLCC s.135 notice.
[912] Openreach response dated 14 September 2018 to question 18b of the 10th LLCC s.135 notice.

reasonable. However, as in the Consultation, we consider that the costs would be more appropriately recovered from the connection service rather than being capitalised and recovered from the rental service. We understand that the activities identified above are required for each circuit that is installed. The circuit will be broken at the end of its life – we discuss cessation costs in more detail below – and so could then not be used by anyone else. We therefore do not consider that an asset is being created by these activities and so the costs should not be capitalised.

A20.137 We assume that initial testing takes 2.5 hours and use our estimate of the FAC labour rate for a less qualified engineer of £45.00 per hour. We continue to consider that Openreach should be able to design processes for initial testing so that there is not a material difference in the time or cost required whether testing a single or dual fibre circuit (for instance, by making use of other engineers working at BT exchanges). We therefore include £112.50 in the unit FAC of element C of the inter-exchange dark fibre connection service to reflect the activities associated with the initial testing required for both single and dual fibre inter-exchange dark fibre circuits.

Treatment of non-domestic rates costs

Our proposals

A20.138 Non-domestic rates (NDRs) are a form of property tax paid by ratepayers on their rateable assets which include telecoms assets such as fibre and duct. We proposed to exclude BT's attribution of its NDR costs to the components used to provide EAD services from the cost stack for inter-exchange dark fibre services. This is because the liability for the NDRs applicable to a circuit falls on the telecoms provider that lights the fibre (i.e. the purchasing telecoms provider for an inter-exchange dark fibre circuit).

Stakeholder responses

A20.139 No stakeholders commented on our proposed treatment of NDR costs for inter-exchange dark fibre services.

Our reasoning and decisions

A20.140 In general, the NDR liability is calculated by multiplying a rateable value (RV) by a 'rate in the pound'. RVs are assessed by the relevant rating authority in each nation, for example the Valuation Office Agency (VOA) in England and Wales. In the case of BT, and some other telecoms providers, all contiguous rateable assets are valued together in what is called a 'cumulo assessment'. BT's NDR costs on its rateable network assets are therefore commonly referred to as its cumulo costs. We provide more background on NDRs in Annex 18 when discussing our approach to forecasting BT's cumulo costs.

A20.141 With respect to fibre assets, rating precedent has determined that as a general rule of thumb, the person who lights the fibre is considered to be in rateable occupation.[913] This means that if BT sells an active leased line service it is liable for the NDRs, whereas if BT sells a dark fibre service, the purchasing telecoms provider is liable for the NDRs once it lights that fibre.

A20.142 Prices for inter-exchange dark fibre services should therefore not include any contribution to BT's NDR costs. As we adopt a cost-based approach to setting dark fibre prices in this control, we therefore do not include BT's attribution of its cumulo rates costs to EAD services in the cost stack for inter-exchange dark fibre services. This primarily affects rental services because relatively little of BT's cumulo costs are attributed to connection services.

Decisions

A20.143 The following table shows a breakdown of the starting charges by element and component for each inter-exchange dark fibre service for a one fibre circuit.[914] These are based on costs from BT's 2017/18 RFS using our calculation of WACC as set out in Annex 21 and after making the base year cost adjustments outlined in Section 4 of Volume 3 and Annex 19.

[913] See paragraph 5.2 of Section 871 of the VOA's 2017 Rating Manual. https://www.gov.uk/guidance/rating-manual-section-6-part-3-valuation-of-all-property-classes/section-871-telecommunications-fibre-optic-networks [accessed 22 May 2019].

[914] These are the charges for a one-fibre dark fibre service. The charges for a two-fibre dark fibre service would be twice those above with the exception of the initial testing costs included in the connection charge. As we explain above we consider that these costs should be the same as those for a one fibre circuit. The connection charge for a two-fibre dark fibre circuit would therefore be £638.

Table A20.4: Starting charges for inter-exchange dark fibre services – detailed breakdown

		Connection (£ per circuit)	Rental (£ per circuit per year)	Main Link (£ per metre per year)
A: passive infrastructure costs	Routing and records	2.39	0.00	0.0000
	Ethernet Main Links	0.00	0.00	0.1208
B: other costs not specific to dark fibre	Openreach Systems and Development (Ethernet)	18.38	18.38	0.0025
	Openreach Sales Product Management	1.73	3.61	0.0003
	Openreach Service Centre – Assurance (Ethernet) [915]	0.00	0.00	0.0000
	Openreach Service Centre – Provision (Ethernet)	141.88	0.00	0.0000
	SLG Ethernet Assurance	0.00	0.11	0.0000
	SLG Ethernet Provision	96.54	0.00	0.0000
	Ofcom Administration Fee (Openreach)	0.19	0.08	0.0001
	Revenue Receivables	1.62	0.68	0.0011
C: costs specific to dark fibre	Patch panel	0.00	83.26	0.0000
	Initial testing	112.50	0.00	0.0000
Sub-total		**375.22**	**106.12**	**0.1248**
Final rounded starting charges[916]		**375**	**106**	**0.125**

Charges for ancillary services

A20.144 For Openreach to provide inter-exchange dark fibre services, it would also need to provide a number of ancillary services. These ancillary services can be divided into two groups:

- those that are equivalent to services that Openreach already offers to provide active services (e.g. TRCs); and

[915] In BT's 2016/17 RFS, which we used in the Consultation, some OR Service Centre – Assurance (Ethernet) costs were attributed to EAD rental services. In BT's 2017/18 RFS, this component was split into two components (OR Service Centre – Assurance (Ethernet) and SLG Ethernet Assurance) with OR Service Centre – Assurance (Ethernet) costs no longer being attributed to any EAD services.

[916] Note that in Section 4 of Volume 3 and in the legal instrument, we have rounded rental and connection charges to the nearest pound and main link charges to the nearest tenth of a penny.

- those that Openreach does not currently offer, which would be specific to inter-exchange dark fibre services.

A20.145 In Section 12 of Volume 2 we set out that ancillary services in the former group should be offered and charged for on the same basis as for active services. We identify two new ancillary services specific to the provision of inter-exchange dark fibre services and are setting cost-based prices for these services, namely:

- a cessation charge; and
- a RWT charge.

A20.146 Below we summarise our proposals, review stakeholder comments and explain our decisions as to the pricing of these two services.

Cessation charge

Our proposals

A20.147 An inter-exchange dark fibre circuit would need to be physically ceased by an engineer to stop it from being used when it is no longer being charged for, in contrast to an active circuit which can be ceased remotely using the electronic equipment. We proposed to allow Openreach to recover efficiently incurred costs of ceasing an inter-exchange dark fibre circuit by setting a cessation charge using a FAC cost standard. This was based on our assessment of the appropriateness of activities and timings estimated by Openreach in support of its DFA Final Reference Offer.

Stakeholder responses

A20.148 TalkTalk agreed with our proposal to use a FAC cost standard to set a cessation charge.[917]

A20.149 Openreach argued that the costs of ceasing inter-exchange dark fibre circuits would be better recovered via the rental charge than an ancillary charge for the following reasons[918]:

- this would be consistent with the approach to recovering cessation costs for the majority of other regulated Openreach services;
- a cessation charge may act as a barrier to switching; and
- it estimated that creating a new cessation product would require systems development costs of roughly £65,000 and that implementation may not be possible until the third quarter of 2019/20.

Our reasoning and decisions

A20.150 A dark fibre circuit needs to be physically broken by an engineer to prevent it from being used when it is no longer being charged for. This contrasts with the cessation process for an active service such as EAD that can be switched off remotely using the electronic NTE.

[917] TalkTalk's response to the 2018 BCMR Consultation, paragraph 4.82.
[918] Openreach's response to the 2018 BCMR Consultation (LLCC), paragraph 86.

A20.151 We asked Openreach to explain how it reflected the costs associated with the cessation of dark fibre circuits within its DFA Final Reference Offer pricing and for any updated analysis that Openreach had undertaken on these costs since publishing its DFA Final Reference Offer.

A20.152 Openreach explained that for both its DFA Final Reference Offer pricing[919] and work it had undertaken in August 2017 for the expected launch of dark fibre services[920], it had assumed that the cessation of a dark fibre circuit would require:

- a desk-based engineer to plan the activity and raise it on the system [✂] (one to three) hours; and
- a field engineer to travel to the site, access the site and locate, break and un-label the fibre before closing the job on the system [✂] (zero to two) hours[921].

A20.153 Openreach proposed to capitalise the cost of these activities, depreciate it over an assumed median circuit life of [✂] years and recover it from the dark fibre rental service.

A20.154 We consider that extra activities will need to be undertaken to cease an inter-exchange dark fibre circuit and that Openreach's updated estimates of the time required to perform these activities are reasonable.

A20.155 As in the Consultation, our view is that these costs are most appropriately recovered from a charge levied at the time of cessation rather than from the rental service as in Openreach's DFA Final Reference Offer pricing. It does not seem reasonable that telecoms providers should pay for the cessation in advance when the average life of an inter-exchange dark fibre circuit is unknown and may differ significantly from available proxies such as the average survival life for EAD circuits. Having a cessation charge avoids these uncertainties and the subsequent under-or-over recovery of cessation costs. It is also consistent with our proposed approach to initial testing costs discussed above.

A20.156 In relation to Openreach's reasons for preferring that the cost of ceasing inter-exchange dark fibre circuits be recovered through the rental charge rather than an ancillary charge:

- We do not consider that maintaining a consistent approach to the recovery of cease costs between inter-exchange dark fibre and active products is a priority as the relevant costs are unclear, but potentially significantly higher for inter-exchange dark fibre products compared to the remote cessation possible for active products.
- We do not consider that a cessation charge will act as a material barrier to switching and, in any case, consider that the risk of over or under-recovery arising from uncertainty about circuit life expectancy for inter-exchange dark fibre circuits significantly outweighs any such hypothetical risk.

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919 Openreach response dated 14 September 2018 to question 18a of the 10th LLCC s.135 notice.

920 Openreach response dated 14 September 2018 to question 18b of the 10th LLCC s.135 notice.

921 For the August 2017 update Openreach reduced the field engineer task time on the assumption that the cease would always be performed at a BT exchange, which would reduce travel time and site access time.

- We expect that very few (if any) cessations would be requested between the launch of the inter-exchange dark fibre product and the availability of a cessation product, and that Openreach should be able to find a suitable way of handling any that do occur. [✂][922]

A20.157 We assume that a cessation requires two hours of time from a more qualified engineer to undertake the desk-based planning activities outlined above and one hour of time from a less qualified engineer to undertake the field activities above, with estimated FAC labour rates of £60.92 and £45.00 respectively. This results in an estimated FAC per cessation of £166.85 which we round to set a cessation charge of £167.

A20.158 As for initial testing costs, we do not believe that this estimated FAC per cessation request varies with the number of fibres that are ceased. There should be no need for an engineer to undertake two different journeys to break both fibres on a two-fibre circuit (if that is what is requested) as both can be broken at the same location. Therefore, we set a cessation charge of £167 for both single and dual fibre inter-exchange dark fibre circuits.

Right when tested (RWT) charge

Our proposals

A20.159 A RWT charge is intended to incentivise purchasing telecoms providers experiencing faults on an inter-exchange dark fibre circuit to carry out diagnostic tests eliminating their own networks and/or equipment as potential causes before reporting such faults to Openreach. We proposed to allow Openreach to recover efficiently incurred costs of handling a fault on an inter-exchange dark fibre circuit that it ultimately clears as RWT by setting a RWT charge using a FAC cost standard. This was based on our assessment of activities and timings estimated by Openreach in support of its DFA Final Reference Offer.

Stakeholder responses

A20.160 TalkTalk agreed with our proposal to use a FAC cost standard to set a RWT charge.[923]

A20.161 Openreach agreed that our proposed price for the RWT charge reflected FAC.[924] However, it considered that setting the price for the RWT charge on a FAC basis was not appropriate and argued that a fair and reasonable charges obligation or a 30% mark-up over FAC would discourage inefficient use of Openreach engineering resource as[925]:

- It stated that RWT faults on inter-exchange dark fibre circuits represented engineers that would otherwise not have been dispatched if the circuit were active as Openreach would have had its own diagnostics available from the active equipment. It argued that

[922] [✂]
[923] TalkTalk's response to the 2018 BCMR Consultation, paragraph 4.82.
[924] Openreach's response to the 2018 BCMR Consultation (LLCC), paragraph 79.
[925] Openreach's response to the 2018 BCMR Consultation (LLCC), paragraph 84.

this would divert resource from responding to "genuine customer impacting" faults, resulting in either poorer overall on-time repair performance or higher repair costs from use of overtime.[926]

- It considered that travel times for Openreach engineers were likely to be shorter than for other telecoms providers' engineers due to Openreach's national engineering workforce, resulting in a relatively lower FAC for handling faults (all else being equal). It argued this would incentivise telecoms providers to dispatch Openreach engineers rather than their own engineers.[927]
- It argued that telecoms providers would benefit from reporting faults even if their own diagnostics indicated they were not likely to be fibre faults as this would "start the clock ticking if it subsequently transpires they do need an Openreach engineer to fix the dark fibre fault".[928]

A20.162 Openreach also observed that our proposed RWT charge was based on the hourly cost of labour in standard working hours. It noted that for out-of-hours RWT faults it would raise, in addition to a RWT charge, a supplementary charge for out-of-hours work based on the rate published on its TRC list.[929]

Our reasoning and decisions

A20.163 Openreach's DFA Final Reference Offer proposed that faults reported to Openreach that were ultimately cleared as RWT by an Openreach engineer may be subject to a charge. The RWT charge was intended to encourage telecoms providers to carry out diagnostic testing before reporting a fault. This increases the likelihood that reported faults on dark fibre circuits relate to Openreach's passive infrastructure, rather than to the purchasing telecoms provider's electronic equipment or network.

A20.164 Openreach's DFA Final Reference Offer specified that a RWT charge of £599 would apply only to RWT faults exceeding 6% of the overall fault volumes reported by a telecoms provider (assessed on a quarterly basis). Openreach stated that any RWT faults within this threshold would be charged using TRCs in line with the contract.[930]

A20.165 In Section 12 of Volume 2 we set out that Openreach should be able to levy a RWT charge subject to the thresholds described above and to set a cost-based price for a RWT charge.

A20.166 We consider that the appropriate cost standard for setting a cost-based RWT charge based on these timings is FAC. We consider that such a charge will be sufficient to encourage telecoms providers to carry out appropriately thorough diagnostics using their own active equipment before reporting faults on inter-exchange dark fibre circuits to Openreach.

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[926] Openreach's response to the 2018 BCMR Consultation (LLCC), paragraph 80.
[927] Openreach's response to the 2018 BCMR Consultation (LLCC), paragraph 81.
[928] Openreach's response to the 2018 BCMR Consultation (LLCC), paragraph 82.
[929] Openreach's response to the 2018 BCMR Consultation (LLCC), paragraph 85.
[930] Page 8 of Openreach DFA Final Reference Offer Pricing, 2016.
https://www.openreach.co.uk/orpg/home/products/darkfibreaccess/darkfibreaccess/downloads/DFAfinalreferenceofferpricing011216.pdf.

A20.167 We do not consider that telecoms providers will be incentivised to report faults to Openreach due to any disparity in average travel times as suggested by Openreach. We consider that the relevant comparison for a telecoms provider experiencing a fault on an inter-exchange dark fibre circuit would be between the expected costs of carrying out its own remote diagnostic testing first, as opposed to initiating a fault request to Openreach without having done so. That calculation would need to take account of several factors, including the expected probability of the fault being ultimately on its equipment and network, the likelihood of incurring a relatively high RWT charge and the costs of rectifying the fault. It seems unlikely that average travel times would be a critical factor in that comparison.

A20.168 We also do not agree with Openreach's view that there will be a benefit to reporting a fault to Openreach even if a telecoms provider's diagnostic tests show it is not likely to be due to Openreach's network (to "start the clock ticking" if it later turns out to be due to Openreach's network, e.g. an intermittent fault). To assess whether there was a benefit to reporting a fault in these instances, the telecoms provider would need to assess the likely net cost. This would require weighting outcomes where it did or did not pay a relatively high RWT charge based on the expected probability (at the time of reporting) that the fault would later turn out to be due to Openreach's network. It is unclear that such an assessment would always, or even in a majority of cases, result in there being a benefit. In addition, any delays to rectifying a fault on an inter-exchange dark fibre circuit due to strategic reporting behaviour presents a high risk to the purchasing telecoms provider as a fault is likely to affect the service of multiple end-user customers.

A20.169 We asked Openreach to explain how it set the RWT charge within its DFA Final Reference Offer and for any updated analysis that Openreach had undertaken on these costs since publishing its DFA Final Reference Offer.

A20.170 Openreach explained that in both its DFA Final Reference Offer pricing and its updated launch pricing analysis in August 2017 it had assumed the following activities would be required for a RWT fault[931]:

- A desk-based (more qualified) engineer would:
  - validate the fault, review telecoms provider diagnostic data and create a task; and
  - locate a precision test officer (PTO), a more qualified engineer, assign them the task and arrange site access before finally closing the task.
- The PTO would:
  - travel to the site and conduct an OTDR test;

[931] Openreach response dated 14 September 2018 to question 21 of the 10th LLCC s.135 notice. In Openreach's DFA Final Reference Offer pricing for the RWT charge it also included costs relating to tri-band testers required to perform the ODTR tests specified above. It converted the total cost of a tri-band tester to an hourly recovery charge over an assumed [✂] year asset life of £[✂]. When reviewing the launch pricing for DFA in August 2017, Openreach excluded the cost of tri-band testers from the RWT charge as there was a possibility that this handset type would be ordered for all engineers as standard.

- if the test at a wavelength of 1,250nm proved correct as RWT then attach a light source at the site, travel to the other end where they would test the circuit at wavelengths of 1,310nm and 1,550nm;
- travel back to the initial site, remove the light source and communicate back to the operations centre; and
- travel back to the previous job.

A20.171 It then estimated costs by applying a fully allocated pay cost “blended to create a 24 hour cost” to its estimates of the time taken on these activities; [✂] (0.5 to 1.5) hours for the desk-based engineer and [✂] (4 to 6) hours for the PTO[932].

A20.172 We broadly agree with the activities and timings provided by Openreach for handling a RWT fault, but we do not consider the costs should include [✂] (0.5 to 1.5) hours of time for the PTO to travel back to the previous job.[933] This travel time would have been required regardless of whether the PTO cleared the reported fault as RWT or diagnosed a genuine fault relating to BT’s passive infrastructure. We therefore assume a RWT fault would require 0.75 hours of work for a staff member in BT’s AOC and 4.25 hours of work for a PTO.

A20.173 We therefore set the RWT charge in the same way as we proposed in the Consultation. We have assumed that a RWT fault will require 0.75 hours of work for a staff member in BT’s AOC and 4.25 hours of work for a PTO. We have used our estimate of the FAC labour rate for more qualified engineers of £60.92 per hour. This results in an estimated FAC per RWT fault of £304.62 which we round to set a RWT charge of £305. Finally, we agree with Openreach’s observation that our labour rate assumptions reflect standard working hours and that it should therefore be able to raise supplementary charges based on its published TRCs for RWT faults handled out-of-hours.

[932] Openreach response dated 14 September to question 21 of the 10th LLCC s.135 notice.
[933] Openreach response dated 14 September to question 21 of the 10th LLCC s.135 notice.

A21. Cost of capital

A21.1 In Section 4 of Volume 3 we set our approach to estimating inter-exchange dark fibre prices. This requires an estimate of the appropriate return on the mean capital employed (MCE), which should reflect our view of the forward-looking weighted average cost of capital (WACC) for these services.

A21.2 In Section 2 of Volume 3 we explain our decision to cap prices at current levels for active leased lines services. We explain that to inform our decision on how best to implement price stability for active services at 1 Gbit/s and below, we have modelled the likely evolution of efficient costs up to the end of this review period. This modelling, discussed in Annex 18, requires an estimate of the forward-looking WACC for active leased lines services.

A21.3 In both cases, the cost modelling is done in nominal terms without explicit modelling of tax, and so we require a forecast of the pre-tax nominal WACC. This annex sets out our views of the appropriate WACC for inter-exchange dark fibre services and for active leased lines.

A21.4 The WACC combines the cost of funding from debt (Kd) and equity (Ke), each weighted by their relative share of enterprise value (i.e. the sum of the value of debt and equity). The value of outstanding debt relative to enterprise value (gearing) is denoted by g in the WACC formula below and the rate of corporation tax is denoted by t.

$$WACC = \frac{Ke * (1-g)}{1-t} + Kd * g$$

Summary of our WACC decisions in this statement

A21.5 We start with estimating the WACC for BT Group since we do not have a pure play comparator for the lines of business regulated in this review and the regulated activities within BT represent a large part of the company.[934] We therefore want any disaggregated WACC for the regulated lines of business to be commensurate with the overall WACC for BT Group.

A21.6 We use the same three-way disaggregation of the BT Group WACC used in the 2018 WLA Statement and the preceding 2016 BCMR Statement. Our final estimates for the BT Group WACC and its three constituent parts (Openreach[935], Other UK Telecoms and Rest of BT) are shown in Table A21.1 below.

[934] According to BT's 2018 RFS, markets in which BT was found to have SMP represented 63% of returns and 42% of MCE.
[935] This was previously referred to as 'Openreach copper access', but as a short-hand and reflecting the wider scope of regulated products in that category we now use the shorter notation 'Openreach'.

Table A21.1: BT WACC, 2019 BCMR Statement (2020/21)

WACC component	BT Group	Openreach[936]	Other UK Telecoms	RoBT	Source
Real (RPI-deflated) RFR	-1.3%	-1.3%	-1.3%	-1.3%	Ofcom estimate
RPI inflation forecast	2.8%	2.8%	2.8%	2.8%	OBR
Nominal RFR	1.5%	1.5%	1.5%	1.5%	= (1+real RFR)*(1+RPI inflation)-1
Real (CPI-deflated) TMR	6.7%	6.7%	6.7%	6.7%	Ofcom estimate
CPI inflation forecast	1.9%	1.9%	1.9%	1.9%	OBR
Nominal TMR[937]	8.7%	8.7%	8.7%	8.7%	= (1+real TMR)*(1+CPI inflation)-1
Nominal ERP[938]	7.3%	7.3%	7.3%	7.3%	= Nominal TMR – Nominal RFR
Debt beta (βd)	0.10	0.10	0.10	0.10	Ofcom estimate
Asset beta (βa)	0.68	0.55	0.65	0.98	Ofcom estimate
Asset beta weight	100%	20%	65%	15%	Ofcom estimate
Gearing (forward looking) (g)	40%	40%	40%	40%	Ofcom estimate
Equity Beta (βe)	1.07	0.85	1.02	1.57	= (βa - βd*g)/(1-g)
Cost of equity (post-tax) (Ke)	9.2%	7.6%	8.8%	12.9%	= Nominal RFR + ERP *βe
Cost of equity (pre-tax)	11.1%	9.2%	10.7%	15.5%	= Ke / (1-t)
Corporate tax rate (t)	17.0%	17.0%	17.0%	17.0%	HMRC
Cost of debt (pre-tax) (Kd)	4.0%[939]	3.9%	4.0%	4.1%	Ofcom estimate
WACC (pre-tax nominal)	**8.3%**	**7.1%**	**8.0%**	**11.0%**	**=(Ke*(1-g))/(1-t)+(Kd*g)**
2018 BCMR Consultation	*8.5%*	*7.2%*	*8.0%*	*12.6%*	

Source: Ofcom[940]

[936] In the 2018 WLA Statement we also used the Openreach WACC in the calculation of PIA rental charges as part of the remedy introduced in the 2018 WLA, as well as for LLU services (Volume 3, page 146, paragraph 5.6).
[937] This is equivalent to a real (RPI-deflated) TMR of 5.8% using the Fisher equation, i.e. (1+nominal TMR)/(1+ RPI inflation) = real (RPI-deflated) TMR.
[938] Note: most of the figures shown in the table are rounded to one decimal point, but all intermediate calculations are unrounded. This explains why the nominal ERP is 7.3% rather than 7.2% as would be calculated by subtracting the nominal RFR (of 1.5%) from the nominal TMR (of 8.7%) shown in the table.
[939] Note that we have corrected an error in the calculation of the cost of debt since publishing the Draft 2019 PIMR and BCMR Statement. This explains why, rounded to one decimal point, the final WACCs have increased by ten basis points.
[940] For comparison purposes, the UKRN annual update has previously reported real vanilla WACCs used by UK regulators (where the vanilla WACC represents a weighted average of the post-tax cost of equity and the pre-tax cost of debt) with

A21.7 The main changes from the Consultation relate to the following, which we explain in more detail later in this annex:

- a reduction in the real (RPI-deflated) RFR from -1.25% to -1.3%, based on updated evidence, which, combined with the latest inflation forecasts, leads to a reduction in the nominal RFR from 1.6% to 1.5%;
- a reduction in the nominal TMR from 8.8% to 8.7%, based on an unchanged real (CPI-deflated) TMR of 6.7% combined with latest inflation forecasts;[941]
- a reduction in the BT Group asset beta from 0.71 to 0.68, reflecting updated estimates of the BT Group asset beta and an increase in the forward-looking gearing assumption from 35% to 40%; and
- a decrease in the Openreach asset beta from 0.56 to 0.55, reflecting updated estimates of the BT Group asset beta and UK utility asset betas.

A21.8 We consider that the risk of providing active leased lines circuits is best captured by the Other UK Telecoms WACC. We estimate the pre-tax nominal WACC for Other UK Telecoms as 8.0%. For the purposes of our modelling of active leased line circuits (described in Annex 18), we use a range of 7% and 9% (one percentage point lower and higher than our point estimate), as we did in the Consultation.

A21.9 In relation to inter-exchange dark fibre services, in the Consultation, we noted the difficulty in evaluating the underlying risk, but on a qualitative assessment proposed to use the Other UK Telecoms WACC in estimating the efficient costs of providing these services. However, in light of stakeholder responses and further analysis given the circumstances of the market in which access to dark fibre is being required, we consider that the risk will be lower than for active leased lines supplied in general. As such, we consider that the Openreach WACC will provide a better approximation of the risks in providing inter-exchange dark fibre than the Other UK Telecoms WACC. Our estimates of the efficient costs of providing inter-exchange dark fibre (described in Section 4 of Volume 2 and Annex 20) reflect our estimate of the Openreach WACC of 7.1% (pre-tax nominal).

A21.10 In the remainder of this annex, we set out our framework for estimating the WACC, followed by our decisions on each individual WACC parameter shown in Table A21.1.

respect to RPI. The real vanilla WACC (with respect to RPI inflation of 2.8%) is 4.1%, 3.1%, 3.9% and 6.3% for BT Group, Openreach, Other UK Telecoms and RoBT respectively.

[941] Note that due to the fact that intermediate calculations are unrounded, the updated nominal ERP (rounded to one decimal point) is 7.3%, rather than 7.2% which is implied by subtracting the nominal RFR (1.5%) from the nominal TMR (8.7%).

Framework for estimating an appropriate rate of return

Our proposals

Key objectives

A21.11 Before setting out our proposals in the Consultation, we explained the key objectives guiding our cost of capital estimation.[942]

- **Efficient price and investment signals** – the WACC is an important input in setting cost-based regulated charges (particularly in capital intensive industries). Regulated charges should provide the regulated firm with the opportunity to finance efficient investment and provide access seekers with efficient 'build-vs-buy' price signals.
- **Stability** – financing telecoms infrastructure and services involves making long-term investments where demand may be uncertain and wholesale prices are limited by *ex ante* regulation. It is important for investors (not only those in the regulated firm, but also those in competing infrastructure providers and access seekers) to be able to commit risky capital in the knowledge that our approach to price regulation provides an expectation, but not the guarantee of recovery of efficient costs, including the cost of finance.
- **Consistency** – we aim to ensure that there is consistency in our decisions, both between parameters in a given decision and, as far as reasonably possible, with other regulatory decisions. This should also provide investors with more certainty that our approach to regulation will provide for a fair expected rate of return.
- **Transparency** – we aim to clearly explain our approach to stakeholders and seek to avoid overly elaborate methodologies.

A21.12 We considered that our WACC proposals in the Consultation struck a reasonable balance between these objectives.

Overall approach

A21.13 We explained our approach to estimating the forward-looking efficient rate of return.

- **The cost of equity** is calculated using the Capital Asset Pricing Model (CAPM). Under the CAPM the cost of equity is a function of the risk-free rate (RFR), the expected return on the equity market above the risk-free rate (i.e. the equity risk premium, or ERP) and the systematic risk of the company (i.e. equity beta, βe):

$$Ke = RFR + ERP * \beta e$$

[942] This framework embodies principles similar to those proposed in the 2018 EC Consultation. EC, 2018. *Targeted consultation on guidance on cost of capital for EU electronic communications regulators* (https://ec.europa.eu/digital-single-market/en/news/targeted-consultation-guidance-cost-capital-eu-electronic-communications-regulators). This consultation followed a 2016 report by Brattle for the EC which considered approaches used by European telecoms regulators to estimate the cost of capital (https://publications.europa.eu/en/publication-detail/-/publication/da1cbe44-4a4e-11e6-9c64-01aa75ed71a1/language-en/format-PDF/source-search).

Under our approach, the equity beta is estimated by first undertaking a three-way disaggregation of the BT Group asset beta (into Openreach, Other UK Telecoms and the Rest of BT), before re-levering these asset beta estimates using a forward-looking gearing estimate to calculate equity betas.

- **The cost of debt** is calculated by combining the RFR with a debt premium (dp), i.e. the corporate debt rate above benchmark risk-free assets, such that:

$$Kd = RFR + dp$$

In deciding on the appropriate estimate for the cost of debt, we placed some weight on the cost of BT's existing (or embedded) debt. The cost of debt is also disaggregated three ways into Openreach, Other UK Telecoms and the Rest of BT.

A21.14 We also noted that we had regard to the approaches used by other UK regulators such as Ofgem[943], Ofwat[944] and CAA[945] to set the cost of capital, and to other recent research on the topic such as the March 2018 report by Wright et al commissioned by the UK Regulators Network (UKRN) (2018 UKRN Report).[946]

A21.15 In the interests of stability and consistency, particularly as this is a relatively short, two-year review, we proposed to continue using the same three-way disaggregation of the BT Group WACC used in the 2018 WLA Statement and the preceding 2016 BCMR Statement. We also proposed to use the Other UK Telecoms WACC for active leased lines services as well as for inter-exchange dark fibre services.

A21.16 In the interests of sending efficient price and investment signals, we proposed to reduce the RFR and total market return (TMR, which is the sum of the RFR and the ERP) from that used in the 2018 WLA Statement.

A21.17 We considered it remained appropriate to continue to place some weight on BT's existing debt obligations when estimating the overall cost of debt for the purposes of setting charge controls. This is because an efficiently financed firm may not have anticipated the scale of the Bank of England's quantitative easing (QE) programme and the extent of the current low interest rate environment. Therefore, a cost of debt based primarily on current market rates may not be consistent with providing the regulated firm with a 'fair bet' on its financing costs.[947] As such, the proposed overall cost of debt was estimated by reference to a weighted average of the forward-looking cost of debt (informed by our revised estimate of the RFR and the debt premium) and the cost of BT's existing debt.

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[943] Ofgem, 2018. *RIIO-2 Sector Specific Methodology Annex: Finance*. https://www.ofgem.gov.uk/system/files/docs/2018/12/riio-2_finance_annex.pdf.
[944] Ofwat, 2017. *Delivering Water 2020: Our final methodology for the 2019 price review*, pages 172-180. https://www.ofwat.gov.uk/wp-content/uploads/2017/12/Final-methodology-1.pdf.
[945] CAA, 2019. *Appendices to Draft UK Reference Period 3 Performance Plan proposals, Consultation*, Appendix D. http://publicapps.caa.co.uk/docs/33/CAP%201758A.pdf.
[946] Wright, S. Burns, P., Mason, R., Pickford, D., 2018. *Estimating the cost of capital for implementation of price controls by UK regulators*. http://www.bbk.ac.uk/ems/faculty/wright/wrightburnsmasonpickford2018.pdf.
[947] A 'fair bet' approach to estimating the cost of debt is one which gives the regulated firm an opportunity, but not a promise, to recover efficiently incurred financing costs, with broadly similar probabilities of over- or under-recovery against the regulatory allowances over the longer-term.

Stakeholder responses

A21.18 BT Group and TalkTalk were the only stakeholders to provide substantive comments on our WACC estimates. Neither commented on our overall objectives in estimating the WACC.

A21.19 On the overall approach to market parameters, BT Group disagreed with our proposal to place more weight on recent data to estimate the RFR and it also disagreed with our proposal to reduce the TMR. TalkTalk was generally supportive of the direction of travel on these parameters but considered further reductions were justified.

A21.20 Both stakeholders questioned whether applying the Other UK Telecoms WACC appropriately captured the risk of active leased lines services. TalkTalk further considered that we had substantially overestimated the systematic risk of inter-exchange dark fibre services by using the Other UK Telecoms WACC.

A21.21 BT Group was supportive of our overall approach to estimating the cost of debt, while TalkTalk considered it was not appropriate to give weight to BT's existing debt costs.

A21.22 Finally, BT Group stated that our proposal to reduce the cost of capital since the 2018 WLA Statement was inconsistent with the Government's aim of encouraging fibre investment, as it would constrain Openreach's ability to invest.[948]

Our reasoning and decisions

A21.23 As most stakeholder comments concern estimates of the individual parameters, we respond to these along with our reasoning on each parameter later in the annex. Overall, we have decided to adopt the same approach to the WACC as in the Consultation. The main change is that we have decided to use the Openreach WACC in estimating the risk of providing inter-exchange dark fibre, as noted earlier.

A21.24 In response to BT Group's comment regarding our proposal to lower the WACC since the 2018 WLA Statement, we consider that our decision on each individual parameter is carefully-evidenced, compatible with recent research and regulatory practice and, in light of the available evidence, is designed to provide investors with a fair expected rate of return on their investments.

RFR

Our proposals

A21.25 We proposed a real (RPI-deflated) RFR of -1.25%, reflecting the continued reduction in yields on index-linked gilts and our proposal to place greater weight on more recent evidence on gilt yields.

[948] BT Group's response to the 2018 PIMR and 2018 BCMR Consultations, paragraph 6.3.

Stakeholder responses

A21.26 BT argued that using short-run averages of gilt yields would result in more volatile estimates across regulatory reviews, creating unnecessary regulatory instability.[949]

A21.27 Further, BT argued that while long-run historical averages suggested a real RFR slightly below zero, interest rates were set to increase[950] and therefore a real RFR of 0% (as adopted in the 2018 WLA decision) remained appropriate.[951] BT presented evidence showing that the Bank of England's Base Rate is expected to increase by 80-100bp by 2021, which, in its view, suggested long-run gilt yields would increase in line with base rates.[952]

A21.28 BT also stated that we used forward rates to justify a RFR estimate above spot rates, but it considered that the forward rates were a poor predictor of future yields.[953]

A21.29 BT also noted that higher sovereign risk due to Brexit (which could lead to downgrades of UK's credit rating) could cause higher gilt yields and therefore a higher RFR.[954]

A21.30 TalkTalk welcomed our changes in the level of the RFR but argued that we should go further and use prevailing forward rates which were around -1.5% in the Consultation.[955]

Our reasoning and decisions

A21.31 The RFR in the economy is not directly observable. Instead, it must be approximated by finding an established and (as far as possible) riskless asset which is highly liquid (i.e. regularly traded). Typically, government bonds (known in the UK as 'gilts') are used as a proxy for the RFR.

A21.32 In recent regulatory decisions we have estimated the real (RPI-deflated) RFR by reference to average yields on index-linked gilts.[956] When estimating the real (RPI-deflated) RFR from index-linked gilt yields, two relevant considerations are the bond maturity and the averaging period.

Bond maturity

A21.33 Telecoms investments have relatively long asset lives and an efficient network operator would be expected to finance investments (whether network renewals or enhancements) steadily through time. For example:

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[949] BT Group's response to the 2018 PIMR and 2018 BCMR Consultations Annex 2, paragraph 2.51.
[950] Based on Bank of England and other independent forecasting agencies.
[951] BT Group's response to the 2018 PIMR and 2018 BCMR Consultations, Annex 2, page 4.
[952] BT Group's response to the 2018 PIMR and 2018 BCMR Consultations, Annex 2, paragraphs 2.46-2.47.
[953] BT Group's response to the 2018 PIMR and 2018 BCMR Consultations Annex 2, paragraph 2.48.
[954] BT Group's response to the 2018 PIMR and 2018 BCMR Consultations Annex 2, paragraph 2.50.
[955] TalkTalk's response to the 2018 BCMR Consultation, paragraph 5.6.2.2.
[956] By using index-linked gilts we observe the yield net of compensation for (RPI) inflation – itself a form of risk.

- BT's network infrastructure assets have asset lives of between two and 40 years, while the main assets used to deliver business connectivity services (fibre and duct) have asset lives between five and 40 years[957];
- the average remaining maturity on BT's debt is currently around eight years[958]; and
- the average maturity from issuance on BT's debt is currently around 14 years.[959]

A21.34 In previous decisions we have considered yields on five-, ten- and 20-year index-linked gilts, but have tended to place most weight on ten-year gilts as a reasonable estimate of the relevant time horizon for telecoms investments. We continue placing most weight on ten-year gilts in this decision.

Averaging period

A21.35 In recent regulatory decisions we have estimated the real (RPI-deflated) RFR by reference to average yields on index-linked gilts rather than current (spot) yields. Using averages avoids putting too much weight on spot rates which may be volatile and avoids large swings from one regulatory decision to the next.

A21.36 However, a key question is how long a period should be used for averaging. Given that the same RFR underpinned both the cost of equity and the overall cost of debt in previous decisions, we tended to use longer averaging periods to inform our RFR estimate. This recognised that firms issue debt over several years and at various points through the economic cycle.[960] We did not mechanistically follow a single averaging period but, in practice, our estimates have been between the five- and 15-year averages of yields on ten-year gilts (as shown in Figure A21.2).

A21.37 Using longer term averages helps ensure that the cost of debt estimated by combining a RFR with a debt premium is reasonable when compared to estimates of the weighted average cost of existing and new debt.[961] We considered that this cross-check against the overall average cost of debt was reasonable because even an efficiently financed firm might not have anticipated the length and scale of QE coupled with an extended period of low interest rates.

A21.38 However, taking a particularly long averaging period for gilt yields means the RFR underpinning the cost of equity is slow to adjust to current market data. Given the fact that low gilts yields have persisted for several years (and it seems unlikely rates will revert to pre-crisis levels for the foreseeable future) and concerns over the overall cost of debt can be addressed by other means, we have decided to place greater weight on more recent gilt yields in this statement.

[957] Page 211 of BT's 2018 annual report shows the asset lives used by BT for network infrastructure assets. Page 91 of the 2018 Regulatory Financial statements shows that fibre and duct represent the majority of assets used to provide business connectivity services.
[958] Based on Ofcom analysis of S&P Capital IQ data as at 2 March 2019.
[959] Based on Ofcom analysis of S&P Capital IQ data as at 2 March 2019.
[960] 2018 WLA Statement, paragraph A20.33.
[961] 2018 WLA Statement, paragraph A20.48.

A21.39 While the principle of stability referred to in the framework section above could support the use of longer averaging periods, we consider that placing greater weight on more recent yields would help ensure that our estimates of the cost of equity provide efficient price and investment signals, i.e. they would more closely reflect the current financial market conditions facing investors.

A21.40 We disagree with BT's assertion that our approach would increase regulatory uncertainty. While the RFR may display more volatility between decisions than historically, we are still not relying on spot rates, but are considering the available evidence in the round (including averages over several years as well as forward rates). Further, the overall impact on the WACC is moderated by our approach to the TMR (which does not move one-for-one with the RFR) and our approach to the cost of debt (in which we make some allowance for embedded debt). As such, we do not believe that our approach would materially increase the volatility of the WACC estimates across regulatory reviews, or that any potential increase in the volatility outweighs the benefits of using a WACC which is more reflective of the prevailing market conditions.

A21.41 We agree with TalkTalk's suggestion that forward rates are an informative source of evidence on the RFR. However, we consider it is appropriate to consider the evidence in the round (including evidence on historical averages) to ensure we are not placing too much weight on only the very latest spot and forward yields which could lead to decisions which are unduly affected by 'noise' in the data.

A21.42 With regards to BT's statement that forward rates are a poor predictor of future yields, as with any forecast, we accept that forward rates could turn out to be wrong. However, they remain an objective source of evidence on the forward-looking expectations of future gilt yields.

A21.43 BT argued that HM Treasury's consensus forecasts of the official Base Rate and the Bank of England's forecasts of the market-implied path for the Base Rate would support a higher estimate of the RFR than we proposed. However, BT has not provided any evidence that these forecasts have proven more accurate in the past than forward gilt yields. It is also not clear that any expected increases in the Base Rate (which is a short-term rate) would translate into an equivalent increase in a ten-year gilt yield.

A21.44 Finally, these forecasts, similar to forward rate evidence, can change frequently. While the latest consensus forecasts from HM Treasury for the Base Rate for 2021 are broadly similar to the forecasts presented by BT[962], the Bank of England notes a fall in both short-term and long-term interest rates since the November 2018 report cited by BT, with the Base Rate now expected to be around 20 basis points lower on average over the next three years compared to November.[963] Therefore, while this evidence suggests interest rates are

[962] HM Treasury Forecast for the UK economy, February 2019. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/780025/PU797_Forecast_for_the_UK_Economy_feb_2019.pdf.

[963] The Bank of England's February 2019 Inflation Report. https://www.bankofengland.co.uk/-/media/boe/files/inflation-report/2019/february/inflation-report-february-2019.pdf.

expected to rise, it is not obvious that we should solely place weight on this evidence and not consider forward rate evidence for longer-term gilt yields.

A21.45 As we illustrate below, our RFR assumption is above the spot rate by some margin and is consistent with expectations of interest rates rising. However, we also show that the evidence does not support a real RFR of 0%, as suggested by BT.

A21.46 Further, we do not agree with BT that an adjustment to the RFR is required because of higher sovereign risk due to Brexit (which could lead to downgrades of UK's credit rating) as:

a) current expectations of the risks associated with Brexit have been priced into gilt yields already; and

b) if Brexit develops in a way that negatively impacts the UK's sovereign risk, it may imply that UK gilts are a less appropriate proxy for the risk-free asset.

A21.47 We present updated market evidence on the RFR below, which we consider justifies adopting a real (RPI-deflated) RFR of -1.3%.

Market evidence on yields on index-linked gilts

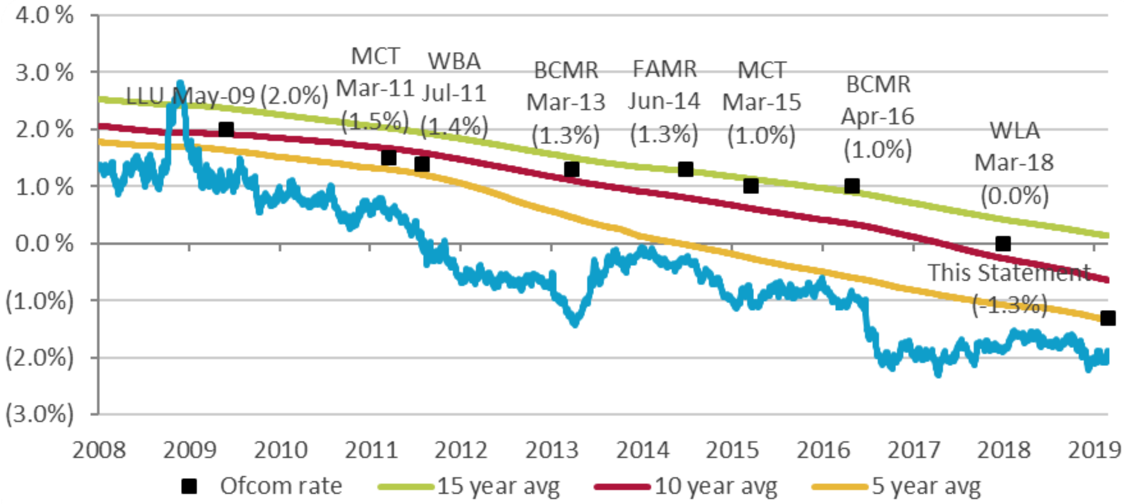
A21.48 Yields on ten-year index-linked gilts averaged over different periods (between five and 15 years) are currently in the range of -1.3% to 0.1%, while spot rates are around -2.0% (as shown in Figure A21.2). While the spot rate has shown signs of increasing at times in the last year, it remains close to some of the lowest levels seen in the last decade and the historical averages (with the exception of the 15-year average) remain notably below the real (RPI-deflated) RFR of 0% used in the 2018 WLA Statement.

A21.49 Real forward rates on five- and ten-year gilts are currently in the region of -1.7% (as shown in Figure A21.3) suggesting that it might not be appropriate to use a RFR as low as indicated by current spot rates.[964] Given the available data on index-linked gilt yields, the earliest forward rate we can calculate is a forward rate in four years' time (i.e. for February 2023, which is two years after the end of the charge control).[965] Therefore, we have also considered evidence on nominal forward rates which are shown in in Figure A21.4. Nominal forward rates indicate that the ten-year nominal gilt yield is expected to be around 1.5% by the end of the charge control.

[964] The end of the charge control is in 2020/21, which is in two years' time. Forward rates shown in Figure A21.3 represent the expected yields on five- and ten-year gilts four years from the date shown on the horizontal-axis.

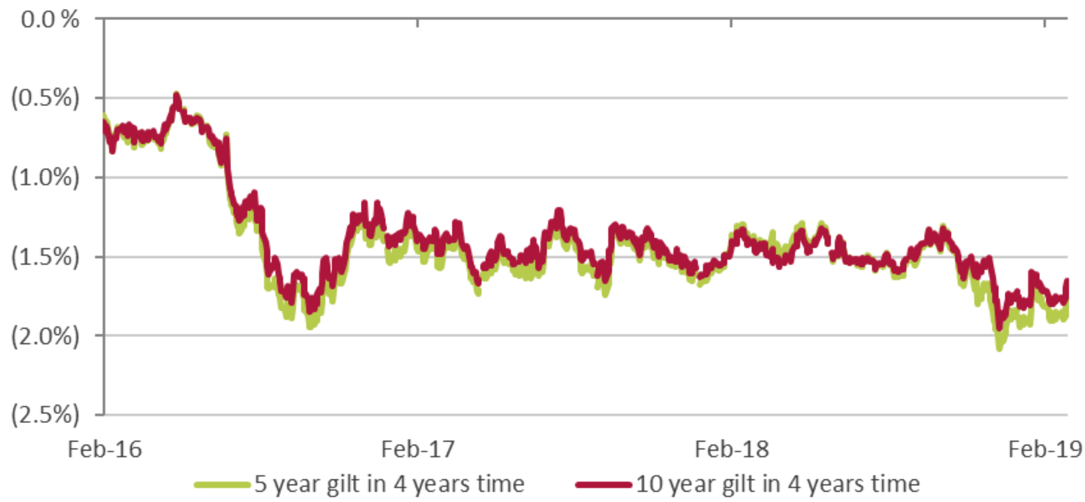
[965] The Bank of England no longer publishes real yields for two-year and three-year gilts and we are therefore unable to calculate the real forward rate for a five- and ten-year year gilt in two or three years' time.

Figure A21.2: Yields on ten-year gilts and Ofcom decisions on real RFR



Source: Bank of England, Ofcom analysis. Data as at 28 February 2019.

Figure A21.3: Real forward rates on five- and ten-year gilts taken out in four years' time



Source: Bank of England, Ofcom analysis. Data as at 28 February 2019.

Figure A21.4: Nominal forward rates on five- and ten-year gilts taken out in two years' time

Source: Bank of England, Ofcom analysis. Data as at 28 February 2019.

Our decision

A21.50 Based on the evidence above, we consider that a real (RPI-deflated) RFR of -1.3% is appropriate. Combined with our RPI inflation forecast for 2020/21 of 2.8% (see below), the nominal RFR is 1.5%. We do not consider it is appropriate to use a RFR based on spot rates because forward rate evidence suggests gilt yields are expected to increase from current spot yields and, placing too much weight on the latest yields, could mean our decisions are unduly affected by noise in the data. This does not align with our principles of stability and consistency.

A21.51 However, as explained above, we also do not consider it is appropriate to use a RFR based on very long-run averages (which are significantly above spot and forward rates) as this could undermine our objective of sending efficient price signals. A real (RPI-deflated) RFR of -1.3% is consistent with a five-year historical average of index-linked gilt yields, whereas an implied nominal RFR of 1.5% (using an RPI-deflated RFR of -1.3% and an RPI inflation forecast of 2.8%) is consistent with nominal forward rates for ten-year gilts taken out in two years' time (i.e. around the end of the charge control). We consider this strikes a reasonable balance between our different objectives and the available market evidence.

TMR and ERP

Our proposals

A21.52 We proposed a real (CPI-deflated) TMR of 6.7%. This was equivalent to a real RPI-deflated TMR of 5.8% and therefore represented a decrease from the value of 6.1% (RPI-deflated) used in the 2018 WLA Statement. This revision was based on our assessment of the latest available evidence and informed by advice from Europe Economics. Our proposals on the RFR and the TMR, together with latest inflation assumptions, implied a nominal ERP of 7.2% (an increase from the 6.3% used in the 2018 WLA Statement).

Stakeholder responses

A21.53 BT said that our reduction in the TMR since the 2018 WLA Statement was driven by placing more weight on forward-looking evidence derived from a dividend growth model (DGM), rather than long-run historical averages that we placed weight on previously.[966] BT said that DGM results can be volatile over time and cited alternative DGM models from the Bank of England and Bloomberg which produce different TMR estimates, arguing that it was not appropriate to rely on such models in a regulatory context.[967]

A21.54 BT further stated that both Europe Economics[968] and the authors of the 2018 UKRN Report are of the view that long-run historical evidence was the most objective source of evidence to use when setting the TMR in a regulatory context.[969] BT also disagreed with our reliance on historical *ex ante* evidence because such evidence relies on subjective adjustments to historical data.[970]

A21.55 Finally, BT questioned the robustness of Europe Economics' work on the correlation between the RFR and TMR. BT suggested that other studies point to a one-for-one relationship between the RFR and the ERP, such that the TMR is stable over time.[971]

A21.56 Overall, BT considered that a real (CPI-based) TMR of 7.0% would be more appropriate, based on long-run historical data.

A21.57 TalkTalk welcomed our evidence-based approach to the TMR but considered that most weight should be placed on the historical *ex ante* evidence which points to a TMR of around 6%. TalkTalk said that historical *ex post* data relies heavily on long time series, and so can be misleading if there are structural breaks. It suggested there was strong evidence that such a structural break occurred in the cost of finance at the time of the 2007/08 financial crisis.[972]

Our reasoning and decisions

A21.58 The TMR represents the sum of the RFR and the ERP. While the expected TMR and expected ERP are not directly observable, in recent decisions we have placed more weight on estimates of the TMR because historically it has been less volatile than the ERP[973], with the ERP estimated by subtracting the RFR estimate from the TMR estimate.

A21.59 We recognise that the views of experts can differ when it comes to estimating the level of the TMR and the relationship between the RFR, ERP and TMR. We present the available

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[966] BT Group's response to the 2018 PIMR and 2018 BCMR Consultations, Annex 2, paragraph 2.96.
[967] BT Group's response to the 2018 PIMR and 2018 BCMR Consultations, Annex 2, paragraphs 2.24-2.26.
[968] BT Group's response to the 2018 PIMR and 2018 BCMR Consultations, Annex 2, paragraph 2.14.
[969] BT Group's response to the 2018 PIMR and 2018 BCMR Consultations, Annex 2, paragraph 2.16.
[970] BT Group's response to the 2018 PIMR and 2018 BCMR Consultations, Annex 2, paragraph 2.22.
[971] BT Group's response to the 2018 PIMR and 2018 BCMR Consultations, Annex 2, paragraph 2.39.
[972] TalkTalk's response to the 2018 BCMR Consultation, paragraph 5.110.
[973] From Table 71 of the 2018 Yearbook the ratio of standard deviation to arithmetic mean for the nominal TMR is 1.9, which is lower than the equivalent ratio for the nominal ERP calculated for equities against bonds (3.4) and equities against bills (3.1).

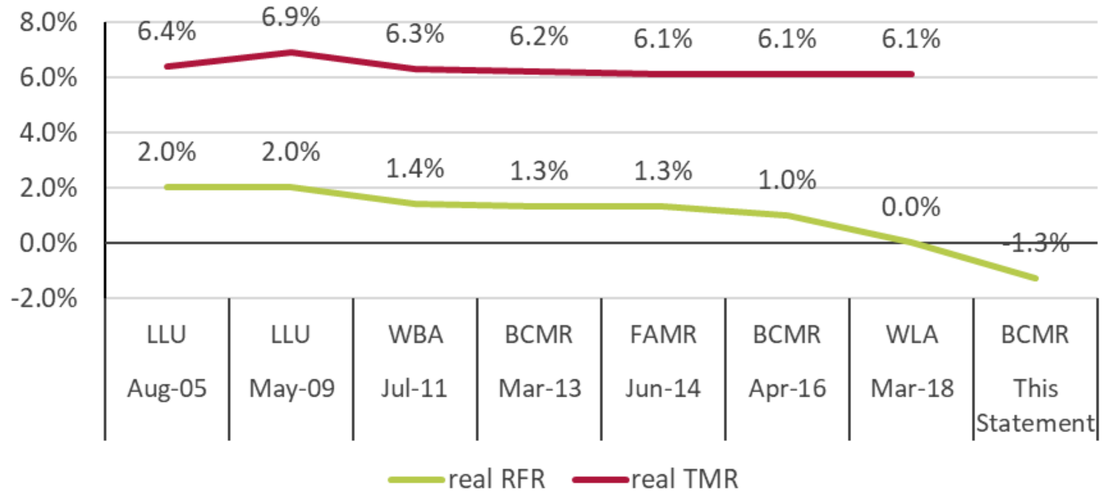
evidence and respond to stakeholder comments below. We conclude that a real (CPI-deflated) TMR of 6.7% remains appropriate.

Our previous decisions

A21.60 In the 2018 WLA Statement we used a real (RPI-deflated) TMR of 6.1% informed by historical *ex post* and *ex ante* estimates of the TMR using data from Dimson, Marsh and Staunton (DMS) in the Credit Suisse 2017 Yearbook (2017 Yearbook) and the 2017 Barclays Equity Gilt Study (2017 EGS).

A21.61 Between 2005 and 2018, our decisions on the real (RPI-deflated) RFR estimates fell by two percentage points and we have now decided to reduce this further (as discussed above).[974] Over the same period, our real TMR estimates also reduced, though at a much slower rate. We have used a real (RPI-deflated) TMR of 6.1% for the last three fixed telecoms market reviews (starting with the 2014 FAMR Statement), during which time we have reduced the real RFR by only 1.3 percentage points up to the 2018 WLA Statement. These decisions are shown in Figure A21.5.

Figure A21.5: Real RFR and real TMR decisions in charge controls on BT (RPI-deflated)



Source: Ofcom decisions. Note that real TMR estimates for 2005 to 2014 have been estimated by adding the real RFR rate to the real ERP used in our decisions because the TMR was not directly estimated and reported in those decisions.

A21.62 Given the sustained period of very low gilt yields, we consider it is appropriate to revisit the evidence on the TMR, including more recent studies.

[974] Taking into account our decision on the real RFR (RPI-deflated) in this Statement (in 2019) the real RFR (RPI-delated) has fallen by 3.3 percentage points since 2005.

Historical *ex post* evidence

A21.63 Historical *ex post* approaches assume that realised equity returns are a good proxy for the forward-looking expected TMR. Since asset returns, especially equity returns are volatile, it is reasonable to consider long periods of history (if data permits).

A21.64 As BT points out, the 2018 UKRN report recommends that regulators base their estimate of the TMR on historical averages calculated over a very long period.[975] While the authors of that report recognise that actual returns may deviate from the long-run historical average, they suggest that regulators cannot do better when forecasting the TMR than to assume that the TMR is stable over time.

A21.65 The 2018 UKRN report recommends a real (CPI-deflated) TMR range of 6% to 7%.[976] The report uses the Bank of England's long-term CPI measure to calculate the real CPI-based historic return for the UK[977], and supplements it with evidence on international returns (which it notes are CPI-based)[978], to derive a range.

A21.66 The 6% to 7% 2018 UKRN report range is estimated by adding a volatility adjustment to the historical geometric return to arrive at an arithmetic average return, with the size of the adjustment depending on the choice of the investment horizon and the extent to which serial correlation in returns is taken into account.[979] The historical geometric return used by the UKRN report as the starting point is around 5.5%[980] although the authors note that a figure of not much more than 5% looks increasingly persuasive.[981]

A21.67 The 2018 UKRN report, drawing on earlier research, suggests that, given that there is some evidence of serial correlation in returns over time, annual returns for longer holding periods would be expected to be lower than for shorter holding periods.[982] Therefore, the adjustment to the historical geometric average return to arrive at an estimate of the arithmetic average return (which can then be used to proxy the forward-looking TMR) would depend on the chosen investment horizon, and this is reflected in the range

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[975] 2018 UKRN report, page 47. This is consistent with the recommendation in the 2003 report by Wright et al, February 2003. *A Study into Certain Aspects of the Cost of Capital for Regulated Utilities in the UK*, page 48.
[976] UKRN report, Appendix E.
[977] In comparison, the 2019 Yearbook (page 212) reports UK real returns using RPI until 1949, back history of CPI from 1949 until 1988, and CPI from 1988 onwards to deflate UK nominal returns. The 2018 Yearbook (cited by the UKRN report) reports UK real returns using a cost of living index until 1947, RPI from 1947 until 1988, and CPI from 1988 onwards to deflate UK nominal returns (page 210 of the 2018 Yearbook).
[978] Appendix D of the UKRN report discusses the issues relating to inflation measurement in interpreting historical returns data. For example, on page 117, the UKRN report sets out the reasons why the authors recommend estimating the real cost of equity in CPI terms. One of the reasons given is that "we can calculate a CPI based historic real return on a consistent basis, and then augment this with evidence on international returns which are essentially CPI based real returns".
[979] UKRN report, Appendix E, page 125.
[980] The real historical geometric average return (in sterling) for the UK quoted by the UKRN report is between 5.5% (as calculated by DMS) and 5.2% (if nominal DMS returns are deflated using the Bank of England's CPI series).
[981] UKRN report, Appendix E, page 125.
[982] UKRN report notes that "long-horizon returns have distinctly lower volatility than would be the case in a random walk stock market". UKRN report, Appendix, page 125.

presented in the 2018 UKRN report. The top end of the UKRN range would be consistent with a shorter holding period.[983]

A21.68 Europe Economics' October 2018 report estimates that average historical returns imply a real TMR of 7.0% to 7.3%. Europe Economics directly estimates the arithmetic average of historical returns: the figure of 7.0% is derived by deflating nominal DMS UK returns using the Bank of England's CPI series, and the figure of 7.3% is the real arithmetic average return reported by DMS.[984] Europe Economics assumes no serial correlation in returns, which leads it to conclude that the historical arithmetic average would be a reasonable proxy for the forward-looking TMR.

A21.69 While BT is correct to recognise that Europe Economics has placed some weight on historical *ex post* evidence, Europe Economics also considers other evidence on the TMR to inform their recommended range, which we discuss further below.[985]

A21.70 We consider that evidence on returns over holding periods longer than one year is relevant because most investors are likely to hold shares for more than one year. We also recognise that the evidence on serial correlation of returns over time is mixed. Given these uncertainties, we consider it is appropriate to give weight to the 2018 UKRN report range as well as evidence from Europe Economics. This suggests a range for historical real returns from 6% up to 7.3%.

A21.71 It is difficult to assess the impact of changes in measuring inflation on real realised returns over the period of more than one century for which equity returns have been measured. However, in 2013, the ONS declassified the UK RPI index as a national statistic and has recently concluded that RPI is an upwardly biased measure of inflation.[986] The 2015 Johnson Review of price indices explored the shortcomings of RPI and noted that CPI was the headline measure of inflation in the economy.[987]

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[983] A longer holding period would equate to a TMR closer to 6% than 7%.

[984] See Europe Economics, 2018. *Cost of Capital: Total Market Return* (Europe Economics' October 2018 report), pages 14-15.
https://www.ofcom.org.uk/__data/assets/pdf_file/0026/124739/europe-economics-wacc-report.pdf. Using the latest addition of the DMS Yearbook (the 2019 Yearbook), average historical arithmetic returns are 6.9% and 7.2% using the Bank of England's CPI series or the DMS inflation series respectively.

[985] See Europe Economics, 2019. *Comments on BT's response to the BCMR consultation in relation to WACC market parameters*, (Europe Economics' April 2019 report), page 5. https://www.ofcom.org.uk/consultations-and-statements/category-1/review-physical-infrastructure-and-business-connectivity-markets.

[986] The debate about the appropriateness of RPI as an inflation measure has largely been triggered by the ONS methodology changes introduced in 2010. See ONS's latest discussion on the shortcomings of RPI:
https://www.ons.gov.uk/economy/inflationandpriceindices/articles/shortcomingsoftheretailpricesindexasameasureofinflation/2018-03-08.

[987] Johnson, P., 2015. *UK Consumer Price Statistics: A Review*. https://www.statisticsauthority.gov.uk/archive/reports---correspondence/current-reviews/uk-consumer-price-statistics---a-review.pdf. The Review also recommends that the ONS should work towards making CPIH (a variant of CPI which includes a measure of housing costs) the headline measure of inflation, after certain shortcomings in its composition are resolved.

A21.72 Over the 20th century, the estimated difference between the UK CPI and UK RPI has been relatively modest (0.14%)[988], suggesting that the choice of inflation index used to deflate nominal returns may not be that significant, at least for the first century of data reported in the DMS dataset. The wedge between RPI and CPI has been more significant in recent years.[989] The DMS dataset uses CPI to deflate historical returns from 1988 onwards, implying that their real estimates are not too affected by recent changes to RPI and that at least the last quarter of their real data sample is CPI-based.[990] Therefore, we consider that the evidence presented above (from the 2018 UKRN report, Europe Economics report, as well as from the DMS dataset directly) can be used to provide reasonable estimates of real *ex post* CPI-based returns to inform future expectations.

A21.73 It is harder to assess the impact of changes in inflation measurement on how investors form their return expectations. However, as explained above, the ONS has recently established that RPI is a flawed and upwardly biased measure of inflation.[991] Hence, assuming investors target real returns, it seems reasonable to assume that expected returns would be shaped by an expectation that nominal returns would compensate investors for CPI (the headline measure of inflation targeted by the Bank of England for monetary policy) rather than RPI inflation.

A21.74 In summary, we conclude that historical *ex post* evidence would support a real (CPI-based) TMR in the range from 6% up to 7.3%.[992]

Historical *ex ante* evidence

A21.75 In previous charge controls we have also considered two historical *ex ante* approaches to estimating the real TMR from Fama and French, and DMS.

A21.76 Fama and French's approach estimates the real TMR from the sum of average dividend yields and the average real rate of dividend growth.[993] Data from the 2018 Barclays EGS suggests that the average dividend yield was 4.5% over the period 1900 to 2017 in the UK[994], with dividend yields in recent years below the long-run average (around 3.5% since 2010). Both the Barclays and DMS datasets suggest average real dividend growth rates of

[988] 2018 UKRN report, page 122.
[989] The wedge between RPI and CPI has increased in recent years and averaged at 0.7% over the 2000-16 period (2018 UKRN report, page 122).
[990] In the 2019 Yearbook, DMS changed their methodology to estimate UK inflation. DMS has switched to using a back history of CPI between 1949 and 1988 (O'Neil and Ralph, 2013) rather than RPI. Since 1988 DMS uses CPI, and for period before 1949 it uses RPI.
[991] See ONS's discussion on the shortcomings of RPI: https://www.ons.gov.uk/economy/inflationandpriceindices/articles/shortcomingsoftheretailpricesindexasameasureofinflation/2018-03-08.
[992] Assuming forecast CPI of 1.9%, this would imply a nominal TMR of around 8.0% up to 9.3%.
[993] Fama, E. F. and French, K. R., April 2002. *The Equity Premium*, Journal of Finance Vol. LVII, No. 2.
[994] DMS reports an average dividend yield of 4.6% for the UK market over the same time period. However, the DMS dataset does not provide data on dividend yields by year. 2019 Yearbook, page 34.

around 1.2%. These numbers would imply a real TMR of 5.7% (based on long-run average dividend yields) or lower (based on current dividend yields).

A21.77 As discussed in some detail by the CMA in its 2014 decision on the Northern Ireland Electricity appeal[995], part of the difference between expected returns under a dividend yield approach (such as the one described above) and historical (arithmetic) averages could be due to historically lower volatility of dividend growth (i.e. income) relative to equity price (i.e. capital) growth. However, part of the difference might also be attributed to relatively high realised returns in the second half of the 20th century, which might be due to unrepeatable factors or good luck. This would suggest that TMR estimates based on historical *ex post* evidence could overstate future expected returns.

A21.78 This conclusion is similar to the findings of DMS, most recently described in the 2019 Yearbook. The authors infer what returns investors may have been expecting in the past by separating the historical equity risk premium into elements that correspond to investor expectations and those that relate to non-repeatable good or bad luck. DMS consider dividend income, real dividend growth, expansion of valuation ratios and changes in the real exchange rate.[996] DMS infer that going forward, once they adjust for non-repeatable factors of the past, globally diversified investors might expect an arithmetic average ERP over treasury bills of around 5.0%.[997] Given the average long run real return on US treasury bills (which is the DMS preferred measure of risk-free returns[998]) is 0.9%[999], this implies an expected real TMR of around 5.9% (or lower if based on current treasury bill rates rather than long-run averages[1000]). As the DMS estimates are for a global investor, we consider it is appropriate to view these estimates as an indication of the expected real, CPI-based, return.[1001] The DMS evidence is consistent with the analysis from Fama and French that historical returns may overstate future returns, but we recognise that this evidence is not UK-specific.

A21.79 BT states that there is no clear evidential basis for the DMS adjustment to historical *ex post* returns. We recognise that it is unclear whether past returns incorporate an element of non-repeatable 'good luck'. However, we consider it is useful to take account of alternative sources of evidence on the TMR (in addition to historical ex post evidence), consistent with our approach in previous reviews. Both the DMS and the Fama-French research are

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[995] See the discussion by the CMA in its 2014 NIE Determination, Section 13 and Appendix 13.2. https://assets.publishing.service.gov.uk/media/535a5768ed915d0fdb000003/NIE_Final_determination.pdf; https://assets.publishing.service.gov.uk/media/534cd4b4ed915d630e000041/appendices-glossary.pdf.
[996] For example, see pages 33-36 of the 2019 Yearbook.
[997] 2019 Yearbook, page 37.
[998] See page 26 of the 2017 Yearbook.
[999] See page 221 of the 2019 Yearbook. The equivalent long run real return on UK treasury bills is 1.2% from page 211 of the 2019 Yearbook.
[1000] For example, yields on US 6-month treasury bills are currently around 2.5% (nominal), which, assuming expected CPI inflation in the US is greater than 1.6%, would imply a real rate of less 0.9%. UK treasury bills (of similar maturity) are trading at significantly lower yields (less than 1% nominal). Sources: US Treasury, Bank of England.
[1001] Appendix D of the 2018 UKRN report notes that international price indices tend to be more comparable to CPI (or CPIH).

reputable sources of evidence, and the CMA analysis found some evidence of a similar, albeit smaller, effect in the UK.[1002]

A21.80 However, we disagree with TalkTalk's suggestion that we should only rely on historical *ex ante* evidence. Given that the expected TMR is unobservable, we consider it appropriate to consider a range of evidence to inform our estimate including evidence from *ex post* and *ex ante* approaches. It should also be noted that although historical data is used in the *ex post* approach, it is used as a basis for estimating the future.[1003] Using historical long-run data to inform the future expected TMR is a well-established approach used by practitioners and regulators.

Other evidence

A21.81 Europe Economics' October 2018 report included forward-looking TMR estimates using three variants of the dividend growth model (DGM). Its DGM analysis implied a real (CPI-based) TMR of 6.4% to 6.7%.[1004] Together with the other evidence considered in the report (historical *ex post* estimates, which we have summarised above, and regulatory precedent), Europe Economics recommended a range of 6.25% to 7.0% for the real (CPI-based) TMR.[1005]

A21.82 BT critiqued Europe Economics' DGM model and referenced alternative DGM evidence from the Bank of England and Bloomberg which produce higher TMR estimates. Europe Economics' April 2019 report responds to BT's points.[1006]

A21.83 Forecasting dividend growth in a DGM model is uncertain and involves assumptions. Different assumptions can lead to significant differences in the estimated TMR. However, we note that it is not clear that the two DGM models cited by BT are superior to Europe Economics' analysis:

a) The Bank of England's DGM model relies on analyst dividend forecasts which academic evidence has shown to be upwardly biased. The Bank of England also produces spot DGM-based estimates for the ERP (which BT has used to estimate the implied TMR)[1007], while Europe Economics gives most weight to five-year rolling averages of DGM-based TMR estimates (the latter being more stable and preferred by Europe Economics for that reason).[1008]

[1002] CMA, 2014 NIE Determination, Appendix 13.2.
[1003] Europe Economics' October 2018 report page 6.
[1004] The three DGM models considered by Europe Economics make different assumptions for short-term and long-term dividend growth rates. See section 2.5.2 and Table 2.3 of Europe Economics' October 2018 report.
[1005] Europe Economics' October 2018 report, page 15.
[1006] Europe Economics' April 2019 report, pages 4 and 5.
[1007] BT has made some assumptions to derive the implied TMR from the Bank of England estimates of the ERP, however, the Bank of England itself does not publish estimates of the TMR directly.
[1008] Europe Economics' April 2019 report, pages 4 and 5.

b) The purpose of the Bank of England's model is to explain shifts in the stock market, not to predict returns. The Bank of England recognises the limitations of its model and has acknowledged that the model does not provide an accurate point estimate for the ERP but rather it is used to understand movements in the ERP over time.[1009]

c) We have little visibility over how the Bloomberg DGM estimates have been derived, however, we note that they are substantially higher than estimates from alternative DGM models (Europe Economics notes that DGM outputs produced for other regulators point to a nominal TMR of 7.1 to 9.4% compared with the c.13% reported by Bloomberg).[1010] In addition, the Bloomberg DGM is based on the FTSE100 index; we consider that estimates of the TMR from DGM models based on the FTSE All Share (such as the Europe Economics model) are likely to give a better estimate of the market return relevant for the UK. The use of the FTSE All Share is also consistent with the market index preferred for the equity beta analysis of UK-listed companies (including BT).[1011]

A21.84 Finally, we disagree with BT's assertion that the proposed reduction in the TMR since the 2018 WLA Statement has been driven solely by placing weight on DGM evidence. We have always considered a range of evidence on the TMR in previous decisions, with historical evidence being an important, but not the only, source of evidence considered. There is no inconsistency in considering other TMR evidence such as DGM analysis, to inform our judgement. Our preferred TMR of 6.7% (CPI-deflated) is also comfortably within the range supported by historical data.

A21.85 The Europe Economics' October 2018 report also investigated the empirical relationship between the RFR and TMR over time. Using outputs from its DGM models, Europe Economics found that, there was a statistically significant relationship between the real TMR and the real RFR (each deflated by CPI), with the coefficient ranging from around 0.3 to 0.6.[1012] When deflating returns by RPI however, there was a less clear relationship between the TMR and RFR, with some coefficients not significantly different from zero.[1013]

A21.86 Europe Economics responds to BT's comments on this analysis in its second report.[1014]

A21.87 We disagree with BT's assertion that the fact that the TMR is more stable than the RFR means there is no relationship at all between the TMR and the RFR. BT cites the 2018 UKRN report to support its argument. However, the 2018 UKRN report merely states that the TMR is comparatively more stable than returns on other asset classes; it does not claim

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[1009] Bank of England Quarterly Bulletin Q2 2017: An improved model for understanding equity prices, page 93. https://www.bankofengland.co.uk/-/media/boe/files/quarterly-bulletin/2017/an-improved-model-for-understanding-equity-prices.pdf?la=en&hash=F0385353B45A130A1AA557165FBEC5E326FD57F.
[1010] Europe Economics' April 2019 report, pages 4-5; BT Group's response to the 2018 PIMR and 2018 BCMR Consultations, Annex 2, paragraph 2.26.
[1011] NERA's April 2019 report, page 2.
[1012] Europe Economics' October 2018 report, page 15.
[1013] Europe Economics' October 2018 report, page 15.
[1014] Europe Economics' April 2019 report, pages 7-8.

that there is no change at all in the TMR over time. Indeed, the report explicitly states that evidence suggesting the ERP is counter-cyclical "should not be taken as a claim that the ERP instead moves precisely one-for-one in the opposite direction to the RFR". [1015]

A21.88 We also note that the 2019 Yearbook examines the empirical relationship between real interest rates and subsequent real returns for equities and concludes that "when real interest rates are low, expected future returns on all risky assets are also lower"[1016], consistent with there being a positive relationship between real interest rates and real returns on equity.

Our decision

A21.89 In real (CPI-deflated) terms, the 2018 WLA TMR was implicitly 7.1% (although it was not expressed in CPI-deflated terms in that statement).[1017] Considering the available evidence on equity returns together with the sustained and substantial reduction in gilt yields over the last decade, we consider that a reduction in the forward-looking TMR is appropriate.

A21.90 Taking all the evidence together, we note that:

- historical *ex post* approaches suggest a real (CPI-deflated) TMR of around 6% up to 7.3%;
- historical *ex ante* approaches generally suggest lower numbers, potentially below 6%;
- forward-looking evidence (based on the DGM in the Europe Economics report) implies a range of 6.4% to 6.7%; and
- there is empirical evidence (albeit mixed) of a positive relationship between the RFR and the TMR and gilt yields (the proxy for the RFR) have been in decline over the last decade (falling more than 3 percentage points).

A21.91 We consider that the TMR is more stable than the ERP and we continue to place weight on historical *ex post* evidence because there is marginally more consensus on the possible range for the forward-looking TMR implied by historical data, however, using historical evidence also assumes the underlying return generating process has not changed. Placing weight on historical evidence does not imply the regulatory view of the TMR should remain static for all time, particularly as there is a range of values based on historical estimates.

A21.92 Taking account of the other sources of evidence discussed above, we consider that a reduction in the TMR (from that used in the 2018 WLA Statement) to a figure closer to the middle of the range implied by historical *ex post* evidence described above is appropriate. Overall, bearing in mind our stability and consistency objectives, we consider that reducing the TMR to 6.7% in CPI-deflated terms is a reasonable estimate given the range of evidence available.

[1015] 2018 UKRN Report, page 39.
[1016] 2019 Yearbook, page 21.
[1017] Given the nominal TMR of 9.2% and CPI forecast of 2% (for 2020/21).

A21.93 Using our forecast of CPI inflation for 2020/21 of 1.9% (see below), a real (CPI-deflated) TMR of 6.7% implies a nominal TMR of 8.7%. This is equivalent to a real (RPI-deflated) TMR of 5.8% using forecast RPI inflation of 2.8% for 2020/21.

ERP

A21.94 Based on a nominal TMR of 8.7% and a nominal RFR of 1.5%, the implied nominal ERP is 7.3%.[1018]

A21.95 We have cross-checked this estimate of the ERP against:

- The historical premium of UK equities over UK gilts; and
- the Bank of England's DGM model.

Historical premia of UK equities over gilts

A21.96 The 2019 Yearbook reports that the average (arithmetic mean) equity risk premium over bonds for the UK between 1900 and 2018 was 4.9%[1019] while the Barclays 2018 EGS indicates it was 5.1%.[1020]

DGM estimates of the ERP

A21.97 Figure A21.6 below shows the Bank of England's estimates of the nominal ERP derived using a DGM.[1021] It shows that the ERP estimates obtained from a DGM can vary widely depending on the time when the estimation is made. Broadly speaking, the ERP appears to range from around 4% to 13% over the period shown in the chart. However, in the last five years shown in the chart, the ERP estimates have tended to fall within a narrower range of around 7.5% to around 10%.

[1018] Note that due to the fact that intermediate calculations are unrounded this is 7.3%, rather than 7.2% which is implied by subtracting the nominal RFR (1.5%) from the nominal TMR (8.7%).
[1019] 2019 Yearbook, page 211, Table 72.
[1020] Derived from tables on page 106 (inflation) and page 118 (real equity and gilt returns) of the Barclays 2018 EGS.
[1021] The ERP derived from the BoE DGM is nominal because it has been estimated by reference to nominal gilts.

Figure A21.6: Bank of England ERP estimates derived from a DGM

Source: Bank of England. Data to 31 January 2019. The above ERP estimates are taken from the Bank of England's DGM model.

Our decision

A21.98 We consider our nominal ERP estimate of 7.3% is reasonable since it lies between historical *ex post* estimates of the ERP (around 5%) and the ERP derived from a more forward-looking model, i.e. the Bank of England's DGM model (7.5% to 10%). As such, we consider it strikes a reasonable balance between historical averages and forward-looking analysis (consistent with our approach to the TMR).

Cost of debt

Our proposals

A21.99 In previous decisions we estimated the cost of debt by adding an estimate of the debt premium to the estimated nominal RFR. This approach meant that we took a consistent view of components that were common to different elements of the WACC (i.e. the same RFR underpinned both the cost of debt and the cost of equity). We also checked that our estimated cost of debt was reasonable when compared to estimates of the weighted average cost of BT's existing debt and new debt which might be issued during the charge control period.

A21.100 We proposed to continue placing some weight on BT's existing debt costs. We considered it appropriate to recognise the potential impact that QE and the prolonged period of low interest rates may have had on a firm's ability to recover efficiently incurred debt costs. However, as explained above, we proposed to set the RFR to better reflect the forward-looking cost of equity.

A21.101 We therefore proposed the following approach to estimating the cost of debt:

a) we first derived a forward-looking cost of debt of 2.9% based on our chosen RFR assumption plus a debt premium;

b) second, we estimated the cost of BT's existing debt ([✂]% to [✂]%);

c) we then weighted the cost of new and existing debt based on how much new debt BT might be expected to issue during the charge control period to derive a range for the cost of debt (15% to 35%); and

d) we then proposed a point estimate of 4.0% (pre-tax nominal) within the range calculated ([✂]% to [✂]% (3.5% to 4.5%)).

Stakeholder responses

A21.102 BT agreed with our modified approach to estimate the cost of debt which reflected the cost of new and existing debt. However, BT argued that we should increase the cost of new debt to 4.2% reflecting its proposed increase to the RFR, which would have the effect of increasing the overall cost of debt to 4.2%.[1022]

A21.103 TalkTalk disagreed with our proposed approach. First, it argued that using a backward-looking cost of debt was inconsistent with other WACC parameters, which are all forward-looking. Second, it said that the use of a backward-looking cost of debt was inconsistent with our established approach, citing our court submissions in 2012, which set out that "the consistent guidance of the EU institutions had been that, when performing its analysis for setting [a] charge control, it should adopt a forward-looking analysis and allow only efficiently-incurred costs". TalkTalk also argued that our revised approach which uses BT's actual debt costs created perverse incentives for BT to game the regulatory system. Overall, TalkTalk did not consider we had appropriately justified the change in methodology in the Consultation.[1023]

A21.104 Notwithstanding its concerns with the revised approach, TalkTalk argued that the allowance on existing debt was too high. TalkTalk calculated the cost of BT's existing debt at 3.5% based on the weighted average coupon yield of BT's traded debt. TalkTalk argued that BT's 2030 bond ($2.67bn) issued in 2000 at a coupon of 9.125% should be excluded since it was issued at a time when BT was seen as a poorly run firm facing pressure on its credit rating and that the bond was likely issued to fund overseas acquisitions and mobile spectrum auction bids rather than its UK fixed lined network.[1024] TalkTalk said the cost of BT's existing debt was 2.57% excluding this 2030 bond. However, it did agree that we should allow 0.1% for issuance costs in the cost of debt calculation. TalkTalk proposed an overall cost of debt of 2.9% to 3.0% with embedded debt taken into account.[1025]

[1022] BT Group's response to the 2018 PIMR and 2018 BCMR Consultations Annex 2, paragraph 2.83.
[1023] TalkTalk's response to the 2018 BCMR Consultation, paragraphs 5.83-5.92.
[1024] TalkTalk's response to the 2018 BCMR Consultation, paragraphs 5.98-5.102.
[1025] TalkTalk's response to the 2018 BCMR Consultation, paragraphs 5.93-5.104.

Our reasoning and decisions

A21.105 We apply the same methodology as proposed in the Consultation. We disagree with TalkTalk that including an allowance for embedded debt costs is a significant departure for us. Our pre-2012 decisions on the cost of debt were made in different economic conditions, before the full extent of the Bank of England's QE programme was known. Our approach to the cost of debt has evolved since then to recognise that, in the current environment, an efficiently financed firm may not be given a fair opportunity to recover efficiently incurred costs if the cost of debt allowance reflects forward-looking debt costs only. In recent decisions, including the 2016 BCMR, by using longer term averages to calculate the RFR combined with a forward-looking debt premium, we were effectively giving some weight to historical debt cost albeit without making an explicit reference to it.

Cost of new debt

Debt premium

A21.106 As at 28 February 2019, we estimate that BT's fixed rate listed debt (all currencies) had an outstanding tenor of around eight years[1026], while for sterling denominated debt it was higher at around 14 years.[1027] The tenor on sterling debt has increased recently since BT issued some long-dated sterling debt in June 2018.

A21.107 To estimate the debt premium, we have considered the observed spreads on sterling denominated debt over government bonds for BT Group, however we recognise that going forward the weighted average tenor on all BT's sterling debt will be slightly greater than the BT average.[1028] We also place weight on the observed spreads on an index of BBB bonds over government gilts with a maturity of five to ten years. This is consistent with the rating on BT's debt (BBB)[1029] and the weighted average maturity of BT's debt across all currencies.

Sterling debt

A21.108 We consider the sterling denominated debt of BT Group with both short-term and long-term maturity dates because we would expect BT to raise debt of varying maturities when considering its future financing requirements. Table A21.7 below lists the sterling debt we have considered alongside the average, minimum, maximum and upper and lower quartile spread of this debt in the last one and two years.

[1026] Ofcom analysis of S&P Capital IQ data as at 2 March 2019.
[1027] Ofcom analysis of S&P Capital IQ data as at 2 March 2019.
[1028] BT issued a number of long-term bonds in June 2018 which will affect one-year and two-year averages spreads in the future.
[1029] This is the Bloomberg composite rating which is a blend of the ratings from Moody's, S&P, Fitch and DBRS.

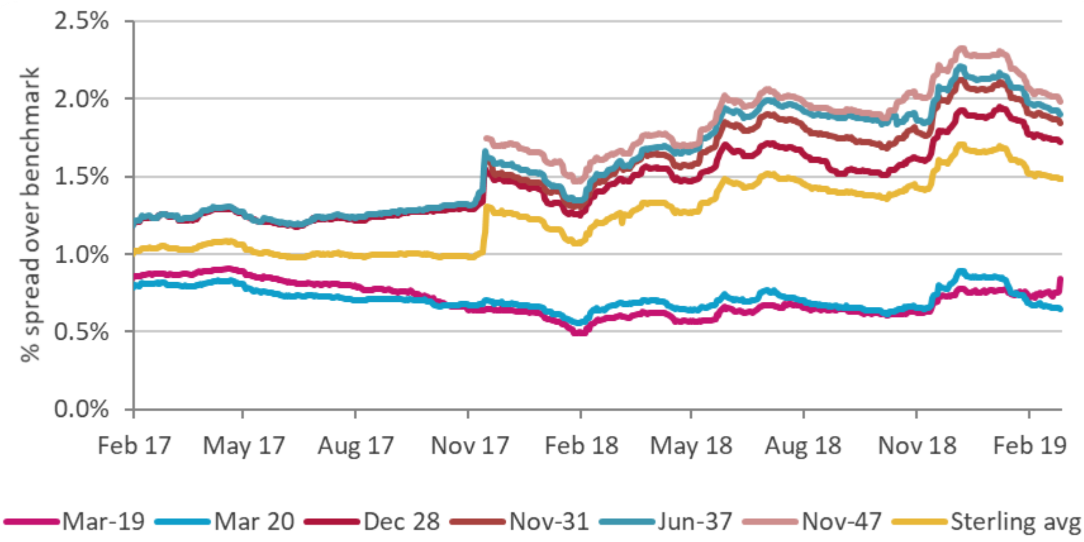
Table A21.7: Spread of BT's sterling denominated debt over UK gilts

Maturity	Tenor (years)	1 year Avg	Min	Max	Lower quartile	Upper quartile	2 year Avg	Min	Max	Lower quartile	Upper quartile	Current 28 Feb 2019
Mar-19	0.1	0.7%	0.6%	0.8%	0.6%	0.7%	0.7%	0.5%	0.9%	0.6%	0.8%	0.7%
Mar-20	1.1	0.7%	0.6%	0.9%	0.7%	0.7%	0.7%	0.6%	0.9%	0.7%	0.7%	0.7%
Dec-28	9.8	1.7%	1.5%	2.0%	1.5%	1.7%	1.5%	1.2%	2.0%	1.3%	1.6%	1.8%
Jun-37	18.3	1.9%	1.6%	2.2%	1.8%	2.0%	1.6%	1.2%	2.2%	1.3%	1.9%	2.0%
Nov-31	12.7	1.8%	1.5%	2.1%	1.7%	1.9%						1.9%
Nov-47	28.7	2.0%	1.6%	2.3%	1.9%	2.0%						2.0%
Average	**12.3**	**1.4%**	**1.2%**	**1.7%**	**1.4%**	**1.5%**	**1.3%**	**1.0%**	**1.7%**	**1.0%**	**1.4%**	**1.5%**

Source: Bloomberg, Ofcom analysis. Data to 28 February 2019[1030]

A21.109 Figure A21.8 charts the spread of BT's sterling debt over the last two years. BT's debt premium has increased over the past year, particularly since March 2018 when Moody's downgraded BT's credit rating from Baa1 to Baa2[1031] (followed in June 2018 by S&P's downgrade from BBB+ to BBB), giving BT a Bloomberg composite rating of BBB. Over the last 12 months (the period which reflects the impact of the rating downgrades), the average debt premium on sterling debt has been 1.4%.[1032]

Figure A21.8: Spread of BT's sterling denominated debt over UK gilts



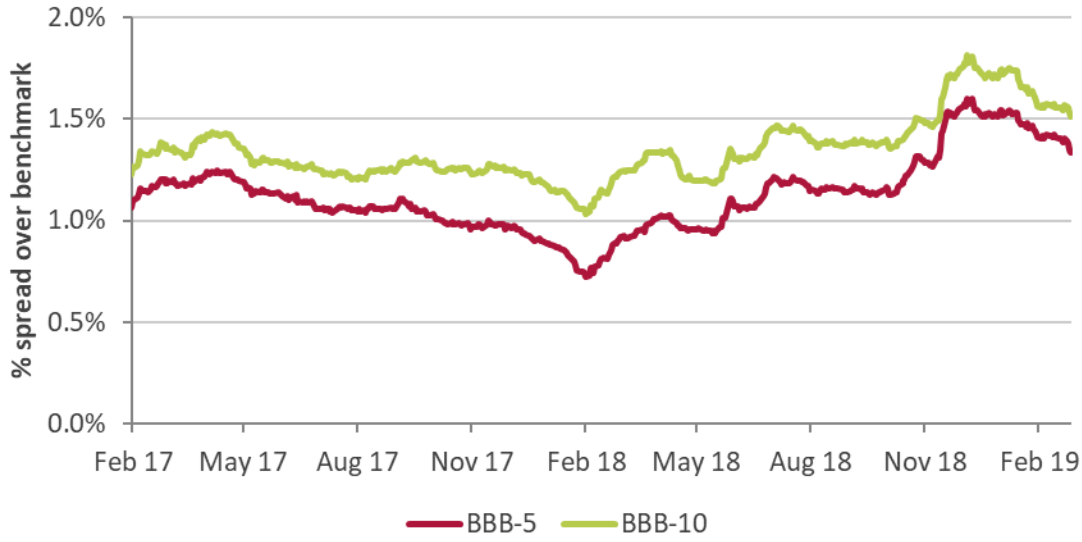
[1030] Spread over nominal gilt yields. Average maturity is a weighted average and average spreads are simple averages. These bonds have a Bloomberg Composite credit rating of BBB. The table does not include sterling debt issued by BT in June 2018 since one- and two-year average spreads are unavailable. Also note, the November bonds in the table above do not have two-year averages as they have traded for less than two years.
[1031] https://www.moodys.com/research/Moodys-downgrades-BTs-and-EEs-ratings-to-Baa2-stable-outlook--PR_380805 [accessed 22 May 2019].
[1032] For the bonds in Table A21.7.

Source: Bloomberg, Ofcom analysis. Data to 28 February 2019. Sterling average is a simple average of the spread of BT's sterling denominated debt over UK gilts.

Spreads derived from a BBB Index

A21.110 Figure A21.9 shows the spread of an index of BBB bonds over UK gilts with maturities of five and ten years. More recently, the BBB index spreads have been broadly in line with BT's average sterling debt spreads on debt with similar maturity.[1033]

Figure A21.9: Spread over nominal gilts of an index of five and ten-year BBB bonds



Source: Bloomberg, Ofcom analysis. Data to 28 February 2019.

A21.111 The above bond data indicates a range for the debt premium of 1.0% to 1.6% (slightly higher than the 0.9% to 1.4% we proposed in the Consultation). This captures the interquartile range of the average spread on BT's sterling denominated debt over the last one and two years (1.4% to 1.5% and 1.0% to 1.4%, respectively), and the interquartile ranges of the spread on five- and ten-year BBB corporate bonds over the last one and two years (1.1% to 1.6% over the last year and 1.0% to 1.4% over the last two years).[1034] We have decided on a point estimate of 1.3% which is the mid-point of the range.[1035]

A21.112 Given the nominal RFR of 1.5%, this implies a cost of new debt of 2.8% (pre-tax nominal). We have compared this estimate against historical and forward yields on BBB debt.

[1033] The BBB index includes bonds with ratings of BBB-, BBB and BBB+. BT's debt has had a composite rating of BBB on Bloomberg since March 2018, so we would expect its recent average debt spreads to be in line with the spreads for the index.

[1034] Referencing inter quartile ranges avoids placing weight on the highest and lowest spreads over the period.

[1035] We also note that BT has issued three bonds in June 2018 with spreads greater than average. The average spread on these bonds has been 2.0% since issuance, however, these bonds have longer maturity than BT's average sterling debt.

BBB yields

A21.113 We have considered BBB-rated bonds with maturities of around five to ten years because, as noted above, BT is rated BBB and its average tenor is around eight years across all currency denominations, although we recognize that BT could issue new debt with longer or shorter maturities to the average.[1036]

A21.114 Figure A21.10 shows yields over the last two years for an index of BBB bonds with five- and ten-year maturities. The average yield over the last year was 2.2% and 2.9% respectively, while over two years the average was 1.9% and 2.7% respectively.

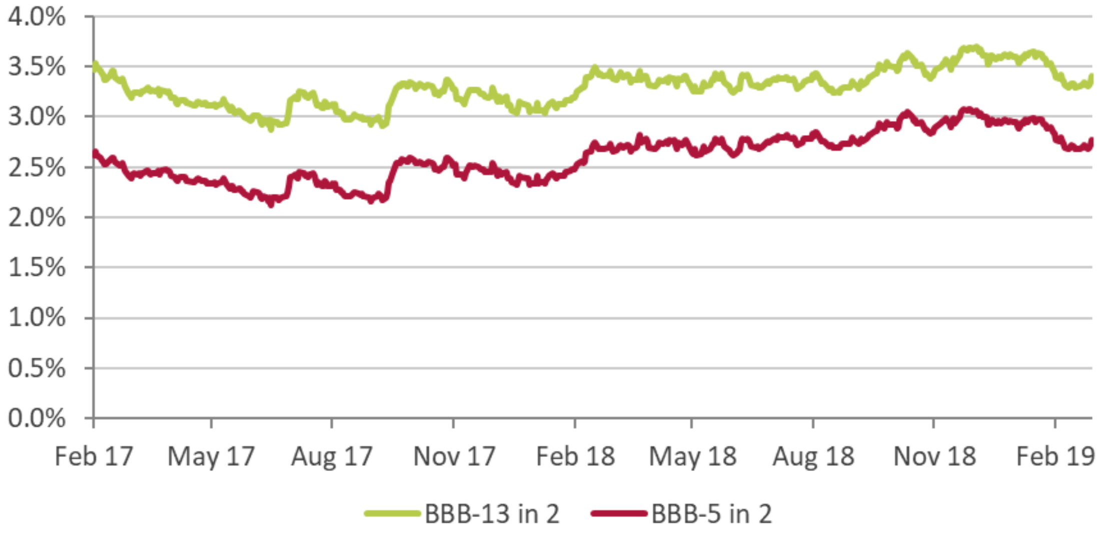
Figure A21.10: Yields on indices of five- and ten-year BBB bonds

Source: Bloomberg, Ofcom analysis. Data to 28 February 2019.

A21.115 We have also calculated forward rates on BBB bonds. Figure A21.11 shows forward rates on five- and 13-year BBB bonds for the final year of the charge control.[1037] As at 28 February 2019, forward rates were between 2.7% to 3.3%, slightly higher than spot yields observed over the last two years.

[1036] For example, in June 2017 BT issued three tranches of debt with maturities of five, seven and ten years while in June 2018 BT issued three further tranches of fixed rate debt with maturities of 15, 20 and 24 years.
[1037] The end of the charge control is in March 2020/21, in around two years' time. On Bloomberg, information on BBB indices exist for two-year, seven-year and 15-year periods. A forward rate can therefore be estimated for five-year and 13-year periods where the five-year forward rate is estimated from the two-year and seven-year indices. Ideally, we would estimate a ten-year forward rate from a two -year and 12-year bond. However, this information is not available in Bloomberg and therefore we estimate a 13-year rate from the two-year and 15-year indices.

Figure A21.11: Two-year forward yields on indices of five- and 13-year BBB bonds



Source: Bloomberg, Ofcom analysis. Data to 28 February 2019[1038]

A21.116 Based on this cross-check against BBB yields above we consider that a range of around 2.5% to 3.5% would reasonably reflect the cost of new debt. Our estimate of the cost of new debt for BT of 2.8% sits slightly below the mid-point of this range. Given the range of uncertainty in the cost of new debt (reflected in the range above) and given the overall cost of debt includes an allowance for existing debt (which we explain below) we consider that the point estimate of 2.8% is reasonable.[1039]

Cost of existing debt

A21.117 We asked BT to provide a breakdown of the interest rate on its fixed and floating rate debt, taking account of any hedging effects, to help us calculate the cost of its existing debt.

A21.118 As at 2 March 2019[1040], nominal fixed rate debt represented around [✂]% of BT's total debt, with floating rate debt the remainder.[1041]

A21.119 The relevant cost of existing fixed debt is uncertain and could be estimated in several ways, for example: i) as of today; ii) as at the end of the charge control period (2020/21); or iii) as a weighted average over that period. In addition, while the interest rate may currently be fixed, BT's future hedging strategy could see it swap fixed debt for floating debt.[1042]

[1038] In February 2019, the lines represent forward rates on five- and 13-year BBB bonds in February 2021. The 13-year line represents the forward rate implied by the Bloomberg two-year and 15-year BBB indices.
[1039] Note that a cost of new debt of 2.8% (pre-tax nominal) is consistent with the cost of debt used in our recent annual licence fees decision for 900 and 1800 MHz spectrum. See Table A5.3 of https://www.ofcom.org.uk/__data/assets/pdf_file/0021/130548/Annexes-1-6.pdf.
[1040] We have used 2 March 2019 to exclude the £450m bond which matured on 1 March 2019.
[1041] Openreach response dated 6 March 2019 to question 1 of the 9th LLCC s.135 notice. Floating rate debt includes index-linked debt.
[1042] Openreach response dated 26 September 2017 to question B9d of the 12th WLA s.135 notice.

A21.120 We estimate that the interest rate on BT's existing nominal fixed debt is between [✂]% and [✂]%.[1043]

A21.121 The cost of floating rate debt is also uncertain, although it represents a smaller amount of total debt than fixed rate debt. We estimate that the interest on BT's floating rate debt was around [✂]% as at 2 March 2019.

A21.122 Combining these estimates and weighting by the estimated relative amounts of fixed and floating debt as at 2 March 2019, we estimate that the cost of BT's existing debt is between [✂]% and [✂]%.[1044]

A21.123 Based on publicly available information on BT's bonds, TalkTalk estimated the average cost of BT's existing debt at 3.5%.[1045] This differs to our estimates since TalkTalk's analysis does not take into account the impact of foreign exchange rate hedges on the interest rate for non-sterling denominated debt. Our approach reflects BT's financing strategy which is to swap non-sterling debt immediately into fixed sterling debt.[1046]

A21.124 We do not agree with TalkTalk that we should exclude BT's 2030 US-denominated bond. We recognise that this bond has a higher coupon than BT's other listed debt. However, at the time the bond was issued BT had an AA credit rating from S&P (several notches higher than its current rating of BBB). The cost of the bond would have reflected this higher credit rating, and as such it is not clear to us that BT's financial health inflated its cost of finance at the time. The high coupon rate is likely to reflect the long maturity of the bond (30 years) and the general cost of finance at the time.[1047]

A21.125 As BT raises debt at the group level we recognise that not all the debt BT raises is used to support investment in its fixed network. However, we do not consider that it would be practicable to robustly assess how BT uses the cash raised from different tranches of debt, especially since that could change over time (for example where initial investments are sold).[1048]

A21.126 We understand TalkTalk's concerns about the potential impact on incentives if we use BT's *actual* cost of debt, however since BT raises debt at the group level, and regulated products represent a fraction of the financing requirements of the group, we would not

[1043] The higher number is the rate as at 2 March 2019 and the lower number is the estimated rate in 2020/2021, taking account of debt that is due to mature over this period (where more recent debt has been issued at a lower interest rate).
[1044] We have assumed that the amount of floating debt as a proportion of total debt remains at estimated March 2019 levels.
[1045] TalkTalk's response to the 2018 BCMR Consultation, paragraph 5.97
[1046] See https://www.btplc.com/Sharesandperformance/Financialreportingandnews/Debtinvestors/index.htm [accessed 22 May 2019].
[1047] We note that the coupon on BT's 2030 bond is similar to debt issued by other telecoms operators around the same time. For example, Deutsche Telekom issued a $3.5bn 30-year bond on 6 July 2000 with a coupon of 8.25%, Telefonica issued a $1.25bn 30-year bond on 21 September 2000 with a coupon of 8.25% and Orange SA issued a $2.5bn 30-year bond on 14 March 2001 with a coupon of 8.5%.
[1048] TalkTalk said that the main use of the cash raised by BT's 2030 bond was the £9.25bn purchase of Viag Interkom. We note that this was later merged into BT Wireless and spun off as mmO2 (later O2) plc in 2001. The cash proceeds from the spin off could have been used for a variety of purposes.

expect this to have a significant impact on the incentives faced by BT Group's treasury department. Going forward if we were to see BT's debt costs deviate from what we consider to be efficient, we could reconsider our approach.

A21.127 To ascertain whether BT's existing cost of debt is in line with the market, we have performed additional cross-checks. We have considered the ten-year average[1049] of yields on a BBB-rated index and A-rated index. As at 28 February 2019 the ten-year average yield on BBB and A rated debt was 4.0% and 3.5% respectively. These values broadly align within the range identified above, indicating that the overall cost of BT's existing debt is in line with market rates for debt of similar credit rating.

Weighting of existing debt and new debt

A21.128 Approximately 5% of BT's listed debt is due to mature before the end of the charge control. If BT were to replace all the debt that is due to mature we might therefore expect around 5% of its debt to be 'new debt' by the end of the charge control. Alternatively, given that the average maturity of BT's listed debt is around eight years and this is an approximately two year charge control ending 31 March 2021, we might expect up to 25% of debt to be new. However, we are not certain how much of its existing debt BT will refinance.[1050] To allow for this uncertainty, we have assumed that new debt could represent between 5% to 25% of debt by the end of the charge control period.

Our decision

A21.129 Combining the above weightings with our estimate for the cost of new debt of 2.8% and the cost of existing debt range of [✂]% to [✂]% indicates that the weighted average cost of new and existing debt lies in the range of [✂]% to [✂]% (3.4% to 4.4%).

A21.130 As noted in the 2018 WLA Statement, when estimating the weighted average cost of existing and new debt, it may be appropriate to include an allowance for debt issuance costs since these costs are not included in operating costs within BT's RFS and so would not otherwise be included in charge controls based on BT's cost data.[1051] We asked Openreach for details of the issuance costs associated with the four tranches of debt BT issued between September and December 2018 and on an annualised basis these ranged from [✂]% to [✂]% with an average of [✂]%.[1052]

[1049] Ten years is broadly in line with the outstanding tenor on all BT's debt. Therefore, if we assume that a company issues debt steadily through time with an average maturity of around ten years, we might expect the ten-year trailing average of corporate debt yields to be a reasonable proxy for its existing cost of debt.
[1050] For example, while BT's 2017 Annual Report included an objective to reduce net debt (page 26), its 2018 Annual Report did not.
[1051] See paragraph A20.71 of the 2018 WLA Statement.
[1052] Openreach response dated 6 March 2019 to question 2 of the 9th LLCC s.135 notice.

A21.131 In its Bristol Water decision, the CMA allowed for a ten basis points uplift in the cost of debt for a notional company.[1053] Taking account of this and the evidence on BT's actual debt issuance costs, we consider it appropriate to include an allowance of ten basis points for debt issuance. This means that our estimate for the total cost of debt between [✂]% to [✂]% (3.5% to 4.5%).

A21.132 We have decided on a pre-tax nominal cost of debt for BT Group of 4.0% which represents the midpoint of the range above.[1054]

Inflation assumptions

A21.133 TalkTalk agreed with our proposal to use the most recent OBR forecasts[1055] and, as no other stakeholders commented, we have decided to use the latest RPI and CPI forecasts from the OBR. The OBR's March 2019 forecast of RPI in 2020/21 is 2.8% and for CPI it is 1.9%.[1056] We have used these RPI and CPI forecasts in our WACC calculations.

Equity beta and asset beta – BT Group

Our proposals

A21.134 In the Consultation we presented data on BT's two-year and five-year daily equity betas calculated by NERA against the FTSE All Share index. We explained that BT's two-year equity beta fell significantly in July 2018 due to the European referendum in June 2016 falling out of the two-year estimation window (the 'referendum effect'), while the five-year equity beta had been relatively stable. We said that the statistical reliability of the two-year equity beta had reduced and, given the high degree of uncertainty around the referendum and how it would affect UK company returns going forward, we proposed to estimate BT's beta by reference to its five-year daily betas.

A21.135 BT's five-year equity beta against the FTSE All Share as at 20 July 2018 was 0.94, equivalent to an asset beta of 0.71.

A21.136 Based on a forward-looking gearing assumption of 35% and a debt beta of 0.1, we proposed a forward-looking equity beta for BT Group of 1.04.

Stakeholder responses

A21.137 BT agreed with the use of a five-year beta estimation window, considering that this placed less weight on atypical events such as the referendum and meant the resulting beta was

[1053] See Appendix 10, paragraphs 48-53, CMA Bristol Water (October 2015). https://assets.digital.cabinet-office.gov.uk/media/5627997640f0b60368000001/Appendices_5.1_-_11.1_and_glossary.pdf.
[1054] We have rounded the mid-point of the overall cost of debt range to 4.0%.
[1055] TalkTalk's response to the 2018 BCMR Consultation, paragraph 5.114.
[1056] OBR, The economy forecast: Inflation, updated on 13 March 2019. https://obr.uk/forecasts-in-depth/the-economy-forecast/inflation/ [accessed 13 March 2019].

less likely to be biased.[1057] However, referencing NERA's work on the explanation of movements in the BT Group beta following the EU referendum, BT said we should allow some headroom in its beta estimate because if sterling appreciates in the next few years BT's beta could increase.[1058]

A21.138 TalkTalk considered that we should use a two-year beta rather than a five-year beta since this would exclude the impact of the EU referendum but include the consequent change in market expectations.[1059] TalkTalk said that our previous practice was to use two-year betas and moving to five-year betas would reduce regulatory certainty.

A21.139 TalkTalk also commented on our forward-looking gearing assumption; some of its comments are directed at our assumption for BT Group as a whole, while others are targeted more specifically at the assumed gearing for Openreach.[1060] On the gearing level for BT Group as a whole, TalkTalk noted that a gearing level of 35% would be unusually low for a regulated entity, that TalkTalk and Sky are not relevant comparators, and that some major telecom incumbents (Deutsche Telekom and Telefonica) have gearing well in excess of 30%.[1061]

Our reasoning and decisions

Equity beta estimates

A21.140 As at 31 January 2019, BT's two-year equity beta was 0.66, a 36% reduction from the two-year equity beta of 1.03 at the time of the 2018 WLA Statement. NERA explains that the sharp decline in the two-year equity beta is due to a referendum effect.[1062]

A21.141 We previously placed weight on two-year betas as a trade-off between recent beta estimates (which may better reflect current views of systematic risk but can be volatile and less statistically robust) and average betas over a longer period (which can be less volatile and more statistically robust but may be less reflective of current views of systematic risk). The referendum effect has clearly had a significant impact on BT's two-year equity beta (as well as other UK focused companies', as shown in NERA's October 2018 report).[1063] Accompanying the decline in two-year equity betas, is an increase in the confidence intervals on two-year betas, reducing the statistical reliability of the two-year estimates.[1064]

1057 BT Group's response to the 2018 PIMR and 2018 BCMR Consultations Annex 2, paragraph 2.55.
1058 BT Group's response to the 2018 PIMR and 2018 BCMR Consultations, Annex 2, paragraph 2.58.
1059 TalkTalk's response to the 2018 BCMR Consultation, paragraph 5.116.
1060 TalkTalk proposes a slightly different disaggregation of the BT Group asset beta, discussed later in the annex. By Openreach, TalkTalk refers to BT's access business as well as leased lines.
1061 TalkTalk's response to the 2018 BCMR Consultation, paragraph 5.120.
1062 See NERA 2018, Cost of capital: Beta and Gearing for the 2019 BCMR (NERA's October 2018 report), Appendix A. https://www.ofcom.org.uk/__data/assets/pdf_file/0018/124740/nera-wacc-report.pdf.
1063 NERA's October 2018 report, Appendix A.
1064 See NERA 2019, Cost of capital: Beta and Gearing for the 2019 BCMR (NERA's April 2019 report), Appendix B, Figure 4B. For example, the BT two-year asset beta had a 95% confidence interval of 0.62 to 0.94 as at September 2017, yet at July 2018 this had increased by around 50% to a 95% confidence interval of 0.28 to 0.75. Although the two-year confidence

A21.142 We do not agree with TalkTalk that we should use BT's two-year beta. As NERA comments, due to ongoing uncertainty surrounding Brexit the standard errors in the two-year betas remain elevated, reducing their statistical reliability. We agree with NERA that the high degree of uncertainty around Brexit and how it will affect UK-listed company returns supports placing greater weight on five-year betas.[1065] We do not consider it appropriate to ignore the referendum effect, but rather to give it due weight in our analysis. Placing weight on five-year betas captures the time before and after the referendum and, given current uncertainties, strikes a better balance between regulatory stability and efficient price and investment signals.

A21.143 As we are placing weight on five-year betas, we do not agree with BT's suggestion to allow headroom above the mid-point of our estimated beta range to account for risk of future changes. We consider that using the five-year beta sufficiently addresses the risk of future uncertainty by reflecting a period before and after the referendum.

A21.144 We have therefore estimated BT's beta by reference to its five-year daily betas. BT's five-year daily equity beta as at 31 January 2019 was 0.91.[1066]

Asset beta

A21.145 The asset beta is calculated from the equity beta using average gearing over the same period and assuming a debt beta of 0.10 (consistent with our proposal on the debt beta below).

A21.146 BT's average gearing in the five years to 31 January 2019 was 29%, with gearing measured using the gross value of short-term debt and long-term debt as a proportion of enterprise value, consistent with previous market reviews.[1067]

A21.147 De-levering the BT Group five-year equity beta of 0.91 using average gearing of 29% gives an asset beta of 0.68.[1068]

Forward-looking gearing

A21.148 As can be seen in Figure A21.12 below, BT's gearing increased in January 2016 following its acquisition of EE. Since then, while BT's debt levels have been relatively stable, its gearing has increased as its market capitalisation has reduced. As at 31 January 2019, BT's gearing stands at around 40%.

A21.149 We continue to consider that a reasonable forward-looking gearing level for BT Group would lie between 25% to 50%. The lower end of this range approximately reflects the

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intervals have narrowed slightly since July 2018, they remain noticeably wider compared to the analysis underpinning the 2018 WLA Statement.

[1065] NERA's April 2019 report, page 31.

[1066] NERA's April 2019 report, Table 2.2.

[1067] NERA's April 2019 report, Table 2.4.

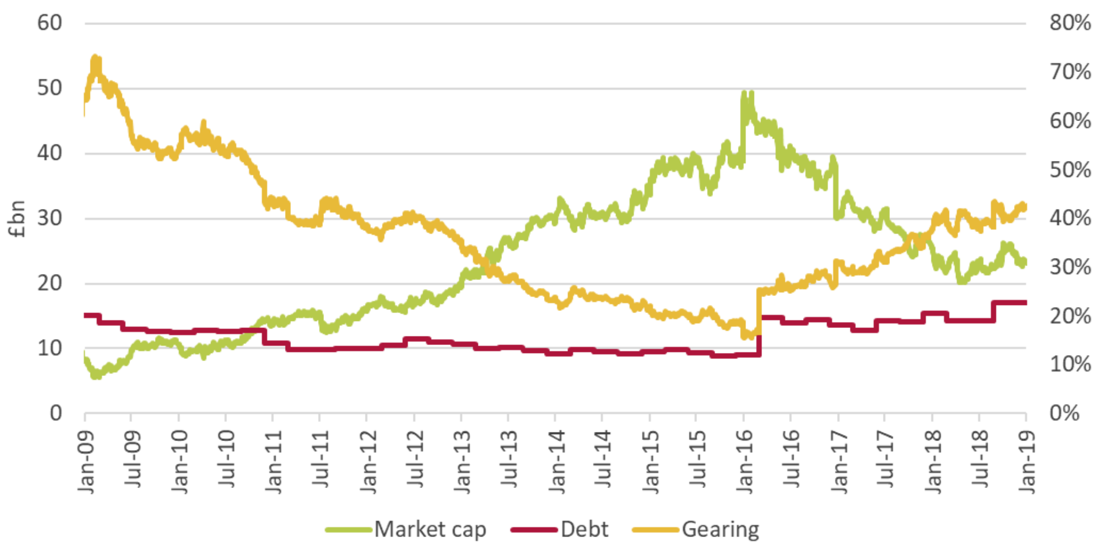
[1068] NERA's April 2019 report, Table 2.4.

average gearing for BT over the last five years. The upper end of the range is around the average gearing for UK listed utilities[1069] and the maximum level proposed in the 2016 Brattle Report for the European Commission.[1070]

A21.150 We recognise TalkTalk's point regarding Sky and TalkTalk not necessarily being appropriate comparators[1071], however, we have compared BT's gearing against a broad range of comparators. For example, as at 31 January 2019 the average five-year gearing for UK utilities was 50%[1072], for UK telecoms (including TalkTalk) it was 34%[1073], and for European telecoms it was 36%.[1074] Telefonica and Deutsche Telekom (which TalkTalk refers to) form part of the European telecoms sample and therefore have been used to inform our forward-looking gearing estimate.

A21.151 Considering this information in the round and recognising that BT's gearing has been increasing we have decided that a forward-gearing of 40% is reasonable. It is similar to BT's current gearing and falls within a credible range based on comparator companies and the range identified by Brattle.

Figure A21.12 BT Group gearing, market cap and total debt



Source: Bloomberg (debt = short-term + long-term debt; gearing = debt/(Market cap + debt)), data to 31 January 2019.

[1069] NERA's April 2019 report, Table 2.4.
[1070] On 18 July 2016 the European Commission published a report from Brattle reviewing approaches to estimating the WACC across European telecoms regulators ('2016 Brattle Report') in which Brattle recommends a maximum forward-looking gearing rate for telecoms operators of 50% to 55%. https://publications.europa.eu/en/publication-detail/-/publication/da1cbe44-4a4e-11e6-9c64-01aa75ed71a1/language-en.
[1071] Sky is no longer included in the sample as it was purchased by Comcast in October 2018 and subsequently delisted in November 2018.
[1072] NERA's April 2019 report, Table 2.4.
[1073] NERA's April 2019 report, Table 2.5.
[1074] NERA's April 2019 report, Table 2.10.

Forward-looking equity beta

A21.152 Combining an asset beta of 0.68, a forward-looking gearing of 40% and a debt beta of 0.10 (see the next subsection) we derive a forward-looking equity beta for BT Group of 1.07.

Debt beta

Our proposals

A21.153 We proposed to use a debt beta of 0.1, the same as that used in the 2018 WLA Statement.

Stakeholder responses

A21.154 TalkTalk agreed with our proposal to use a debt beta of 0.10.[1075] No other stakeholders commented specifically on the debt beta.

Our reasoning and decision

A21.155 NERA concluded that a debt beta of 0.10 would be consistent with the upper end of recent regulatory determinations in the UK and with the more recent evidence provided by academics and practitioners.[1076] NERA also found that the asset beta was relatively insensitive to modest changes in the debt beta.[1077]

A21.156 As such, we continue use a debt beta of 0.1.

Corporate tax rate

A21.157 TalkTalk agreed to our proposal to use a corporate tax rate of 17%[1078] and no other stakeholder commented on our proposal. We have maintained a corporate tax rate assumption of 17% for 2020/21 as the most up-to-date view on future tax costs.[1079]

Disaggregation of BT Group asset beta

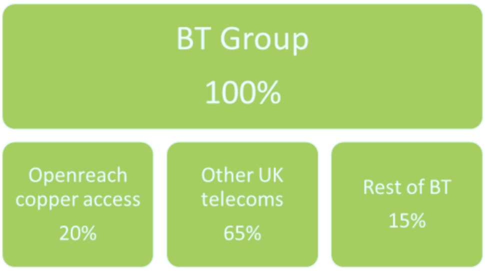
A21.158 In our last two fixed telecoms reviews we split the BT Group asset beta between Openreach[1080], Other UK Telecoms and the Rest of BT:

[1075] TalkTalk's response to the 2018 BCMR Consultation, paragraph 5.127.
[1076] NERA's October 2018 report, Appendix F.
[1077] NERA's October 2018 report, Appendix F. If we were to increase the debt beta to 0.15 (to reflect the higher gearing assumption compared to the 2018 WLA Statement) the asset beta for BT Group would only increase by 0.01.
[1078] TalkTalk's response to the 2018 BCMR Consultation, paragraph 5.128.
[1079] https://www.gov.uk/government/publications/rates-and-allowances-corporation-tax/rates-and-allowances-corporation-tax.
[1080] We have previously referred to this part of BT as 'Openreach copper access', but in this statement we use 'Openreach' for brevity and reflecting the fact this part of BT includes services other than wholesale access to copper lines.

- Openreach includes wholesale access to copper lines to customer premises and, since March 2018, wholesale access to BT's network of duct and poles[1081];
- Other UK Telecoms includes BT's wholesale and retail leased lines, retail and wholesale voice, mobile, broadband and bundled services; and
- Rest of BT (RoBT) primarily includes BT's ICT operations from its Global Services and Business and Public Sector divisions.[1082]

A21.159 This is illustrated in Figure A21.13, which shows the relative weights put on each disaggregated part of BT in the 2018 WLA Statement (so that the weighted sum of the disaggregated asset betas equals the BT Group asset beta).

Figure A21.13: Weights used in the 2018 WLA Statement



Source: Ofcom

A21.160 In the rest of this subsection we set out our decision on disaggregating the BT Group asset beta as follows:

- approach to estimating a beta for active leased lines;
- approach to estimating a beta for inter-exchange dark fibre services;
- asset beta weightings;
- comparator company asset betas;
- Openreach asset beta; and
- Other UK Telecoms and RoBT asset beta.

Asset beta for active leased lines services

Our proposals

A21.161 In line with previous reviews we considered that a leased lines business would face higher systematic risk than wholesale fixed line access services (which we include within

[1081] Since 2005 we have distinguished BT's copper access services from other services it provides because we consider that wholesale access to copper lines has lower systematic risk than other services such as those delivered over those lines (i.e. usage services such as voice and broadband). In the 2018 WLA Statement we also used the Openreach WACC to derive PIA rental charges.

[1082] On 1 April 2016, BT reorganised its divisions and the UK-focused parts of Global Services moved into a new 'Business and Public services' division (which also includes the old BT Business division) while multinational and international clients continued to be served from Global Services. Other changes included EE's business division moving into the new 'Business and Public Sector' division. See BT press release dated 1 February 2016: http://www.btplc.com/news/#/pressreleases/bt-announces-new-structure-1304769 [accessed 20 February 2018].

Openreach) and was instead likely to share similar characteristics to other telecoms usage services included within Other UK Telecoms. We therefore proposed to apply the Other UK Telecoms asset beta to active leased lines services.

Stakeholder responses

A21.162 TalkTalk disagreed with our three-way disaggregation approach and stated it was no longer fit for purpose. In TalkTalk's opinion there was unlikely to be any consistency between the systematic risk of a business leased line network and the other elements of the Other UK telecoms basket (a mobile network and a sports broadcaster) and we had not presented arguments as to why the risk of this set of products should be similar.[1083]

A21.163 TalkTalk proposed two approaches:

a) A four-way disaggregation where leased lines is removed from Other UK Telecoms and put in its own basket along with all non-copper access regulated services (Other Openreach) while the remaining products in Other UK Telecoms (e.g. consumer focused lines of business, such as EE and BT Sport) would be called Non-Openreach. TalkTalk suggested that companies like Heathrow, Network Rail and NATS would be good comparators for Other Openreach.

b) A new disaggregation where leased lines is included in an Openreach basket along with current access services.[1084]

A21.164 TalkTalk also said it was unclear why we believe that businesses are more likely than consumers to cut demand in an economic downturn.[1085]

A21.165 BT also disagreed with using our proposed estimate of the Other UK Telecoms asset beta for active leased lines. BT suggested that active leased lines had a higher asset beta than other activities within Other UK telecoms since they faced higher operational gearing and greater demand-side risk.[1086]

Our reasoning and decisions

A21.166 We have decided to continue applying the Other UK Telecoms asset beta (and WACC) to active leased lines for the following reasons.

A21.167 First, **the systematic risk for active leased lines services is likely to be somewhat greater than that for the services included in Openreach.** We consider that demand for wholesale leased lines in general is likely to be more closely correlated with macro-economic activity than residential fixed lines and passive access services (and hence have a somewhat higher asset beta) since the downstream leased lines services, from which the demand for

[1083] TalkTalk's response to the 2018 BCMR Consultation, paragraph 5.130.
[1084] TalkTalk's response to the 2018 BCMR Consultation, paragraphs 5.134-5.136.
[1085] TalkTalk's response to the 2018 BCMR Consultation, paragraph 5.138.
[1086] BT Group's response to the 2018 PIMR and 2018 BCMR Consultations, Annex 2, paragraph 2.62.

wholesale services is derived, are used in part by corporate customers.[1087] Wholesale leased lines revenue is also likely to be more variable due to volume changes, whereas revenues from local access connections – particularly to residential properties – will typically vary less with the economic cycle. Evidence from BT on the monthly volume variability and forecast accuracy of different types of products also supports this view, showing that leased lines exhibit greater volume variability than copper access and are more difficult to forecast.[1088] Higher operational leverage (i.e. extent of fixed costs within total costs) can also imply higher systematic risk. Analysis by NERA suggests that on this basis leased lines may be somewhat riskier than copper access, although there are limitations in this analysis.[1089]

A21.168 Second, **the systematic risk faced by the telecoms activities included in Other UK Telecoms is likely to be sufficiently similar that they can be grouped together**. We consider that the systematic risk faced by the telecoms activities included within Other UK Telecoms is likely to be reasonably similar since they are characterised by: (a) using a fixed telecoms network, which often involves shared or similar passive infrastructure and hence, similar degrees of operational gearing; and (b) sales to customers who are able to scale demand in response to changes in the macro-economic cycle to a greater extent than for basic access connections to residential premises.[1090] Evidence from BT on the monthly volume variability and forecast accuracy of different types of products supports this view, showing that the variability and forecast accuracy of services included in Other UK Telecoms is broadly similar.[1091]

A21.169 We asked NERA to consider the detailed points raised by stakeholders on the relative risk of leased lines compared to other services in Other UK Telecoms. NERA's April 2019 Report concludes that there is no strong evidence that active leased lines face higher or lower systematic risk than other activities in Other UK Telecoms on the basis that:

a) NERA's March 2016 Report showed that empirical asset beta ranges for Pay TV were only slightly higher than asset beta ranges of telecoms comparators in general and that Pay TV ranges were relatively wide.

b) NERA's November 2017 Report showed no evidence of statistically significant differences in the betas of companies with mainly fixed businesses rather than mainly mobile businesses.

[1087] We consider that business customers are more likely to reduce their consumption of bandwidth or number of lines in the event of a downturn.

[1088] NERA's October 2018 report, Section 5.3 and Appendix C.2. We would expect services with lower demand risk to be associated with lower volume variability and be easier to forecast (which is the case for copper lines).

[1089] NERA's October 2018 report, Section 5.3.

[1090] 2018 WLA Statement, paragraph A20.203.

[1091] 2018 WLA Statement, paragraph A20.204 and NERA's October 2018 report, Appendix C.2. NERA also compares the operational leverage of leased lines to BT Group overall, noting that it has "no reason to conclude that leased lines have a lower or higher operational leverage than BT as a whole or OUKT (Other UK Telecoms)" (see Appendix C.1).

c) NERA's October 2018 report found evidence supporting the view that copper access is likely to have lower systematic risk than active leased lines, but found no strong evidence that active leased lines had a significantly different exposure to systematic risk than other activities within Other UK Telecoms.

d) While TalkTalk and BT both stated leased lines were not exposed to the same level of systematic risk as other activities in Other UK Telecoms, neither provided strong evidence supporting those claims. TalkTalk provided no evidence supporting its assertion that leased lines were less risky than other activities. BT provided analysis of volume risk exposure by looking at the variation of mobile revenues to UK GDP however, it did not show that leased lines demand varied more than mobile demand and revenues.[1092]

A21.170 We agree with NERA's analysis and have therefore decided to continue to apply the Other UK Telecoms asset beta to active leased lines services.

Asset beta for inter-exchange dark fibre services

Our proposals

A21.171 We proposed to use the Other UK Telecoms beta for inter-exchange dark fibre services. We noted that most of the underlying infrastructure for dark fibre circuits was shared with active leased lines and that the customers (i.e. downstream telecoms providers) were also likely to be the same.

A21.172 Nevertheless, we noted two factors which could contribute to differences in risk between active leased lines and inter-exchange dark fibre.

A21.173 First, the scope of our proposed remedy was limited to inter-exchange connectivity only (i.e. it excluded access connections), suggesting that demand for dark fibre is likely to be less sensitive to demand from individual customers (i.e. business sites) in the access part of the network compared to active leased lines in general (and hence, less correlated with the economic cycle).

A21.174 Second, revenue from dark fibre sales would be less dependent on bandwidth requirements of downstream users since a dark fibre service is essentially agnostic to bandwidth. Our proposed pricing for dark fibre was not dependent on bandwidth, whereas prices for active services offered by Openreach are specified by bandwidth (e.g. 100 Mbit/s, 1 Gbit/s, or 10 Gbit/s). To the extent that demand for bandwidth is correlated with the economic cycle, this might suggest a lower exposure to systematic risk compared to active services.

A21.175 However, we considered that it was difficult to assess if any difference in demand risk would be significant in practice, as there was uncertainty around how dark fibre would be used and there was no existing service for which we might analyse volumes. Therefore, we

[1092] NERA's April 2019 report, Section 4.3.3.

proposed using the Other UK Telecoms asset beta (and WACC) in capping inter-exchange dark fibre prices.

Stakeholder responses

A21.176 TalkTalk was the only stakeholder to comment on this proposal. It argued strongly that the provision of dark fibre services would be lower risk than that of active leased lines and in fact, it would even be lower risk than that of residential broadband.

A21.177 TalkTalk considered it would likely be one of the largest users of dark fibre and that, under our proposed scope for the remedy, dark fibre would be used to support its copper (and FTTC) access network customers, i.e. it would be used to support residential broadband provision. Once TalkTalk switches to using dark fibre to backhaul from a BT exchange, it would only stop taking dark fibre if all services from the exchange were to be ceased.

A21.178 TalkTalk argued that loss of demand from customers ceasing to take broadband would not result in a reduction in dark fibre demand. It also argued that the converse applies i.e. faster growth in customer demand would not impact the demand for dark fibre. TalkTalk therefore concluded that, since there would be no correlation of Openreach's revenue from dark fibre with the economic cycle, the best estimate for the asset beta for inter-exchange dark fibre was zero or, at the very least, significantly less than the proposed asset beta.[1093]

Our analysis and decision

A21.179 Our consultation position reflected a balanced judgement on the relative risk of inter-exchange dark fibre services and active leased lines in general.

A21.180 On further consideration and in light of the arguments advanced by TalkTalk, we consider that the case for assuming that inter-exchange dark fibre services are lower risk than active leased lines in general is stronger than we previously proposed. Our conclusion is that the Openreach beta is more consistent with the expected systematic risk of inter-exchange dark fibre services than the asset beta of Other UK Telecoms due to our re-assessment of the demand risk of inter-exchange dark fibre services.

A21.181 In Volume 2 we set out our decision to require Openreach to provide access to dark fibre. This requirement relates only to inter-exchange connectivity routes from certain BT Only exchanges. In contrast, regulated access to active leased lines (the risk of which we believe is captured by the Other UK Telecoms beta) includes business access connections as well as all inter-exchange routes on which BT has SMP (and not just those that are from BT Only exchanges).

A21.182 As discussed in Section 7 of Volume 2, BT exchanges act as network nodes, which are used to aggregate traffic and act as interconnection points between networks. Operators need access to BT exchanges to be able to use some of BT's wholesale access services. This includes wholesale access for business sites, mobile backhaul and residential fixed

[1093] TalkTalk's response to the 2018 BCMR Consultation, paragraphs 5.142-5.146.

broadband. For example, operators offer access services based on LLU and VULA, served from BT exchanges, where they have equipment co-located to aggregate broadband traffic. They rely on leased lines to backhaul this aggregated broadband traffic to their core network from BT's exchanges.

A21.183 While demand and usage of dark fibre is likely to vary by exchange, there are a substantial number of NGA handover exchanges which are BT Only[1094], where other telecoms operators will have enduring backhaul demand. Their backhaul needs will largely be determined by the aggregation of downstream consumer demand from broadband over local access connections. This would support our suggestion in the Consultation that demand for dark fibre is likely to be less sensitive to demand from individual end-users (i.e. business sites) in the access part of the network compared to demand for active leased lines in general.

A21.184 We also largely agree with TalkTalk that changes in bandwidth requirements in the access part of the network are unlikely to translate into significant changes in demand for dark fibre, since a single dark fibre connection can be used to serve foreseeable bandwidth requirements. This would make inter-exchange dark fibre lower risk compared to active leased lines as a whole.

A21.185 However, we do not consider that demand risk for dark fibre would be zero, as suggested by TalkTalk. Backhaul requirements may still change in response to changes in demand and we still expect customer demand to have some correlation with the economic cycle. Finally, demand risk is not the only driver of systematic risk. Cost structure can also affect the beta.[1095]

A21.186 Some of the infrastructure which will be used to provide dark fibre inter-exchange connectivity will be similar to active leased lines however, a bigger proportion of the cost base will relate to passive infrastructure, most of which is already in place. This makes inter-exchange dark fibre more akin to the provision of lower risk copper access connections or other passive products, such as PIA.

A21.187 Overall, we conclude that, given the market conditions under which we are requiring this access remedy, the systematic risk of providing inter-exchange dark fibre will be sufficiently lower than the systematic risk of providing active leased lines that a different asset beta is appropriate. As we have decided to maintain our three-way disaggregation of the BT WACC, we consider that the relevant risk will be better reflected by the Openreach asset beta rather than that of Other UK Telecoms.

A21.188 Therefore, we use the Openreach asset beta in setting cost-based charges for inter-exchange dark fibre services.

[1094] As discussed in Section 12 of Volume 2.

[1095] For example, companies where fixed costs are a large proportion of the total cost base (i.e. higher operating leverage) will tend to have higher betas all things being equal than those with lower fixed costs.

Asset beta weightings

Our proposals

A21.189 In line with the 2018 WLA Statement we proposed to assign Openreach a weight of 20%, Other UK telecoms a weight of 65% and the Rest of BT a weight of 15%.

Stakeholder responses

A21.190 No stakeholders specifically commented on the weights we attributed to the disaggregated parts of BT.

Our reasoning and decision

A21.191 Table A21.14 below reports weightings based on EBITDA and the ratio of net replacement cost to enterprise value (NRC/EV) for Openreach (as defined for the purposes of our disaggegation) as a proportion of BT Group.

Table A21.14: Weightings for Openreach

	2013/14	2014/15	2015/16	2016/17	2017/18	5Y Average
EBITDA	25%	24%	22%	24%	22%	24%
Regulatory NRC/EV	25%	22%	17%	15%	20%	20%

Source: Ofcom[1096]

A21.192 In estimating the relevant weightings, we have considered the same period as used for estimating the BT Group asset beta – i.e. the last five years. On the basis of the five-year averages above, we consider that a weighting of 20% for Openreach remains appropriate.

A21.193 To estimate the weightings of Other UK Telecoms and RoBT, we have considered the proportion of BT Group EBITDA that relates to each division. This is shown in Table A21.15 below.

[1096] EBITDA is estimated using information reported in BT's RFS (specifically the 'performance summary by market table'), with EBITDA equal to total revenue less HCA operating costs (excluding depreciation). 'Openreach' includes EBITDA associated with WLR and WLA (excluding fibre) markets and a proportion of 'Other Openreach markets and activities' that we estimate relates to internal SMPF. Total EBITDA is equal to that reported in BT's annual report but prior to 2015/16 the EBITDA percentage assumes that EE was owned for the full year. NRC is taken from the cost model supporting the 2018 WLA Statement divided by BT's average enterprise value for the year, derived from Bloomberg. Note that in the 2016 BCMR Statement enterprise value was taken at the end of the financial year but we consider that an average for the year better matches the NRC (which is an average of the opening and closing balances for the year).

Table A21.15: Proportion of total EBITDA represented by each BT division

	2013/14	2014/15	2015/16	2016/17	2017/18	5Y Average
Global Services	17%	17%	13%	6%	6%	12%
Openreach	43%	41%	34%	34%	34%	37%
BT Consumer	14%	16%	13%	13%	14%	14%
BT Business and Public Sector	16%	17%	14%	20%	19%	17%
BT Wholesale	10%	9%	7%	11%	10%	9%
EE	0%	0%	20%	15%	18%	11%
Other	0%	0%	(1%)	0%	0%	0%
Total	100%	100%	100%	100%	100%	100%

Source: 2015/16 data from pro-forma results published by BT on 29 June 2016.[1097] All other data taken from BT's annual reports. Note that the Openreach division reported here includes wholesale copper access, wholesale Ethernet leased lines and wholesale fibre broadband products and is therefore broader than the Openreach business shown in Table A21.14.

A21.194 We note that the proportion of EBITDA represented by Global Services reduced in 2016/17 due to issues in its Italian business[1098] and the 2016 reorganisation noted above. Since BT's ICT operations (which are captured in our RoBT disaggregated asset beta) are spread across its Global Services and Business and Public Sector divisions in 2016/17 and 2017/18, we asked BT to provide EBITDA figures for UK-focused ICT services in Business and Public Sector and its internationally focused ICT services in Global Services in these years.

A21.195 Our analysis suggests that in 2016/17 and 2017/18, EBITDA for ICT services across these two divisions represented around [✂]% (10-15%) of BT Group EBITDA[1099], comparable to the 2015/16 percentage for Global Services in Table A21.15. As such we propose to apply a (rounded) weighting of 15% to the RoBT, which captures BT's ICT operations.

A21.196 Based on the analysis above, Openreach would receive a weighting of 20% and the RoBT would receive a weighting of 15%, which implies a weighting for Other UK Telecoms of 65%. These weightings are the same as those used in the 2018 WLA Statement.

Comparator company asset betas

Our proposals

A21.197 Our disaggregation of the BT Group asset beta is informed by the asset betas for comparator companies. We commissioned NERA to estimate asset betas for the following

[1097] See http://www.btplc.com/Sharesandperformance/Quarterlyresults/2015-2016/RestatedhistoricalfinancialinformationJune2016/Downloads/Proforma/ProformahistoricalfinancialsJune2016.pdf.

[1098] See page 6 of BT's 2017 Annual Report.

[1099] 2018 WLA Statement, paragraph A20.163 (for 2016/17); Openreach response dated 20 June 2018 to question 3 of the 6th LLCC s.135 notice (for 2017/18).

comparators: UK network utilities, UK telecoms operators, European telecoms operators, and international ICT companies. Consistent with our approach to the BT Group asset beta, we proposed to place more weight on five-year asset betas for comparator companies to inform the disaggregation.

A21.198 We proposed two ranges for UK telecoms, one including Sky and one excluding Sky (due to increasing M&A speculation affecting Sky's share price). We also proposed to exclude SSE from the UK network utilities sample as a large portion of SSE's revenues do not relate to regulated network assets and was therefore less close to a traditional network utility.

A21.199 NERA estimated each comparator's asset beta against a home index and a world index (FTSE All World). For the home index, NERA used the FTSE All Share for the UK listed companies and the FTSE All Europe for European telecoms companies. For ICT comparators the home betas were estimated against the S&P 500 and the FTSE All Europe depending on where the company was listed.

Stakeholder responses

A21.200 BT noted that the European telecoms comparator sample included a number of non-euro quoted companies (namely Telenor, Swisscom and Tele2). To BT it was not clear if the currency differentials for these companies had been accurately accounted for. BT re-estimated the equity betas for Telenor, Swisscom and Tele2 against a domestic index (Oslo Bors index, Swiss Market index and OMX Stockholm 30 index respectively) and found higher asset betas which resulted in a higher range for the European telecoms sample. BT also stated that Sky should be excluded from the sample of UK telecoms companies.[1100]

Our reasoning and decisions

A21.201 Table A21.16 below summarises the updated five-year asset beta averages and ranges for these comparators. The table shows average asset betas for UK telecoms excluding Sky since Sky was purchased by Comcast in September 2018 and subsequently delisted in November 2018.

A21.202 We asked NERA to consider BT's point regarding Telenor, Swisscom and Tele2. In NERA's view:

a) The use of local indices for estimating betas was problematic in the context of countries with small equity markets. This is because if a particular stock accounts for a considerable part of the market index this will result in a high correlation of the stock with the market, resulting in elevated asset betas.

b) Regardless of the currency, the FTSE All Europe represents an appropriate benchmark for EU/EEA countries given the level of integration of EU/EEA markets.[1101]

[1100] BT Group's response to the 2018 PIMR and 2018 BCMR Consultations, Annex 2, paragraphs 2.74-2.75.
[1101] NERA's April 2019 report, Section 4.4.2, page 35.

Table A21.16: Five-year daily asset beta ranges and averages for comparator groups

	Home index		World index	
	Range	Average	Range	Average
UK utilities	0.38 to 0.40	0.39	0.28 to 0.31	0.29
UK telecoms	0.60 to 0.66	0.63	0.53 to 0.59	0.56
European telecoms	0.39 to 0.67	0.53	0.40 to 0.75	0.58
ICT (Tier 1 and Tier 2)	0.63 to 1.12	0.79	0.65 to 1.27	0.90
ICT (Tier 1)	0.63 to 0.92	0.80	0.74 to 1.25	0.93
BT Group	**0.68**		**0.57**	

Source: NERA, 5-year asset betas with a cut-off date of 31 January 2019

A21.203 In line with our approach in the 2018 WLA Statement, we have based the disaggregated asset beta for each part of BT on the following comparators.

- **Openreach –** we expect this line of business to face lower systematic risk than BT Group, but to face greater systematic risk than UK network utilities.[1102] When considering the Openreach asset beta, we also take account of the asset betas for UK telecoms operators. In general, we would expect the systematic risk facing Openreach to be lower than that facing UK telecoms operators.
- **Other UK Telecoms** – to estimate the beta for Other UK Telecoms, we generally take account of the asset betas of UK and European telecoms operators as comparators. We would expect Other UK Telecoms to face somewhat greater systematic risk than Openreach but less systematic risk than the ICT activities included in RoBT.
- **RoBT** – this primarily represents BT's ICT operations[1103], which include services in three main areas: i) managed networked IT services and security; ii) unified communications and IT infrastructure; and iii) professional services and IT consulting. NERA identifies two tiers of comparators: 'Tier 1' comparators that are active across all three main business areas and 'Tier 2' comparators that are active in two of the three main business areas. We take account of the asset betas for Tier 1 and Tier 2 ICT comparators when estimating an asset beta for RoBT, and these asset betas tend to be higher than asset betas for telecoms comparators.

Openreach asset beta

Our proposal

A21.204 We proposed to use an asset beta of 0.56 for Openreach, based on the mid-point between the BT Group (0.71) and network utility asset betas (0.40).

[1102] We do not consider it is clear that systematic demand would be as low as that for products provided by pure network utility operators (such as water and electricity networks).
[1103] Since BT's 2016 reorganisation, its ICT services are spread between Business and Public Sector (UK ICT Services) and Global Services (International ICT Services), as noted above.

Stakeholder responses

A21.205 No stakeholder specifically commented on our proposal on the Openreach beta.

Our reasoning and decisions

A21.206 As in previous reviews, we expect Openreach to face lower systematic risk than BT Group, but we consider that it is likely to face greater systematic risk than network utilities such as water companies and energy networks. Therefore, a figure around the mid-point between the BT Group (0.68) and UK network utility asset betas[1104] (0.39), is likely to provide a good starting point. To the nearest 0.05, that would be 0.55.

A21.207 In determining the asset beta for each disaggregated part of BT Group, we also need to take account of the relevant weightings and comparator asset beta evidence since we require the weighted sum of disaggregated betas to reconcile to that of BT Group. An Openreach asset beta of 0.55 (combined with the weightings previously discussed and the Other UK Telecoms asset beta at 0.65 – see below) gives a RoBT asset beta towards the middle of the ICT range (see next heading).

A21.208 Therefore, we use an asset beta of 0.55 for Openreach.

Other UK Telecoms and RoBT asset beta

Our proposals

A21.209 In the 2018 WLA Statement, we considered that an asset beta range of 0.55 to 0.75 was appropriate for Other UK Telecoms and that an asset beta range of 0.70 to 1.25 was appropriate for ICT services. In the Consultation, we proposed that these ranges broadly remained appropriate for this review period. On the basis of the available evidence, we proposed an asset beta of 0.65 for Other UK Telecoms and an asset beta of 1.17 for RoBT.

Stakeholder responses

A21.210 BT argued that we had provided no evidence that the risk of active leased lines services had changed from the 2016 BCMR (in which we used an asset beta of 0.70).[1105] Overall, BT concluded that we should set a point estimate for business connectivity markets above the midpoint of the 0.55 to 0.75 range.[1106]

A21.211 BT stated that our estimate of the RoBT beta was well above the average of the range for global ICT comparators. In its opinion this provided evidence that the betas for the other parts of BT were set too low. BT said we should have undertaken a relative risk assessment of the Rest of BT versus Other UK Telecoms to determine whether the gap in asset beta estimates of the two segments was plausible given fundamental systematic risk drivers. BT also argued that many of the services Global Services provided had similar systematic risk to those contained in Other UK Telecoms (e.g. voice services). BT said we had not shown

[1104] As estimated by NERA on a consistent basis to BT.
[1105] BT Group’s response to the 2018 PIMR and 2018 BCMR Consultations, Annex 2, paragraph 2.66.
[1106] BT Group’s response to the 2018 PIMR and 2018 BCMR Consultations, Annex 2, paragraph 2.68.

any evidence of Global Services having higher operating leverage than Other UK Telecoms to explain our higher asset beta for RoBT.

A21.212 BT proposed an asset beta of 0.70 for Other UK Telecoms which combined with our proposal of 0.56 for Openreach (and the proposed weightings) would imply an asset beta of 0.95 for RoBT.[1107]

Our reasoning and decisions

A21.213 In this subsection, we set out asset beta ranges for Other UK Telecoms and RoBT and select point estimates within these ranges.

Asset beta range for Other UK Telecoms

A21.214 Based on evidence from telecoms comparators, we have considered whether the asset beta range of 0.55 to 0.75 used in the 2018 WLA Statement for Other UK Telecoms remains appropriate.

A21.215 The 0.55 to 0.75 range captures the updated five-year asset betas of UK telecoms comparators measured against the FTSE All Share (which range from 0.60 to 0.66) and the asset beta for BT Group (0.68). Further, the mid-point of the 0.55 to 0.75 range (0.65) is close to the average UK telecoms asset beta of 0.63.[1108] In addition, the 0.55 to 0.75 range largely captures the 95% confidence intervals for the UK telecoms asset betas (0.58 to 0.77 for BT, 0.46 to 0.75 for TalkTalk, and 0.59 to 0.73 for Vodafone).[1109]

A21.216 Since the 2018 WLA Statement, the five-year average UK telecoms asset beta has been relatively flat, although the two-year average has come down (mainly due to the referendum effect).[1110] We recognise that none of the UK telecoms comparators are perfect comparators for BT's Other UK Telecoms activities; for example, TalkTalk has fewer infrastructure assets and focuses on retail customers and Vodafone is predominantly focused on mobile services and generates a minority of its revenue from the UK.

A21.217 It is difficult to determine the appropriate market index when estimating asset betas for European telecoms comparators when seeking to inform our Other UK Telecoms range. Against the FTSE All Europe index the five-year asset betas range from 0.39 to 0.67 while against the FTSE All World they range from 0.40 to 0.75. On this evidence, 0.75 could represent a reasonable upper end for the Other UK Telecoms range since it captures the upper end of the European telecoms asset betas against the All World index, although it also suggests the lower end of the Other UK Telecoms range could be less than 0.55. Similar to UK telecoms asset betas, since the 2018 WLA Statement, the five-year average European telecoms asset beta has been relatively flat, though the two-year average asset beta has trended down very slightly.[1111]

[1107] BT Group's response to the 2018 PIMR and 2018 BCMR Consultations Annex 2, paragraphs 2.77-2.81.
[1108] We have excluded Sky from the UK telecoms sample as it delisted on 7 November 2018 following its acquisition by Comcast.
[1109] NERA's April 2019 report, Appendix B, Figure B.1.
[1110] NERA's April 2019 report, Figure 2.6.
[1111] NERA's April 2019 report, Figures 2.10 and 2.11.

A21.218 Overall, we consider that an asset beta range of 0.55 to 0.75 remains appropriate for Other UK Telecoms. This range is compatible with the five-year asset beta averages of UK telecoms comparators (0.60 to 0.66) and the asset beta for BT Group; it overlaps with the 95% confidence intervals for each of the UK telecoms comparators' five-year asset betas and spans much of the five-year asset beta averages for European telecoms (0.40 to 0.75 against the FTSE All World).

Asset beta range for RoBT

A21.219 In the 2018 WLA Statement we used an ICT range of 0.70 to 1.25. We consider that the ICT asset betas presented in Table A21.14 continue to support this range. The highest five-year asset betas for the Tier 1 and Tier 2 ICT comparators are between 1.12 and 1.27 depending on whether the home or world index is used as the reference. While there could be scope to reduce the lower end of the range based on the ICT ranges from Table A21.14 (the lower end now being nearer 0.65), given the evidence supports an ICT asset beta above a telecoms asset beta, we consider that 0.70 remains a reasonable lower end of the range as it sits above the midpoint of our proposed 0.55 to 0.75 range for the Other UK Telecoms asset beta. We therefore conclude that an ICT range of 0.70 to 1.25 remains reasonable to apply to RoBT.

Our point estimates

A21.220 When selecting a point estimate for the Other UK Telecoms and RoBT asset betas, we need to consider evidence from comparator companies as well as the weightings and implications for the asset beta for the other parts of BT. The UK telecoms asset beta range would support a value towards the middle to lower part of the 0.55 to 0.75 range, while the European asset betas are quite wide and could imply values anywhere in the 0.55 to 0.75, although the concentration of values is in the lower part of the range.[1112]

A21.221 An asset beta for Other UK Telecoms lower than the mid-point of the 0.55 to 0.75 range would imply an increase in the Openreach asset beta and /or a relatively high RoBT asset beta. An asset beta for Other UK Telecoms of 0.65 is consistent with a RoBT asset beta of 0.98 when the Openreach beta is 0.55.[1113] The RoBT asset beta of 0.98 is consistent with the midpoint of our ICT range and only slightly above the average for all ICT comparators against the All World index (0.90).

A21.222 We agree with BT's comment that a RoBT asset beta at the top of our ICT range might be inappropriate when the Openreach and OUKT asset betas are closer to the middle of their respective benchmark ranges (as is the case here). We consider our revised asset betas for each constituent part of BT are now more reasonable on this basis.

A21.223 We disagree with BT's proposal to use the same asset beta for Other UK Telecoms as in the 2016 BCMR Statement. Even if the underlying business risk has not fundamentally changed, perceptions of the risk of telecoms companies compared to the market as a

[1112] While the top end of the European telecoms asset beta range against the FTSE All World is 0.75, the majority of European telecoms asset betas are lower than 0.65 (9 out of 11 observations), with the average at 0.58.
[1113] This is based on weightings of 20%, 65% and 15% for Openreach, Other UK Telecoms and RoBT respectively.

whole may have changed. Our decision to use an asset beta of 0.65 reflects updated market evidence for BT and relevant comparators, consistent with previous decisions.

Disaggregation of BT Group cost of debt

Our proposals

A21.224 Consistent with previous market reviews, we considered that a firm facing lower systematic risk could attract a higher credit rating for a given level of gearing than a firm facing higher systematic risk. This implies that BT's businesses with lower systematic risk (i.e. Openreach copper access) would face a lower cost of debt than Other UK Telecoms or the RoBT (at the same level of gearing). As such we proposed a cost of debt for:

a) Openreach which was 0.1% lower than BT Group, representing a one notch uplift in credit rating;

b) Other UK Telecoms in line with BT Group; and

c) RoBT 0.1% higher than BT Group (using the same three-way disaggregation weights as used to calculate the RoBT asset beta).

Stakeholder responses

A21.225 TalkTalk considered the proposal to disaggregate the cost of debt for BT Group is correct, providing for a lower cost of debt for less risky parts of BT such as copper access and a higher cost of debt for riskier parts of BT such as Global Services. However, it said we should justify why we only uplift the credit rating for Openreach by one notch. It proposed we should conduct more detailed analysis to attempt to determine what the increase in credit rating would be for Openreach compared to the other elements of BT.[1114]

Our reasoning and decision

A21.226 The credit ratings of UK utilities currently range from BBB to A- compared to BT Group at BBB.[1115] While on the face of this evidence BT Group's rating (BBB) sits within the range of UK utilities, the utilities are all more highly geared than BT Group although the gap has reduced recently.[1116]

A21.227 To estimate the potential difference in the cost of debt for Openreach, we have compared the spreads between BBB-rated debt and A-rated debt with maturities of ten years (as at 28 February 2019), which is shown in Table A21.17 below.[1117] This suggests that the spread between yields on A-rated debt and BBB-rated debt is between 0.18% and 0.34%; the

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[1114] TalkTalk's response to the 2018 BCMR Consultation, paragraph 5.149.
[1115] Long-term credit ratings from S&P: Severn Trent (BBB), United Utilities (BBB+) and National Grid (A-).
[1116] BT Group one-year average gearing is 40% and the utilities average is 52% whereas on a five-year average basis BT Group's average is 29% against a utilities average of 50%.
[1117] There are effectively three ratings notches between BBB rated debt and A rated debt.

lower spread reflecting a comparison of UK utilities' indices and the higher spread reflecting a comparison of BBB and A-rated companies in general.

A21.228 In response to TalkTalk's comment, we have assumed a one notch uplift in the credit rating for Openreach since BT Group's current credit rating is BBB and the rated utilities either have the same credit rating (but supported by higher gearing) or have ratings one or two notches above BT Group. On average these utilities have a credit rating of BBB+, therefore we have assumed a one notch uplift to BT Group's credit rating to reflect a slightly higher credit rating.

A21.229 Assuming a one notch uplift to Openreach from the BT Group rating, Openreach might be able to reduce its cost of debt by around 0.06% to 0.11% relative to BT Group.[1118]

Table A21.17: Spread between BBB and A-rated benchmark indices (10 years)

	One-year average	Two-year average
BBB vs A ratings	0.31%	0.34%
UK Utilities BBB vs A ratings	0.22%	0.18%

Source: Bloomberg, Ofcom analysis using data to 28 February 2019. BBB index is the BVCSGU10 Index from Bloomberg. 'A' index is the BVCSGK10 Index from Bloomberg. UK Utilities BBB index is the BVGBUB10 Index from Bloomberg. UK Utilities A index is the BVGBUA10 Index from Bloomberg.

A21.230 Any adjustment based on this approach is approximate as it depends on the extent to which Openreach is perceived as utility-like and the assumed level of gearing, among many factors. An adjustment somewhere between the utility range and that for other companies would imply a cost of debt for Openreach around 0.1% lower than for BT Group, i.e. around 3.9% compared to BT Group's 4.0%.

A21.231 It is similarly difficult to assess precisely what rating the Other UK Telecoms activities would achieve. However, we note that across the UK and European telecoms comparators described above many have similar credit ratings to BT Group implying that the Other UK Telecoms activities might have a cost of debt similar to that of BT Group, i.e. the 4.0% cost of debt estimated above.[1119]

A21.232 To estimate the cost of debt for the RoBT under a three-way disaggregation, we use the weightings from the asset beta disaggregation. On this basis, the weightings imply a RoBT cost of debt of 4.1%.[1120]

A21.233 We have therefore decided to use a cost of debt of 3.9% for Openreach and 4.0% for Other UK Telecoms. For presentation purposes (since we do not regulate services supplied within what we describe as RoBT), we use a cost of debt of 4.1% in calculating the WACC for the RoBT.

[1118] One-notch estimates have been derived by dividing the figures in the table by three.

[1119] S&P rates 11 of the 14 UK and European telecoms comparators. Six of these have BBB ratings (similar to BT), three have A ratings and two have BB ratings. Orange Belgium is owned by Orange S.A and does not have a separate credit rating. S&P does not rate Iliad or Tele2.

[1120] 3.9% x 20% [Openreach] + 4.0% x 65% [Other UK Telecoms] + 4.1% x 15% [RoBT] = 4.0% [BT Group].

Gearing for the constituent parts of BT Group

Our proposals

A21.234 In line with previous reviews we proposed to use BT Group's forward-looking gearing (35%) for all constituent parts of BT (i.e. Openreach, Other UK telecoms and RoBT).

Stakeholder responses

A21.235 TalkTalk disagreed with this approach and stated that Openreach should have a notional gearing level modelled on a suitable set of comparators.[1121] In its opinion, a level of gearing around 50% to 60% would seem appropriate given other regulators' approaches to setting notional gearing including CAA (60% in H7), Ofwat (60% in PR19) and Ofgem (50-65% in RIIO-2).

A21.236 TalkTalk also stated that other parts of BT would likely have lower gearing than Openreach referencing Global Services and BT Sport which TalkTalk states would have zero gearing.

A21.237 TalkTalk also proposed no uplift to the debt premium to reflect this higher gearing, citing Telefonica and Heathrow Airport which have sustained the same credit rating as BT at 50% to 60% gearing.[1122]

Our reasoning and decisions

A21.238 In principle we recognise that lines of business with different levels of risk could have different optimal gearing levels. However, it is not clear that Openreach would have a materially higher gearing than 40%.

A21.239 We consider the systematic risk of Openreach to be between that of a utility company and a telecoms operator. We note that:

a) the average five-year gearing for BT is 29% while its current gearing is around 40%;

b) the average five-year gearing of listed utilities is 50%, with current gearing slightly higher at around 55%;

c) the average five-year gearing of a European telecoms operator is 36% and 34% for a UK telecoms operator while current gearing for these comparator groups is also a bit higher at 38% and 42% respectively.

A21.240 This combined with the fact that Brattle has proposed a range of 25% to 50% for legacy telecoms networks we might expect a reasonable level of gearing for Openreach to be at least 30%, but not necessarily greater than 50%.

A21.241 Further, provided that a consistent set of debt beta and debt premia assumptions are used for different levels of gearing, changes in gearing should not have a material impact on the overall WACC.

[1121] When TalkTalk refers to Openreach it references Openreach access and leased lines.
[1122] TalkTalk's response to the 2018 BCMR Consultation response, paragraphs 5.121-5.126.

A21.242 Therefore, we consider that, given the additional complexity and judgement involved in disaggregating BT's gearing, this would be disproportionate, and we continue to assume the same level of gearing for each constituent part of BT for this review period.

Our decision on the disaggregated WACC

A21.243 Table A21.18 summarises the pre-tax nominal WACC for BT Group and the three-way disaggregation.

Table A21.18: BT pre-tax nominal WACC for BT Group and disaggregated lines of business

	BT Group	Openreach	Other UK Telecoms	RoBT
Pre-tax nominal WACC	8.3%	7.1%	8.0%	11.0%

Source: Ofcom

A22. Ethernet SLAs and SLGs

A22.1 In Section 15 of Volume 2, we have set out the quality of service remedies we are imposing. This annex contains additional material relating to our consideration of the SLAs and SLGs which form part of the package of remedies, namely:

- the contract negotiation principles and the SLA/SLG assessment criteria which should apply to future contract negotiations between Openreach and its customers for wholesale Ethernet leased lines;
- a summary of the 2016/2017 negotiations on Ethernet SLAs and SLGs; and,
- our guidance on the key points of difference in the 2016/2017 Ethernet SLA/SLG negotiations.

Contract negotiation principles and SLA/SLG assessment criteria

A22.2 In this section we:

- reprise the reasoning for adopting contract negotiation principles and SLA/SLG assessment criteria;
- specify the relevant principles and criteria and related matters which should apply to future contract negotiations between Openreach and its customers in relation to SLAs/SLGs for the provision of wholesale Ethernet leased lines; and,
- set out why we consider that it is appropriate to adopt these principles and criteria as part of the package of remedies we are imposing to address our QoS concerns in this market review.

Reasoning for the adoption of contract negotiation principles and SLA/SLG assessment criteria

A22.3 In response to concerns raised by telecoms providers about the process for industry negotiations when Openreach or telecoms providers consider that existing terms should be changed or that Openreach should provide new SLAs/SLGs for an element of a service, we recognise that Openreach, as the SMP provider for services in fixed access markets, naturally holds a more powerful negotiating position than other telecoms providers.

A22.4 In our view, where all parties are negotiating from a broadly similar position of market power, commercial negotiation without the involvement of the industry regulator is the preferred method for reaching agreement on the terms of SLAs and SLGs.

A22.5 In recognition of the likely imbalance in negotiating positions as between Openreach and its customers, we have concerns about the predictability and visibility of the process that determines critical aspects of SLA/SLG terms.

A22.6 While maintaining that regulatory intervention should be the last resort, we consider that there should be a defined, structured and open process for the negotiation of SLA/SLG terms which reserve a central role for the OTA2 and set a time limit for negotiations.

Principles for the contract negotiation process and criteria for the assessment of SLA/SLG requests

A22.7 We consider that the principles set out in Table A22.1 and the criteria set out in Table A22.2 should apply to future contract negotiations between Openreach and its customers in relation to SLAs/SLGs for the provision of wholesale Ethernet leased lines.

A22.8 These principles and criteria are the same as those set out in the 2016 BCMR Statement.

Table A22.1: Principles for the contract negotiation process

Principle	Description
Principle 1	The OTA2 should facilitate all negotiations to create or change an SLA/SLG and that this negotiation will allow input from all affected parties.
Principle 2	The OTA2 will, using stated criteria, assess whether a request for negotiations on a new SLA/SLG or change to an existing SLA/SLG (and related contract terms) should be facilitated through this negotiation process.
Principle 3	No negotiations over the content of an SLA/SLG should extend beyond six months, with regular reporting to Ofcom. If, in the opinion of the OTA2, negotiations cannot be successfully concluded or have not been concluded within six months, then the OTA2, as part of its final report to Ofcom, will set out its view on whether and on what basis Ofcom should initiate a review.
Principle 4	Provision should continue according to the terms of an appropriate, pre-existing SLA/SLG until such time as a new SLA/SLG can be agreed.

Principles 1 and 2 – the role of the OTA2 and practical application

A22.9 We envisage that the OTA2's role will be to facilitate the negotiation process, rather than to make decisions. However, we consider that there is significant scope for the OTA2 to contribute to, as well as guide and structure, the negotiation process and to assist in ensuring that parties are able fully to participate.

A22.10 We would expect that the OTA2 would also have a key role in prioritising the issues to be considered in the process. This could mean that the OTA2 would decide that an issue is not appropriate for consideration in the process. This would not, of course, prevent any stakeholder from raising this issue as a dispute directly with Ofcom, but would ensure that what would be a resource-intensive process is used effectively.

A22.11 We have decided that the initial criteria used by the OTA2 for making its assessment of SLA/SLG requests under Principle 2 are those set out in Table A22.2 below. While these criteria may need to be adapted over time, we consider that they form a reasonable basis for decisions as to prioritising issues for review.

Table A22.2: Criteria for the assessment of SLA/SLG requests

Criterion	Description
Criterion 1	The request does not duplicate an existing request that is either being considered by the OTA2 or is under discussion within an existing industry forum.
Criterion 2	The request could provide an adequate material benefit for the telecoms provider or industry and that any negative impact of the request not being addressed cannot be easily mitigated without the reasonable support of Openreach.
Criterion 3	The request does not seek to address a telecoms provider's deficiency that should more appropriately be addressed by the telecoms provider(s) themselves.
Criterion 4	The request has adequate scale and support across industry or from those telecoms providers addressing a recognised end customer group to which the request relates.

Principle 3 – Time limits for negotiation and clarifying/amending the subsequent process

A22.12 We consider that six months is an appropriate period in which to allow negotiations to take their course, where it is clear they are progressing. However, where negotiations have clearly broken down, then the OTA2 need not wait for the full six-month period to elapse before providing its report to Ofcom.

A22.13 Principle 3 provides that: (i) the OTA2 will be actively reporting to Ofcom on the progress of negotiations, including setting out its view on whether and on what basis Ofcom should initiate a review; and (ii) after receiving this report, we will consider the matter on its merits. We cannot commit (in the principles) to a full investigation or to invite parties to raise disputes without considering the facts of each specific case first. While we will need to take an independent view of the issues, we will take appropriate account of the OTA2's report, which we expect will include details about the contribution of all participants, including their role in any delays to negotiations.

Principle 4 – Clarifying the date when new SLAs/SLGs take effect

A22.14 We consider that the 'backdating' of SLAs/SLGs may risk distorting any negotiation process. It could lead to a disproportionate focus on performance in that period and may act to discourage Openreach from engaging positively with the proposed changes, as Openreach would not have an opportunity to modify its behaviour in response to the new targets and any compensation payments. We also consider that our principle that 'provision should continue according to the terms of an appropriate, pre-existing SLA/SLG until such time as a new SLA/SLG can be agreed' provides sufficient clarity as to the time at which the new SLA/SLG would take effect, i.e. on its agreement.

Negotiating behaviours and references to Ofcom under the principles

A22.15 We would expect all parties to any such negotiations (including Openreach) to make all reasonable efforts to exhibit the following behaviours:

- to approach negotiation of these matters with professional courtesy and an openness and willingness to consider the issues raised and any evidence presented;
- to be responsive to requests for negotiation and dialogue in a timely manner;
- to ensure that suitably empowered staff are available for meetings within a reasonable period following a request; and,
- to ensure that requests for information are responded to as quickly as reasonably possible.

A22.16 If Openreach does not engage in a manner we consider appropriate, then we may consider whether there is a need for additional regulatory conditions (to be imposed either as part of future market reviews or at another time) which impose a process for negotiation in such circumstances.

A22.17 If an issue is referred to us under these arrangements, we will need to consider what is appropriate, including whether an issue/range of issues warrants our intervention. In addition to considering any such issues under our dispute resolution powers, it may also be necessary to consider whether a broader intervention might be required through, for instance, an own initiative compliance investigation or a policy review. Any decision about intervention will be based on our assessment of the issues referred to us in light of our duties and the broader regulatory framework. In the context of any such considerations, we would also consider any advice that the OTA2 offers in its final report, as appropriate.

A22.18 Where an issue is referred to us and we consider that it is appropriate to intervene, our starting point will be the respective proposals of each of the parties. In the first instance, we would expect to consider whether it would be appropriate, in light of our duties and the broader regulatory framework, to choose between these proposals, rather than seek to consider other alternative options in detail. This would be intended to create the incentive for parties to set out their most reasonable final positions, rather than taking an extreme position to try to distort any eventual regulatory outcome in their favour. However, such an approach remains subject to the overall requirement to adopt an outcome which overall best meets our statutory duties.

Summary of the 2016/17 negotiations on Ethernet SLAs and SLGs

Service level agreements

A22.19 The first phase of the negotiations concerned the SLAs that should apply to Ethernet provisioning. The negotiations were successfully completed in September 2016. Participants agreed that:

- The main provisioning SLA would be aligned with the measure of provisioning performance used by Ofcom for the QoS standards. The SLA would therefore continue to apply to the completion of orders by the CDD, but the use of deemed consent would be limited to customer delays, MBORC and other cases explicitly agreed by telecoms providers.[1123]

[1123] In practical terms, this change would mean that a greater proportion of delays would be allowable for SLG payments.

- The main provisioning SLA would be extended to include the delivery of handover documentation (i.e. failure to provide the handover document would constitute a failure for SLA purposes).
- There would be a separate SLA to cover cases where remedial work is required after a circuit has been handed over by Openreach.[1124]
- The same SLG rate would apply to both SLAs.

Service level guarantees

A22.20 The second phase of the negotiations concerned the level of the SLGs and was unsuccessful.

A22.21 In relation to the types of costs (arising because of Openreach provisioning failures), participants agreed that the SLGs should include an allowance for:

- delayed revenue margin;
- cancelled orders; and
- delay management (the customer service costs relating to delays).

A22.22 The participants disagreed on whether the SLGs should also include an allowance for:

- Compensation to downstream customers – [✂], [✂] and [✂] considered that the SLGs should include a pre-estimate for the compensation paid to downstream customers in connection with Openreach provisioning failures. [✂] considered that such losses should be excluded from SLG calculation as they are not normally included in commercial contracts.
- Brand/reputational damage – [✂] and [✂] considered that the SLGs should include a pre-estimate for the brand/reputational damage arising because of Openreach provisioning failures. [✂] considered that brand/reputational damage should be excluded from the SLG calculation as it is not normally included in commercial contracts. [✂] considered that such losses are intangible.[1125]

A22.23 There were also significant differences between the SLG proposed by Openreach and other participants. For simplicity, SLG payments were discussed in terms of the average SLG payment for Ethernet circuits of all bandwidths:

- Openreach proposed a dual rate SLG with an average payment of £53 per day with an inflection point at 21 days. This proposal was based on a model of telecoms provider costs, which indicated that delay management costs and the propensity (of end-users) to cancel would be higher for longer delays.

[1124] The detailed specification of this SLA was not discussed.

[1125] Ofcom summary drawn from the OTA2 SLG negotiation closure report to Ofcom, 29 January 2018 and telecoms providers submissions to the OTA2, provided to Ofcom by the OTA2, 22 May 2018.

- The OTA2's consolidated view of the other participants estimates of their SLG costs[1126] was £165 per day using the current SLA definition and £103 after applying Openreach's cost neutral adjustment for the proposed SLA definition.[1127] [1128]

A22.24 For comparison, Openreach estimated that the average SLG payment under the current SLG arrangements, adjusted for the proposed SLA definition, was £76 per day.

A22.25 The OTA2 found that the differences between the Openreach proposal and their consolidated view of other participants' estimates was due principally to two factors. These were:

- the brand/reputational loss estimate in two participants' submissions, which was the principle influencing factor; and,
- the estimate for additional senior management costs in one participant's submission.[1129]

Guidance on the key points of disagreement in the 2016/17 Ethernet SLA/SLG negotiations

A22.26 Here we set out our consideration of the negotiations between Openreach and industry and the most pertinent points of discussion. While not determinative in the event of any future referral to Ofcom, and we would consider all evidence presented to us in those circumstances, we set out initial considerations below to assist parties in reaching an expeditious agreement.

A22.27 In Section 15 of Volume 2, we set out our consideration of the responses to the 2018 BCMR Consultation concerning this guidance and explain why we decided not to amend it in light of those responses.

Types of costs which should be included in the SLG calculation

A22.28 We note firstly that the SLGs are a matter of negotiation and it is therefore open to participants to agree what types of cost should be included in the SLG calculation.

A22.29 If we are asked to consider which types of cost should be included in the SLG calculation our starting point would be the 2008 SLG Statement which established the first principles for SLGs. This states that when Openreach fails to meet agreed service levels, it should pay telecoms providers compensation which is based on a pre-estimate of an average telecoms provider's loss resulting from that failure. We remain of the view that this principle is appropriate given that Openreach's wholesale Ethernet services are SMP services.

[1126] The OTA2 weighted contributions according to each participant's share of circuit volumes and adjusted for non-participating telecoms providers.
[1127] SLG payments were reduced to reflect the increase in the average number of allowable SLG days from [✂] to [✂] days.
[1128] Ofcom summary drawn from the OTA2 SLG negotiation closure report to Ofcom, 29 January 2018 and telecoms providers submissions to the OTA2, provided to Ofcom by the OTA2, 22 May 2018.
[1129] Ofcom summary drawn from the OTA2 SLG negotiation closure report to Ofcom, 29 January 2018 and telecoms providers submissions to the OTA2, provided to Ofcom by the OTA2, 22 May 2018.

A22.30 In accordance with this principle, we would therefore be likely to consider that including pre-estimates of compensation to end-users and damage to brand/reputation could be appropriate provided that:

- there is evidence that telecoms providers incur such costs in practice; and
- the allowance for such costs is a genuine pre-estimate of those losses.

Brand/reputational damage

A22.31 [✂] and [✂] estimate that Openreach provisioning failures lead to a significant incidence of brand/reputational damage in the form of lost future business. [✂], for example, estimates that [✂].[1130]

A22.32 We have not seen the underlying evidence supporting these estimates, so we are unable to give a definitive view, however, we would question high estimates for several reasons:

- Ethernet services are typically purchased by businesses. In most circumstances these end-users would understand Openreach's role in delays and would understand that they affect all suppliers that use Openreach rather than impacting on one brand.
- Telecoms providers should be able to mitigate reputational damage by handling delays professionally e.g. by keeping end-users appraised of developments and by organising projects to minimise dependence on individual circuits.
- A proportion of Ethernet circuits will be purchased for internal usage (e.g. for use as backhaul circuits) and would be much less likely to affect end-users directly.

A22.33 Consequently, it would appear to us that losses arising from brand/reputational damage are likely to be the exception rather than the rule. Our research with end-users for the 2016 BCMR tends to support this view. The research found that only 38% of respondents (business and public sector users of leased lines) had ever switched suppliers for their leased line services.[1131] End-users would be likely to switch suppliers for a variety of reasons so the incidence of switching due to brand/reputational damage would be much lower than this figure.

A22.34 We therefore initially consider that the brand/reputational damage estimates would warrant further examination with particular focus on the extent to which such harm occurs in practice.

Delay management costs

A22.35 [✂] estimate of delay management costs was significantly higher than those of other participants, principally due to its estimate of the management costs of dealing with

[1130] Ofcom summary drawn from the OTA2 SLG negotiation closure report to Ofcom, 29 January 2018, OTA2 SLG model and telecoms providers submissions to the OTA2, provided to Ofcom by the OTA2, 22 May 2018.
[1131] Ofcom, 2015. Quality of service: Ethernet Leased Lines 2014 by BDRC-Continental, section 5.8.1 [accessed 30 October 2018].

delayed orders (as distinct from other delay management activities such as customer service costs).

A22.36 We have not seen the source data and calculations supporting the estimate, however we note that:

- At £[✂] per order, this management element appears to be very high both in absolute terms and in relation to wholesale Ethernet charges.
- The estimate was based on an analysis of orders that missed their contractual delivery dates between July and December 2016. It therefore relates to a period shortly after the imposition of the QoS standards when Openreach was taking steps to improve provisioning performance and performance was still comparatively poor.[1132]

A22.37 It appears probable that the management costs may be a function of the poor Openreach provisioning performance at the time and therefore may not be representative of the costs that telecoms providers incur now that performance has improved.

A22.38 More generally, we note that most participants are likely to have based their estimates on information relating to 2016 when Openreach's provisioning performance was significantly lower than at present and may therefore benefit from updating to reflect current costs.

[1132] Ofcom summary drawn from the OTA2 SLG negotiation closure report to Ofcom, 29 January 2018, OTA2 SLG model and telecoms providers submissions to the OTA2, provided to Ofcom by the OTA2, 22 May 2018.

A23. Sources of Evidence

A23.1 We have noted throughout this statement the evidence we have relied upon in relation to our findings and how we have relied upon that evidence. This annex lists the main sources of evidence used, including all responses to our consultations and to our formal s.135 notices requesting information.

A23.2 While this annex lists the main evidence we have relied upon, the list is for convenience only and is not intended to be exhaustive.

Consultation responses

Responses to the 2018 PIMR Consultation

A23.3 On 2 November 2018, we published a consultation (2018 PIMR Consultation), to gather stakeholders' views access to ducts and poles to support investments.[1133]

A23.4 30 stakeholders provided written responses to this consultation:

- Arqiva
- BT Group
- CityFibre
- Colt Technology Services
- Communication Workers Union
- Communication Workers Union NW Safety Forum
- Department for the Economy
- Digital Colony Partners
- Gamma
- Gigaclear
- Hyperoptic Limited
- Independent Networks Cooperative Association
- Infrastructure Investors Group
- Internet Telephony Services Providers' Association
- NextGenAccess
- Openreach
- Passive Access Group (PAG) via Towerhouse LLP
- Paul Wheelhouse, MSP, Minister for Energy, Connectivity and the Islands
- SSE
- TalkTalk Group
- Telefónica
- Hutchinson 3G UK Limited (Three)
- UK Competitive Telecommunications Association
- Virgin Media

[1133] Ofcom, 2018. *Physical Infrastructure Market Review – Access to ducts and poles to support investment* [accessed 13 May 2019].

- Vodafone
- [✂]
- [✂]
- [✂]
- [✂]
- [✂]

A23.5 Where available, we have published non-confidential versions of the responses from the stakeholders listed above. These can be found on our website.[1134]

Responses to the 2018 BCMR Consultation

A23.6 On 2 November 2018 (updated on 19 December 2018) we also published a consultation (2018 BCMR Consultation), to gather stakeholders' views on the work we had undertaken in assessing the state of competition in the business connectivity markets in the UK and our proposals for regulating these markets in the next review period.

A23.7 The 2018 BCMR Consultation contained two volumes: Volume 1 set out our market analysis, proposed SMP findings and remedies, and Volume 2 set out our proposed leased lines charge control (LLCC).[1135]

A23.8 25 stakeholders provided written responses to this consultation:

- BT Group (including EE)
- BUUK Infrastructure
- CenturyLink (formerly Level 3)
- CityFibre
- Colt Technology Services
- Communication Workers Union
- Gamma
- Gigaclear
- Hyperoptic Limited
- Infrastructure Investors Group (IIG)
- Independent Networks Cooperative Association (INCA)
- KCOM
- Openreach
- Passive Access Group (PAG) via Towerhouse LLP
- Sky UK
- Sorrento Networks
- SSE
- TalkTalk Group
- Telefónica O2
- Hutchinson 3G UK Limited (Three)

[1134] Ofcom, 2018. *Consultation: Physical Infrastructure Market Review* [accessed 11 June 2019] .
[1135] Ofcom, 2018. *Business connectivity market review – Volume 1: Market analysis, proposed SMP findings and remedies* [accessed 21 May 2019]; Ofcom, 2018. *Business connectivity market review – Volume 2: Proposed leased lines charge control* [accessed 21 May 2019].

- UK Competitive Telecommunications Association
- Virgin Media
- Vodafone
- Zayo Group
- [✂]

A23.9 Where available, we have published non-confidential versions of the responses from the stakeholders listed above. These can be found on our website.[1136]

Information gathered using statutory powers

A23.10 During this market review, we have issued a series of notices under section 135 of the Communications Act 2003 requiring various telecoms providers to provide specified information as set out in the notice. We have set out the information requests below by reference to the part of our statement where we mainly discuss the information received from stakeholders, and by stakeholder.

Volume 1 – PIMR and related annexes

Notices addressed to and responses received from Arqiva

A23.11 1st notice of 30 August 2018 regarding network deployment strategy and underlying physical infrastructure. Response received on 07 September 2018.

Notices addressed to and responses received from CityFibre

A23.12 1st notice of 21 August 2018 regarding network deployment strategy and underlying physical infrastructure. Response received on 06 September 2018 (except for the response to question 8 which was provided on 14 September 2018).

Notices addressed to and responses received from Colt Technology Services

A23.13 1st notice of 28 August 2018 regarding network deployment strategy and underlying physical infrastructure. Response received on 07 September 2018.

Notices addressed to and responses received from Gigaclear

A23.14 1st notice of 17 September 2018 regarding network deployment and underlying physical infrastructure. Response received in two tranches, one on 21 September 2018 and the other on 5 October 2018.

[1136] Ofcom, 2018. *Consultation: Business connectivity market review* [accessed 11 June 2019].

Notices addressed to and responses received from Hyperoptic

A23.15 1st notice of 30 August 2018 regarding network deployment strategy and underlying physical infrastructure. Response received in two tranches, one on 14 September 2018 and the other on 5 October 2018.

Notices addressed to and responses received from Openreach

A23.16 1st notice of 08 October 2018 regarding assumptions and estimates in relation to the potential impacts from introducing an unrestricted duct and pole access remedy on Openreach's leased lines business. Response received on 12 October 2018.

Notices addressed to and responses received from TalkTalk Group

A23.17 1st notice of 30 August 2018 regarding network deployment strategy and underlying physical infrastructure. Response received in two tranches, one on 14 September 2018 and the other on 5 October 2018.

Notices addressed to and responses received from Hutchinson 3G UK (Three)

A23.18 1st notice of 03 May 2019 regarding the use of non-telecoms infrastructure for fibre deployment. Response received 09 May 2019.

Notices addressed to and responses received from Virgin Media

A23.19 1st notice of 30 August 2018 regarding network deployment strategy and underlying physical infrastructure, including information on architecture, capacity, state of repair and serviceability. Response received in two tranches, one on 7 September 2018 and the other on 21 September 2018.

A23.20 2nd notice of 23 October 2018 regarding network deployment strategy and underlying physical infrastructure, including information on architecture, capacity, state of repair and serviceability. Response received 26 October 2018.

A23.21 3rd notice of 30 April 2019 regarding Virgin Media's view on the use of non-telecoms infrastructure for fibre deployment. Response received 09 May 2019.

Notices addressed to and responses received from Zayo Group

A23.22 1st notice of 28 August 2018 regarding network deployment strategy and underlying physical infrastructure. Response received in two tranches, one on 14 September 2018 and the other on 7 September 2018.

Volume 2 - BCMR and related annexes

Notices addressed to and responses received from AT&T

A23.23 BCMR s.135–20 notice of 14 December 2018 regarding IEC clarification, Cablelink and egress data check. Response received on 18 January 2019.

Notices addressed to and responses received from BT Group (including EE)

A23.24 BCMR s.135–1 notice of 17 January 2018 regarding circuit data and new adds for share, network reach for competitor intensity, future roll out plans. Response received in two tranches on 15 February 2018 and 23rd February 2018.

A23.25 BCMR s.135-2 notice of 01 February 2018 regarding list of Principal Core Operators at exchanges (PCOs). Response received on 22 February 2018.

A23.26 BCMR s.135-3 notice of 13 April 2018 regarding backhaul self-use wholesaling, wholesaling of leased lines and supporting questions to PCOs. Response received on 11 May 2018.

A23.27 BCMR s.135-6 notice of 20 April 2018 regarding impact of EFM/FTTx as a constraint on 100Mb/s services. Response received on 21 May 2018.

A23.28 BCMR s.135-23 notice of 21 February 2019 regarding specific documents on 5G roll out from list provided in 5G roll out plans responses. Response received from EE between 12 March 2019 and 19 March 2019.

A23.29 BCMR s.135-25 notice of 20 March 2019 regarding MNO consultation responses. Response received from EE on 27 March 2019.

A23.30 BCMR s.135-25 notice of 04 March 2019 regarding Re-imagining Ethernet Provision consultation responses. Response received on 25 March 2019.

A23.31 BCMR s.135-26 notice of 08 May 2019 regarding additional information provided by telecoms providers that we rely on in the statement – 1st tranche. Response received on 14 May 2019.

A23.32 BCMR s.135-29 notice of 29 May 2019 regarding additional information provided by telecoms providers that we rely on in the statement – 4th tranche. Response received on 6 June 2019.

Notices addressed to and responses received from CenturyLink

A23.33 BCMR s.135-1 notice of 17 January 2018 regarding circuit data and new adds for share, network reach for competitor intensity, future roll out plans. Responses and clarifications received between 06 February 2018 and 06 March 2018.

A23.34 BCMR s.135-3 notice of 13 April 2018 regarding backhaul self-use wholesaling, wholesaling of leased lines and supporting questions to PCOs. Responses and clarification received between 18 May 2018 and 31 May 2018.

A23.35 BCMR s.135-11 notice of 04 April 2018 regarding fibre connected buildings. Response and clarification received on 18 April 2018 and 09 May 2018.

A23.36 BCMR s.135-25 notice of 04 March 2019 regarding Re-imagining Ethernet Provision consultation responses. Response received on 04 March 2019.

Notices addressed to and responses received from CityFibre

A23.37 BCMR s.135-1 notice of 17 January 2018 regarding circuit data and new adds for share, network reach for competitor intensity, future roll out plans. Responses received between 13 March 2018 and 12 December 2018.

A23.38 BCMR s.135-3 notice of 13 April 2018 regarding backhaul self-use wholesaling, wholesaling of leased lines and supporting questions to PCOs. Response and clarification received on 09 May 2018 and 23 May 2018.

A23.39 BCMR s.135-10 notice of 26 April 2018 regarding CI internal evidence. Response received on 22 May 2018.

A23.40 BCMR s.135-11 notice of 04 April 2018 regarding fibre connected buildings. Response received on 04 June 2018.

A23.41 BCMR s.135-26 notice of 08 May 2019 regarding additional information provided by telecoms providers that we rely on in the statement – 1st tranche. Response received on 13 May 2019.

Notices addressed to and responses received from Colt Technology Services

A23.42 BCMR s.135-1 notice of 17 January 2018 regarding circuit data and new adds for share, network reach for competitor intensity, future roll out plans. Response and clarification received on 28 February 2018 and 15 March 2018.

A23.43 BCMR s.135-3 notice of 13 April 2018 regarding backhaul self-use wholesaling, wholesaling of leased lines and supporting questions to PCOs. Responses received between 11 May 2018 and 29 May 2018.

A23.44 BCMR s.135-10 notice of 26 April 2018 regarding CI internal evidence. Response received on 22 May 2018.

A23.45 BCMR s.135-11 notice of 04 April 2018 regarding fibre connected buildings. Response received on 13 April 2018.

A23.46 BCMR s.135-20 notice of 14 December 2018 regarding IEC clarification, Cablelink and egress data check. Clarification received on 30 January 2019.

Notices addressed to and responses received from Commsworld Limited

A23.47 BCMR s.135-3 notice of 13 April 2018 regarding backhaul self-use wholesaling, wholesaling of leased lines and supporting questions to PCOs. Response and clarification received on 14 May 2018 and 31 May 2018.

Notices addressed to and responses received from Daisy Group

A23.48 BCMR s.135-3 notice of 13 April 2018 regarding backhaul self-use wholesaling, wholesaling of leased lines and supporting questions to PCOs. Responses received on 02 May 2018 and 14 May 2018.

Notices addressed to and responses received from eir

A23.49 BCMR s.135-3 notice of 13 April 2018 regarding backhaul self-use wholesaling, wholesaling of leased lines and supporting questions to PCOs. Response received on 04 May 2019.

A23.50 BCMR s.135-19 notice of 05 December 2018 regarding circuit data and new adds for share, network reach for competitor intensity and future roll out plans. Responses received on 28 January 2019 and 29 January 2019.

Notices addressed to and responses received from Entanet

A23.51 BCMR s.135-3 notice of 13 April 2018 regarding backhaul self-use wholesaling, wholesaling of leased lines and supporting questions to PCOs. Response and clarification received on 08 May 2018 and 22 May 2018.

Notices addressed to and responses received from euNetworks

A23.52 BCMR s.135-1 notice of 17 January 2018 regarding circuit data and new adds for share, network reach for competitor intensity, future roll out plans. Response and clarification received on 14 February 2018 and 07 March 2018.

A23.53 BCMR s.135-3 notice of 13 April 2018 regarding backhaul self-use wholesaling, wholesaling of leased lines and supporting questions to PCOs. Response received on 11 May 2018 and 22 May 2018.

Notices addressed to and responses received from Equinix

A23.54 BCMR s.135-26 notice of 08 May 2019 regarding additional information provided by telecoms providers that we rely on in the statement – 1st tranche. Response received on 14 May 2019.

Notices addressed to and responses received from FibreSpeed Limited

A23.55 BCMR s.135-1 notice of 17 January 2018 regarding circuit data and new adds for share, network reach for competitor intensity, future roll out plans. Response received on 08 February 2018.

Notices addressed to and responses received from Gamma

A23.56 BCMR s.135-3 notice of 13 April 2018 regarding backhaul self-use wholesaling, wholesaling of leased lines and supporting questions to PCOs. Responses and clarification received between 11 May 2018 and 22 May 2018.

A23.57 BCMR s.135-25 notice of 04 March 2019 regarding Re-imagining Ethernet Provision consultation responses. Response received on 08 March 2019.

Notices addressed to and responses received from GTT Communications

A23.58 BCMR s.135-25 notice of 04 March 2019 regarding Re-imagining Ethernet Provision consultation responses. Response received on 25 April 2019.

Notices addressed to and responses received from Hyperoptic Limited

A23.59 BCMR s.135-3 notice of 13 April 2018 regarding backhaul self-use wholesaling, wholesaling of leased lines and supporting questions to PCOs. Response and clarification received on 10 May 2018 and 22 May 2018.

A23.60 BCMR s.135-25 notice of 04 March 2019 regarding Re-imagining Ethernet Provision consultation responses. Response received on 11 March 2019.

Notices addressed to and responses received from Interoute Communications Limited

A23.61 BCMR s.135-1 notice of 17 January 2018 regarding circuit data and new adds for share, network reach for competitor intensity, future roll out plans. Responses received on 14 February 2018 and 05 March 2018.

A23.62 BCMR s.135-3 notice of 13 April 2018 regarding backhaul self-use wholesaling, wholesaling of leased lines and supporting questions to PCOs. Response and clarification received on 16 May 2018 and 23 May 2018.

A23.63 BCMR s.135-20 notice of 14 December 2018 regarding IEC clarification, Cablelink and egress data check. Response received on 20 February 2019.

Notices addressed to and responses received from KCOM

A23.64 BCMR s.135-1 notice of 17 January 2018 regarding circuit data and new adds for share, network reach for competitor intensity, future roll out plans. Responses received between 20 February 2018 and 13 April 2018.

A23.65 BCMR s.135-3 notice of 13 April 2018 regarding backhaul self-use wholesaling, wholesaling of leased lines and supporting questions to PCOs. Response and clarification received on 22 May 2018 and 24 May 2018.

A23.66 BCMR s.135-11 notice of 04 April 2018 regarding fibre connected buildings. Responses and clarification received between 20 April 2018 and 25 May 2018.

A23.67 BCMR s.135-20 notice of 14 December 2018 regarding IEC clarification, Cablelink and egress data check. Response and clarification received on 14 January 2019 and 24 February 2019.

A23.68 BCMR s.135-26 notice of 08 May 2019 regarding additional information provided by telecoms providers that we rely on in the statement – 1st tranche. Response received on 14 May 2019.

Notices addressed to and responses received from Mobile Broadband Network Limited (MBNL)

A23.69 BCMR s.135-5 notice of 26 February 2018 regarding LLUO for backhaul connections, network equipment sites and EFM for TTG. Responses received on 23 March 2018 and 16 April 2018.

A23.70 BCMR s.135-7 notice of 04 April 2018 regarding details of large MNO backhaul contracts. Response received on 11 May 2018.

A23.71 BCMR s.135-25 notice of 20 March 2019 regarding MNO consultation responses. Response and subsequent clarifications received between 25 March 2019 and 26 March 2019.

Notices addressed to and responses received from MS3 Networks Limited

A23.72 BCMR s.135-11 notice of 04 April 2018 regarding fibre connected buildings. Response received on 14 June 2018.

Notices addressed to and responses received from Openreach

A23.73 BCMR s.135-1 notice of 17 January 2018 regarding circuit data and new adds for share, network reach for competitor intensity, future roll out plans. Responses received on 15 March 2018 and 18 April 2018.

A23.74 BCMR s.135-2 notice of 01 February 2018 regarding details of Principal Core Operators at exchanges (PCOs). Responses received on 22 February 2018 and 05 March 2018.

A23.75 BCMR s.135-3 notice of 13 April 2018 regarding backhaul self-use wholesaling, wholesaling of leased lines and supporting questions to PCOs. Response received on 14 May 2018.

A23.76 BCMR s.135-8 notice of 20 April 2018 regarding FTTX, EFM and CI services. Response received in two tranches between 20 April 2018 and 21 May 2018.

A23.77 BCMR s.135-12 notice of 01 May 2018 regarding QoS order data. Response received on 22 May 2018.

A23.78 BCMR s.135-13 notice of 08 May 2018 regarding Openreach discounts. Responses received on 06 June 2018 and 26 July 2018.

A23.79 BCMR s.135-15 notice of 13 June 2018 regarding TI services. Response received on 27 July 2018.

A23.80 BCMR s.135-16 notice of 12 June 2018 regarding WDM, KPI data since TCs. Response received on 25 July 2018.

A23.81 BCMR s.135-17 notice of 21 August 2018 regarding Openreach's cost model data. Response received on 24 August 2018.

A23.82 BCMR s.135-18 notice of 14 September 2018 regarding external Cablelink including those resold by downstream BT. Response received on 21 September 2018.

A23.83 BCMR s.135-21 notice of 13 February 2019 regarding new connections delivery. Response received on 25 February 2019.

A23.84 BCMR s.135-24 notice of 21 February 2019 regarding questions to Openreach on Re-imagining Ethernet Programmes. Response received on 29 March 2019.

A23.85 BCMR s.135-26 notice of 08 May 2019 regarding additional information provided by telecoms providers that we rely on in the statement – 1st tranche. Response received on 16 May 2019.

A23.86 BCMR s.135-29 notice of 29 May 2019 regarding additional information provided by telecoms providers that we rely on in the statement – 4th tranche. Response received on 5 June 2019.

Notices addressed to and responses received from Original Broadband Limited

A23.87 BCMR s.135-3 notice of 13 April 2018 regarding backhaul self-use wholesaling, wholesaling of leased lines and supporting questions to PCO. Response and clarification received on 14 May 2018 and 23 May 2018.

Notices addressed to and responses received from Service Direct Newco Limited

A23.88 BCMR s.135-3 notice of 13 April 2018 regarding backhaul self-use wholesaling, wholesaling of leased lines and supporting questions to PCOs. Response received on 11 May 2018.

Notices addressed to and responses received from Six Degrees Holdings Limited

A23.89 BCMR s.135-3 notice of 13 April 2018 regarding backhaul self-use wholesaling, wholesaling of leased lines and supporting questions to PCOs. Response and clarification received on 10 May 2018 and 18 May 2018.

Notices addressed to and responses received from Sky UK

A23.90 BCMR s.135-3 notice of 13 April 2018 regarding backhaul self-use wholesaling, wholesaling of leased lines and supporting questions to PCOs. Response and clarification received on 16 May 2018 and 23 May 2018.

A23.91 BCMR s.135-5 notice of 26 February 2018 regarding LLUO for backhaul connections, network equipment sites and EFM for TTG. Responses received between 14 March 2018 and 04 May 2018.

A23.92 BCMR s.135-20 notice of 14 December 2018 regarding IEC clarification, Cablelink and egress data check. Response received on 07 January 2019 and 24 January 2019.

A23.93 BCMR s.135-26 notice of 08 May 2019 regarding additional information provided by telecoms providers that we rely on in the statement – 1st tranche. Response received on 14 May 2019.

A23.94 BCMR s.135-27 notice of 10 May 2019 regarding additional information provided by telecoms providers that we rely on in the statement – 2nd tranche. Response received on 15 May 2019.

Notices addressed to and responses received from Surf Telecoms

A23.95 BCMR s.135-1 notice of 17 January 2018 regarding circuit data and new adds for share, network reach for competitor intensity, future roll out plans. Response received on 14 February 2018.

A23.96 BCMR s.135-11 notice of 04 April 2018 regarding fibre connected buildings. Response received on 02 May 2018.

Notices addressed to and responses received from SSE

A23.97 BCMR s.135-1 notice of 17 January 2018 regarding circuit data and new adds for share, network reach for competitor intensity, future roll out plans. Response received on 14 February 2018.

A23.98 BCMR s.135-3 notice of 13 April 2018 regarding backhaul self-use wholesaling, wholesaling of leased lines and supporting questions to PCOs. Responses and clarification received between 11 May 2018 and 29 May 2018.

Notices addressed to and responses received from TalkTalk Group

A23.99 BCMR s.135-3 notice of 13 April 2018 regarding backhaul self-use wholesaling, wholesaling of leased lines and supporting questions to PCOs. Responses and clarification received between 14 May 2018 and 22 May 2018.

A23.100 BCMR s.135-5 notice of 26 February 2018 regarding LLUO for backhaul connections, network equipment sites and EFM for TTG. Responses received between 15 March 2018 and 23 March 2018.

A23.101 BCMR s.135-6 notice of 20 April 2018 regarding impact of EFM/FTTx as a constraint on 100Mb/s services. Response received on 14 May 2018.

A23.102 BCMR s.135-25 notice of 04 March 2019 regarding Re-imagining Ethernet Provision consultation responses. Response received on 05 March 2018.

A23.103 BCMR s.135-26 notice of 08 May 2019 regarding additional information provided by telecoms providers that we rely on in the statement – 1st tranche. Response received on 14 May 2019.

A23.104 BCMR s.135-27 notice of 10 May 2019 regarding additional information provided by telecoms providers that we rely on in the statement – 2nd tranche. Response received on 13 May 2019.

Notices addressed to and responses received from Telefónica O2

A23.105 BCMR s.135-5 notice of 26 February 2018 regarding LLUO for backhaul connections, network equipment sites and EFM for TTG. Response received on 26 March 2018.

A23.106 BCMR s.135-23 notice of 21 February 2019 regarding 5G roll out plans. Response received on 01 March 2019.

A23.107 BCMR s.135-25 notice of 8 March 2019 regarding MNO consultation responses. Response received 12 March 2019.

A23.108 BCMR s.135-28 notice of 15 May 2019 regarding additional information provided by telecoms providers that we rely on in the statement – 3rd tranche. Response received on 21 May 2019.

Notices addressed to and responses received from Net Support

A23.109 BCMR s.135-22 notice of 12 February 2019 regarding IEC clarification. Response and clarifications received between 20 February 2019 and 25 February 2019.

Notices addressed to and responses received from The Networking People

A23.110 BCMR s.135-25 notice of 04 March 2019 regarding Re-imagining Ethernet Provision consultation responses. Response received on 04 March 2019.

Notices addressed to and responses received from Novosco

A23.111 BCMR s.135-22 notice of 12 February 2019 regarding IEC clarification. Response and clarifications received on the 19 February 2019.

Notices addressed to and responses received from Hutchinson 3G UK (Three)

A23.112 BCMR s.135-5 notice of 26 February 2018 regarding LLUO for backhaul connections, network equipment sites and EFM for TTG. Response received on 26 March 2018.

A23.113 BCMR s.135-23 notice of 21 February 2019 regarding 5G roll out plans. Response received on 01 March 2019.

A23.114 BCMR s.135-25 notice of 8 March 2019 regarding MNO consultation responses. Response received 12 March 2019.

A23.115 BCMR s.135-29 notice of 29 May 2019 regarding additional information provided by telecoms providers that we rely on in the statement – 4th tranche. Response received on 4 June 2019.

Notices addressed to and responses received from Updata Infrastructure

A23.116 BCMR s.135-6 notice of 20 April 2018 regarding impact of EFM/FTTx as a constraint on 100Mb/s services. Response received on 18 May 2018.

A23.117 BCMR s.135-22 notice of 12 February 2019 regarding IEC clarification. Response received on 7 March 2019.

Notices addressed to and responses received from Verizon UK Limited

A23.118 BCMR s.135-1 notice of 17 January 2018 regarding circuit data and new adds for share, network reach for competitor intensity, future roll out plans. Responses and clarification received between 14 February 2018 and 10 July 2018.

A23.119 BCMR s.135-3 notice of 13 April 2018 regarding backhaul self-use wholesaling, wholesaling of leased lines and supporting questions to PCOs. Response and clarification received on 16 May 2018 and 21 May 2018.

A23.120 BCMR s.135-9 notice of 29 March 2018 regarding TI Services. Response received on 25 April 2018.

A23.121 BCMR s.135-11 notice of 04 April 2018 regarding fibre connected buildings. Clarification received on 27 April 2018.

Notices addressed to and responses received from Virgin Media

A23.122 BCMR s.135-1 notice of 17 January 2018 regarding circuit data and new adds for share, network reach for competitor intensity, future roll out plans. Responses received between 02 March 2018 and 11 May 2018.

A23.123 BCMR s.135-3 notice of 13 April 2018 regarding backhaul self-use wholesaling, wholesaling of leased lines and supporting questions to PCOs. Response received on 22 May 2018.

A23.124 BCMR s.135-6 notice of 20 April 2018 regarding impact of EFM/FTTx as a constraint on 100Mb/s services. Response received on 21 May 2018.

A23.125 BCMR s.135-11 notice of 04 April 2018 regarding fibre connected buildings. Response received on 15 June 2018.

A23.126 BCMR s.135-20 notice of 14 December 2018 regarding IEC clarification, Cablelink and egress data check. Response received on 14 January 2019.

A23.127 BCMR s.135-26 notice of 08 May 2019 regarding additional information provided by telecoms providers that we rely on in the statement – 1st tranche. Response received on 15 May 2019.

Notices addressed to and responses received from Virtual 1 Limited

A23.128 BCMR s.135-3 notice of 13 April 2018 regarding backhaul self-use wholesaling, wholesaling of leased lines and supporting questions to PCOs. Responses and clarification received between 09 May 2018 and 18 May 2018.

A23.129 BCMR s.135-25 notice of 04 March 2019 regarding Re-imagining Ethernet Provision consultation responses. Response received on 11 March 2019.

Notices addressed to and responses received from Vodafone

A23.130 BCMR s.135-1 notice of 17 January 2018 regarding circuit data and new adds for share, network reach for competitor intensity, future roll out plans. Response received between 14 February 2018 and 16 May 2018.

A23.131 BCMR s.135-3 notice of 13 April 2018 regarding backhaul self-use wholesaling, wholesaling of leased lines and supporting questions to PCOs. Responses and subsequent clarifications received between 14 May 2018 and 21 March 2019.

A23.132 BCMR s.135-5 notice of 26 February 2018 regarding LLUO for backhaul connections, network equipment sites and EFM for TTG. Response received on 27 March 2018.

A23.133 BCMR s.135-6 notice of 20 April 2018 regarding impact of EFM/FTTx as a constraint on 100Mb/s services. Response received on 14 May 2018.

A23.134 BCMR s.135-11 notice of 04 April 2018 regarding fibre connected buildings. Response received on 01 May 2018.

A23.135 BCMR s.135-20 notice of 14 December 2018 regarding IEC clarification, Cablelink and egress data check. Responses received on 10 January 2019 and 18 January 2019.

A23.136 BCMR s.135-23 notice of 21 February 2019 regarding 5G roll out plans. Response received on 01 March 2019.

A23.137 BCMR s.135-25 notice of 20 March 2019 regarding MNO consultation responses. Response and subsequent clarifications received between 25 March 2019 and 26 March 2019.

A23.138 BCMR s.135-25 notice of 04 March 2019 regarding Re-imagining Ethernet Provision consultation responses. Response received 8 March 2019.

A23.139 BCMR s.135-26 notice of 08 May 2019 regarding additional information provided by telecoms providers that we rely on in the statement – 1st tranche. Response received on 14 May 2019.

A23.140 BCMR s.135-27 notice of 10 May 2019 regarding additional information provided by telecoms providers that we rely on in the statement – 2nd tranche. Response received on 14 May 2019.

Notices addressed to and responses received from Zayo Group

A23.141 BCMR s.135-1 notice of 17 January 2018 regarding circuit data and new adds for share, network reach for competitor intensity, future roll out plans. Multiple responses received between 19 January 2018 and 06 December 2018.

A23.142 BCMR s.135-3 notice of 13 April 2018 regarding backhaul self-use wholesaling, wholesaling of leased lines and supporting questions to PCOs. Response and subsequent clarifications received between 11 May 2018 and 24 May 2018.

A23.143 BCMR s.135-11 notice of 04 April 2018 regarding fibre connected buildings. Response and subsequent clarifications received between 20 April 2018 and 08 May 2018.

A23.144 BCMR s.135-20 notice of 14 December 2018 regarding IEC clarification, Cablelink and egress data check. Response received on 28 December 2018.

Notices addressed to and responses received from Zen Internet

A23.145 BCMR s.135-20 notice of 14 December 2018 regarding IEC clarification, Cablelink and egress data check. Response received on 25 January 2019.

A23.146 BCMR s.135-25 notice of 04 March 2019 regarding Re-imagining Ethernet Provision consultation responses. Response received on 08 March 2019.

Volume 3 – LLCC and related annexes

Notices addressed to and responses received from BT Group

A23.147 1st notice of 1 February 2018 regarding volume and usage rates. Response received on 9 March 2018.

A23.148 2nd notice of 20 February 2018 regarding WACC. Response received in three tranches on 2 February 2018, 12 September 2018, 15 June 2018, and 23 June 2018.

Notices addressed to and responses received from Openreach

A23.149 1st notice of 2 February 2018 regarding volumes and usage rates. Response received in three tranches on 2 March 2018, 7 March 2018 and 6 August 2018.

A23.150 2nd notice of 29 March 2018 regarding clarifications on the 1st. Response received 11 April 2018.

A23.151 3rd notice of 25 April 2018 regarding efficiency. Response received in three tranches, tranche one responses received on 9 May 2018, 11 May 2018, and 12 September 2018, tranche two response received 16 May 2018 and tranche three response received 23 May 2018.

A23.152 4th notice of 2 May 2018 regarding base year. Response received on 4 June 2018, 17 May 2018 and 27 June 2018.

A23.153 5th notice of 21 June 2018 regarding volumes and base year adjustments. Response received on 4 June 2018, 13 June 2018 and 27 June 2018.

A23.154 6th notice of 6 June 2018 regarding WAAC. Response received 20 June 2018.

A23.155 7th notice of 11 June 2018 regarding efficiency and base year adjustments. Response received in three tranches on 25 June 2018, 3 July 2018 and 9 July 2018.

A23.156 8th notice of 6 August regarding capex efficiency and base year. Response received in three tranches on 20 June 2018, 27 June 2018 and 3 August 2018.

A23.157 9th notice of 9 June 2018 regarding WACC. Response received 23 July 2018.

A23.158 10th notice of 24 August 2018 regarding model crosscheck and dark fibre. Response received in two tranches on 10 October 2018 and 12 September 2018.

A23.159 11th notice of 21 November 2018 regarding post consultation updates. Response received in three tranches on 5 December 2018, 12 December and 19 December 2018.

A23.160 12th notice of 20 February 2019 regarding post responses to consultation updates. Response received in two tranches, tranche one response received on 6 March 2019 tranche two responses received on 13 March 2019 and 18 March 2019.

Ofcom documents

Consultations to the 2019 PIMR and BCMR Statement

A23.161 Ofcom, 2018. *Business connectivity market review – Volume 1: Market analysis, proposed SMP findings and remedies.* https://www.ofcom.org.uk/__data/assets/pdf_file/0025/124729/llcc-bcmr-2018-volume-1.pdf.

A23.162 Ofcom, 2018. *Business connectivity market review – Volume 2: Proposed leased lines charge control.* https://www.ofcom.org.uk/__data/assets/pdf_file/0022/124726/llcc-bcmr-2018-volume-2.pdf.

A23.163 Ofcom, 2018. *Business connectivity market review: corrections and clarifications.* https://www.ofcom.org.uk/consultations-and-statements/category-1/business-connectivity-market-review#accordion__target-131284 [Accessed 4 May 2019].

A23.164 Ofcom, 2018. *Physical Infrastructure Market Review – Access to ducts and poles to support investment*. https://www.ofcom.org.uk/__data/assets/pdf_file/0014/125420/PIMR-consultation.pdf.

Consultations and statements for other market reviews

A23.165 Ofcom, 2009. Business Connectivity Market Review: Review of the retail leased lines, wholesale symmetric broadband origination and wholesale trunk segment markets. https://www.ofcom.org.uk/__data/assets/pdf_file/0025/36556/statement.pdf

A23.166 Ofcom, 2010. *Review of the wholesale broadband access markets: Statement on market definition, market power determinations and remedies.* https://www.ofcom.org.uk/__data/assets/pdf_file/0028/37666/wbastatement.pdf

A23.167 Ofcom, 2013. Business Connectivity Market Review – Review of retail leased lines, wholesale symmetric broadband origination and wholesale trunk segments. https://www.ofcom.org.uk/consultations-and-statements/category-2/business-connectivity-mr.

A23.168 Ofcom, 2014. *Fixed access market reviews: wholesale local access, wholesale fixed analogue exchange lines, ISDN2 and ISDN30 – Statement*. https://www.ofcom.org.uk/phones-telecoms-and-internet/information-for-industry/telecoms-competition-regulation/narrowband-broadband-fixed/fixed-access-market-reviews-2014/statement.

A23.169 Ofcom, 2015. *Business Connectivity Market Review – Review of competition in the provision of leased lines – Consultation.* https://www.ofcom.org.uk/__data/assets/pdf_file/0027/47754/Business-connectivity-market-review-2015-consultation.pdf.

A23.170 Ofcom, 2015. *Business Connectivity Market Review: Leased lines charge controls and dark fibre pricing.* https://www.ofcom.org.uk/__data/assets/pdf_file/0026/58193/llcc-dark-fibre.pdf.

A23.171 Ofcom, 2016. *Business Connectivity Market Review – Review of competition in the provision of leased lines – Statement*. https://www.ofcom.org.uk/consultations-and-statements/category-1/business-connectivity-market-review-2016.

A23.172 Ofcom, 2017. *Wholesale Broadband Access Market Review: Consultation on market definition, market power determinations and remedies*. https://www.ofcom.org.uk/__data/assets/pdf_file/0013/103180/wba-consultation.pdf.

A23.173 Ofcom, 2017. *Narrowband Market Review: Statement.*https://www.ofcom.org.uk/__data/assets/pdf_file/0020/108353/final-statement-narrowband-market-review.pdf.

A23.174 Ofcom, 2017. *Non-domestic rates and the price for regulated Dark Fibre: Final Statement.* https://www.ofcom.org.uk/__data/assets/pdf_file/0021/103647/statement-non-domestic-rates-dark-fibre.pdf

A23.175 Ofcom, 2017. *Business Connectivity Markets: Revocation of certain measures imposed in the business connectivity markets.* https://www.ofcom.org.uk/__data/assets/pdf_file/0018/108018/BCMR-Revocation-Notification.pdf

A23.176 Ofcom, 2017. *Business Connectivity Markets: Temporary SMP conditions in relation to business connectivity services.* https://www.ofcom.org.uk/__data/assets/pdf_file/0019/108019/BCMR-Temporary-Conditions.pdf

A23.177 Ofcom, 2017. *Dark Fibre Consultation: Consultation on adding dark fibre to the remedies for business connectivity markets.* https://www.ofcom.org.uk/__data/assets/pdf_file/0014/108032/Dark-Fibre-Consultation.pdf

A23.178 Ofcom, 2017. *Wholesale Local Access Market Review: Recovering the costs of investment in network expansion.* https://www.ofcom.org.uk/__data/assets/pdf_file/0022/105682/Recovering-the-costs-of-investment-in-network-expansion.pdf

A23.179 Ofcom, 2018. *Wholesale Local Access Market Review: Statement.* https://www.ofcom.org.uk/consultations-and-statements/category-1/wholesale-local-access-market-review

A23.180 Ofcom, 2018 *Wholesale Broadband Access Market Review: Statement* https://www.ofcom.org.uk/consultations-and-statements/category-1/wholesale-broadband-access-market-review

A23.181 Ofcom, 2018. *Statement on adding dark fibre to the temporary remedies for business connectivity markets.* https://www.ofcom.org.uk/__data/assets/pdf_file/0015/112902/dark-fibre-statement.pdf

A23.182 Ofcom, 2018. *Wholesale Local Access and Wholesale Broadband Access Market Reviews: Review of competition in the Hull Area*. https://www.ofcom.org.uk/__data/assets/pdf_file/0027/116991/statement-wba-competition-hull.pdf

A23.183 Ofcom, March 2019. *Promoting competition and investment in fibre networks.* https://www.ofcom.org.uk/consultations-and-statements/category-1/promoting-investment-competition-fibre-networks-approach-remedies

Other consultations and statements

A23.184 Ofcom, 2005. *Better Policy Making: Ofcom's approach to Impact Assessment.* https://www.ofcom.org.uk/__data/assets/pdf_file/0029/45596/condoc.pdf.

A23.185 Ofcom, 2005. Undue discrimination by SMP providers – How Ofcom will investigate potential contraventions on competition grounds of requirements not to unduly discriminate imposed on SMP providers. http://stakeholders.ofcom.org.uk/binaries/consultations/undsmp/statement/contraventions4.pdf.

A23.186 Ofcom, 2008. *Service level guarantees: incentivising performance – Statement and Directions.* https://www.ofcom.org.uk/__data/assets/pdf_file/0020/33617/statement.pdf.

A23.187 Ofcom, 2014. *Regulatory Financial Reporting – Final Statement*. https://www.ofcom.org.uk/__data/assets/pdf_file/0025/78460/financial-reporting-statement-may14.pdf.

A23.188 Ofcom, 2015. *Quality of service: leased lines.* https://www.ofcom.org.uk/__data/assets/pdf_file/0023/58721/qos_report_27th_april.pdf

A23.189 Ofcom, 2016. *Making communications work for everyone – Initial conclusions from the Strategic Review of Digital Communications.* https://www.ofcom.org.uk/__data/assets/pdf_file/0016/50416/dcr-statement.pdf.

A23.190 Ofcom, 2016. *Statement following consultation on Guidance under the Communications (Access to Infrastructure) Regulations 2016.* https://www.ofcom.org.uk/__data/assets/pdf_file/0026/95192/Statement-following-consultation-on-Guidance-under-the-Communications-Access-to-Infrastructure-Regulations-2016.pdf.

A23.191 Ofcom, 2017. *Delivering a more independent Openreach.* https://www.ofcom.org.uk/__data/assets/pdf_file/0035/98855/Openreach-consultation-2017.pdf.

A23.192 Ofcom, 2017. *Enforcement guidelines for regulatory investigations.* https://www.ofcom.org.uk/__data/assets/pdf_file/0015/102516/Enforcement-guidelines-for-regulatory-investigations.pdf.

A23.193 Ofcom, 2018. *Regulatory certainty to support investment in full-fibre broadband.* https://www.ofcom.org.uk/phones-telecoms-and-internet/information-for-industry/telecoms-competition-regulation/regulatory-certainty-investment-full-fibre

A23.194 Ofcom, 2018. *Progress on delivering a more independent Openreach*. https://www.ofcom.org.uk/__data/assets/pdf_file/0019/114814/openreach-implementation-report-2018.pdf

A23.195 Ofcom, 2018. *Delivering a more independent Openreach.* https://www.ofcom.org.uk/__data/assets/pdf_file/0034/126799/Delivering-a-more-independent-Openreach-Interim-monitoring-update.pdf

A23.196 Ofcom, 2018. *Delivering the Broadband Universal Service* https://www.ofcom.org.uk/consultations-and-statements/category-1/delivering-broadband-universal-service

A23.197 Ofcom, 2018 *Annual Licence Fees for 900 MHz and 1800 MHz frequency bands* https://www.ofcom.org.uk/consultations-and-statements/category-2/annual-licence-fees-900-1800-mhz

A23.198 Ofcom, 2019. *Statement: BT regulatory financial reporting.* https://www.ofcom.org.uk/consultations-and-statements/category-1/bt-regulatory-financial-reporting

A23.199 Ofcom, 2019. *Statement: Regulatory Financial Reporting – new regulatory financial reporting directions for KCOM.* https://www.ofcom.org.uk/consultations-and-statements/category-2/regulatory-financial-reporting-directions-kcom

Research and reports

A23.200 Ofcom, 2011-2018. *Communications Market Report.* http://stakeholders.ofcom.org.uk/market-data-research/market-data/communications-market-reports/.

A23.201 Ofcom, 2017. *Connected Nations Report 2017: Data analysis*. https://www.ofcom.org.uk/__data/assets/pdf_file/0016/108511/connected-nations-2017.pdf.

A23.202 BDRC Continental, 2016. *High bandwidth connections*. https://www.ofcom.org.uk/__data/assets/pdf_file/0020/32069/bdrc_ci_survey.pdf

A23.203 Cartesian, 2018. *Business Connectivity Market Assessment*. https://www.ofcom.org.uk/__data/assets/pdf_file/0009/113112/cartesian-business-connectivity-market-assessment.pdf

A23.204 Europe Economics, 2018. *Cost of Capital: Total Market Return.* https://www.ofcom.org.uk/__data/assets/pdf_file/0026/124739/europe-economics-wacc-report.pdf

A23.205 NERA, 2018. *Cost of Capital: Beta and Gearing for the 2019 BCMR.* https://www.ofcom.org.uk/__data/assets/pdf_file/0018/124740/nera-wacc-report.pdf

A23.206 Ofcom, 2018. *CMR 2018 Interactive report data: Telecoms* https://www.ofcom.org.uk/__data/assets/file/0023/118472/CMR-2018-Interactive-Report-Data-Telecoms.csv [accessed 30 October 2018].

A23.207 Ofcom, 2018. *Connected Nations 2018*. https://www.ofcom.org.uk/research-and-data/multi-sector-research/infrastructure-research/connected-nations-2018

A23.208 Ofcom, 2019. *Indicative dig distance cost model* https://www.ofcom.org.uk/__data/assets/file/0025/149263/indicative-dig-distance-cost-model.xlsm.

A23.209 Europe Economics, 2019. *Comments on BT's response to the BCMR consultation in relation to WACC market parameters.* https://www.ofcom.org.uk/consultations-and-statements/category-1/review-physical-infrastructure-and-business-connectivity-markets

A23.210 NERA, 2019. *Cost of Capital: Beta and Gearing for the 2019 BCMR – Update.* https://www.ofcom.org.uk/consultations-and-statements/category-1/review-physical-infrastructure-and-business-connectivity-markets

European Commission publications

A23.211 *Commission notice of 9 December 1997 on the definition of relevant market for the purposes of Community competition law.* http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:31997Y1209(01)&from=EN [accessed 1 May 2019].

A23.212 Directive 2002/21/EC of the European Parliament and of the Council of 7 March 2002 on a common regulatory framework for electronic communications networks and services, as amended by Directive 2009/140/EC and Regulation 544/2009. http://ec.europa.eu/information_society/policy/ecomm/doc/140framework.pdf.

A23.213 Commission Recommendation of 29 March 2005 on the provision of leased lines in the European Union – Part 2 – pricing aspects of wholesale leased lines part circuits (C(2005) 951) and the accompanying Explanatory Memorandum (the Leased Lines Pricing Recommendation). https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32005H0268&from=EN

A23.214 Commission Recommendation of 19 September 2005 on accounting separation and cost accounting systems under the regulatory framework for electronic communications (2005/698/EC). http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32005H0698&from=EN.

A23.215 *Commission Recommendation of 20 September 2010 on regulated access to Next Generation Access Networks (NGA) (2010/572/EU).* http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010H0572&from=EN.

A23.216 Commission Recommendation of 11 September 2013 on consistent non-discrimination obligations and costing methodologies to promote competition and enhance the broadband investment environment (C(2013) 5761). http://ec.europa.eu/smart-regulation/impact/ia_carried_out/docs/ia_2013/c_2013_5761_en.pdf.

A23.217 Directive 2014/61/EU of the European Parliament and of the Council of 15 May 2014 on measures to reduce the cost of deploying high-speed electronic communications networks, OJEU L155/1, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014L0061&from=EN).

A23.218 Commission Recommendation of 9 October 2014 on relevant product and service markets within the electronic communications sector susceptible to ex ante regulation in accordance with Directive 2002/21/EC of the European Parliament and of the Council on a common regulatory framework for electronic communications networks and services

(2014/710/EU). http://eurlex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014H0710&from=EN.

A23.219 Explanatory Note accompanying the Commission Recommendation on relevant product and service markets within the electronic communications sector, 9 October 2014. https://ec.europa.eu/digital-single-market/en/news/explanatory-note-accompanying-commission-recommendation-relevant-product-and-service-markets.

A23.220 Commission guidelines on market analysis and the assessment of significant market power under the EU regulatory framework for electronic communications networks and services (2018/C 159/01). http://ec.europa.eu/newsroom/dae/document.cfm?doc_id=51836

A23.221 Commission Staff Working Document, Guidelines on market analysis and the assessment of significant market power under the EU regulatory framework for electronic communications networks and services. http://ec.europa.eu/newsroom/dae/document.cfm?doc_id=51927

A23.222 Directive 2018/1972 of the European Parliament and of the Council of 11 December 2018 establishing the European Electronic Communications Code (Recast). https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L1972&from=EN

A23.223 EC, 2018. *Targeted consultation on guidance on cost of capital for EU electronic communications regulators*. https://ec.europa.eu/digital-single-market/en/news/targeted-consultation-guidance-cost-capital-eu-electronic-communications-regulators

A23.224 Tenders Electronic Daily, 2018. *United Kingdom-Belfast: Wireless telecommunications system 201/S 200-455203. Contract award notice.* https://ted.europa.eu/TED/notice/udl?uri=TED:NOTICE:455203-2018:TEXT:EN:HTML [accessed 14 May 2019].

A23.225 Europe Economics and EUCLID Law for the European Commission, 2019. *EU loan syndication on competition and its impact in credit markets*: *final report*. http://ec.europa.eu/competition/publications/reports/kd0419330enn.pdf

Further Sources

BT Group

Financial reports and statements

A23.226 BT, *Current Cost Financial Statements.* https://www.btplc.com/Thegroup/RegulatoryandPublicaffairs/Financialstatements/index.htm.

A23.227 BT, 2016. *Pro forma historical financial information for BT and EE group.* https://www.btplc.com/Sharesandperformance/Quarterlyresults/2015-2016/RestatedhistoricalfinancialinformationJune2016/Downloads/Proforma/ProformahistoricalfinancialsJune2016.pdf.

A23.228 BT, 2017. *Regulatory Financial Statements 2017 including Openreach Undertakings.* https://www.btplc.com/Thegroup/RegulatoryandPublicaffairs/Financialstatements/2017/RRD2017Final.pdf.

A23.229 BT, 2017. *Regulatory Financial Statements 2017.* https://www.btplc.com/Thegroup/Policyandregulation/Governance/Financialstatements/2017/RRD2017Final.pdf

A23.230 BT, 2017. *BT Group plc 2017 Annual Report and Form 20F* https://www.btplc.com/Sharesandperformance/Annualreportandreview/pdf/2017_BT_Annual_Report.pdf

A23.231 BT, 2018. *Annual Report and Form 20F 2018*. https://www.btplc.com/Sharesandperformance/Annualreportandreview/pdf/2018_BT_Annual_Report.pdf.

A23.232 BT, 2018. *Regulatory Financial Statements 2018.* https://www.btplc.com/Thegroup/Policyandregulation/Governance/Financialstatements/2018/RegulatoryFinancialStatements2018.pdf [accessed 30 October 2018].

A23.233 BT, 2019. *Q3 2018/19 trading update, 31 January 2019.* https://www.btplc.com/Sharesandperformance/Financialreportingandnews/Quarterlyresults/2018-2019/Q3/Downloads/Slides/q319-slides.pdf [accessed 08 May 2019].

A23.234 BT, 2019. *Debt investors update.* https://www.btplc.com/Sharesandperformance/Financialreportingandnews/Debtinvestors/index.htm [accessed 20 May 2019]

Press releases

A23.235 BT, 2016. *BT announces new structure.* http://www.btplc.com/news/#/pressreleases/bt-announces-new-structure-1304769 [accessed 20 February 2018].

A23.236 BT, 2018. *BT to close defined benefit pension scheme for 10,000 managers.* https://www.btplc.com/News/#/pressreleases/bt-to-close-defined-benefit-pension-scheme-for-10000-managers-2405030 [accessed 21 May 2019].

A23.237 BT, 2018. *BT announces closure of its defined benefit pension scheme.* https://www.btplc.com/News/#/pressreleases/bt-announces-closure-of-its-defined-benefit-pension-scheme-2451910 [accessed 21 May 2019].

Other materials

A23.238 BT, 2016. *Accounting Methodology Document 2016 – Long Run Incremental Cost Model: Relationships & Parameters.* https://www.btplc.com/Thegroup/RegulatoryandPublicaffairs/Financialstatements/2016/LRICModelRelationshipsandParameters201516.pdf.

A23.239 BT, 2017. *Proposals agreed with Ofcom.* https://www.btplc.com/UKDigitalFuture/Agreed/index.htm. [accessed 30 October 2018].

A23.240 BT, 2017. *Accounting Methodology Document 2017.* https://www.btplc.com/Thegroup/Policyandregulation/Governance/Financialstatements/2017/AMD2016-17.pdf

A23.241 BT, 2018. *Accounting Methodology Document 2018.* https://btplc.com/Thegroup/Policyandregulation/Governance/Financialstatements/2018/AMD_2017-18.pdf

A23.242 BT, 2018. *Change Control Notification.* https://www.btplc.com/Thegroup/Policyandregulation/Governance/Financialstatements/2018/ChangeControlNotification2017-18.pdf

A23.243 BT Letter to Ofcom, 2018. *BCMR 2019: Low bandwidth wholesale TI business connectivity services.* https://www.ofcom.org.uk/__data/assets/pdf_file/0021/124734/bt-low-bandwidth-wholesale-ti-services.pdf

Openreach

Product Information

A23.244 Openreach, *BT Egress/LLU Egress – External.* https://www.openreach.co.uk/orpg/home/products/llu/downloads/RANF_Part_IV_S03.rtf [accessed 15 May 2019].

A23.245 Openreach. *Dark Fibre Access.* https://www.openreach.co.uk/orpg/home/products/darkfibreaccess/darkfibreaccess.do [accessed 5 May 2019]

A23.246 Openreach. *Fibre to the Premises (FTTP) on Demand.* https://www.openreach.co.uk/orpg/home/products/ultrafastfibreaccess/fttpondemand/fttpod.do

A23.247 Openreach. *Time Related Charges Product Information.* https://www.openreach.co.uk/orpg/home/products/serviceproducts/timerelatedcharges/timerelatedcharges.do [accessed 20 December 2017].

A23.248 Openreach. *WLR withdrawal.* https://www.openreach.co.uk/orpg/home/products/wlrwithdrawal/wlrwithdrawal.do [accessed 08 May 2019].

A23.249 Openreach, 2019. *PIA Schedule 3: Agreement for Physical Infrastructure Access Schedule 3 – Accreditation.* https://www.openreach.co.uk/orpg/home/products/ductandpoleaccess/contracts/contracts/downloads/New_PIA_Schedule_3_April2019.pdf [accessed 08 May 2019].

Prices

A23.250 Openreach. *Abortive Visit Charge – Price List*. https://www.openreach.co.uk/orpg/home/products/pricing/loadProductPriceDetails.do?d ata=GkB126nkZeU8iCLzoNC7laDd6sNMGW33hRaUUiTutA4lMnGHsqdC0vzO163bJmh34D91D7M0q8u%2FIlSgtIFAKw%3D%3D [accessed 18 December 2017].

A23.251 Openreach. *Access Locate and Access Locate Plus – Price list.* https://www.openreach.co.uk/orpg/home/products/pricing/loadProductPriceDetails.do?data=q%2B2vpfgQQ99SiimXeC7QjskLe4HVN3IVHU%2BmY7RLKoBZ6rNZujnCs99NbIKJZPD9hXYmiijxH6wrCQm97GZMyQ%3D%3D [accessed 3 May 2019]

A23.252 Openreach. *Ethernet Access Direct (EAD) including EAD Enable – Price List*. https://www.openreach.co.uk/orpg/home/products/pricing/loadProductPriceDetails.do?data=0d0zetWgShsjqKWjcN2Y5WJA8BGGqsBLxL7IgSM4fRpZ6rNZujnCs99NbIKJZPD9hXYmiijxH6wrCQm97GZMyQ%3D%3D [accessed 3 May 2019].

A23.253 Openreach. *Excess Construction Charges.* https://www.openreach.co.uk/orpg/home/products/serviceproducts/excessconstructioncharges/excessconstructioncharges.do [accessed 14 May 2019].

A23.254 Openreach. *Fibre Voice Access – Price List.* https://www.openreach.co.uk/orpg/home/products/pricing/loadProductPriceDetails.do?data=z5O0C27SrMPpklBPtmxdCiS%2B9aKzcV8vZVWPlHzNATBZ6rNZujnCs99NbIKJZPD9hXYmiijxH6wrCQm97GZMyQ%3D%3D [accessed 26 January 2018].

A23.255 Openreach. *Full MPF – Price List*. https://www.openreach.co.uk/orpg/home/products/pricing/loadProductPriceDetails.do?data=Wk%2B2hSVL2knF5F0Ve%2F1N8zj9r0QWsRm3Qpmu5FcPTOYlMnGHsqdC0vzO163bJmh34D91D7M0q8u%2FIlSgtIFAKw%3D%3D [accessed 17 May 2019].

A23.256 Openreach. *Generic Ethernet Access (FTTC) – Price List.* https://www.openreach.co.uk/orpg/home/products/pricing/loadProductPriceDetails.do?data=0RIviN9gWGKtCdDGaQ8IFObCjmFDJOVDZEidKC%2F1wh1Z6rNZujnCs99NbIKJZPD9hXYmiijxH6wrCQm97GZMyQ%3D%3D [accessed 22 December 2017].

A23.257 Openreach. *Generic Ethernet Access (FTTP) – Price List.* https://www.openreach.co.uk/orpg/home/products/pricing/loadProductPriceDetails.do?data=M80QNeH46o4g6JKGD604vTypQOKfNn%2Beo6vmoVhAOBZZ6rNZujnCs99NbIKJZPD9hXYmiijxH6wr%0ACQm97GZMyQ%3D%3D [accessed 29 January 2018].

A23.258 Openreach. *Multicast for GEA – Price List*. https://www.openreach.co.uk/orpg/home/products/pricing/loadProductPriceDetails.do?data=BGsObZmZkXxTeKZ%2B1TUSB%2FvP446MIFzyWzwkT4Sjy%2FhZ6rNZujnCs99NbIKJZPD9hXYmiijxH6wrCQm97GZMyQ%3D%3D [accessed 22 December 2017].

A23.259 Openreach, 2017. *Openreach Access Charge Change Notice.* https://www.openreach.co.uk/orpg/home/products/pricing/notificationDetails.do?data=ThQLPOgdo8c%2FpcQlNXj7BVoAzMfOCIw%2B7d4ELMHNgDegfWjPPjkaOfO6Hy2qkqEXWgDMx84IjD7t3gQswc2AN5h5lI0XiKu8GtuFlNk%2FATgP%2FPqHX8N7wMqJrDCqzxUjKX9ukq4RSuolZF02%2ByFJag%3D%3DOpenreach. *Physical Infrastructure Pricing.* https://www.openreach.co.uk/orpg/home/products/pricing/loadProductPrices.do?data=kKE%2F%2FCftg8LAZY%2B8EUaz9dpyYOJW58IELJ3a1hFsXScqDWVqEbA2PDlT5Y2OhxKv.

A23.260 Openreach. *Physical Infrastructure Pricing, Ancillary Activities – Price List.* https://www.openreach.co.uk/orpg/home/products/pricing/loadProductPriceDetails.do?data=%2BDv%2Bc9B8jITi5t3ObgmQQkgPp7N1FyAmTcwlXCnmJclZ6rNZujnCs99NbIKJZPD9hXYmiijxH6wrCQm97GZMyQ%3D%3D.

A23.261 Openreach. *Pricing.* https://www.openreach.co.uk/orpg/home/products/pricing/loadPricing.do [08 May 2019]

A23.262 Openreach. *Product Prices – Special Offers.* https://www.openreach.co.uk/orpg/home/products/pricing/loadProductPrices.do?data=CHwaDmuSf84idOYbWK2Y39pyYOJW58IELJ3a1hFsXScqDWVqEbA2PDlT5Y2OhxKv [accessed 10 May 2019].

A23.263 Openreach. *Repair Service Levels – Price List*. https://www.openreach.co.uk/orpg/home/products/pricing/loadProductPriceDetails.do?data=to6u3F12FmH4GL92i3NosR9iCKrrD%2FZpzK1a%2FvJOccNZ6rNZujnCs99NbIKJZPD9hXYmiijxH6wrCQm97GZMyQ%3D%3D [accessed 22 December 2017]. Openreach. *Superfast and Ultrafast Fibre Access Pricing.* https://www.openreach.co.uk/orpg/home/products/pricing/loadProductPrices.do?data=Po3KnmqvCqPyVFu37aLXIdpyYOJW58IELJ3a1hFsXScqDWVqEbA2PDlT5Y2OhxKv [accessed 26 January 2018].

A23.264 Openreach. *Special Offer Bandwidth Modify Charge – Price List*. https://www.openreach.co.uk/orpg/home/products/pricing/loadProductPriceDetails.do?data=ngULSei%2FAaQz5yg3QvVQN8k%2FK%2F8KMu2%2FNid%2F2Ck5ec%2BrmMllOOG7b%2F12AmPFLBERe6YShZ82RgLOGLsH2e9%2Bmw%3D%3D [accessed 12 January 2018].

A23.265 Openreach. *Time Related Charges (Including Shifts) – Price List*. https://www.openreach.co.uk/orpg/home/products/pricing/loadProductPriceDetails.do?data=hcaYjIWegP2u2KS8FTdcOBScuIM1Opem5f8dVePnh8UlMnGHsqdC0vzO163bJmh34D91D7M0q8u%2F%0AIlSgtIFAKw%3D%3D [accessed 3 May 2019]

A23.266 Openreach, 2016. *DFA Final Reference Offer: Pricing Document*. https://www.openreach.co.uk/orpg/home/products/darkfibreaccess/darkfibreaccess/downloads/DFAfinalreferenceofferpricing011216.pdf [accessed 16 May 2019].

A23.267 Openreach, 2016. *DFA Final Reference Offer: Technical Specification*. https://www.openreach.co.uk/orpg/home/products/darkfibreaccess/darkfibreaccess/downloads/DFAfinalreferenceoffertechnicalspecifications011216.pdf. [accessed 20 May 2019].

A23.268 Openreach, 2018. *EAD 100Mbps connection special offer - Price List.* https://www.openreach.co.uk/orpg/home/products/pricing/loadProductPriceDetails.do?data=cR53yvKcKsLZn61tAuVwKz%2BOIYvmxajujzslhJPIl0JQbovfA25dkZY9OhDK4oNde6YShZ82RgLOGLsH2e9%2Bmw%3D%3D

Other online information

A23.269 Openreach. *ETH012/18 OSAA Filter Connect available from 3 April 2018.* https://www.openreach.co.uk/orpg/home/updates/briefings/ethernetservicesbriefings/ethernetservicesbriefingsarticles/eth01218.do [accessed 10/05/2019].

A23.270 Openreach, 2018. *Re-imagining Ethernet Provision - Faster, simpler, and more responsive Ethernet Delivery.* https://www.openreach.co.uk/orpg/home/newlogin.do?smauthreason=0&target=http%3A%2F%2Fwww.openreach.co.uk%2Forpg%2Fcustomerzone%2Fupdates%2Fbriefings%2Fethernet%2Feth05518.pdf&fromMasterHead=1 (Openreach log in required).

A23.271 Openreach, 2018. *Re-imagining Ethernet Provision Industry consultation published.* https://www.openreach.co.uk/orpg/home/updates/briefings/ethernetservicesbriefings/ethernetservicesbriefingsarticles/eth05518.do [accessed 1 November 2018].

A23.272 Openreach, 2019 *Re-imagining Ethernet Provision - Industry Consultation Summary Report*. https://www.openreach.co.uk/orpg/home/newlogin.do?smauthreason=0&target=http%3A%2F%2Fwww.openreach.co.uk%2Forpg%2Fcustomerzone%2Fupdates%2Fbriefings%2Fethernet%2Feth00819.pdf&fromMasterHead=1 (Openreach log in required).

A23.273 Openreach, 2019, *Re-imagining Ethernet Provision – implementation*, *Openreach customer briefing.* https://www.openreach.co.uk/orpg/home/newlogin.do?smauthreason=0&target=http%3A%2F%2Fwww.openreach.co.uk%2Forpg%2Fcustomerzone%2Fupdates%2Fbriefings%2Fethernet%2Feth00919.pdf&fromMasterHead=1 (Openreach log in required).

A23.274 Openreach, 2019. *Industry update: Openreach voluntary commitments in respect of the BCMR lacuna period.* https://openreach-comms.co.uk/t/BAK-649KJ-6FKHTQUPF8/cr.aspx [Accessed 08 May 2019].

Government

Competition and Markets Authority (CMA)

A23.275 CMA, 2015. *Bristol Water plc final determination.* (October 2015). https://assets.digital.cabinet-office.gov.uk/media/5627997640f0b60368000001/Appendices_5.1_-_11.1_and_glossary.pdf [accessed 20 May 2019].

A23.276 CMA, 2016. *A report on the anticipated acquisition by BT Group plc of EE Limited* https://assets.publishing.service.gov.uk/media/56992242ed915d4747000026/BT_EE_final_report.pdf [accessed 16 January 2019].

Department for Digital, Culture, Media & Sport (DCMS)

A23.277 DCMS, 2018. *Consultation: Ensuring tenants' access to gigabit-capable connections.* https://www.gov.uk/government/consultations/ensuring-tenants-access-to-gigabit-capable-connections

A23.278 DCMS, 2019. Statement of Strategic Priorities for telecommunications, the management of radio spectrum and postal services. *https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/779226/SSP_Consultation_-_Publication_Version__2_.pdf* [Accessed 16 May 2019].

Office of Fair Trading (OFT)

A23.279 OFT, 2004. *Assessment of market power.* https://www.gov.uk/government/publications/assessment-of-market-power [accessed 30 October 2018].

A23.280 OFT, 2004. *Market Definition: Understanding competition law.* https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/284423/oft403.pdf [accessed 10 May 2019].

A23.281 OFT, 2010. *Merger Assessment Guidelines*. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/284449/OFT1254.pdf [accessed 14 May 2019].

Office for National Statistics (ONS)

A23.282 ONS, 2017 *Fibre Optic Cables index*. https://www.ons.gov.uk/economy/inflationandpriceindices/timeseries/jv7b [accessed 13/09/2018].

A23.283 ONS, 2018 *Shortcomings of the Retail Prices Index as a measure of inflation* https://www.ons.gov.uk/economy/inflationandpriceindices/articles/shortcomingsoftheretailpricesindexasameasureofinflation/2018-03-08

Other materials

A23.284 Department of Finance. *NI public sector shared network.* https://www.finance-ni.gov.uk/articles/ni-public-sector-shared-network [accessed 14 May 2019].

A23.285 Greater London Authority. *Central Activities Zone* https://www.london.gov.uk/what-we-do/planning/implementing-london-plan/supplementary-planning-guidance/central-activities-zone

A23.286 HMRC, *Rates and allowances – Corporation Tax.* https://www.gov.uk/government/publications/rates-and-allowances-corporation-tax/rates-and-allowances-corporation-tax.

A23.287 The United States Department of Justice. *Horizontal Merger Guidelines.* https://www.justice.gov/atr/horizontal-merger-guidelines-0#32 [accessed 10 May 2019].

A23.288 UK Government. *Business rates*. https://www.gov.uk/introduction-to-business-rates

A23.289 Valuation Office Agency. *Rating Manual section 6 part 3: valuation of all property classes*. https://www.gov.uk/guidance/rating-manual-section-6-part-3-valuation-of-all-property-classes/section-871-telecommunications-fibre-optic-networks

A23.290 The United States Department of Justice and the Federal Trade Commission, 2010. *Horizontal Merger Guidelines.* https://www.ftc.gov/sites/default/files/attachments/merger-review/100819hmg.pdf [accessed 10/05/2019].

A23.291 Competition Commission, 2014. *Northern Ireland Electricity Limited price determination.* https://assets.publishing.service.gov.uk/media/535a5768ed915d0fdb000003/NIE_Final_determination.pdf

A23.292 Ofgem, 2018. *RIIO-2 Finance annex.* https://www.ofgem.gov.uk/system/files/docs/2018/12/riio-2_finance_annex.pdf

A23.293 HM Treasury, 2019. *Forecasts for the UK economy: a comparison of independent forecasts.* https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/780025/PU797_Forecast_for_the_UK_Economy_feb_2019.pdf

Other telecoms providers

CityFibre

A23.294 CityFibre, *The rise of the Gigabit City.* https://www.cityfibre.com/gigabit-cities/ [accessed 15 May 2019].

A23.295 CityFibre, 2015. *CityFibre provides dark fibre connectivity to Purebroadband's wireless network in Hull.* https://www.cityfibre.com/news/2015331cityfibre-provides-dark-fibre-connectivity-to-purebroadbands-wireless-network-in-hull/ [accessed 14 May 2019].

A23.296 CityFibre, 2018. *CityFibre announces a £2.5bn investment plan to expand its full fibre network and unlock the UK's next generation broadband*. https://www.cityfibre.com/news/cityfibre-announces-2-5bn-investment-plan-expand-full-fibre-network-unlock-uks-next-generation-broadband/ [accessed 3 May 2019].

A23.297 CityFibre, 2018. CityFibre puts in place a debt package of £1.12 billion to underpin capital investment in full fibre across UK towns and cities. https://www.cityfibre.com/news/cityfibre-puts-place-debt-package-1-12-billion-underpin-capital-investment-full-fibre-across-uk-towns-cities/ [accessed 3 May 2019].

TalkTalk Group

A23.298 TalkTalk Business. *Ethernet over Fibre to the Cabinet.* https://www.talktalkbusiness.co.uk/globalassets/collateral/datasheets/partner/50081969---ttb-eofttc-datasheet-partner-v3.pdf

A23.299 TalkTalk. *TalkTalk launches new company FibreNation.* https://www.talktalkgroup.com/articles/talktalkgroup/TalkTalk-launches-new-company-FibreNation- [accessed 10 May 2019].

A23.300 TalkTalk letter to Ofcom, 2019. *Estimation of dig distance within the context of the BCMR.* https://www.ofcom.org.uk/__data/assets/pdf_file/0025/143647/talk-talk-supplementary-submission-dig-distance-estimation.pdf

Toob

A23.301 Toob. *Southampton to become a gigabit city thanks to toob's £50m full fibre investment.* https://www.toob.co.uk/wp-content/uploads/2019/05/toob-press-release-Southampton-launch-8-May-2019.pdf [accessed 10 May 2019]

A23.302 Toob. *Toob raises £75 million to fund initial full fibre broadband rollout.* https://www.toob.co.uk/wp-content/uploads/2019/05/toob-secures-75m-investment.pdf [accessed 10 May 2019].

Other

A23.303 EE. *It's official: EE to launch 5G across 16 UK cities in 2019.* https://shop.ee.co.uk/features-and-articles/its-official-ee-to-launch-5g-across-16-uk-cities-in-2019 [accessed 14 May 2019].

A23.304 Ericsson, 2015. *Centralized RAN and Fronthaul.* https://www.isemag.com/wp-content/uploads/2016/01/C-RAN_and_Fronthaul_White_Paper.pdf [accessed 26 February 2019].

A23.305 Gigaclear, *About.* https://www.gigaclear.net/about [accessed 3 May 2019].

A23.306 Hyperoptic. *Hyperoptic raises strategic investment from Mubadala Company and announces additions to its Senior Leadership Team.* https://www.hyperoptic.com/press/posts/hyperoptic-raises-strategic-investment-from-mubadala-investment-company-and-announces-additions-to-its-senior-leadership-team/ [accessed 3 May 2019].

A23.307 MS3, *About us.* http://www.ms-3.co.uk/pages/about-us.html [accessed 30 October 2018].

A23.308 Three, 2018. *Three UK continues 5G network preparation.* http://www.threemediacentre.co.uk/news/2018/sse-unbundling-announcement.aspx [accessed 14 May 2019].

A23.309 Wightfibre. *A different kind of broadband…Gigabit Broadband.* https://www.wightfibre.com/gigabit-island/ [accessed 10 May 2019].

A23.310 Vodafone, 2019. *Vodafone to launch 5G in 19 cities during 2019.* https://mediacentre.vodafone.co.uk/news/5g-in-19-cities-during-2019/ [accessed 14 May 2019].

Body of European Regulators for Electronic Communications (BEREC)

A23.311 *ERG Common Position on Geographic Aspects of Market Analysis (definition and remedies), October 2008.* https://berec.europa.eu/doc/publications/erg_08_20_final_cp_geog_aspects_081016.pdf

A23.312 BEREC, 2012. Revised BEREC common position on best practice in remedies on the market for wholesale (physical) network infrastructure access (including shared or fully unbundled access) at a fixed location imposed as a consequence of a position of significant market power in the relevant market, BoR (12) 127. http://www.berec.europa.eu/files/document_register_store/2012/12/20121208163628_BoR_(12)_127__BEREC__COMMON_POSITION_ON_BEST_PRACTICE_IN_REMEDIES_ON_THE_MARKET_FOR_WHOLESALE.pdf.

A23.313 BEREC, 2012. Revised BEREC common position on best practices in remedies as a consequence of a SMP position in the relevant markets for wholesale leased lines, BoR (12)

126.
https://berec.europa.eu/eng/document_register/subject_matter/berec/download/0/1096-revised-berec-common-position-on-best-pr_0.pdf

A23.314 BEREC, 2014. *Common Position on geographic aspects of market analysis (definition and remedies).* http://berec.europa.eu/eng/document_register/subject_matter/berec/download/0/4439-berec-common-position-on-geographic-aspe_0.pdf.

A23.315 BEREC, 2018. Draft BEREC Report on Access to physical infrastructure in the context of market analysis. *https://berec.europa.eu/eng/document_register/subject_matter/berec/download/0/8323-draft-berec-report-on-access-to-physical_0.pdf*

Press

A23.316 ISP Review, 2018. *EE UK Switches On First Live Trial of 5G Mobile Tech in Canary Wharf.* www.ispreview.co.uk/..first-live-trial-of-5g-mobile [accessed 30 October 2018].

A23.317 ISP Review, 2018. *New Full Fibre Broadband ISP Trooli Starts Rural UK Rollout in Kent.* https://www.ispreview.co.uk/index.php/2018/06/new-full-fibre-broadband-isp-trooli-starts-uk-deployment-in-kent.html[accessed 10 May 2019].

A23.318 ISP Review, 2018. *Truespeed CEO – We Hope to Reach 200,000 UK Premises with FTTP.* https://www.ispreview.co.uk/index.php/2018/05/truespeed-ceo-we-hope-to-reach-200000-uk-premises-with-fttp.html/2 [10 May 2019].

A23.319 ISP Review, 2018. *Who is Building – UK Summary of Full Fibre Broadband Plans and Investment UPDATE15.* https://www.ispreview.co.uk/index.php/2018/04/building-uk-summary-fttp-broadband-rollouts-investment.html [accessed 3 May 2019].

A23.320 Land Mobile, 2018. *3GPP Release 15 final freeze delayed by three months* http://www.landmobile.co.uk/news/release-15-delayed-3gpp-5g/ [accessed 18 March 2019].

A23.321 ISP Review, 2019. *O2 Name First UK Cities to Benefit from 5G Mobile Rollout in 2019.* https://www.ispreview.co.uk/index.php/2019/02/o2-name-first-uk-cities-to-benefit-from-5g-mobile-rollout-in-2019.html [accessed 14 May 2019].

A23.322 ISP Review, 2019. *Virgin Media Ponders Opening Up UK Network to Rival ISPs.* https://www.ispreview.co.uk/index.php/2019/04/virgin-media-ponders-opening-up-uk-network-to-rival-isps.html [Accessed 10 April 2019]

Other Sources

Bank of England (BoE)

A23.323 BoE, 2017. *Quarterly Bulletin Q2 2017: An improved model for understanding equity prices.* https://www.bankofengland.co.uk/-/media/boe/files/quarterly-bulletin/2017/an-improved-model-for-understanding-equity-prices.pdf?la=en&hash=F0385353B45A130A1AA557165FBEC5E326FD57F

A23.324 BoE, 2019. *Inflation Report*. https://www.bankofengland.co.uk/-/media/boe/files/inflation-report/2019/february/inflation-report-february-2019.pdf.

Competition Appeals Tribunal (CAT)

A23.325 CAT 2017, 1260/3/3/16 British Telecommunications v Office of Communications (BCMR) – Judgment (Market Definition) [2017] CAT 25|10 Nov 2017 https://www.catribunal.org.uk/sites/default/files/1260_BT_Judgment_CAT_25B_101117.pdf

A23.326 CAT, 2017, 1261/3/3/16 CityFibre Infrastructure Holdings plc v Office of Communications and 1259/3/3/16 TalkTalk Telecom Group plc v Office of Communications. Final Determination. Notified 6: April. https://www.catribunal.org.uk/sites/default/files/1259%3B1261_BCMR_CMA_Final_Determination_100417.pdf

Office of Budget Responsibility (OBR)

A23.327 OBR, 2019. *Economic and fiscal outlook – March 2019.* https://cdn.obr.uk/March-2019_EFO_Web-Accessible.pdf

A23.328 OBR, 2019. *The economy forecast: Inflation, updated on 13 March 2019* https://obr.uk/forecasts-in-depth/the-economy-forecast/inflation/

3GPP

A23.329 3GPP, 2018. *Release 16 update* https://www.3gpp.org/release-16 [accessed 12 March 2019].

A23.330 3GPP, 2018. *Study on enhancement of Ultra-Reliable Low-Latency Communication (URLLC) support in the 5G Core network (5GC)* https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=3453 [accessed 12 March 2019].

Other

A23.331 Bailey, D & John, LE (eds), 2018. *Bellamy & Child European Union Law of Competition*. Eighth Edition, Oxford: Oxford University Press.

A23.332 CAA, 2019. *Appendices to Draft UK Reference Period 3 Performance Plan proposals, Consultation* http://publicapps.caa.co.uk/docs/33/CAP%201758A.pdf

A23.333 Council of Europe, Deployment & Operations Committee, *White Paper: Innovative FTTH Deployment Technologies*, available at http://www.ftthcouncil.eu/documents/Publications/DandO_White_Paper_2_2014.pdf

A23.334 Cisco, June 2017. *VNI Complete Forecasts Highlights* [accessed 21 May 2019].

A23.335 Fama, E. F. and French, K. R., 2002. *The Equity Premium*, Journal of Finance Vol. LVII, No. 2.

A23.336 Federal Reserve Bank of St. Louis. *Fiber Optic Cable Manufacturing Index.* https://fred.stlouisfed.org/series/PCU3359213359210 [accessed 23/04/2019].

A23.337 Harris, B.C. and Simons, J.J., 1989. *Focusing Market Definition: How Much Substitution is Necessary?*, Research in Law and Economics, 12.

A23.338 IEEE Standards Association. https://standards.ieee.org/ [Accessed 08 May 2019].

A23.339 Moody's, 2018. *Moody's downgrades BT's and EE's rating to Baa2.* https://www.moodys.com/research/Moodys-downgrades-BTs-and-EEs-ratings-to-Baa2-stable-outlook--PR_380805

A23.340 Nardotto, M., Valletti, T., and Verboven, F., 2015. *Unbundling the incumbent: evidence from UK broadband. Journal of the European Economic Association.* 2015, vol.13, issue 2, 330-362.

A23.341 OpenStreetMap. *https://www.openstreetmap.org/*

A23.342 OTA2. *Update for July 2018.* http://www.offta.org.uk/updates/otaupdate2018July.htm [accessed 1 November 2018].

A23.343 RS Components Ltd. *Huber & Suhner 24 Port SC Single Mode Simplex Fibre Optic Patch Panel.*https://uk.rs-online.com/web/p/fibre-optic-patch-panels/1442457/ [accessed 7 May 2019].

A23.344 Scottish Government, 2017. *Digital Scotland – Reaching 100% Programme.* http://www.gov.scot/Publications/2017/07/4529/343135.

A23.345 Wright, S., Burns, P., Mason, R., and Pickford, D., 2018. *Estimating the cost of capital for implementation of price controls by UK Regulators*. http://www.ukrn.org.uk/wp-content/uploads/2018/03/2018-CoE-Study.pdf.

A23.346 Xiao, M., & Orazem, P. F., 2011. Does the fourth entrant make any difference?: Entry and competition in the early US broadband market. International Journal of Industrial Organization, 29(5).

A24. Equality impact assessment

A24.1 Ofcom is required by statute to assess the potential impact of all our functions, policies, projects and practices on equality.[1137] An equality impact assessment (EIA) also assists us in making sure that we are meeting our principal duty of furthering the interests of citizens and consumers regardless of their background or identity.

A24.2 Unless we otherwise state in this document, it is not apparent to us that the outcome of this statement will have a differential impact on any equality group.

A24.3 Further, we have not considered it necessary to carry out separate EIAs in relation to race or sex equality or equality schemes under the Northern Ireland and Disability Equality Schemes. This is because we anticipate that our proposals will not have a differential impact on people of different sexes or ethnicities, consumers with protected characteristics in Northern Ireland[1138] or disabled consumers compared to consumers in general.

A24.4 The aim of this statement is to define the retail and wholesale leased lines markets and physical infrastructure markets in the UK and assess the state of competition.

Equality impact assessment

A24.5 We have considered whether our proposals are likely to have an adverse impact on promoting equality. In particular, we have considered whether it is likely to have a different or adverse effect on UK consumers and citizens with respect to the following equality groups: age, disability, sex, gender reassignment, pregnancy and maternity, race, religion or belief and sexual orientation, and, in Northern Ireland, political opinion and persons with dependants.

A24.6 We do not have detailed sectoral information on the businesses that purchase wholesale leased lines services or physical infrastructure services, or whether there is a correlation between the customers of their products or services and the defined equality groups. We also do not have information on any correlation between retail leased lines services and the defined equality groups.

A24.7 Also, we do not have any reason to suspect that there would be a correlation between the affected consumers and businesses and any of the above defined equality groups. We also do not find any reason to suspect that our proposals have the potential for negative impacts on members of the defined equality groups. On that basis we believe that it would be disproportionate to commission relevant research and have not done so.

[1137] Ofcom has a general duty under the 2010 Equality Act to advance equality of opportunity in relation to age, disability, sex, gender reassignment, pregnancy and maternity, race, religion or belief and sexual orientation.

[1138] In addition to the characteristics outlined in the 2010 Equality Act, in Northern Ireland consumers who have dependents or hold a particular political opinion are also protected.

A25. Glossary

Term	Description
2013 BCMR	The business connectivity market review (BCMR) for the period 1 April 2013 to 31 March 2016.
2014 EC Recommendation	The 2014 EC Recommendation on relevant product and service markets.
2014 FAMR	The fixed access market review (FAMR) for the period 1 April 2014 to 31 March 2017.
2016 BCMR	The BCMR for the period 1 April 2016 to 31 March 2019.
2016 LLCC	The leased line charge controls imposed by the 2016 BCMR.
2017 Dark Fibre Consultation	The November 2017 Dark Fibre Consultation on adding dark fibre to the remedies for business connectivity markets.
2018 BT Regulatory Financial Reporting Consultation	The consultation published on 4 December 2018 in relation to BT's regulatory financial reporting across all regulated markets, including business connectivity and physical infrastructure markets.
2019 BCMR	The BCMR for the period 1 April 2019 to 31 March 2021.
5G	The term used to describe the next generation of wireless networks beyond 4G LTE mobile networks. 5G is expected to deliver faster data rates and better user experience.
Access Charge Change Notice (ACCN)	A contractual notification, issued by BT, of a change to the price of a regulated network access service.
Accumulated CCA depreciation	Totality of deductions made to the gross replacement cost of a tangible fixed asset to reflect its cumulative consumption since acquisition.
Accumulated HCA depreciation	Totality of deductions made to the original purchase price of a tangible fixed asset to reflect its cumulative consumption since acquisition.
Active leased line	A permanently connected communications link between two sites, dedicated to the customers' exclusive use, and provided with active electronics at either end of the connection.
ADSL (Asymmetric Digital Subscriber Line)	A variant of DSL that supports higher bandwidth on downlink transmissions i.e. from the exchange to the end-user rather than from the end-user to the exchange.
AFI (Additional Financial Information)	Detailed financial information provided in confidence to Ofcom as part of BT's Regulatory Financial Statements.
AI (Alternative Interface)	Leased line services typically using an Ethernet interface. Now referred to as Contemporary Interface (CI).

AISBO (Alternative Interface Symmetric Broadband Origination)	Leased line terminating segment typically using an Ethernet interface. Now referred to as Contemporary Interface Symmetric Broadband Origination (CISBO).
Anchor pricing	An approach that sets the upper bound for charges of existing services by reference to the cost of providing those services using existing technology. This ensures that the introduction of new technology which is intended to provide a greater range of services does not inappropriately lead to an increase in the cost of the existing services.
ATM (Asynchronous Transfer Mode)	A network technology that uses asynchronous time division multiplexing techniques and which supports data transmissions at up to 622 Mbit/s.
AVE (Asset Volume Elasticity)	The percentage increase in capital costs required for a 1% increase in volume.
Backhaul	Connections between access, backhaul, and core aggregating nodes.
Bandwidth	The rate at which data can be transmitted. Usually expressed in bits per second (bit/s).
Basket	A term used in relation to the structure of charge controls, where the charge control is applied to the total revenue from a group of services in a given year, subject to a specified compliance formula.
BCMR	Business Connectivity Market Review.
BCMR Judgment	The Competition Appeal Tribunal judgment of 10 November 2017.
Bearer	A transmission link that carries one or more multiplexed smaller capacity connections.
BEIS	Department for Business, Energy & Industrial Strategy.
BEREC	Body of European Regulators for Electronic Communications.
BES (Backhaul Ethernet Services)	A legacy Openreach Ethernet service providing high bandwidth inter-exchange connectivity, superseded, for example, by Openreach' EBD and EAD products.
BoR	Board of Regulators which is part of BEREC, and is sometimes used when referring to BEREC documents in the form , for example, BoR (12)
BT	British Telecommunications plc.
BT CCN (Change Control Notification)	BT's publication of RFS methodology changes that were implemented between the 2017 RFS and the 2018 RFS.
BT TSO (Technology and Service Operations)	BT's internal technology unit responsible for creating and operating BT's networks, platforms and IT systems. Now named BT Technology.

BTL (Bulk Transport Link)	An Openreach Ethernet interconnection product providing high bandwidth, point-to-point connections between an Openreach Handover Point (OHP) to a telecoms provider's site.
BTPS (BT Pension Scheme)	A defined benefit pension plan for BT employees that closed to new members in 2001.
BTRSS (BT Retirement Savings Scheme)	A new defined contribution group pension plan for BT employees set up on 1 April 2009 to replace the BT Retirement Plan, which in turn replaced the BT Pension Scheme (BTPS).
BTW (BT Wholesale)	The part of BT which provides wholesale services to telecoms providers, referred to in the 2016 BCMR. BTW is now in the BT Enterprise division which was formed in May 2018.
CAGR (Compound Annual Growth Rate)	The year-on-year smoothed annualised growth rate of an investment. It can be calculated as follows: CAGR = $(\frac{\text{EndingValue}}{\text{BeginningValue}})^{(\frac{1}{\text{numberofyears}})}$-1.
CAPM	Capital Asset Pricing Model.
Capex (Capital Expenditure)	The firm's investment in fixed assets.
CBDs (Central Business Districts)	The central business districts of urban centres in Birmingham, Bristol, Glasgow, Leeds and Manchester.
CCA (Current Cost Accounting)	An accounting convention, where assets are valued and depreciated according to their current replacement cost while maintaining the operating or financial capital of the business entity.
CCA adjustments	The accounting convention where the value of assets is adjusted and depreciated according to their current replacement cost while maintaining the operating or financial capital of the business entity.
CDD (Contractual Delivery Date)	A date provided by Openreach to a telecoms provider on which Openreach contracts for an order to become a completed order.
Certainty of iCCD (Certainty MSL)	A QoS standard to assess Openreach's ability to deliver Ethernet circuits on the date initially provided to the customer.
CI (Contemporary Interface)	A set of modern technologies used for delivery of leased line services (e.g. Ethernet or wavelength-division multiplexing).
CISBO (Contemporary Interface Symmetric Broadband Origination)	A service defined in the 2016 BCMR consisting of wholesale leased line services using CI technologies.
CLA (Central London Area)	A proposed geographic market in central London.
Common costs	Costs which are shared by multiple services supplied by a firm.

Co-location	The provision of space and associated facilities at a BT exchange for telecom provider equipment.
CoW (Class of Work)	A type of activity which engineers are engaged in and is a code for engineers to book their time to, for tracking of costs.
CP (Communications Provider)	An organisation that provides electronic communications services. We refer to as telecoms provider.
CPE (Customer Premises Equipment)	Sometimes referred to as customer apparatus or consumer equipment. Equipment on consumers' premises which is not part of the public telecommunications network but is directly or indirectly attached to it via network terminating equipment (NTE).
CPI (Consumer Price Index)	The official measure of inflation of consumer prices in the UK.
CRF (Common Regulatory Framework)	The European Union harmonised framework for the regulation of electronic communications by Member States.
CSH (Customer Sited Handover)	An interconnection between BT and another telecoms provider which involves BT providing a point of handover (POH) at the site of the interconnecting telecoms provider.
CTCS (Core Transmission Costing System)	A BT core network costing system which models the volumes and network usage associated with the transmission across the BT Core network.
Cumulo rates	The business (non-domestic) rates paid by BT on the rateable network assets within its cumulo rating assessment.
CVE (Cost Volume Elasticity)	The percentage increase in operating costs required for a 1% increase in volume.
CVR (Cost Volume Relationship)	The relationship of how cost and volumes move in relation to one another.
CWU (Communication Workers Union)	A union for the communications industry which represents members in postal, telecom, mobile, administrative and financial companies.
DAM (Detailed Attribution Methods)	A document prepared by BT which sets out the methodologies used to attribute its costs to prepare the Regulatory Financial Statements. (See the June 2015 Cost Attribution Review).
DC (Data Centre)	Premises whose main purpose is to house computing, data and application hosting, and communications equipment. They tend to have multiple tenants and may be owned and operated by carriers and/or run by third party providers that are carrier neutral. A carrier neutral data centre is owned and operated entirely independently of network providers and allows interconnection to and between multiple telecoms providers.

Deemed consent	A contractual provision allowing Openreach to deem the consent of its customers to a change of the CDD in a range of circumstances as provided for in its contract.
DF (Dark Fibre)	A so called 'passive' remedy which allows telecoms providers to lease only the fibre element of the leased lines from BT, allowing them to attach equipment of their own choosing at either end to 'light' the fibre and use it as the basis for offering a range of leased lines products. Also referred to as DFA (Dark Fibre Access).
Disposals	The assets that the firm disposes of (e.g. an asset that becomes fully depreciated or an asset that the firm sells) over the course of the financial year.
DLRIC (Distributed Long Run Incremental Cost)	The long-run incremental cost of the individual service with a share of costs which are common to other services over BT's core network.
DOCSIS (Data Over Cable Service Interface Specification)	A telecommunications standard that enables cable TV networks to support broadband internet access services.
DP (Distribution Point)	A flexibility point in BT's access network where final connections to customer premises are connected to D-side cables. Usually either an underground joint or a connection point on a pole where dropwires are terminated.
DPA (Duct and Pole Access)	A wholesale access service allowing a telecoms provider to make use of the underground duct network and the poles of another telecoms provider.
DPCN (Digital Private Circuit Network)	A BT network that is used to provide very low bandwidth TI leased lines services (services at bandwidths below 2 Mbit/s).
Dropwire	An overhead cable, connecting BT's access network to a customer's premises.
DSAC (Distributed Stand Alone Cost)	An accounting approach estimated by adding a proportionate share of the inter-increment common costs to the DLRIC. Rather than all common costs shared by a service being allocated to the service under consideration, the common costs are instead allocated amongst all the services that share the network increment.
DSL (Digital Subscriber Line)	A family of technologies generically referred to as DSL or xDSL that enable the transmission of broadband signals over ordinary copper telephone lines. ADSL, HDSL (High bit rate Digital Subscriber Line) and VDSL (Very high data rate Digital Subscriber Line) are all variants of xDSL.
EAD (Ethernet Access Direct)	An Ethernet product offered by Openreach providing high bandwidth, point-to-point connections.

EBD (Ethernet Backhaul Direct)	An Ethernet backhaul product offered by Openreach providing high bandwidth, inter-exchange connectivity between designated BT exchanges.
EBITDA	Earnings before interest, tax, depreciation and amortization.
EC	The European Commission.
ECCs (Excess Construction Charges)	A charge levied by Openreach where additional construction of duct and fibre or copper is required to provide service to customer site. Provided either directly by Openreach or by a contractor.
EFM (Ethernet in the First Mile)	A network technology for the delivery of Ethernet services over access networks. Although the technology also encompasses fibre access networks, in common usage, EFM refers to the provision of Ethernet services over copper access networks.
EMP (Equivalence Management Platform)	A set of operational support systems and associated processes put in place by Openreach.
EOI (Equivalence of Input)	A remedy designed to prevent a vertically-integrated company from discriminating between its competitors and its own business in providing upstream inputs. This requires BT to provide the same wholesale products to all telecoms providers including BT's own downstream division on the same timescales, terms and conditions (including price and service levels) by means of the same systems and processes, and includes the provision of the same commercial information about such products, services, systems and processes to all telecoms providers (including BT).
EPMU (Equi-Proportional Mark-Up)	An approach to allocating common costs to products proportionally to the product's share of total LRIC.
ERP	Equity Risk Premium.
Ethernet	A packet-based technology originally developed for use in Local Area Networks (LANs) but now also widely used in telecoms providers' networks for the transmission of data services.
EV	Enterprise Value.
Exchange	The BT telephone exchange, to which customers are directly connected.
FAC (Fully Allocated Cost)	An accounting approach under which all the costs of the company are distributed between its various products and services. The fully allocated cost of a product or service may therefore include some common costs that are not directly attributable to the service.
FCM (Financial Capital Maintenance)	An approach to CCA in which an allowance is made within the capital costs for the holding gains or losses associated with changes over the year in the value of the assets held by the firm. In contrast to OCM, the

	FCM approach seeks to maintain the financial capital of the firm, and hence the firm's ability to continue financing its business.
Fibre channel	Standardised storage area network CI protocol operating at bandwidths between 1 Gbit/s and 16 Gbit/s.
FRO (Final Reference Offer)	The product description and associated pricing published by Openreach on 1 December 2016 in relation to its Dark Fibre Access product.
FTTC (Fibre-to-the-Cabinet)	An access network structure in which the optical fibre extends from the exchange to the street cabinet. The street cabinet is usually located only a few hundred metres from the subscriber's premises. The remaining part of the access network from the cabinet to the customer is usually copper wire but could use another technology, such as wireless.
FTTP (Fibre-to-the-Premises)	An access network structure in which the optical fibre network runs from the local exchange to the end-user's house or business premises. The optical fibre may be point-to-point (there is one dedicated fibre connection for each home) or may use a shared infrastructure such as a GPON. Sometimes also referred to as Fibre-to-the-home (FTTH), Fibre-to-the-Business (FTTB) or full-fibre.
FTTX (Fibre-to-the-X)	An access network structure in which the optical fibre is used for any part of the network from the exchange to the end-user's premises. This general term encompasses both FTTC and FTTP. The remaining part of the access network is usually copper wire but could use another technology, such as wireless.
GBCI (General Building Cost Index)	A national index that measures the costs of construction work including materials and labour.
Gbit/s	Gigabits per second (1 Gigabit = 1,000,000,000 bits). A measure of bandwidth in a digital system.
GBV (Gross Book Value)	The original (historical) price paid for an asset, without any depreciation deducted.
GEA (Generic Ethernet Access)	Openreach's wholesale service providing telecoms providers with access to its FTTC and FTTP networks to supply higher speed broadband services. The GEA service meets BT's obligation to provide VULA.
GPON (Gigabit Passive Optical Network)	A shared FTTP network architecture that can be used for NGA.
GRC (Gross Replacement Cost)	The cost of replacing an existing tangible fixed asset with an identical or substantially similar new asset having a similar production or service capacity.
HCA (Historic Cost Accounting)	The measure of the cost in terms of its original purchase price of the economic benefits of tangible fixed assets that have been consumed

	during a period. Consumption includes the wearing out, using up or other reduction in the useful economic life of a tangible fixed asset whether arising from use, effluxion of time or obsolescence through either changes in technology or demand for the goods and services produced by the asset.
HGL (Holding Gains and Losses)	The change in the value of the underlying assets used by the company over the course of the financial year.
HNR (High Network Reach Areas)	Geographic areas with at least two rival leased lines providers within a specific distance from a business site, as defined in this consultation.
Hull Area	The area defined as the 'Licensed Area' in the licence granted on 30 November 1987 by the Secretary of State under section 7 of the Telecommunications Act 1984 to Kingston upon Hull City Council and Kingston Communications (Hull) plc (KCOM).
IBH (In Building Handover)	An interconnection between BT and another telecoms provider's network which is where BT provides a point of handover (POH) at co-location space rented by a telecoms provider inside a BT exchange.
iCDD (initial Contractual Delivery Date)	In Ethernet provisioning, the iCDD is the first date provided to Openreach's customers by Openreach advising of the anticipated circuit completion date.
ISDN (Integrated Services Digital Network)	A digital telephone service that supports telephone and switched data services.
ISH (In Span Handover)	An interconnection between BT and another telecoms provider where the BT interconnect circuit terminates (is handed over) at a point between BT's site and the telecoms provider's site.
ITU	International Telecoms Union.
Jitter	A measure of the variation of delay in transmission over a transmission path.
Kbit/s	Kilobits per second (1 kilobit = 1,000 bits). A measure of bandwidth in a digital system.
KPIs (Key Performance Indicators)	Specified information to be provided for the purposes of assessing performance and providing transparency of service provision by a dominant provider.
LA (Local Access)	This refers to an Openreach leased line variant of an EAD (Ethernet Access Direct) product which only runs between an end-user site and the local access serving exchange. An LA leased line has no main fibre link between exchanges.
Latency	A measure of delay in transmission over a transmission path.

Lead-in	The final section of a physical infrastructure network, housing the connection between the distribution point and the Customer's Premises Equipment.
Leased line	A permanently connected communications link between two sites dedicated to the customers' exclusive use.
LLCC	Leased line charge control.
LLU (Local Loop Unbundling)	A process by which a dominant provider's local loops are physically disconnected from its network and connected to competing providers' networks. This enables operators other than the incumbent to use the local loop to provide services directly to customers.
LP (London Periphery)	A proposed geographic market set out in the 2015 BCMR Consultation and adjacent to the CLA.
Lower percentile	A QoS standard put in place in the 2016 BCMR and Temporary Conditions to protect against the risk that Openreach's focus would shift exclusively to the tail or more complex Ethernet provisioning orders, to the detriment of the easier 'quick win' circuits.
LRIC (Long Run Incremental Cost)	A measure of the change in the long-run total costs of the firm that arises from the provision of a discrete increment of output.
Mbit/s	Megabits per second (1 Megabit = 1 million bits). A measure of bandwidth in a digital system.
MBORC (Matters Beyond Our Reasonable Control)	MBORCs are usually raised when Openreach's network has experienced serious damage caused by extreme weather, or as a result of criminal or negligent damage caused by third parties.
MCE (Mean Capital Employed)	BT's definition of Mean Capital Employed is total assets less current liabilities, excluding corporate taxes and dividends payable, and provisions other than those for deferred taxation. The mean is computed from the start and end values for the period, except in the case of short-term investments and borrowings, where daily averages are used in their place.
MCT (Mobile Call Termination)	The wholesale service provided by an MCT provider to allow an originating telecoms provider to connect a caller with the intended mobile call recipient on that MCT provider's network.
MDF (Main Distribution Frame)	A wiring flexibility frame where copper local loops are terminated and interconnected.
MDF Site	A BT operational building containing an MDF. Also referred to as a Local Serving Exchange.

MEA (Modern Equivalent Asset)	The approach to set charges by basing costs and asset values on what is believed to be the most efficient available technology that performs the same function as the current technology.
MEAS (Managed Ethernet Access Service)	This is a service provided by BT Enterprise (previously BT Wholesale) to provide connectivity from multiple mobile base station sites back to a mobile core network.
MI (Multiple Interface) leased lines	Leased line services with bandwidths greater than 1 Gbit/s and leased lines services of any bandwidth delivered using WDM equipment.
MISBO (Multiple Interface Symmetric Broadband Origination)	Leased line terminating segments supporting high bandwidth services – either an Ethernet interface with bandwidths greater than 1 Gbit/s or services of any bandwidth/interface delivered using WDM equipment.
MNO (Mobile Network Operator)	A provider which owns a cellular mobile network.
Modified Greenfield Approach	An approach to analysing markets, where we consider a hypothetical scenario in which there are no *ex ante* SMP remedies in the market being considered or in any markets downstream of it.
MPF (Metallic Path Facility)	The provision of access to the copper wires from the customer site to a BT MDF that covers the full available frequency range, including both narrowband and broadband channels, allowing a competing provider to provide the customer with both voice and/or data services over such copper wires.
MSAN (Multi Service Access Node)	A network access device associated with an IP-based network that provides network interfaces for telephony, broadband and other services. MSANs are typically installed in a telephone exchange or a roadside cabinet.
MSC (Mobile Switching Centre)	A component of a mobile telephone network that switches voice calls between mobile users.
MSL (Minimum Service Level)	A term used in the 2016 BCMR referring to the level of service performance we consider to be acceptable and at which we set Openreach standards to meet. This term is now referred to as QoS standards.
MTTP (Mean Time To Provide)	A QoS standard measuring the average time to provide an Ethernet circuit excluding customer caused delays.
NCA (Net Current Assets)	A measure of the amount of capital being used in day-to-day activities by the company. It is equal to current assets less current liabilities.
NDRs (Non-Domestic Rates)	A form of property tax paid by organisations and businesses to contribute towards the cost of local services.

NGA (Next Generation Access)	A new or upgraded access network capable of supporting much higher capacity broadband services than traditional copper access networks. Generally an access network that employs optical fibre cable in whole or in part.
NICC	A technical forum for the UK communications sector that develops interoperability standards for public communications networks and services in the UK. It is an independent organisation owned and run by its members. Ofcom participates in NICC as an observer. NMR: Narrowband Market Review.
NRA	National Regulatory Authority.
NRC (Net Replacement Cost)	Gross replacement cost less accumulated depreciation based on gross replacement cost.
OCM (Operating Capability Maintenance)	A CCA convention, where the depreciation charge to the profit and loss account relates to the current replacement cost of the firm's assets, taking account of specific and general price inflation. As the name suggests, the OCM approach seeks to maintain the operating capability of the firm. Cumulative OCM depreciation is the sum of the individual in-year OCM depreciation over the asset life up to the year being forecast, adjusted to reflect any changes in asset values over time.
ODTR (Optimal Time Domain Reflectometer)	An instrument used to test the performance of fibre links and detect problems, in particular to identify the location of a broken fibre.
OHP (Openreach Handover Point)	Network nodes in BT's network at which certain Openreach backhaul services are terminated.
ONBS (Openreach Network Backhaul Services)	An Openreach Ethernet backhaul service providing high bandwidth inter-exchange connectivity.
Openreach Division	The line of business of BT which comprises BT's access and backhaul network assets and the products and services provided using those assets and which Openreach Limited, a wholly owned subsidiary of BT plc, has responsibility for operating and managing on behalf of BT.
Opex (operating expenditure)	Costs reflected in the profit and loss account excluding depreciation financing costs such as interest charges.
OSA (Optical Spectrum Access)	An Openreach WDM service.
OSEA (Optical Spectrum Extended Access)	Openreach WDM services supporting longer circuits than OSA.
OTA2 (Office of the Telecommunications Adjudicator)	An organisation independent of Ofcom and the industry, tasked with overseeing cooperation between telecoms providers.

OUKT	Other UK telecoms.
PAC (Previously Allocated Costs)	BT's cost attribution system (see Section 5 of the June 2015 Cost Attribution Review) allocates costs to the different levels of their cost exhaustion system. When we propose that these costs should be allocated based on all previously allocated total costs we mean that each division, market, service, and component (i.e. the different levels of the cost exhaustion system) should be allocated these costs based on the previously allocated total costs at that level of the cost exhaustion system divided by the total of all previously allocated total costs within BT as shown in the following formula $x = \textbf{OUC costs X} \left[\frac{\textbf{Previously allocated total costs at level x}}{\textbf{Total previously allocated total costs within BT}}\right]$, where x = allocation of the OUC (Operational Unit Costs) at a specific level of BT's cost exhaustion system.
PCO (Principal Core Operator)	A telecoms provider with its own network infrastructure, has a substantial footprint, and offers a wholesale inter-exchange connectivity service to other telecoms providers.
PDH (Plesiochronous Digital Hierarchy)	An older TI digital transmission technology that uses TDM. Although PDH systems are still widely used, they are being replaced by SDH and increasingly Ethernet services.
PIA (Passive Infrastructure Access)	A remedy requiring BT to provide telecoms providers with access to its passive access network infrastructure (i.e. ducts and poles).
POH (Point of Handover)	A point (location) where one telecoms provider interconnects with another telecoms provider for the purposes of connecting their networks to 3rd party customers to provide services to those end customers. May also be referred to as point of connection (POC).
PON (Passive Optical Network)	A point to multipoint fibre-optic network architecture that uses passive optical splitters.
POP (Point of Presence)	A node in a telecoms provider's network (such as an exchange or other operational building), generally one used to serve customers in a particular locality.
PPC (Partial Private Circuit)	A TI leased line which provides the connection between an end-user site and a point of handover with a telecoms provider's network.
PTO (Precision Test Officer)	An Openreach technician who undertakes optical fibre testing and fault diagnosis.
PTR (Pricing Transparency Report)	A report detailing the charges that a telecoms provider makes to its customers for certain services.
PVEO (Price, Volume, Efficiency and Other) analysis	A form of analysis that groups price movements into four categories.

QE	Quantitative easing.
QoS (Quality of Service) standards	The level of provisioning and fault repair QoS performance standards that we have set Openreach to meet, previously known as MSLs.
RANF (Revised agreement for Access Network Facilities)	The Reference Offers which set out revised terms and conditions on which Openreach will provide local loop unbundling services.[1139]
RAP (Regulatory Accounting Principles)	A set of guiding principles with which BT's Regulatory Financial Reporting must comply in order to preserve the integrity and consistency of BT's RFS.
RAV (Regulatory Asset Value)	The value ascribed by Ofcom to an asset or capital employed in the relevant licensed business.
RBS (Radio Base Station) backhaul circuit	A TI circuit provided by BT that connects a mobile network operator's base station to the operator's mobile switching centre which is made up of leased line access and leased line backhaul segments.
Remitted Matters	The matters that the Competition Appeal Tribunal remitted to Ofcom for consideration, following the BCMR judgment of 10 November 2017.
RFR	Risk-free Rate.
RFS (Regulatory Financial Statements)	The financial statements that BT is required to prepare by Ofcom. They include the published RFS and AFI provided to Ofcom in confidence.[1140]
RO (Reference Offer)	A document published by a telecoms provider setting out matters such as technical information, the terms and conditions for provisioning, SLAs and SLGs, and availability of other related services such as accommodation.
ROCE (Return on Capital Employed)	The ratio of accounting profit to capital employed.
RoUK (Rest of the UK)	A geographic market set out in the 2016 BCMR, consisting of an area outside the Central London Area, Central Business Districts, and the Hull Area.
RPI (Retail Price Index)	A measure of inflation published monthly by the Office for National Statistics. It measures the change in the cost of a basket of retail goods and services.
RWT (Right When Tested)	When a line tests as 'OK' when tested remotely or tested by an onsite engineer visit.
SAC (Stand Alone Cost)	An accounting approach under which the total cost incurred in providing a product is allocated to that product.

[1139] See: LLU Contract, Openreach [accessed 11 June 2019].
[1140] Available at: Regulatory financial statements, BT [accessed 11 June 2019].

SBO (Symmetric Broadband Origination)	A symmetric broadband origination service provides symmetric capacity from a customer's site to an appropriate point of aggregation, generally referred to as a node, in the network hierarchy. In this context, a 'customer' refers to any public electronic communications network provider or end-user.
SDH (Synchronous Digital Hierarchy)	A TI digital transmission standard that is widely used in communications networks and for leased lines. Although SDH systems are still widely used, they are being replaced increasingly by Ethernet services.
SDSL (Symmetric Digital Subscriber Line)	A DSL variant that allows broadband signals to be transmitted at the same rate from end-user to exchange (downstream) as from exchange to end-user (upstream).
SFP (Small Form-factor Pluggable)	The small form-factor pluggable is a compact, optical module transceiver (laser) used in network equipment for data transmission over a fibre connection.
SLA (Service Level Agreement)	A contractual commitment provided by Openreach to telecoms providers about service standards.
SLG (Service Level Guarantee)	A contractual commitment by Openreach to telecoms providers specifying the amount of compensation payable by Openreach to a telecoms provider for a failure to adhere to an SLA.
SMP (Significant Market Power)	The significant market power test is set out in European Directives. It is used by National Regulatory Authorities (NRAs), such as Ofcom, to identify those telecoms providers which must meet additional obligations under the relevant Directives.
SoR (Statement of Requirement)	A BT process for submission and processing of requests for product/service enhancements.
SPM (Sales Product Management)	A network cost component.
SSNIP (Small but Significant Non-transitory Increase in Price)	Usually considered to be 5 to 10 per cent, which is part of the hypothetical monopolist test used in market definition analysis.
Sub-basket	A sub-basket refers to a control on a group of two or more charges.
Sub-cap	A sub-cap refers to a control on a single charge.
Supplementary depreciation	The additional depreciation charge to convert a HCA depreciation charge into a CCA depreciation charge.
TAN (Trunk Aggregation Node)	In the 2013 BCMR we identified 85 of BT's 107 OHPs to be major nodes. At the time, we considered that BT's competitors would be unlikely to connect to each major node, because some were geographically close to each other. We therefore decided to group the 85 major nodes into

	56 Trunk Aggregation Nodes (TANs). We found the core/backhaul conveyance between TANs to be competitive, however conveyance within each TAN was not competitive and therefore not part of the competitive core.
TCO (Total Cost of Ownership)	The total price of a service, including all incurred charges, over a specified period.
TDM (Time Division Multiplexing)	A method of combining multiple data streams for transmission over a shared channel by means of time-sharing. The multiplexor shares the channel by repeatedly allowing each data stream in turn to transmit data for a short period. PDH and SDH are examples of systems that employ TDM.
Telecoms provider	An organisation which provides an electronic communications network or provides an electronic communications service.
Temporary Conditions	The temporary regulation Ofcom imposed in business connectivity markets in November 2017 to safeguard competition and protect the interests of consumers until the new analysis is complete. The Temporary Conditions Statement, including associated Annexes, published by Ofcom on 23 November 2017 imposed the temporary conditions.
The Act	The Communications Act 2003.
TI (Traditional Interface)	Leased lines services with an ITU G.703 Interface.
Time-limited discount	A temporary reduction in the charge for a service. After a certain period of time, the relevant charge is set back to its original level (before the change was implemented). These are marketed as 'Special Offers.'
TISBO (Traditional Interface Symmetric Broadband Origination)	Leased line terminating segment with an ITU G.703 interface. Referred to in the 2016 BCMR.
TMR (Total Market Return)	TMR includes interest, capital gains, dividends and distributions derived from an investment over a given period of time, as opposed to just capital gains.
TPI (Tender Price Index)	A national index that measures tender prices charged for construction work.
TRC (Time-Related Charge)	A charge raised by Openreach to recover costs incurred when Openreach engineers perform work not covered under the terms of the Openreach standard service.
Tribunal	The Competition Appeal Tribunal.

TTP (Time To Provide)	How long it takes Openreach to deliver an Ethernet circuit following acceptance of a customer's order.
UKRN	UK Regulators Network.
Upper percentile	A QoS standard intended to protect customers whose orders fall into the 'tail' of complex orders from suffering excessively long lead times for Ethernet provisioning.
VHB (Very High Bandwidth)	Bandwidths above 1 Gbit/s, normally used when referring to CI services.
VLB (Very Low Bandwidth)	Bandwidth below 2 Mbit/s, normally used when referring to TI services.
VOA (Valuation Office Agency)	An executive agency of HM Revenue & Customs (HMRC). Amongst other functions, it compiles and maintains the business rating and council tax valuation list for England and Wales.
VPN (Virtual Private Network)	A technology allowing users to make inter-site connections over a public telecommunications network that is software partitioned to emulate the service offered by a physically distinct private network.
VULA (Virtual Unbundled Local Access)	A regulatory obligation requiring BT to provide access to its FTTC and FTTP network deployments which allows telecoms providers to connect at a local aggregation point and are provided a virtual connection from this point to the customer premises.
WACC (Weighted Average Cost of Capital)	The rate that a company is expected to pay on average to all its security holders, both debt and equity, to finance its assets.
WAN (Wide Area Network)	A geographically dispersed telecommunications network, typically a corporate network linking multiple sites at different locations.
WBA (Wholesale Broadband Access) market	The WBA market concerns the wholesale broadband products that telecoms providers provide for themselves and sell to each other.
WES (Wholesale Extension Service)	A legacy Openreach Ethernet service that can be used to link customer site to a node in a communications network, superseded by Openreach' EAD product.
WEES (Wholesale end-to-end service)	A legacy Openreach Ethernet service that can be used to provide a point-to-point connection between two customer's sites, superseded by Openreach' EAD product.
WDM (Wavelength Division Multiplex)	An optical frequency division multiplexing transmission technology that enables multiple high capacity circuits, to share an optical fibre pair by modulating each on a different optical wavelength.
WiFi	A short range wireless access technology that allows devices to connect to the internet. These technologies allow an over-the-air connection

	between a wireless client and a base station or between two wireless clients.
WLA (Wholesale Local Access) market	The market that covers fixed telecommunications infrastructure, specifically the physical connection between customers' premises and a local exchange.
WLR (Wholesale Line Rental)	The service offered by Openreach to other telecoms providers to enable them to offer retail line rental services in competition with BT's own retail services.