Business Connectivity Market Review

Review of retail leased lines, wholesale symmetric broadband origination and wholesale trunk segments

Redacted for publication ✂

Statement

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Contents

Section 1

Summary

Introduction

1.1 This Statement sets out decisions designed to address concerns we have identified about the extent of competition in the provision of leased lines in the UK.

1.2 Leased lines provide dedicated symmetric transmission capacity between fixed locations, and their overall value exceeds £2bn per annum in the UK. They play an important role in business communications services and are used to support a wide variety of applications, both in the private and public sectors. They also play a significant role in delivering fixed and mobile broadband services to consumers, because communications providers (CPs) use them extensively in their networks.

1.3 BT remains by far the largest wholesale supplier of leased lines in the UK. For illustrative purposes, if we consider all wholesale circuits, we estimate that BT has a share of 82% of volumes. The majority of CPs remain reliant on BT's network in providing services to their customers.

1.4 Our decisions are designed to promote competition in the provision of leased lines and the services which use them, and will affect the availability, choice, price, quality and value for money of data-transfer services throughout the UK. They are therefore important in furthering the interests of citizens and consumers.

Key trends in the market

1.5 The demand for leased lines bandwidth has increased steadily in the last few years, driven by sustained increases in both the penetration and the speed of business and consumer data services. Adoption of remotely hosted computing applications (often known as 'cloud computing'), growing consumption of video content, and the rapid growth of e-commerce and of internet applications have all added to businesses' bandwidth demands. At the same time, providers of consumer broadband services, both fixed and mobile, have required steadily increasing bandwidth to support the growth in traffic from their end-users.

1.6 Looking forward, the growth in demand for leased lines capacity seems set to continue as businesses demand more bandwidth, and as providers of mass market broadband services invest in fixed super-fast services and mobile next-generation (4G) services.

1.7 Modern technologies are driving down the unit costs of leased lines bandwidth. The number of services which use legacy time-division multiplex (TDM) technologies has been declining, although they still account for most installed leased lines. Modern Ethernet transmission equipment is now preferred in most new installations because it costs less and supports higher bandwidths.

1.8 The trend to lower unit costs is particularly evident in the increasing adoption of wavelength-division multiplex (WDM) technology. This technology can multiply by several times the bandwidth transmissible in an optical fibre. WDM equipment allows CPs to aggregate traffic from different services and to use optical fibres efficiently in the core of their networks as demand for bandwidth continues to increase. CPs are

also deploying WDM equipment increasingly at their customers' premises if very high bandwidths are required.

The market review process

1.9 We review competition in some communications markets periodically, in accordance with the EU regulatory framework which is implemented in the UK by the Communications Act 2003 as amended (the Act). Our review process involves three analytical stages. First, we define each relevant market in terms of its products and geographic scope. Then we assess whether any CP has a position of significant market power (SMP) in any of the relevant markets, which means an undertaking enjoying a position of economic strength affording it the power to behave to an appreciable extent independently of competitors, customers and ultimately consumers. As part of our SMP assessment we consider how competitive conditions may change over a forward-look period, which, in this review, we have taken as three years. Finally, we assess which regulatory remedies we should impose to address competition concerns that arise from any SMP we find.

1.10 We last reviewed these markets in 2007/8 (the 2007/8 Review), and set out our findings in statements published in December 2008 and February 2009.[1,2]

Consultations and sources of information

1.11 Before starting our substantive analysis in this review, we published a Call for Inputs (CFI) in April 2011 to gather stakeholders' views on the key aspects of the review such as market definition, SMP assessment and remedies. [3,4]

1.12 We then conducted market research, held extensive discussions with industry stakeholders and user groups, and analysed data which CPs provided in response to our formal requests for information. We have also reviewed relevant publicly-available information.

1.13 We set out the provisional conclusions of our market review in two consultations in summer 2012.The first, published in June 2012 (the June BCMR Consultation)[5] set out our provisional findings and proposals to address the concerns we have identified about the extent of competition in the provision of leased lines in the UK. The second published in July 2012 (the LLCC Consultation) [6] covered our proposals to apply charge controls to certain services provided by BT in these markets.

1.14 After reviewing the responses to the June BCMR Consultation and further discussions with industry stakeholders, we issued a further consultation in November 2012 (the November BCMR Consultation) in which we proposed some changes to our proposals.[7] This Statement incorporates our consideration of responses to the June BCMR Consultation, the LLCC Consultation and the November BCMR Consultation.

[1] http://stakeholders.ofcom.org.uk/binaries/consultations/bcmr08/summary/bcmr08.pdf

[2] http://stakeholders.ofcom.org.uk/binaries/consultations/bcmr08/statement/statement.pdf

[3] http://stakeholders.ofcom.org.uk/consultations/bcmr-inputs/?a=0

[4] Annex 1 lists the respondents.

[5] http://stakeholders.ofcom.org.uk/consultations/business-connectivity-mr/

[6] http://stakeholders.ofcom.org.uk/consultations/llcc-2012/

[7] http://stakeholders.ofcom.org.uk/consultations/bcmr-reconsultation/

1.15 On 21 February 2013, we notified our draft Statement containing our provisional conclusions on market definitions, market power determinations and remedies for EU consultation to the European Commission (Commission), BEREC and national regulatory authorities of other Member States. In its decision letter of 21 March 2013, the Commission made two comments on the draft Statement, but it did not raise any concerns about our measures.[8]

Summary of our decisions

Retail product market definitions

1.16 We have defined a new product market for very high bandwidth services, and refer to it as 'Multiple Interface' or 'MI' leased lines. This market includes services with bandwidths greater than 1Gbit/s and services of any bandwidth delivered with WDM equipment at customers' premises. In the 2007/8 Review, we did not define a market for such services. Since then, the cost premium associated with WDM equipment has eroded and many major CPs now use WDM to provide high-bandwidth services.

1.17 In other respects, our retail product market definitions are similar to those identified in the 2007/8 Review. We recognise the growing capabilities of current generation asymmetric broadband services and the advent of super-fast broadband, but do not consider, based on our analysis, that leased lines and broadband services are in the same economic market. We also continue to distinguish between services presented to the end-user with traditional interface (TI) technologies, either TDM or analogue, and those with alternative interfaces (AI), mainly Ethernet. While there is migration from TI to AI products, the evidence on relative pricing and patterns of demand suggests that they are not sufficiently close substitutes for us to consider them as parts of the same economic markets. Similar distinctions lead us to define separate markets for TI products at different bandwidths. We summarise below the product markets we believe can be identified at the retail level generally.

Retail leased lines product market definition[9]

Service interface	**Retail product markets and bandwidth breaks**				
Traditional (TI)	**TI very low bandwidth**: below 2Mbit/s	**TI:** from 2Mbit/s up to and including 8Mbit/s	**TI medium bandwidth**: Above 8Mbit/s up to and including 45Mbit/s	**TI high bandwidth**: Above 45Mbit/s up to and including 155Mbit/s	**TI very high bandwidth**: 622Mbit/s
Alternative (AI)	**AI low bandwidth** - Up to and including 1Gbit/s				
Multiple (MI)	**MI** – services with bandwidth greater than 1Gbit/s, and services of any bandwidth delivered with WDM equipment at customers' premises.				

1.18 In the June BCMR Consultation we defined a retail market for low bandwidth TI services at bandwidths up to 8Mbit/s. After further analysis, we have revised our definition as shown above and now define a retail market for very low bandwidth TI services at bandwidths below 2Mbit/s and a retail market for TI services at bandwidths from 2Mbit/s up to and including 8Mbit/s.

[8] See Annex 4 about the EU consultation.

[9] In the presence of wholesale regulation.

1.19 In light of our analysis of the geographic scope and of the corresponding wholesale markets (see below), we have identified the retail market for TI very low bandwidth leased lines in the UK (excluding the Hull area) as susceptible to SMP regulation. We did not identify any other retail markets outside the Hull area as susceptible to SMP regulation, because we consider that addressing any competition concerns in the wholesale markets which we have identified for AI, MI and higher-bandwidth TI leased lines will address any concerns in the corresponding retail markets.

1.20 In the Hull area, we have identified two separate retail markets as susceptible to SMP regulation: one for TI low-bandwidth leased lines (up to and including 8Mbit/s) and the other for AI low-bandwidth leased lines. We consider that addressing any competition concerns in the wholesale markets for higher-bandwidth TI leased lines in the Hull area will address any concerns in the corresponding retail markets. No MI leased lines services are currently supplied in the Hull area.

Wholesale market definitions

1.21 In many respects our wholesale market definitions reflect those of the retail market. Our analysis also indicates that:

- combined markets exist for wholesale access and backhaul products, particularly because, in general, CPs are likely to continue to purchase access and backhaul together. These markets are referred to as TI Symmetric Broadband Origination (TISBO), AI Symmetric Broadband Origination (AISBO) and MI Symmetric Broadband Origination (MISBO);

- wholesale services used to provide backhaul for Local Loop Unbundling (LLU) and Radio Base Station (RBS) services still fall within the markets for wholesale symmetric broadband origination; and

- the bandwidth breaks we define for TI and AI retail services are mostly applicable to the wholesale markets.

1.22 The main differences between our analysis now and that of the 2007/8 Review are:

- There are separate markets for regional and national TI trunk connectivity. In our previous review of the market we defined a single TI trunk market. We now consider that the characteristics of the regional trunk market are very similar to those of symmetric broadband origination, and are significantly different from those of national trunk routes.

- Consistent with our view in relation to the retail market, we are defining a wholesale MI market which includes any service faster than 1Gbit/s and any service delivered with WDM equipment at the customers' premises, irrespective of bandwidth and interface.

Wholesale product market definition

	Product markets			
Traditional Interface Symmetric Broadband Origination (**TISBO**)	**Low bandwidth TISBO**: <= 8Mbit/s	**Medium bandwidth TISBO**: >8Mbit/s, <=45Mbit/s	**High bandwidth TISBO**: >45Mbit/s, <=155Mbit/s	**Very high bandwidth TISBO**: 622Mbit/s
Alternative Interface Symmetric Broadband Origination (**AISBO**)	**Low bandwidth AISBO**: <=1Gbit/s			
Multiple Interface Symmetric Broadband Origination (**MISBO**)	**MISBO:** >1Gbit/s irrespective of interface, and services of any bandwidth delivered with WDM equipment at customers' premises			
Trunk / core connectivity	**TI regional trunk** at all bandwidths			
	TI national trunk at all bandwidths			
	National core conveyance at all bandwidths			

1.23 We have determined that separate geographic markets exist (i) in the Hull area for all wholesale leased lines, and (ii) in a defined area of London and including Slough (the Western, Eastern and Central London Area, or WECLA) for all the defined wholesale symmetric broadband origination product markets other than the low bandwidth (up to and including 8Mbit/s) and very high bandwidth (622Mbit/s) TISBO markets. We summarise below the wholesale markets we have defined (both product and geographic), each of which is susceptible to SMP regulation.

Wholesale symmetric broadband origination market definitions

Product market		Geographic markets		
TISBO	Low bandwidth <= 8Mbit/s	The UK excluding the Hull area		The Hull area
	Medium Bandwidth >8Mbit/s, <=45Mbit/s	The UK excluding the WECLA and the Hull area	The WECLA	The Hull area
	High bandwidth >45Mbit/s, <=155Mbit/s	The UK excluding the WECLA and the Hull area	The WECLA	The Hull area
	Very high bandwidth 622Mbit/s	The UK excluding the Hull area		The Hull area
AISBO	Low bandwidth <=1Gbit/s	The UK excluding the WECLA and the Hull area	The WECLA	The Hull area
MISBO	>1Gbit/s, and any services with WDM equipment at customers' premises	The UK excluding the WECLA and the Hull area	The WECLA	The Hull area

1.24 Our analysis has not found separate geographic markets in any other parts of the UK for any wholesale services.

Market power assessment

Overview of SMP findings

1.25 We summarise below our market power determination for each relevant market or, as the case may be, our finding that the market in question is effectively competitive.

Overview of SMP findings

<table>
<tr><th colspan="2" rowspan="2"></th><th colspan="2">Retail Services</th><th colspan="3">Wholesale Segments</th></tr>
<tr><th colspan="3">Symmetric Broadband Origination</th><th>Trunk</th></tr>
<tr><th>Interface technology</th><th>Bandwidth (Mbit/s)</th><th>UK</th><th>Hull</th><th>The WECLA</th><th>UK except the WECLA and Hull</th><th>Hull</th><th>UK</th></tr>
<tr><td rowspan="4">Traditional (TI)</td><td>V Low: <2</td><td>BT</td><td rowspan="2">KCOM</td><td colspan="2" rowspan="2">BT</td><td rowspan="2">KCOM</td><td rowspan="5">National
No SMP

Regional
BT</td></tr>
<tr><td>Low: <=8</td></tr>
<tr><td>Med: >8, <=45</td><td></td><td>No SMP</td><td>BT</td><td>KCOM</td></tr>
<tr><td>High: >45, <=155</td><td></td><td>No SMP</td><td>BT</td><td>KCOM</td></tr>
<tr><td>Very High: 622</td><td></td><td colspan="2">No SMP</td><td>KCOM</td></tr>
<tr><td>Alternative (AI)</td><td>Low <=1,000</td><td></td><td>KCOM</td><td>BT</td><td>BT</td><td>KCOM</td><td></td></tr>
<tr><td>Multiple (MI)</td><td>>1,000, and any if WDM at customer's premises</td><td></td><td></td><td>No SMP</td><td>BT</td><td></td><td></td></tr>
</table>

Retail markets outside the Hull area

1.26 We have found that BT has SMP in the retail very low bandwidth TI market outside the Hull area for services at bandwidths below 2Mbit/s. BT continues to have a very high share (84%) of the supply of these services. In the light of this and the existence of barriers to entry and expansion, and taking into account that CPs are less likely to invest in this market since demand is declining, we found that BT has SMP in this market.

1.27 We consider that since the 2007/8 Review upstream wholesale remedies have stimulated competition for provision of 2Mbit/s retail digital services and consequently we have withdrawn ex ante regulation of these services.

Wholesale markets outside the Hull area

1.28 We have found little, if any, change in competitive conditions in wholesale TISBO markets, whose volumes, although significant, are declining rapidly. Having defined separate regional and national markets for TI trunk services, we found that BT does not have SMP in the national trunk market. We summarise below the markets we have identified at the wholesale level outside Hull and whether or not we have found SMP in them.

SMP findings for the TI wholesale markets in the UK excluding the Hull area

Product market	Geographic scope	SMP designation now	SMP designation in 2007/8 Review
Low bandwidth TISBO (<=8Mbit/s)	**UK excluding the Hull area**	BT	BT
Medium bandwidth TISBO (>8Mbit/s, <=45Mbit/s)	**UK excluding the Hull area & the WECLA**	BT	BT*
	The WECLA	No SMP	No SMP*
High bandwidth TISBO (>45Mbit/s, <=155Mbit/s)	**UK excluding the Hull area & the WECLA**	BT	BT*
	The WECLA	No SMP	No SMP*
Very high bandwidth TISBO 622Mbit/s)	**UK excluding the Hull area**	No SMP	No SMP
Wholesale national TI trunk segments	**UK excluding the Hull area**	No SMP	BT**
Wholesale regional TI trunk segments	**UK excluding the Hull area**	BT	

** These relate to the market power designations in 2008 for UK excluding the Central and East London Area (CELA) and Hull, and for CELA.*
** *Ofcom defined a single trunk market in 2008 and found BT to have SMP.*

1.29 In the case of wholesale AI terminating segments (AISBO services) at bandwidths at or below 1Gbit/s, similar to our last market review, we found that BT has SMP in the UK excluding the Hull area and the WECLA. We consider that outside the WECLA and the Hull area, despite growing CP investment, BT's 74% share by volume has changed little since the 2007/8 Review. We believe that these circumstances are not likely to change over the forward-look period of this review. The costs of digging trenches and building duct network are unlikely to reduce significantly, and the ubiquity of BT's network means that other CPs will continue to incur higher average costs than BT to serve new customers.

1.30 In the WECLA, our analysis shows that there has been more infrastructure investment than in the rest of the UK. However, despite extensive alternative network infrastructure and despite strong growth in demand, BT has maintained its competitive position since the last market review with a volume share that we estimate to be in the range 45%-55%. Taking into account this estimate as well as other relevant criteria in assessing the economic characteristics of the market, while we have concluded that BT has SMP in the WECLA, we believe that the prospects for competition are more favourable there than elsewhere in the UK.

1.31 We have also concluded that BT has SMP in the wholesale MI (MISBO) market in the UK excluding the Hull area and the WECLA. Demand for services faster than 1Gbit/s has been growing very fast since the last review. We believe that circuit volumes have increased more than threefold since 2006/07, and we expect that this rate of growth will continue throughout the coming review period. We estimate that BT's share of volumes is 57%, and we are confident that it exceeds 50%. The market

appears to be highly concentrated, with BT supplying more than six times the volumes of the second largest provider. Whilst the high growth and high average revenue per customer suggest that the prospects for competitive entry in this market may be favourable, BT derives a strong advantage from the ubiquity of its network.

Retail markets in the Hull area

1.32 We have found that KCOM has SMP in the retail TI low bandwidth (<=8Mbit/s) market and the retail AI low bandwidth (<=1Gbit/s) market in the Hull area. In the 2007/8 Review we found that no operator had SMP in either of these markets.

1.33 We now believe that our finding in the 2007/8 Review that KCOM did not have SMP in the retail TI low bandwidth market was based on incomplete submissions from KCOM, which resulted in a significant understatement of its shares of the retail (and wholesale) markets. Our estimate of KCOM's share of the retail low bandwidth TI market of 78% is very similar to our estimate for the 2003/04 Review. Therefore, we now believe that KCOM's share is both high and relatively stable over time.

1.34 The retail TI low bandwidth (<=8Mbit/s) market in Hull is small and declining. We therefore consider that there is little prospect of increased competition during this review period. Overall, we consider that even though a regulated wholesale input is available, KCOM is unlikely to be effectively constrained by competitors in the retail market, and therefore has SMP.

1.35 In the retail AI low bandwidth (<=1Gbit/s) market in Hull we consider, in particular, that KCOM has a very high share and that, even though the market is growing, it does not offer sufficient potential for growth to attract significant new competitive entry.

Wholesale markets in the Hull area

1.36 We have concluded that KCOM has SMP in all wholesale markets in the Hull area with the exception of MISBO, in which no services are currently supplied. Our findings are consistent with the conclusions of the 2007/8 Review.

1.37 We have concluded that KCOM has SMP because there is almost no alternative fixed network infrastructure in the Hull area, and KCOM's share in each of the markets is at, or very close to, 100%. Although there has been very recent entry into the market by MS3 Communications, which is building a network in the Hull area, we consider it unlikely that this will represent a sufficient constraint at the majority of business premises in Hull to constrain KCOM's behaviour over the course of the three year review period.

SMP findings for wholesale markets in Hull

Product market	SMP designation	SMP designation in 2007/8 Review
Low bandwidth TISBO (<=8Mbit/s)	KCOM	KCOM
Medium bandwidth TISBO (>8Mbit/s, <=45Mbit/s)	KCOM	KCOM
High bandwidth TISBO (>45Mbit/s, <=155Mbit/s)	KCOM	KCOM
Very high bandwidth TISBO (622Mbit/s)	KCOM	No SMP
Low bandwidth AISBO (<=1Gbit/s)	KCOM	KCOM
MISBO (>1Gbit/s)	No SMP	No SMP**

*** MISBO had not been defined in 2008. However, there was no SMP in relation to circuits above 1Gbit/s throughout the UK.*

SMP remedies

Overall approach

1.38 Our overall approach to remedies in leased lines markets is aimed primarily at promoting competition in the long term at the wholesale level based on investment in economically efficient alternative infrastructure, and supplemented by seeking to ensure that CPs can compete effectively elsewhere in downstream markets by using regulated access to BT's, and KCOM's (in the Hull area), wholesale services. This approach is designed to ensure that CPs can compete effectively in providing services downstream of the relevant wholesale leased lines market anywhere in the UK. However, we consider that some regulation to ensure the provision of retail leased lines remains necessary as part of our overall approach.

1.39 CPs often rely heavily on BT's regulated wholesale leased lines services throughout the UK except the Hull area, and on those of KCOM in the Hull area. Having considered appropriate SMP remedies in this review, we have imposed regulations designed to ensure, amongst other things, that BT and KCOM continue to provide such services.

Passive remedies

1.40 We have also considered the case for imposing an alternative or additional set of requirements known as passive remedies, such as requiring BT to provide access to its ducts, poles or dark fibre. We have decided not to impose such passive remedies.

1.41 We recognise that it is possible that the imposition of passive remedies in leased lines could support competition in downstream markets. However, imposition of passive remedies is likely to be inconsistent with important aspects of the package of remedies which we are imposing, including the form of the charge controls. We therefore needed to decide which of the two alternative approaches is likely to be more consistent with securing or furthering our statutory duties.

1.42 We have considered the potential benefits that imposition of passive remedies could deliver. Some CPs have argued, for example, that the pace of innovation could be increased in some parts of the market. However, it is not clear to us that the competition issues we have identified in leased lines would be addressed more effectively in the round by the imposition of passive remedies than by our current

approach to remedies. Our analysis suggests that the specific benefits put forward by stakeholders of imposing passive remedies could, to a large extent, be achieved by imposing alternative remedies such as price controls on BT's provision of wholesale leased lines services. At the same time, we consider there are significant risks that the imposition of passive remedies could lead to worse outcomes for consumers and for competition.

1.43 Facilitating the transition from the current regulatory regime to one where competition based on passive remedies is sustainable and effective would require a significant degree of regulatory support and intervention and, potentially, changes to the definition of the regulatory boundaries and role of Openreach.

1.44 At present we have seen no evidence that any CPs would invest substantially in infrastructure based on passive remedies if we were to impose them in leased lines markets. Furthermore, we have seen no evidence that imposing passive remedies in leased lines markets would, as some stakeholders have claimed, unlock significant new investments in fixed next-generation access (NGA) infrastructure for consumer superfast broadband services.

1.45 In conclusion, while imposition of passive remedies is likely to require significant regulatory changes and intervention, and we would therefore need clear evidence to persuade us that this would be justified, it is not clear at present that imposing passive remedies would lead to better market outcomes in the round than the package of remedies we have decided to impose. We have therefore decided not to impose passive remedies.

Retail very low bandwidth TI services outside the Hull area

1.46 In relation to retail markets, we have had regard to the fact that these are not included in the list of markets in the EC's Recommendation in which, at the European level, *ex ante* regulation is likely to be required.[10] We have therefore applied the so-called 'three criteria test' to assess whether such regulation is appropriate to national circumstances in the UK, and consider that the three criteria are cumulatively satisfied in relation to the retail market for services at bandwidths below 2Mbit/s (very low bandwidth TI services) in the UK (outside the Hull area).

1.47 In light of our revised market definition, retail services at 2Mbit/s or above fall outside the market. Consequently we are removing all *ex ante* obligations on BT concerning the provision of these retail services.

1.48 BT intends to withdraw services at bandwidths below 2Mbit/s, including some analogue services (i.e. those within the revised market definition) by no later than March 2018. In the interim, we are concerned to ensure that CPs and end users will have certainty of continuing supply, appropriate notice of retirement dates of services, protection from potentially excessive pricing and protection from the risk that groups of customers will be subject to undue discrimination.

1.49 The table below summarises the remedies we have decided to impose on BT in order to address these concerns.

[10] Commission Recommendation of 17 December 2007 on relevant products 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.

Overview of SMP remedies in the retail very low bandwidth TI market

Product type	Remedies
Analogue circuits	• Obligation to supply existing services, with at least a year's notice of withdrawal • Obligation not to discriminate unduly • Requirement to publish a reference offer, including prices, terms and conditions • Cost accounting obligations • Safeguard cap on retail prices
Sub 2Mbit/s digital circuits	• Obligation to supply existing services, with at least a year's notice of withdrawal • Obligation not to discriminate unduly • Requirement to publish a reference offer, including prices, terms and conditions • Cost accounting obligations
2Mbit/s and 8Mbit/s digital circuits	None - Under our revised market definition these services fall outside the scope of the market and we are therefore removing all ex-ante regulation

Wholesale TI markets in which we have found that BT has SMP

1.50 As with retail markets, we have noted that TI regional trunk segments are not included in the list of markets in the EC's Recommendation in which, at the European level, *ex ante* regulation is likely to be required. We have therefore applied the three criteria test to assess whether such regulation is appropriate to national circumstances in the UK, and consider that the three criteria are cumulatively satisfied in relation to this market.

1.51 We have found that BT has SMP in the wholesale markets for low bandwidth TISBO in the UK excluding the Hull area and for TI regional trunk segments of leased lines in the UK. We have also found that BT has SMP in the medium and high bandwidth TISBO markets in the UK excluding the Hull area and the WECLA. The state of competition in these markets broadly mirrors that of our previous market review. We have therefore decided to maintain the same set of SMP regulations that are in place today including the existing PPC and RBS Backhaul directions.

Overview of SMP remedies imposed on BT in the wholesale TI markets

- Requirement to provide network access on reasonable request including an obligation to offer fair and reasonable charges, terms and conditions
- Requirement not to discriminate unduly
- Requirement to publish a reference offer
- Requirement to notify changes to prices, terms and conditions (28 days notice for new services and price reductions, 90 days for all other notifications)
- Requirement to publish quality of service information as required by Ofcom
- Requirement to notify changes to technical information with 90 days notice
- Accounting separation and cost accounting obligations
- Requirements relating to requests for new network access
- Charge control
- A direction under the network access obligation requiring BT to provide Partial Private Circuits
- A direction under the network access obligation requiring BT to provide RBS Backhaul
- Requirements to provide accommodation in BT exchanges and to provide specific types of interconnection service:
    - Customer Sited Handover
    - In Span Handover
    - In Span Handover extension
    - In Building Handover

Wholesale AISBO markets in which we have found that BT has SMP

1.52 We have decided to impose new controls on BT's charges for wholesale AISBO services. A separate control will apply in each of the two geographic markets – one within the WECLA and the other outside it (except the Hull area) – which we identified for these products. The charges subject to the controls will include those for wholesale AISBO products and for ancillary services reasonably required, such as interconnection, accommodation and excess construction.

1.53 Our charge controls take into account that the prospects that competition in the provision of wholesale AISBO services will become effective beyond the forward-look period of this review are more favourable in the WECLA than elsewhere in the UK.

1.54 In all other respects, the remedies for the two geographic markets which we have identified outside Hull are identical. They are summarised in the table below.

Overview of remedies for wholesale AISBO services (both within the WECLA and elsewhere in the UK except the Hull area)

- Requirement to provide network access on reasonable request, including an obligation to fair and reasonable charges, terms and conditions and also including (without prejudice to the generality of the network access requirement)
  - disaggregated Ethernet access and backhaul;
  - end-to-end Ethernet products
- Requirement not to discriminate unduly
- In addition, a requirement to provide network access on the basis of Equivalence of Inputs (except for certain specified exceptions including accommodation services)
- Requirements relating to requests for new network access
- Requirement to publish a reference offer
- Requirement to notify changes to charges and to terms and conditions (28 days notice for new services and price reductions, 90 days for all other notifications)
- Requirement to notify technical information
- Requirement to publish quality of service as required by Ofcom
- Accounting separation and cost accounting obligations
- Charge controls – separate controls to apply within and outside the WECLA
- Requirement to provide accommodation in BT exchanges and to provide specific types of interconnection service:
  - Customer-sited handover
  - In-building handover
- A direction under the network access obligation relating to service-level guarantees

1.55 Since we concluded the 2007/8 Review there have at times been differences in view between BT and CPs as to how BT should comply with its obligations in the market for wholesale low bandwidth AISBO. In imposing remedies in this review we have therefore sought to achieve greater certainty. In particular, we have:

- required BT to provide network access on the basis of equivalence of inputs (EOI) excluding any network access which BT is not providing on an EOI basis at 31 March 2013.[11] We have concluded that the EOI requirements should extend to BT's allocation of accommodation and power to CPs in its exchanges, but not to other aspects of provision of accommodation services or to interconnection services;

- specified explicitly that BT's wholesale Ethernet products must include separate access and backhaul services; and

- clarified the definitions of trunk segments and terminating segments in the AI markets.

1.56 We have also clarified that Openreach should process requests to develop products in accordance with the SMP condition which regulates new network access, and not in accordance with its own commercial process.

[11] Equivalence of inputs is 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 CPs 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 to all CPs (including BT) of the same commercial information about such products, services, systems and processes.

The wholesale MI market in which we have found that BT has SMP

1.57 We have not regulated this market under the EC Framework until now, although BT has, in Undertakings it agreed with us under the Enterprise Act, committed to provide wholesale services in this market on the basis of equivalence of inputs (EOI).[12] We summarise in the table below the remedies we have decided to impose in this market.

Remedies imposed on BT for the wholesale MI services outside the WECLA

- Requirement to provide network access on reasonable request, including an obligation to offer fair and reasonable charges, terms and conditions and also including (without prejudice to the generality of the network access requirement):
  - disaggregated single-service Ethernet access and backhaul;
  - end-to-end single-service Ethernet products
  - end-to-end and backhaul services with WDM equipment at the customer's premises
- Requirement not to discriminate unduly
- In addition, a requirement to provide all network access on the basis of Equivalence of Inputs (except for certain specified exceptions including accommodation services)
- Requirements relating to requests for new network access
- Requirement to publish a reference offer
- Requirement to notify changes to charges and to terms and conditions (28 days notice for new services and price reductions, 90 days for all other notifications)
- Requirement to notify technical information
- Requirement to publish quality of service as required by Ofcom
- Accounting separation and cost accounting obligations
- Charge control on single-service Ethernet products
- Requirement to provide accommodation in BT exchanges and to provide specific types of interconnection service:
  - Customer-sited handover
  - In-building handover

1.58 We recognise that CPs which invest in physical infrastructure compete with BT in this wholesale market, and that such competition could be sustainable, both because demand is growing and because the value of MI services is relatively high. We want to maintain their incentives to do so and yet protect consumers from the risk of excessive prices.

1.59 While most MI services are delivered by installing WDM equipment at customers' premises, WDM technology is still evolving rapidly, and we have not imposed price controls on BT's WDM-based wholesale products in this market. However, we have imposed a charge control on BT's wholesale single-service Ethernet products. We consider that imposing such a control is likely to maintain CPs' incentives to invest in physical infrastructure, while applying appropriate constraints on BT's ability to charge high prices.

1.60 At the same time, we want to promote greater competition by supporting development of solutions that could enable CPs to deliver WDM-based services by interconnecting their own core networks with BT's ubiquitous access to end-users' premises. Until recently, BT's WDM-based wholesale MI products only supported connectivity entirely over BT's physical infrastructure from end to end, and could not

[12] With the exception of WDM services longer than 70km where BT currently is exempted from providing services on an EOI basis.

support interconnection effectively. BT has recently launched product variants which may support such interconnection, but it is too early to tell if those product variants will enable effective interconnection solutions.

1.61 Currently, BT has no need to consume the variants which could support interconnection. We consider that this gives BT the ability to discriminate between its competitors and its own downstream divisions in providing those variants. Noting that those variants are very similar to BT's other WDM-based wholesale MI products, we have concluded that:

a) in relation to matters other than price, BT should provide the interconnection variants of its WDM-based wholesale MI products on the basis of EOI with its other WDM-based wholesale MI products; and

b) BT should not discriminate unduly between the prices it charges for the variants of its products, which means that the difference in price between variants of the same product which do and do not support interconnection, and are of the same radial distance, should be no greater than the difference between their long-run incremental costs.[13]

1.62 We are also imposing a set of obligations on BT in relation to accommodation and other interconnection services which would support the remedies we have imposed for this market.

Retail markets in the Hull area in which we have found that KCOM has SMP

1.63 As noted above, the retail markets for TI low-bandwidth and AI low-bandwidth leased lines are not included in the list of markets in the EC's Recommendation in which, at the European level, *ex ante* regulation is likely to be required. We have therefore applied the three criteria test to assess whether such regulation is appropriate to national circumstances in the UK, and consider that the three criteria are cumulatively satisfied in relation to these markets.

1.64 As there is very little competition in the retail low bandwidth TI and AI markets in the Hull area, our aim is to ensure that consumers have certainty of supply, are protected from exploitation through high prices and that there is no undue discrimination between different classes of customer. In imposing remedies on KCOM we have sought to achieve this aim while taking into account the relatively small scale of the market in the Hull area. We summarise them in the table below.

Remedies imposed on KCOM for retail low bandwidth TI services and AI services in the Hull area

• Requirement to supply retail leased lines • Obligation not to discriminate unduly • Requirement to publish a reference offer

1.65 Whilst we are not imposing a control on KCOM's retail charges, we would expect those charges to align with a reasonable benchmark of competitive charges. We consider that a suitable candidate for such a benchmark would be KCOM's

[13] The charge for the variant which supports interconnection is expected to be higher than the variant which does not support interconnection for a given radial distance.

wholesale charges with a reasonable allowance for gross retail margin. We have also decided to require KCOM to publish maximum prices to facilitate monitoring.

1.66 We have decided that KCOM should be allowed to offer bespoke pricing as long as prices are not unduly discriminatory and do not exceed the prices set out in its published reference offer.

Wholesale markets in the Hull area in which we have found that KCOM has SMP

1.67 During the forward-look period of this market review we foresee limited scope for competitive entry even in the fast growing AISBO market. However, to the extent that CPs require wholesale services in Hull to fulfil the requirements of customers outside Hull who may require connectivity in Hull (e.g. for branch offices), we consider it important that CPs are assured of access to wholesale services on non-discriminatory terms and of protection from excessive pricing. We have imposed substantially the same SMP obligations on KCOM as we did in the previous market review.

Remedies imposed on KCOM in wholesale TI and wholesale AI services in the Hull area

- Requirement to provide network access on reasonable request
- Obligation not to discriminate unduly
- Requirement to publish a reference offer
- Requirement to notify charges, terms and conditions
- Requirement to notify technical information
- Accounting separation obligation

1.68 Whilst we have not proposed to control KCOM's wholesale charges, we would expect those charges to align with a reasonable benchmark of competitive charges. KCOM has offered voluntary undertakings in relation to its wholesale prices, which we publish at Annex 11 to this Statement. We welcome these undertakings, which we think will provide stakeholders with valuable reassurance about leased line charges in Hull over the next three years.

1.69 We require KCOM to publish maximum prices to facilitate monitoring. We have also decided that KCOM will be allowed to offer bespoke pricing as long as prices are not unduly discriminatory and do not exceed the prices set out in its published reference offer.

Charge controls for BT's services

1.70 The previous charge controls expired on 30 September 2012. From 1 October 2012 BT has set charges in accordance with its voluntary commitments.[14] These voluntary commitments expire on 31 March 2013.

[14] See https://www.btwholesale.com/shared/document/CPL/ACCN_2011_july/accn_1150.rtf and http://www.openreach.co.uk/orpg/home/products/pricing/loadProductPriceDetails.do?data=bj1iagV2rmVhUxhJRV2ltZ6l6oCf3ew2ZeuZm4VRqG0lMnGHsqdC0vzO163bJmh34D91D7M0q8u%2F%0AIlSgtIFAKw%3D%3D

1.71 The charge controls set out in this Statement will commence on 1 April 2013 and last for three years. We considered that the duration of the charge controls should be consistent with the forward-look period used in our analysis.

Our approach to charge controls

1.72 In developing and designing our charge control we have had regard to a number of objectives[15], including:

- To ensure that the prices for wholesale leased lines services are not excessive and are broadly in line with the cost of provision. Wholesale prices for leased lines are likely to be reflected in retail prices. Excessive wholesale prices are likely to result in excessive retail prices, which would be to the detriment of consumers.

- We are seeking to promote efficiency and sustainable competition in the provision of wholesale leased lines services, as well as conferring the greatest possible benefit to end-users; in doing so we have also taken into account the extent of BT's investments. Through the structure of the charge control, it is possible to provide BT with the opportunity to make efficiency improvements. These improvements would also be in the interest of consumers, as they can ultimately share the benefits of greater efficiency.

1.73 We are introducing an RPI[16]-X type control for the main basket controls. This type of control aims to align prices with cost at the end of the charge control period (i.e. 2015/16). This approach has been widely used in the regulation of UK utilities, including those in the telecommunications sector. However, for AISBO services <=1Gbit/s in the WECLA, where the prospects that competition will become effective beyond the forward-look period of this review are more favourable than elsewhere in the UK, we follow a more deregulatory approach, with a 'safeguard cap'.

1.74 As with the previous leased lines charge controls, we will charge control TI services and Ethernet services in separate baskets. However, in contrast to the previous controls, we have incorporated some of the additional ancillary services in the main baskets, e.g., associated ancillary services and equipment. We apply a number of sub-caps on certain services, together with sub-baskets, where the overall basket cap may not offer sufficient protection to customers.

1.75 Overall, we consider that the charge controls are appropriate to secure or further our statutory duties, including ensuring that we further the interests of citizens and consumers in the relevant leased lines markets.

Summary of our conclusions for charge controls

1.76 We are implementing two separate service baskets for wholesale services:

i) TI – covering low, medium and high bandwidth services outside the WECLA, low bandwidth services within the WECLA and regional trunk services at all bandwidths.

[15] See Section 2.

[16] Retail Prices Index.

ii) Ethernet – covering services up to and including 1Gbit/s outside the WECLA and Ethernet services above 1Gbit/s outside the WECLA.

1.77 In addition, we are separately controlling excess construction charges (ECCs), accommodation services and AISBO services in the WECLA, covering AISBO services up to and including 1Gbit/s inside the WECLA.

1.78 Our controls for the TI basket and Ethernet basket are RPI+2.25% and RPI-11.50% respectively. These controls have changed from RPI+2.50% and RPI -11.0% respectively as set out in the draft Statement. These changes followed the announcement of the Budget 2013 by the Chancellor, resulting in a change of the tax rate used in our WACC calculation, and a correction of an error in our model impacting the calculation of Ethernet costs. In respect of the AISBO services up to and including 1Gbit/s in the WECLA, we are applying a safeguard cap of RPI-RPI on each relevant service.

1.79 For ECCs, we are implementing average starting charge adjustments of -29% and then a sub-cap of GBCI[17]-0% on each charge. For accommodation services, we concluded on a sub-cap of RPI-0% on each charge.

1.80 For TI retail analogue services we are imposing a safeguard cap, which is set at the same level as the overall TI basket of RPI+2.25%.

1.81 The table below summarises our conclusions.

Summary of charge controls imposed on BT

	Services within scope	Value of X	Sub baskets & Sub-caps*
TI basket	<u>Connection and rental charges for:</u> Wholesale low, medium and high bandwidth PPCs outside the WECLA Wholesale low bandwidth PPCs inside the WECLA Regional Trunk (all bandwidths) – rental only RBS, Netstream 16 Longline and SiteConnect TI equipment and infrastructure TI ancillary services(excluding ECCs) Interconnection services	RPI+2.25%	Point of Handover sub-basket (RPI-0%) RBS, Netstream 16 Longline and SiteConnect sub-basket (RPI+2.25%) Ancillary services, equipment and infrastructure sub-cap (RPI+2.25%) TI all services sub-cap (RPI+10%)

[17] General Building Cost Index.

Ethernet basket	<u>Connection and rental charges for:</u> Ethernet services (up to and including 1Gbit/s) outside the WECLA Ethernet services (above 1Gbit/s) outside the WECLA Ethernet ancillary services (excluding ECCs) Interconnection services	RPI-11.5%	Interconnection services sub-basket (RPI--11.5%) EAD 1 Gbit/s sub-basket (RPI-11.5%) Ethernet all services sub-cap (RPI-RPI)
Excess Construction Charges		GBCI-0% on each charge	
Accommodation services	Access Locate Administration Fee Cablelink	RPI-0% on each charge	
AISBO services in the WECLA	Wholesale low bandwidth AISBO services (up to and including 1Gbit/s) in the WECLA	RPI-RPI on each charge	
Retail Analogue basket	Rental charges	RPI+2.25%	Retail analogue sub-cap (RPI+10%)

*A sub-basket control applies to the weighted average value of revenues of services within the basket. This is in contrast to a sub-cap which applies to each charge.

1.82 We consider that these charge controls are sufficient to constrain BT's pricing. They will provide incentives to make efficiency improvements and are appropriate for achieving the other objectives pursued. We are therefore not imposing a cost orientation obligation in addition to these charge controls.

Section 2

Introduction

Scope and purpose of this review

2.1 This business connectivity market review (BCMR) considers the markets for:

- the retail provision of leased lines in the UK; and
- the wholesale provision of terminating segments and trunk segments in the UK.

2.2 When referring to these markets as a whole and in general terms we use the term 'the leased lines market' or 'the leased lines markets'.

2.3 The purpose of the BCMR is threefold:

i) to identify and define the relevant markets, appropriate to the national circumstances in the UK, under the regulatory framework harmonised across the EU;

ii) to determine whether or not any of the markets are effectively competitive. This involves assessing whether any operator has significant market power (SMP) in any of those relevant markets; and

iii) where there has been a finding of SMP, to assess the appropriate remedies which should be imposed, based on the nature of the competition problem(s) identified in the relevant markets or, where we determine that a market is effectively competitive, to remove regulation that currently applies to that market.

2.4 The market review process we followed is described in summary below, and in more detail in Annex 2.

2.5 The leased lines charge control (LLCC) forms part of the market review as a whole and falls under the third purpose, as set out above. Charge controls indeed form part of the appropriate remedies which will be imposed in some of the relevant markets to address the competition problems we have identified in those markets. While we have previously published separately the BCMR and the LLCC consultations, this Statement contains our conclusions on our entire review, including the charge controls.

Background

2.6 Leased lines provide dedicated transmission capacity between fixed locations, and are essential components of information and communications technology (ICT) services used by businesses. We estimate that the market at the wholesale level is worth more than £2bn per annum in the UK.

2.7 Many organisations, both in the private and public sectors, use leased lines to support a wide variety of ICT applications, such as access to the internet, private voice and data networks, backup and disaster recovery, remote monitoring and telemetry applications.

2.8 Leased lines are also used by communications providers (CPs) as components of consumer communication services, and hence play a significant role in determining the speed and cost of those services. For example, mobile network operators (MNOs) use large volumes of leased lines to carry mobile voice and data services between their radio base stations and switching centres; and providers of fixed broadband services use substantial volumes of leased lines to carry their customers' traffic between BT's local exchanges and their networks.

Market structure

2.9 The leased lines market is part of a complex value chain, with business ICT services downstream and physical network components upstream. End-user organisations engage with leased lines in a wide variety of ways, depending largely on the level of involvement they require in the engineering of the ICT services that they consume.

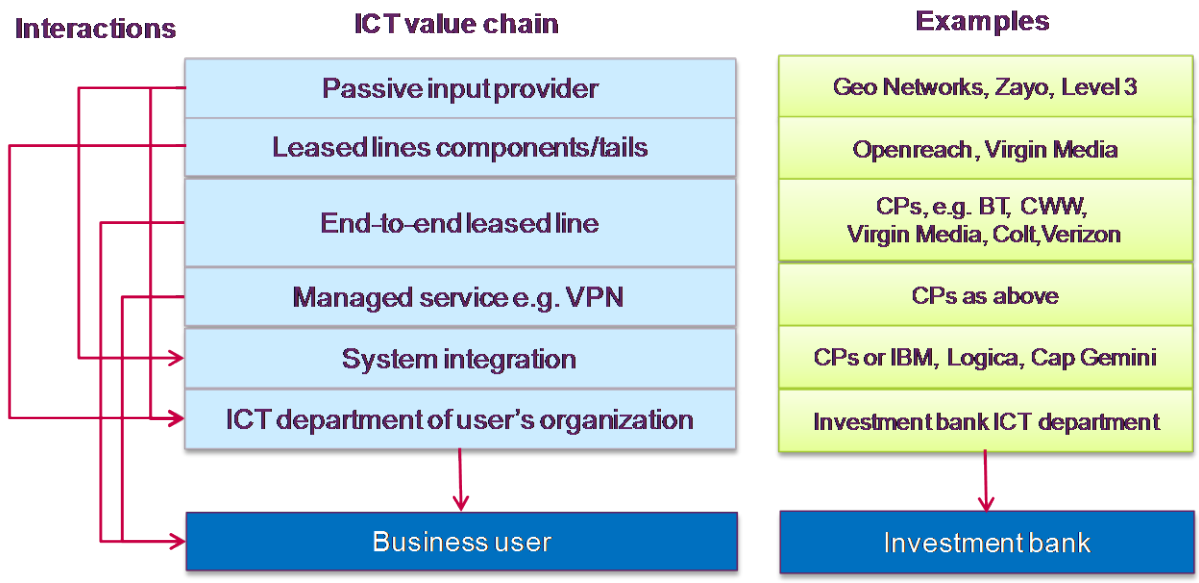
2.10 Many end-user organisations do not purchase leased lines as distinct services even though they might use them. For example, a business might have a turnkey contract with a systems integrator which provides and manages a corporate data network serving its offices. The systems integrator would, as part of the contract, purchase leased lines from a CP and use them to connect the offices together. The business would, in that case, not have a distinct contract in relation to those leased lines.

2.11 Other end-user organisations might purchase leased lines directly from CPs. For example, an operator of data centres, which house computer equipment hosting other companies' ICT applications, might purchase leased lines directly from a CP to connect its data centres together and/or to a carrier-neutral location to interconnect with the wider internet.

2.12 We also understand that, in some cases, end-user organisations fulfil some of their connectivity services by procuring access to a network operator's unlit optical fibres and using it to connect equipment in their sites.

2.13 The range of participants in the value chain, and the interactions between them, is illustrated in the figure below.

Figure 2.1 The ICT value chain and examples



2.14 CPs that supply leased lines include BT, Virgin Media (Virgin), Cable & Wireless Worldwide (CWW), Level 3, Colt, Verizon and Geo Networks, among others.

2.15 CPs usually deliver leased line services using either copper wires or optical fibres, although fixed microwave links are also sometimes used. The inherent transmission capacity of optical fibre is far greater than that of either copper wire or microwave links. Construction of physical networks of copper wires or optical fibres requires a high initial investment in civil infrastructure, including trenches, ducts, poles and cables.

2.16 BT remains by far the largest wholesale supplier of leased lines in the UK. For illustrative purposes, if we consider all wholesale circuits, we estimate that BT has a share of 82% of volumes. BT's physical network is ubiquitous in the UK and BT can deliver leased lines almost everywhere in the country except in Hull, where KCOM operates the only ubiquitous physical network. While other CPs including, for example, Virgin, CWW and Level 3, own and operate sizeable physical networks in the UK, the coverage of each of those networks is significantly less extensive than BT's.

Market trends and recent developments

2.17 The capacity demanded of leased lines has been increasing in recent years and seems set to continue to increase. Businesses' needs for bandwidth are driven by a number of factors, including increased adoption of remotely hosted ICT applications (often referred to as 'cloud computing'), greater consumption of bandwidth hungry applications and video content and increased reliance on the internet as a means of communicating and transacting with employees, customers and suppliers. As a result, more and more businesses are migrating from legacy based leased lines to modern Ethernet and WDM based services which are more cost effective in delivering higher data speeds. This has resulted in demand for legacy leased lines falling significantly (over 30%[18]) since the last market review and the take-up of

[18] See Section 7 Figure 7.5. Note that this is the rate of decline for low bandwidth TISBO which is the largest TISBO market by volume. Other TISBO markets have experienced a more significant rate of decline.

Ethernet / WDM services growing by around 80%.[19] There nevertheless continues to be a significant number of customers who continue to consume legacy services.

2.18 Leased lines are also an important enabler of fixed and mobile broadband as they allow MNOs and fixed Internet Service Providers (ISPs) to aggregate and transport data traffic from multiple end users to an internet aggregation point. The last two to three years have seen explosive growth in the take-up of mobile broadband – over the last year the proportion of UK adults using their mobile phones to access the internet has doubled to 36%[20]. As MNOs begin to deploy new 4G networks demand for mobile broadband capacity is likely to increase significantly.

2.19 Fixed broadband penetration has grown from 65% to 72% of households over a period of three years.[21] Average broadband speeds have also been increasing. Between November 2011 and May 2012 average speeds for residential use increased by 19% from 7.6Mbit/s to 9.0Mbit/s[22] as a result of ISPs either upgrading their broadband technologies or encouraging their customers to move to higher bandwidth packages. We expect this trend to continue particularly with the rollout of superfast broadband by BT and Virgin's intention to double the speeds available to its end users.[23]

2.20 Upgrades in fixed and mobile broadband capacity / technologies coupled with growing demand from end users for streamed video content will require fixed ISPs and MNOs to increase the capacity of their networks by consuming higher bandwidth leased lines.

2.21 Meanwhile, the costs of network equipment, particularly equipment using Ethernet and wave-division multiplex (WDM) technologies, have been falling. The number of leased lines services which use those technologies has been increasing. Legacy time-division multiplex (TDM) transmission technology now supports a declining but still large number of leased lines services. In addition, the transmission speeds that readily-available Ethernet and WDM equipment can support has also increased in recent years.

2.22 Until 2008 BT provided Ethernet leased line services by linking optical fibres to create a continuous optical path between the two end-user sites of each Ethernet leased line. This meant that each Ethernet service used a dedicated fibre link. Since then, BT has upgraded its national transmission network with modern Ethernet and WDM equipment. The new design allows BT to aggregate services efficiently, so that several leased lines and other services can share a single optical fibre where their respective routes coincide between BT's exchanges.

2.23 The last few years have also seen some significant mergers and acquisitions. Following its acquisition of Energis in 2006, Cable & Wireless acquired Thus Group in October 2008. In March 2010 Cable & Wireless Worldwide demerged from Cable

[19] See Section 7 Figure 7.10

[20] Ofcom research Jan-Feb 2012 (unpublished)

[21] Ofcom technology tracker, Q1 2009 to Q1 2012

[22] http://stakeholders.ofcom.org.uk/market-data-research/other/telecoms-research/broadband-speeds/broadband-speeds-may2012

[23] Virgin announced in January 2012 that over the next 18 months it would be doubling the speeds available to its end-users. Upload speeds and traffic management fair usage amounts will be increased in proportion to the increase in downstream speed. See http://mediacentre.virginmedia.com/Stories/Virgin-Media-boosts-Britain-s-broadband-speeds-2322.aspx

& Wireless plc and in July 2012 was acquired by Vodafone. Separately, Global Crossing acquired Fibrenet at the end of 2006 and merged in October 2011 with Level 3.

Services considered in this review

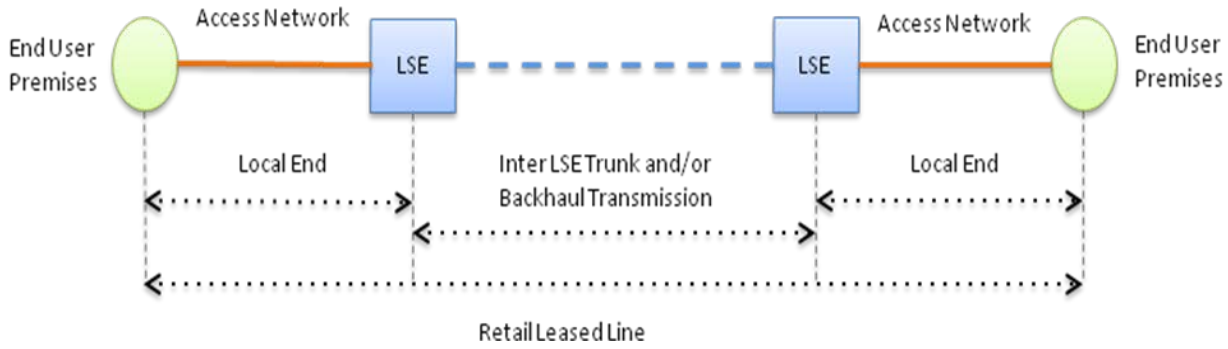
2.24 As set out above, in our review we have considered the market for the retail provision of leased lines, and the wholesale markets for the provision of terminating segments and trunk segments of leased lines in the UK.

Retail services

Leased lines

2.25 Retail leased lines are fixed connections that provide end-user organisations with dedicated symmetric capacity between their sites. They can be used for a variety of communications including voice, video and data communications.

Figure 2.2 Retail leased line

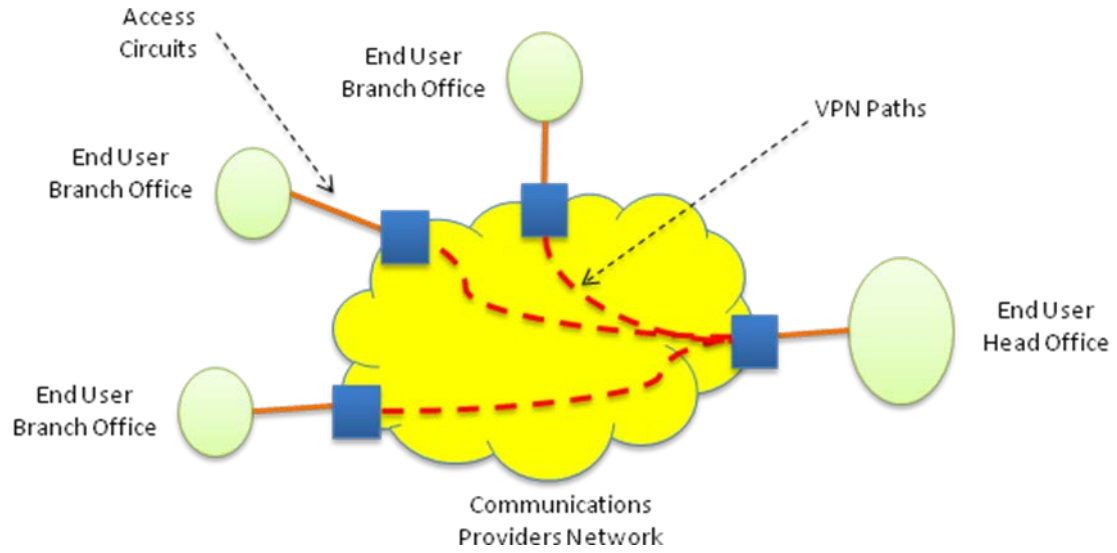


2.26 Figure 2.2 above shows a simplified configuration. The business sites at each end of the circuit are linked to the nearest nodes in the CP's network (the Local Serving Exchange (LSE)) using an access network. The access network links are commonly known as 'local ends'. Connectivity between the LSEs may be provided by a direct fibre or copper connection or, more commonly for longer distance connections, using the CP's backhaul and core transmission network.

Virtual private networks

2.27 Organisations often use leased lines to build private networks linking their sites together so that offices can exchange data and access corporate applications. Virtual private networks (VPNs) provide an alternative to private data networks to achieve this functionality, using a public core network provided by a CP. The organisation's data is transmitted typically using virtual paths across a core infrastructure shared with other services. Specific protocols are used to ensure the privacy of each user organisation's transmissions through the shared infrastructure. The figure below illustrates a simple example connecting several branch offices to a head office.

Figure 2.3 Virtual Private Network (VPN)



2.28 Each site needs an access circuit to connect it to the VPN. This may be provided with a leased line but other types of connection such as ADSL broadband are also used depending on the user's requirements.

Wholesale services

2.29 CPs provide wholesale leased lines services to each other, either on a commercial basis or on a regulated basis. A CP purchasing wholesale leased lines uses them either as components to construct retail leased lines services for end-user organisations, or to build its own network, for example to connect its network nodes together.

2.30 There are three broad types of wholesale leased lines service:

- end-to-end services: these link two end-user sites, typically over relatively short distances;
- terminating segments: most commonly these link an end-user's site to the purchasing CP's network node, enabling the purchasing CP to assemble an end-to-end service using a combination of wholesale inputs and its own network. Terminating segments can also be used to link together nodes in the purchasing CP's network; and
- trunk segments: these are segments of leased lines carried over aggregated links between major network nodes.

Technologies

2.31 In this review, we have considered leased lines that employ technologies in common use in the UK. We classify those technologies into two main groups:

- **Traditional Interface (TI) leased lines**: This group includes services which use legacy analogue and digital interfaces. These have hitherto been the most common types of leased line in use in the UK, but their volume is now in sustained decline. In this category there are two broad types of circuit:

- Analogue interface leased lines: These are commonly used for voice transmission e.g. external extension circuits between business sites. They are also used for low-bandwidth data transmission.

- Digital interface leased lines based on legacy TDM technical transmission standards, including Plesiochronous Digital Hierarchy (PDH) and Synchronous Digital Hierarchy (SDH), and which use the ITU G.703 interface. As a result, they have stable and predictable transmission characteristics, low transmission delay (latency) and low jitter (variation in transmission delay). These characteristics are important in some user applications. PDH and SDH circuits are currently the most common type of leased line, and are used for enterprise voice and data services. They are available in bandwidths ranging from 64kbit/s up to 10Gbit/s. The most popular variants are n x 64kbit/s and 2Mbit/s.

- **Alternative Interface (AI) leased lines**: This group of digital leased lines services uses modern interfaces that are generally more suitable for transmission of Internet protocol (IP) data, and are often more cost-effective in delivering high bandwidth services than legacy technologies. Interfaces used in AI leased lines include:

  - Ethernet is the most common AI leased lines technology. It was originally developed for office environments, where it is still used to transmit data between computers in local area networks (LANs). In recent years it has been developed for use in telecommunications networks. Ethernet services are currently available in a range of bandwidths from 10Mbit/s to 100Gbit/s with the most common being 100Mbit/s.

  - Fibre Channel (and related FICON and ESCON interfaces) is a high-bandwidth technology primarily used for data storage network applications. Originally developed for use with super-computers it has now become the standard connection type for enterprise storage area networks.

2.32 In addition, we have also considered leased lines that use WDM technology. WDM is a transmission technology originally used by network operators to provide optical fibre links with very high capacity within their networks. It is increasingly being used by businesses that have very high bandwidth requirements, particularly for data centre and data storage network applications and in the media and broadcast industries. The distinguishing feature of WDM is its scalability. Each WDM system can support multiple circuits over one or two optical fibres (typically 16 or 32 circuits at capacities above 1Gbit/s). Additional circuits can be quickly added without disruption to the existing circuits and without adding additional fibres. WDM is most commonly used to provide circuits with AI interfaces such as Ethernet or Fibre Channel but it also supports the TI SDH interfaces.

Terminology

2.33 In the previous BCMRs we used an older term ‘Symmetric Broadband Origination’ to describe terminating segments. As the acronyms associated with this term are well known, in this document we have continued to use them to describe the markets for terminating segments. We therefore refer to the markets as follows:

- TI Terminating Segments = TI Symmetric Broadband Origination (TISBO);

- AI Terminating Segments = AI Symmetric Broadband Origination (AISBO); and

- MI Terminating Segments = MI Symmetric Broadband Origination (MISBO) to describe the markets for very high bandwidth services that are newly defined in this review. These markets include Ethernet services at bandwidths above 1Gbit/s and services of any bandwidth delivered using WDM at customers' premises.

The regulatory framework

2.34 The regulatory framework has its basis in five EU Communications Directives, each of which has been implemented into national legislation.[24] It imposes a number of obligations on the relevant national regulatory authorities, such as Ofcom. One of these obligations is to carry out a market review. We set out the market review process, and the regulatory framework, in more detail in Annex 2. In this section we have set out, in summary, what the market review process involves.

The market review process

2.35 The review is carried out in three stages:

i) we identify and define the relevant markets, appropriate to the national circumstances in the UK;

ii) we assess whether any of the markets are effectively competitive, which involves assessing whether any operator has significant market power (SMP) in any of the relevant markets; and

iii) we assess the appropriate remedies which should be imposed, where there has been a finding of SMP, based on the nature of the competition problem identified in the relevant markets, or, where we determine that a market is effectively competitive, we remove regulation that currently applies to that market.

2.36 In carrying out the review, we are obliged to define relevant markets "appropriate to national circumstances". [25] In so doing, we are also obliged to in particular, take "utmost account"[26] of the European Commission's (Commission) Recommendation[27] and SMP Guidelines.[28]

The Recommendation and its application to this review

2.37 The Recommendation sets out those product and service markets which, at a European level, the European Commission has identified as being susceptible to ex ante regulation. These markets are identified on the basis of the cumulative application of three criteria:

[24] Recent amendments to the five EU Communications Directives were transposed into national legislation and came into effect from 26 May 2011. See Annex 2 for more detail.

[25] See Article 15(3) of the Framework Directive (Directive 2002/21/EC on a common regulatory framework for electronic communications networks and services, as amended).

[26] Ibid.

[27] Commission Recommendation 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 (Second Edition) (C(2007)5406 rev1).

[28] Commission guidelines on market analysis and the assessment of significant market power under the Community regulatory framework for electronic communications networks and services (2002/C 165/03).

- the presence of high and non-transitory barriers to entry;
- a market structure which does not tend towards effective competition within the relevant time horizon; and
- the insufficiency of competition law alone to adequately address the market failure(s) concerned.

2.38 The requirement to define relevant markets appropriate to national circumstances means we are free to identify relevant markets in the UK as susceptible to regulation other than those on the Recommendation. However, where we do so, the Recommendation requires that for each relevant market we must show that the cumulative criteria are satisfied.

2.39 All of the markets we have identified in this review are listed in the Recommendation apart from four. These are:

- the retail market for the provision of very low bandwidth Traditional Interface (TI) leased lines in the UK excluding the Hull area;
- the retail market for the provision of low bandwidth Traditional Interface (TI) leased lines in the Hull area;
- the retail market for the provision of low bandwidth Alternative Interface (AI) leased lines in the Hull area; and
- the wholesale market for the provision of regional trunk segments.

2.40 In this statement we set out how the cumulative criteria are satisfied for each of these relevant markets we have defined.

The SMP Guidelines and their application to this review

2.41 The SMP Guidelines include guidance on market definition, assessment of SMP and SMP designation. Oftel produced additional guidelines on the criteria to assess effective competition based on the SMP Guidelines (Oftel Guidelines).[29] In the relevant Sections of this Statement, we set out how we have taken the SMP and Oftel Guidelines, as well as other relevant guidance, into account in reaching our decisions.

Forward look

2.42 Rather than just looking at the current position, market reviews look ahead to how competitive conditions may change in future. For this review, we have taken a forward look of three years, reflecting the characteristics of the retail and wholesale markets and the factors likely to influence their competitive development, as well the expected timing of the next market review.[30]

2.43 This does not preclude us reviewing any of the markets earlier, but absent unforeseen developments we anticipate that we would time the next market review to

[29] See www.ofcom.org.uk/static/archive/oftel/publications/about_oftel/2002/smpg0802.htm.

[30] See, in this respect, paragraph 20 of the SMP Guidelines.

conclude three years after completion of the current review.[31] The relevant charge controls set out in this Statement will therefore apply for a period of three years following the publication of this Statement.

Relevant legal tests and statutory duties

2.44 In this Statement, we explain why we consider that each of the SMP conditions we are implementing, including the price controls, are appropriate to apply to BT and KCOM in respect of their networks and facilities under review.

2.45 We explain why the SMP conditions are consistent with our general duties under section 3 of the Act and our duties for the purpose of fulfilling our Community obligations as set out under section 4 of the Act.

2.46 Under section 3, 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. In so doing, 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. As to the prescribed specific statutory objectives in section 3(2), we explain that the objective of securing the availability throughout the UK of a wide range of electronic communications services is particularly relevant to the markets we have reviewed, and therefore to the regulation we impose.

2.47 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. We consider that a number of such considerations are relevant to the market review, namely 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 United Kingdom[32].

2.48 Section 4 of the Act requires us to act in accordance with the six Community requirements for regulation. The first and fifth of those requirements are of particular relevance to this market review, namely to promote competition in the provision of electronic communications networks and services and associated facilities; and to encourage, to such extent as Ofcom considers appropriate for certain prescribed purposes, the provision of network access and service interoperability, namely securing efficient and sustainable competition, efficient investment and innovation and the maximum benefit for customers of communications providers[33].

2.49 As section 4(2) provides that the six Community requirements are to be read in light of Article 8 of the Framework Directive, we have also acted in accordance with our duty in Article 8(5) to apply objective, transparent, non-discriminatory and proportionate regulatory principles.

[31] The BCMR is arguably the most complex of the market reviews conducted under the regulatory framework in the UK and we recognise that it imposes very significant demands on industry stakeholders. We are nevertheless conscious that the market is changing quite rapidly, and will therefore continue to keep developments in the market under review. We will take those into account in deciding when to initiate the next BCMR.

[32] See, in this respect, Annex 2 to this Statement and also paragraph 8.33 of the June BCMR Consultation.

[33] See Annex 2 to this Statement and also paragraph 8.37 of the June BCMR Consultation.

2.50 We also explain why we consider that the SMP conditions meet the test set out at section 47 of the Act. In summary, section 47 requires that any SMP condition must not be imposed unless it is:

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

2.51 As part of our considerations, we have carefully assessed the test set out in section 88 of the Act. Section 88 prohibits in its effect the setting of SMP conditions under section 87(9) of the Act (including charge controls, recovery of costs, and cost accounting) except where it appears to us, from the market analysis, that there is a relevant risk of adverse effects arising from price distortion; and it appears to us that the setting of the condition about network access pricing is appropriate for the purposes of promoting efficiency, promoting sustainable competition and conferring the greatest possible benefits on end users. We are also required to take into account the extent of BT's investment in the matters to which the condition relates.

2.52 In light of the above, we have sought to balance a number of specific policy objectives – as derived from those statutory duties. In particular, in relation to charge controls:

- to prevent BT setting excessive charges for specific leased line services where it has SMP, while providing appropriate incentives for it to increase its efficiency;
- to promote efficient and sustainable competition in the delivery of specific leased line services;
- to confer the greatest possible benefits on the end-users of public electronic communications services;
- to take account of the extent of BT's investment in the matters covered by the charge controls;
- to ensure prices are subject to appropriate controls, for example in allowing BT to retain sufficient flexibility in the way it sets its prices;
- to provide regulatory certainty for BT and its customers and to avoid undue disruption;
- to encourage investment and innovation in the relevant markets; and
- to ensure that the delivery of the regulated services is sustainable, in that the prevailing prices provide BT with the opportunity to recover all of its relevant costs (where efficiently incurred), including the cost of capital.

2.53 We have taken due account of all applicable recommendations issued by the European Commission under Article 19(1) of the Framework Directive, as required by section 4A of the Act. For the decisions set out in this Statement, we have taken such

account in relation to the 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 and the accompanying explanatory memorandum (the Leased Lines Pricing Recommendation); [34] which we further discuss later in this Statement. In addition, we have had regard to the European Regulators' Group (ERG) common position on best practice in remedies imposed as a consequence of a position of SMP in the relevant wholesale leased lines markets[35] and the revised ERG common position on the approach to appropriate remedies in the regulatory framework for electronic communications and network services[36].

2.54 Finally, in developing our decision, we have also taken into account the approaches we have taken in the following previous decisions:

- Wholesale Broadband Access Charge Control (the WBA CC) through the application of the 'rest of BT' cost of capital[37];
- Wholesale Line Rental & Local Loop Unbundling Charge Control (the WLR LLU CC) on issues relevant to the regulatory asset value (RAV)[38]; and
- Point of handover pricing review (the POH Statement) on issues specifically relating to POH.[39]

Regulation of the leased lines markets to date

2.55 In January 2009, we completed the last BCMR[40] (the 2007/8 Review) as a result of which we imposed certain regulatory obligations on BT and KCOM in those markets where they were found to have SMP. Figure 2.4 below summarises the market definitions and SMP findings of the last BCMR. A number of separate leased lines markets were defined based on the capabilities of different technologies: traditional interface services and alternative interface services. Figure 2.5 provides an overview of the remedies imposed on BT and KCOM.

[34] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2005:083:0052:0055:EN:PDF

[35] http://www.erg.eu.int/doc/publications/erg_07_54_wll_cp_final_080331.pdf

[36] http://www.erg.eu.int/doc/meeting/erg_06_33_remedies_common_position_june_06.pdf

[37] We published the WBA CC Statement in July 2011: http://stakeholders.ofcom.org.uk/binaries/consultations/823069/statement/statement.pdf. See Section 5, 6 and Annex 7 to see our reasoning.

[38] We published the WLR LLU CC Statement on 7 March 2012: http://stakeholders.ofcom.org.uk/binaries/consultations/wlr-cc/statement/LLU_WLR_CC_statement.pdf. See Section 5 and 6 to see our reasoning.

[39] We published the POH Statement in September 2011: http://stakeholders.ofcom.org.uk/binaries/consultations/revision-points-handover-pricing/statement/final-statement.pdf. See Section 5 and Annex 6 to see our reasoning.

[40] http://stakeholders.ofcom.org.uk/consultations/bcmr08/statement/

Figure 2.4: Market definitions and SMP findings from the 2007/8 Review

	Markets	UK except Kingston upon Hull	Kingston upon Hull
1	Retail market for analogue and digital low bandwidth TI leased lines at bandwidths up to and including 2Mbit/s and 8Mbit/s	BT	No SMP
2	Wholesale market for TI symmetric broadband origination (TISBO) at bandwidths up to and including 2Mbit/s and 8Mbit/s	BT	KCOM
3	Wholesale market for TISBO at bandwidths above 8Mbit/s and up to and including 45Mbit/s in the Central and East London Area (CELA)	No SMP	
4	Wholesale market for TISBO at bandwidths above 8Mbit/s and up to and including 45Mbit/s outside the CELA	BT	KCOM
5	Wholesale market for TISBO at bandwidths above 45Mbit/s and up to and including 155Mbit/s in the CELA	No SMP	
6	Wholesale market for TISBO at bandwidths above 45Mbit/s and up to and including 155Mbit/s outside the CELA	BT	KCOM
7	Wholesale market for TISBO at bandwidths above 155Mbit/s and up to and including 622Mbit/s	No SMP	No SMP
8	Wholesale market for low bandwidth AI symmetric broadband origination (AISBO) at bandwidths up to and including 1Gbit/s	BT	KCOM
9	Wholesale market for high bandwidth AISBO at bandwidths above 1Gbit/s	No SMP	No SMP
10	Wholesale trunk segments for TI leased lines[41]	BT	

[41] The market for wholesale trunk segments of TI leased lines was defined as a national market. We did not assess the trunk market for the Hull area as no market then existed – or was thought likely to do so on a forward looking basis - for trunk circuits within the Hull area. See the January 2008 consultative document, (esp. para 6.89) at http://stakeholders.ofcom.org.uk/binaries/consultations/bcmr/summary/bcmr_pt2.pdf.

Figure 2.5: Remedies imposed on BT and KCOM in the 2007/8 Review

SMP obligation	Applying to market(s)
BT	

- Obligation to provide existing and new 2Mbit/s leased lines
- Requirement not to unduly discriminate
- Publish a reference offer
- Plus the following BT voluntary undertakings:
  - Supply new analogue circuits until 1st Jan 2011
  - Supply new sub 2Mbit/s circuits until 1st Jan 2011
  - Prices of analogue circuits capped to RPI-0% until 2010
  - Further 2 year price cap to be agreed with Ofcom
- Cost orientation and accounting separation would apply only if BT fails to comply with the agreed caps, or if Ofcom and BT fail to agree a new 2 year price cap for 2011-12[42]
	1

- Obligation to provide network access - Requirement to not unduly discriminate - Cost orientation - Publish a reference offer - 90 days notice of changes - 28 days notice of new services - Publish quality of service information - Notify technical information within 90 days of request - Obligations relating to requests for new network access - Cost accounting and accounting separation - Charge control - a direction under the quality of service information obligation (Only for TI services) - a direction under the network access obligation relating to SLGs (only for AI services) - Partial Private Circuit direction (only for TI services)	2, 4, 6, 8, 10

- Handover products offering comprising:
  - Customer Sited Handover
  - In Span Handover extensions
  - In Span Handover
- Make available accommodation products to support disaggregated AI and later TI products
- In Building Handover for low bandwidth AI services and later for disaggregated TI products
	2, 4, 6, 8, 10

KCOM	
- Obligation to supply wholesale products on request - Requirement to not unduly discriminate - Publish a reference offer - Publish technical information - Voluntary price increases limited to RPI+0% until 2012 included for low, high and very high TI services - Voluntary price increases limited to RPI-16% until 2012 included for low bandwidth AI services - Cost orientation and accounting separation would apply only if KCOM fails to comply with the agreed caps	2, 4, 6, 8

[42] Ofcom and BT did not agree a new 2 year price cap for 2011-12.

Charge controls imposed in the previous Leased Lines Charge Control Statement (the LLCC 2009)

2.56 Following the SMP findings of the 2007/8 Review, we issued a further statement in July 2009 (the LLCC 2009) in which we imposed charge controls in markets 2,4,6,8,10, as listed in Figure 2.4 above.[43]

2.57 In addition we imposed charge controls on interconnection and accommodation services relating to BT's provision of services in these markets. We also imposed sub-caps[44] on some individual prices and some sub-baskets[45] as part of the charge control, to ensure that the charge controls delivered our stated policy objectives as set out in paragraphs 2.14 and 2.15 of the LLCC 2009 Statement.

2.58 The last leased line charge controls came into effect for the three years from 1 October 2009 to 30 September 2012. We summarise in Figure 2.6 below the scope and levels of those controls. Since September 2012, BT provided commitments as to their pricing intentions. [46]

Figure 2.6: Summary of the LLCC 2009 charge controls

Basket	Services in scope	Value of X	Value of sub-cap
TI	Wholesale low bandwidth TISBO (≤8Mbit/s) – connections and rental Wholesale high bandwidth TISBO (>8Mbit/s and ≤34/45Mbit/s) – outside CELA connections and rental Wholesale high bandwidth TISBO (>34/45Mbit/s and ≤145/155Mbit/s) – outside CELA connections and rental Trunk all bandwidths) - rental	RPI-3.25%[47]	RPI-0% sub-cap on sub-basket of TISBO terminating segments RPI+5% sub-cap on each charge (excluding POH charges) RPI-0% sub-cap on each charge (POH charges only)
Equipment and Infrastructure (TI)	All relevant equipment and infrastructure charges	RPI-0%	No charge to increase by more than 5% in nominal terms
Ancillary Services (TI)	All relevant ancillary services used in the provision of TI services in scope of the TI Basket	RPI-0%	None
AI	Wholesale low bandwidth AISBO (≤1Gbit/s) – connection and rental	RPI-7%	RPI-0% sub-cap on sub-basket of BES RPI+5% sub-cap on each charge

[43] http://stakeholders.ofcom.org.uk/binaries/consultations/llcc/statement/llccstatement.pdf

[44] Sub-caps are 'price-point' controls. These can be used in conjunction with basket controls, or as a stand-alone control.

[45] Sub-baskets control a group of services within a 'main' basket. Sub-baskets impose a constraint on the weighted average charge for the services in question. Therefore, the sub-basket maintains the flexibility to balance in a similar way as the main basket would allow.

[46] Both BTW and Openreach have written to Ofcom to confirm that they expect to make price changes from the end of September and not to make further changes unless the interim period were to extend beyond March 2013. https://www.btwholesale.com/shared/document/CPL/ACCN_2011_july/accn_1150.rtf and http://www.openreach.co.uk/orpg/home/products/pricing/loadProductPriceDetails.do?data=bj1iagV2rmVhUxhJRV2ltZ6l6oCf3ew2ZeuZm4VRqG0lMnGHsqdC0vzO163bJmh34D91D7M0q8u%2F%0AIlSgtIFAKw%3D%3D

[47] Following the subsequent appeal of the LLCC 2009, this changed to RPI-1.75% for 2010/11 and 2011/12.

Accommodation (AI)	Access Locate AI Accommodation Administration Fee	3.5% nominal terms (2009/10) RPI+4.5% (2010/11)	Controlling percentage ± on each charge RPI-0%
Ancillary Services (AI)	All relevant ancillary services used in the provision of AI services in scope of the AI Basket	RPI-0%	None

Appeal against the LLCC 2009 Statement

2.59 Cable and Wireless Worldwide (CWW) appealed a number of the decisions we made in the LLCC 2009, in relation to specific services in the TI basket. The appeal was lodged to the Competition Appeal Tribunal (CAT) and subsequently referred to the Competition Commission (CC) for its consideration.

2.60 The CC issued its Final Determination (CC Determination) on 30 June 2010[48] followed by the CAT's order. The CC concluded that Ofcom had not erred in the decision in relation to a number of the grounds of appeal, such as our decision with respect to the cost of capital. However, the CC concluded that we had erred in respect of the following areas:

- in permitting the starting charge increases for 2Mbit/s local ends as part of the one-off adjustments to starting charges ;
- in the allocation of costs in relation to the 21CN cost adjustment and the allocation of costs to SiteConnect; and
- in using BT's estimate of the costs to be recovered by the Point of Handover (POH) charges, in determining that the recovery of POH charges was appropriate for promoting sustainable competition and in giving BT the discretion regarding future charges for POH.

2.61 Following the CC's determination and the CAT's Ruling, BT was required to amend its 2Mbit/s local end charges and adjustments were made to BT's final year costs to reflect errors with respect to the allocation of 21CN and SiteConnect costs.[49] These adjustments resulted in a revised value of X from 3.25% to 1.75% for the TI basket for the charge control years 2010/11 and 2011/12.[50]

2.62 In September 2011, we also mandated that a number of POH charges are set at the long run incremental costs (LRIC) from 1 October 2011 to 30 September 2012.[51] This is discussed in more detail in Annex 13.

2.63 In developing the charge controls for this review, we have had regard to the issues raised in the appeal where they may have some wider implications for the new charge controls. In particular, we have considered:

[48] http://www.competition-commission.org.uk/appeals/communications_act/final_determination_excised_version_for_publication.pdf

[49] See Table 6.6 of the CC Determination.

[50] See paragraph 1.11 of the LLCC 2009– Amendment to SMP Services Conditions http://stakeholders.ofcom.org.uk/binaries/consultations/llcc/statement/LLCC_decision_final.pdf

[51] http://stakeholders.ofcom.org.uk/binaries/consultations/revision-points-handover-pricing/statement/final-statement.pdf

- the appropriateness of starting charge adjustments, including how the proposed adjustments impact the regulatory framework more widely including:
  - the level of outperformance from previous charge controls;
  - the impact of adjustments on BT's ability to earn an appropriate return on efficiently incurred costs;
  - balancing between the appropriateness of these adjustments against the glide-path approach to allow for cost convergence over the charge control period;
- alternative regulatory options for the appropriate cost standard for charges which are consumed by external parties only, for example interconnection products;
- if it is appropriate for us to calculate a leased lines specific cost of capital or use the 'rest of BT' cost of capital; and
- whether we should be setting the detailed pricing structures or leaving this to BT subject to an overall basket constraint on average charges.

Call for inputs and consultations

2.64 Before starting our substantive analysis in this review, we published on 21 April 2011 a Call for Inputs (CFI) to gather stakeholders' views on the key issues.[52]

2.65 In the CFI we sought stakeholders' views about the range of products and services that we should cover and the analytical approach for the review, including our approach to considering appropriate remedies. In particular:

i) we asked stakeholders about the issues that we need to consider;

ii) we tested some hypotheses relating to the status of some of the market definition findings of the last BCMR which we thought might not have changed materially;

iii) we gathered stakeholders' views on their overall experience with regulated access products, market entry and competition in relation to business connectivity markets throughout the UK; and

iv) we sought stakeholders' views on whether and how, in their view, these markets had changed since the last BCMR was completed, both from their own perspective and the perspective of their end-users.

2.66 We received nineteen responses, primarily from communication providers. We considered these responses and took them into account when developing our proposals.

2.67 On 18 June 2012 we published a consultation covering our market definition, SMP assessment and proposed remedies (the June BCMR Consultation)[53] and on 5 July

[52] http://stakeholders.ofcom.org.uk/consultations/bcmr-inputs/

[53] Business Connectivity Market Review http://stakeholders.ofcom.org.uk/consultations/business-connectivity-mr/

2012 we published a further consultation covering our charge control proposals (the LLCC Consultation)[54].

2.68 We received twenty-one responses to the June BCMR consultation and the LLCC Consultation.

2.69 On 15 November 2012 we published a further consultation (the November BCMR Consultation) [55] seeking the stakeholders' views on our revised proposals:

i) Geographic market in the London area – we proposed to include in the West, East and Central London area (the WECLA) some postcode sectors in Slough;

ii) Service-level guarantees – we proposed changes to correct a drafting error. The revised version would apply limits to the compensation payments payable by BT;

iii) Accounting obligations – we proposed that BT should be subject to cost accounting obligations in each of the product markets in which we proposed that it has SMP, and that BT and KCOM should be subject to accounting separation obligations in each of the wholesale product markets in which we proposed that they have SMP;

iv) Circuit routing rules – we proposed changes to the rules that would apply to Openreach's provision of Ethernet services operating at or below 1Gbit/s.

2.70 We received ten responses to the November BCMR Consultation.[56]

Impact assessment

2.71 The analysis presented in this document constitutes an impact assessment as defined in section 7 of the Act.

2.72 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 we have to carry out impact assessments where our proposals would be likely to have 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 impact assessments in relation to the great majority of our policy decisions.

2.73 Specifically, pursuant to section 7 of the Act, 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 what we propose.

2.74 For further information about our approach to impact assessments, see the guidelines, Better policy-making: Ofcom's approach to impact assessment, which are on our website: http://stakeholders.ofcom.org.uk/binaries/consultations/ia_guidelines/summary/condoc.pdf

[54] http://stakeholders.ofcom.org.uk/consultations/llcc-2012/

[55] BCMR further consultation: http://stakeholders.ofcom.org.uk/consultations/bcmr-reconsultation/

[56] See Annex 1 for a list of respondents to the consultations.

Equality impact assessment

2.75 Annex 10 of this Statement summarises our Equality Impact Assessment for this market review. Ofcom is separately required by statute to assess the potential impact of all our functions, policies, projects and practices on race, disability and gender equality. Equality Impact Assessments (EIAs) also assist 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. Unless we otherwise state in this Statement, it is not apparent to us that the outcome of our review is likely to have any particular impact on race, disability and gender equality. Specifically, we do not envisage the impact of any outcome to be to the detriment of any group of society.

2.76 Nor are we envisaging any need to carry out separate EIAs in relation to race or gender equality or equality schemes under the Northern Ireland and Disability Equality Schemes. This is because we anticipate that our regulatory intervention will affect all industry stakeholders equally and will not have a differential impact in relation to people of different gender or ethnicity, on consumers in Northern Ireland or on disabled consumers compared to consumers in general. Similarly, we are not envisaging making a distinction between consumers in different parts of the UK or between consumers on low incomes. Again, we believe that our intervention will not have a particular effect on one group of consumers over another.

Our approach to data and model disclosure

2.77 In developing our charge control, we have undertaken modelling which:

- calculates the appropriate level of costs to be recovered by BT Wholesale and Openreach from services within the scope of the LLCC based on BT's 2011/12 Regulatory Financial Statements (RFS);
- projects these costs forward to 2015/16 based on certain policy assumptions outlined in this Statement; and
- calculates the implied path of prices which would permit BTW and Openreach to recover those costs in 2015/16.

2.78 The modelling is very detailed, to reflect the complexity of the network used to deliver TI and Ethernet services and to allow us to have confidence in the outcome of our analysis. Inevitably such complex modelling brings risks of error. We have undertaken both external and internal reviews of the model in addition to the reviews which took place at the consultation phase.

2.79 We are publishing two reports from Ernst & Young which comment on the reviews they have undertaken on:

- the network reach and service share analysis for the market review part of this process;[57] and
- the data analysis of the input data for the charge control.[58]

[57] http://stakeholders.ofcom.org.uk/binaries/consultations/business-connectivity/statement/ernst-young-bcmr-report.pdf

[58] http://stakeholders.ofcom.org.uk/binaries/consultations/business-connectivity/statement/EY-LLCC-model-review.pdf

2.80 This supplements the work Ernst and Young undertook for the LLCC Consultation in which it confirmed that it has not identified any issues within the model which could question the integrity of the model outputs.[59]

2.81 We are publishing a copy of our charge control financial model including all the formulae used to generate the level of the charge control for the TI and Ethernet baskets alongside this Statement. This model is not populated to reflect the confidentiality of much of the data.

2.82 The modelling undertaken as part of this review contains data supplied by BT with respect to its business which has been obtained under the Act. There is a general restriction under the Act on Ofcom disclosing such information without consent unless an exception applies[60]. Ofcom has engaged closely with BT on model disclosure to obtain BT's consent to allow underlying data to be disclosed, including testing BT's assertions on confidentiality. The charge control models contain highly disaggregated data, much of which BT considers is commercially confidential or outside the scope of these charge control reviews.

2.83 One of the exceptions under the Act permits Ofcom to disclose data without consent for the purpose of facilitating the carrying out of its functions, including its functions as to consultation[61]. In light of the level of disclosure consented to by BT, Ofcom has considered whether any further disclosure is required, including considering whether confidentiality concerns can be addressed by masking and/or aggregating data.

2.84 In undertaking this exercise, we have also considered our framework for disclosure of charge control models[62]. We have concluded that the most appropriate approach to inform stakeholders is to provide a copy of the model populated with that proportion of the data which is not commercially confidential. This includes some aggregation of the actual data within the models, such that the published data is not commercially confidential. This approach to disclosure is consistent with that taken for the LLCC Consultation and in the WLR LLU CC. In combination with our publication of a version of the model formulae, we consider this provides stakeholders with sufficient understanding of the process we have taken in developing the values of X used within our charge controls.

Structure of this document

2.85 This Statement is structured as follows:

- Sections 3-6 explain our conclusions with respect to market definition: Section 3 explains our retail product market definition for the leased lines market in the UK; Section 4 explains our wholesale product market definition. Section 5 identifies the geographic boundaries for our wholesale product markets in the UK and Section 6 sets out our product and geographic market definition for wholesale trunk.

[59] http://stakeholders.ofcom.org.uk/binaries/consultations/llcc-2012/annexes/EY_model.pdf

[60] Section 393 of the Act.

[61] Section 393(2)(a) of the Act.

[62] *Framework for Disclosure of Charge Control Models*' published in October 2010 http://stakeholders.ofcom.org.uk/binaries/consultations/784024/Charge_control.pdf. This has included meetings with Openreach and with the UK Competitive Telecoms Association ('UKCTA'). We have also held bilateral discussions on this issue with CPs who have requested it.

- Section 7 explains our assessment of SMP in the markets identified.
- Section 8 discusses our considerations in relation to passive remedies for the markets where we have identified SMP.
- Section 9: discusses our conclusions on price control remedies other than charge controls such as cost orientation and fair and reasonable charges obligations.
- Sections 10 to 16 discuss the remedies we are imposing in those retail and wholesale leased lines markets where we have found SMP. Section 10 covers the retail low bandwidth TI market, Section 11 covers the wholesale TI markets, Section 12 the wholesale AI market, Section 13 the wholesale MI market, Section 14 accommodation and interconnection services, Section 15 remedies for the Hull markets and finally Section 16 discusses cost accounting and accounting separation remedies.
- Sections 17 to 24 discuss the charge controls we are imposing on BT. Section 17 and 18 discuss the form and duration and the design of the charge control respectively. Section 19 details our charge controls for TI services with Section 20 detailing our charge controls for Ethernet services. Section 21 describes the price control we have imposed in AI WECLA and Section 22 sets out the controls for accommodation and excess construction services. Section 23 describes the price control we are imposing on retail analogue services with Section 24 detailing how we will be implementing the charge controls.

2.86 There are also a number of annexes covering the following:

- Annex 1 lists respondents to the consultations;
- Annex 2 describes the regulatory framework for market reviews;
- Annex 3 covers our approach to defining markets;
- Annex 4 covers the Commission's comments on the draft Statement;
- Annex 5 explains our approach to analysing the data we have collected for the purposes of this review;
- Annex 6 discusses whether there may be a case to apply differential remedies for data centres;
- Annexes 7 and 8 set out the draft SMP conditions and Directions;
- Annex 9 describes our geographic analysis concerning the inclusion of some postcode sectors in Slough in the WECLA geographic market;
- Annex 10 sets out the Equality Impact Assessment we have carried out;
- Annex 11 reproduces a letter from KCOM setting out the voluntary commitments it has made to Ofcom about its wholesale leased line prices in Hull;
- Annex 12 describes the forecasting model that we have used for the charge controls;

- Annex 13 sets out our conclusions on charge controls for PPC Point of Handover (POH);
- Annex 14 describes our conclusions on BT's cost of capital;
- Annex 15 describes our geographic analysis for the retail very low bandwidth TI market;
- Annex 16 lists the main sources of evidence we have relied on in undertaking this market review; and
- Annex 17 is a glossary of specialist terms used in this document.

Section 3

Retail product market definition

Introduction

3.1 This Section sets out two main conclusions (as summarised in Figure 3.1 below), namely:

- the definitions of the relevant retail product markets, analysed in the absence of upstream wholesale SMP regulation, which are relevant to our analysis of the relevant wholesale markets which we discuss in Section 4; and
- the definitions of the retail product markets, analysed in the presence of upstream wholesale SMP regulation, which are relevant to our identification of the relevant retail markets.[63]

[63] I.e. those retail markets in which we have concluded, despite the existence of upstream wholesale SMP regulation, it is appropriate to impose SMP regulation and for which we therefore need to define their geographic scope.

Figure 3.1: Summary of retail product market definitions

In the absence of wholesale regulation	**Bandwidth breaks**			
TI leased lines	**Low bandwidth** - Up to and including 8Mbit/s	**Medium bandwidth -** Above 8Mbit/s up to and including 45Mbit/s	**High bandwidth** - Above 45Mbit/s and up to and including 155Mbit/s	**Very high bandwidth -** 622Mbit/s
AI leased lines	**Low** - Up to and including 1Gbit/s			
MI leased lines	**Multiple Interface -** services with bandwidth greater than 1Gbit/s, and services of any bandwidth delivered with WDM equipment at customers' premises.			
In the presence of wholesale regulation	**Bandwidth breaks**			
TI leased lines	**Very low bandwidth TI retail leased lines -** sub-2Mbit/s bandwidths	**TI retail leased lines -** From 2Mbit/s up to and including 8Mbit/s	**Medium bandwidth TI retail leased lines -** Above 8Mbit/s up to and including 45Mbit/s	**High bandwidth TI retail leased lines -** Above 45Mbit/s and up to and including 155Mbit/s	**Very high bandwidth TI retail leased lines** - 622Mbit/s
AI leased lines	**Low** - Up to and including 1Gbit/s			
MI leased lines	**Multiple Interface -** services with bandwidth greater than 1Gbit/s, and services of any bandwidth delivered with WDM equipment at customers' premises.			

Summary of approach

3.2 In arriving at our conclusions on the retail product market definition, we have followed our approach to market definition for leased lines, which we describe in detail in Annex 3. The key steps are as follows:

- The first stage of the analysis is to consider the key characteristics of the services that might be classified as leased lines and to identify a set of focal services which form the starting point of our analysis.

- We then determine the market boundaries, meaning the range of services that fall within each market. As discussed in Annex 3, we focus on two matters:

  - Demand-side substitution – the extent to which end-users could substitute other services for those in question; and

  - Homogeneity of competitive conditions – the extent to which levels of competition for the services in question are similar.

- We initially explore the constraints between the focal services and subsequently consider a wider set of services which do not exhibit all the characteristics of leased lines but may still impose a competitive constraint on leased line services.

3.3 In this Section, we address in turn five key issues. For each issue we first set out the proposals we made in the June BCMR Consultation, with the reasoning which underpinned them. Secondly we summarise the comments on each issue made by respondents to the June BCMR Consultation, where we asked the following question:

> Question 1: Do you agree with our approach to retail market definition and our proposed retail product market definition?

3.4 We then explain how, in reaching our conclusions, we have taken into account responses to this question and other information put to us. Figure 3.2 summarises the issues.[64]

Figure 3.2: Structure of retail product market definition section

Issue	Summary of issue being considered
Issue 1: Technology and service requirements	Some types of leased lines might not be able to meet the service requirements of all end-users - how material is this to our assessment of market definition?
Issue 2: Virtual Private Networks (VPNs)	Are business connectivity services provided over VPNs in the same market as leased lines?
Issue 3: Broadband markets	Are symmetric or asymmetric broadband services a substitute for low bandwidth leased lines?
Issue 4: Bandwidth breaks	Can separate markets for leased lines at different bandwidths be identified?
Issue 5: Wave Division Multiplex (WDM) services	Do WDM services fall within either or both of the TI or AI leased lines market?

Scope of our assessment

3.5 A leased line is a service that provides dedicated symmetric transmission capacity to carry voice and/or data traffic. Dedicated in this context means uncontended, and symmetric means there are identical transmit and receive data rates. They are mainly used to provide enterprise networks to carry inter-site and inter-company traffic. The terminology used in this section is further explained in the Glossary (Annex 17).

3.6 Our retail product market assessment is mainly concerned with services sold to end-user business consumers to support their business connectivity needs. Many business consumers such as, for example, large financial institutions that require high quality connections to reliably transmit data, are willing to pay a premium for dedicated services that give them high quality connectivity. Quality requirements may

[64] We note that the standard approach to market definition is to start with the narrowest product market and then apply the SSNIP test to see if it can be broadened. However, in the June BCMR Consultation we noted that given the complexity of the services considered and the number of possible permutations we would have to analyse, the above approach is the most appropriate.

differ for different consumer types, but in general, end-users that demand leased lines services need to ensure that they have reliable connectivity services that guarantee delivery of their voice, data and/or video services to a high standard.

Approach

3.7 We analyse each of the service types introduced in Section 2, and potential substitutes, and, rather than starting from the view that there is an 'intrinsic' demand for particular service types, we focus on the key underlying technical characteristics of each service.[65] These are summarised in Figure 3.3 below.

Figure 3.3: Key technical characteristics of leased line services

Characteristic	Definition
Availability	The percentage of time a transmission path is in a functioning condition.
Bandwidth	In digital telecommunications systems the rate at which information can be transferred. Measured in bits per second (bit/s).
Contention	A measure of whether a service provides dedicated capacity to an end-user or whether that capacity is shared amongst a number of end-users. A dedicated connection has a contention of zero.
Jitter	A measure of the variation of delay in transmission over a transmission path.
Latency	A measure of delay in transmission over a transmission path.
Range	The distance over which transmission is supported.
Resilience	Provision of alternative resources (equipment or route) to protect against failure and enabling higher availability.
Security	A measure of the confidentiality and integrity of a communications service.
Symmetry	The ratio of transmitted to received bandwidth. Symmetric services have identical transmit and receive bandwidths, asymmetric services have differing transmit and receive bandwidths.
Synchronisation	The delivery of the accurate timing information needed for services such as mobile backhaul and telemetry.

Source: Ofcom 2012

3.8 The differences in these service characteristics may be important reasons why end-users require a particular type of leased line service over another. Additional evidence is provided by comparing prices and costs, where relevant, of different services – as where there are large differences in competitive price levels (which we

[65] We consider this is consistent with the Explanatory Note. See, in this respect, Section 4.2.3 where the Explanatory Note states "[t]he key elements in the demand for and supply of dedicated connections are service guarantees, bandwidth, distance and the location or locations served. There may also be qualitative characteristics because in some cases distinctions are still made between voice grade and data grade circuits".

expect to be close to costs), we consider that it is less likely that services are close demand-side substitutes. This analysis is used to specify market boundaries by determining which services are demand-side substitutes for each other.

3.9 In addition, we consider whether a wider set of products and services, which were not included in the initial starting definition of leased lines, might act to constrain some or all of the starting leased line services. These alternative telecommunications services do not share all of the typical characteristics of a leased line, but they may be a realistic alternative for sufficient (current) users of leased lines to impose a competitive constraint. For example ADSL broadband and some VPNs do not provide dedicated capacity (and they may entail some compromises in service quality), but they may be able to deliver a sufficiently high service quality to act as a competitive constraint on certain leased line services. At the other end of the spectrum there are other 'high-end' business connectivity services – such as WDM services – currently sold at a premium that may also be in a leased line market. Therefore, our retail product market assessment considers both the narrow set of leased lines services and the wider products and services, which might act to constrain some or all of the starting leased line services.

Responses to the June BCMR Consultation about our approach to retail product market definition

3.10 BT commented on the general framework we used for our retail analysis. BT noted that market definition in the BCMR is unusually complex as the market is characterised by high levels of customisation and bespoke services, with a complex production chain.

3.11 BT did not agree with our approach to retail product market definition, arguing that our starting "focal product" was arbitrarily narrow, and that this had led us to define excessively narrow markets. BT also suggested that we had erred in our market definition as we based our analysis on point-to-point circuits, whereas most leased lines are in fact sold as part of multi-site solutions. In particular, BT argued that:

- the pricing structure of multi-site solutions differs from that of point-to-point circuits in that the price of the solution is not simply the sum of the individual circuit prices;
- we placed too much emphasis on the technical properties (such as bandwidth, contention and latency) given in Figure 3.3 above. BT argued that a multi-site solution may have different properties (for example, access bandwidth) to the individual circuits, or that these properties (for example, contention) could be chosen by the customer independently of the underlying technology;
- these factors make it difficult to assess the scope of substitution between different multi-site packages; and
- market shares based on circuit counts are likely to be of little value as an indicator of market power in the context of multi-site connectivity.

3.12 BT argued that our approach led to errors in the assessment of market share and hence market power based on the derived wholesale definitions. Here BT expressed the view that, owing to our approach to retail product market definition, our proposals did not take account of all the constraints on prices in the market under consideration.

3.13 BT also raised a number of specific points related to our approach to assessing Issues 1-5, which we have discussed under the relevant heading.

Ofcom's view

3.14 In this Section, we set out responses to the comments BT made on our approach to market definition. We did not receive any other responses on this issue.

3.15 BT's argument about our "focal product" being arbitrarily narrow challenges, in our understanding, our description of a leased line as set out in paragraph 3.5 above. In doing so, BT seeks to distinguish our description from that set out in the Explanatory Note to the EC's Recommendation.[66] In particular, BT argues that our focus on point-to-point communication between pairing of sites has the consequences we summarise in paragraph 3.11 above.

3.16 First, we consider that our description of a leased line is appropriate to national circumstances and also consistent with the Explanatory Note's description. Furthermore, and for the reasons set out in this Section, it is supported by our assessment of the key underlying technical characteristics of the services that might be classified as leased lines.[67]

3.17 Secondly, contrary to BT's argument, we have not started with a single narrowly defined focal product and progressively broadened the market because (as BT says) it would become unusually complex for the purposes of analysing leased lines. The large number of different leased line products would make identification of the single "focal product" and its closest substitutes very difficult and potentially arbitrary. Equally, we have not assumed a broad market definition because such an assumption could lead to error. For example, it could mean that we subsequently overlook market power in the supply of a more narrowly defined product market, or find SMP in a broad 'market' when parts of it are effectively competitive.

3.18 By adopting an issue-by-issue method, our approach to retail product market definition overcomes these difficulties. This approach was developed for the first leased line market review in 2003/4 and we used it in the 2007/8 Review. As noted in the June BCMR Consultation, there was in the responses to the 2011 CFI broad high level agreement on the key issues identified and no stakeholder suggested that there were other issues that should be highlighted.[68] We therefore remain of the view that our approach is an effective way of identifying substitute products and constraints on prices and has the benefits of practicality, consistency over time and acceptance by many stakeholders.

3.19 Using this approach, we reach a judgement on market definition taking into account all the constraints identified in our issue-by-issue analysis. Services which are outside the identified product markets are considered again in the SMP assessment[69] as a source of external constraints on prices. We therefore consider that we have properly taken into account all relevant competitive constraints.

[66] Explanatory note 2007 (Second Edition), accompanying document to the Commission Recommendation 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.

[67] The identification of which, as noted above, we consider is consistent with the EC's Explanatory Note (see Section 4.2.3).

[68] See paragraphs 3.5 and 3.6 of the June BCMR Consultation.

[69] See Section 7.

3.20 Further, we do not agree with BT that the prevalence of multi-site packages undermines our approach to retail product market definition. Multi-site packages can be seen as bundles of leased lines (plus other services), and the choice of different packages involves a choice (whether explicit or implicit) as to the underlying components. The service characteristics end-users demand at the retail level influence which forms of underlying connectivity can be used to provide the services.

3.21 As with other products which may sometimes be sold in bundles, this practice does not necessarily mean that the bundle is, in itself, the relevant market at the retail level. In addition:

- not all retail customers require multi-site connections;
- retail customers that do require multi-site connections do not always purchase connectivity to all sites from a single supplier, and others that do purchase multi-site connections from a single supplier may have considered a purchase from multiple suppliers as another option;
- even where the purchase is from a single retail supplier, the underlying wholesale products may not need to be supplied by the same operator since interconnection is possible (and is a requirement where an operator has SMP);
- competitive conditions may differ between components of a multi-site package, either because of geographic variations in competitive conditions, or variations between different services which may be included in the package. For example, one service in a package may be provided competitively (e.g. a high bandwidth connection in London), but others (low-bandwidth services or connections to sites in other parts of the UK) may not be; and
- BT has not offered a coherent set of alternative market definitions, or showed how a focus on multi-site packages would lead to such a set.

3.22 In any case, retail bundling would not constrain wholesale market power as, in order to supply a retail bundle, an operator would require access to all the individual components of the bundle. Hence, regulation of all the wholesale services where there is SMP would be needed to enable competition to occur in the bundle. Moreover, in this market review, for the purpose of assessing market power in wholesale markets where CPs generally purchase terminating and trunk segments, it is appropriate to focus on the underlying infrastructure for any market definition and subsequent market power assessment.[70]

3.23 We also note that, if we were to consider multi-site solutions, the resulting retail product market definitions could be broader than the ones we have proposed.[71] This would result in reduced granularity in our analysis which we do not consider would be appropriate given the significant heterogeneity of leased lines services. We return to this point in our assessment of bandwidth breaks, where BT has in some instances argued for narrower markets, despite its assertion that bandwidth-dependent costs are of limited significance in multi-site packages.

[70] The OFT guidelines on market definition note that whether it is appropriate or not to reflect bundling in market definition "depends on the investigation." See OFT 403, December 2004, paragraph 5.11.

[71] On the other hand, BEREC note that "retail bundling could have the effect of diluting the [indirect] constraint on the wholesale provider imposed by competition at the retail level": Report on impact of bundled offers in retail and wholesale market definition, December 2010.

3.24 While the focus of our analysis does not make it necessary to look in depth at whether there may be separate downstream markets for multi-site purchases, we recognise that they are a market feature that may inform our assessment of competitive conditions. Therefore, where appropriate, we have taken multi-site purchases into account, for example in our assessment of buyer power.[72]

Ofcom's conclusion on the approach to retail product market definition

3.25 In the light of the above considerations we have not made changes to our general approach to retail market definition as set out in the June BCMR Consultation. In the remainder of this Section we discuss the specific market definition Issues (1-5) as set out above.

Issue 1: Technology and service requirements

3.26 As set out above, our starting point is to assess demand for dedicated leased lines services. Given end-users have specific service requirements, we have considered how far the characteristics of particular leased lines services matter and whether the differences are significant enough to lead to separate markets for leased lines services with different technological characteristics.[73]

3.27 In the June BCMR Consultation we proposed to classify two types of retail leased line services, namely 'Traditional Interface' (TI) services and 'Alternative Interface' (AI) services. Retail TI leased lines provide dedicated symmetric transmission at a range of bandwidths between two third party end-user premises using SDH or PDH transmission via copper or fibre.[74] We classified analogue circuits as a TI service. Retail AI leased lines also provide dedicated symmetric transmission at a range of bandwidths between two third party end-user premises, supplied generally by means of Ethernet over fibre.[75]

3.28 In line with the June BCMR Consultation our discussion of Issue 1 is split into two parts. We first discuss whether analogue and SDH/PDH leased lines are in the same market, before considering whether there continue to be distinct retail markets for AI and TI leased lines. Under each heading we first set out the proposals we made in the June BCMR Consultation, together with the reasoning which underpinned them. We then summarise the responses we received and explain how we have taken the responses into account in reaching our final conclusions. We then present our conclusions.

[72] The role of multi-site purchases is also discussed in Sections 4 and 7.

[73] Our assessment here is focused on the different technologies associated with dedicated leased lines connections. Wider telecommunication services that may be a substitute to leased lines are discussed in this Section under Issue 2 (VPNs) and Issue 3 (Broadband).

[74] Demand for wholesale TI and AI circuits arising from retail VPNs and other services outside retail leased line markets is taken into account when assessing wholesale market shares for our SMP assessment.

[75] As discussed in Section 2 Ethernet is not the only form of alternative interface and other AI interfaces include FICON and Fibre channel. Additionally AI services can be supplied over copper: EFM services, which are based on multiple copper access lines bonded together and at the retail level are used to deliver Ethernet at low bandwidths to businesses, are included in the AI market.

(i) Analogue and SDH/PDH leased lines

Our proposals in the June BCMR Consultation

3.29 In the June BCMR Consultation we proposed that analogue and low bandwidth SDH/PDH leased lines are in the same market.

3.30 In support of this proposal we noted that:

- the services in question are based on legacy technologies which are no longer being developed and therefore the functional capabilities of the technologies are unlikely to have changed significantly;
- many analogue and low bandwidth SDH/PDH leased lines run on the same network using the same technology – this suggested that any significant changes in costs are likely to have affected both services and hence be reflected in the competitive price levels of both; and
- research found that end-users would be likely to switch between these services in response to changes in relative prices. Although the research was conducted for the 2007/8 Review, we considered the results were robust since the services are based on legacy technologies and the profile of end-users is unlikely to have changed materially.

Responses to the June BCMR Consultation

3.31 Only BT commented on our proposal for a combined market for analogue and low bandwidth SDH/PDH leased lines. It agreed with our analysis, but considered that we were inconsistent in recognising the role of "emulation" in the provision of these services but not in others (e.g. TI/AI).[76]

Ofcom's view

3.32 In the June BCMR Consultation we did not refer to emulation in the context of analogue and SDH/PDH leased lines. The key reasons for finding a single market are those set out in paragraph 3.30 above (which were also included in paragraph 3.21 of the June BCMR Consultation). Our analysis looked at whether the two services are substitutes, irrespective of whether or not one of them is described as an emulated service. We consider that the available evidence leads us to conclude that this is the case for analogue and low bandwidth SDH/PDH leased lines.

Ofcom's conclusion on the inclusion of analogue and low bandwidth SDH/PDH leased lines in the market

3.33 In light of our analysis in the June BCMR Consultation and stakeholder responses we conclude that analogue and low bandwidth SDH/PDH leased lines are in the same market.

[76] For example in the AI/TI context, "emulation" would refer to the provision of a service imitating, as far as possible, TI characteristics and behaviour, delivered to the user using suitably adapted AI technology and service platforms.

(ii) Traditional interface versus alternative interface

Our proposals in the June BCMR Consultation

3.34 In the June BCMR Consultation we proposed that there are distinct retail product markets for AI and TI leased lines. This was based on a consideration of:

- a qualitative assessment of the current capabilities of AI and TI services;
- a forward looking assessment of market developments;
- evidence from consumer surveys;
- relative price comparisons;
- migration trends; and
- an assessment of barriers to switching.

Below, we set out our analysis of each of these matters in the June BCMR Consultation, before summarising stakeholder responses and our view on those responses.

Qualitative assessment

3.35 We explained that carrier class Ethernet equipment based on IEEE, ITU-T and MEF standards has become available and has been deployed by CPs, including BT.[77] We noted that we expect carrier class Ethernet to gradually displace earlier Ethernet services and that carrier class Ethernet services have narrowed the differences between Ethernet and SDH/PDH services. This is shown by Figure 3.4 below (reproduced from June BCMR Consultation) which compares the key features of SDH/PDH and carrier class point-to-point Ethernet leased lines services.

[77] The Institute of Electrical and Electronic Engineers (IEEE) modified the Ethernet standards to improve management and scalability. Further work by the IEEE and the International Telecommunications Union Telecommunications Standardisation Sector (ITU-T) added operations, administration and maintenance functionality. Alongside this, work by the Metro Ethernet Forum (MEF) defined the characteristics of Ethernet-based services to facilitate interworking between equipment and networks.

Figure 3.4: Comparison of key features of SDH/PDH and carrier class point-to-point Ethernet leased line services

	Point-to-point Ethernet (carrier class)	**SDH/PDH**
Contention	Dedicated	Dedicated
Distance limitations	Not limited	Not limited
Jitter	Low (load dependent[78])	Low
Latency	Low (load dependent)	Low
Resilience	High	High
Symmetry	Symmetrical	Symmetrical
Synchronisation	Networks supporting resilient synchronisation beginning to be deployed. Not supported by older carrier Ethernet services	Networks support resilient synchronisation of end-user equipment

Source: Ofcom 2012

3.36 We then considered, in detail, how market developments have affected distance limitations, latency, jitter and synchronisation, and resilience (the characteristics identified in the 2007/8 Review as important differentiators between SDH/PDH and Ethernet services).

Distance limitations

3.37 We noted that distance limitations on Ethernet services have now largely disappeared and CPs now offer long distance services across the UK.[79]

Latency, jitter and synchronisation

3.38 SDH/PDH leased lines are used for their ability to deliver Time Division Multiplexed (TDM) services which are deterministic in operation and therefore offer low and predictable latency and jitter and support for synchronisation. These features are important for certain applications including for example:

- Electricity network protection applications – electricity networks use TI leased lines for telemetry applications that control their electricity distribution networks. These applications require low delay and jitter performance.

- Mobile backhaul – mobile operators have to keep their mobile base stations synchronised to a reference clock source. TI leased lines are used to backhaul traffic from base stations to mobile switching centres and as a reference timing

[78] See paragraph 3.39 below.

[79] As noted in Figure 3.4, the introduction of defined carrier class Ethernet standards have enabled long distance native Ethernet services to be carried.

source to maintain synchronisation (see Section 4 for a more detailed discussion).

- Legacy voice services – TDM telephony services such as ISDN Primary Rate Interface (also known as ISDN30) are designed to use TDM leased lines as their bearer circuits.

3.39 Ethernet services use packet transmission techniques and unlike SDH/PDH services are designed to handle bursts of traffic that exceed the service capacity for short periods of time. They do this by buffering traffic for later transmission. Therefore, latency and jitter performance inevitably degrade at high traffic loads, making the service quality provided by point-to-point Ethernet services, unlike TI services, load dependent. Older Ethernet services had a higher and more variable latency and jitter and, as a result, were unable to support synchronisation. However, we noted that provided traffic loads are adequately managed, carrier class Ethernet services now used in point-to-point solutions offer latency and jitter performance that is comparable with SDH/PDH services.[80]

3.40 We also explained that, to the extent that differences in latency and jitter performance remain, these differences are becoming less important as mainstream enterprise applications are increasingly migrating to Ethernet/IP technologies and are therefore designed to accommodate the performance characteristics of Ethernet services. For example IP based enterprise voice telephony applications such as SIP Trunking and IP Centrex can use Ethernet leased lines services unlike their predecessors that require SDH/PDH leased lines.[81]

3.41 Finally, we noted that another major development since the 2007/8 Review is that CPs are beginning to deploy carrier class Ethernet services that support synchronisation protocols such as SyncE and IEEE 1588. The main application for these services is expected to be mobile backhaul (see Section 4 for a further discussion).

Resilience

3.42 Older Ethernet services were based predominantly on point-to-point fibre circuits and did not offer the same level of resilience as SDH/PDH services. We noted that this issue has now been largely addressed by CPs who have launched new carrier class point-to-point services with high resilience options (such as dual circuits with diversified routing and automatic switchover) that more closely match the capabilities of SDH/PDH services.

Forward looking assessment

3.43 As part of the qualitative assessment we also considered whether expected market developments over the timeframe of this review could impact our conclusions.

3.44 We noted that Ethernet leased lines services have developed considerably with the widespread deployment of carrier class services and Ethernet can now be

[80] The MEF service description provides an example of this, see: http://metroethernetforum.org/metro-ethernet-services.pdf

[81] This said, we note that SIP Trunking is not seen as equivalent to a traditional voice service as there are perceived quality differences and barriers to switching that mean it is not a fully effective substitute. For full details of this see Ofcom's "Wholesale ISDN30 price control Statement", paragraphs 4.60, 4.64 and 5.112: http://stakeholders.ofcom.org.uk/binaries/consultations/isdn30-price-control/statement/ISDN30_Statement.pdf

considered a mature service. Thus from a technical perspective, we stated that we do not expect major innovations over the timeframe of this review other than the deployment of services supporting synchronisation.

3.45 We considered that, although Ethernet services cannot match all of the characteristics of SDH/PDH services, as discussed above, these differences are becoming progressively less important as mainstream enterprise applications migrate to Ethernet/IP technologies and are therefore able to use Ethernet leased lines. Thus while legacy applications and some specialist applications will continue to require SDH/PDH leased lines, we stated that we expect that many businesses will increasingly favour (lower cost) Ethernet services over TI services. However, we explained that migration of enterprise applications can be disruptive and typically requires investment in new or upgraded equipment. We therefore stated that we expect migration to proceed gradually and that there will be significant demand for TI leased lines during the timescale of this review and beyond.

Consumer survey analysis

3.46 To help establish the importance of service characteristics to end-users of leased lines we referred to an independent market research report commissioned by Ofcom, which was carried out by Jigsaw research. The market research involved interviews conducted in the summer of 2011 with 461 companies that purchase business connectivity services. The companies were selected to provide coverage of a range of business sizes, industry sectors and regions.[82]

3.47 Although these survey results were used to inform our market definitions, we noted that the results should be seen as suggestive rather than definitive as they are subject to important caveats. Notably, they were based on claimed behaviour as opposed to observed consumer behaviour and, despite being based on robust sample sizes, could be subject to certain margins of error. In particular when interpreting the research results we explained that care is needed for the following reasons:

- for some service groupings and questions there are small sample sizes which means that in some cases analysis of the results can only be indicative;[83]
- some technologies may be able to offer a greater range of services and hence it may be that end-users find it difficult to isolate the service that is of interest, e.g. the leased line service may also include value-added managed IT solutions as part of the contract;[84] and

[82] The research sample was structured to ensure an even split between small (10-100 employees), medium (101-500) and large (501+) companies. Sector and region were broadly represented but some of the low incidence sectors or regions were boosted to allow for analysis. As the survey participants were a random sample; this meant that (subject to sample size) the survey was able to provide us with robust inferences to the demands of the broader population of leased line end-users.

[83] In some cases this reflected the low overall population of respondents that used particular leased line services or in a particular sector or region. In addition, some questions were “nested” such that an initial question could yield multiple answers. Hence, even where initial sample sizes were quite high, because questions were asked of a smaller sub-set of the original sample this sometimes resulted in insufficiently large samples for the follow-up questions.

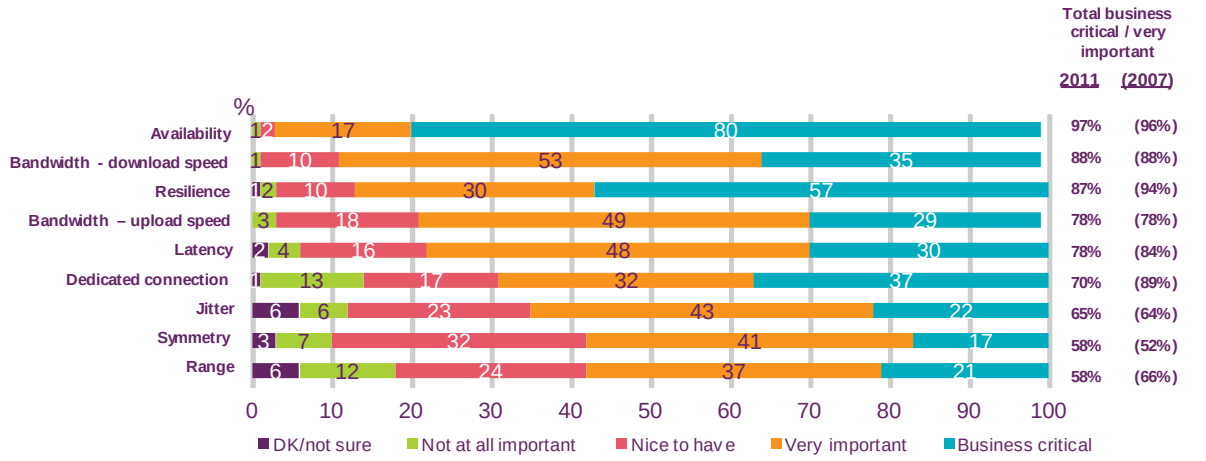
[84] A possible way to overcome this is to use conjoint analysis which requires research participants to make a series of trade-offs to isolate the service that is of interest. This approach was used in the consumer survey in the 2007/8 Review, but we were unable to obtain robust results. Therefore we did not try to replicate the results of the analysis for this review.

- there may be other factors that influence consumer choice, such as whether they have an affinity to a particular service provider's brand, which means that the consumer would be willing to pay a premium to access that brand, even if it is only available on a sub-set of technologies.

3.48 A full copy of the independent market research report is available on Ofcom's website.[85]

3.49 In order to inform our understanding of the importance of the different service characteristics of a leased line, we asked those interviewed to rate the importance of nine service characteristics to their business on a scale from business critical, to not at all important. Figure 3.5 below (reproduced from June BCMR Consultation) provides a summary of these results and provides a comparison with the results of the 2007/8 Review where the same question was also asked. We noted that for jitter and latency, two characteristics where AI and TI leased lines differ most markedly, the results suggested their importance to users of business connectivity services is broadly the same as in 2007.

Figure 3.5: The importance of service characteristics



Source: Ofcom end-user research, QC1 (2011 n=461; 2007 n=450)

3.50 Expanding on this question respondents were asked to think about how their business connectivity requirements might evolve over the next two years,[86] and to state whether each of the above service characteristics is likely to become more important, less important or to stay about the same in importance. For each of the characteristics listed above, over 95% of respondents stated that the characteristic would be more important or stay about the same in importance over the next two years. Only a small proportion (<5%) of respondents thought that latency and jitter would become less important, while 28% thought that latency would become more important and 23% thought jitter would become more important. We noted that if this is borne out in practice, it may act as a brake on migration from TI to AI, as it could offset the reduction in the disparity between TI and AI latency and jitter performance.

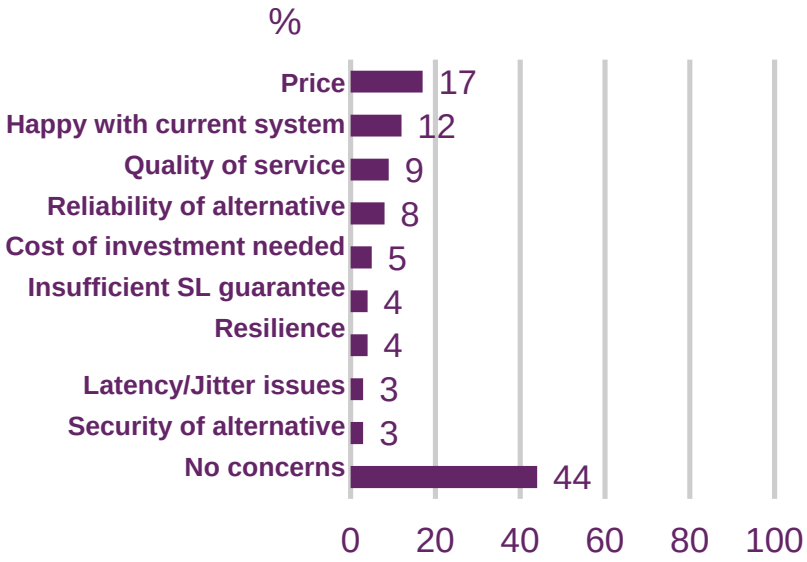
3.51 We also asked current users of TI services to consider the service characteristics of analogue or SDH/PDH leased lines compared to Ethernet leased lines and to identify the challenges or concerns they have about replacing analogue or SDH/PDH leased

[85] http://stakeholders.ofcom.org.uk/binaries/consultations/business-connectivity/annexes/business-review.pdf

[86] This question was based on a two year time horizon which was considered to be a reasonable planning period and comparable to our forward look, which covers the duration of this review.

lines with Ethernet lines. Respondents were able to identify more than one challenge or concern. The results across all respondents are summarised below in Figure 3.6 (reproduced from June BCMR Consultation).

Figure 3.6: Challenges or concerns about replacing TI services with Ethernet



Source: Ofcom end-user research, QE5 (n=177)

3.52 We observed that the responses to this question indicated that notwithstanding respondents' views about the increasing importance of latency and jitter over the next two years, only a small minority consider these characteristics to be a barrier to switching from TI to AI leased lines. We explained that several of the other challenges and concerns identified by respondents may however relate to differences in the characteristics of TI and AI leased lines, or at least end-users perceptions of them (quality of service, reliability of alternative, insufficient service levels guarantees (SLGs), resilience, latency/jitter and security of alternative). We further noted that among those who do mention challenges or concerns around replacing TI services with Ethernet, price (17%) and 'being happy with current system' (12%) are the two most quoted challenges/concerns.

3.53 We noted that the results from the end-user research suggested that there has not been a fundamental change in end-users' service requirements since the 2007/8 Review and that, with the advances in AI, some end-users perceive there to be fewer challenges to switching to Ethernet. However, we stated that there are still many TI end-users who identify challenges and concerns about switching to Ethernet that relate to differences in the characteristics of TI and AI leased lines or at least a perception of them.

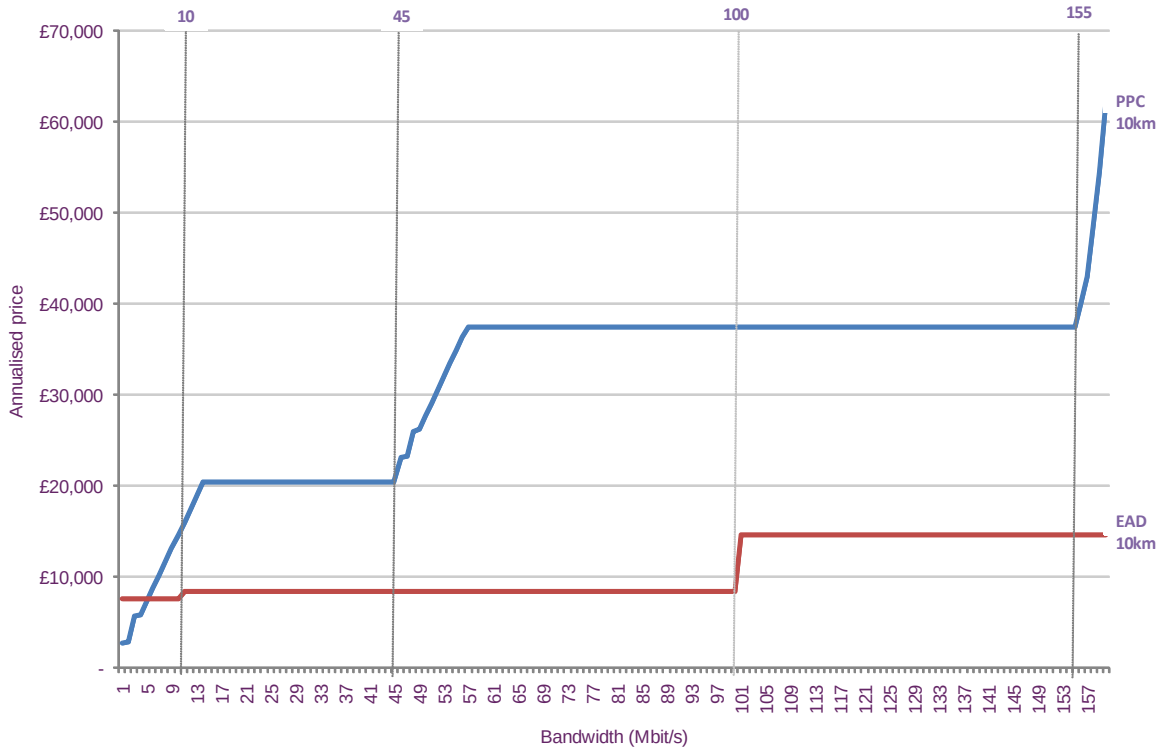
Relative price comparisons

3.54 We compared the relative prices of AI and TI services. Figure 3.7 (reproduced from June BCMR Consultation) shows the relative prices of AI and SDH/PDH services across a range of bandwidths. Our modelling was based on the underlying wholesale input services and prices, namely BT's EAD (AI) and PPC (TI) prices, with the assumption that these prices should provide a reasonable proxy for the relative differences in competitive retail price levels between services.[87] We analysed circuits

[87] The figure was constructed on the basis that the prevailing wholesale prices were at competitive levels. This is in line with EC guidelines, which state that we should proceed on this basis unless there is evidence that this is

of 10km and outside of the Central London Zone (CLZ)[88], but as sensitivity we also tested these relationships across a range of distances and our analysis showed that the general picture holds at both lower and higher distances.

Figure 3.7: PPC/EAD wholesale price comparison by bandwidth for a 10km service



Source: Ofcom analysis, based on BT wholesale pricelists for PPC and EAD services

3.55 We noted that the figure showed that at higher bandwidths, SDH/PDH circuits were still markedly more expensive than an Ethernet equivalent, which suggested that at higher bandwidths SDH/PDH circuits do not constrain the price of Ethernet circuits. At low bandwidths up to 6Mbit/s we noted it would still be cheaper to buy a PPC, whereas at higher bandwidths, it would be more economic to use an Ethernet service, if this met end-users requirements. Both of these results corresponded broadly to the findings in the 2007/8 Review.

3.56 We also considered the pricing of EFM services which provide Ethernet connectivity over multiple copper access lines. As EFM services use existing copper infrastructure they do not require the deployment of fibre. This means that EFM can be a lower cost alternative to dedicated fibre-based leased lines. To compare the relative prices of EFM and other leased line services we conducted research on the pricing of EFM packages offered by CPs. The research was carried out in February

not the case, and this applies both to unregulated prices, and also to regulated, cost-based prices (SMP Guidelines, paragraph 42). We did note, that there is the possibility that actual retail prices may differ from the wholesale cost, for example because of the way relative prices are set to recover common costs or because, if competition is not yet effective at the retail level, there is some supernormal profit. Both of these factors may have affected actual patterns of usage at the retail level.

[88] CLZ refers to an area of London served by the 0207 dialling code. For the CLZ, BT applies different tariffs for some, but not all, of its leased lines services.

2012 and was based on publicly available information on CPs' websites. In total we reviewed the packages offered by seven CPs, identifying 30 individual offerings.[89]

3.57 We observed that across the packages surveyed there was a considerable variation in EFM prices reflecting the different available bandwidths and service wraps. The most commonly offered bandwidths were 2Mbit/s, 10Mbit/s and 20Mbit/s, though increments between and above these bandwidths were available up to 45Mbit/s. On average, across the packages surveyed a 2Mbit/s service cost £2,000 per year, a 10Mbit/s service cost £4,800 per year and a 20Mbit/s service cost £7,300 per year.[90] We noted that at each bandwidth there was also a range of prices which in part reflected different service wraps, where at a given bandwidth higher priced services could be seen as 'Premium' services offering enhanced features compared with 'Basic' EFM. Enhanced features varied by package but typically included higher level service guarantees and priority customer support. Differentials in service wraps were to some extent reflected in the highest and lowest prices at a given bandwidth and this is highlighted in Figure 3.8 (reproduced from June BCMR Consultation) below.

Figure 3.8: Annualised prices for EFM services by bandwidth

Bandwidth	Number of packages	Average price	Lowest price package	Highest price package
2Mbit/s	4	£2,000	£1,500	£2,900
10Mbit/s	7	£4,800	£2,000	£8,400
20Mbit/s	6	£7,300	£3,200	£13,200

Source: Publicly available prices on CPs' websites

3.58 We also compared the prices of EFM, PPC and standard fibre-based Ethernet services. Our analysis indicated that to provide 2Mbit/s using a PPC in the same exchange area would cost approximately £2,000, increasing to £10,000 for 10Mbit/s and £13,000 for 20Mbit/s.[91] For standard fibre-based Ethernet our estimates indicated that a 10Mbit/s service would cost approximately £3,000, increasing to just under £5,000 for a 100Mbit/s service.[92] A comparison with the EFM prices discussed above showed that EFM was priced at comparable levels to PPCs at 2Mbit/s. Packages were also available at 10Mbit/s and 20Mbit/s that undercut the charges for EADLA at 10Mbit/s and 100Mbit/s.[93] However, we noted that as bandwidth increases EFM became less economical (reflecting the cost of using additional copper access

[89] The research was based on the available prices for a three year contract; this was to allow easy comparison with our PPC and EAD prices which were also calculated over a three year term. If applicable the annual charges included the connection charge which was annualised over the three years. Our sample of EFM prices was limited because the majority of CPs do not provide pricing information publicly and instead price on application. We noted that this creates the risk of sample bias, as we only had a limited number of CPs in our sample there is the possibility that the unpublished prices could have been significantly higher or lower than the ones collected in our research.

[90] Our research included four packages at 2Mbit/s, seven packages at 10Mbit/s and six packages at 20Mbit/s.

[91] This and the EADLA charges were calculated using wholesale input prices using the same methodology as Figure 3.7.

[92] This was based on EADLA which is only available in same exchange areas.

[93] If there is no existing fibre and excess construction charges have to be incurred to deploy fibre, this would be magnified.

lines). Highlighting this, the most expensive EFM package covered by our research was for a 45Mbit/s service, which cost approximately £22,200 per year.

3.59 We observed that this analysis highlighted that EFM services are most likely to be a substitute for fibre-based Ethernet and PPCs (for users who do not require TI functionality) at low bandwidths. In order to assess the possible impact of EFM usage and to draw out the implications, if any, for market definition, we reviewed the available EFM volume data below, comparing EFM volumes to those for TI leased lines in particular.

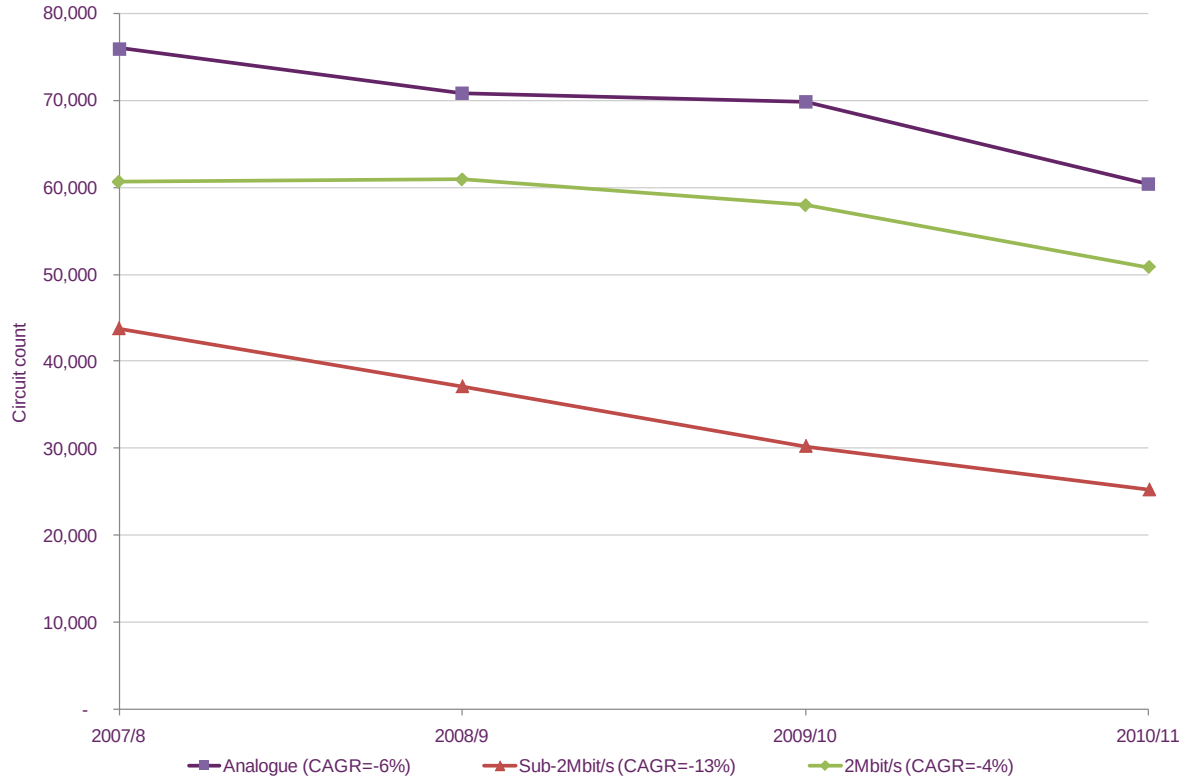
Migration trends

3.60 We noted that since the 2007/8 Review there have been significant structural changes in demand for business connectivity services, with a shift away from analogue and SDH/PDH leased lines towards Ethernet. To understand how the retail market has evolved we looked at the retail installed service volume data provided to us by CPs. This data was subject to some important caveats. In particular, some CPs were not able to collate full historic data for service volumes, while a number of CPs were not able to break out historic service volumes by bandwidth.[94] Nevertheless, we considered that the data should provide a reasonable guide to market developments over the last four years and we have reproduced the relevant charts below.

3.61 The trends in low bandwidth and high bandwidth TI services are shown in Figure 3.9 and Figure 3.10 respectively (reproduced from the June BCMR Consultation) where volumes by bandwidth for all CPs (including BT) as of Q4 in 2007/8, 2008/9, 2009/10 and 2010/11 are plotted.

[94] This predominantly affected AI services, where approximately 15% of services were not broken down by bandwidth.

Figure 3.9: Retail volume trends in low bandwidth TI services, 2007/8-2010/11

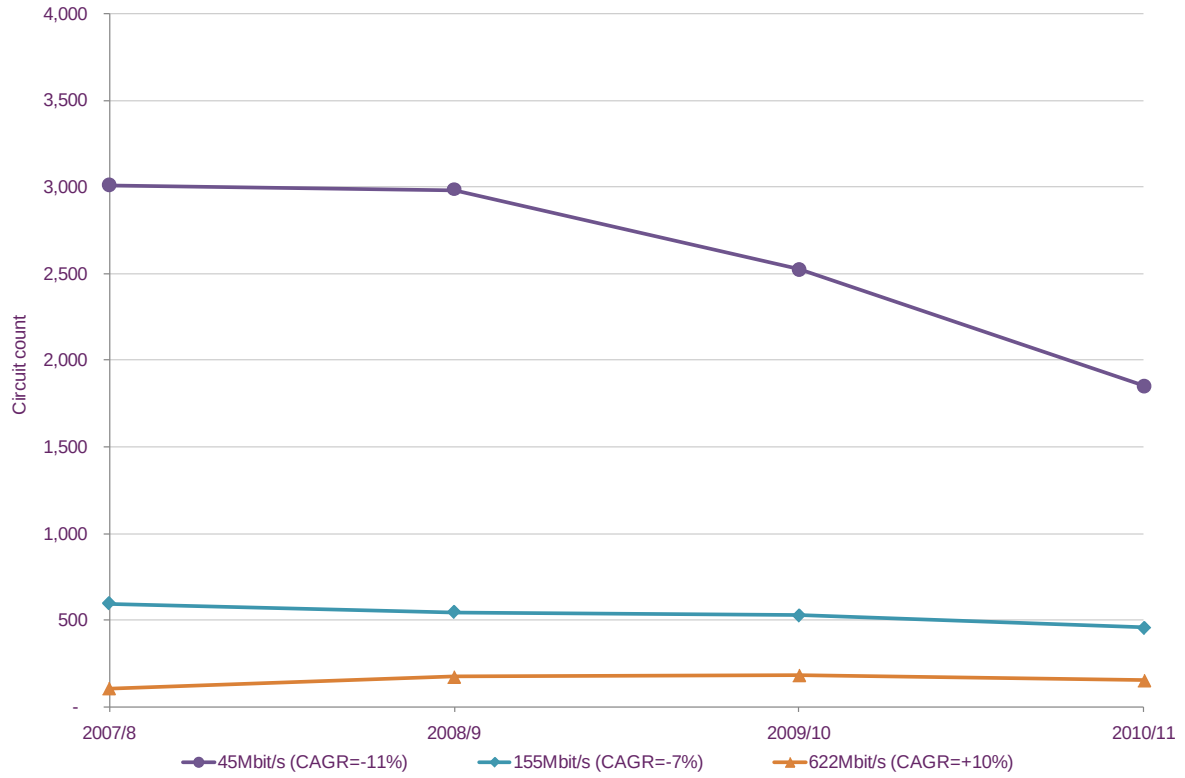


Source: CP's responses to s.135 information request, 2011

3.62 We noted that the figure shows that, at low bandwidths, TI services have been in steady decline since 2007/8. Sub-2Mbit/s services saw the steepest decline with our estimates indicating that volumes fell by 43% (19,000 circuits) between 2007/8 and 2010/11. Over the same time period, volumes of analogue and 2Mbit/s services also fell, by 21% (16,000 circuits) and 16% (10,000 circuits) respectively. Even with these falls in Q4 2010/11 our estimates indicated that there was still a substantial installed base of approximately 136,000 low bandwidth TI circuits.

3.63 The trends in low bandwidth TI services were then compared to the trends for high bandwidth TI services shown in Figure 3.10 below.

Figure 3.10: Retail volume trends in high bandwidth TI services, 2007/8-2010/11

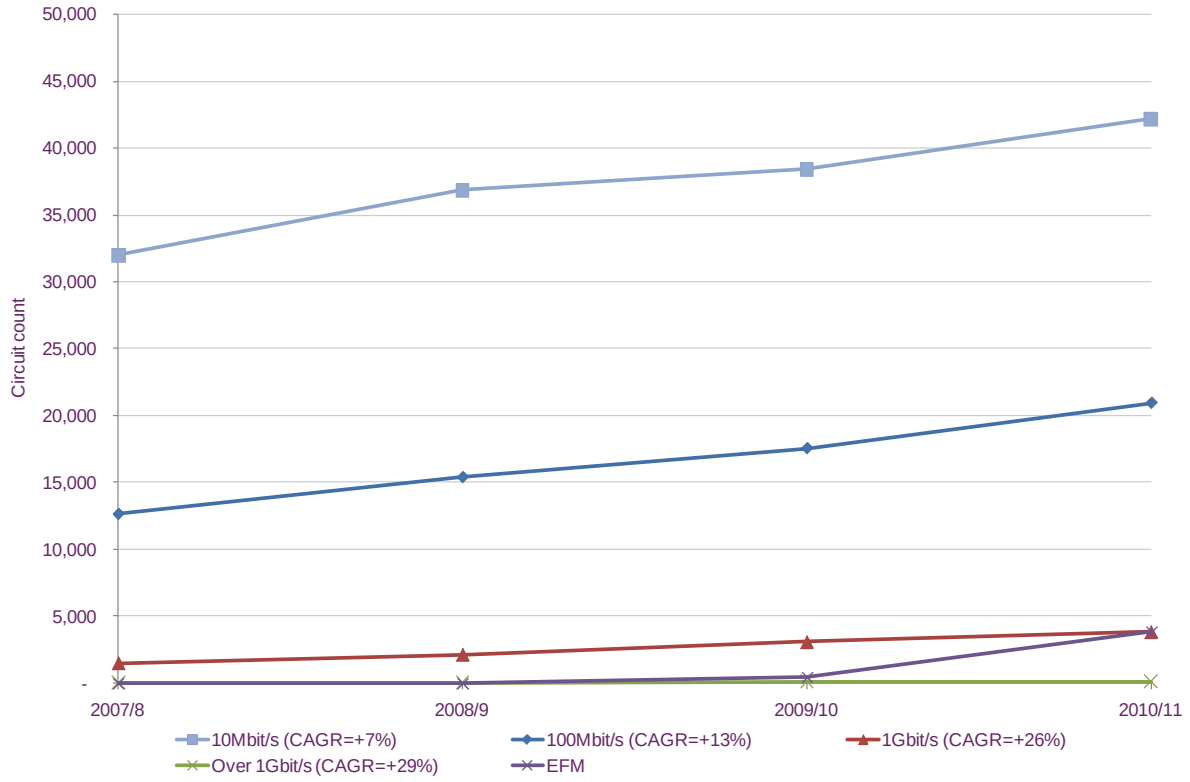


Source: CP's responses to s.135 information request, 2011

3.64 We observed that at high bandwidths there were only approximately 2,500 circuits. Of these, our estimates indicated that volumes at 45Mbit/s saw the steepest decline, with volumes falling by nearly 40% (1,200 circuits) between 2007/8 and 2010/11. Over the same time period volumes at 155Mbit/s also fell, but the fall was less marked at 24% (140 circuits). In contrast our estimates suggested that volumes of 622Mbit/s increased over this period, though we noted that as 622Mbit/s volumes only account for approximately 200 circuits the trend should be treated with caution as it is particularly susceptible to reporting errors.

3.65 For AI services, Figure 3.11 below shows the volumes by bandwidth for all CPs (including BT) as of Q4 in 2007/8, 2008/9, 2009/10 and 2010/11. As discussed in paragraph 3.60 because of the issues with the AI data we stated that these estimates should be seen as indicative of the trends in the AI services and not a definitive view on the market as a whole.

Figure 3.11: Retail volume trends in AI services, 2007/8-2010/11[95]



Source: CP's responses to s.135 information request, 2011

3.66 We noted that the figure illustrates that AI volumes at all bandwidths have increased in every year since 2007/8. In terms of service count, while the largest increases were at 10 and 100Mbit/s, there was also significant growth at higher bandwidths. For example our estimates indicated that between 2007/8 and 2010/11, volumes at 1Gbit/s increased by 152% (2,300 circuits) while our corresponding estimate for services above 1Gbit/s is 173% (100 circuits).[96] While these estimates should be treated with caution, they pointed to a market that is seeing significant growth.

3.67 The figure also includes our estimates of EFM service volumes. We noted that these have to be treated with caution as we only had full historic volume data for one CP, with four other CPs only providing data for 2010/11. We also recognised that as until recently the EFM market was dominated by smaller CPs whose volumes are not captured in our data request, even our estimate of volumes in 2010/11 is likely to be an underestimate. Therefore we also considered available industry research and in particular an Analysys-Mason viewpoint report published in October 2011 which discussed the prospects for EFM-based services and provided estimates for historical and forecast volumes.[97] The report noted that EFM services have seen strong growth, typically with a CAGR of around 100% (but from a low base) and

[95] Note we have not reported the CAGR for EFM as we only have full historical data for one CP, with four other CPs only providing data for 2010/11.

[96] Our analysis here excludes WDM-based services which are often used to provide bandwidths of above 1Gbit/s. The appropriate market definition for WDM services is discussed under Issue 5 in this section. We also note that while volumes of these services are low, in revenue terms they account for a larger percentage of the market.

[97] Bonded copper business broadband access services have good mileage yet to come, Viewpoint, Analysys-Mason, October 2011, available at: http://www.analysysmason.com/Research/Content/Viewpoints/RDTW0_RDME0_Bonded_copper_Oct2011/

estimated that the number of EFM services in 2012 is 15,000, forecast to increase to a peak of about 22,000 in 2014.[98]

3.68 However, when taken as a whole, we considered that while there has been significant growth in the AI market, the pricing and migration trend data did not support placing Ethernet and SDH/PDH circuits in the same market. On pricing we noted that there was no evidence that the price differentials between the two services were closing, which we would expect to see if they were close demand-side substitutes and both were competitively supplied.[99] On migration, we observed that the decline in TI volumes has been relatively slow given the observed difference in prices. This was especially true at high bandwidths, where given such large price differentials and clear savings already enjoyed by users of Ethernet circuits; we would have expected a larger proportion of SDH/PDH end-users to have switched. This suggested that for the end-users who are still using TI services, other factors like functional differences and switching costs may still be important. All these factors when taken together suggested that, on balance, a SSNIP on SDH/PDH services would be unlikely to accelerate migration to Ethernet to an extent which would make the SSNIP unprofitable. This suggested that AI and TI services continue to be in separate markets.

3.69 We also noted that with the introduction of EFM, a lower cost alternative to fibre-based Ethernet, there is an increased scope for substitution at lower bandwidths. However, our available evidence suggested that this is likely to be limited and that switching to EFM-based services, which are included in the AI market, will not have a significant impact on the low bandwidth TI market. For example, we noted that the Analysys-Mason viewpoint report estimated that EFM take-up will peak at 22,000 in 2014 (an additional 7,000 services).

Barriers to switching

3.70 Barriers to switching can arise from the need to change Customer Premises Equipment (CPE) or from concerns about service disruption or could reflect end-users' perceptions of differences between the two services. We noted that if barriers to switching between AI and TI services are significant this would be evidence in support of separate markets.

3.71 In our assessment, we noted that switching from a TI to AI-based service can be a complex process with the potential for service disruption. To avoid disruption typically a new service will be set up running alongside the current service for testing before any applications are migrated across. Before migration can happen, a change in the end-user equipment is also typically required. This means that current end-users wishing to switch from SDH/PDH to Ethernet need to make various investments so that corporate applications can be carried on Ethernet networks. Moreover, we noted that the move from a TI-based enterprise network to one based on Ethernet circuits may also require investment in desktop CPE, such as IP PBXs, to allow convergence of voice and data traffic onto Ethernet circuits.

[98] This is because over the long-term, EFM use is expected to decline in favour of NGA, principally because the latter is likely to be substantially cheaper.

[99] However, the market definition is not simply inferred from the observed price differential. Rather prices are seen in the context of other facts about the market including volume trends and the speed of migration. It is then possible to develop hypotheses to account for the observed combination of prices and volume trends. For example, a hypothesis that AI and TI services are very close substitutes and that the differences in characteristics do not matter very much to users would not seem to be consistent with these market facts. Our hypothesis is that they do matter, and this seems more consistent with the observed pattern of prices and volumes.

3.72 As such, we considered that the investments required of the end-user and the potential for disruption in changing over applications were likely to constitute barriers to rapid switching in response to a SSNIP, which is the relevant consideration for market definition purposes. Therefore, although the savings associated with the move from SDH/PDH to Ethernet are potentially quite high, we considered that migration would only proceed gradually.

3.73 We also discussed the results of our consumer survey, which suggested that while the equipment and application changes required to support equivalent services have become less of an issue over time, there was still a number of TI end-users, as shown in Figure 3.6, who identified challenges and concerns about switching to Ethernet. These either related to differences in the characteristics of TI and AI leased lines or at least a perception of them.

Responses to the June BCMR Consultation about our proposal for separate AI and TI markets

3.74 Only BT provided specific comments on our proposal for distinct AI and TI retail product markets. Five other respondents (EE/MBNL, Level 3, TalkTalk, Telefónica and [✂]) provided comments on the distinction between AI and TI at the wholesale level, which are also relevant to the retail discussion. BT and Level 3 did not support separate markets, while the other four respondents did.[100]

3.75 TalkTalk argued that the technical capabilities of AI and TI services mean that they are not fully effective demand-side substitutes for one another. For example, it stated that it has never considered deploying TI services for the purposes of providing backhaul in its LLU network (which it started to build in 2005/6).

3.76 Telefónica argued that there were additional barriers to switching for MNOs, including the excess construction often required to establish fibre-based AI services, which is another barrier to switching from TI to AI.

3.77 [✂] argued that while the market for TI services has been in decline since 2007, it saw the rate of decline slowing due to the fact that many of the circuits that lend themselves to migration have already moved. It argued that a significant proportion of remaining circuits would be unable to migrate due to various constraining factors such as voice requirements or the fact that they are point-to-point circuits.

3.78 In contrast, Level 3 re-iterated comments it made in the CFI, where it argued that the distinction between TI and AI was somewhat artificial as it was based on technological and product differences rather than distinct differentiation based on customer and supplier behaviour. It argued that application of the hypothetical monopolist test would indicate that substitution is sufficiently strong for AI and TI products to be in the same market.

3.79 BT argued that there is one-way substitution from TI to AI circuits and that the services should be in a combined market on this basis. It noted that this view has been adopted by a number of other European countries, including by the regulators in Germany, France, Italy and Portugal. In support of this view BT made a number of

[100] We also note that in the CFI eleven respondents commented on our question about AI and TI services, and all bar one respondent agreed that they should remain separate markets. For a summary of the responses on this point see paragraphs 3.27 to 3.30 of the June BCMR Consultation.

specific points on our approach in determining whether AI and TI services are in the same or separate retail markets, covering our discussion of:

- qualitative capabilities of AI and TI services;
- evidence from consumer surveys;
- relative price comparisons;
- migration trends; and
- barriers to switching.

BT's arguments on these points are summarised below.

Qualitative capabilities of AI and TI services

3.80 BT argued that as you can send the same information in a variety of ways, such as via an AI or TI interface, the interface used to send the information is not an important characteristic of the service. It further argued that technical differences we identified between AI and TI services only arise in the particular BT services examined, rather than being inherent to the service interfaces, suggesting that a service with full TI characteristics could be provided using AI technology if a CP wanted to do so.

Evidence from consumer surveys

3.81 BT stated that the survey evidence in the 2007/8 Review provided support for a combined market and argued that this has been supported by market developments since then. BT noted that we have not conducted a SSNIP test based on survey evidence this time, but instead rely on a variety of indirect evidence.

3.82 BT also disagreed with our interpretation of Figure 3.6 above (Figure 5 in the June BCMR Consultation) which we said showed that many TI end-users identify challenges and/or concerns about switching to Ethernet. BT suggested that this conclusion is "not at all self evidently correct."[101] It stated that it was likely that many of the users who had concerns would report multiple concerns, which could mean the proportion of end users with no concerns could be over 50%. It further argued that the fact that some users were happy with the current system or expressed concern about prices or the cost of investment did not provide "per se reasons for doubting the degree of technical substitutability between the services."[102] Moreover, even where end-users did express concerns BT expressed the view that end-users would be induced to switch in response to SSNIP.

3.83 DotEcon's report, on behalf of BT, also commented on the Jigsaw research. It argued that the value of the research was limited as we did not probe end-users on their recent purchase decisions or the range of factors that they would usually take into account when purchasing a leased line. It argued that the research was not an appropriate means for identifying potential substitutes that customers might consider.

[101] BT response, page 117, paragraph 67.

[102] Ibid.

Relative price comparisons

3.84 BT disagreed with the pricing comparison we carried out between PPCs and EAD/WES, arguing that we only compared the prices of BT products and based our estimates on selected wholesale inputs with no discussion of like for like retail pricing. BT further argued that, if we were to cross check with the prices of Other CPs' (OCPs[103]) products at both the retail and wholesale level, we would come to a different conclusion.

3.85 BT also argued that our comparison between PPC and EAD/WES is not a like for like comparison, as PPCs are services based on a national network of SDH equipment, while EAD/WES are services based on an end to end fibre. Therefore, in BT's view, the differences in prices are not driven by any cost differences resulting from the interface, but by the underlying network structure, and the reflection of this in the price (as the TI products we consider are equipment-intensive whereas the AI products are fibre and duct-intensive). BT further claimed that this means that the AI and TI services we considered are at different levels in the value chain and therefore their prices should not have been compared.

Migration trends

3.86 BT expressed the view that no weight could be put on the relative number of AI and TI circuits reported in Figures 3.9-3.11 (Figures 7-9 in the June BCMR Consultation) as there is likely to be a significant underreporting of retail services and self-provision, which would be missed in our migration analysis.

3.87 BT also noted that in our discussion of switching to broadband in the June BCMR Consultation we observed that some users of sub-2Mbit/s leased lines may have migrated to Ethernet. It suggested that this pointed to a combined market, albeit one of one-way substitution (as has been found in many European countries). If this is not the case, then BT alleged that the logical conclusion of our current position is that TI and AI will remain separate until the entire user base of TI services disappears.

Barriers to switching

3.88 BT considered that we had not quantified either the extent of investment required for migration or shown that these "represent a material barrier to overcome a SSNIP test."[104]

Ofcom's view about separate markets for AI and TI services

3.89 In the following paragraphs, we explain why, having taken into account stakeholders' responses and carried out further analysis, we have concluded it is appropriate to retain separate product markets for retail AI and TI services.

3.90 We note that this conclusion is consistent with the EC's Recommendation and SMP Guidelines, which we have taken utmost account of in our analysis, where our obligation is to define relevant markets appropriate to national circumstances in accordance with the principles of competition law. We recognise that this conclusion is different from the conclusions reached by some other NRAs in Europe, but note

[103] CPs other than BT.

[104] BT response, page 118, paragraph 72.

that it is inherent in the framework that different countries will come to different conclusions.

3.91 In particular, in the following paragraphs we discuss the comments received on the distinction between AI and TI in the following areas:

- qualitative capabilities of AI and TI services;
- evidence from consumer surveys;
- relative price comparisons;
- migration trends; and
- barriers to switching.

Qualitative capabilities of AI and TI services

3.92 Here we set out our conclusions having considered BT's comments, summarised above, on our qualitative assessment.

3.93 We do not agree with BT's view that the interface is not an important characteristic of the service as, although the same information can be sent over a variety of interfaces, the value of the data can depend on how it is sent. For example, for some users, synchronisation is important (e.g. electricity network protection applications) whilst, for others, very low latency is needed (e.g. stock traders). We also note that our comparison of AI and TI services in Figure 3.4 was based on generic AI and TI services and was not CP specific. For example, the provision of accurate timing data for synchronisation, low latency and low jitter are inherent qualities of TDM-based TI services, regardless of CP.

3.94 Further, to the extent that a service with full TI characteristics could be provided using AI technology if a CP wanted to do so, we consider that this only appears to mean that supply-side substitution could be technically feasible.[105] We note that it will often be the case that a single network can be used to supply many different services, but this does not imply that all services provided, or capable of being provided, over it form a single market.

3.95 Supporting this conclusion, a number of other stakeholders identified technical differences between AI and TI services that mean they are not full demand side substitutes. For example [✂] noted that many circuits would be unable to migrate due to constraining factors such as voice requirements. This was also identified in CFI responses, where [✂] noted that there are certain characteristics of AI and TI services that are not replicable, which means that there are many instances where a suitable AI-based substitute to a TI service does not exist. It considered that this situation was unlikely to change during the period covered by the market review. Supporting this, our discussion below on barriers to switching highlights that emulation of TI services over AI is not always suitable substitute for all TI-based applications.

[105] We explain in Annex 3 why we do not generally define markets on the basis of supply-side substitution. See, in particular, paragraphs A3.27 to A3.37.

Evidence from consumer surveys

3.96 Here we set out our responses to BT's comments, summarised above, on our evidence from consumer surveys.

3.97 We do not agree that BT's interpretation of the results of the 2007/8 survey is correct. In the January 2008 Consultation, we noted that the results of the survey suggested that in response to a SSNIP only 10% of TI users would switch to alternative services, which was well below the level of critical loss likely to render a SSNIP unprofitable.[106] This in turn indicated that AI services were unlikely to provide a sufficiently strong constraint on TI services to justify including them in a wider market, especially in the absence of strong price or trend analysis to support a combined market. We recognise that some caution is needed in interpreting survey results in relation to hypothetical questions such as those relating to a SSNIP, and consequently did not repeat the same questions as in 2007/8 in the most recent survey.[107]

3.98 We also disagree with BT's interpretation of Figure 3.6 (Figure 5 in the June BCMR Consultation). The results of our research as summarised in Figure 3.6 indicate that many TI end users identify challenges or concerns about switching to Ethernet. BT's comments on the proportion of end users who might have expressed no concerns are speculative. While we accept that some of the concerns, such as those regarding prices, do not preclude "technical substitutability"[108], the key factor in market definition is whether end-users will switch in response to a SSNIP. In this context, the fact that users have concerns does suggest that they may be less likely to switch in response to a SSNIP than if they had no concerns.

3.99 Nevertheless, we recognise that, if the respondents with no concerns were all marginal customers who would switch in response to a SSNIP, this would be significant.[109] However, given the size and duration of actual price differentials, we consider it likely that any such marginal customers would be likely to have switched already. We note that this view is supported by a number of stakeholders, for example, [✂] response noted that the rate of decline in TI is slowing due to the fact that many of the circuits that lend themselves to migration have already moved and that a significant proportion of remaining circuits would be unable to migrate due to various constraining factors such as voice requirements.[110] Further supporting this, we note that BT itself acknowledged that "the nature of many business applications

[106] See the discussion in paragraphs 3.164 to 3.171 of the January 2008 Consultation.

[107] We considered the 2007/8 analysis to be subject to a number of significant caveats, in particular see paragraphs 3.161, 3.167, 3.171 and 3.178 of the January 2008 Consultation. Therefore, for this Review, our SSNIP test has been informed by a cumulative assessment of the following:

- qualitative capabilities of AI and TI services;
- evidence from consumer surveys;
- relative price comparisons;
- migration trends; and
- barriers to switching.

[108] This is the technical ability of two services to perform a similar function, without an implication that users necessarily view them as close substitutes.

[109] As noted by BT, as respondents could identify more than one challenge or concern, it is possible that the proportion of end-users with no concerns could be up to 50%.

[110] See also the comments about continuing demand for ISDN30 services in the footnote accompanying paragraph 3.40 above.

means that the actual event of migration is tied to many other factors" and is "steady and persistent"[111], a view that is consistent with slow migration rather than a rapid response to a SSNIP.

3.100 Overall, we consider the results of consumer surveys are consistent with the gradual migration observed over time, with small changes in relative prices – i.e. in the range of 5 to 10% – having a limited effect.

Relative price comparisons

3.101 Here we set out our responses to BT's comments, summarised above, on our relative price comparisons.

3.102 We do not agree with BT's view that our price comparisons were incorrect. In the circumstances, the use of prices of BT wholesale products is reasonable and appropriate because:

- the SSNIP test is applied to the competitive level of prices;
- in a competitive market, it would be expected that prices would be approximately equal to cost;
- BT' s wholesale charges are subject to charge control or cost orientation and, as a result, will often also be reasonably close to cost, although possibly with some exceptions which we consider on a case-by-case basis.[112]

3.103 If, however, there is retail market power (and retail prices are unregulated), retail prices may not be closely related to costs. If such prices are used in the SSNIP test then this may result in an excessively broad definition.[113] Moreover, as recognised by BT, retail prices are typically unpublished and may vary from customer to customer. Therefore, in this context we consider that an analysis focused on retail prices would not be appropriate or practical.

3.104 We have also considered BT's argument that the price differences between AI and TI services do not arise as a result of the differences in the interface, but rather from the underlying network structure. We note that whether the observed price differences result from differences in the interface or are merely associated with them is not the key issue for market definition. What matters is whether the services are seen as substitutes, and the evidence suggests that they are not sufficiently close substitutes to be regarded as being in a single market. The large price differentials observed support the view that AI and TI are not sufficiently close substitutes.

[111] BT makes this comment in the context of broadband and leased lines, but it appears to be applicable here as well. BT response, page 120, paragraph 89.

[112] Moreover, this approach is in line with the SMP Guidelines, which state that we should proceed on this basis that the prevailing wholesale prices are at the competitive level, unless there is evidence that this is not the case. This applies both to unregulated prices, and also to regulated, cost-based prices (paragraph 42).

[113] This is known as the 'cellophane fallacy' and is named after the US case US v EI Du Pont Nemours & Co, 1956. This effect occurs because if prevailing prices are already above the competitive level, even a monopolist reaches a point where further price increases become unprofitable and where competitive constraints come into action that would not have applied at competitive price levels. If this is not taken into account, the erroneous conclusion could be reached that a monopolist who has successfully exercised market power by raising price is subject to competitive constraints since, starting from monopoly price levels, it would be constrained from implementing further price increases.

3.105 Further, we do not agree with BT that the comparison of AI and TI service prices in the June BCMR Consultation was invalid because the services compared are at different levels in the value chain. We consider that the comparisons were reasonable, since both the services in question are active services comprising fibre and equipment (albeit different types of equipment) and both can serve as a wholesale input upstream of a retail leased line (as they both provide terminating segments).

3.106 We also note that there is no consistent relationship between PPC and EAD prices at different bandwidths. A consistent relationship between the relative prices of AI and TI services might be expected if the price differential was simply a reflection of the extra quality of TI services and was constrained by the threat of switching to AI services. However, the lack of a consistent relationship is more consistent with prices being independent than it is with an equilibrium in a price/quality trade-off. This further supports our conclusion that the services are in separate markets.

Migration trends

3.107 Here we set out our responses to BT's comments, summarised above, on our analysis of migration.

3.108 While we accept that the data provided on trend volumes is subject to some limitations[114], we do not agree with BT that the limitations are sufficiently severe that no weight can be put on the estimates. The estimates show that there continues to be significant retail demand for low bandwidth TI leased lines and that this demand is likely to be sustained, albeit with steady and persistent migration, for the duration of this Review.[115] Supporting this conclusion, we note that [✂] stated that while the market for TI services has been in decline since 2007, it saw the rate of decline slowing due to the fact that many of the circuits that lend themselves to migration have already moved. For example, key users of low bandwidth TI leased lines include Airwave (the Police/Fire radio system) and network monitoring and protection applications for power and water utilities. These services use the characteristics of a TI leased line to perform their role. Moreover, we note that if it were the case that, as claimed by BT, volumes of retail TI circuits had been understated, one implication could be that TI services were of greater importance to end-users than we had believed.

3.109 We also consider that it would be a mischaracterisation of our observation in paragraph 3.213 of the June BCMR Consultation that some users of TI leased lines may have migrated to Ethernet, to say that this implies that there is a combined market for TI and Ethernet leased lines. The market definition (SSNIP) test requires that sufficient switching would occur within a short space of time to make a small increase in the price of one service unprofitable. However, the extent of such switching alongside the size of the price differences between AI and TI services, does not suggest that sufficient switching would occur in response to a SSNIP to render it unprofitable. The picture is one of a much more gradual migration over time.

[114] See discussion above in paragraph 3.60.

[115] Supporting this, we note that the forecast volumes of TI services in our charge control model, envisage that even at the end of this review period, in 2015/16, there will still be significant demand for TI services. These forecasts are discussed in Annex 12.

Barriers to switching

3.110 BT considered that we had not quantified either the extent of investment required for migration or shown that this represents a material barrier to overcome a SSNIP.

3.111 We have considered these comments, and set out below in more detail the potential barriers to switching, drawing on our own technical experience and other stakeholders' responses to the June BCMR Consultation. However, we note that the costs involved will vary by end-user, as for example, the costs of switching from TI to AI will be very different for end-users with large legacy networks, or those who use specialised applications, when compared to end-users with only a small number of non-specialist leased lines.

3.112 There are a number of options available to switch from TI to AI services. These include:

- changing the leased line service from a TI service to an emulated TI service[116], making no changes to the customer's equipment;
- changing the interfaces on the customer's equipment from a TI interface to an AI interface, e.g. from an E1 PDH interface to an Ethernet interface; and
- changing the customer's equipment and or system such that it performs the same function for end users but has AI service interfaces and can communicate using AI services.

3.113 For the first option, emulated TI, international recommendations have been put in place to provide the performance required to interwork with and in existing TDM networks and to support the distribution of timing and synchronisation.[117] However, emulated TDM services may not be a suitable substitute for all TDM applications as they generally exhibit greater latency, error bursts rather than single errors and, in certain circumstances, longer settling times after a protection switching event (within the transporting packet network). Even when suitable, before it can be deployed for TDM services, any system is also likely to require extensive testing, which is likely to act as a extra barrier given the age and difficulty of obtaining support for TDM equipment.

3.114 The second option would involve changing the equipment interface to AI to be compatible with the new AI service. As before, this would require parallel operation whilst the new service is tested. Although this would be the easiest option for migration, it would only be suitable for applications for which TI functionality is not needed. We note that [✂] expressed the view that many such circuits which lend themselves to migration were likely to have already moved.

3.115 Where neither of the first two options are feasible, then it would be necessary to adopt the third approach and replace the whole application system using the TDM services, e.g. telephones, PABX, standard telephony and certain utility applications. This is a significant barrier because it can require significant financial investment to cover the necessary development, testing, installation and commissioning of a complete new system. The magnitude of the barrier will depend on how large the

[116] This is also known as circuit emulated service or pseudo-wire service.

[117] ITU-T reference G.8261/Y.1361, available at: http://www.itu.int/rec/T-REC-G.8261-200804-I/en

system is compared to the capacity and capability of the operator of the system. In some cases it could take years to plan, develop and deploy the necessary changes.

3.116 Barriers to switching were also highlighted in a number of responses to the CFI, where [✂] noted that they require TI services beyond the period of this review primarily because there are many instances where a suitable AI-based substitute does not exist or because the transition to suitable alternative arrangements will not be complete until after this review period. A further barrier identified by Telefónica in the MNO context is that the transition from TI to AI will often require the deployment of fibre and the resulting excess construction charges.

3.117 The level of testing and bespoke nature of the solutions for options one and three are also important as they could produce a significant time delay, even once a decision to switch has been made. This is relevant as in the context of a SSNIP the period for switching to occur should be within a reasonable time frame.[118]

Ofcom's conclusion about separate markets for AI and TI services

3.118 We conclude that it is appropriate to retain distinct retail product markets for AI and TI leased lines. While there is a trend of customers switching over time from TI to AI, we do not expect a SSNIP to generate sufficient extra switching between AI and TI services for it to be unprofitable, for the following main reasons:

- a comparison of relative prices and migration trends indicates that even with quite large price differentials there has only been a limited degree of switching between the two services, with SDH/PDH in steady and persistent decline. There is also no consistent relationship between PPC and EAD prices at different bandwidths;
- a qualitative assessment shows that while carrier class Ethernet has narrowed the performance gap between AI and TI, there are still differences which mean that on a forward looking basis some legacy and specialist applications will continue to require TI services for the duration of this review period;
- consumer survey evidence, as summarised in Figure 3.6, shows that many TI end-users still identify challenges and concerns about switching to Ethernet which reflects differences in the characteristics of TI and AI leased lines, or at least end-users perceptions of them; and
- there are barriers to switching, including switching costs.

Issue 2: Virtual Private Networks (VPNs)

3.119 As discussed in Section 2, VPNs are an important means of delivering business services for many end-users. There are two types:

i) internet-based VPNs that use internet access connections as access connections (and sometimes also the internet for core connectivity); and

[118] See, in this respect, paragraph 52 of the SMP Guidelines. See also paragraphs 20 and 23 of the Commission's Notice on the definition of the relevant market for the purposes of Community competition law (97/C 372/03). The OFT guidelines on market definition also note that "[a]s a rough rule of thumb, if substitution would take longer than one year, the products to which customers eventually switched would not be included in the same market as the focal product" (see OFT 403, December 2004, paragraph 3.6).

ii) higher specification leased line VPNs that use leased lines as access connections and dedicated core networks.

3.120 VPNs therefore differ from leased lines that make use of dedicated point-to-point capacity over the entirety of the route. Given these differences, in this section we review whether VPNs are likely to provide a competitive constraint on the dedicated leased lines services (i.e. analogue, SDH/PDH and Ethernet).

3.121 In our assessment below, we first set out the proposals we made in the June BCMR Consultation, together with our reasoning. We then summarise the responses we received on this issue and explain how we have taken the responses into account in reaching our final conclusions. We then present our conclusions.

Our proposals in the June BCMR Consultation

3.122 In the June BCMR Consultation we proposed not to include VPNs as being part of either the retail AI or TI markets. This was consistent with the conclusions of the 2007/8 Review.[119]

3.123 For VPNs accessed via Internet links we considered that they were unlikely to be substitutes for point-to-point leased line networks because they did not offer comparable levels of reliability, performance or security, all of which were of considerable importance to leased line users. We also noted that VPNs were considerably cheaper than an equivalent network constructed from leased lines. We considered that, with these price savings available, if internet-VPNs were able to address the same needs as a leased line service then the majority of users would have switched to such VPN services already. The fact that there is still significant demand for leased lines despite the much higher prices suggested that these VPNs do not address the same end-user needs and were not close demand-side substitutes.

3.124 For VPNs accessed via leased lines, we considered they offered equivalent service features, but noted that they made heavy use of leased lines as an input and involve the additional provision of a network management function. For this reason these VPNs were best characterised as a downstream service rather than as a substitute for leased lines. The fact that leased lines were a significant input to such VPNs also limited the extent to which VPNs were able to constrain leased line prices. This was because if the price of leased lines increased then this would also affect the price of a VPN service that used leased lines as an input.

3.125 We also noted that, in the 2007/8 Review, our end-user survey included a number of questions on VPNs and leased lines. Taking the responses to all relevant questions together, the results suggested that VPNs were not likely to be seen as a good substitute for leased lines. We concluded that end-users would only be willing to switch to VPN services as part of a wider decision to replace all of their connectivity services, rather than in response to a SSNIP on either an AI or TI leased line service over relatively short timeframes. This end-user research also suggested that VPNs were often purchased alongside leased lines, rather than as a substitute for them.

3.126 We also identified switching costs which could inhibit substitution between VPNs and leased lines. In particular, it rarely made sense to switch to a VPN on a link-by-link basis and migrating to a VPN therefore required careful and costly management. We

[119] In the 2007/8 Review we carried detailed analysis on VPNs; see the January Consultation, paragraphs 3.187 to 3.255.

also explained that VPNs are usually managed by third parties, so any decision to move to a VPN was likely to involve a more wide-ranging decision to outsource functions such as IT support, which could also involve significant changes to staff and equipment. We concluded that these costs made it unlikely that end-users would substitute to a VPN simply in response to a SSNIP on leased line prices.

3.127 In light of the above analysis, we proposed not to include VPNs as part of either the retail TI or AI markets. We did, however, explain that it is important to assess demand from retail VPNs in our market review, as these services make use of wholesale leased lines as inputs to the service. Therefore we made sure that any demand for wholesale TI and AI circuits arising from retail VPNs was taken into account when assessing wholesale market shares for our SMP assessment.

Responses to the June BCMR Consultation about VPNs

3.128 Only BT commented on our proposal that VPNs are outside the retail AI and TI leased line markets. Whilst BT said that it agreed with Ofcom on this point and it accepted that VPNs were downstream of wholesale leased line markets[120] at the same time it commented that, with the advent of packet switching technology, VPNs increasingly offer a price constraint on leased lines as they will be a substitute for some customers. It also expressed the view that both EFM and xDSL broadband are relevant as access mechanisms to VPNs and form indirect constraints on AI and TI services.

3.129 We also asked respondents in the CFI for their views on whether VPNs continued to be outside the retail AI and TI markets. Twelve respondents commented on our question, nine [✂] were in agreement that we should continue to identify VPNs as a separate market - with many commenting that these services used leased lines as an input. Some respondents also highlighted that the quality characteristics of certain VPN services (such as IP-VPNs) did not make them a good substitute for dedicated services.

3.130 The three other respondents did not explicitly disagree with our proposals. One respondent [✂] noted that the distinction between leased lines and VPNs was being blurred as leased lines are now being included in the VPN offerings as opposed to being sold separately. Two other respondents highlighted the importance of VPNs and agreed that they were in a downstream market, although CWW said that wholesale rather than retail leased lines were inputs into retail VPNs.

Ofcom's view

3.131 We note that there was a broad consensus on our proposals and only BT provided specific comments.

3.132 In our SMP assessment we seek to identify all the constraints on prices in the market under consideration. In principle, services like VPNs, which are outside a market, can still exercise some constraint on market power in that market and our consideration of the strength of these constraints, where relevant, is set out in Section 7. However,

[120] BT states "We support Ofcom's conclusion at paragraph 3.86 (of the BCMR Consultation) not to include VPNs as part of either the retail TI or AI market." BT response, page 20, paragraph 20. In paragraph 3.86, we said: "Hence, we do not propose to include VPNs as part of either the retail TI or AI markets. We note, however, the comments of some respondents [to the CFI] that it is important to assess demand from retail VPNs in our market review, as these services make use of wholesale leased lines as inputs to the service. We agree with this view and have therefore made sure that any demand for wholesale TI and AI circuits arising from retail VPNs is taken into account when assessing wholesale market shares for our SMP assessment."

in general, constraints arising from services outside the market will tend to be relatively weak. We further note that as set out in Issue 1, EFM is included in the AI market, and that consideration of the constraint imposed by xDSL services is set out under Issue 3. We note that BT appears to accept that VPNs do not provide a sufficiently strong constraint on retail leased line prices for them to be included in the same market and accepts that VPNs are downstream of the wholesale markets we primarily focus on in the SMP analysis.

Ofcom's conclusion about VPNs

3.133 On the basis of our analysis, VPNs fall outside of the retail leased lines market. VPNs accessed via Internet links are unlikely to be close substitutes for point-to-point leased line networks as they are not able to offer the same service features, while leased-line based VPNs are excluded for the following reasons in particular:

- such VPNs appear to be more appropriately regarded as a service downstream of leased line markets as they involve not just the provision of a network but also of a network management function; and

- as wholesale leased lines are an input to such VPNs services, the ability of a retail supplier of VPNs to constrain a hypothetical monopolist supplier of wholesale leased lines is limited.

3.134 Hence, we do not propose to include VPNs as part of either the retail TI or AI markets. We note, however, that it is important to assess demand from retail VPNs in our market review, as these services make use of wholesale leased lines as inputs to the service. We have therefore made sure that any demand for wholesale TI and AI circuits arising from retail VPNs is taken into account when assessing wholesale market shares for our SMP assessment.

Issue 3: Broadband markets

3.135 In this section we review the extent to which symmetric and asymmetric broadband provide a competitive constraint on retail leased lines. The following section does not consider whether a constraint exists in the opposite direction, namely whether retail leased lines offer a competitive constraint on broadband services. This has been considered (at the retail level) in the context of Ofcom's Wholesale Broadband Access (WBA) market review which concluded in 2010 that broadband access services are not constrained by symmetric services like leased lines.[121]

3.136 We also note the EC's Recommendation – and while we have taken utmost account of this, we have also conducted a full assessment of asymmetric broadband and leased lines.

3.137 Our assessment of Issue 3 is split into two parts. We first discuss current generation symmetric broadband services (SDSL) before considering asymmetric services, by first reviewing current generation ADSL and then next generation broadband services. Under each heading we first set out the proposals we made in the June BCMR Consultation, together with the reasoning which underpinned them. We then summarise the responses we received and explain how we have taken the responses into account in reaching our final conclusions. We then present our conclusions.

[121] See Ofcom's "Review of the wholesale broadband access markets", statement, 3 December 2010 at http://stakeholders.ofcom.org.uk/binaries/consultations/wba/statement/wbastatement.pdf

(i) Symmetric broadband

Our proposals in the June BCMR Consultation

3.138 In the June BCMR Consultation we proposed that SDSL services are within the retail TI leased lines market. This was consistent with the conclusions of the 2007/8 Review.

3.139 In support of this we noted the following relevant factors:

- the qualitative characteristics of SDSL and TI services;
- SDSL service features and pricing; and
- migration trends.

Qualitative assessment

3.140 The results of our qualitative assessment of the key features of SDH/PDH and SDSL services are shown below in Figure 3.12 (reproduced from June BCMR Consultation).

Figure 3.12: Key features of SDH/PDH and SDSL services

	SDH/PDH	SDSL
Geographic availability	Nationwide	Easynet provides services from 1200 exchanges, covering 70% of SME across the UK.[122] BT provides services from 809 exchanges, with an estimated national coverage of 20%.
Bandwidth	64kbit/s up to 2.5Gbit/s	Up to 2Mbit/s, bonded SDSL solutions are available offering bandwidths of up to 8Mbit/s[123]
Contention	Dedicated	Service dependent. Contention typically varies from 1:1 (i.e. uncontended) to 20:1
Latency/jitter	Low	High
Local Loop Distance (Note SDSL distance limits refer only to the loop length and not the end to end service length)	Not limited	Bandwidth decreases according to local loop length (practical limit of the order of 3km).
Resilience	High	Low
Symmetry	Symmetric	Symmetric

Source: Ofcom 2012

3.141 We noted that SDSL connections offer the ability to support dedicated symmetric bandwidth at bandwidths comparable to low bandwidth leased lines, i.e. up to 8Mbit/s. Moreover, in contrast to ADSL, we found that SDSL was generally targeted at business end-users and was offered with a business class quality of service. This included higher traffic priority, lower contention ratios and business level service agreements and guarantees. We stated that these features mean that SDSL can be a viable alternative to low bandwidth leased lines for applications where the principal requirement is data transmission.

3.142 However, we noted that SDSL is not suitable for applications which require predictable latency. We also recognised that the opportunity to substitute was limited by the smaller footprint of SDSL compared to SDH/PDH leased lines, though since the 2007/8 Review the availability of SDSL services had increased due to deployments by a number of LLU operators. Another limitation noted was that the capabilities of SDSL are limited by the distance a premise is from the SDSL enabled exchange. BT has estimated that 1.6km is the practical limit for the provision of 2Mbit/s SDSL services and beyond this distance available bandwidths would be

[122] See: http://www.easynetconnect.net/products/sdsl.aspx

[123] Bonded SDSL allows multiple lines to be bonded together to increase bandwidth.

lower, with a practical limit of approximately 3km.[124] The distance limitations would also apply to the bonded solutions available.

3.143 We also noted that BT announced that it will be retiring its SDSL network by the end of 2014, and while SDSL will still be available from LLU operators after this date, we considered that the announcement suggested that SDSL is coming to the end of its life cycle and is being replaced by newer technologies.[125]

3.144 We concluded that these factors suggest that, while TI services are a good substitute for SDSL services, it is unlikely that this constraint will be symmetric. This is because SDSL services cannot offer a fully equivalent service.

Service features and pricing

3.145 We also considered the marketing, service characteristics and pricing of SDSL packages offered by CPs. This was based on publicly available information on CPs websites. In total we reviewed the packages offered by 11 CPs, identifying 37 individual offerings.

3.146 On marketing, we noted that a number of CPs provided online literature highlighting the potential to substitute leased lines with SDSL services with the selling point that business SDSL can provide a performance level that is comparable to TI leased line services.[126] We also observed that SDSL was often marketed as being an ideal service for small businesses, as it can support sophisticated requirements like the centralisation of systems and servers, high volume email usage, and multi-site networking.[127] We concluded that the marketing suggested that SDSL was positioned as a substitute for low bandwidth TI services.

3.147 On pricing, we observed that there was a considerable range of SDSL prices, which reflected the different available bandwidths and service wraps. Typical bandwidths offered included 512kbit/s, 1Mbit/s and 2Mbit/s, while services up to 8Mbit/s were offered using bonded SDSL. At each bandwidth there was also a range of service wraps, where at a given bandwidth higher priced services or 'Premium' services offered enhanced features over cheaper 'Basic' SDSL services. Enhanced features varied by package but typically included higher level service level guarantees, priority customer support and lower contention rates. We noted that across all the packages surveyed, the cheapest package was just over £1,500 per year and the most expensive was almost £6,500 per year, with an average price of approximately £2,600 per year.

3.148 We noted that the prices of SDSL and PPCs are broadly comparable; 2Mbit/s SDSL services were generally available from approximately £2,000, while the estimated cost of using a 2Mbit/s PPC in the same exchange area was just over £2,000.[128] We

[124] See SIN405 available from: http://www.sinet.bt.com/

[125] See: https://www.btwholesale.com/shared/document/21CN_Consult21/c21_MG_015_DSP_Jan12_Issue17.pdf

[126] For an example of this see: http://www.managedcomms.co.uk/products/business-sdsl

[127] For an example of this see: http://www.easynetconnect.net/products/sdsl.aspx

[128] This has been calculated using the wholesale input prices using the same methodology as Figure 3.7.

considered that this closeness in price, combined with the similar functionality of the two services suggested a reasonable degree of substitutability.[129]

Migration trends

3.149 Since the 2007/8 Review we noted that SDSL volumes had increased, albeit from a low base. Our estimate of the retail sales, based on volumes reported by CPs, suggested that volumes had more than tripled, increasing from just fewer than 3,000 services in 2007/8 to almost 14,000 services in Q4 2010/11.[130] The overall trend did, however, hide some disparities between CPs, with some CPs seeing a decline towards the later end of this period. We noted that this was broadly in line with the declines in the low bandwidth TI market discussed under Issue 1.

Responses to the June BCMR Consultation about symmetric broadband

3.150 Only BT provided specific comments on our proposed market definition for SDSL services. It agreed that SDSL is part of the relevant market but queried our conclusion that it was part of the TI market and not the AI market as it noted that the OCP service cited by Ofcom was provided with an AI interface. It also expressed the view that it was not clear whether our comparison was based on specific retail services or the underlying technology.

Ofcom's view

3.151 Our analysis of SDSL was based on the SDSL retail services available to end-users, with our analysis of service features and pricing being based on publicly available information from CPs' websites. We note that SDSL does not provide the same characteristics as a full TI service so, for similar reasons to AI, SDSL prices are unlikely to constrain TI prices very strongly. However, we consider that TI prices place a ceiling on the price which could be charged for an SDSL service and, given the level of SDSL prices, this ceiling seems to be an effective constraint – as we observe that the pricing evidence suggests that it is priced at a similar level to TI services of the same bandwidth. Hence, while we note BT's comment that an OCP service we cited in the June BCMR Consultation was provided with an AI interface, we consider that it is most appropriate for SDSL services to remain as part of the low bandwidth TI market.[131]

Ofcom's conclusion about symmetric broadband

3.152 On the basis of our analysis, we consider that SDSL services are within the retail TI leased lines market.

[129] As we noted above we considered that the pricing constraint is unlikely to be symmetric, as SDSL services do not provide a fully equivalent service, which means that SDSL services are unlikely to constrain the price of leased line services. The "means to an end" argument is relevant here - it is unlikely to be possible to exploit market power in SDSL alone (unlike AI, where there are also significant price differences).

[130] There are a number of CPs who sell SDSL at the retail level and our estimate of the market was based on a combination of retail and wholesale data.

[131] We also note that given the small volumes of SDSL services, relative to the size of the low bandwidth TI and AI markets, its inclusion in either market is not material to the results.

(ii) Asymmetric broadband

Our proposals in the June BCMR Consultation

3.153 In the June BCMR Consultation we proposed that there continue to be separate markets for asymmetric broadband services and leased lines. This proposal was based on detailed analysis we carried out to assess whether asymmetric broadband may act as a competitive constraint on retail AI or TI services. We also took account of the extensive stakeholder comments on this issue in the CFI, where we asked stakeholders for their views on the extent to which broadband services could be used effectively for the delivery of business connectivity services, and how they thought this might change over the forward look of this review period.[132] The majority of respondents noted that even though substitution had been occurring there were still a number of barriers, both technological and service quality based, that limit switching. Respondents also commented on the impact of next generation broadband, with most respondents fairly cautious about the potential impact.

3.154 Therefore, our analysis included a consideration of the impact of changes in broadband technology since the 2007/8 Review and expected future developments in this review period. In particular our analysis covered:

- a qualitative assessment of different broadband technologies;
- evidence from consumer surveys;
- broadband service features and pricing;
- relative price comparisons and migration trends; and
- barriers to switching.

These topics are covered in turn below, before we move on to summarising and evaluating responses to the June BCMR Consultation in relation to asymmetric broadband, and drawing conclusions.

Qualitative assessment

3.155 Our qualitative assessment set out the technology, network architecture and service features of the dominant technologies used in the provision of fixed broadband access in the UK.[133] At a high level, we categorised the dominant broadband technologies as:

- current generation;
- next generation; and

[132] For a full summary of the responses to our question on broadband in the CFI see the June BCMR Consultation, paragraphs 3.111 to 3119.

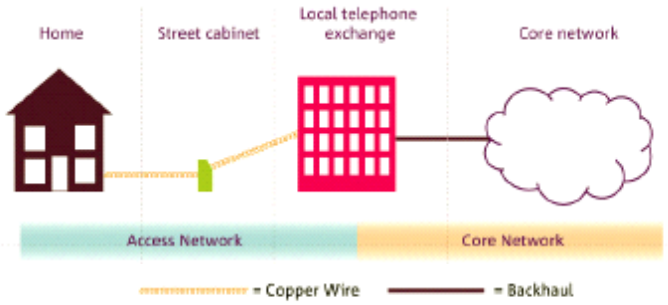
[133] Alternative broadband technologies are discussed in Annex 7 to the Review of the wholesale broadband access markets 2010.

- cable modem.[134]

Current generation broadband

3.156 Current generation broadband uses ADSL or ADSL2+ technology over the copper access network from the local exchange to the end-user premises. ADSL technology allows the use of a standard copper telephone line to provide high bandwidth asymmetric data communications. It is asymmetric as it provides higher download than upload bandwidths. The bandwidths available to end-users are dependent both on the equipment at the local exchange (e.g. the type of ADSL technology deployed) and the distance the customer is from the local exchange. Available bandwidths can also be increased by using bonded ADSL, a process where multiple ADSL lines are bonded together to create larger internet pipes, increasing the physical upload and download capability of ADSL. The architecture required to deliver current generation broadband is shown below in Figure 3.13.

Figure 3.13: Current generation broadband[135]



3.157 The results of our qualitative assessment of the key features of current generation broadband and leased line services are shown below in Figure 3.14 (reproduced from June BCMR Consultation).[136]

[134] We noted here that cable modem services are capable of matching both current and next generation broadband bandwidths. We included cable as a separate category because it is delivered over a different access network.

[135] With current generation broadband no active equipment is deployed to the street cabinet.

[136] Note, here when we used the term leased line we were referring to both TI and AI services. We made this simplification because although some noteworthy performance differences between TI and AI services remain, the differences between an ADSL service on the one hand, and either an AI or a TI service on the other, are likely to be much more marked.

Figure 3.14: Key features of current generation broadband and leased line services

	ADSL	ADSL2+	Leased line
Geographic availability	Nationwide	BT has deployed this to cover 80-85% of the UK. TalkTalk covers 90% of the UK and has announced plans to cover up to 95% of the country	Nationwide
Bandwidth	Download bandwidth of up to 8Mbit/s, upload bandwidth of up 832kbit/s	Download bandwidth of up to 24Mbit/s, upload bandwidth of up 1.4Mbit/s	64kbit/s up to 100Gbit/s symmetric capacity available
Bandwidth limitations	Bandwidth decreases according to local loop length e.g. distance from the customer premise to the exchange (practical limit of the order of 3km (ADSL2+) - 5km (ADSL))		Not limited
Contention	The amount of contention can be varied by provision of backhaul capacity, depending on the demands of the end-user, contention typically varies between 20:1 to 50:1		Uncontended
Latency/ Jitter	Variable - dependent on the bandwidth capacity of the network and offered traffic at any given point in time, specified levels cannot be guaranteed		Low
Resilience	Not deployed to support resilience options		Resilience options available
Security	Perceived as less secure as carried over a shared infrastructure		Medium to High
Service level agreements/ guarantees (SLA/SLG)	Deployed to support residential end-user requirements[137]		Deployed to meet business level requirements
Synchronisation	Not supported		Supported

Source: Ofcom 2012

3.158 We noted that, in terms of bandwidth, the introduction of ADSL2+ technologies offers much higher upload and download bandwidths compared to the ADSL services available at the time of the 2007/8 Review. We explained that an ADSL connection could be used to provide a symmetric service with a maximum data rate equal to the upload bandwidth of the ADSL service. Therefore a user with a 1.5Mbit/s leased line could compare this to an ADSL2+ service running (dependent on line) with a download bandwidth up to 24Mbit/s and an upload bandwidth of up to 1.4Mbit/s and consider this as broadly 'equivalent' in bandwidth terms to its current leased line

[137] Broadband networks are built to provide a specific quality of service. While this can be varied to provide business services, where business has lower contention and so on, it is still a shared network. Therefore in order to match the service levels provided on leased lines would require much more capacity and possibly increased resilience, which would add costs.

service. We further noted that with bonded ADSL services, higher bandwidths could also be considered as equivalent, with the equivalent bandwidth dependent on the bandwidth of each bonded line.[138]

3.159 In contrast to leased lines, however, we noted that the highest current generation bandwidths are only available to end-users close to the exchange. Ofcom research on UK fixed broadband bandwidths carried out in 2011 found that across end-users the typical download bandwidth range for ADSL up to 8Mbit/s packages was between 1-5Mbit/s.[139] The corresponding estimate for ADSL2+ packages was 3-10Mbit/s. We noted that upload bandwidth is also distance dependent but, because upload bandwidths are lower they are not necessarily impacted to the same extent as download bandwidths as the distance from the exchange increases. In addition, with associated high contention rates of ADSL connections, we noted that typically the bandwidth is not guaranteed and is associated with poorer service quality compared to leased lines in terms of latency, jitter, and overall throughput. Moreover, we also noted that there are differences in the level of security, the available resilience options and synchronisation support. We also found that the level of SLA/SLG available were also lower than for leased line services.

3.160 The above analysis highlighted that since the 2007/8 Review there has been a significant increase in download bandwidths available from 8Mbit/s to 24Mbit/s, with a relatively smaller increase in upload bandwidths from 832kbit/s to 1.4Mbit/s. We noted that while the nature of inter-site traffic for a business is such that the same capacity requirement is often needed in both directions, for many users it is not 'symmetry' per se that is required, but simply the necessary upload and download bandwidths to meet their needs. Therefore, we considered that for end-users who may not need exact symmetry but do not have a marked asymmetry in their upload and download bandwidths current generation broadband could be seen as 'equivalent' in bandwidth terms to a wider set of leased lines. However, we cautioned that even for these end-users, a range of service features of a leased line cannot be matched by current generation broadband.

3.161 Therefore, we concluded that the analysis set out above suggested that where leased line features are required, current generation broadband is unlikely to be a direct substitute for a leased line.

Next generation broadband

3.162 Next generation broadband deployments focus on upgrading the access connection between the end-user and the network. The two main next generation architectures currently being rolled out are:

- Fibre To The Cabinet (FTTC) - the connection to the cabinet is replaced by fibre and active equipment is deployed in the cabinet. The current copper access network connection from the cabinet to the end-user remains in place; and

- Fibre To The Premise (FTTP) - fibre is used all the way from the exchange to the end-user.

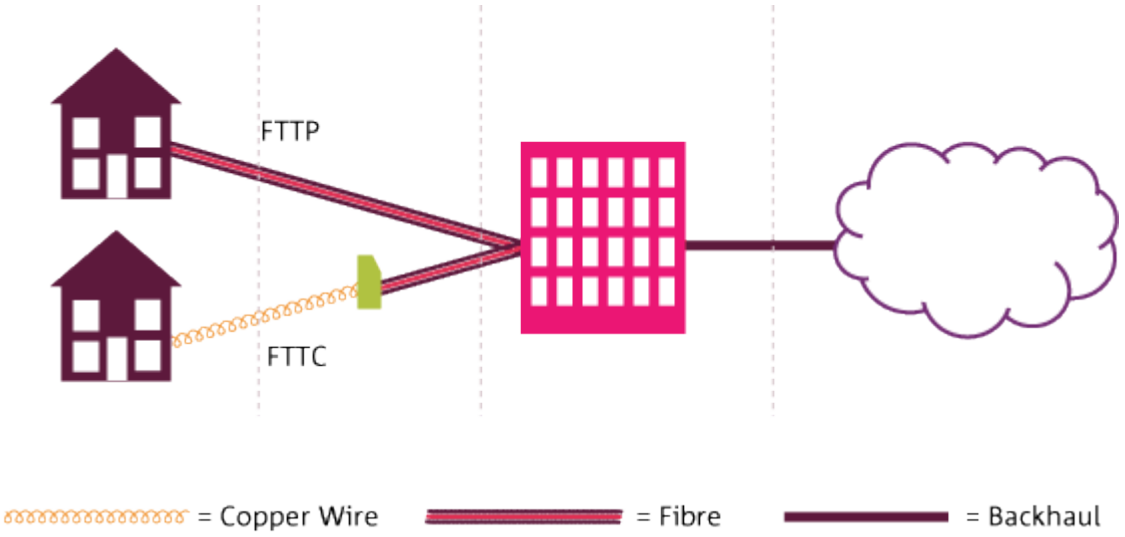
3.163 The architecture used to provide these two services is shown below in Figure 3.15. FTTC deployments use VDSL2 technology over the copper connection that remains

[138] Bonding copper loops increases the distance or bandwidth ADSL can achieve, typically a second copper loop will double the bandwidth available.

[139] See: http://stakeholders.ofcom.org.uk/binaries/research/broadband-research/Fixed_bb_speeds_Nov_2011.pdf

between the cabinet and the end-user, while FTTP services can be provided using a range of different technologies. BT plans to deploy FTTP using a Gigabit Passive Optical Network (GPON) which shares a single fibre from the exchange between a number of end premises.

Figure 3.15: Next generation broadband



3.164 The results of our qualitative assessment of the key features of next generation broadband and leased line services are shown below in Figure 3.16 (reproduced with a minor amendment from June BCMR Consultation).

Figure 3.16: Key features of FTTC and FTTP and leased lines services

	FTTC	FTTP	Leased line
Geographic availability	As of 2012, BT has announced plans to deploy next generation broadband to 66% of the UK by the end of 2014. This will be made up of mostly FTTC VDSL2 and small deployments of GPON FTTP.[140] There are also numerous smaller deployments by other companies. KCOM is planning trial deployments in the Hull area. Alongside this government funding has been announced to help cover the final third of the UK.		Nationwide
Bandwidth	Download bandwidth of up to 40Mbit/s, upload bandwidth of up to 10Mbit/s (Starting in Spring 2012 these bandwidths are expected to be doubled).	Download bandwidth of up to 110Mbit/s, upload bandwidth of up 30Mbit/s. (Starting in Spring 2012 this is expected to be increased to 300Mbit/s)	64kbit/s up to 100Gbit/s symmetric capacity available
Bandwidth limitations	Whilst bandwidth decreases according to loop length, the effect is much less than for ADSL technologies as the relevant local loop length is the distance from the end-user to the cabinet	Not distance limited	Not distance limited
Contention	The amount of contention can be varied by provision of backhaul capacity, depending on the demands of the end-user		Uncontended
Latency/ Jitter	Variable - dependent on the bandwidth capacity of the network and offered traffic at any given point in time, specified levels cannot be guaranteed[141]		Low
Resilience	Not deployed to support resilience options		Resilience options available
Security	Perceived as less secure as carried over a shared infrastructure		Medium to High
Service level agreements/ guarantees (SLA/SLG)	Deployed to support residential end-user requirements		Deployed to meet business level requirements
Synchronisation	Not supported	Supported	Supported

Source: Ofcom 2012

3.165 We noted that, with the introduction of next generation broadband, available upload and download bandwidths have significantly increased. A leased line user with a 10Mbit/s leased line could compare this to a FTTC service running (dependent on line) with a download bandwidth up to 40Mbit/s and an upload bandwidth of up to 10Mbit/s and consider this as broadly 'equivalent' in bandwidth terms to their current symmetric service. We also noted that in contrast to current generation broadband,

[140] BT have also announced that fibre on demand will be available in FTTC areas during this review period, this provides FTTP connectively, but requires an additional charge (not yet specified) for connection of fibre to the premises. For initial details see: http://www.btplc.com/News/Articles/Showarticle.cfm?ArticleID=14863CF1-DD70-4D79-83F8-2CDA88B3E51B

[141] We note that while GPON is actually a TDM-based system and has predictable latency and low jitter, once at the exchange the core network can introduce variable latency and jitter.

because the copper section of the local loop is the distance from the cabinet to the end-user, rather than from the exchange to the end-user, a greater proportion of end-users are able to obtain the highest bandwidths. Highlighting this, we referred to Ofcom research on fixed broadband bandwidths which found that average download bandwidths for FTTC were 36Mbit/s, 90 per cent of the advertised bandwidth of 40Mbit/s. We further noted that over the period of this review available bandwidths will increase as BT announced that, commencing in spring 2012, it plans to upgrade its network and double current bandwidths.[142]

3.166 We also noted that FTTP services offer even higher bandwidths than FTTC services, with download bandwidths of up to 110Mbit/s and upload bandwidths of 30Mbit/s, which means FTTP could be seen in bandwidth terms as equivalent to a 30Mbit/s symmetric leased line. As FTTP is provided over fibre there is no significant decrease in attainable bandwidths with distance. Moreover, we noted that over the period of this review available bandwidths are expected to increase further as BT announced that commencing from spring 2012 available download bandwidths will increase to 300Mbit/s. Trials of download bandwidths of up to 1Gbit/s are also taking place.[143]

3.167 However, we considered that while FTTC and FTTP services can provide higher download and upload bandwidths there were still a number of differences in service features compared to leased lines. These included differences in terms of contention, latency and jitter, the level of security, resilience options, SLAs/SLGs and synchronisation support (for FTTC). Also we noted that because next generation broadband services are currently being deployed they do not have the same coverage as leased line services, and that there is some uncertainty about how widely they will be available at the end of this review, especially in the final third.[144]

3.168 We considered that the analysis above suggested that, next generation broadband services can be seen as a closer substitute for a wider set of leased lines than current generation broadband services in bandwidth terms. But, as there are a range of leased line service features that cannot be matched by next generation broadband, we noted that where these features are required, it is unlikely that next generation broadband will be a direct substitute to a leased line. For end-users whose bandwidth requirements can be met by next generation broadband, we noted that the level of switching will depend on their willingness to pay for the extra service features that leased lines offer over next generation broadband.

3.169 We also considered the potential impact of virtual unbundled local access (VULA), a wholesale remedy imposed in our market review of the wholesale local access market.[145] VULA is a “virtual” passive remedy that allows competitors to deliver services over BT's next generation access network, using the FFTC/FTTP infrastructure, with a degree of control that is similar to that achieved when taking over the physical line to the end-user.[146] As VULA offers a service-agnostic and uncontended Ethernet connection to the end-user, it could be used to provide a leased line service (i.e. dedicated symmetric transmission capacity to carry voice

[142] See http://www.btplc.com/News/Articles/Showarticle.cfm?ArticleID=7E309437-6929-442F-8F25-CDD388518C64

[143] Ibid.

[144] The final third captures the areas for which BT has not announced next generation broadband rollout plans. Though we note that this in itself does not imply that next generation broadband should be excluded from the product market, it will not in practice be a constraint in the final third and there may also be some resulting limits on its impact in other areas, particularly where sites both inside and outside the final third have to be connected.

[145] See Ofcom’s “Review of the wholesale local access market”, Statement, 20 October 2010.

[146] Further discussion of passive remedies is provided in Section 8.

and/or data traffic), which would be carried over the broadband infrastructure. For market definition, although these services would be carried over the broadband infrastructure, the services would offer similar functionality to low bandwidth Ethernet leased lines. As such, we considered that VULA-based leased lines should not be characterised as constituting a separate market from the current low bandwidth retail AI market, but rather as a different way of providing a retail AI service.[147]

3.170 On a forward looking basis, over the duration of this review, we considered that there is likely to be only limited take-up of leased line VULA-based solutions. We noted that the availability of VULA is limited to the areas where BT has deployed infrastructure (about 66% of the UK by the end of 2014) and that the bandwidth available and the ability to support additional service features is limited by the technology deployed by BT, as highlighted in Figure 3.16. Further, as VULA is predominantly focused on the residential market, we considered it likely that VULA services would require additional investment to support enterprise customers with more stringent quality of service requirements.

Cable modem

3.171 Virgin's access network is different to the current and next generation broadband architecture discussed above. In respect of the broadband service, the connection between the end-user and the network is not provided over copper, and DSL technology is not used in the access network. Instead, the end-user connects via a hybrid coaxial/fibre network utilising Data Over Cable Service Interface Specification (DOCSIS) technology to the head-end equipment in the Virgin serving exchange. The use of DOCSIS technology means that the cable network is not subject to the same bandwidth limitations that are evident with DSL technology. Having upgraded the DOCSIS technology in its network, Virgin is able to run services at higher bandwidths than current generation broadband and as such it can be considered to be a next generation access network.

3.172 The results of our qualitative assessment of the key features of cable modem broadband and leased line services are shown below in Figure 3.17 (reproduced from June BCMR Consultation).

[147] By the same reasoning EFM services, which offer Ethernet over the copper access network, are also part of the low bandwidth retail AI market.

Figure 3.17: Key features of cable modem broadband and leased line services

	Cable	Leased line
Geographic availability	48% of UK premises are covered by Virgin	Nationwide
Bandwidth	Download bandwidth of up to 100Mbit/s, upload bandwidth of up 10Mbit/s[148] Bandwidth not dependent on distance.	64kbit/s up to 100Gbit/s symmetric capacity available
Contention	The amount of contention can be varied by provision of backhaul capacity, depending on the demands of the end-user	Uncontended
Latency/ Jitter	Variable - dependent on the bandwidth capacity of the network and offered traffic at any given point in time, specified levels cannot be guaranteed	Low
Bandwidth limitations	Cable networks have been deployed to ensure there is no significant decrease with distance	Not limited
Resilience	Not deployed to support resilience options	Resilience options available
Security	Perceived as less secure as carried over a shared infrastructure	Medium to High
Service level agreements/ guarantees (SLA/SLG)	Deployed to support residential end-user requirements	Deployed to meet business level requirements
Synchronisation	Not supported	Supported

Source: Ofcom 2012

3.173 We noted that cable modem services are able to offer bandwidths similar to next generation broadband, and that trials are taking place to further increase the headline download bandwidth to 200Mbit/s.[149] There has also been limited trials of cable services offering download bandwidths of 1.5Gbit/s with 150Mbit/s upload.[150] We also noted that unlike DSL services, with cable services bandwidth does not vary with distance. We referred to the Ofcom fixed broadband speed report which found that on average cable modem services delivered between 94 and 100 per cent of the advertised download bandwidth. However, as with FTTC and FTTP, we explained that although cable modem can offer the same download and upload bandwidths as many leased lines there are still a number of differences in the service features, as with asymmetric broadband generally. These included differences in terms of contention, latency, jitter, the level of security, resilience options, SLAs/SLGs and synchronisation support. Furthermore we noted that, even if it were included, cable

[148] Virgin announced in January 2012 that over the next 18 months it would be doubling the bandwidths available to most end-users (I.e. Below 100Mbit/s bandwidth would double, end-users currently at 100Mbit/s will see their bandwidth increase to 120Mbit/s). Upload bandwidths and traffic management fair usage amounts will be increased in proportion to the increase in downstream bandwidth. See http://mediacentre.virginmedia.com/Stories/Virgin-Media-boosts-Britain-s-broadband-speeds-2322.aspx

[149] See: http://mediacentre.virginmedia.com/Stories/Virgin-Media-rolls-out-UK-s-fastest-broadband-with-100Mb-1c6.aspx

[150] See: http://mediacentre.virginmedia.com/Stories/Virgin-Media-delivers-world-s-fastest-cable-broadband-2131.aspx

services are only available in 48% of the UK. Therefore as with next generation broadband, we considered that although cable modem services can match many leased lines in terms of bandwidth, there are key differences in service features. Where these features are required (see Figure 3.5), we considered that cable modem broadband is unlikely to be a close substitute for a leased line.

Consumer survey analysis

3.174 Our assessment of broadband technology highlighted a number of differences to the characteristics offered by leased lines. However, we considered that these differences alone did not necessarily mean that these services are in separate markets, as users may be willing to compromise or upgrade their services in response to a SSNIP. To help establish whether this is the case, we referred to an independent market research report commissioned by Ofcom, which was carried out by Jigsaw research.[151] We also referred to relevant stakeholder evidence; including the Internet Opportunity Survey (IOS) which focused on business users and was commissioned by the Communications Management Association (CMA) and the Federation of Small Businesses (FSB).[152] This survey included 300 organisations in total, covering both the public and private sectors and large and small organisations.

3.175 To understand the characteristics on which end-users may be prepared to compromise, we reconsidered the results on leased line characteristics and their relative importance, summarised below in Figure 3.18.[153] We noted that symmetry was identified as either business critical or very important by 58% of respondents and was (along with range) the lowest rated service feature in terms of importance amongst those surveyed. This suggested that that a larger proportion of users would be willing to compromise on symmetry than on other characteristics and that these users might be willing to use an asymmetric service provided it met their other requirements.

3.176 Importantly however, these requirements are likely to include the level of available upload speed as well as a minimum download speed which were seen as either business critical or very important by a high proportion of respondents (78% and 88% respectively). If these are similar, there would be a de facto requirement for symmetry. Even where these are not precisely the same, the differences between the upload and download speeds of available asymmetric products may be too great for them to be an acceptable substitute for many leased line applications. We considered that these demands mean that, at higher bandwidths, broadband is unlikely to provide a constraint on leased lines as it is not able to offer the similar levels of upload and download performance which end-users value. In contrast, at lower bandwidths we considered that there could be greater scope for substitution.[154]

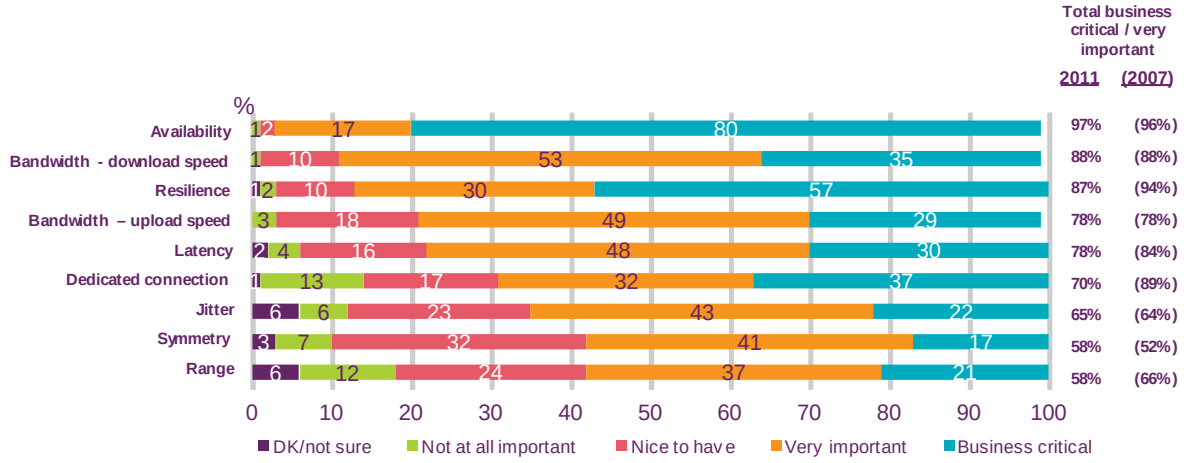
[151] See: http://stakeholders.ofcom.org.uk/binaries/consultations/business-connectivity/annexes/business-review.pdf

[152] An executive summary of the results is available at: http://www.bcs.org/upload/pdf/internet_opportunity_survey_2011.pdf

[153] These results were also discussed under Issue 1.

[154] Our qualitative analysis highlighted that in terms of download bandwidth next generation broadband will by the end of this review period offer bandwidths of 80Mbit/s on FTTC, 300Mbit/s on FTTP and 200Mbit/s on cable modem. While the effective symmetric bandwidth available will be much lower because of lower upload bandwidths, there will be scope for substitution for bandwidth requirements lower than 100Mbit/s.

Figure 3.18: The importance of service characteristics



Source: Ofcom end-user research, QC1 (2011 n=461; 2007 n=450)

3.177 However, we noted that substitution may be limited due to end-users' demand for other characteristics. Our qualitative assessment noted that broadband is not able to offer the same level of performance in terms of contention, latency/jitter and resilience. We further noted that due to different levels of SLAs/SLGs broadband does not offer the same level of guarantee on availability as a typical leased line.[155] These were all features that were identified as business critical or very important by over 65% of all respondents, with availability being cited by 97% of respondents, resilience by 87% and latency by 78%. Having a dedicated connection (no contention) and jitter were seen as relatively less important but were still cited by 69% and 65% of respondents respectively. These results suggested that end-users typically place higher value on one or more characteristics of leased lines which cannot be matched by broadband. Therefore we considered that end-users may be unwilling or unable to switch to broadband because it cannot meet the requirements that end-users see as vital to their organisations.

3.178 For all characteristics, respondents were also asked whether the relative importance they attached to them would increase or decrease over the next two years.[156] For all the above characteristics 95% of respondents stated that it would either be more important or stay about the same level of importance. This suggested that the above findings are likely to be robust over the duration of this Review.

3.179 We also asked respondents specific questions on ADSL services. All respondents were asked whether their company/organisation had ever replaced leased lines with ADSL services. Across all respondents, 20% had replaced leased lines with ADSL, with switching being more prevalent among larger organisations. Alongside this respondents were also asked whether they were likely to replace leased lines with ADSL, with answers ranging from very likely to very unlikely. In total, only 14% of respondents answered that they were either very or quite likely to replace leased lines with ADSL, while 74% of respondents stated they were either very or quite

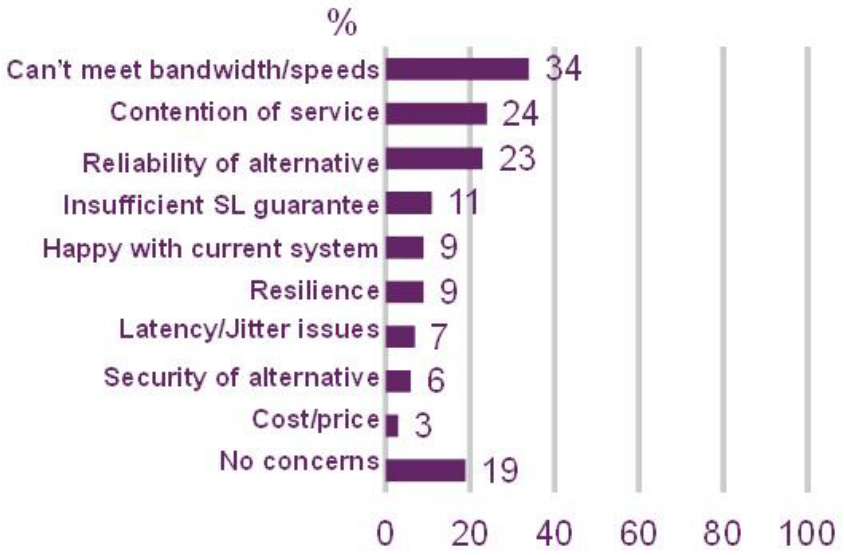
[155] As we noted above broadband networks are shared among businesses and consumer end-users and are built to provide a specific quality of service and while this can be increased this would come at a cost. We noted that as there are no current broadband products on the market that offer equivalent SLA/SLG as leased lines this suggested that there is insufficient demand from end-users, especially consumer end-users, to pay for higher level SLA/SLG.

[156] This question was based on a two year time horizon which was considered to be a reasonable planning period and comparable to our forward look, which covers the duration of this review.

unlikely to replace leased lines with ADSL. In contrast to the previous question smaller organisations were more likely to switch to ADSL than larger organisations.[157]

3.180 As a follow up question respondents were asked to consider the service characteristics of ADSL and leased lines and to identify the challenges or concerns they had about replacing leased lines with ADSL.[158] Responses are summarised below in Figure 3.19.

Figure 3.19: Challenges or concerns about switching to ADSL



Source: Ofcom end-user research, QE3 (n=308)

3.181 Among those interviewed, we noted that just 19% of current leased line users identified no challenges or concerns in switching to ADSL. The most commonly cited concern was bandwidth limitations (identified by 34% of respondents), followed by concerns about the contention of service (24%) and the reliability of ADSL (23%). Several of the other challenges or concerns also related to the differences in characteristics of leased lines and ADSL (level of SLGs, resilience, latency/jitter and security). These results suggested that a significant percentage of leased line users have concerns about switching to ADSL services.

3.182 In addition to questions on ADSL, we also asked about the impact of next generation broadband. All respondents were told that in the next few years super-fast broadband will offer much higher upload and download bandwidths than are currently available with existing ADSL technology. They were then asked how likely this is to prompt them to switch from their current services, with possible responses ranging from very likely to very unlikely. Here 53% of respondents answered that they were very or quite likely to switch to super-fast broadband, while 32% answered that they were very or quite unlikely to switch.[159] The remaining 16% of respondents either did not know or were either unlikely or likely to switch. We observed that this result

[157] We noted that for this question small businesses have a low base size so any results should not be overstated as they are subject to a larger statistical margin of error.

[158] This question was asked to all respondents with leased line access links irrespective of whether they said they were likely to consider switching.

[159] The question did not specify whether the respondent would switch all of their leased lines or just some of them.

suggested that super-fast broadband could potentially be highly significant with over 50% of users saying they were likely to switch.

3.183 However, we noted that caution must be applied to this estimate because this was a stated rather than revealed preference. One issue is stated preference bias – this is the tendency of respondents to overstate their willingness to undertake an action, like switching to super-fast broadband, which means that the levels of switching may be over-estimated.[160] We noted that as discussed above, upload and download bandwidths are not the only features end-users value from a leased line. The demand for other characteristics, like resilience, may limit substitution because even if the upload and download bandwidth requirements are met, super-fast broadband is not able to match leased lines in terms of other characteristics. Also as no time limit was set on this question, we considered that it is likely that respondents stated their general interest in the service, rather than a concrete confirmation of switching in the short to medium term.

3.184 Nevertheless, we explained that it is clear that with the rollout of super-fast broadband there will be a greater opportunity for end-users who value bandwidth but have a lesser need for specific characteristics to switch. This is because higher levels of bandwidth, which previously were only available with leased lines, will be available with NGA, and this may lead some end-users in this group to switch away to lower cost NGA services. As shown in Figure 3.19, the most commonly cited concern about switching to ADSL was that it would not be able to meet the bandwidth required; we noted that this would be less of issue with super-fast broadband.

3.185 The impact of super-fast broadband was also a focus of the Internet Opportunity Survey commissioned by the Communication Management Association and the Federation of Small Businesses. All respondents were asked whether their organisation used super-fast broadband. Across all respondents 16% were already using or implementing super-fast broadband, 19% were planning to use it in the next 12 months, while 65% had no plans to use it. We considered that this showed that a majority of businesses have no plans to adopt super-fast broadband. Moreover, we noted that for those with plans to use, or who are already using NGA, we cannot tell from the data if it is a substitute or a complement to leased line use, or if end-users are upgrading from current generation broadband.

3.186 As a follow-up question, respondents who had no plans to use super-fast broadband were asked to identify the main factor preventing their organisation from using it. Here the most commonly cited reason was geographic availability. These users were then also asked to assess the likelihood of using super-fast broadband once available. Similar to the above result, 60% of respondents said they were either very likely or likely to switch from their existing service, while 40% of respondents were either unlikely or very unlikely to switch.[161] Again we noted that this pointed to the potentially significant impact of super-fast broadband.

3.187 We concluded that the end-user research discussed above suggested that differences in service characteristics mean there are a number of barriers to switching from leased lines to broadband. This was highlighted by the discussion of ADSL and end-user concerns/challenges about replacing leased lines with ADSL. On

[160] For a discussion of stated preference bias, see Ofcom's "Wholesale mobile voice call termination", Statement 15 March 2011 (see Annex 5, paragraphs A5.2 to A5.5). Available at: http://stakeholders.ofcom.org.uk/binaries/consultations/mtr/statement/MCT_statement_Annex_5.pdf

[161] We note that the question did not distinguish between the type of existing service used and it covers both current generation broadband and leased lines.

super-fast broadband, our analysis suggested that there will be a greater opportunity for end-users who value bandwidth but have a lesser need for specific characteristics to switch, but we considered that the full competitive impact of super-fast broadband cannot be known with certainty at this stage.

Broadband service features and pricing

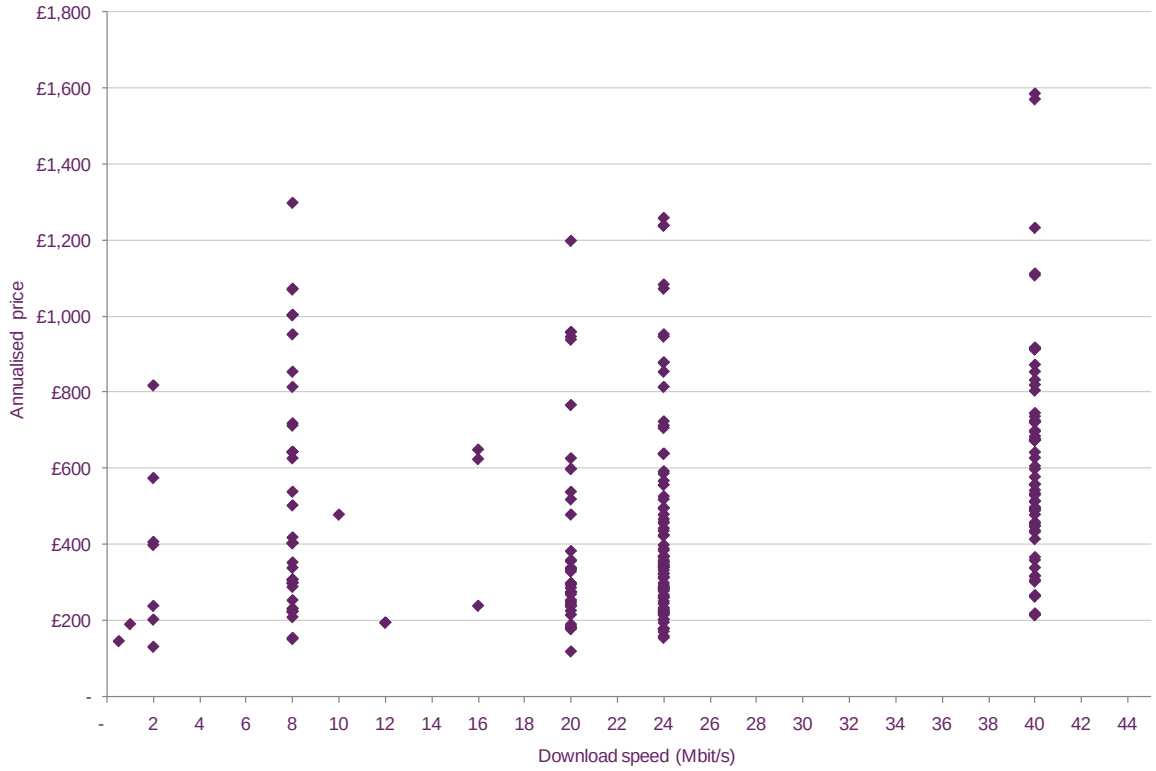
3.188 We also considered the marketing, service characteristics and pricing of broadband packages offered by CPs. This was based on publicly available information on CPs' websites. In this section we first provide an overview of marketing and then discuss the relationship between price and download/upload bandwidth, usage allowances and contention ratios.

3.189 The marketing of business broadband packages helped provide an understanding of how providers position broadband services relative to leased lines. The review of marketing covered the websites for each of the packages included in our research. We observed that a common feature in the marketing was to set out the sort of business the service might apply to, this was often designated by the number of end-users it was designed to support, or whether the service was suitable for heavy or low business usage. Across providers, we noted that business broadband was not usually positioned directly against leased lines. CPs who provide both broadband and leased lines typically positioned leased lines as a premium service. Overall the marketing suggested that broadband services are not simply characterised as a cheap substitute for leased lines but are aimed at end-users who demand different service characteristics.

3.190 On service features and pricing we first considered the relationship between download bandwidth and price. Our research covered 249 individual broadband packages offered by 40 providers covering downloads bandwidths of 512kbit/s up to 40Mbit/s.[162] Figure 3.20 (reproduced from June BCMR Consultation) plots the relationship between the annualised price including connection fees and the headline download bandwidths in Mbit/s across these packages.

[162] Note the analysis was based on headline bandwidths and that where no contract length was given we assumed it to be 12 months.

Figure 3.20: Broadband price comparison by download bandwidth



Source: Ofcom analysis, based on publically available prices on CPs' websites

3.191 We noted that the figure showed that there was a considerable range in broadband prices and businesses can expect to pay from as little as £120 per year to up to £1600 per year.[163] Across the packages and bandwidths the (unweighted) average price for broadband was approximately £500 per year. At each bandwidth the range of prices reflected the variety of different service wraps available, where higher priced services were seen as 'Premium' services offering enhanced features over 'Basic' broadband. These enhanced features were typically a mix of improved upload bandwidths, lower contention rates, higher usage allowances or other features like static IP addresses. We noted that at the package level there was no clear relationship between price and bandwidth because of the variety of different 'Premium' services available at each bandwidth. But on average, we found that prices increased with bandwidth, as the research suggested that a business can expect to pay approximately £400 per year for a broadband service offering a 2Mbit/s download bandwidth, increasing to £620 per year for a 40Mbit/s service.

3.192 The upload bandwidth available was another key service feature considered; across all the packages available upload bandwidths varied from 256kbit/s to 10Mbit/s with a ratio of download to upload bandwidths of roughly 15:1. This varied across broadband technologies and for ADSL and ADSL2+ the ratio of download to upload bandwidths was roughly 20:1, while the corresponding estimate for FTTC packages was roughly 10:1. Across bandwidths, packages offering higher upload bandwidths were typically 'Premium' services, however, because improved upload bandwidths were normally just one of the improved service features it was difficult to draw a definitive conclusion on the additional cost of improved upload bandwidths, though

[163] Note this figure excludes estimates for uncontended broadband solutions which were the most expensive broadband solutions available and were only offered by a small subset of providers. These are discussed further below.

our research did find one CP offering a straight upload upgrade from 448kbit/s to 832kbit/s on all of its ADSL packages for an additional £84 per year.[164]

3.193 Business broadband packages also offer a range of usage allowances; these define the total amount of download and upload capacity available to an end-user. Across all the packages surveyed we found that usage allowances ranged from 1Gbit per month up to unlimited usage (subject to a 'fair use' restriction) with prices typically increasing with higher usage allowances. On average (unweighted) across all bandwidths, we found that a business broadband end-user would expect to pay £280 per year for a service with a 20Gbit monthly allowance, £640 per year for a service with a 100Gbit monthly allowance, and £675 per year for a service providing unlimited usage.

3.194 Alongside usage allowances there were also different contention ratios available, ranging from 50-1 to uncontended. As we noted in footnote 100 we excluded uncontended services from Figure 3.20 because they were some of the most expensive broadband packages available. Our research found an uncontended 2Mbit/s package costing approximately £5,000 per year; this can be compared to an average price of £400 for a 2Mbit/s package.[165] We observed that while there is a clear price mark-up for an uncontended service, as with upload bandwidths it was difficult to assess the relationship between price and improved contention ratios because they were normally part of a 'Premium' packages offering other improved service features as well.

3.195 Our analysis above of broadband pricing and service features highlighted the range and variety of business broadband packages available. We noted that across packages there were clear price differences with 'Premium' services offering higher upload bandwidths, usage allowances and lower contention ratios being significantly more expensive than 'Basic' packages at the same download bandwidth. We also considered marketing, noting that broadband is not typically characterised as a cheap substitute for leased lines but rather is positioned as appealing to end-users with different requirements, which seems consistent with them not being close demand-side substitutes.

Relative price comparisons and migration trends

3.196 While broadband and leased lines have different pricing structures, we explained that it is possible to compare the relative price of delivering a given bandwidth. We noted that to deliver 2Mbit/s using a PPC in the same exchange area would incur an annual charge of approximately £2,000.[166] In contrast our broadband pricing research suggested that on average a business can expect to pay approximately £400 per year for a broadband service offering 2Mbit/s download bandwidth, increasing to £620 per year for a 40Mbit/s service. This highlighted that in general, broadband, even at higher bandwidths, is significantly cheaper than SDH/PDH circuits.[167] We

[164] See http://www.timico.co.uk/soho/ip_connectivity/adsl

[165] This was the most expensive broadband solutions covered. We note that these solutions are typically marketed as being particularly suited to businesses sited near busy exchanges, for example see http://idnetnew.idnet.net/solutions/uncontendedadsl.jsp

[166] This has been calculated using the wholesale input prices using the same methodology as Figure 3.7 in Issue 1.

[167] Here we compared the wholesale price of a PPC or Ethernet circuit with retail asymmetric broadband package prices. We considered that wholesale prices represented the minimum price of a PPC, as they did not include the costs of the retail service wrap. Thus the finding that PPC prices are significantly above asymmetric broadband prices would be stronger if we had used retail leased line prices.

also noted that, as discussed in Issue 1 in this section, as Ethernet circuits are more expensive than SDH/PDH at low bandwidths this result will also hold for Ethernet circuits (i.e. broadband is significantly cheaper).

3.197 We considered that the above price comparisons showed that significant savings were available by switching to broadband, but that these appear to have been insufficient to act as a constraint on pricing of low bandwidth circuits. If there was a sufficient constraint between low bandwidth leased lines and broadband services we noted that we might expect the pricing of the two services to be closer, or for there to be much less demand for the higher priced service. Therefore we concluded that the presence of significant demand for leased lines at the same time as significant price differentials suggested that they are in separate markets.[168]

3.198 We noted that a finding of separate markets was also consistent with the market trend data discussed under the heading of Issue 1 and summarised in Figure 3.21 below. The figure highlights that sub-2Mbit/s volumes saw the steepest volume decline, falling by 43% by the end of 2010/11 compared to 2007/8; the corresponding estimate for analogue and 2Mbit/s volumes is 21% and 16% respectively. By contrast our estimates indicated that business broadband had grown strongly over the same period, with an increase of 16% (111,000 extra services).[169] We noted that as our data was at the aggregate level, and not at the level of the individual end-user, we could not accurately measure or track the extent of switching between services. Nevertheless, we considered that it is likely that some of the growth in broadband use will have been due to low bandwidth leased line users switching to broadband, although we also observed that some of the reduction in low bandwidth leased line volumes may also be due to other factors, such as switching to higher bandwidth leased lines.

Figure 3.21: Market trends for low bandwidth services, 2007/8-2010/11

Service	2007/8 Volumes	2010/11 Volumes	Volume (%) change
Analogue	76,000	60,000	-16,000 (-21%)
Sub-2Mbit/s	44,000	25,000	-19,000 (-43%)
2Mbit/s	61,000	51,000	-10,000 (-16%)
Business broadband[170]	674,000	785,000	111,000 (16%)

Source: CP's responses to s.135 information request, 2011

3.199 However, we did not think that these trends meant that low bandwidth leased lines and asymmetric broadband services should be regarded as part of a single market. One reason for this conclusion was that the price differentials to which users may have been responding to are far larger than a 10% SSNIP. So even if these differentials were inducing some switching to broadband and contributing to the fall in demand for TI services, we did not think it meant that a SSNIP would be unprofitable.

[168] We also note that next generation broadband services are just emerging in the marketplace.

[169] To provide some context to this increase we noted that in the 2011 Ofcom Communications Market Review it was reported that the number of residential broadband connections increased from 15.6m in 2007 to 19.6m in 2010. See: Communications Market Report, Ofcom, August 2011, Figure 5.32, available at: http://stakeholders.ofcom.org.uk/binaries/research/cmr/cmr11/UK_CMR_2011_FINAL.pdf

[170] Note this captures business broadband volumes submitted to us by CPs and as above while we recognise that it may not accurately capture all volumes, it should provide a robust view of the trends in the market.

3.200 We also noted that even though low bandwidth leased lines have been in decline, there is still a relatively large installed base of 136,000 circuits. We stated that the majority of these are likely to be concentrated across a narrower set of end-users who either have a legacy network for site interconnection or require specific characteristics of a leased line.[171] Given the significant price premium of leased lines over broadband we considered it was unlikely that end-users would continue to purchase leased lines if broadband was a good substitute. Here we noted that while there have been advances in broadband technology and applications that allow it to be used where previously leased lines would be required,[172] we consider that, during this review period, broadband is unlikely to be a sufficiently close substitute to a leased line to define a broad market.

Barriers to switching

3.201 We noted that end-users wanting to switch from leased lines to broadband face some of the same considerations as end-users considering moving from TI to AI leased lines, this includes:

- the potential for service disruption;
- parallel operation whilst the new broadband service is tested; and
- for TI end-users, change of CPE such that data is mapped to Ethernet rather than TDM interfaces and investment in new CPE to convert existing TDM services, such as voice, to a data interface.

3.202 Alongside these, we identified additional factors that end-users need to consider:

- the end-user must consider the security considerations of using a shared medium rather than the dedicated medium of leased lines;
- the service level agreement for broadband is different to that for a leased line and the end-user needs to determine that it is sufficiently robust for their needs; and
- there needs to be an analysis of the upstream and downstream bandwidth available over the course of a typical week - broadband services exhibit varying transmission rates depending on network loading, the service quality set and whether data is being downloaded or uploaded.

3.203 We noted that, in situations where broadband is a good substitute for a leased line, the impact of switching costs will vary by type of end-user. For end-users with large legacy networks or who use specialised applications, there are likely to be significant switching costs involved. This is because of the need to upgrade all the customer premises equipment and applications to support broadband and, before migrating applications across, the broadband systems would have to be set up and tested. We considered that these factors are likely to delay switching, and mean that switching might only take place when the end-user equipment or applications come to the end of their product life cycle. In contrast, we considered that for end-users who do not require specific characteristics and/or use a small number of leased lines, the costs

[171] Significant end-users include utility companies, local government and high street banks. BT's view is that in the future there may be step changes in volumes as large end-users migrate and/or upgrade their applications to run on higher bandwidth leased lines and/or broadband.

[172] This includes applications like CCTV and road traffic management applications, for example see: http://www.easynet.com/gb/en/about/pressRelease.aspx?SecondaryNavID=52&pressreleaseid=1461

of switching are likely to be less significant. This is because broadband can be delivered with relatively inexpensive customer premises equipment (relative to leased lines).

Responses to the June BCMR Consultation about asymmetric broadband

3.204 Five respondents provided specific comments on our assessment of asymmetric broadband (BT, Colt, Level 3, TalkTalk, UKCTA).

3.205 BT did not agree that broadband and leased lines are in separate markets. In support of this it expressed the view that the observed differences in the characteristics of broadband and leased lines are chosen by CPs, and do not necessarily arise from the access technology but instead arise from how the services are deployed, and consequently supply-side substitution may be possible. BT also claimed that our comparison was wrongly based on comparing broadband services with TI leased lines, rather than AI.

3.206 BT further claimed that we had not taken into account services which are comparable to leased lines but are not based on direct fibre as they do not fit with what it considers to be our narrow market definition. Most notably it considered that we have not taken into account contended AI retail services, which are services where broadband and leased lines most overlap. It expressed the view that, if such services were included in our analysis, this would lead to a conclusion that broadband and leased lines are in the same market.

3.207 BT also argued that broadband places a real price constraint on low bandwidth leased lines and is a ready replacement, although it noted that "the nature of many business applications means that the actual event of migration is tied to many other factors" and is "steady and persistent."[173] On this point DotEcon (in its report prepared on behalf of BT) highlighted that in the Jigsaw research report it was found that 53% of respondents thought that they were very likely or quite likely to switch to super-fast broadband at some point in the future. Further, it argued that our emphasis on the reported importance of specific service characteristics to customers could tell us little about the factors that these customers would in fact take into account when looking to switch over to super-fast broadband services.

3.208 Colt argued that the UK is an outlier (compared to other European countries) as LLU has never emerged as a mainstream business connectivity option. However, it expressed the view that this is now changing due to NGA as the higher speeds offered allow the infrastructure increasingly to be used by business connectivity services. It considered that BT's "Infinity Business" product range is an example of this. It further argued that this convergence offers reduced costs as business connectivity services can exploit the capability and density of the residential infrastructure and that any CP who could exploit this before its competition (i.e. BT) would have a significant competitive advantage.

3.209 Colt also commented on our treatment of VULA. A particular concern was the absence of a "business grade" VULA product, and Colt argued that BT had no incentive to develop a business grade product swiftly because it would limit what Colt saw as the competitive advantage that BT currently enjoys in the form of its Infinity Business portfolio. Colt also linked this to our "dismissal" of VULA-based services as an alternative to more traditional leased lines. It argued that it was wrong, and based on circular reasoning, to believe that there would only be a limited take-up of VULA

[173] BT response, page 120, paragraph 89.

as, in its view, the only reason there would be limited take-up was the lack of a business grade VULA product. Colt further argued that, even if only 66% of the country will be covered by the end of 2014, the parts that will be covered are precisely those in which VULA has the greatest potential for business connectivity. Therefore, by not accounting for VULA, Colt alleged that in our market definition we were adopting too narrow a view of the market and ignoring the evolving linkages between business and residential infrastructure.

3.210 Level 3 did not agree that broadband and leased lines continue to fall into separate markets. It observed that a significant number of customers that would have traditionally consumed low speed AI services are now switching to low cost broadband in order to meet their needs. Given this, it asked us to provide further analysis as to why a new business connectivity market that encompasses business consumers of broadband services does not yet exist at the retail level and the potential for future change in this regard.

3.211 Level 3 also commented on VULA. It expressed the view that there is the potential for VULA to affect both the TI and AI markets within the period of the next 3 years. It speculated that this would be from CPs moving low bandwidth TI services to replacement technologies ahead of the DPCN closure, and from CPs looking to make savings in managing their AI services. However, it considered that the VULA product as currently specified will not be able to meet business and CP needs.

3.212 TalkTalk characterised our position as being that we had found asymmetric services to be outside the leased line market due to the absence of business grade features. It expressed the view that the lack of these features is not, for the most part, inherent in asymmetric broadband technology (e.g. ADSL2+ or VDSL). Instead, in TalkTalk's view, the lack of features is a result of how BT has chosen to implement the technology. It argued that business grade SLA/SLGs could easily be offered on asymmetric broadband but that BT has chosen not to for commercial (rather than any technical) reasons, particularly because BT does not want to reduce its revenues from leased line services through offering higher quality broadband services.

3.213 The UKCTA response discussed VULA, expressing the view that next generation broadband could be a potential competitive constraint, but only if a business grade VULA product is made available. However, it considered that we had arbitrarily dismissed VULA without considering its full implications. Further it noted that, as BT does not have an incentive to roll out business grade VULA, our argument about a lack of demand is weakened, as this is only the case because of the lack of a business grade service. In light of this, it argued that we should consider making a business-grade solution a mandatory remedy or alternatively carry out an assessment of the impact that VULA could have on competition, innovation, and investment in the business connectivity market, setting this against the costs of developing a business grade solution.

Ofcom's view on asymmetric broadband

3.214 We note that a number of respondents did not agree with our proposal that broadband and leased lines are in separate markets and there were also a number of comments on our treatment of VULA. We have considered the responses carefully and discuss each of these issues in turn, explaining why we have concluded that it is appropriate to retain separate markets for broadband and leased line services as previously proposed.

3.215 BT argued the observed differences in the characteristics of broadband and leased lines are chosen by CPs and arise from how the services are deployed and a similar view was shared by TalkTalk. We note that even if this argument were correct, it would appear only to amount to a claim that supply-side substitution is technically feasible. It will often be the case that a single network can be used to supply many different services and this might be said to mean that supply-side substitution is technically possible, but without a general implication that all services provided, or capable of being provided, over it form a single economic market.

3.216 Instead, the key factor relevant to this issue is the extent to which end-users will switch in response to a SSNIP Here we note it seems to follow from BT's and TalkTalk's argument (and other arguments for the provision of specific "business grade" services) that the existing current and next generation services which do not have the relevant service characteristics are not good demand-side substitutes for leased lines – this is also our view. Overall, we consider that it is unlikely that a sufficient number of end-users would be willing to switch to broadband in response to a SSNIP on leased lines to make it unprofitable.

3.217 BT also argued that we should have compared broadband with AI services rather than TI services. We consider that this represents a misinterpretation of our analysis, as in the June BCMR Consultation we noted that when we use the term "leased line" for our comparison with broadband, we are referring to both TI and AI services.[174] We made this simplification because, although some noteworthy performance differences between TI and AI services remain, the differences between an ADSL service on the one hand, and either an AI or a TI service on the other, are likely to be much more marked.

3.218 We also disagree with BT's view that services which have the characteristics of leased lines, but which are provided over other technologies, would necessarily be excluded from our market definition. For example, services provided using EFM, which is based on multiple copper access lines bonded together and delivers Ethernet at low bandwidths to businesses, is included in our assessment as part of the low bandwidth retail AI market. Similarly, as noted in the June BCMR Consultation, if VULA were used to provide a leased line service, that leased line service would be included in the low bandwidth retail AI market.[175]

3.219 We also do not agree with BT that our analysis has erred by excluding contended AI services, which we consider as VPN-type solutions. Our discussion, under Issue 2 in this section, explains why we consider that VPNs fall outside the retail leased line markets.[176] In addition to this we note that the evidence suggests that dedicated capacity is important to end-users. Figure 3.5, for example, shows that 70% of end-users reported that having a dedicated connection was either business critical or very important which suggests that contended services are unlikely to be an effective substitute for many users of leased lines.

3.220 Moreover, we do not agree with BT that broadband places a sufficient price constraint to be in the same market as low bandwidth leased lines, particularly because:

[174] See footnote 72 to paragraph 3.123 of the June BCMR Consultation.

[175] See the June BCMR Consultation, paragraph 3.135.

[176] A view with which BT agreed.

- The fact that some customers previously consuming low bandwidth leased lines are now purchasing broadband services does not in itself mean that the two services are in the same market, since it does not imply that sufficient switching would occur in response to a SSNIP to render it unprofitable.

- Our assessment of barriers to switching leads to the conclusion that end-users with large legacy networks and/or requiring specialised applications are likely to face significant switching costs.

- As BT recognised, "the nature of many business applications means that the actual event of migration is tied to many other factors". These factors suggest that switching would not occur within a reasonable time frame in response to a SSNIP.[177]

3.221 Furthermore, even if we accepted BT's arguments on market definition and were to find that broadband and leased lines were in the same market, it would be unlikely to change the SMP finding or range of remedies. For example, BT is required to provide both LLU and VULA in the wholesale local access market in order to support downstream competition in current and next generation broadband access respectively, even though, at the retail level, both are part of a single broadband market. This is to ensure that competition can occur across the full extent of the market, a principle which would also apply in the event that wider markets also including leased lines were identified.

3.222 A number of other respondents (Colt, Level 3 and DotEcon on behalf of BT) also expressed the view that we had not fully taken into account next generation broadband. It was also argued that the survey evidence suggested that a significant number of respondents were likely to switch to superfast broadband in the future.

3.223 We have carefully considered the issue of next generation broadband, and recognise that it is likely to place some degree of constraint on lower bandwidth leased line prices. However, we consider this constraint would not be significant enough to support a finding of a combined market. Next generation services are currently at a relatively early stage of development and take-up by businesses will be dependent on the capabilities of the technology deployed. Substitution is most likely where users have less need for specific characteristics, like high quality service levels and low contention rates. This was noted in the responses to the CFI where [✂] noted that requirements for low latency and jitter which could not currently be met by broadband would not change over the short to medium term, limiting potential substitution. Similarly KCOM noted that although substitution could increase, it did not believe that it would be a significant factor during the period covered by this market review because some of the requirements of business customers cannot be met with broadband.

3.224 We also acknowledge that our survey found a relatively high stated willingness to switch to superfast broadband. However, we consider that the survey evidence in this case should be treated with additional caution, particularly because it is likely that respondents' experience of using next generation broadband will, as yet, be less than other services.[178] Therefore, on balance, we consider that broadband and leased lines will not be part of the same market in the timeframe of this review. This said we

[177] See, in this respect, paragraph 3.117 and accompanying footnote.

[178] Also see discussion in paragraph 3.183 and accompanying footnote.

do take next generation broadband into account in the SMP analysis as a source of external constraints.

3.225 There were also a number of responses which commented on VULA. However, as VULA is a remedy in the wholesale local access market, and outside the scope of the BCMR, whether BT should be required to provide a different VULA service would be a matter for the forthcoming WLA Review, where we will look at the issue of VULA for business. For the purposes of this review, we have not assumed that VULA will be widely used to supply leased-line type services.

Ofcom's conclusion about asymmetric broadband

3.226 On the basis of our analysis, and having taken into account responses to the June BCMR Consultation, we continue to consider that broadband and leased lines fall into separate markets, in particular for the following reasons:

- our assessment of the qualitative differences between broadband services and leased lines highlighted that, while broadband bandwidths have increased significantly there are still a number of key differences in service features;
- evidence from consumer surveys highlighted that the service features of leased lines are highly valued by end-users, and the fact that end-users have significant concerns about switching to ADSL-based services. We also discussed the impact of next generation broadband and we noted that it had a potential to increase switching in the future, but that this would be limited in the short term and that it could be limited by end-users demands for characteristics only offered by leased lines. Accordingly, the competitive impact of next generation broadband is uncertain;
- relative price comparisons and migration trends highlighted that, although significant savings are available from switching to broadband, switching does not appear to have resulted in convergence between the prices of asymmetric broadband and low bandwidth leased lines. At the same time there is still significant demand for low bandwidth leased lines; and
- consideration of barriers to switching highlighted that end-users with large legacy networks and/or who use specialised applications are likely to face significant switching costs.

3.227 Our analysis summarised above suggests that broadband is likely to have some impact on the demand for leased lines and that this impact may increase with the deployment of next generation broadband. However, the evidence indicates that substitutability is insufficiently strong, and will remain so over the course of the three year review period, even for lower bandwidth leased lines, to point to a broad market including both asymmetric broadband and leased lines.

Issue 4: Bandwidth

3.228 Business end-users have a diverse range of bandwidth requirements. Some only require very low bandwidths reflecting requirements to transmit relatively small amounts of data reliably and quickly (e.g. for bank cash points), while at the top-end, other business end-users such as those operating data centres may require many Gbit/s of capacity. As part of the retail product market definition we consider whether AI and TI services fall into one or more service markets by bandwidth. This is dependent on whether there are breaks in the chain in substitution.

3.229 Figure 3.22 below sets out the typical bandwidths available for TI and AI services.

Figure 3.22: Typical bandwidth increments of leased line services

	TI services	AI services
Typical bandwidth increments	64kbit/s	2 - 20Mbit/s (Ethernet First Mile)
	n * 64kbit/s (up to n=31)	10Mbit/s
	2Mbit/s	100Mbit/s
	n * 2Mbit/s	1Gbit/s
	45Mbit/s	2.5Gbit/s
	155Mbit/s	10Gbit/s
	622Mbit/s	

Source: Ofcom 2012

3.230 In terms of pure functionality, multiples of low bandwidth circuits are, in the majority of cases, substitutes for circuits of higher bandwidth and vice versa.[179] This means there is the potential for substitution between services of different bandwidths and we observe that this does in practice happen in the market. For example, in the TI market, an end-user's requirement for 10Mbit/s of capacity could be met by using a 45Mbit/s service or by buying five 2Mbit/s circuits. The choice between these two options will depend on their relative prices, with the assumption that end-users want their total bandwidth requirement to be met at the lowest possible price, given the other service characteristics which they also value (such as latency, jitter etc).

3.231 If there are enough end-users who are willing and able to switch between services of two different (but adjacent) bandwidths in response to small price changes, then this demand-side substitution may be sufficient to mean that there is a single market including circuits of both bandwidths. If there are enough such end-users throughout the available range of bandwidths then circuits of all capacities might be linked by a chain of substitution. For example if in response to a small price change, enough end-users would switch between 2Mbit/s TI services and 45Mbit/s TI services for them to be regarded as close substitutes, and 45Mbit/s circuits in turn were substitutes for 155Mbit/s TI services, then this would create a chain of substitution, and a single market, consisting of all three bandwidths.

3.232 We have found that chains of substitution of this kind exist in some markets. When we reviewed markets for asymmetric broadband access we did not distinguish separate markets according to the bandwidth of the package.[180] We took the view that a chain of substitution means that there is a single market for packages of all currently available bandwidths. However, the existence of a chain of substitution is an empirical question specific to the circumstances of the markets under review. In leased line markets, the number of end-users is smaller and the 'gaps' in the chain, in bandwidth and price, are larger, reducing the likelihood that a chain of substitution exists. Indeed, in the 2003/4 and 2007/8 Reviews, we found that a chain of substitution did not exist and that there were separate markets based on bandwidth.

[179] However there may be some costs associated from moving from a single circuit to multiple bonded circuits which are likely to require the use of more complex and expensive CPE to implement the bonding.

[180] For a full discussion of this see Ofcom's "Review of the wholesale broadband access markets" 2010 (Section 3).

3.233 Our discussion of Issue 4 is split into two parts below. We first review the bandwidth breaks in the TI market, before reviewing bandwidth breaks in the AI market. Under each heading we first set out the proposals we made in the June BCMR Consultation, together with the reasoning which underpinned them. We then summarise the responses we received and explain how we have taken the responses into account in reaching our final conclusions. We then present our conclusions.

(i) Bandwidth breaks in the TI market

Our proposals in the June BCMR Consultation

3.234 In the June BCMR Consultation we proposed to define four retail TI markets based on the same bandwidth breaks as in the 2007/8 Review.

3.235 Our analysis was shaped by stakeholder comments in response to the CFI and covered:

- the main TI bandwidth breaks;
- an assessment of whether it is appropriate to combine the up to 45Mbit/s and the up to 155Mbit/s markets; and
- an assessment of the appropriate market definition for sub-2Mbit/s services.

Revalidating the main TI bandwidth breaks

3.236 We noted that there is more than one way of meeting a requirement for a given total bandwidth and that this means that services of different bandwidths can be substitutes. Therefore we assessed whether switching between bandwidths would be sufficiently strong to constrain a SSNIP above the competitive price imposed by a hypothetical monopolist across a range of bandwidths. To do this we used the market definition methodology developed for the 2003/4 and 2007/8 Reviews:

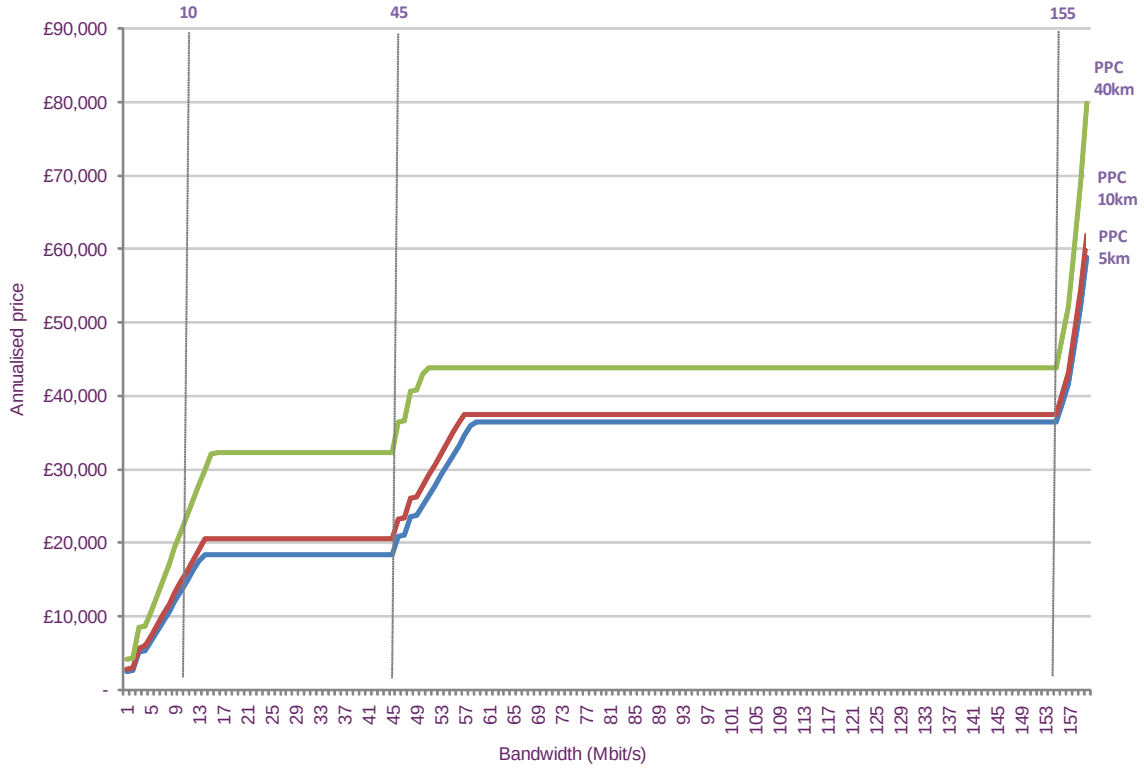
- First, for a particular end-user's bandwidth requirement we identified the lowest price (that is, from the viewpoint of the user, the lowest cost) theoretical combination of circuits needed to deliver that bandwidth requirement. For these purposes, we needed to base this comparison on competitive price levels which may not be the same as current prices, as the latter may be distorted by the presence of SMP. In a competitive market, prices would be driven to a level just sufficient to recover costs and allow a reasonable return on capital. We therefore used BT's cost orientated wholesale service (PPC) charges[181] as a proxy for the structure of competitive retail prices since, as a result of regulation, PPC charges should be reasonably close to costs (on an fully allocated cost (FAC) basis).
- Having calculated the least cost combination of services over the likely range of end-user bandwidth requirements, we then considered what would be the impact of imposing a SSNIP on the price of the circuits of each bandwidth (as identified in Figure 3.22 above).

[181] Note before 2009 TI trunk products were not charge controlled and were only subject to cost orientation.

- We then assessed, given the likely distribution of demand for different levels of bandwidth, whether a SSNIP would be profitable for a circuit of a particular bandwidth.

3.237 The results of our assessment of the cheapest theoretical combination of circuits that can be used to provide a particular bandwidth requirement at different distances are shown below in Figure 3.23 (reproduced from June BCMR Consultation). This showed that a user requiring 100Mbit/s would be likely to purchase a 155Mbit/s service, while at low bandwidths up to around 10Mbit/s, a user could use multiples of 2Mbit/s circuits to deliver their bandwidth requirements (rather than using the next bandwidth increment of 45Mbit/s).

Figure 3.23: Wholesale price estimates for TI services (non-CLZ)[182]



Source: Ofcom analysis, based on BT wholesale pricelist for PPC services

3.238 The analysis pointed to the continued existence of bandwidth breaks at around 8Mbit/s, 45Mbit/s and 155Mbit/s as shown by the 'steps' in the figure above and this result was consistent across the range of distances shown. We explained that the smoother the increase in the (total) price as total bandwidth increases, the more likely it is that circuits of different bandwidths fall in the same market.[183] However, in the above analysis we noted that there appeared to be clear steps, this indicated that there were significant price increments at certain points which we referred to as "bandwidth breaks".

[182] CLZ refers to an area of London served by the 0207 dialling code. For the CLZ, BT applies different tariffs for some, but not all, of its leased lines services.

[183] The steeper "steps" in the graph show where cost increases most sharply with bandwidth, as multiple circuits are purchased to achieve the required total bandwidth. The vertical size of the steps indicates the difference in price between lower and higher bandwidth circuits and is such that switching between them in response to a SSNIP is unlikely.

3.239 The presence of bandwidth breaks suggested that a SSNIP applied on a bandwidth just below these levels would not prompt switching to higher bandwidth services, which in turn indicated that there were breaks in the chain of substitution between bandwidths. For example, in response to a SSNIP, we noted that an end-user with a bandwidth requirement of 45Mbit/s would not switch to a 155Mbit/s service, because the jump in price (indicated by the step in the figure) would be greater than the effect of the SSNIP (which is typically taken to be a price increase of 5 or 10%). These results continued to apply under the range of different sensitivity scenarios on a range of assumptions relating to the mix of trunk and terminating segments, the utilisation of the point of handover and the circuit length.[184]

3.240 For 155Mbit/s and 622Mbit/s, we noted that because of the much higher price of 622Mbit/s circuits, substitution was only likely to occur where an end-user is acquiring four or five 155Mbit/s along the same route (i.e. if an end-user is acquiring multiple 155Mbit/s services as part of a higher bandwidth requirement). However, our updated analysis suggested that the majority of 155Mbit/s lines are still acquired as single circuits, as only 10% of 155Mbit/s lines linked the same two points as another 155Mbit/s line.[185] This suggested that the two services still operated in separate retail markets. Our analysis also suggested that the competitive conditions in the two markets still differed significantly, as our wholesale service share estimates showed that BT appeared to have only 5% of 622Mbit/s lines, compared to 50% of 155Mbit/s lines in the UK excluding Hull.

3.241 Under Issue 5 in the June BCMR Consultation, we identified a multiple interface market serving customers with very high bandwidth requirements, which covered all leased lines services above 1Gbit/s. The analysis of very high bandwidth services focused on Ethernet and WDM services. But we noted that retail WDM services allow equipment installed at customer premises to support multiple wavelengths and different client interfaces including SDH. SDH carried on such WDM equipment would retain all of the characteristics of a native SDH service. We stated that given the significant declines in the cost of WDM-equipment, TI services above 155Mbit/s may face an additional competitive constraint from WDM retail services such that we could, in principle, include some or all of the very high bandwidth TI services (e.g. TI services at 622Mbit/s, 2.5Gbit/s or 10Gbit/s) in the MI market. Therefore in our SMP assessment we took into account the potential for an additional competitive constraint arising from WDM services.[186]

3.242 On the basis of the analysis set out above, we proposed to find that the main bandwidth breaks from the 2007/8 Review had not materially changed.

Should the up to 45Mbit/s and the up to 155Mbit/s markets be combined?

3.243 Even though we had found a break in the chain of substitution, we noted that 45Mbit/s and 155Mbit/s services could still be regarded as being part of the same market if the competitive conditions of the supply of the two services were sufficiently

[184] Our sensitivities followed the approach taken in the 2007/8 Review. For a full explanation of the sensitivities applied to this model see paragraph 3.328 of the January 2008 Consultation.

[185] This estimate was based on an analysis of per circuit data of 5 CPs (BT, Colt, C&WW, Verizon and Virgin) who together accounted for over 90% of 155Mbit/s volumes in 2010/11. As an additional piece of analysis for this Statement we have looked at the data again to assess the percentage of circuits that the link the same two points as four or more other 155Mbit/s lines (as this is where substitution becomes viable). Our analysis found that less than 2% of 155Mbit/s lines meet this criteria, which is consistent with our finding of separate markets.

[186] Due to issues over data quality and on practicality grounds, we included all leased lines services above 1Gbit/s (including where specified any SDH circuits for example at 2.5Gbit/s or 10Gbit/s) in the MI market.

homogeneous.[187] We noted that, if competitive conditions were sufficiently similar, the SMP analysis could be simplified without affecting the outcome by combining two services in a single market.

3.244 However, our analysis suggested that the competitive conditions in the two markets was not sufficiently similar to support combining them. In the wholesale market for the UK excluding Hull, BT appeared to have a market share of around 60% in the up to 45Mbit/s market, compared to a market share of 50% in the up to 155Mbit/s market. This result did not seem to be explained by 'small number' issues because significant quantities of both lines were still supplied.[188] Therefore we considered that these differences called for separate examination, although ultimately we concluded that BT had SMP in both markets (at the wholesale level).

Should there be a separate market for sub-2Mbit/s services?

3.245 In the CFI BT argued that we should take into account significant differences in the characteristics of TI services at 2Mbit/s and those below 2Mbit/s which it suggested point to a separate market for sub-2Mbit/s services. BT noted that over the last three years volumes of sub-2Mbit/s circuits had declined by 42% as end-users switched to broadband and Ethernet, a greater decline than that experienced in 2Mbit/s circuits. In response to these arguments we reviewed the appropriate market definition for sub-2Mbit/s services. We considered in turn:

- the qualitative characteristics of sub-2Mbit/s and 2Mbit/s services;
- relative price comparisons; and
- migration trends.

Qualitative assessment

3.246 Sub-2Mbit/s and 2Mbit/s services are both TDM services and are deterministic, in that they offer low and predictable latency and jitter. As highlighted in Figure 3.5 these are features that end-users value. We noted that the fact that sub-2Mbit/s and 2Mbit/s services share these characteristics suggested that there is the potential for substitution between them for end-users whose demand can be met either by multiple 64kbit/s circuits or a single 2Mbit/s circuit.

3.247 We noted that one difference between the two services is that sub-2Mbit/s services are typically delivered over copper, while 2Mbit/s services are typically delivered over fibre. In the 2007/8 Review we considered whether there should be separate markets for copper-based and fibre-based services but concluded that there should not. We considered that retail end-users will in general be indifferent between a service provided over copper and an equivalent service provided over fibre, as the underlying technology only matters to end-users to the extent that it affects prices or quality of service. We noted that at low bandwidths there are no significant qualitative differences between copper and fibre-based services and 2Mbit/s circuits can be provided over copper, at the same prices as equivalent services provided over

[187] As discussed in Annex 3, although homogeneity of competitive conditions is usually used in the context of geographic market definition as a reason for aggregating different areas not linked by demand or supply side substitution, it might also be used in the product market context.

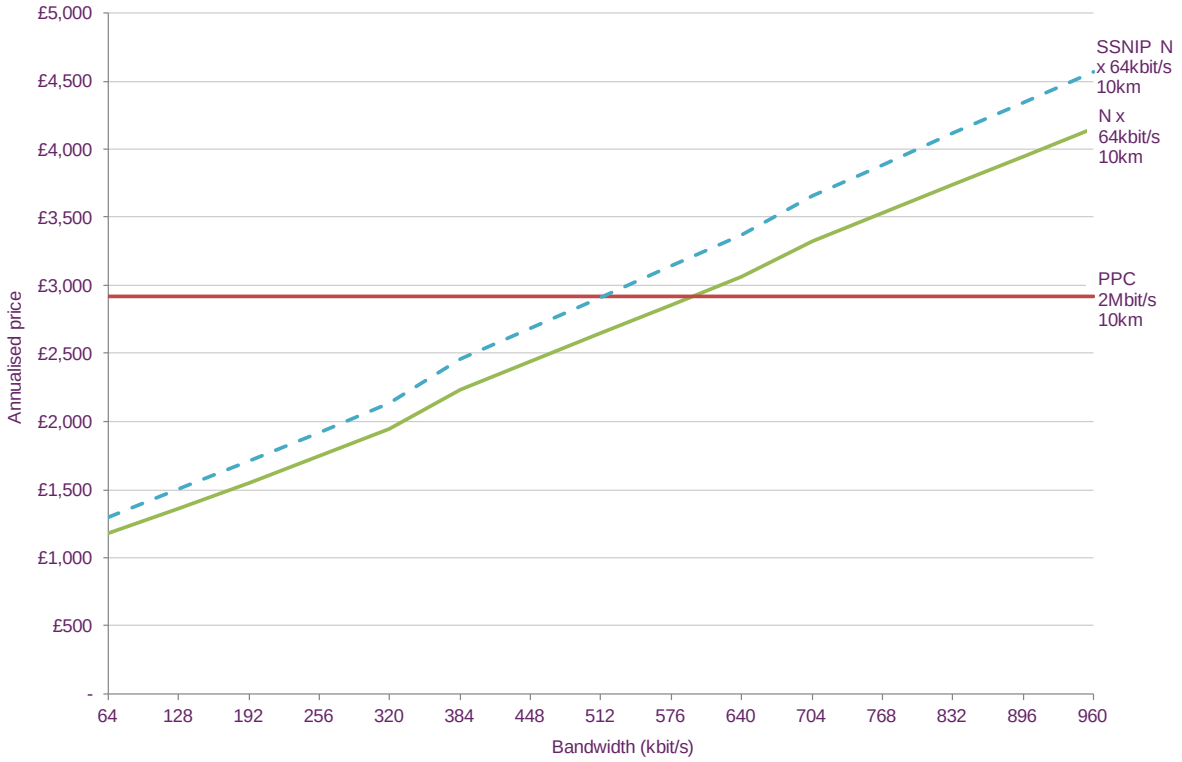
[188] Around 10,000 ends were provided in the up to 45Mbit/s market, against around 6,000 in the up to 155Mbit/s market.

fibre.[189] These factors did not point towards the identification of separate markets for fibre-based or copper-based services.

Relative price comparisons

3.248 We also looked at comparative price information for 2Mbit/s and sub-2Mbit/s PPCs. The analysis was based on BT's wholesale input prices, with the assumption that these prices should provide a reasonable proxy for the relative differences in competitive retail prices between services. The results of this analysis are shown in Figure 3.24 (reproduced from June BCMR Consultation) where the SSNIP adjusted prices of sub-2Mbit/s circuits are also plotted.

Figure 3.24: Wholesale price estimates for low bandwidth TI services (non-CLZ)



Source: Ofcom analysis, based on BT wholesale pricelist for PPC services

3.249 The analysis suggested that, for bandwidth requirements of above 576kbit/s it was cheaper to buy a 2Mbit/s service rather than sub-2Mbit/s services. After a SSNIP on sub-2Mbit/s services for bandwidths of 512kbit/s and above it would be cheaper to buy a 2Mbit/s service. These results continued to apply under a range of different sensitivity scenarios including changing the distances modelled.

3.250 We noted that if a hypothetical monopoly supplier of sub-2Mbit/s services could impose a SSNIP above the competitive level modelled above without losing sales to such a degree as to make this unprofitable, sub-2Mbit/s services could be considered to constitute a separate market. This was assessed by critical loss analysis. The critical loss is the percentage reduction in demand required as a result of the price increase in order for a SSNIP to be unprofitable. A SSNIP will have a number of offsetting effects, which the critical loss calculation attempts to capture. On the one hand, the end-users switching away will result in a loss of revenue. On the other, a

[189] In 2007/8 Review our analysis indicated that approximately 20% of BT's 2Mbit/s services were provided over copper.

hypothetical monopolist would no longer incur costs of serving the end-users that switched away. In addition, the monopolist on whose network end-users stay would receive additional revenue in proportion to the size of the SSNIP.

3.251 In order to assess the level of switching that would render a SSNIP unprofitable, we considered the critical loss factor. The critical loss can be interpreted as follows: if the reduction in demand in response to a SSNIP were above this level, the SSNIP would be unprofitable, with the implication that the market should be defined more widely than the focal service being considered. In contrast if the reduction in demand in response to a SSNIP were below this range, the SSNIP would be profitable and the focal service being considered may constitute a separate market. In the 2007/8 Review we estimated that for the main leased line services the critical loss factor was around 16 to 21%.[190] We noted that given that sub-2Mbit and 2Mbit/s services are based on mature technologies, we would not expect there to have been significant changes in the cost of provision such that this estimate will have materially changed.[191] Therefore, we applied a range of 16 to 21% in our analysis below.

3.252 In the scenario above the change in demand will depend on the distribution of end-users by bandwidth and the willingness of end-users to switch services in response to a SSNIP. The distribution of end-users by bandwidth is important because Figure 3.24 clearly shows that for lower bandwidth requirements (64-448kbit/s) even after a SSNIP it would not be economic to switch to 2Mbit/s services. Therefore we noted that if the majority of end-user demand was concentrated at these bandwidths then it is likely that a SSNIP would be profitable. To gain an understanding of the distribution of end-users we have investigated the distribution of retail end-users for BT's 64kbit/s Kilostream services by bandwidth in 2010/11 and the results of this analysis are summarised in Figure 3.25 (reproduced from June BCMR Consultation).

[190] The critical loss is calculated as a function of the SSNIP (which we take to be 10%) and the ratio of the marginal cost to the current price (i.e. the price before the SSNIP). Our estimate in the 2007/8 Review was based on available data on price/cost relationships for the main leased line services. For a full discussion of the critical loss see Annex 9 of the January 2008 Consultation.

[191] To derive an estimate of the ratio of marginal cost / price, we analysed measures we have on how BT's costs of TI services are likely to react to a decline in BT's volumes. These measures are known as asset volume and cost volume elasticities ('AVEs' and 'CVEs'). These AVEs and CVEs can be used to provide a reasonable estimate of the likely costs that a hypothetical monopolist would avoid if it lost a particular level of sales (although they will not be identical). For the LLCC BT provided updated information on the relationship of its costs of TI services to a decline in volumes. Relative to estimates available at the time of the 2007/8 Review, BT estimated that its cost volume relationships may have changed for some operating costs (CVEs), but it did not forecast any significant changes for its AVEs.

Therefore we considered that if we were to use BT's updated AVEs and CVEs to estimate the likely costs that a hypothetical monopolist would avoid if it lost a particular level of sales, our estimate of critical loss would not change materially. In support of this we noted that our critical loss estimates derived in the January 2008 Consultation (Figure 95a) shows that a ratio of marginal cost to the initial competitive price of up to 60% would yield a critical loss of just over 20%. It is only at very high ratios of marginal costs relative to initial competitive prices there is a steep increase in the level of switching required to make a SSNIP unprofitable. As BT's updated AVEs and CVEs did not suggest a ratio of marginal cost to the competitive price level above this 60% mark we therefore proposed to retain our estimate of the critical loss in 2007/8 Review of 16 to 21%.

Figure 3.25: Distribution of BT's Kilostream services by bandwidth 2010/11

Bandwidth	Percentage of Kilostream end-users
64kbit/s or under[192]	38%
128-192kbit/s	7%
256-320kbit/s	10%
384-448kbit/s	1%
512kbit/s	44%
Above 512kbit/s	1%

Source: BT response to s.135 information request, 2011

3.253 The table highlights that the distribution of end-users was concentrated at two bandwidths with 44% of end-users at 512kbit/s and 38% at 64kbit/s. Of the remaining end-users, 18% were at bandwidths between 128 to 448kbit/s while only 1% were at bandwidths above 512kbit/s. This was in line with Figure 3.24 which showed that for bandwidth requirements above 576kbit/s, it was cheaper to buy a 2Mbit/s service. This distribution turned out to be key to our analysis as, when combined with the SSNIP analysis above, it suggested that the 44% of end-users at 512kbit/s would have an incentive to switch to 2Mbit/s services in response to a SSNIP.

3.254 Of this group, the level of switching will depend on the willingness of end-users to switch services in response to the SSNIP. We noted that in the 2007/8 Review our consumer survey evidence suggested that for SDH services up to and including 2Mbit/s there was likely to be significant levels of switching in response to a SSNIP.[193] This was further supported by our assessment of switching costs, which found that they would not be material enough to prevent existing users switching following a SSNIP.[194]

3.255 Given these findings we considered that the available evidence suggested that in response to a SSNIP a significant percentage of end-users at 512kbit/s would be likely to switch to 2Mbit/s services. The resulting reduction in demand for 64kbit/s circuits would be considerably greater than the critical loss which indicated that a SSNIP on sub-2Mbit/s services would be unprofitable.[195] This suggested that sub-2Mbit/s and 2Mbit/s are linked by a chain of substitution and are in the same market. We also noted that BT plans to cease new supply of some Kilostream services, though it plans to continue to supply 512Kbit/s. A full discussion of the future withdrawal of sub-2Mbit/s services is provided in Section 10.

[192] Some services are supplied over 64kbit/s bearers but have their bandwidth throttled.

[193] Indeed in the 2007/8 Review we considered that this would be well above the upper bound of the critical loss range, indicating that a SSNIP would be unprofitable.

[194] This excluded any connection fees the communications provider would be likely to levy. For example, if an end-user wanted to migrate its analogue leased lines to digital leased lines, a supplier would need to carry out engineering work (the most expensive part of the migration) and to install new network terminating equipment (NTE). However, these equipment costs should already be reflected in the relative price comparisons (for example as annualised connection fees) set out previously under this discussion. On this basis, these costs were not viewed as additional switching costs.

[195] For example if we assume that 40% of end-users at 512Kbit/s switch this would result in a 31% fall in demand for 64kbit/s services (weighted by circuit numbers), this was far higher than our critical loss estimate of 16 to 21%.

Migration trends

3.256 Migration trends in the low bandwidth TI market are shown in Figure 3.9 and summarised in Figure 3.21. These highlighted that volumes of sub-2Mbit/s and 2Mbit/s leased lines have both fallen steadily since 2007/8. As noted by BT the steepest decline in both percentage and service (number of circuits) terms was for sub-2Mbit/s circuits, which fell by 43% (19,000 circuits) by the end of 2010/11 compared to 2007/8. The corresponding estimate for 2Mbit/s volumes was 16% (10,000 circuits). Even with these declines in Q4 2010/11 there was still a substantial installed base of circuits (25,000 sub-2Mbit/s and 51,000 2Mbit/s circuits respectively).

3.257 BT suggested that the steeper fall in volumes of sub-2Mbit/s services is because of higher levels of switching to broadband than for 2Mbit/s services. We noted that, certainly in terms of bandwidth, broadband, even during the 2007/8 Review could have been a viable alternative to many sub-2Mbit/s leased lines, while it is only with the recent advances in broadband technology that symmetric-equivalent bandwidths of 2Mbit/s and above have become available. This suggested that end-users who value bandwidth but have a lesser need for specific characteristics at sub-2Mbit/s will have had greater opportunity to switch to broadband than similar users of 2Mbit/s services. We noted that this is likely to be reflected in the volumes.

3.258 However, we stated that our consumer survey provided no evidence that sub-2Mbit/s end-users are more likely to switch to broadband than 2Mbit/s end-users. In addition, we considered that there was no evidence that demand for the service characteristics of a leased line (i.e. latency, jitter, resilience, etc.) are lower at sub-2Mbit/s than at 2Mbit/s. For example important uses of sub-2Mbit/s circuits include Airwave (the Police/Fire radio system), high street banks' ATM networks and network monitoring and protection applications for power and water utilities. All of these services use the characteristics of a leased line to perform their role. We further noted that in the 2007/8 consumer survey when sub-2Mbit/s users were asked to identify the service that they saw as the closest substitute to their current service, Ethernet was the most commonly cited substitute candidate, suggesting that end-users at these bandwidths value the characteristics of a leased line.

3.259 Indeed we noted that another possible explanation of the divergence in trends between sub-2Mbit/s and 2Mbit/s services was that 2Mbit/s services are used as inputs to a wider array of services than sub-2Mbit/s circuits. For example 2Mbit/s circuits are often used as the bearer circuits for legacy voice services such as ISDN Primary Rate Interface (also known as ISDN30). Continued demand for these applications that require 2Mbit/s circuits could provide an explanation for the slower decline in 2Mbit/s services than seen at sub-2Mbit/s. We considered that the difference in volume trends did not, in our view, indicate a significant difference in competitive conditions, which would point to separate markets.

3.260 In all, we concluded that given the above analysis of the qualitative characteristics, comparative prices and migration trends of sub-2Mbit/s and 2Mbit/s services, the evidence did not point to a separate market for sub-2Mbit/s services. However, in Section 7 of the June BCMR Consultation we considered whether there were some differences in competitive conditions and therefore whether different remedies were required (see Section 10 of the June BCMR Consultation).

Responses to the June BCMR Consultation about bandwidth breaks in the TI market

3.261 Only BT provided specific comments on our proposed bandwidth breaks for TI services. These covered our general approach and our proposal for a combined market for sub-2Mbit/s and 2Mbit/s services.[196]

General approach to bandwidth breaks

3.262 BT agreed with the principle that there are bandwidth breaks and that the principles behind them were "intuitive and well-founded."[197] However, it had concerns about our analysis. In particular, BT argued that:

- the analysis did not make comparisons based on real retail services or OCP services;
- the services analysed are regulated and have been for many years, which BT claimed means that the analysis is not on a modified Greenfield basis; and
- the comparison is based on single circuit, and does not take into account aggregation at the point of handover, as the capacity of the access link may not equal that of the end to end circuit as it may be aggregated. This can affect costs, and can also affect PPC prices. BT cited Netstream access as an example of this.[198]

Migration from sub-2Mbit/s services to broadband

3.263 BT also did not agree with our approach to considering migration from sub-2Mbit/s services to broadband. It expressed the view that the Jigsaw survey did not provide evidence to enable us to understand the migration preferences of sub-2Mbit/s users as our questions on purchases and switching did not distinguish between the bandwidth or type of leased line. Further, BT argued that other results from the Jigsaw survey give support to ADSL broadband imposing a price constraint on sub-2Mbit/s leased lines with real switching taking place. In particular:

- in the end-user surveys the percentage of SDH/PDH leased lines customers with sub-2Mbit/s services appears to have fallen from 53% in 2007 to 6% in 2011;
- bandwidth appeared to BT to be the main barrier to switching to broadband and when offered superfast broadband (where the question only identified bandwidth as the differentiator to ASDL broadband) the percentage likely to switch to broadband increased from 14% to 53%; and
- in BT's opinion, the importance of bandwidth indicated that general matching of bandwidths is important and BT expressed the view that sub-2Mbit/s services are more likely to be replaced by ADSL than higher rate leased lines.

[196] We also asked respondents in CFI for their views on TI bandwidth breaks. Eight respondents (3UK, Airwave, C&WW, CMA, KCO, MBNL, Verizon and Virgin) commented and there was a broad consensus on retaining the main bandwidth breaks.

[197] BT response, page 121, paragraph 97.

[198] Netstream is used by end-users that need to connect several sites that require high bandwidth links and is typically used by mobile operators. Each of the sites must have a minimum bandwidth of 150Mbit/s and in total there must be 20 or more 155Mbit/s links across the sites. See: https://www.btwholesale.com/pages/static/Products/Data_and_IP_Connectivity/Netstream/index.htm

3.264 BT also expressed the view that our discussion on the diversity of applications was irrelevant, as what matters is not the diversity of the applications but the stickiness of applications, and a priori the number of applications has no bearing on this stickiness.

Ofcom's view

General approach to bandwidth breaks

3.265 Having carefully considered the points raised by BT, we do not agree that their criticisms of our bandwidth break analysis are valid. As discussed, in paragraphs 3.102 and 3.103, we base our analysis on wholesale rather than retail prices because wholesale charges are regulated to reflect costs, as would also be expected of prices in a competitive market.[199] The competitive level of prices is the appropriate level for carrying out the SSNIP test. Further, using the prevailing wholesale prices as a proxy for competitive prices is also consistent with the SMP Guidelines which state that this is appropriate unless there is evidence that this is not the case.[200] Moreover, actual retail prices may not be closely related to cost, particularly if there is retail market power which may result in an over-estimation of the scope for substitution, resulting in an excessively broad market definition and vice versa. Compounding this, retail prices are typically unpublished and may vary from customer to customer.

3.266 Further, as the regulated wholesale charges are being used as a proxy for the competitive level of prices, their use is consistent with the modified Greenfield approach. The modified Greenfield approach requires us to assume that there is no SMP regulation in place at the level of the market being reviewed and we are not relying on the availability of regulated inputs for the substitution analysis (except when it is necessary to do so in the final stage assessment of the need for retail remedies in the presence of wholesale remedies).[201]

3.267 BT also argued that we did not consider aggregation at the point of the handover and that the capacity of the access link may not equal that of the end to end circuits as it may be aggregated. We do not consider that this observation would affect the analysis we carry out, in which we explicitly consider whether a user would meet a given bandwidth demand in the cheapest way, either by a single large capacity circuit or multiple (aggregated) lower capacity lines. Moreover, we take into account aggregation at the point of handover in our pricing comparison in Figure 3.23.[202]

3.268 BT appears to be arguing that there are volume discounts for purchases of multiple circuits. This would tend to smooth, to some extent, the "steps" in Figure 3.23, as total cost would then increase more slowly with the number of circuits purchased than when prices are uniform. In theory this could reduce the significance of the bandwidth breaks we identify, leading in the direction of broader markets. However, given the large steps identified in Figure 3.23, discounts would have to be very deep

[199] We further note that PPC and AI charge controls are set to bring charges into line with expected costs on an FAC basis which includes an allowance for common cost recovery, at a basket level.

[200] See paragraph 42.

[201] We also note that BT uses the term "modified Greenfield site" in its response and it is unclear whether BT attaches any importance to the word "site". We note the term does not appear in Annex 3 that sets out our approach to market definition. We have assumed that BT is in fact referring to the standard modified Greenfield approach.

[202] We assume the circuits are set up and delivered over one or more SDH bearers (155Mbit/s STM1) from an add-drop multiplex at the point of handover.

to have a significant effect. Further, we consider that the observed substantial differences in competitive conditions for TI services at different bandwidths, highlighted by differences in BT's market share across the TI markets, suggests that narrow markets are appropriate. In contrast, for AI services, we do not observe the same significant differences in competitive conditions, and this is reflected in our finding of a broader low bandwidth AI market.

Migration from sub-2Mbit/s services to broadband

3.269 BT also did not agree with our discussion of migration from sub-2Mbit/s services to broadband. We consider this is based on a misinterpretation of our analysis in the June BCMR Consultation. As we set out, the key issue was not a lack of significant migration from sub-2Mbit/s services, but rather that there was no evidence of a significant difference in migration from 2Mbit/s, on the one hand, and from sub-2Mbit/s circuits on the other (see paragraph 3.258 above, which was also included as paragraph 3.213 of the June BCMR Consultation). We also note that the fall in the percentage of end-users with sub-2Mbit/s services is consistent with our understanding of the market as a whole. As noted in the June BCMR Consultation, the majority of the remaining low bandwidth leased lines are likely to be concentrated across a narrow set of end-users who either have a legacy network for site-interconnection or require specific characteristics of a leased line.[203]

3.270 We agree with BT that what is important is not the diversity of the applications *per se,* but the need of users of some applications within the diverse set for TI service features, or, in BT's words, the "stickiness" of some applications. Here we consider that the evidence shows that there are a number of applications for which end-users are likely to be less willing to switch and/or able to switch without a significant time delay. This may be due to perceived quality differences which particularly affect voice services, for example, or where end-users face significant switching costs. Supporting this, we note that in the response to the June BCMR Consultation [✂] noted that while the market for TI services has been in decline since 2007, the rate of decline slowed because many of the circuits that lend themselves to migration have already moved. The respondent argued that a significant proportion of remaining circuits would be unable to migrate due to various constraining factors such as voice requirements or the fact that they are point-to-point circuits. This was supported by our end-user survey and assessment of barriers to switching discussed under Issue 1.

3.271 Therefore, we do not consider that the evidence provides support for a price constraint, especially as (for market definition) we consider the relevant period for switching to occur after a SSNIP is within a reasonable time frame. The persistence of sub-2Mbit/s demand, despite the savings which could be made by switching to other services, does not suggest that there is such a constraint.

Ofcom's conclusion about bandwidth breaks in the TI market

3.272 Based on the results of our analysis, and having carefully considered responses to the June BCMR Consultation, we conclude that for the purposes of informing our wholesale market definitions, the bandwidth breaks in the TI market are unchanged from the 2007/8 Review and are as follows:

- Low – up to and including 8Mbit/s (including analogue and SDSL services);

[203] See the June BCMR Consultation, paragraph 3.166, and also paragraph 3.200 of this Section.

- Medium – above 8Mbit/s up to and including 45Mbit/s;
- High – above 45Mbit/s and up to and including 155Mbit/s; and
- Very High – 622Mbit/s.

(ii) Bandwidth breaks in the AI market

Our proposals in the June BCMR Consultation

3.273 In the June BCMR Consultation we proposed to find that there continues to be a break in the market for standard AI services provided at bandwidths above 1Gbit/s. This was based on a consideration of:[204]

- relative price comparisons;
- equipment and other costs of providing services; and
- variations in competitive conditions.

Relative price comparisons

3.274 As a first step we considered whether relative prices suggested that different AI services at different bandwidths are in the same market. We noted that wholesale AI charges up to and including 1Gbit/s have been charge controlled and should now be broadly cost-reflective. Our price comparisons were based on Openreach's wholesale input prices for EAD and WES services which applied throughout the UK.[205] In the analysis, each service consisted of one local end and a main link and the price included:

i) a connection fee which was amortised over three years;

ii) the annual rental cost; and

iii) the main link charge if applicable.[206]

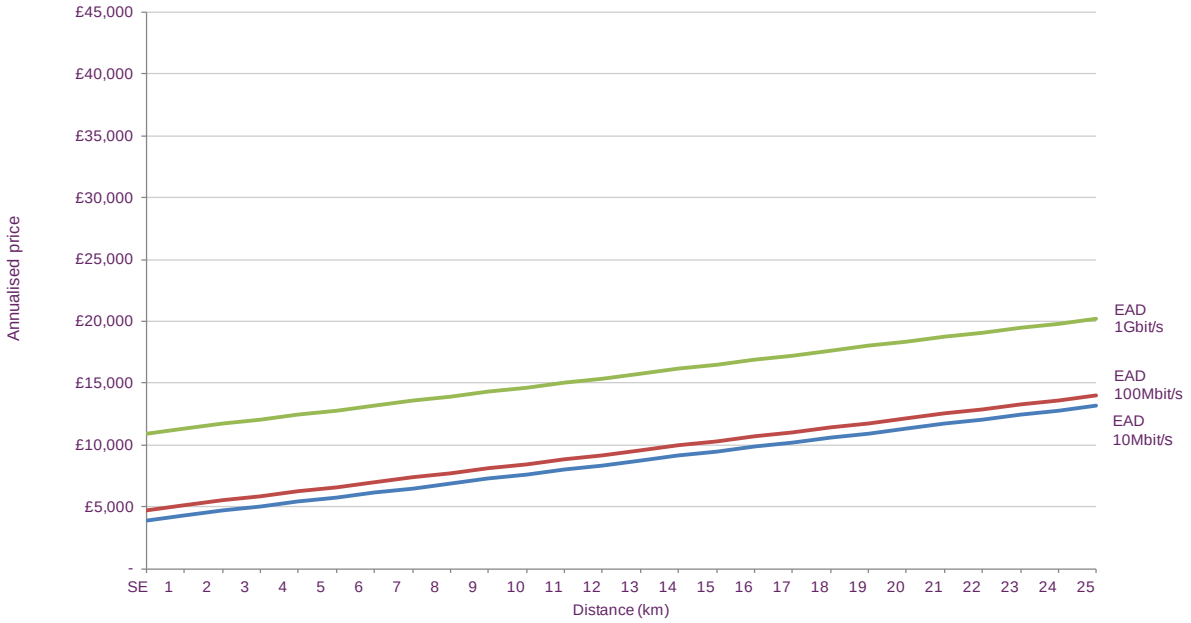
3.275 As WES services have a maximum distance of 25km the comparison was made over distances up to 25km.

[204] Note we did not discuss Ethernet supplied over WDM under this issue, as the implications of WDM-based services were discussed under Issue 5.

[205] EAD services are available for new supply with 10Mbit/s, 100Mbit/s and 1Gbit/s Ethernet interfaces WES services are available for new supply with 10Gbit/s Ethernet interface and also 2.5Gbit/s and 10Gbit/s TI interfaces (STM-16 and STM-64 respectively). For the purposes of this discussion we treat these latter options as AI services as they are Ethernet standards based services and use the same series of equipment as the Ethernet interface WES services.

[206] There is no trunk/terminating distinction for AI products, therefore no trunk/terminating ratio assumptions or sensitivity analysis were needed in relation to this analysis.

Figure 3.26: Comparison of wholesale AI prices by bandwidth [✂WES prices redacted]



Source: Ofcom analysis, based on BT wholesale prices for EAD and WES services

3.276 The results showed that 10 and 100Mbit/s services are closely priced, while a 1Gbit/s service is approximately double the price of these services. Above 1Gbit/s, there was a step change in the price of services of approximately £[✂] and this increase was higher than the step-ups in price for services of 1Gbit/s and below. We noted that given the significant price gap the figure suggested that it would be unlikely that many end-users would upgrade from low to high bandwidth services if a hypothetical monopolist sought to impose a SSNIP on the low bandwidth services.

3.277 We explained that, by itself, the pricing comparison suggested that there could be separate markets at every bandwidth increment. This was because for any intermediate bandwidths between two bandwidth increments, it would always be cheaper to buy the higher bandwidth service rather than multiples of low bandwidth services. We gave the example of a user with demand for capacity between 10 and 100Mbit/s, for whom a 100Mbit/s service will always be cheaper than multiple 10Mbit/s services; this would not be affected by a SSNIP. Defining a market for circuits at each bandwidth would have been a change from the conclusions of the 2007/8 Review.

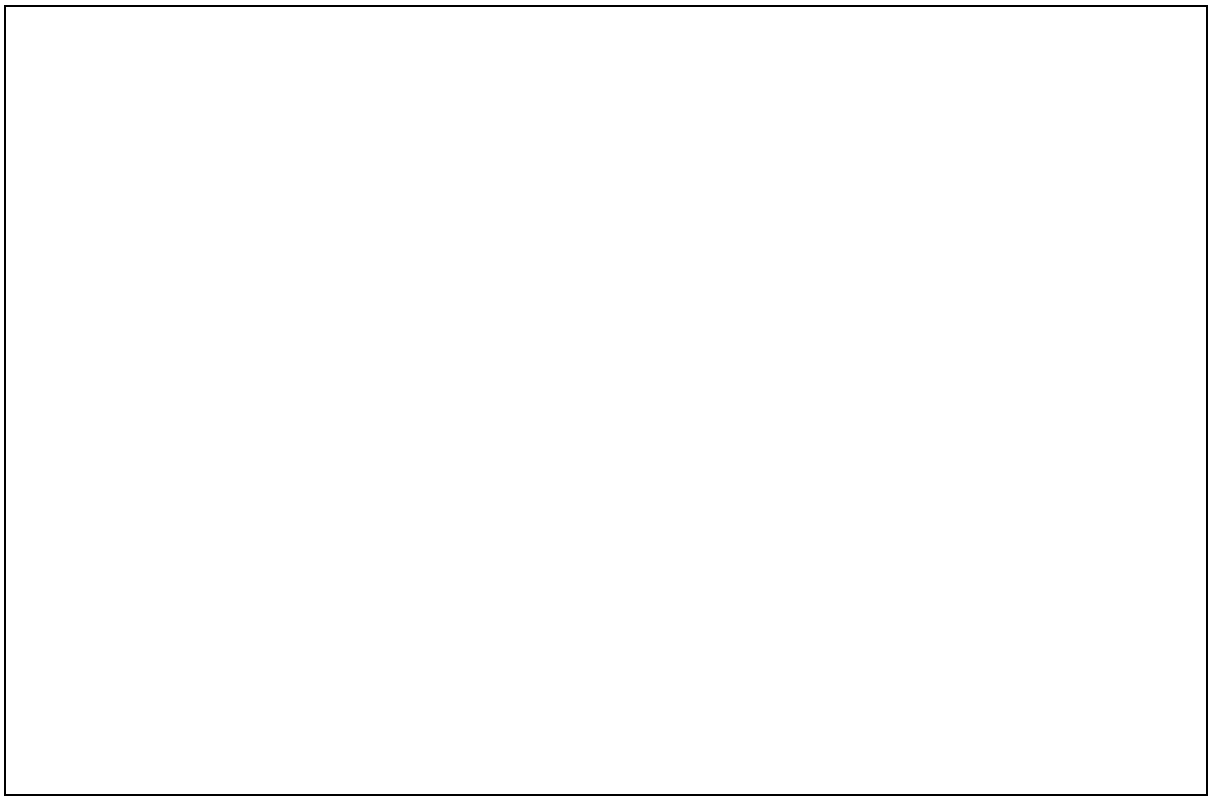
3.278 However, we noted that we do not know with certainty what prices would look like in a competitive market. It may be that even though prices have been regulated, there is still some supernormal profit and the pricing structure is distorted by market power. In a competitive market, the increases in price with bandwidth could be larger or smaller than the ones we observed. Hence, as in the 2007/8 Review, we investigated the underlying costs of provision. This was in order to provide some additional insight into the likely competitive level of prices although we also noted that, whilst competitive markets would bring prices into line with costs on average, some prices could be lower than BT's FAC whilst others could be above FAC. This is because the structure of prices in a competitive market could still feature prices which increase with bandwidth more steeply than BT's FAC.

Equipment and other costs of providing services

3.279 In the June BCMR Consultation, we noted that the way that the cost of provision varies with bandwidth is largely driven by the higher cost of equipment at higher bandwidths. We said that these costs can form a large proportion of the total cost of provision and that other common costs such as digging and ducting are typically constant across bandwidths.[207] In the June BCMR Consultation we presented updated analysis of the cost of equipment across bandwidths and considered how indirect costs like planning, design and installation vary across bandwidths.

3.280 The results of our analysis of equipment costs are shown in the figure below (reproduced from the June BCMR Consultation). This was based on data supplied by BT in January 2012 which we used to derive estimates of the equipment costs incurred to provide services across a range of bandwidths. The costs modelled were for the provision of a new leased line (i.e. there was no existing equipment) between an end-user premises and a CP POP located in a BT exchange collocation space. As WES services are only available on a single service point-to-point basis the comparison was made on this basis. The equipment costs included the cost of the chassis, the required optics and the management router – they did not capture any installation costs or estimates of ongoing costs like space and power.

Figure 3.27: Cost of AI equipment by bandwidth [✂Figure redacted]



Source: BT response to s.135 information request, 2012

3.281 The results of our analysis showed that up to and including 1Gbit/s, the variations in cost per service were not significant. On the other hand there appeared to be a step change in the costs of provisioning 2.5 and 10Gbit/s. Our estimates indicated that the

[207] Common costs here refer only to costs that do not vary by bandwidth, this includes the cost of digging and duct etc which can be used to support services of all bandwidths and are common to all the services contained in the duct. This is in contrast to other general overheads which would be common to a wider range of services.

equipment costs at 2.5Gbit/s were seven times higher than at 1Gbit/s while at 10Gbit/s equipment costs were nine times higher than at 1Gbit/s.[208]

3.282 However, we noted that caution should be applied to these estimates as they may be overstating the equipment cost gap for services up to 1Gbit/s and above 1Gbit/s. This is because our analysis was based on the cost of equipment for EAD for services up to 1Gbit/s while for 2.5Gbit/s and 10Gbit/s our analysis was based on WES, an earlier generation AI service.[209] In the 2007/8 Review our analysis of WES equipment costs by bandwidth found that while the cost gap was significant, it was smaller than our estimates above.[210] A comparison with the previous results showed that while costs of equipment above 1Gbit/s had fallen, the main driver of the higher multiples seen above was been the significant decline in equipment costs for services at 1Gbit/s and below.[211]

3.283 While our estimate above may overstate the extent to which equipment costs increase above 1Gbit/s, we considered that there still is a step change in the costs of provisioning services above 1Gbit/s. Further, we noted that it is possible to increase the bandwidth of AI services at up to 1Gbit/s by changing the port card in the network terminating equipment (NTE). However, for services above 1Gbit/s dedicated NTE are employed. Therefore, migration within the sub-2.5Gbit/s portfolios can be accomplished via card change whereas migration from sub-2.5Gbit/s to 2.5Gbit/s or 10Gbit/s, or from 2.5Gbit/s to 10Gbit/s, requires NTE change. Due to this we considered that the cost of moving from a low bandwidth (up to 1Gbit/s) service to a high bandwidth (over 1Gbit/s) service is likely to be significantly higher than the cost of substituting one low bandwidth service (e.g. 100Mbit/s) for another low bandwidth service of different bandwidth (e.g. upgrading to 1Gbit/s), with the implication that the likelihood of switching from a low bandwidth (up to 1Gbit/s) to a high bandwidth (over 1Gbit/s) circuit in response to a SSNIP would be limited.

3.284 In addition, we noted that users of Ethernet interfaces at 1Gbit/s and below are able to benefit from scale economies arising from the higher volumes of Ethernet components used in carrier and enterprise markets at these bandwidths.[212] Indeed our analysis above suggested that this has already happened, because the cost of equipment at 1Gbit/s and below has fallen significantly and at a faster rate than the fall in equipment costs for services above 1Gbit/s. Nevertheless, we noted that with the expected higher take-up of services above 1Gbit/s over the three year review period we would expect to see a greater downward pressure on equipment costs at higher bandwidths in future.

3.285 We further noted that there are other indirect costs which distinguish higher bandwidth services from lower bandwidth services. These include higher levels of

[208] This suggests that a user is unlikely to switch from a 1Gbit/s circuit to one of a higher bandwidth in response to a SSNIP.

[209] We made this comparison because while WES services at 1Gbit/s and below have been withdrawn from new supply and replaced by EAD, WES services at 2.5Gbit/s and 10Gbit/s are still available and there is no equivalent EAD product available at these bandwidths.

[210] In the December 2008 Statement and Consultation we estimated that equipment costs at 2.5Gbit/s were 3 times higher than at 1Gbit/s while at 10Gbit/s equipment costs were 7 times higher than at 1Gbit/s.

[211] The mass IT market now includes 1Gbit/s Ethernet interface bandwidths resulting in significant price reductions. Bandwidths above 1Gbit/s are generally only seen in large networks with correspondingly low volumes and higher prices.

[212] Our retail market volumes summarised in Figure 3.11 suggests that as of Q4 2010/11 there are approximately 68,000 services at 1Gbit/s and below, our corresponding estimate for services above 1Gbit/s is approximately 150.

planning and design and the provision of additional fibre for dual-fibre 2.5Gbit/s and 10Gbit/s services. Installation costs are also typically higher, as higher levels of training are required to install and configure the equipment and often additional tests are required such as Polarisation Mode Dispersion (PMD).[213] Also due to the higher SLAs associated with these services, there are additional costs associated with the equipment used to conduct these tests. With higher level SLAs and lower volumes, equipment spares need to be stored on a geographically-dispersed basis to enable BT to respond to its SLAs. This and the generally higher cost of servicing higher levels of SLAs, means that there are higher costs associated with higher bandwidth services.

3.286 Therefore we concluded that the above analysis suggested that there is a break between services at 1Gbit/s and below and services above 1Gbit/s. This is because the differences in equipment and other indirect costs are sufficiently significant that prices in a competitive market would reflect them, and the scale of these differences would then make it unlikely that users of the lower bandwidth service would switch to the higher bandwidth service in response to a SSNIP. A SSNIP would be unlikely to prompt switching from 1Gbit/s to a higher bandwidth service. It would also not be economic for users requiring 2.5Gbit/s and above to use multiple 1Gbit/s services if a SSNIP were imposed on the higher bandwidth service.

Variations in competitive conditions

3.287 We noted in the June BCMR Consultation that competitive conditions are likely to vary between low and high bandwidth AI services because of the presence of significant sunk costs and economies of scale which are likely to act as a barrier to competitive entry, especially at lower bandwidths. In the absence of regulation, it is likely that retail competitors to BT would be reliant on self-supply or interconnection with OCPs in order to compete. Given that a significant proportion of the costs of entry would need to be sunk, the question is whether these barriers are more or less likely to be overcome at different bandwidths such that variations in competitive conditions might be observed.

3.288 In the case of higher bandwidth AI services, we considered that the much higher revenues likely to be associated with these suggest that CPs would be more likely to enter the market, as the CP could be more confident that any investments sunk in the provision of a single retail contract could be recovered over the duration of the contract. In contrast, at lower bandwidths, costs are likely to be a higher proportion of prices. This reflects the fact that observed prices tend to increase with bandwidth to a much greater extent than costs, particularly duct costs. Therefore we noted that in order to recover costs the CP would need to ensure a larger volume of sales over a particular timeframe, which may limit the scope of competition as it makes the prospect of entry riskier (i.e. the CP would need to secure multiple contracts in order to compete).

3.289 We considered, therefore, that CPs may be able to compete more intensively for higher bandwidth services. This was supported by our estimates of BT's wholesale market shares. Our estimates indicated that BT's wholesale national market share for low bandwidth AI (up to and including 1Gbit/s) services was 62% compared to 50% for high bandwidth (above 1Gbit/s) AI services.

[213] PMD causes pulse distortion through the differential interaction of the polarisation states of the light, comprising the pulse, interacting with the non-circular perturbations of the optical fibre. Pulse distortion becomes progressively damaging at higher transmission bandwidths where the pulses are shorter.

Responses to the June BCMR Consultation about bandwidth breaks in the AI market

3.290 Only BT provided specific comments on our proposed market definition for AI services up to and including 1Gbit/s. BT also commented on our general approach and on our market definition for 1Gbit/s services.[214]

General approach to AI bandwidth breaks

3.291 BT argued that, to the extent we present the AI bandwidth break analysis as being equivalent to the TI bandwidth break analysis, it will be subject to many of the same criticisms raised in relation to TI by BT.

3.292 BT further argued that we cannot follow the same approach for AI as TI as the services are intrinsically different, as EAD is significantly upstream from a true multi-site retail service. This is because, in BT's view, our analysis of point-to-point services does not take into account the costs of shared infrastructure and network costs, such as switching and multiplex equipment, which are likely to heavily dominate bandwidth dependent costs for multi-site services. Instead BT argued that we should look for high value sites.

Market definition for 1Gbit/s services

3.293 BT supported our proposal to find that the AI upper limit was kept at up to and including 1Gbit/s, given the cost differences between a 1Gbit/s and a 10Gbit/s circuit, but argued for a differentiated assessment of SMP at 1Gbit/s as it considered that the competitive conditions are different.[215]

3.294 DotEcon's report, on behalf of BT, asserted that the proposed market definition covers roughly the same range of bandwidths as the four product markets for TI and the consequence of this, in its view, is that services with quite different supply conditions are included within the AI market. It argued that a consumer of a 1Gbit/s AI service is likely to be very different, and paying a very different amount, to a consumer of a 10Mbit/s (or less) service and that the incentives to build out to these customers will differ correspondingly. Therefore, it expressed that view that once geography is considered, it is difficult to conclude that competitive conditions are necessarily similar at all locations at the two ends of the bandwidth spectrum.

3.295 Further, DotEcon argued that even if we start with a market definition for AI that includes all services below 1Gbit/s for reasons of demand substitutability, it is then necessary to consider the conditions of competition, including potential supply. It suggested that if we find these conditions vary significantly then the market definition will need to be revisited. It argued that we had not done so, which meant that the AI market definition may be too broad to allow proper consideration of how local competitive conditions may apply.

[214] We also note that in the CFI, nine respondents commented on our question about AI bandwidth breaks. Four respondents supported the continuation of the bandwidth break at 1Gbit/s, two called for it to be moved upwards, while three respondents proposed alternative definitions. For more details see paragraphs 3.223 to 3.229 of the June BCMR Consultation.

[215] "We also consider that the competitive conditions for 1Gbit/s Ethernet services are likely to be significantly different than for services below 1Gbit/s, which, notwithstanding the specific market boundary definition, should justify a differentiated assessment of SMP." BT response, page 23, paragraph 6e.

3.296 Under this issue, BT also raised a number of specific points related to our approach to geographic market definition and SMP, which we discuss in Sections 5 and 7 respectively.

Ofcom's view

General approach to AI bandwidth breaks

3.297 BT argued that our assessment had a number of the same problems as the TI assessment and our responses to these points are covered in paragraphs 3.265 to 3.268 above.

3.298 As noted above, BT claimed that TI and AI services are intrinsically different and that for AI services multi-site costs would dominate bandwidth-dependent costs. Consequently, it argued we should look for high value sites. First we note that both AI and TI circuits can be used as end to end circuits in addition to their use to support multi-site connectivity and as VPN tails, suggesting that the services are not intrinsically different in this respect.

3.299 As regards BT's more general point about multi-site connectivity, we respond to this point earlier in this Section where we discuss the appropriateness of the focal services we have identified based on key characteristics. We also note that it is unlikely that a focus on multi-site connectivity as the "focal product" would change our conclusions on AI bandwidth breaks. In particular, it seems unlikely that it would lead to additional bandwidth breaks below 1Gbit/s, as there may be no clear bandwidth gradient in the price of multi-site, multi-service packages. This view is consistent with the broad market already we have defined for AI services at up to 1Gbit/s. Supporting this we note that it would not affect the change in equipment costs at above 1Gbit/s, which is a key piece of evidence for the distinction between the market for circuits at up to 1Gbit/s and the market for higher bandwidth circuits.

Market definition for 1Gbit/s services

3.300 Our approach, as set out in Annex 3 and followed in the June BCMR Consultation, is to consider product market definition before considering the appropriate geographic market definition. The first step in product market definition is an analysis of demand-side substitution. Supply-side substitution can also be taken into account, where relevant. Finally, we may consider related products as part of a single market even where they are not good demand- or supply-side substitutes, if competitive conditions in their provision are sufficiently similar. With this approach, any variations in competitive conditions subsequently found within the defined product and geographic markets can be reflected in differentiated remedies, without necessitating another iteration of the market definition process.

3.301 In the June BCMR Consultation, we proposed a single product market for AI services at up to and including 1Gbit/s. We argued that demand-side substitution was likely to constrain the prices of lower bandwidth circuits below 1Gbit/s, as users would be likely to switch to a higher bandwidth circuit in response to a SSNIP. Supply-side substitution between circuits of all bandwidths in the market is clearly technically feasible, although we did not put weight on it as a source of constraints on prices for market definition purposes. Finally, in the UK as a whole, we have not found significant variations in competitive conditions between 1Gbit/s and sub-1Gbit/s AI circuits.

3.302 In the light of BT's response we have considered whether competitive conditions remain broadly homogeneous across circuits of different bandwidths once geographic markets have been defined. In particular, we have considered whether, in the WECLA[216], competitive conditions for AI services at 1Gbit/s differ from competitive conditions for AI services at lower bandwidths.

3.303 Our analysis of service shares suggests that, on the face of it, BT faces somewhat greater competition in the WECLA for 1Gbit/s AI services than for lower bandwidth services. Competitive conditions outside this area are more clearly homogenous, to the extent that they are reflected in service shares.

3.304 However, while service shares are a relevant consideration, they are not the sole relevant indicator of competitive conditions and, on balance, we do not consider these results are sufficient to lead to us to change our conclusion. This is because we consider that other evidence suggests that competitive conditions are broadly homogeneous across AI services up to and including 1Gbit/s.

3.305 In support of this we note that essentially similar fibre, duct and equipment are used to supply AI circuits at all bandwidths up to and including 1Gbit/s. The (direct) costs of provision for AI at all bandwidths up to and including 1Gbit/s are also consequently very similar, with little tendency to increase with bandwidth. There are also economies of scope to be gained from using a single network to supply multiple services, in this case, AI circuits at different bandwidths. Given this, the likely outcome of a (hypothetical) competitive market, with no first mover advantages, is that operators with their own infrastructure would compete to supply all bandwidths in order to benefit from the economy of scope, maximising use of the shared parts of their networks. Competitive conditions at the different bandwidths would then also be broadly similar. We also note that these conditions mean that supply-side substitution between bandwidths is feasible, although we do not rely on supply-side substitution to define the market.

3.306 In practice, we observe that BT's competitors in the WECLA have concentrated on, or at least seem to have been more successful in, supplying 1Gbit/s circuits. We consider that the most likely explanation is that the ability to enter has been conditioned primarily by BT's pricing policy. This has allowed one OCP in particular [✂] to build up a large share of 1Gbit/s services in the WECLA. Entry has occurred primarily at 1Gbit/s because BT's pricing structure makes it the most profitable part of the market as BT's prices for these services and the margins generated on them are notably high. This was shown in the recent dispute between BT and a number of other CPs regarding BT's charges for Ethernet services[217], which found that BT overcharged for three 1Gbit/s services during the period 2006/7-2010/11. These included BES 1000 rental in 2006/7-2009/10 and WES 1000 rental for 2006/7-2010/11. In these cases, we found that BT's prices were above DSAC and not cost-oriented and that the ROCE was substantially above BT's WACC, indicating very high margins.

3.307 This is consistent with BT having market power across the broadly defined market, reflected in high share at lower bandwidths but loss of share - but with high prices - at 1Gbit/s. Here we note that we also believe that a lot of the growth in OCP supply for 1Gbit/s AI services in the WECLA has been driven by OCPs targeting their existing

[216] As defined in Section 5, the WECLA is the West, East and Central London area including parts of Slough.

[217] See: http://stakeholders.ofcom.org.uk/enforcement/competition-bulletins/closed-cases/all-closed-cases/cw_01078/

customers for bandwidth upgrades, which is consistent with the view that operators with their own infrastructure will supply at all bandwidths.

3.308 [✂]

3.309 An additional point to note is that the service share estimates are only based on circuits which connect to retail business customer sites and do not include similar circuits used for backhaul by MNOs and LLU operators, of which BT's share is significantly higher. If these services are included, the difference in service shares at 1Gbit/s and less than 1Gbit/s in the WECLA becomes much less marked.[218]

Ofcom's conclusion about bandwidth breaks in the AI market

3.310 Based on the analysis set out above, we conclude it is appropriate to define two separate AI product markets: one for services up to and including 1Gbit/s and the other for services over 1Gbit/s. In summary, the key reasons for this are:

- evidence that demand-side substitution is limited:
  - a comparison of relative prices, which suggested that there was a step change in the price of services above 1Gbit/s; and
  - an analysis of equipment and other costs of providing services, which suggested that differences in these costs are sufficiently significant that a competitive provider would be expected to price to reflect these differences.
- evidence that the competitive conditions in the two markets appear to differ significantly:
  - an assessment of CPs' incentives, which suggested that they will be able to compete more intensively for high bandwidth services; and
  - BT's market share is significantly lower in the high bandwidth market.

3.311 We also note that although there is evidence that there are variations in competitive conditions for AI services at 1Gbit/s in WECLA, we do not consider that it is appropriate to define a separate product market. This said we do consider the implications of variations in service shares in our SMP assessment (Section 7).

Issue 5: Wave Division Multiplex (WDM) services

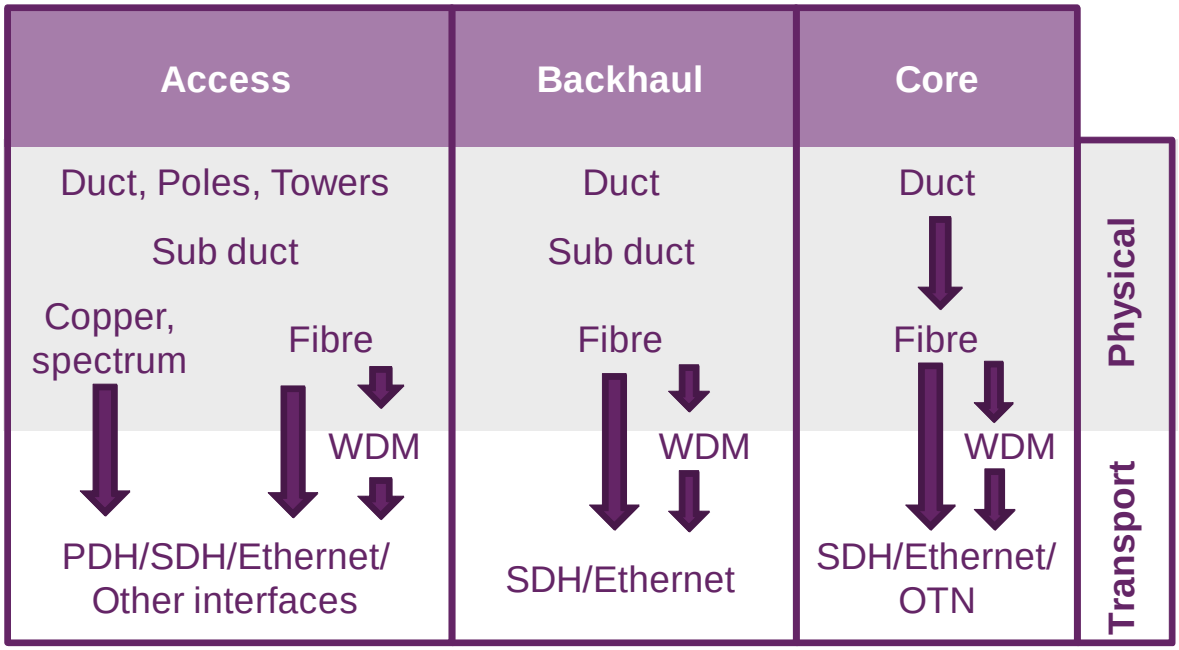
3.312 Wave Division Multiplexing (WDM) is a technology that can be deployed to significantly increase the data carrying capacity of a single optical fibre as it allows multiple wavelengths of light (operating at different frequencies) to be sent down a single optical fibre simultaneously. This allows WDM-based services to support multiple circuits (typically 16, 32, 40 or 80) at capacities above 1Gbit/s. Further, once a system is installed, additional circuits can be quickly added without disruption to the existing circuits. These characteristics mean that WDM is often deployed for backhaul and core networks where CPs need to transport multiple traffic streams efficiently over high capacity links.

[218] If all circuit ends including network nodes, not just customer ends, are counted BT's wholesale service share at 1Gbit/s increases from 31% to 45%. This is consistent with the fact that its share of network ends, which includes some CP backhaul, is much greater than customer-ends. See the discussion of this in Section 7.

3.313 Retail WDM services extend the use of WDM to the access part of the network and allow end-users to buy an end-to-end solution with WDM equipment installed at each end-user site. As a retail service, it is typically presented to the end-user using a specified AI interface such as Ethernet, but it can also support TI SDH interfaces and other interfaces like Fibre Channel. These services have historically been used by data intensive end-users such as data-centres. Since 2007/8 the use of retail WDM services has expanded and a wide range of CPs have begun to offer WDM-based retail services.

3.314 Figure 3.28 shows the different uses of WDM and highlights its use as a high capacity wholesale input to leased lines services (TDM and Ethernet-based services) and as an input into an optical-based retail service in its own right.[219]

Figure 3.28: WDM services as upstream inputs and retail services



Source: Ofcom 2012

3.315 Figure 3.28 highlights that there are a number of upstream wholesale inputs to retail leased lines and other retail services. These wholesale inputs include duct, fibre and, in the core/backhaul parts of the network, WDM as a transmission medium. For TDM and Ethernet retail leased lines, these inputs are combined with access fibre and necessary TDM or Ethernet equipment to deliver dedicated point-to-point services via SDH or Ethernet interfaces to the end-user. WDM-based retail services are provided on an end-to-end basis and require dedicated WDM equipment to be installed at the retail end-user premises. For the retail WDM service to be able to transport traffic between sites it must be presented to the end-user with the relevant interface. As discussed above and shown in the figure above, this includes a range of interfaces such as Ethernet or SDH or other interfaces like Fibre Channel.

3.316 In the June BCMR Consultation, our assessment focused on the demand from retail end-users for WDM services. We noted that, while it is possible for retail end-users to make use of SDH/PDH interfaces over WDM, we considered that it was only relevant

[219] The role of WDM as both an upstream input to leased lines and as a retail service also has implications for our wholesale market definition which is considered in Section 4.

to assess WDM services against retail AI services that offer high bandwidth services (at 1Gbit/s and above) because of the small number of TI SDH interfaces being sold – i.e. the majority of demand for high bandwidth services is for services presented with Ethernet interfaces.[220] Below we first set out the proposals we made in the June BCMR Consultation, together with the reasoning which underpinned them. We then summarise the responses we received and explain how we have taken the responses into account in reaching our final conclusions. We then present our conclusions.

Our proposals in the June BCMR Consultation

3.317 In the June BCMR Consultation we proposed to define a very high bandwidth retail product market (the Multiple Interface market) consisting of WDM services and high bandwidth AI services.[221] This reflected significant developments in the market since the 2007/8 Review. Our conclusions were based on a consideration of two broad areas:

- a qualitative assessment, which started with a comparison of the functionality of retail WDM and AI leased lines; and
- demand-side substitution analysis based on the relative costs of provision, relative prices and SSNIP analysis for WDM and leased lines services; evidence on market trends and usage of high bandwidth services; and an assessment of possible switching costs.[222]

Qualitative assessment

3.318 We noted that the scalability of WDM was one of the key features of retail WDM services identified in the 2007/8 Review. The time required to change the configuration of the service is a function of the commissioning and installation of cards in the equipment at each end. In principle, where the relevant WDM equipment is available, bandwidth upgrades to WDM services can be applied in a few days. This is because any increase in capacity will use the existing fibre circuit and would simply entail an additional card being installed on existing equipment chassis. In contrast, we noted that for both SDH/PDH and Ethernet circuits, where existing capacity is fully utilised, new fibre circuits must be added which is costly and will have a far longer lead time. The ability to add additional high bandwidth connectivity (with guaranteed delivery times) quickly and in a cost-effective manner once the end-user has purchased an initial service is a key feature of WDM-based services.

3.319 A retail WDM service also needs a service layer (interface) to be added in order to be used to transfer data. The modularity of WDM equipment allows line cards to be installed so that traffic can be transported using various interfaces such as Ethernet, SDH or other interfaces such as Fibre Channel. In contrast, a standard Ethernet

[220] At higher bandwidths a key driver of demand is data transfer, this does not require the specific characteristics of TI services. Illustrating this, our analysis of a sample of BT's Wavestream Regional and National services orders from 2005-2010,[✂] indicates that SDH interfaces account for approximately 18% of orders.

[221] This market would include Ethernet at above 1Gbit/s and WDM services including AI interfaces.

[222] Following the reasoning set out in Annex 3, we do not consider in detail whether supply-side substitution would provide a competitive constraint. Further discussion of supply-side constraints between WDM and AI and TI leased lines is set out in the January 2008 Consultation, paragraphs 3.391 to 3.393. However, we note that the fact that some CPs appear to supply all high bandwidth services in the form of WDM circuits suggests that supply-side substitution into the provision of high bandwidth AISBO circuits might be a relevant possibility; this would of course provide further support for the definition of a single high bandwidth market.

service while also relying on a pair of lit wavelengths over fibre, does not offer this modularity. For example if an end-user using Ethernet wanted to change the transmission to SDH, then new customer premises equipment would be required.

3.320 The above qualitative assessment did not suggest there had been significant changes in the feature set of WDM since the 2007/8 Review; it is still a scalable service, able to support very high bandwidths over multiple interfaces and distances. However, we noted that a key change since the 2007/8 Review is that there has been a marked decline in the cost of WDM equipment. This was a key theme of a number of CFI responses and is confirmed by our analysis of current Ethernet and WDM equipment costs discussed below.

3.321 We noted that the fall in WDM equipment costs has implications for market definition. In the 2007/8 Review we considered WDM-based services to be relatively "niche", reflecting the premium associated with WDM and the small class of end-users such as data centres willing to face this initially higher upfront cost of equipment to deliver scalable bandwidth and more configurable solutions. Given the increasing demand for higher bandwidths from end-users, highlighted by the fast-growing market above 1Gbit/s, and the fall in the premium associated with WDM services, due to falling equipment costs, WDM-based services are potentially no longer only restricted to a small number of specialist application end-users. Therefore, below we considered the available cost, pricing and demand evidence.

Demand-side substitution analysis

3.322 In this section we assessed whether, at very high bandwidths, end-users consider WDM-based retail services to be a substitute for AI high bandwidth services and vice versa. Our assessment focused on WDM versus AI services because, as noted above, the majority of demand for high bandwidth services is for services presented with Ethernet interfaces. Our analysis included a consideration of:

- the relative costs of equipment;
- relative price comparisons;
- an assessment of the hypothetical monopolist test;
- demand for high bandwidth Ethernet and WDM services; and
- the barriers to switching.

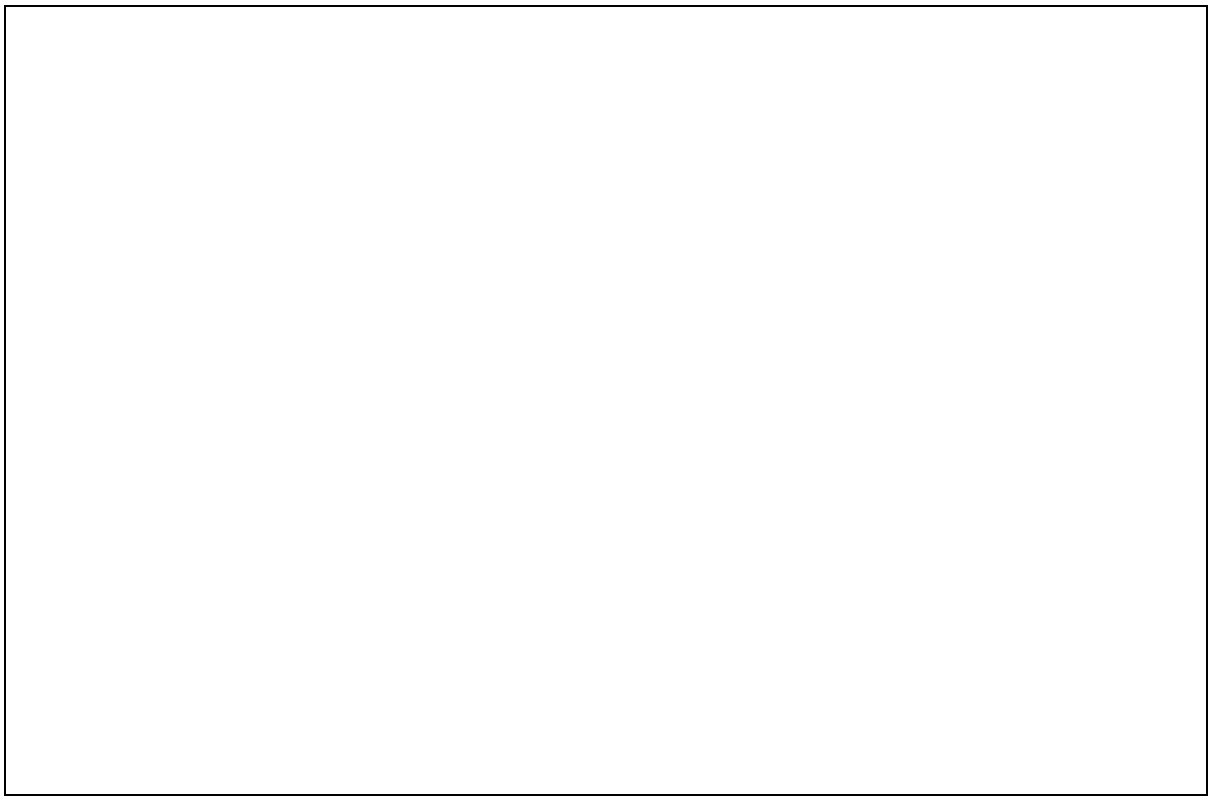
Relative differences in the cost of equipment

3.323 A key message from stakeholders in the responses to the CFI was that there had been a marked decline in the cost of WDM equipment since the 2007/8 Review, which suggested that the price premium previously associated with WDM-based services was being eroded. Therefore we investigated the relative costs of provisioning different bandwidths using Ethernet and WDM equipment.

3.324 Our analysis was based on information on equipment costs supplied by BT in January 2012 and is presented in Figure 3.29 (reproduced from the June BCMR Consultation). We used the equipment cost information to derive estimates of the lowest cost combination of equipment that can be used to provide a range of bandwidths. The costs modelled were for the provision of a new (i.e. there was no existing equipment) point-to-point leased line and included the cost of the chassis,

the required optics and an estimate for the cost of fibre.[223] The results did not capture any installation costs or ongoing costs like space and power.

Figure 3.29: Relative costs of Ethernet and WDM equipment by bandwidth - for a 10km service [✂Figure redacted]



Source: Ofcom analysis, based on BT response to s.135 information request, 2012

3.325 We noted that the figure showed that for the provision of services at 1Gbit/s, there was still a significant cost gap between WDM and Ethernet. As total bandwidth increases, this gap narrowed and our estimates indicated that the equipment required to provide 10Gbit/s using WDM only cost approximately [✂%] more than the equivalent Ethernet solution. We further noted that if we were to take into account other costs like installation and ongoing costs such as management, it is likely that the gap between WDM and the cost of provisioning bandwidth above 10Gbit/s using multiple Ethernet services would be more pronounced as additional Ethernet bandwidth requires the installation of entirely new circuits with their associated costs, while in contrast, WDM only requires the adding of additional wavelengths. Below 10Gbit/s the gap would be smaller.

3.326 As noted above, we observed that the fall in WDM equipment costs had implications for market definition because it would make WDM a viable alternative to Ethernet at lower bandwidths and for a greater number of customers than previously. In the 2007/8 Review we argued that only a small number of end-users would be prepared to pay the premium required (due to higher equipment costs) for WDM-based services that offer scalable and configurable bandwidth. However, our estimates now indicated that WDM-based services no longer incur a significant premium over Ethernet solutions. As WDM provides a more enhanced feature set than dedicated

[223] The analysis included an estimate of the cost of fibre as while a WDM system can support multiple bandwidths on a single optical fibre, multiple Ethernet services will require multiple fibres. In the analysis our estimate of fibre costs was based on the average of the main link charge for EAD, WES and OSA services which we assumed was a proxy for fibre costs.

Ethernet, providing increased flexibility for CPs and end-users, this suggested that WDM may now be the technology of choice for delivering higher bandwidth services.

3.327 Supporting this, our analysis of CP provisioning of services highlighted that for services above 1Gbit/s many major CPs such as [✂] and [✂] have predominately provided new retail leased lines above 1Gbit/s using WDM. This was further support for the view that WDM was now the technology of choice for supplying end-users with bandwidth requirements above 1Gbit/s and that WDM would be a relevant constraint on a service otherwise provided using high bandwidth AI circuits.

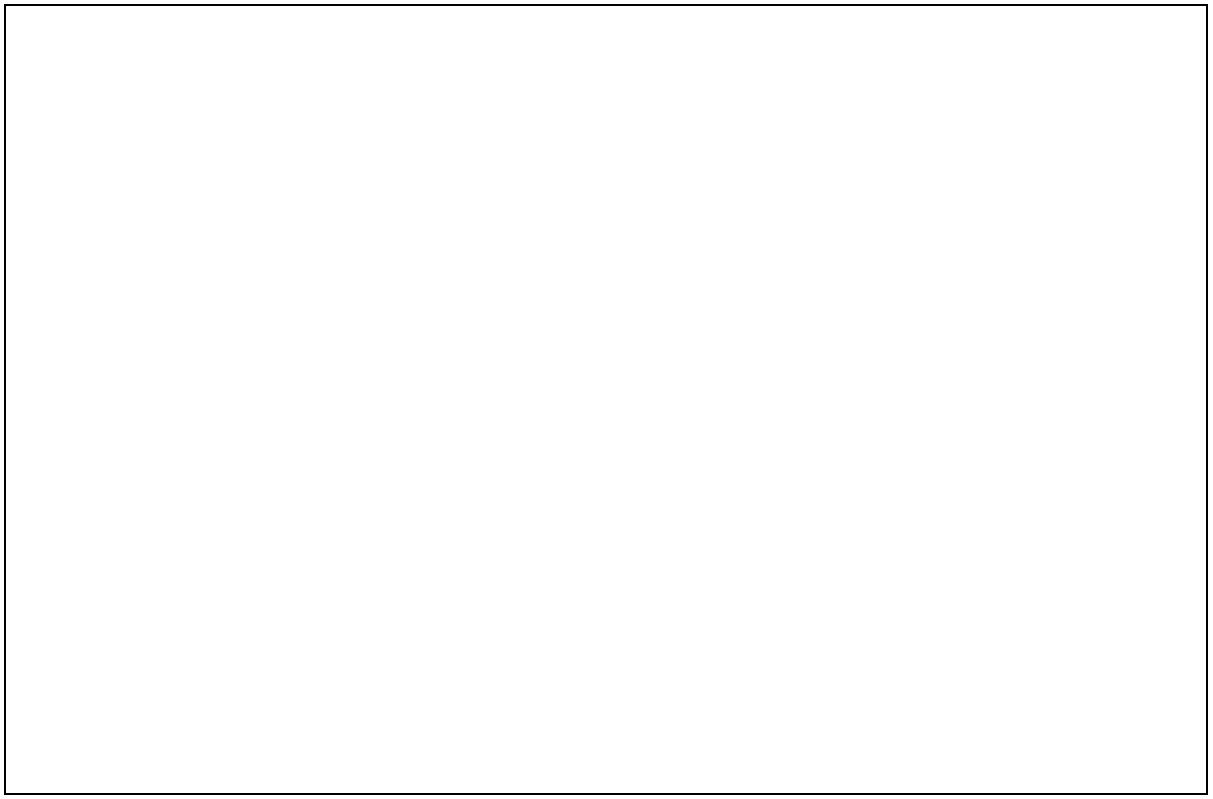
Relative price comparisons

3.328 We also conducted pricing analysis, which was based on Openreach's wholesale price lists because, given the bespoke nature of pricing to end-users, we were not able to obtain representative data on retail service pricing.[224] We noted that, in practice, the prices of retail services will include not only the prices for the wholesale inputs but will also include relevant retail costs and service wrap that might accompany business connectivity services. Nevertheless, in the absence of this retail data, we assumed that these prices should provide a reasonable proxy for the relative differences in competitive prices between retail services.

3.329 First we compared the service-based price per annum of a 1Gbit/s EAD circuit and that of a similar capacity circuit provided over a WDM service (based on Openreach's OSA service). The annualised price includes the connection fee which has been amortised over a typical contract length of three years, plus annual rental and the distance related fees. The results of this analysis are shown in Figure 3.30 below (reproduced from the June BCMR Consultation).

[224] We also noted that because of the bespoke nature of contracts it is likely that any pricing information gathered would be likely to exhibit significant variation across end-users.

Figure 3.30: Comparison of wholesale input prices of a 1Gbit/s point-to-point Ethernet and a WDM circuit [✂Figure redacted]



Source: Ofcom analysis, based on BT wholesale pricelists for EAD and OSA services

3.330 We noted that the figure showed that for the distances considered WDM-based services are sold at a significant premium to Ethernet circuits at 1Gbit/s.[225] This suggested that the majority of end-users requiring bandwidth less than or equal to 1Gbit/s would prefer to purchase point-to-point Ethernet circuits.[226]

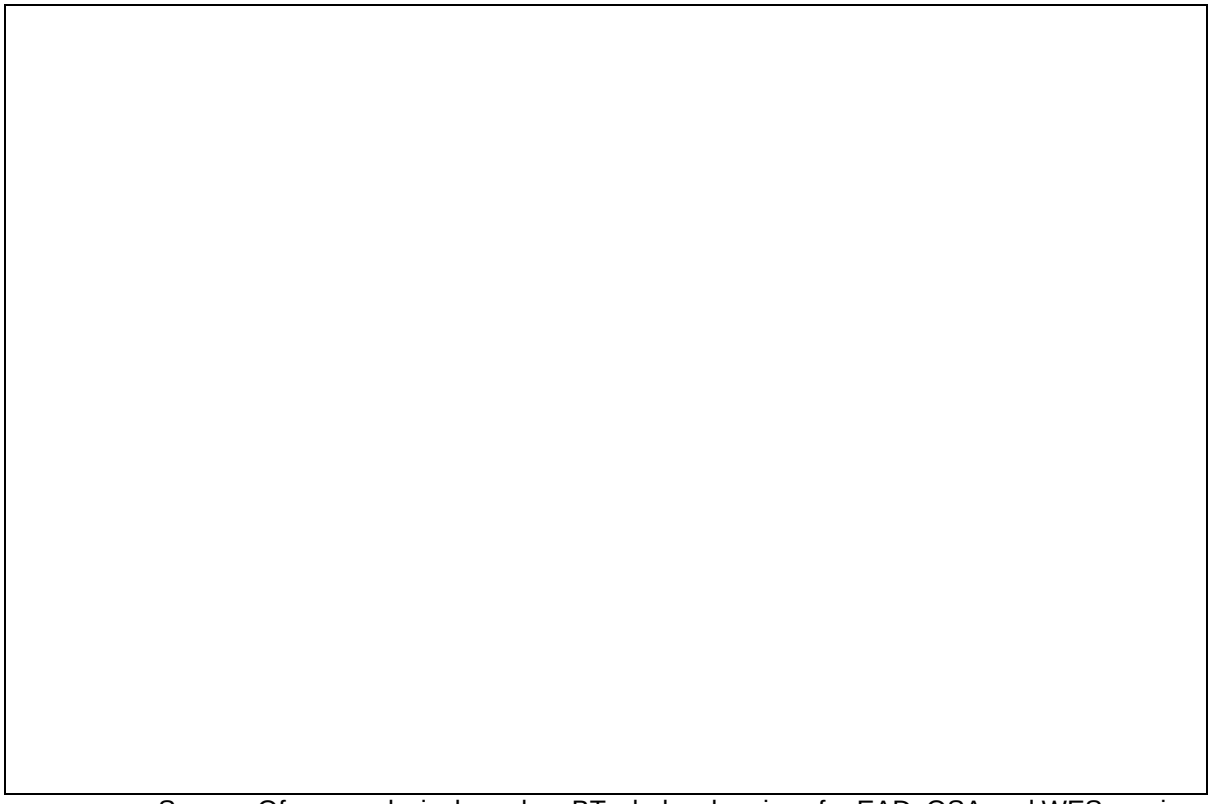
3.331 However, as noted in the qualitative assessment, a key differentiator of WDM-based services is the ability to support multiple circuits at high bandwidths. Therefore Figure 3.31 (reproduced from the June BCMR Consultation) below compared the cost of meeting increasing bandwidth demands (from 1-20Gbit/s) using point-to-point Ethernet and WDM-based services. An illustrative circuit length of 10kms was used for the comparison.[227]

[225] We note that this result is not dependent on the contract length chosen and holds for one year and five year contracts.

[226] This is confirmed by an analysis of a sample of the sales of WDM by BTGS, [✂], where we found that no end-users in the sample were using WDM to supply only 1Gbit/s.

[227] There are a number of configurations of WDM services, which would add significant complexity to any comparison of an Ethernet service with WDM. To overcome this complexity, we have selected OSA as the basis for our comparison of WDM with high bandwidth Ethernet services because it represents the least cost method of delivering a retail WDM circuit. To the extent that there is still a significant price premium for the least cost WDM service, then the fact that there are more complex and expensive solutions available would not overturn this observation.

Figure 3.31: Comparison of the price of bandwidth for wholesale point-to-point Ethernet services (EAD 1Gbit/s, WES 2.5Gbit/s and 10Gbit/s) and WDM services (OSA 2.5Gbit/s and 10Gbit/s) inputs - 10km distance [✂Figure redacted]



Source: Ofcom analysis, based on BT wholesale prices for EAD, OSA and WES services

3.332 We noted that as shown in the previous figure at 1Gbit/s WDM still attracted a significant premium. Above 1Gbit/s, for bandwidth requirements that can be supported using a 2.5Gbit/s service (1.5-2.5Gbit/s), Ethernet and WDM-based services are closely priced. At 2.5Gbit/s our estimates indicated that dedicated Ethernet cost only [✂]% less than a WDM-based solution. For bandwidth requirements above 2.5Gbit/s WDM-based services were the most efficient solution and the gap between Ethernet and WDM increased with bandwidth given that, as discussed above, additional Ethernet bandwidth requires the installation of entirely new circuits while WDM only requires the adding of additional wavelengths.

3.333 This analysis suggested that WDM is the most economic way to deliver capacity to end-users with total bandwidth requirements above 2.5Gbit/s. For these end-users it is likely that WDM is no longer seen as a premium service as irrespective of whether their requirement is to scale capacity quickly or a 'generic' requirement for high capacity Ethernet services, WDM was currently the most economic way for a retail end-user to purchase a bandwidth requirement above 2.5Gbit/s. In contrast dedicated Ethernet was the cheaper solution for end-users with bandwidth requirements of 2.5Gbit/s and below.

3.334 However, the available market evidence discussed in below suggested that there may be some retail end-users using WDM with total bandwidth requirements between 1 and 2.5Gbit/s. Given the premium associated with WDM services at these bandwidths, this suggested that there are end-users that value the service features of WDM, such as the ability to quickly increase bandwidth, even though they could in theory meet their current bandwidth requirements at a lower price with dedicated Ethernet. The observation of demand for WDM circuits at bandwidths where

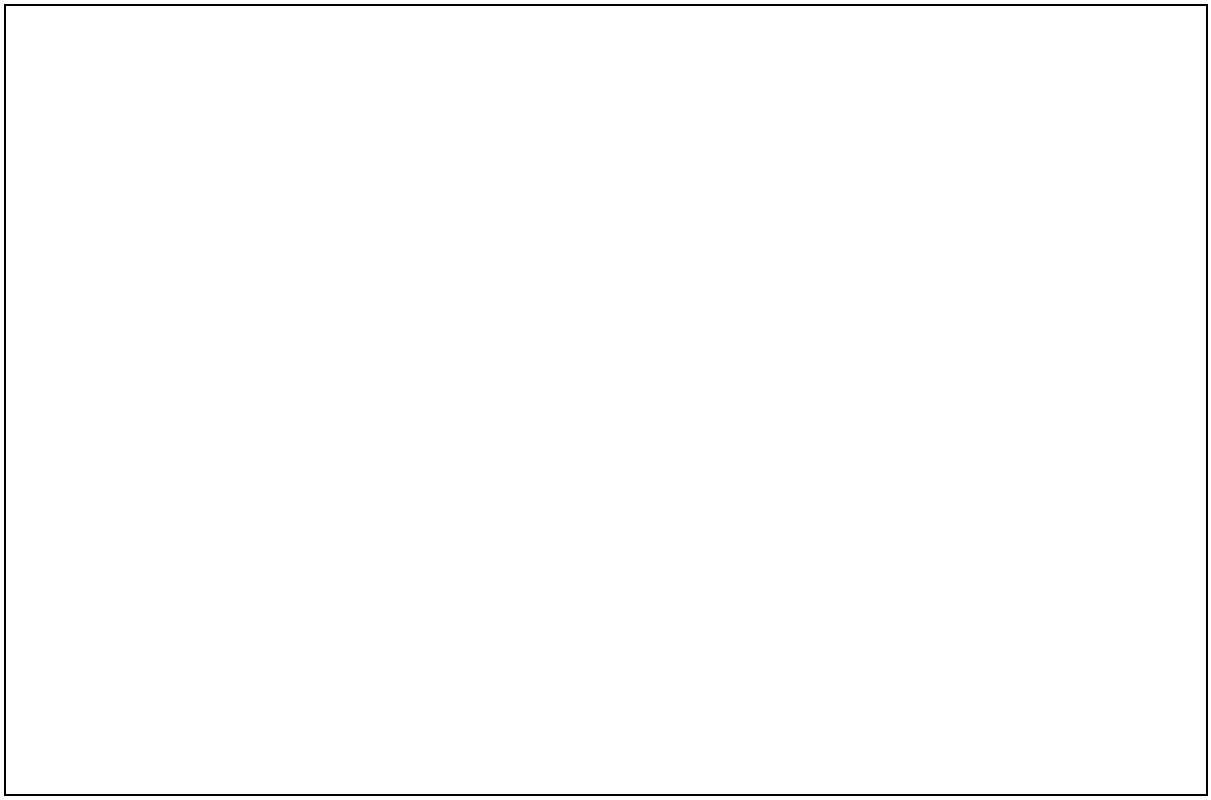
dedicated Ethernet could in theory be cheaper also suggested that it is important not only to consider an end-user's current bandwidth requirements, but also their need to increase capacity in the near future. The implications of this observation are discussed in paragraph 3.343.

Assessment of the hypothetical monopolist test

3.335 We then considered whether in response to a SSNIP on high bandwidth Ethernet services, sufficient numbers of end-users with dedicated Ethernet services were likely to switch to retail-WDM services (or vice versa) to make the price increase unprofitable. We noted that if the SSNIP was unprofitable then it would suggest that high bandwidth Ethernet services and WDM-based services can be considered to constitute a single market (and vice versa).

3.336 The figure below (reproduced from the June BCMR Consultation) shows the cost of providing a range of specific bandwidth requirements using dedicated Ethernet, after a SSNIP, and WDM-based services.

Figure 3.32: Comparison of the price of bandwidth for SSNIP adjusted wholesale point-to-point Ethernet services (EAD 1Gbit/s, WES 2.5Gbit/s and 10Gbit/s) and WDM services (OSA 2.5Gbit/s and 10Gbit/s) inputs - 10km distance [✂Figure redacted]



Source: Ofcom analysis, based on BT wholesale prices for EAD, OSA and WES services

3.337 We observed that the figure suggested that after a SSNIP on Ethernet services, end-users currently using a 2.5Gbit/s service would have the incentive to switch to WDM - especially as there are service benefits associated with WDM-based services. For end-users who were using Ethernet services above 2.5Gbit/s, even before the SSNIP, WDM should be a more efficient solution. At 1Gbit/s our analysis showed that even after the SSNIP, WDM-based services are priced at a premium to Ethernet. Therefore, for current Ethernet demand at 2.5Gbit/s there could be switching, as we considered that any barriers to switching from standard Ethernet to a WDM-based

service are unlikely to be significant[228], while at 1Gbit/s - a SSNIP is unlikely to prompt switching. At higher bandwidths, where remaining Ethernet users could already apparently make savings by switching to WDM, we did not consider that the failure to switch so far means that they would not respond to a SSNIP. We explain why below, and the reasons include the fact that there do not appear to be any significant barriers to switching.

Analysis of volume and demand trends

3.338 We considered the available evidence on volumes and the distribution of demand for high-bandwidth Ethernet and WDM-based services from service volume data provided to us by CPs. There were a number of data limitations around this analysis. We noted that, for high bandwidth services, some CPs did not distinguish between high bandwidth services that were delivered using WDM and those that were delivered using dedicated Ethernet.[229] Additionally some CPs were unable to collate full historic data for service volumes and some volumes were not separated by bandwidth. Nevertheless, we considered that the data should provide a reasonable guide to market developments and the distribution of demand at high bandwidths over the last four years.

3.339 Figure 3.33 (reproduced from the June BCMR Consultation) shows the demand trends and the distribution of demand for WDM services based on the number of retail wavelengths sold between 2007/8 and 2010/11. The distribution of wavelengths through time is also shown in indexed form in Figure 3.34 (reproduced from the June BCMR Consultation).

Figure 3.33: Demand trends and distribution of WDM services, 2007/8-2010/11

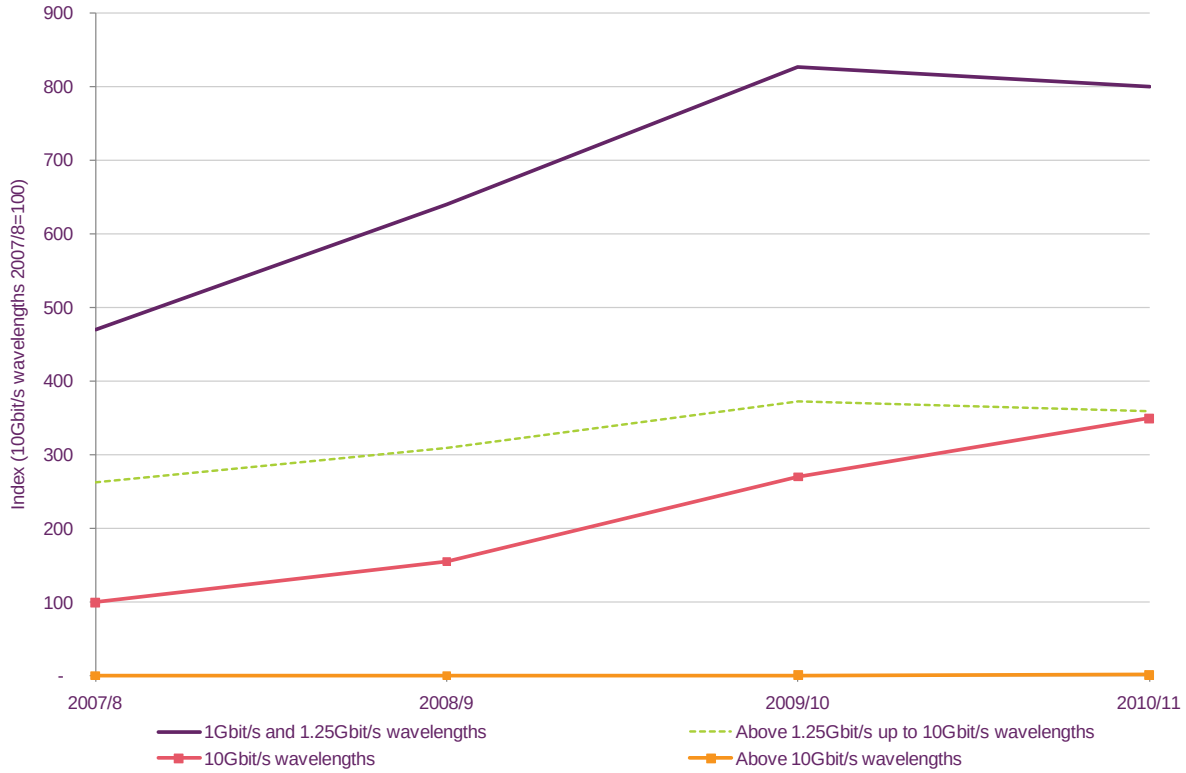
	Unit	Installed base			
		2007/8	2008/9	2009/10	2010/11
1Gbit/s and 1.25Gbit/s	Wavelengths	✂	✂	✂	✂
Above 1.25Gbit/s up to 10Gbit/s	Wavelengths	✂	✂	✂	✂
10Gbit/s	Wavelengths	✂	✂	✂	✂
Above 10Gbit/s	Wavelengths	✂	✂	✂	✂
Total	Wavelengths	✂	✂	✂	✂
Total bandwidth	Gbit/s	✂	✂	✂	✂
Average bandwidth per wavelength	Gbit/s	✂	✂	✂	✂

Source: CP's responses to s.135 information request, 2011

[228] See the discussion below.

[229] For the affected CPs we estimated the split between Ethernet and WDM-based retail volumes on the basis of the CPs reported split between dedicated Ethernet and WDM above 1Gbit/s at the wholesale level.

Figure 3.34: Distribution of WDM wavelengths, 2007/8-2010/11



Source: CP's responses to s.135 information request, 2011

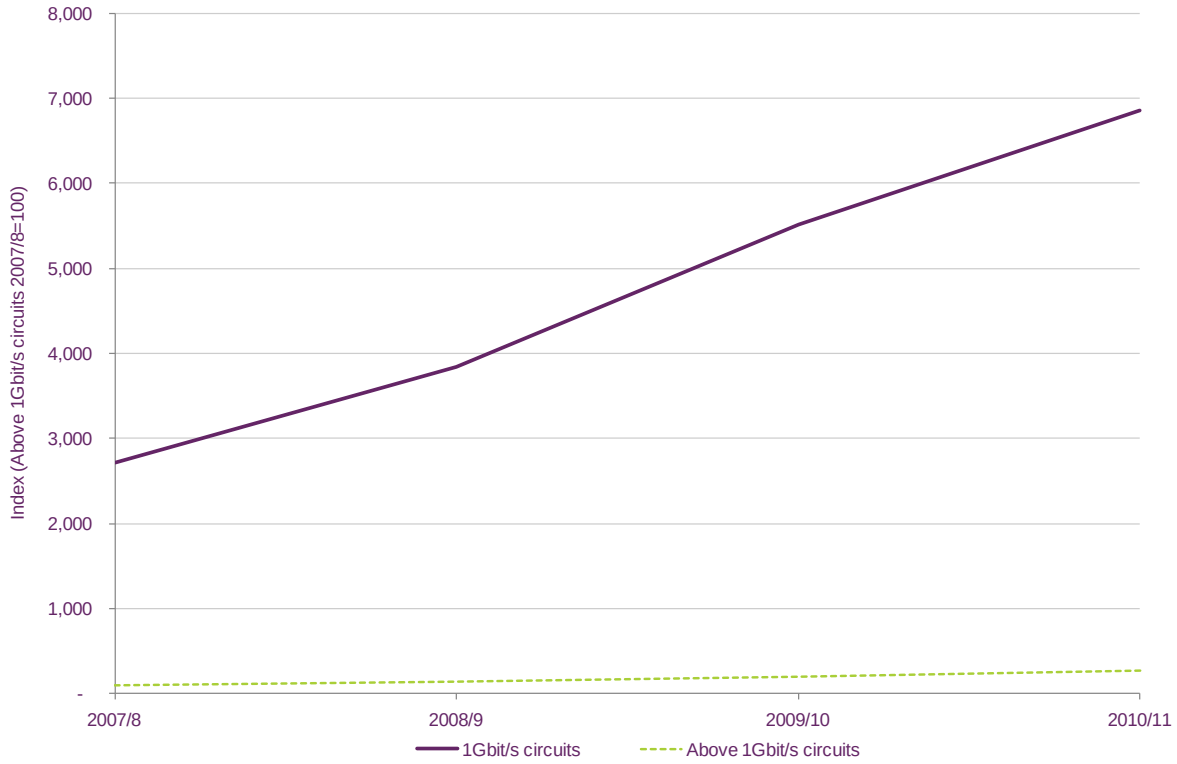
3.340 We noted that the figures show that there has been significant growth in the total wavelengths sold over the last four years. More recently at the lower bandwidths there has been a slight decline in the number of installed wavelengths, although the increase in wavelengths at 10Gbit/s has more than off-set this slight reduction in demand at lower bandwidths. Our estimates indicated that the total bandwidth supplied more than doubled between 2007/8 and 2010/11 and the average bandwidth per wavelength increased from 2.6 to 3.6Gbit/s. The trends in WDM volumes can be compared with the trends in higher bandwidth Ethernet services over the same period summarised in Figures 3.35 and 3.36 (reproduced from the June BCMR Consultation).

Figure 3.35: Demand trends and distribution of high bandwidth Ethernet services, 2008/8-2010/11

	Unit	Installed base			
		2007/8	2008/9	2009/10	2010/11
1Gbit/s	Circuits	✂	✂	✂	✂
2.5Gbit/s	Circuits	✂	✂	✂	✂
10Gbit/s	Circuits	✂	✂	✂	✂
Above 10Gbit/s	Circuits	✂	✂	✂	✂
Total	Circuits	✂	✂	✂	✂
Total bandwidth	Gbit/s	✂	✂	✂	✂
Average bandwidth	Gbit/s	✂	✂	✂	✂

Source: CP's responses to s.135 information request, 2011

Figure 3.36: Distribution of high bandwidth Ethernet services, 2007/8-2010/11[230]



Source: CP's responses to s.135 information request, 2011

3.341 The figures show that demand for dedicated Ethernet services is limited at bandwidths of more than 1Gbit/s and our estimates indicate that circuit volumes above 1Gbit/s account for less than 1% of all Ethernet volumes. However, these volumes have seen strong growth, albeit from a low base, but we noted that above 1Gbit/s significantly more bandwidth is delivered over WDM rather than over dedicated Ethernet.

Addressing data imperfections

3.342 We noted that there are a number of limitations associated with basing our market definition on Openreach's current wholesale prices. Furthermore, even if these prices were reflective of current cost differences, on a forward-looking basis such analysis could become invalid if - as a number of stakeholders have pointed out - the gap between the cost of WDM and Ethernet equipment continues to narrow significantly.

3.343 As discussed above, an assessment of price and bandwidth should take into account not only an end-user's current bandwidth requirements but also their future requirements. In the context of the hypothetical monopolist test, end-users' expectations about their future bandwidth demand might influence their propensity to switch to WDM today, since doing so will reduce the cost of future expansion. For example, a group of end-users with a bandwidth requirement of 2.5Gbit/s today, which they expect to double in the space of two to three years, will need to upgrade their capacity sometime in the near future. In these circumstances WDM would offer a stronger competitive constraint over the prices of Ethernet services above 1Gbit/s than in the static scenario analysed above. We noted that this is because if a

[230] In light of the small number of high bandwidth Ethernet volumes above 1Gbit/s, in the figure we have aggregated volumes at 2.5 and 10Gbit/s in order to show the overall trend in volumes.

hypothetical monopolist were to impose a SSNIP on high bandwidth Ethernet circuits then these end-users may simply bring forward their purchasing decision (which our analysis indicated would be met using a WDM-based solution) which makes it more likely that sufficient end-users would switch such that a SSNIP on dedicated Ethernet circuits would be unprofitable.

3.344 We noted that the views of a number of stakeholders in the CFI clearly suggest that end-users' bandwidth demands are continuing to grow. The SSNIP analysis combined with a forward looking consideration of bandwidth demand over the duration of this review suggests that WDM is the natural successor service to address growing high bandwidth requirements (including the current Ethernet end-user base). However, at lower bandwidths, standard Ethernet is much cheaper, and this is where demand for Ethernet is strongest. We considered that this shows that there are distinct markets for low (Ethernet only) and high (including multiple interfaces over WDM) bandwidth circuits.

Barriers to switching

3.345 Barriers to switching from high bandwidth Ethernet services to WDM could weaken substitution possibilities between the services. This could reflect the commercial costs and risks of moving from an existing service, or barriers that could arise if end-users perceive that there are differences between the two services. If barriers to switching are significant then this would be a factor that might suggest that the two services are in separate retail markets.

3.346 We noted that the change in the price of equipment discussed above suggests that WDM is the efficient way to deliver very high bandwidth services particularly for end-users. If an end-user were to switch from an Ethernet or SDH-based leased line service, this would require a CP to make some changes in the equipment it provisions at the end-user's site. However, as WDM offers delivery over multiple interfaces (Ethernet, SDH and Fibre Channel) this would not require a user currently on an individual Ethernet circuit to invest in additional customer premises equipment or systems to deal with new interfaces. We concluded that, for end-users, this means that the perceived risks of switching to retail WDM may be quite low.

3.347 As with all other leased lines markets, there would remain a degree of market inertia associated with possible disruption of service and installation of new equipment. However, we considered that this is unlikely to be that significant a factor relative to the significant costs associated with high bandwidth circuits.

3.348 This said, we noted that there may be a number of reasons why a small number of users remain on high bandwidth AI circuits. For example, this may indicate that they benefit from prices below the level assumed in our analysis. Alternatively, they may be waiting for further declines in the price of WDM equipment before switching, or they may be in a long term contract.

3.349 We also noted that demand for high bandwidth services is growing strongly, and this means that providers are competing not just for existing end-users, who might face barriers to switching, but also for new end-users, who will not. Even with switching costs/barriers, competition for new end-users should benefit all end-users (unless firms can price discriminate between new and existing end-users) and would tend to suggest that different end-users bases are not in separate markets.

Responses to the June BCMR Consultation about WDM

3.350 Six respondents (BT, Colt, Geo, Level 3, TalkTalk, and Virgin) provided specific comments on our proposal for a MI market. Five respondents welcomed our proposal, while BT agreed with our proposal to identify a product market for high bandwidth services but had a number of specific concerns.

3.351 The respondents who welcomed our proposal provided a number of comments:

- Colt noted that it will bring greater regulatory certainty to the treatment of services above 1Gbit/s, which are growing in importance.
- TalkTalk and Virgin both separately noted that there is growing evidence of demand-side substitution between AI circuits of higher bandwidth and WDM services (OSA services in Openreach terminology).
- Level 3 agreed with the proposal, but thought that it was unclear as to whether we had understood the drivers behind consumer behaviour.
- Geo welcomed the proposal, but considered that we should have reviewed the market for dark fibre as there is, in Geo's view, evidence of a material amount of demand substitution by high-end business users between dark fibre and dedicated fibre managed services.

3.352 As noted above, BT agreed with our proposal to identify a product market for high bandwidth services. However:

- It expressed the view that the 'multiple interface' definition was potentially confusing, ambiguous and unnecessary. BT argued that the proposed definition was too technology specific and that we should consider the merits of a simpler bandwidth definition that MI refers to services with a total bandwidth over 1Gbit/s. Further it argued that a consequence of the MI definition would be to re-regulate the market for very high bandwidth TI services, which are typically provided using WDM technology, despite this having been found to be competitive in the 2007/8 Review.
- It claimed that, while there is a retail market, most of these services are packaged with other telecoms services and not priced uniquely and/or used as an input into 'downstream' telecom services before being sold to retail customers. Therefore BT expressed the view that the relevant economic market would not just consist of these services alone.
- It considered that we had not adequately commented on or discussed the role of these services in this wider retail market or presented evidence of absence of competitiveness in this wider market. Indeed it claimed that we had not considered the full range of competitive constraints, including dark fibre (as set out further in the Analysys Mason report accompanying BT's submission) and those arising indirectly from downstream products, and that our economic analysis was based on the presumption of services being offered according to BT's network topology.

3.353 BT also provided specific comments on our relative price comparisons, analysis of equipment costs and the HMT:

- It claimed that all the products considered are BT products and the prices of some (the AI products) are currently regulated and therefore cannot be relied on this analysis as it should be based on a modified Greenfield assumption. It also noted that while for sub-2Mbit/s and 2Mbit/s services we carried out a critical loss test to see if a SSNIP would be profitable, we did not conduct the analysis here between AI services above 1Gbit/s and WDM services.

- It argued that reliance on the analysis of the equipment costs required to support services at above 1Gbit/s services and comparisons with the lower cost optical equipment used in lower speed NTE is misplaced. This is because during the forward-look period of this market review, cheaper equipment will start to become available capable of supporting 10Gbit/s over tens of kilometres whether using DWDM or non-DWDM equipment.

- Further, it argued that our cost comparisons are only relevant in the context of the way BT provides its services as there are many other ways to engineer an equivalent service in which the costs of the WDM multiplex play a much less prominent role (i.e. end-to-end fibre is not needed, and network equipment could be used to share costs across services). It argued that the lack of focus on alternative engineering solutions arises directly from what BT sees as a narrow, prescriptive definition of the market.

3.354 This said, BT agreed with our conclusion that there are no significant barriers to switching between high bandwidth Ethernet services and WDM-based services, due to the universal acceptance of Ethernet as an interface standard. It further noted that current high bandwidth Ethernet Services WES 2.5Gbit/s and WES 10Gbit/s use DWDM type equipment (though the passive filters required for multiplexing are not required for a single wavelength to be carried).

Ofcom's view

3.355 As set out above, most stakeholder comments agreed with our proposal to identify a MI market for very high bandwidth services, but there were a number of specific comments from BT. We set out below why, having carefully considered each of the points raised, we consider it is still appropriate to identify a MI market.

3.356 We do not agree with BT that our definition is ambiguous or confusing or that it would be simpler for market definition just to cover all services above 1Gbit/s. The definition set out in the June BCMR Consultation clearly states the MI market encompasses:

- AI services such as Ethernet at bandwidths above 1Gbit/s; and

- WDM services including AI interfaces such as Ethernet (typically at bandwidths above 1Gbit/s) and other interfaces including TI SDH interfaces, some of which have bandwidths below 1Gbit/s.[231]

3.357 The reason for the inclusion of WDM at any bandwidth is due to the scalability of WDM services that means it does not fit well with a bandwidth-based market definition. We consider that this means that BT's suggestion for a simpler market definition where only services above 1Gbit/s are included in the MI market would not be appropriate as, if a customer has gone to the effort and cost of installing WDM

[231] June BCMR Consultation, paragraph 3.296.

capacity, even if it only currently delivering 1Gbit/s initially, it can be scaled very quickly to deliver multiple wavelengths and services.[232]

3.358 BT also contested the inclusion of very high bandwidth TI services which are provided over WDM. We consider that this point does not really address market definition, but is instead a point about past competitive conditions when WDM services were in their infancy. As competitive conditions can and do change over time, SMP findings can also change. This is discussed in more detail in Section 7. [233]

3.359 We recognise that these services are often bundled with other services and can be sold in multi-site packages, but do not believe that this means that a wider market should be defined. Here we note that the general comments we discuss earlier in this Section under our approach to market definition on the problems that would arise if we tried to define product markets based on multi-site packages are equally applicable here. Importantly, we note that the possibility of differences in competitive conditions between areas seems particularly relevant. BT also agrees that the correlation between site and circuit value should be close.[234]

3.360 Further, contrary to BT's and Geo's assertions, we did take account of use of dark fibre. This was part of the discussion of countervailing buyer power in the SMP Section of the June BCMR Consultation.[235] We noted that whether it might be appropriate to reflect the notional MI product self-supplied by dark-fibre using customers in market shares depends on how wide-spread its usage is; as if it is something that only the most technically savvy users would do, it might be better to reflect it in countervailing power. We concluded that it was unlikely to provide a constraint across the market as a whole as, in the absence of regulation, BT would be able to price discriminate between customers on the basis of ability to self-supply. This issue if further explored in Section 7.

3.361 BT also argued, as did Level 3, that it was unclear as to whether we had adequately understood the drivers behind consumer behaviour. In light of this, we commissioned CSMG to carry out research[236] on very high bandwidth connectivity users, where 'very high bandwidth' captures any bandwidth greater than 1Gbit/s. This research consisted of 25 in-depth interviews with very high bandwidth end-users and communication and ICT companies that provide managed connectivity services (including systems integrators). Some key findings from this report include:

- Interviewees suggested that demand for very high bandwidth connectivity will materially increase over the next three years. Key drivers of future demand identified included:
    - the need for ever-lower latencies and growing trading volumes in finance;

[232] For example, the capability of the WDM-equipment is many times 1Gbit/s (potentially 160 wavelengths at 1, 2.5, 10Gbit/s or higher). Moreover, if the end-user is only ever likely to need capacity below 1Gbit/s with a specific interface, it would be more efficient to purchase a single service 1Gbit/s link rather than paying WDM service. The latter would be more expensive and over-engineered for the end-user's bandwidth requirements. See for example Figure 3.30 above where we compare the relative prices of WDM and AI services at 1Gbit/s.

[233] This said, we note that as in the 2007/8 Review we concluded that WDM-based services were outside the leased lines market, we did not assess whether its provision was competitive.

[234] "The practical reality is that "high value sites" for retail services are attractive to OCPs and profoundly affect competitive conditions" BT response, page 207, paragraph 46

[235] See the June BCMR Consultation, paragraphs 7.250, 7.261, 7.280-7.283, 7.291 and footnote 97.

[236] CSMG, "Research on Very High Bandwidth Connectivity", February 2013, available at: http://stakeholders.ofcom.org.uk/binaries/consultations/business-connectivity/statement/CSMG-report.pdf

- data-intensive research programmes and teaching methods in higher education and research;
- the growing appetite for richer content and HD video in media; and
- off-site hosting.

- The research included dark fibre users and, consistent with our view set out above, found that these tend to be very sophisticated users such as [✂]. Those organisations not using dark fibre indicated that they currently lack the skills to buy and use dark fibre (e.g. the operation and maintenance of WDM equipment).

- In relation to switching costs, seven (i.e. just under half) of the organisations interviewed by CSMG suggested they were reluctant to switch due either to the costs involved or the hassle in setting up a new contractual framework with a new supplier. This was a surprising result and reinforces the importance of switching costs, as even in these high value markets, end-users still have concerns. This may explain why some customers apparently continue to use AI services where a WDM service might be cheaper, a point noted earlier. However, the number of users surveyed by CSMG was small, and our view as supported by respondents to the June BCMR Consultation, is that the barriers to switching between AI services above 1Gbit/s and WDM will not generally be significant relative to the cost savings available with WDM circuits.

3.362 We also do not agree with BT's specific comments on our relative price comparisons, analysis of equipment costs and the HMT:

- As noted above, the use of BT products is appropriate and the use of regulated prices is consistent with the modified Greenfield approach. Further, given the small number of end-users at high-bandwidths we considered that we were likely to be unable to obtain a robust sample to look at the critical loss. But, the fact that barriers to switching between AI services above 1Gbit/s and WDM appear, in general, to be low, a finding with which BT agrees, suggests that levels of switching in response to a SSNIP are likely to be sufficient to support definition of a single market.[237]

- We recognise that the costs of bandwidth and equipment are steadily falling and that the costs of providing services over 1Gbit/s are likely to decline over the period of this review. Nevertheless, we consider that there are observable differences in the competitive conditions associated with providing services above 1Gbit/s – reflecting end-user demand - that distinguish them from lower bandwidth AI services that use lower cost equipment and that these will be maintained for the duration of this Review.

- We also recognise that WDM does not have to be deployed exclusively as an end-to-end solution, and that different operators may adopt technically different solutions. Nevertheless, given that we would expect a network operator such as BT to build network to deliver services efficiently, we consider it is appropriate to regard BT's costs as representative.

[237] Also see the discussion in paragraphs 3.345 to 3.349 above.

Ofcom's conclusion about WDM

3.363 On the basis of the analysis set out above, we conclude that it is appropriate to identify a very high bandwidth retail product market consisting of WDM services and high bandwidth AI services encompassing:

- AI services such as Ethernet at bandwidths above 1Gbit/s; and
- WDM services at all bandwidths including AI interfaces such as Ethernet (typically at bandwidths above 1Gbit/s) and other interfaces including TI SDH interfaces, some of which have bandwidths below 1Gbit/s.

3.364 As WDM services support multiple interfaces including TI interfaces we call this market the Multiple Interface market.

3.365 In summary, our conclusion is based on the following considerations:

- An analysis of equipment costs suggests that the cost premium associated with WDM equipment has eroded. Many major CPs also now use WDM to provide services above 1Gbit/s. These factors suggest that WDM is likely to be a good alternative to AI services at above 1Gbit/s;
- Relative price comparisons show that at 1Gbit/s WDM is priced at a premium but, for bandwidth requirements that can be met using a 2.5Gbit/s service, WDM and Ethernet are closely priced, with Ethernet being marginally cheaper. Above 2.5Gbit/s our analysis supports the conclusion that WDM is the most economic way of delivering the service;
- An assessment of the hypothetical monopolist test supports the conclusion that, after a SSNIP, end-users with a 2.5Gbit/s service would have an incentive to switch to WDM. While there is some uncertainty on the level of switching between AI services above 1Gbit/s and WDM, there are a number of factors that suggest it would be significant. This view is reinforced by a discussion of the implications of increasing bandwidth demand; and
- An assessment of the barriers to switching between AI services above 1Gbit/s and WDM suggests that, because of the inherent flexibility of WDM services, these will not in general be significant relative to the cost savings available with WDM circuits.

Retail product market definition (in the presence of upstream wholesale SMP regulation)

3.366 The purpose of this section is to assess whether the retail product market definitions derived above change if wholesale remedies based on a finding of SMP in the relevant wholesale markets are taken into account.[238] This is necessary for the retail product markets which we have identified in this Section, to assess whether any additional regulatory remedies are required for the relevant retail market (i.e. in the retail low bandwidth TI market).

3.367 For the purpose of this section it is assumed that cost-based TI and AI wholesale services are available on regulated terms and conditions. These wholesale remedies

[238] This is Stage 4 of the market definition process as set out in Annex 3.

do not affect our proposed retail product market definitions based on our demand-side substitution analysis and set out earlier in this section, because our retail market analysis under the modified Greenfield approach was conducted under the framework of the hypothetical monopolist test, which assumed competitive retail prices as the starting point. Hence, any demand-side analysis of consumer responses should be unaffected by the availability of regulated wholesale inputs set at a similar cost based level.

3.368 However, the availability of regulated wholesale inputs could impact our conclusions about supply-side substitution. As set out in Annex 3, we consider that, absent wholesale regulation, supply-side substitution would in general not be a strong constraint in response to a SSNIP on the price of a particular leased lines service. This is because it would involve CPs incurring significant sunk-costs associated with entering the market to self supply and/or obtaining commercially agreed access. In principle, the availability of regulated wholesale inputs could increase the strength of any constraint arising from supply-side substitution because, instead of having to invest in its own infrastructure, a CP could begin to supply a retail service which it did not previously offer simply by purchasing a regulated wholesale service. Put simply, wholesale regulation makes entry into retail markets quicker and easier – this is its intention – and supply-side substitution is just a form of rapid low-cost entry.

3.369 We start first with an assessment of supply-side substitution which is focused on whether we need to define wider markets. We would not anticipate that increased opportunities for supply-side substitution due to the availability of regulated wholesale inputs will result in a narrower definition for retail markets.[239] Therefore, we reconsider below the five main issues for the retail product market definition, to assess whether, in the presence of wholesale regulation, supply-side substitution is likely to support wider markets.

3.370 In addition, and importantly, we also reconsider our assessment of whether competitive conditions are homogenous across low bandwidth retail TI products (those proposed in the June BCMR Consultation to be included in the retail low bandwidth TI market) in the light of our revised estimates of service shares.

3.371 In line with the June BCMR Consultation, under each heading we first set out the proposals we made in the June BCMR Consultation, together with the reasoning which underpinned them. We then summarise the responses we received and explain how we have taken the responses into account in reaching our final conclusions. We then present our conclusions.

Our proposals in the June BCMR Consultation

Issue 1: Technology and service requirements

3.372 We considered that the introduction of wholesale remedies will not modify the results of our analysis of technology and service requirements and that our defined market including both analogue and low bandwidth SDH/PDH services could not be narrowed by the presence of PPC regulation at the wholesale level.

3.373 Similarly, we noted that our finding of separate markets for TI and AI services would still hold. On the demand side, our analysis would be unaffected because the

[239] As set out in Annex 3, supply-side substitution will only place additional constraints on prices where the potential supply-side substituter is not already present in the narrowly-defined market. In many cases where supply-side substitution is technically feasible, the same CPs will already be present in all the relevant narrowly-defined markets, and supply-side substitution will not then be a reason to broaden the market.

availability of cost based wholesale inputs will not affect consumer preferences. On the supply-side, the presence of wholesale regulation could make it easier for suppliers of one symmetric data service (TI or AI-based) to enter the supply of the other. This is because existing suppliers of one service (e.g. Ethernet-based AI retail leased lines) might use wholesale inputs (such as PPCs), in order to offer the other service (e.g. TI retail leased lines). However, we noted that all the major suppliers of AI retail leased lines are also suppliers of TI retail leased lines and cannot therefore be considered a new and additional competitive constraint on the hypothetical monopolist.[240]

3.374 Therefore, we concluded the markets defined in the absence of regulation are not changed by considering the impact of upstream regulation.

Issue 2: Virtual Private Networks (VPNs)

3.375 We noted that the presence of wholesale regulation could make it easier for suppliers of other symmetric data services to enter the supply of retail leased lines. This is because existing suppliers of other symmetric data services might then purchase leased line wholesale services, such as PPCs, in order to offer retail leased line services. However, we noted that almost all existing suppliers of other symmetric data services are also suppliers of retail leased lines and cannot therefore be considered a new and additional competitive constraint on the hypothetical monopolist.

3.376 We therefore considered that the other existing suppliers of other symmetric data services, if any, are not in a position to impose a competitive constraint on the hypothetical monopolist. This is why in the presence of the proposed wholesale remedies, supply-side substitution between retail leased lines and other symmetric data services is not present.

3.377 The above considerations showed that in the presence of the proposed wholesale remedies, retail leased line services and other symmetric data services are in separate markets.

Issue 3: Broadband markets

3.378 We considered that the introduction of wholesale remedies is not expected to modify the conclusion of the demand-side substitution analysis. This is because the demand-side substitution analysis was not influenced by the presence or absence of regulation at the wholesale level.

3.379 On the supply-side, we noted that the presence of wholesale regulation could make it easier for suppliers of asymmetric broadband services to enter the supply of symmetric broadband services and of leased lines in particular. This is because existing suppliers of asymmetric broadband services might then purchase leased line wholesale inputs, such as PPCs, in order to offer leased lines.

3.380 In the case of broadband service providers, in our market review of Wholesale Broadband Access we identified a number of 'Principal Operators' that were the main LLU operators in the provision of broadband access.[241] In general most of these

[240] We noted that there are a number smaller CPs who focus exclusively on Ethernet services, however, in general these CPs would not be able to easily offer PPC services as entry would still entail additional investment in network infrastructure to support TI services.

[241] The principal operators are defined as BT, C&WW, O2, TalkTalk, Sky and Virgin.

providers are already present in leased line markets. Further, we considered that those LLU operators that are not present in leased lines markets typically have a strong residential focus - so they would require additional investment to support enterprise customers with more stringent quality of service requirements.[242] This suggested that any supply-side substitution from broadband would be on a limited scale such that it is unlikely to impose a sufficient additional constraint.

3.381 In support of this we also identified factors that are likely to limit the speed at which these asymmetric broadband services suppliers (who are not present in leased lines markets) can enter the supply of leased lines and win end-users from the existing suppliers. These factors are of two types:

i) Factors affecting the time needed to acquire and organise leased lines in a network capable of delivering retail leased lines: This captures the lead time needed to acquire wholesale leased line services and equipment. In addition it captures that time needed for a new entrant to set up a fully functional network, this includes installation and testing.

ii) Factors influencing the time needed to attract a sufficiently large number of end-users: This relates to the various barriers to switching (e.g. contract lengths, end-users averse to forgoing volume discounts, end-user inertia) and barriers to expansion identified as part of the market power assessment in Section 7.

3.382 We noted that for a class of new entrants to constitute supply-side substitutes, it is necessary that they would be able to enter sufficiently quickly and at sufficiently low cost to make a SSNIP by the hypothetical monopolist in leased lines unprofitable. The above considerations showed that this requirement is not fulfilled by potential entrants into leased lines from asymmetric broadband services. The possibility of entry into retail leased lines by such suppliers was, however, included as part of the assessment of market power (under criteria such as potential competition and entry barriers).

3.383 Therefore, we proposed to find that in the presence of the wholesale remedies, retail leased lines and asymmetric broadband services are in separate markets.

Issue 4: Bandwidth breaks

3.384 Our analysis of demand-side substitution identified a number of breaks in the chain of substitution for both TI and AI services. As above, we considered whether the availability of symmetric broadband origination at cost-based prices was likely to modify our market definition. Again, the focus was on supply-side substitution as the existence of wholesale regulation will not modify our conclusions derived from demand-side analysis.

3.385 For TI services, we considered that a hypothetical monopolist supplier of low bandwidth TI leased lines was not constrained by supply-side substitution from a higher bandwidth supplier because there is no supplier that only sells high bandwidth leased lines. In other words, all high bandwidth suppliers are also likely to be low bandwidth suppliers and vice versa. The same principle also applies to suppliers of low bandwidth AI and MI leased lines, all low bandwidth AI suppliers are also likely to be MI bandwidth suppliers and vice versa. Therefore, we considered that supply-side substitution is not relevant.

[242] For example Sky broadband services are targeted at residential end-users and are often bundled with Pay TV services.

3.386 The above considerations showed that, in the presence of the proposed wholesale remedies, our proposed bandwidth breaks would not change.

Issue 5: Wave Division Multiplex (WDM) services

3.387 As described previously, we noted that the introduction of wholesale remedies is not expected to modify the conclusion of the demand-side substitution analysis. On the supply-side, we considered that the relatively broad market we defined would not be narrowed any further by the presence of regulated inputs at the wholesale level. In addition, we noted that as all high bandwidth Ethernet suppliers are also likely to supply bandwidth over WDM and vice versa, any supply-side substitution is unlikely to be material.

3.388 Therefore, we proposed to find that the presence of wholesale regulation will not modify the conclusion of the analysis carried out in the absence of any regulation.

Responses to the June BCMR Consultation

3.389 We received no comments on our analysis of whether the introduction of wholesale remedies will modify our retail product market definitions. We note the comments on the retail product market definitions themselves are dealt with under the relevant issue above. This said, in light of further analysis, we have reconsidered the appropriate definition for low bandwidth TI retail services.

Ofcom view

3.390 In light of further analysis, discussed below, we propose that in the presence of upstream wholesale SMP regulation the following product markets exist for low bandwidth TI retail leased lines:

- Very low bandwidth TI retail leased lines, sub-2Mbit/s bandwidths (including analogue services); and
- TI retail leased lines, at bandwidths from 2Mbit/s up to and including 8Mbit/s.

3.391 This is a change from the June BCMR Consultation, where we proposed a single retail product market for TI services up to and including 8Mbit/s, incorporating analogue, sub-2Mbit/s and 2Mbit/s services. We argued that demand-side substitution was likely to constrain the prices of lower bandwidth circuits below 2Mbit/s, as users would be likely to switch to a higher bandwidth circuit in response to a SSNIP. Further, while we found there were differences in competitive conditions for 2Mbit/s services relative to sub-2Mbit/s services, BT's share across all the segments was above the 40% threshold, where SMP concerns arise. Therefore, given that market definition is a means to end, we dealt with the observed differences in competitive conditions through differentiated remedies.[243]

3.392 We have concluded that we should adopt the market definitions set out above in the light of our revised estimates of retail market shares summarised in Figure 3.37 below. These suggest that difference in competitive conditions between 2Mbit/s retail TI circuits and lower bandwidth retail TI circuits are greater than we believed at the time of the June BCMR Consultation. Notably, our estimate of BT's retail service

[243] Reflecting BT's lower market share at 2Mbit/s we did not propose any remedies, while for analogue and sub-2Mbit/s we proposed a safeguard cap (analogue only) and obligations to supply/not discriminate unduly and to publish a reference offer.

share at 2Mbit/s has fallen from 45% to 34%, which is significantly below the 40% threshold at which SMP concerns would normally arise. In contrast, while our estimate of BT's market share in the sub-2Mbit/s segment has also fallen, it remains above 50% and so would be consistent with a presumption of dominance. BT's share of analogue and sub-2Mbit/s digital circuits combined is 84%. This suggests that it is more appropriate to define a separate retail product market for services at 2Mbit/s and above, rather than a combined market.

Figure 3.37: Service shares for low bandwidth retail TI leased lines in the UK excluding the Hull area[244]

Product segment	Consultation estimate of BT's service share	Revised estimate of BT's service share
TI low	68%	61%
Analogue	96%	99%
Sub-2Mbit/s	73%	53%
2Mbit/s	45%	34%
Analogue & sub-2Mbit/s combined	NA	84%

Source: Ofcom analysis of CP's responses to s.135 information request, 2011

3.393 While service shares are a relevant consideration, they are not the sole relevant indicator of competitive conditions. We consider that there are a number of factors that also suggest that competitive conditions will be significantly different between sub-2Mbit/s and 2Mbit/s TI retail services in the presence of wholesale regulation. In particular:

- since the 2007/8 Review there have been a number of regulatory interventions designed to improve the effectiveness of the wholesale remedies, including, reductions in Point of Handover charges for PPCs, and the achievement of replicability requirements (by which we mean that BT's retail services should be able to be replicated by BT's competitors) for digital sub-2Mbit/s and 2Mbit/s services;

- sub-2Mbit/s and 2Mbit/s wholesale services run over different networks and BT's wholesale product for sub-2Mbit/s services runs on its Digital Private Circuit Network (DPCN) which BT intends to support until March 2018, with a commitment to give at least three years notice if it decides to bring the withdrawal date forward for individual services.[245] In contrast there are no plans to switch off the 2Mbit/s network, and demand for 2Mbit/s circuits is expected to continue at significant levels; and

- there is no analogue wholesale service. Where an end-user requires such a service OCPs can only compete with BT by either incurring sunk costs in extending their network to the end-user or by purchasing a retail analogue service from BT.

[244] The revised estimates exclude VPNs and Internet access (as they are excluded from our definition of a retail leased line) and are based on a more comprehensively cleaned dataset where we allocate any sales to non s135 CPs (resellers) to a hypothetical CP. See Annex 5 for more details.

[245] See: http://www.globalservices.bt.com/CampaignDetailAction.do/Campaigns/tdm-services/param/Record/tdm_services_campaign_all_en-gb/fromPage/Furl/chapterKey/1

3.394 In the light of this, we have considered what weight should be placed on the chain of substitution between end-users of sub-2Mbit/s and 2Mbit/s which we identified above. Our underlying assumption was that the hypothetical monopolist in our SSNIP test was a non-discriminating monopolist.[246] We consider that this was reasonable in context, because we expected to, and did, take account of BT's ability to discriminate in the SMP analysis and choice of remedies. Further, given that price discrimination requires a degree of market power in order to prevent resale, an assumption of non-discrimination at the market definition stage is often reasonable.

3.395 That said, given that the service shares suggest that competitive conditions are different at the retail level, we now consider that it may also be more appropriate to take account of BT's ability to discriminate in the market definition. Discrimination is likely given the differences in competitive conditions and the location specific nature of leased lines which limit the possibilities of resale. We noted that after a SSNIP, end-users with bandwidth demands up to and including 448kbit/s would not find it economic to switch to 2Mbit/s services.[247] Given the observed differences in competitive conditions we think it likely that BT could price discriminate against end-users with bandwidth demands at these levels (e.g. via volume discounts) and profitably impose a SSNIP, which would point to a separate market for sub-2Mbit/s services.

Ofcom's conclusion

3.396 We have concluded that the following product markets exist in the UK (in the presence of wholesale regulation) for retail leased lines:

- Very low bandwidth TI retail leased lines, sub-2Mbit/s bandwidths (including analogue services);
- TI retail leased lines, at bandwidths from 2Mbit/s up to and including 8Mbit/s;
- Medium bandwidth TI retail leased lines, at bandwidths above 8Mbit/s and up to and including 45Mbit/s;
- High bandwidth TI retail leased lines, at bandwidths above 45Mbit/s and up to and including 155Mbit/s;
- Very high bandwidth TI retail leased lines, at a bandwidth of 622Mbit/s;
- Low bandwidth AI retail leased lines, at bandwidths up to and including 1Gbit/s (including EFM services); and
- MI retail leased lines - AI leased lines over 1Gbit/s and WDM services with all bandwidths and interfaces.

[246] I.e. There was linear pricing of 64kbit/s circuits (no volume discounts).

[247] See the discussion in paragraphs 3.248 to 3.255.

Section 4

Wholesale product market definition

Introduction

4.1 This Section sets out our conclusions on the definition of the relevant product markets at the wholesale level. Our conclusions are set out in Figure 4.1 below.[248]

Figure 4.1: Summary of relevant wholesale product market definitions

	Product markets			
Traditional Interface Symmetric Broadband Origination (**TISBO**)	**Low bandwidth TISBO**: <= 8Mbit/s	**Medium bandwidth TISBO**: >8Mbit/s, <=45Mbit/s	**High bandwidth TISBO**: >45Mbit/s, <=155Mbit/s	**Very high bandwidth TISBO**: 622Mbit/s
Alternative Interface Symmetric Broadband Origination (**AISBO**)	**Low bandwidth AISBO**: <=1Gbit/s			
Multiple Interface Symmetric Broadband Origination (**MISBO**)	**MISBO:** >1Gbit/s irrespective of interface, and services of any bandwidth delivered with WDM equipment at the customer's premises			

Summary of approach

4.2 CPs use wholesale leased lines extensively, not only to provide leased lines services to business end-users, but also to link facilities in their own networks. For example, mobile network operators (MNOs) use them to link radio base stations to switching centres to provide consumers with mobile voice and data services; and several providers of residential broadband and voice services use them to link equipment in BT's local exchanges to their networks.

4.3 In arriving at our conclusions on market definition for wholesale leased lines product markets, we have followed our approach to market definition which we describe in Annex 3.

4.4 Demand for wholesale products derives from demand for retail services, and we therefore identify wholesale product markets by drawing on the market definitions set out in the previous Section on retail leased lines markets. Accordingly, we examine whether there are separate product markets for wholesale circuits which are of different bandwidths or types of interface, in a similar manner to our assessment in the previous Section in relation to the retail markets.

4.5 We do not, however, rely solely on our retail product market definitions to inform the boundaries of wholesale product markets. In order to define product market boundaries, we also examine the ability of CPs to switch to alternative wholesale products and whether this would be sufficient to act as a constraint on the price-setting behaviour of firms for each of the wholesale products (demand-side substitution). Where relevant we also consider whether potential providers not currently active in supplying that wholesale product could quickly enter the market and provide an additional competitive constraint (supply-side substitution). In addition

[248] For a glossary of terms used in this Section, please refer to Annex 17.

to looking at demand and supply-side substitution, we also consider other relevant supporting evidence. For example, when we propose separate product markets (as informed by our retail product market definitions and based on demand and supply-side substitution analysis), we also consider whether there are any differences in competitive conditions associated with the supply of different products.

4.6 We also recognise that characteristics specific to wholesale products may support identification of product markets which may not be apparent from examination of retail services. We therefore consider whether we should distinguish between markets for access, backhaul and trunk services, which correspond to different levels of traffic aggregation in networks. Opportunities for aggregation on networks can be very location specific, and there is therefore a need to consider product and geographic market definition in parallel to some degree. Our approach to analysing these different parts of the network takes this into account when considering how to capture any distinctions between these network elements.

Structure

4.7 Our analysis in this Section is structured in a similar way to the structure of our analysis in the June BCMR Consultation, in that we address in turn five key issues in wholesale leased lines product market definition. In each case we first set out the proposals we made in the June BCMR Consultation, with the reasoning which underpinned them. Figure 4.2 summarises the issues.

Figure 4.2: Structure of Section on wholesale product market definition

Issue	Summary of issue being considered
Issue 1: Alternative and traditional interfaces	Should we identify separate product markets for the wholesale inputs used to deliver retail AI and TI leased lines services?
Issue 2: Very high bandwidth leased lines	In light of our identification of a retail Multiple Interface (MI) product market, is there a single wholesale product market for all leased lines services supporting very high bandwidths?
Issue 3: Access and backhaul	Are there separate product markets for access and backhaul (or is there a combined product market for terminating segments)?
Issue 4: Wholesale leased lines as an input to other retail services	Should we identify separate product market(s) for leased lines services used to support: mobile backhaul; LLU backhaul and CCTV or include them in either the AI or TI wholesale product markets?
Issue 5: Bandwidth breaks	Do our findings on retail bandwidth breaks result in similar bandwidth breaks for terminating segments or is there a case for wider markets?

4.8 Under Issues 1-2, we consider whether to identify separate wholesale product markets depending on the interface type (i.e. AI, TI or MI). In our retail product

market definition Section, we have identified three broad categories of retail leased lines services defined by their interface type (AI, TI and very high bandwidth MI services). Given this retail product market definition, under Issue 1 we first consider whether to identify separate wholesale leased lines product markets for wholesale terminating segments used to support retail AI and TI services. As a result of this analysis, we have concluded that we should retain separate AI and TI wholesale product markets.

4.9 We then discuss under Issue 2, whether there is a single wholesale multiple interface product market for wavelength division multiplexed (WDM) services and other leased lines services above 1Gbit/s. We have concluded that there is such a combined wholesale product market, which we refer to as the Multiple-Interface Symmetric Broadband Origination (MISBO) market.

4.10 Under Issue 3, we consider whether we should identify a separate product market for different parts of the network used to deliver the terminating segments of leased lines services. Many retail leased lines services rely both on access and backhaul wholesale inputs. But there may be greater scope for competition in backhaul parts of the network (relative to access) such that these services are not always purchased together. However, our analysis overall does not support defining separate access and backhaul product markets, and we therefore define symmetric broadband origination markets (i.e. combined access and backhaul product markets).

4.11 Under Issue 4, we consider the impact of demand for leased lines coming from other retail services on our product market definition findings. In particular, we consider whether wholesale leased lines used to provide backhaul services to LLU providers and mobile operators are in the wholesale leased lines product markets we have identified as a result of our assessment of Issues 1-3. As a result of this analysis, we have concluded that RBS backhaul is part of the same product market as TISBO, and that mobile Ethernet backhaul and LLU backhaul are each part of the same product market as AISBO. We do not include CCTV, Broadcast Access and Street Access in either the AISBO, TISBO or MISBO product markets.

4.12 Finally, under Issue 5, for each of the key wholesale terminating segment products (AISBO, TISBO and MISBO) we then consider whether there is a chain of substitution linking circuits at different bandwidths or whether there are instead breaks in the chain of substitution at certain bandwidths. In particular, we consider whether our findings on retail bandwidth breaks map onto our identified terminating segment markets. As a result of this analysis, we define four wholesale TISBO product markets (at low, medium, high and very high bandwidths respectively), a low bandwidth wholesale AISBO market at speeds up to and including 1Gbit/s, and a combined wholesale MISBO at speeds exceeding 1Gbit/s.[249]

4.13 We consider product and geographic market definition for trunk services together, reflecting the inherently location specific nature of trunk services. Our analysis of trunk market definition is therefore contained in a separate Section, after the analysis of geographic market definition for terminating segments.

The scope of our wholesale assessment

4.14 Before discussing each of the above issues we explain three important issues. First, we explain that the focus of our wholesale product market definition is primarily on

[249] Our MISBO definition all includes relevant WDM-services at all bandwidths.

'active' wholesale leased line services. Secondly, we also discuss the relevance of existing ex-ante regulation to our wholesale product market definition. Thirdly, we explain that when we analyse relevant competitive constraints at the wholesale level, we focus on wholesale network providers rather than intermediary firms.

We focus on 'active' wholesale leased lines services

4.15 In the June BCMR Consultation, we showed the various levels in the leased lines value chain. We said that CPs need active wholesale products to deliver a fully managed retail service. 'Passive' inputs[250] such as duct access or dark-fibre are upstream in the value chain. Hence, if a CP were to purchase a commercially available 'passive' input such as dark fibre, it would still need to invest in additional equipment to make that service capable of supporting a fully managed retail service.

4.16 We do not include passive inputs within the scope of this wholesale product market definition section as they are upstream of the markets we first need to assess. However, our analysis of active services has taken into account relevant upstream passive inputs used in the delivery of those active products. For example, when we assess circuit volumes, we include in our circuit count any leased line services which may be provided by one operator using a passive input (such as dark fibre) provided by another. Thus a dark fibre input used to supply a leased line is counted once only, as a leased line provided by the using operator. Dark fibre which remains unlit is not included in the market but could be relevant to the SMP assessment.

We conduct our assessment under the modified Greenfield approach

4.17 We conduct our market definition assessment as if there were no wholesale SMP regulation in the relevant leased lines markets under review, a method which we refer to as the modified Greenfield approach. To the extent that any wholesale leased lines remedies associated with a market power determination in leased lines markets exist, then, following the modified Greenfield approach, it is first appropriate to conduct market definition and SMP analysis assuming the absence of any wholesale leased lines remedies. For example, in our product market definition, we must assume that there is no operator with an ex-ante regulatory obligation to provide network access for leased lines products or subject to any controls on its charges. However, we take into account any ex-ante wholesale regulation upstream of leased lines markets that exists independently of a finding of SMP in the markets being reviewed (e.g. local loop unbundling).

4.18 We noted in the June BCMR Consultation that the application of the modified Greenfield approach has relevance to our consideration of the role 'passive' services should have in our wholesale markets assessment. As set out above, we focus our wholesale assessment on active wholesale products and services (and in subsequent sections we then look at market power and appropriate remedies to address the competition problems we identify arising from our SMP assessment). When we consider remedies to address the competition problems at the wholesale level we consider whether active remedies would be sufficient or whether more upstream passive remedies are necessary. Therefore, passive remedies are fully considered, but our initial focus in our wholesale market definition (and subsequent market power and remedies assessment) is on active services.

[250] They are a 'passive' service as they only provide access to physical network elements (access to duct or dark-fibre) and they are not supplied with any active equipment. 'Active' products by contrast would provide access to the electronic equipment that is connected to the physical infrastructure.

We focus on wholesale providers rather than intermediary firms

4.19 We focus on wholesale providers with their own network[251] (rather than intermediary firms such as aggregators or resellers).[252] Resellers operate downstream of the markets under review and purchase services which are sold by CPs in wholesale markets, so we capture any competition by looking at the wholesale providers selling services to those intermediaries.[253]

Stakeholders' responses

4.20 A number of stakeholders questioned the scope of our analysis of wholesale markets as they considered we should have analysed additional issues. In particular, some respondents suggested that:

- there was a need to consider passive infrastructure access (PIA) either to dark fibre or ducts and poles;
- there was a need to assess data centres and/or identify a market related to specific 'carrier-neutral' data centre connectivity.

4.21 BT made a number of additional comments on the general framework we used for our wholesale analysis:

- the classification of circuit ends as network or customer nodes; and
- other issues on the scope of our wholesale assessment.

4.22 BT also raised a number of specific points related to our approach to assessing Issues 1-5, which we have discussed under the relevant topic.

Classification of circuit ends as network or customer nodes

4.23 BT argued that we had segmented wholesale markets based on our retail definitions and automatically assumed each wholesale market was further segmented into access, backhaul and trunk. BT noted that this assumption had implications for our subsequent geographic and SMP analysis.

4.24 BT argued that by segmenting circuits as retail, access, backhaul and trunk in this way automatically results in classifying network sites either as a customer,

[251] This is likely to include (but is not necessarily limited to):

- BT and major CPs that can compete using their own networks to deliver retail leased lines or services to other retail markets (e.g. using wholesale leased lines to support broadband backhaul). It may be that in doing so, such providers with their own networks rely on third-party supply of leased lines in those locations where they do not currently have network presence; and
- Mobile network operators: where they are purchasing leased lines for the purpose of delivering mobile network connectivity (where mobile network connectivity includes circuits between their radio base stations (RBSs) and for the backhaul of traffic from RBSs to core nodes and between core network nodes).

[252] These resellers essentially buy or aggregate together services from wholesale providers to deliver end-to-end solutions. This includes firms providing reselling or valued-added functions (e.g. IBM or CSC). As such, when considering market power at the wholesale level, these resellers would not impose an additional competitive constraint unless they were to enter by owning or operating their own infrastructure.

[253] We also include mobile operators' purchases of leased lines to build mobile networks in our wholesale assessment. However, our wholesale definition excludes mobile operators' purchases of retail business connectivity circuits (i.e. circuits purchased to connect together their own retail stores to their headquarters).

intermediate aggregation nodes or CP core nodes.[254] BT noted that due to access, backhaul and origination falling in the same market, intermediate CP aggregation nodes[255] were omitted, so that the classification came down to a choice of each end being either a business customer site or a CP node. [256] BT had concerns with this approach, as it had described it, because:

- it assumes that every site must be either a business customer site or a network node (BT considered that we made a binary choice between a site as one or the other whereas some sites could be both a network and customer site);
- BT submitted that a number of services provided by BT to CPs that are handed over at exchange buildings cannot easily be defined within this framework (i.e. as either a customer or network end), even though they are obviously wholesale services;
- it is insufficiently granular as competitive conditions can vary substantially between sites within the same classification.

4.25 BT was concerned that our market definitions results in a classification of ends that is too inflexible to fully capture relevant competition in relevant markets. It accepted that there are many cases where the framework would work, but it was concerned with what it considered was the prescriptive and mechanistic way we had applied it. It argued that there are cases that do not fit well with these definitions, such as sites joined directly by high-speed transmission systems; mobile base stations and LLU exchanges. It considered that we should have undertaken an assessment of an alternative classification of sites and wholesale services. BT submitted that this was an important cross-check that would have demonstrated that the node owner has some freedom in locating a site in order to achieve economically efficient supply of connectivity.

4.26 BT suggested a more detailed approach that would link with the geographic assessment and would avoid errors resulting from sequential assessment of product market definition, geographic market definition and SMP. BT did not advance a clear-cut proposal as to how this classification could be done, but suggested that a classification could include the following:

- Sites selected by the owner to be co-located with a single preferred connectivity supplier, including self-supply (BT argued that this would include all CP nodes with owned infrastructure and all sites where CPs have signed long-term contracts with a customer to provide the connectivity to that location);

[254] BT described five circuit classification types:

- Business customer site to business customer site = retail site
- Business customer site to CP aggregation node = access service
- Business customer site to CP core node = origination service
- CP aggregation node to CP core node = backhaul service
- CP core node to CP core node = trunk service.

[255] BT refers to 'intermediate aggregation' nodes, which we take to mean the point at which an access segment might be combined with other access segments for the purpose of backhaul to a core conveyance network.

[256] BT argued that this approach was not set out explicitly in the formal framework applied to the identification of wholesale markets. Instead this was discussed, implicitly, in Annex 8 of the June BCMR consultation, which shows the way market volumes are calculated.

- Sites where the owner chose the location specifically because it was an existing site with competitive supply or within reach of competitive supply;
- Sites owned by players with considerable countervailing buyer power, such as mobile base stations;
- Sites selected independently of whether or not there is competitive supply, but either:
  - those sites still have competitive supply (or within reach of competitive supply); or
  - those sites are without competitive supply (or within reach of competitive supply).

4.27 BT further argued that these classifications would avoid the artificial assumption that retail services must be segmented into wholesale services.[257] In particular, it submitted that its alternative classification would reflect the reality that, especially under the required assumption of a modified Greenfield approach, any CP is willing to sell leased lines services to whoever requests the service, so CPs do not distinguish between whether such a customer might be viewed as either retail or wholesale. BT's suggestion was that the classifications that it identified would provide a more informative view of the differences in competition for connectivity to particular sites.

Other issues on the scope of our wholesale assessment

4.28 BT submitted that Ofcom was not correct to focus only on active products, as customers can integrate a complete mixture of passive and active with the former not necessarily upstream of the latter. BT further noted that this comment equally applied to intermediaries who may not be pure re-sellers. BT submitted that we almost exclusively use BT's regulated products to assess the market boundaries, which at least raises questions of consistency of our market definition analysis with the modified Greenfield approach.

Ofcom's view

4.29 In the following paragraphs we discuss BT's comments on the scope and our approach to wholesale market definition in the following areas:

- Segmentation and classification of wholesale services;
- Our focus on active products;
- Assessment based on communication providers with their own networks; and
- Modified Greenfield approach

4.30 We discuss issues related to PIA in Section 8 and data centre connectivity in Annex 6.

Segmentation and classification of wholesale services

[257] BT argued that this approach could be interpreted as meaning that, *"wholesale segments cannot be sold to retail customers (defined as players not owning network nodes)."* It argued that this approach is not correct.

Our assessment considers relevant competitive constraints

4.31 BT raised concerns over our treatment of services as either retail or wholesale and claimed we had assumed that wholesale markets are always segmented into access, backhaul and trunk. It considered that classification of network or customer ends that resulted from this had consequences for our subsequent geographic and SMP assessment. The thrust of BT's comments was that our approach to market definition would fail to detect the differences in competition effectively. Instead, it suggested that we should assess issues of product market definition, geographic market definition and SMP together using its alternative approach that used a more 'context specific' classification of network sites.

4.32 In the following paragraphs we explain why it is necessary to consider wholesale product markets (as distinct from retail). Furthermore, we explain why we consider that when we conduct an assessment of wholesale markets, it is appropriate to take as a *starting point* a fairly narrow market definition for wholesale products.

4.33 Notwithstanding BT's general comments on our approach to market definition, we consider that BT's more specific concern that our approach does not provide a sound basis with which to assess leased lines is not valid. The sequence we follow of first defining wholesale product markets (in light of our retail product market definitions), and then geographic market definition and a market power assessment does not, as BT suggests, result in incorrect SMP findings.[258] We explain below that across this sequence of product and geographic market definition and SMP our approach appropriately captures relevant competitive constraints. In any case we consider that BT's alternative suggested approach has significant practical and conceptual issues.

We have taken due account of the EC Recommendation

4.34 The EC Recommendation informs the appropriate starting point for our analysis.[259] The EC Recommendation lists "[w]holesale terminating segments of leased lines, irrespective of the technology used to provide leased or dedicated capacity"[260] as a market, at the European level, whose characteristics may be such as to justify the imposition of *ex ante* regulatory obligations. The EC's Explanatory Note provides further guidance:

> "Dedicated capacity or leased lines may be required by end-users to construct networks or link locations or be required by undertakings that in turn provide services to end-users. Therefore, it is possible to define retail and wholesale markets that are broadly parallel.
>
> The key elements in the demand for and supply of dedicated connections are service guarantees, bandwidth, distance and the location or locations to be served. There may also be qualitative characteristics because in some cases distinctions are still made between voice grade and data grade circuits."

[258] Our sequence is consistent with the approach set out in the SMP Guidelines (see, for example, paragraphs 9 and 44). See also the EC's Explanatory Note (Section 2.1) Defining relevant product markets and then their respective geographic scope is also consistent with the approach set out in the EC's notice on the definition of the relevant market (Commission Notice on the definition of the relevant market for the purposes of Community competition law (97/C 372/03)).

[259] See also, in this respect, paragraph 36 of the SMP Guidelines.

[260] See the Annex to the EC Recommendation.

4.35 At the wholesale level, it is possible to distinguish separate markets, in particular between the terminating segments of a leased circuit (sometimes called local tails or local segments) and the trunk segments. What constitutes a terminating segment will depend on the network topology specific to particular Member States and will be decided upon by the relevant NRA."The passage above clearly envisages that NRAs should review wholesale leased lines services. Further, it suggests the possibility of separate wholesale markets, so we need to consider whether wholesale leased lines markets can be identified based on a further segmentation related to service features and also between network segments (i.e. between terminating and trunk segments).

4.36 BT expressed concerns over the segmentation of wholesale markets based on the assumption that they contain access, backhaul and trunk segments. Again, in line with the EC's Explanatory Note, there is clearly a view that we should consider wholesale services because competition for downstream (retail) customers is based on undertakings that rely on dedicated capacity or leased lines to construct networks to link relevant locations. Our wholesale market definition is concerned about identifying the building blocks (i.e. the network components) that CPs utilise to provide downstream retail end-to-end services. In this respect, in our market definition we need to correctly identify the building blocks that CPs rely including any access, backhaul and trunk components.[261]

4.37 We do not accept however, as BT suggested, that we automatically assume that a retail service *must* be split between access, backhaul and trunk. We use this segmentation but only as a starting assumption in our market definition in order to test for the correct boundaries of product markets. In particular, to identify the relevant wholesale product markets, we first begin with a narrow set of focal products (i.e. segmenting the market by access and backhaul and trunk links). From this starting point we then consider whether it is appropriate to define the market more widely (i.e. a combined access and backhaul markets for various leased lines terminating segments).

Why our approach is sufficiently flexible and considers relevant competitive constraints

4.38 We consider that our approach appropriately captures relevant competitive constraints for leased lines.

4.39 As stated above, our market definition starts with narrowly defined focal product (consistent with relevant EC guidance referred to above), and we then test whether the market should be expanded to include additional products or services. In our view this approach is inherently a more flexible approach than an alternative which started with an assumption that the market should be defined broadly. Starting with narrow focal products allows for the identification of wider markets (if this is supported by evidence). By contrast, taking fairly broad markets as a starting point (without testing for the relevant boundaries) would create an increased risk of wrongly identifying a market as either competitive or uncompetitive. This is because there is a risk that any resulting assessment (based on a broad market) is likely to consider average competitive conditions over an excessively wide range of services.

[261] We note also, as set out above, that the EC's Explanatory Note states that [d]edicated capacity or leased lines may be required by end-users to construct networks or link locations or be required by undertakings that in turn provide services to end-users. *Therefore, it is possible to define retail and wholesale markets that are broadly parallel*" (emphasis added).

4.40 For leased lines markets, we have assessed them at a granular level across different services characteristics (by interface and customer types), bandwidth and across network segments (access, backhaul and trunk). We have also provided a detailed assessment of a number of alternative market definition issues and wider issues relevant to this review (e.g. BT's proposals with respect to data-centres (see Annex 6) and PIA (Section 8)). We consider that this analysis is both extensive and robust to BT's concerns.

4.41 It is also important to note that we do not treat our product market definitions as the end point to our analysis of competition in relevant markets. For example, our analysis of wholesale product market definition of access and backhaul markets (Issue 3) explicitly considers the scope for competitive backhaul provision, and has done so taking into account features of the market both by product and geographic dimensions. In relation to mobile and LLU backhaul, we include these services in the relevant AISBO, TISBO and/or MISBO markets at the wholesale product market definition stage. However, in addition to considering geographic markets based on demand for leased lines services from enterprise customers, our geographic assessment considers variations in competitive conditions by geographic location individually for mobile and LLU backhaul services.

4.42 In our SMP assessment, we have looked at a wide range of evidence (including constraints that may be external to our defined markets). While the primary focus of our market power assessment is based on the defined boundaries of relevant markets (based on our product and geographic markets assessment), our SMP assessment seeks to take into account all relevant competitive constraints, which can be inside and outside of the scope of the defined market.[262] In our market power assessment, we have considered evidence based on market shares and have tested the robustness of the results under a range of scenarios. We have looked at the constraints that could exist from directly provided dark-fibre. For relevant markets, we have also assessed the extent of any countervailing buyer power that customers may hold that could act to limit a supplier's SMP in relevant markets.

4.43 Therefore, we consider that our approach to market definition and our SMP assessment is sufficiently flexible and captures all relevant competitive constraints. In addition to the above, we have considered the implications of narrower market definitions suggested by BT as sensitivities (e.g. we have considered the impact of defining additional bandwidth breaks (e.g. AISBO services at 1Gbit/s)).

BT's alternative classification approach

4.44 BT also argued that our segmentation of markets (i.e. retail and wholesale and terminating and trunk), results in the classifications of circuits either having a customer or a network end which may be too inflexible a definition when we come to assess geographic markets and SMP. BT suggested an entirely different approach to market definition and our market power assessment that would rely on examination of a more granular set of context specific 'network nodes' (as explained above), which in its view would better capture the competition in leased lines markets.

4.45 We regard the classification of circuits as either having a customer or network end as relevant to our method for counting circuits to estimate market shares (reflecting the

[262] For more detail on this point, see Section 7 where we explain that we have explicitly considered any relevant competitive constraints outside the market and explain how we have taken them into account in our analysis of market power.

nature of the data we have available to us).[263] We address many of these points in Annex 5.

4.46 BT referred to the classification of sites where players would, in its view, have considerable countervailing buyer power (CBP). Consistent with the SMP Guidelines, we consider CBP as relevant to our market power assessment. To the extent that BT is advocating a market definition that reflects (among other things) the existence of sufficient competing infrastructure in different locations, we have captured this in our geographic assessment (as discussed in Section 5).

4.47 BT also referred to owners that have the flexibility to locate network nodes where there is significant competing infrastructure. Where this is the case, we would expect to see a higher percentage of leased lines end-users located in high network reach areas and probably very close to multiple networks. Our product and geographic market assessment (which considers areas of the UK where there is scope for competitive supply) takes into account the existence of alternative infrastructure without needing such a granular and detailed assessment of each possible network end or site. In addition, as set out above, we have conducted a detailed assessment for particular groups such as data centres.[264]

4.48 In addition to the above points, we do not consider that BT's alternative proposals to segment the market by individual buildings or customers would be practicable nor would they offer clear and stable boundaries capable of capturing the key variations in competitive conditions in leased lines markets.[265] BT suggested for example an assessment of different classifications of sites (depending on whether the owner had selected the site to co-locate with a preferred connectivity supplier; or to co-locate with competitive supply; and on whether the owner has considerable countervailing buyer power). We consider that it would not be possible to gather information for each circuit end that captured for example a site owner's location decision and that adequately captured the conditions of competition. Such an approach would potentially entail looking at every business premise or node location in the UK. As we discuss in Section 5, such an approach to market definition looking at individual business sites for the whole of the UK would not be practical. It could also result in quite unstable market definitions.

4.49 Therefore, we consider that our wholesale market definition (and subsequent geographic and market power assessment) is capable of capturing sufficiently the key competitive constraints and drivers of variations in competitive conditions for the wholesale provision of leased lines.

We focus on active products

4.50 BT was concerned that we considered only 'active' products in our market assessment and that we have ignored the competitive constraints that could arise from access to dark fibre.

[263] This is because the classification of network and customer ends is not, as BT seems to suggest, something that automatically follows from our wholesale definition. It is an approach that we have developed in our data analysis to allow us to estimate market shares effectively in light of available information. We explain our approach to the classification of circuit ends in Annex 5.

[264] See Annex 6.

[265] See, in this respect, the ERG Common Position, Section 3. See also Section 5 of this Statement for our reasons for choosing postcode sectors as the appropriate geographic unit to define the geographic scope of the relevant product market, one of which, consistent with the ERG Common Position, is that they have clear and stable boundaries.

4.51 As noted above, our analysis of active services has taken into account relevant upstream passive inputs used in the delivery of those active products. For example, when we assess circuit volumes, we include any leased line services which may be provided by one operator using a passive input (such as dark fibre) provided by another. Thus dark fibre inputs are included but as an input to an 'active' leased line provided by an operator using dark fibre.

4.52 BT's concern, however, was that dark fibre is not only an upstream input but in some cases a customer will consider a choice between active/managed leased lines services and direct access to dark fibre (or a combination of both). BT referred to reports by Ovum and Analysys Mason which both highlighted instances where customers have used dark fibre as a basis for very high bandwidth connectivity (i.e. there are customers that effectively self supply the active input). BT submitted that this demonstrates that such an approach does act as a competitive influence in this market.

4.53 We do not agree with BT's view that passive products are not necessarily upstream of active products. Any potential end-user or wholesale provider using dark-fibre would still have to engage in additional investment in equipment and systems to develop a fully functioning active product or service. The active or lit component of the service may well be self-supplied but dark-fibre would remain an upstream input into that self-supplied active service.

4.54 We recognise however that it is appropriate to understand the effectiveness of any competitive constraint that might exist from direct provision of dark fibre. Hence, we have analysed information on dark fibre further in Section 7 so that we can understand the materiality of dark fibre in markets where it could, at least in principle, be a feasible alternative. This analysis focuses, in particular, on the extent to which large customers might seek to access dark fibre directly, thereby by-passing the market for 'active' products offered by wholesale providers. Therefore, we consider that we have analysed all relevant sources of competitive constraint in this Statement.

Our focus on wholesale providers rather than intermediary firms

4.55 BT commented that there are intermediary firms that operate in the market who may not be pure re-sellers. The implication of BT's comment was that we had not fully captured all relevant competitive constraints (which could then affect our market power assessment if such providers were omitted from our calculation of service shares).

4.56 We recognise that most wholesale providers currently competing with BT rely on a combination of their own network as well as third-party supply. Therefore, our wholesale assessment needs to take into account the fact that leased lines markets include CPs that do not compete solely on the basis of service provision wholly over their own infrastructure. Nevertheless, it is important that we do not overstate the competitive constraints that intermediary firms offer at the wholesale level. In particular, if a large OCP such as CWW sells a wholesale service to an undertaking such as IBM that resells that service to a retail customer, we need to ensure that the wholesale services are not double-counted in our wholesale assessment by including both the sale by CWW and the sale by IBM.[266] Our approach to measuring market

[266] When considering our wholesale product market definition, we need to be mindful however that under the modified Greenfield approach there are possibly limits to any competitive constraints that such providers might bring in the absence of available regulated wholesale products.

shares achieves this. We set out the details of the steps we have taken to ensure that we have captured all the major network operators (and hence the relevant competitive constraints) in our market assessment and how we have calculated market shares at Annex 5.

Modified Greenfield approach

4.57 BT submitted that our wholesale definition relied heavily on its network topology and the products and services that it provides on a regulated basis and it questioned the consistency of this approach with the modified Greenfield approach.

4.58 We agree that it is important to conduct our analysis absent regulation related to SMP findings in leased lines markets. However, we set out below that given the nature and history associated with leased lines wholesale markets it remains appropriate to have regard to BT's network and services in our market definition. Given the historic position of BT in the supply of services to these markets, we are primarily concerned with assessing the strength of constraints on BT.

4.59 One of the concerns that BT raised was that our market definition relies heavily on BT's network topology and not that of other CPs. This approach is entirely consistent with the modified Greenfield approach. For example, demand for services such as LLU backhaul exist due to the presence of regulatory obligations that exist independently of the leased lines market (they derive from the Wholesale Local Access market). Hence, any requirement for LLU backhaul is, by definition, based on the location of LLU providers at BT exchanges (or other co-location facilities). In addition, the existence of LLU backhaul requirements can influence competition for other forms of backhaul.

4.60 The modified Greenfield approach requires that we assume the absence of regulated wholesale leased lines services when defining wholesale markets. However, market definition can never be an entirely theoretical exercise. For example, when analysing wholesale markets we have referred to BT's products and services (PPCs, EAD, EBD etc) where these provide useful examples of particular wholesale services. It seems reasonable to assume that in an unregulated market that BT would have access to similar network components for self-supply. The key modified Greenfield assumption is that these services would not necessarily be made available to other CPs at competitive cost-reflective prices. Where we have used BT's regulated wholesale prices as a proxy for the likely competitive price of wholesale services, this is because of an absence of alternative information, which is consistent with the approach advocated in the SMP Guidelines.[267]

4.61 BT had some more specific concerns that we had relied on BT's network topology when considering access and backhaul and trunk markets. We discuss these points respectively under Issue 3 and in Section 6. Nevertheless, we do not consider that our wholesale product market definitions rely on the assumption that BT's wholesale inputs services are the only way in which particular downstream demand from retail customers can be fulfilled by CPs. Therefore, our wholesale product market definitions remain consistent with the modified Greenfield approach.

[267] See, in this respect, paragraph 42 where it states that "the working assumption will be that current prevailing prices are set at competitive levels. If, however, a service or product is offered at a regulated, cost-based price, then such price is presumed, in the absence of indications to the contrary, to be set at what would otherwise be a competitive level and should therefore be taken as the starting point for applying the 'hypothetical monopolist test'".

Ofcom's conclusions

4.62 In the light of the above considerations of our approach to wholesale definition, we have not made changes to our general approach. In the remainder of this section we now discuss the specific market definition issues (1-5) as set out in Figure 4.2 above.

Issue 1: Alternative interface and traditional interface services

Our proposals in the June BCMR Consultation

4.63 In the June BCMR Consultation, we proposed separate product markets for alternative interface (AI) services (at speeds up to and including 1Gbit/s) and for traditional interface (TI) services.[268] We analysed the case for separate wholesale product markets based on AI and TI services in light of:

- *Derived-demand and indirect constraint arguments*: we assessed whether the constraints that we identified in our retail market analysis were generally likely to apply also at the wholesale level;
- *Direct demand-side substitution:* given that we found a base of retail TI customers unlikely to switch from their current services to AI, we considered whether there was any prospect that direct-demand side substitution at the wholesale level could be an alternative source of competitive constraint (in effect, this considered the extent to which (in response to a SSNIP) CPs using a wholesale TI service would seek alternative wholesale inputs (e.g. AI services) to continue to deliver their downstream requirements; and
- *Analysis of competitive conditions*: we assessed whether indicators of competitive conditions (e.g. differences in service shares held by BT) in AI and TI supported our proposed finding of separate markets.

4.64 Having considered all of the above factors, we proposed to find separate product markets for AI and TI wholesale services.

Derived demand and indirect constraints

4.65 The starting point for the analysis of indirect constraints is the retail product market definition.

4.66 A direct constraint at the retail level can give rise to an "indirect" constraint on the prices of the wholesale inputs whose demand is derived from demand for the retail services, in the following way. Suppose a retail market comprises of two retail services which are good substitutes for each other. If there is an increase in the price of a wholesale service which is used to provide one of the retail services (but not the other), and this increase is passed through in the retail price, then the wholesale price increase will result in switching by retail customers to the other product. This is an indirect constraint on the wholesale price.

4.67 Indirect constraints arising from retail level substitution may be sufficiently strong for wholesale products to be placed in a single market, even if there is no possibility of directly substituting one wholesale input for another in the production of a given retail

[268] The retail AI market for services up to and including 1Gbit/s. We identified a number of sub-markets for TI services market on the basis of the particular speed of that service, which we discuss under Issue 5 of this Section.

service. We explained that, for this to be the case, the relevant retail products should be sufficiently good substitutes for there to be a single retail market; wholesale price changes should largely or wholly be passed on to retail customers; and the price of the wholesale service should form a high proportion of the retail price.

4.68 In the June BCMR Consultation we proposed separate AI and TI retail product markets. This being so, we considered it unlikely that indirect constraints at the wholesale level would be sufficiently strong to point to a single wholesale product market.

Direct demand-side constraints

4.69 Although we defined different retail product markets for AI and TI services, we considered whether it was possible that retail demand (for low latency, synchronous and resilient services of the type demanded by TI customers) for TI services could be delivered using AI-based wholesale inputs (and vice versa). If it were possible to "emulate" the main characteristics of TI services that end-users value but over an Ethernet leased line then we said that this could in principle indicate there were not separate wholesale markets.

4.70 We noted that a number of differences between Ethernet and TDM-based services have become of less significance since the 2007/8 Review. One major development has been the emergence of 'carrier-class' Ethernet. Carrier-class Ethernet services can now fulfil many of the functions needed to support the efficient provision of leased lines services across national and international networks (rather than Ethernet having more limited functionality and being confined to metro or local area networks).[269]

4.71 We also noted that Ethernet technologies have evolved to support synchronisation functions (which for some end-users is one of the drivers for the demand for TDM circuits).[270] We therefore suggested that the convergence of Ethernet and TDM may have eroded many of the technical differences that would matter to most end-users.

4.72 On the other hand, we said that BT continues to support TI services using "native" SDH/PDH technologies (rather than a solution that relies on "emulating" those services features on Ethernet or other packet-based technologies) and this was likely to reflect the fact that there continued to be a number of retail customers still requiring the performance characteristics of TDM-based technologies. In addition, at lower bandwidths (2Mbit/s), in particular, TDM services remained competitively priced relative to lower bandwidth Ethernet services (e.g. at 10Mbit/s).[271] In the context of our market definition, this meant that insufficient numbers of wholesale users would be willing to switch to Ethernet in response to a SSNIP on TI services to

[269] This includes a traffic management and hierarchical QoS (quality of service) mechanisms, standard end-to-end OAM (operations, administration and maintenance) and performance monitoring, extensive fault management and diagnostics.

[270] MNOs have for example relied on SDH-based circuits to their mobile base stations. Because SDH uses a common synchronised timing source to deliver SDH circuits using time division multiplexing, MNOs can use this synchronised timing to manage mobile end-users moving between different cell sites. We discuss synchronous Ethernet solutions in more detail in relation to mobile backhaul under Issue 4a below.

[271] Under Issue 3 below, we also highlight that there are barriers to CPs providing Ethernet and TDM backhaul on a converged basis. In some cases the geographic location of networks and circuits used to deliver Ethernet services and TDM-based services can be different. Therefore, even if a CP had invested in support for TDM-emulation over Ethernet circuits, it would not necessarily be straight-forward to re-assign a retail TI circuit to an Ethernet services where the CP's network (used to support each service type) is not always located in the same areas (and even where they are located in similar locations there may be other barriers to migration).

make it unprofitable, because this would mean that their retail customers would experience an unacceptable loss of key service characteristics.

4.73 We noted that another possibility is that CPs could use WDM technologies to deliver TI and AI services. However, given the cost premium associated with WDM (multiple interface) technologies, we considered that it was unlikely that CPs would install (on a forward looking basis) equipment capable of supporting multiple interfaces for lower speed circuits (e.g. TI circuits below 1Gbit/s).

4.74 Given that the TI market is in decline overall, we said that it was likely to be more economic to continue to support the synchronisation, resilience and low-latency features of the TI services currently supplied (which in the main includes services at 2Mbit/s and below) using "native SDH" (i.e. services actually provided over SDH-equipment with associated TDM features rather than products that attempt to emulate the characteristics of the service over Ethernet links). Therefore, for TI terminating segments (at lower speeds), we considered that these services were likely to continue to be provided over dedicated TDM-based equipment.

4.75 Therefore, we considered that, while technical differences had reduced, the evidence pointed to a base of end-users (at least at lower bandwidths) that have a positive preference for TDM-based services.

Competitive conditions

4.76 We also considered whether competitive conditions were homogeneous across AI and TI services. If so, we could combine them in a single product market to enable us to simplify the SMP analysis without affecting the conclusions. We noted, however, that the differences in competitive conditions for AI and TI services tended to support our proposals to define separate product markets.

4.77 We considered that one reason for differences in competitive conditions was that many of the TI markets were largely in decline. One implication of this was that there could be limited incentives for BT's competitors to enter or to invest further in these markets. We recognised that the majority of TI users likely to remain were on lower bandwidths (2Mbit/s and below). BT's share of this market had remained stable through time and it had faced limited competition for the lower bandwidth services that constitute the largest part of the market.

4.78 We said that, by contrast to TI services, there was emerging competition for AI services in some geographic areas. Indeed, for the most commonly purchased TI bandwidths (2Mbit/s and below), we observed BT has a significant national share (86%), including in the London area. This contrasted with the AI services where our market evidence suggested greater variation in competitive conditions by geography (BT's national share was around 62% for the UK overall and – on a comparable basis – about 41% in the London area).[272] Given that competitive conditions appeared to vary it was not appropriate to use a combined market to simplify the analysis.

4.79 On the basis of the above analysis, we proposed to retain separate wholesale product markets for alternative interface and traditional interface services respectively (at least for services below 1Gbit/s). We noted in particular the derived demand analysis and a lack of demand side and supply side substitution

[272]In the June BCMR Consultation, we described refinements which we made to our market share estimates. After these refinements, we estimated BT's share to be between 45% and 50% (see Section 7 of the June BCMR Consultation).

opportunities between the two services at the wholesale level. The evidence on variations in competitive conditions called for separate examination of each.

Responses to the June BCMR Consultation

4.80 Below, we summarise the points made by respondents which are relevant to Issue 1 (whether AISBO and TISBO form separate wholesale markets), and explain how we have taken them into account in reaching our conclusions. Six respondents specifically commented on our proposals for AISBO and TISBO markets. Four respondents (CWW, EE/MBNL, and TalkTalk and Telefónica) agreed with the identification of separate AI and TI markets. [✂ ✂] and BT did not support separate markets. However, as many of the comments made are more relevant to our retail definition we have already summarised the key points in Section 3, we therefore only refer to new points BT raised regarding our wholesale analysis.

4.81 BT did not agree with our proposed finding of separate markets. BT provided the following observations on our wholesale AI and TI analysis:

- BT noted that AI and TI services are used as inputs to serve other retail markets (i.e. asymmetric broadband and mobile services) [273], but this is absent from our analysis of the AI and TI services.
- It noted that our discussion of derived demand/indirect constraints gave the clear impression that primary constraints derive directly from the retail products.
- It argued that the discussion of direct demand-side substitution at the network level was essentially a repeat of the retail analysis;
- We had argued that BT continues to support TI services using 'native' SDH/PDH, which is likely to reflect the fact that a number of retail customers still require the strictest performance characteristics of TDM; and
- BT disagreed with using the "SMP assessment" as the basis for justifying separate markets for AI and TI at the wholesale level.

4.82 BT referred to its comments on our retail market definition (as set out in Section 3), where BT argued that there is one-way substitution from TI to a number of other products (including but not limited to AI services).[274]

4.83 BT submitted that we could not infer anything from the fact that BT still uses its SDH network to deliver downstream services for market definition purposes. BT argued that its SDH/PDH network is largely a sunk cost and normal economic incentives imply that BT would continue to use it even when the performance characteristics are much worse than a newer technology. BT also noted that the only example we provided of customers needing strict performance characteristics of TDM was mobile backhaul. BT argued however that mobile operators were already migrating from TI

[273] At Paragraph 32, page 129, BT referred to our discussion of the scope of our wholesale market analysis in the June BCMR consultation where we identified other retail markets served by wholesale leased lines such as mobile and LLU backhaul (as discussed in paragraph 4.2 above).

[274] BT referred to the conclusions of the report from its consultants, SPC Network: "one way supply-side substitution from TI-based services to AI-based services is clearly technically feasible as SDH features can be emulated easily with AI. From a forward-looking engineering perspective, this applies both at the core conveyance level and at the terminating level as is amply demonstrated by the adoption by MNOs of BT's MEAS." (Section 5, SPC Network, Trunk Technical Report, 6 September 2012).

to AI services, which therefore undermined the arguments Ofcom made over direct demand side substitution.[275]

4.84 BT expressed concern over our analysis of wholesale markets based on indirect constraints. BT referred to a submission it had made to the Narrowband Market Review[276] where it set out in detail its concerns over the application of a SSNIP test in the context of indirect constraints. BT argued that it is flawed; can result in arbitrary outcomes; and is not a good basis for the assessment of upstream market power. BT argued that in the context of the assessment of AI and TI services, the retail AI and TI leased lines markets are only a small proportion of the downstream demand for wholesale services. BT therefore argued that any SSNIP at the wholesale level will be diluted at the retail level thereby limiting the impact of any indirect constraints.

Ofcom's view

4.85 In the following paragraphs, having considered stakeholders' responses and further analysed these markets, we explain why we consider it is appropriate to retain separate markets for wholesale AI and TI services.

4.86 We note that out of the 21 responses to the June BCMR Consultation, only two respondents have raised questions in relation to our analysis in the June BCMR Consultation. [✂] did not consider our product market segmentation reflected customer and supplier behaviour and it saw sufficiently strong substitution between TISBO and AISBO services (based on observed migration trends) for them to be included in a single product market. We have responded to [✂] comments in our retail section. Only BT made specific comments on our wholesale analysis in the June BCMR Consultation for separate markets:

- it questioned our analysis based on derived demand/indirect constraint arguments and our findings of separate markets in retail markets (which it did not agree with);
- it questioned the barriers that wholesale providers face in switching from the provision of services using TI to AI; and
- it argued that we could not rely, for market definition purposes, on the fact that BT and OCPs continue to supply services to customers on SDH/PDH networks.

The relationship between AI and TI retail services and our wholesale product market definition

4.87 In our retail product market definition (Section 3), we concluded that it is appropriate to retain separate markets for AI and TI services. In light of our finding that retail services are in separate product markets, we consider that it should follow that any competitive constraint at the wholesale level based on derived demand/indirect

[275] BT noted that the only other major requirement for a high level of timing accuracy is for PSTN interconnection. BT considered, however, that timing accuracy is only required at the point of interconnection with the PSTN and is not required for packetized voice or video, e.g. VoIP within a private network. BT submitted that PSTN interconnection may well be provided by the CP within the CP network therefore removing the need to have any form of synchronisation at any customer site. It also stated that any ISDN30 used for interconnection automatically resolves this timing requirement as part of the ISDN30 service.

[276] "Further Submission on Issues for the Wholesale Narrowband Calls Market Review 2013", BT, 11 October 2012

constraints would be similarly weak and would not provide a basis for identifying a combined wholesale product market.

4.88 BT referred to a number of conceptual objections it made on the assessment of wholesale markets based on an assessment of indirect constraints (as set out in detail in a submission it made to the Narrowband Market Review). In particular, it was concerned about the use of a SSNIP of 5-10% applied at the wholesale level to assess constraints that might arise from changes in the purchasing behaviour of downstream retail customers. BT was concerned that the assumption that any wholesale price increase would be diluted when passed through to retail customers could result in unduly narrow wholesale market definitions.[277] BT also highlighted that uncertainty over the assumptions applied under a HMT[278] (such as the relationship between price and costs) can also generate quite a wide range of results.[279]

4.89 We recognise that care is needed in conducting a HMT test including when considering indirect constraints. In particular, we need to ensure that any SSNIP is applied correctly in the context of the markets being analysed (as noted in our Narrowband Market Review). However, we consider that the implications of BT's arguments on indirect constraints seem to be that retail substitutability between AI and TI would be less strong at the wholesale level. Accordingly, since we find separate retail AI and TI product markets, BT's argument is consistent with also separating AI and TI at the wholesale level.

Direct substitution at the wholesale level

4.90 BT has also criticised our analysis of direct demand-side substitution at the wholesale level. BT argued that we largely repeated our analysis of AI and TI at the retail level. BT argued for a combined market, noting that the features of TI can be 'emulated' easily over Ethernet links as evidenced by MNOs – historically one of the main customers of TI services - switching to AI services.

4.91 We recognise that there is likely to be a strong relationship between our findings in retail markets and our wholesale assessment. Hence, when considering direct demand-side substitution, if the retail customer has not decided to switch from using TI to AI then direct wholesale level demand-side substitution is unlikely to be a realistic prospect. In other words, a CP would not initiate a change in the delivery method to a TI customer if the end-user has not requested it. If a SSNIP were applied on a wholesale TI service then the threat of a CP switching its TI customer base onto to AI services is unlikely to provide an effective competitive constraint (as discussed above).

[277] For example, consider the following scenario:

- the competitive price of retail service is made up of a number of wholesale inputs: A, B plus the cost of any retail activities C.
- a wholesale provider applied a SSNIP of 5% to one of those inputs, input A,
- input A represented only 10% of the retail service cost stack.

Then this would result in a 0.5% increase in the retail price (assuming full pass-through of the increase in wholesale charges to retail customers).

[278] Hypothetical monopolist test.

[279] For example, the SSNIP test is based on the critical loss, which computes the proportion of existing customers that would need to switch to render a SSNIP unprofitable. BT noted that the point at which a SSNIP would be unprofitable is sensitive to assumptions about the relationship between average and marginal costs, which are often quite uncertain.

4.92 As noted by [✂], the rate of migration from TI and AI is likely to slow as those customers remaining on the TI platform are likely to be customers that find switching to AI or other interfaces less easy. Technically, as those retail customers' systems are geared towards receiving leased lines traffic presented as TI, there is a barrier to switching to AI services in terms of supporting new interfaces as well as the risk to the wholesale provider of general customer disruption.

4.93 In addition to retail leased lines customers (including enterprise customers and major utility companies) there are a number of other users of wholesale TI services such as MNOs and wholesale operators with voice networks and other retail applications. BT argued that we had not taken this demand into account when assessing AI and TI services. Our wholesale product market definition has taken this into account.

4.94 In relation to mobile demand for AI and TI services, as we discuss under Issue 4a in this Section, MNOs are switching to Ethernet circuits reflecting growing backhaul demand and the lower cost per Mbit of Ethernet at higher bandwidths. However, MNOs in response to the June BCMR Consultation noted that they will retain low bandwidth TI links in some cell site locations driven by the lower cost of TI services at lower bandwidths (and as we discuss under Issue 4a, we do not find support for a combined AI and TI market for mobile services).

4.95 At the network level, wholesale providers also make use of TI services to deliver fixed voice networks.[280] The wholesale customers making use of TI services could therefore also be a valid direct demand-side constraint. This point was recognised by BT in its response (as set out in footnote 275 above). In particular, as BT recognised, a number of CPs rely on TDM technologies as the basis for the interconnection of public switched telephone (digital voice) networks (known as the PSTN). This includes voice services delivered to residential customers as well as connections to enterprise networks (digital) voice switches (also known as PABX – private automatic branch exchanges).[281] There are some operators using packet-based next generation networks to deliver voice services to customers (using VoIP). But those operators with TDM-based voice networks have not indicated any intention to migrate their networks to NGN given the significant cost of doing so. Wholesale carriers that rely on TI services to deliver PSTN voice would not switch to alternative voice technologies in response to a SSNIP. Hence, it is likely that there will continue to be demand for TI circuits to support traditional voice services.

4.96 While we still observe an overall migration trend from TI to AI, there is customer inertia, so this migration is relatively slow and we still observe clear differentials in the price of Ethernet and no sign that prices of TI services are converging towards those of AI. We do not consider that a wholesale provider faced with a SSNIP on a wholesale TI service would switch where the downstream end-user had not actively demanded such a change. This in addition to continued demand for wholesale TI

[280] TDM also remains the predominant method of interconnection of Tetra networks. e.g. Airwaves network for emergency services. Tetra stands for Terrestrial Trunked Radio and is the standard for the common mobile radio network for both voice and data services that meets the needs of professional mobile radio (PMR) as used by police, public safety and emergency rescue services, and private access mobile radio (PAMR) applications, including maintenance and repair teams, courier and delivery services, construction, and public transportation.

[281] Enterprise customers are provided with ISDN30 links that in some cases are provided by CPs using 2Mbit/s TI services as an input. Hence, 2Mbit/s TISBO services are seen as an upstream input to wholesale ISDN30, and we have included them in the TISBO product market (this is consistent with the approach that we have taken to include AISBO and TISBO circuits used as inputs to VPN services in our wholesale product market).

services from other sources (such as MNO backhaul and voice), suggests separate wholesale product markets.

Continued delivery of leased lines services over TI technologies

4.97 BT considered that we could not infer anything (for market definition purposes) from its continued use of the SDH/PDH platforms to support leased lines services.

4.98 While our analysis in the June BCMR Consultation did not attach significant weight to this point for market definition purposes, we consider that continued delivery of connectivity using SDH/PDH to a large group of leased lines customers is at least consistent with our view that there is a separate TI market. We agree that from an operator's perspective it would be commercially rational to retain an existing technology platform where it continues to meet the needs of existing customers at lower costs (taking into account migration and transition costs) than a newer technology platform.

4.99 However, BT has suggested in other submissions to this market review (related to the leased lines charge control) that the ongoing cost of its SDH network is likely to increase significantly over the period of the next charge control. We do not agree with BT on the extent of any costs increases, but it serves to highlight a potential inconsistency in BT's arguments that it has obvious incentives to continue to support the TI services on the SDH-platform.

4.100 In addition, if (as BT suggests) nearly all demand for TI services could be addressed on the Ethernet platform (i.e. the majority of demand can switch) without significant barriers at the wholesale level and without customer disruption then, it would be likely to be rational for an operator such as BT to close down an older platform to minimise the costs of parallel running. BT's Ethernet services are now well established and hence the forward looking costs of both the Ethernet and TI platforms should be relatively low. In these circumstances, with lower ongoing costs of the Ethernet platform (and subject to any relevant migration and transition costs), BT would potentially have an incentive to concentrate traffic onto the new network. However, BT does not have plans to actively close its SDH network (at least until 2020). This reflects its continued demand for TI leased lines over "native" rather than emulated technologies and its continued support for voice over its PSTN network (based on TDM).[282]

4.101 Accordingly, the fact that BT continues to use both networks is consistent with our view, which is that there remains demand for TI and there is limited incentive to switch to AI services for some customers in the medium term.[283] This is reflected in the comments made by [✂] that saw the rate of decline slowing due to the fact that many of the circuits that lend themselves to migration would have already moved.[284]

[282] BT has plans to close its DPCN platform used to support sub-2Mbit/s TI circuits by 2018, but it is developing migration products to enable CPs to continue to support customers on its SDH-network rather than migrating those customers onto Ethernet services.

[283] At lower bandwidths, we note that a particular type of AI service called EFM potentially offers an alternative lower cost solution for customers requiring less than 10Mbit/s. However, we find that barriers to switching remain. And uptake of this service is not forecast to be that significant over the next three years.

[284] The drivers for this continued demand for SDH services are mainly commercial (reflecting the price of lower bandwidths) but there are still some technical barriers for a class of customers. As noted in the June BCMR consultation the price of up to 2Mbit/s TI link remains someway below that of an Ethernet link that could deliver equivalent capacity. This is important as lower bandwidth links account for around 99% of all TI circuits.

Conclusion

4.102 We conclude that it is appropriate to retain separate wholesale AISBO and TISBO product markets as:

- this reflects our findings of separate product markets at the retail level;
- although, technically, Ethernet services can now deliver most of the requirements of TI, demand for TI services is likely to remain;
- the available price evidence does not suggest that the prices of AI and TI services are converging as would be expected if TI were constrained by AI; and
- there also remain important barriers to switching both at the retail and wholesale level.

Issue 2: Very high bandwidth leased lines services:

Our proposals in the June BCMR Consultation

4.103 In our retail assessment in the June BCMR Consultation, we proposed to identify a single leased lines product market addressing needs of retail customers requiring very high bandwidths (above 1Gbit/s). We explained that a particular technology: wavelength division multiplexing (WDM) can be used to deliver multiple interface types (including AI and TI) and this would be an effective substitute for standard AI services used to provide very high bandwidth services. In light of this retail market assessment, we proposed to define a "multiple interface" (MI) product market. This MI product market covered all very high bandwidth leased lines services (including WDM services and all other retail leased lines services above 1Gbit/s irrespective of interface presented to the end-user).[285]

4.104 We considered, under Issue 2, the implications of our retail proposals for wholesale product definition. In particular, we considered whether there was a combined product market for very high bandwidth wholesale services (i.e. including WDM services and other interfaces (i.e. such as AI, TI and other specialist interfaces)). We analysed the case for the identification of a separate wholesale product market in light of:

- *Technical assessment:* we looked at the particular wholesale service requirements needed to meet demand from very high bandwidth retail customers;
- *Demand and supply-side substitution:* given our finding of a combined retail product market, we considered any derived demand arguments for a combined wholesale product market based on 'indirect' demand constraints or more direct demand or supply-side constraints at the wholesale level;
- *Analysis of competitive conditions*: we considered whether wider evidence on the competitive conditions of providing WDM services relative to other wholesale

[285] We considered that for this part of the retail market, where users require higher speeds, and given the relative costs of the technologies which can be used to deliver those requirements, many CPs will choose to provide customers with WDM-based retail services. As these WDM-based retail services are capable of supporting high speed and multiple interface services we consider that they would be an effective substitute for AI and TI services provided using dedicated Ethernet or SDH equipment capable of supporting very high bandwidths.

leased lines services was consistent with our proposals for a combined product market; and

- *Barriers to interconnection:* we considered whether any technical and economic issues associated with interconnecting WDM-circuits created any barriers to end-to-end competition that could affect our product market definition.[286]

4.105 In our assessment, we focused our substitution analysis on the wholesale inputs most commonly used to deliver very high bandwidth services, namely WDM-based services and standard Ethernet services (e.g. BT's WES services at 2.5Gbit/s and 10Gbit/s). This was because Ethernet (delivered either over point to point or networked Ethernet links) was one of the main interface types that had typically been used in the delivery of very high speed data services. Hence, we focused on these two services because we expected *a priori* that Ethernet would be the next closest substitute to a WDM service (and vice versa). In light of our proposed findings in the retail market assessment (where we identified a separate market for low bandwidth AI services at 1Gbit/s and below), we also focused our analysis of very high bandwidth services on Ethernet services above 1Gbit/s and WDM.

4.106 As a result of our assessment, we proposed to identify a combined product market for terminating segments with any interface and delivering any service faster than 1Gbit/s, and for terminating segments delivered with WDM equipment at the end-user's premises (providing services at any bandwidth). We called this product market the wholesale Multiple-Interface Symmetric Broadband Origination (MISBO).

Technical assessment

4.107 In the technical assessment, we considered the underlying technologies and services that would be used by CPs to support very high bandwidth services above 1Gbit/s.

4.108 We noted that WDM was first used by CPs to enable efficient transport of traffic in their core networks. The benefit of WDM is that it uses individual wavelengths of light to deliver very high capacity, with each wavelength supporting speeds ranging from 1Gbit/s and now up to 100Gbit/s (and multiples thereof) over a single fibre.[287] The deployment of WDM was initially a solution to make core networks more efficient. But the use of WDM evolved through time as an efficient way to meet the needs of retail customers with very high bandwidth requirements.

4.109 We also noted that there are a range of end-users requiring very high speed services including data centres; companies offering cloud computing hosting or financial firms that need to transfer data with low latency. We said that, if a retail customer had requirements for a very high bandwidth leased lines service (say, 10Gbit/s), this demand could be served using the following wholesale inputs:

[286] This issue arises because any interconnection of a WDM circuit needs to meet the necessary standards to ensure that:

- inter-operability of WDM equipment available from different vendors; and
- the interconnection of wavelengths between equipment also supports the end-to-end service requirements (such as circuit monitoring).

[287] Recently vendors have introduced equipment capable of supporting speeds of 40Gbit/s and 100Gbit/s per wavelength.

- *Ethernet services:* CPs could install 'dedicated' Ethernet equipment at the end-user's premises pre-configured only to provide the relevant required speed.[288] For example, leading equipment vendors such as ADVA and CISCO sell Ethernet-based equipment that is available at specific speeds of 10 and 100Mbit/s and 1, 2.5, 10, 40 and 100Gbit/s. This equipment sends data on a single pair of lit wavelengths over optical fibre.

- *WDM services:* CPs could deploy WDM equipment that enables single or multiple wavelengths of light to be sent down the same optical fibre. Because the end-user would have additional WDM equipment at its premises, additional wavelengths could be added ranging from 1Gbit/s through to 100Gbit/s very easily (i.e. without further change in equipment). The modularity of WDM equipment would also allow line cards to be installed to deliver retail services with all major interface types (Ethernet, traditional interface (SDH) or other 'niche' interfaces such as Fibre Channel).

4.110 We drew a distinction between 'WDM equipment' and a wholesale WDM service. Provision of a wholesale WDM service would require installation of WDM equipment at a customer's premises and an interface such as Ethernet to actually transport data across those wavelengths (and to support any operations, administration and management of that service on an end-to-end basis). Therefore, to enable WDM equipment to provide an active very high bandwidth wholesale service would require appropriate line cards at either end of the circuit. Hence, we defined a wholesale WDM service as a wholesale service delivered:

- over a WDM-based transmission medium, including WDM-based equipment at customer's premises; and

- delivered to an end-user with a specified client interface(s).

4.111 We noted that one of the key features of WDM service was the flexibility/scalability of the service. The time required to change the configuration of the service was a function of the commissioning and installation of cards in the equipment at each end. Where the relevant equipment was available, upgrades to the bandwidth of the WDM service could be achieved in a few working days. This was because any increase in capacity would use the existing fibre circuit and would simply entail an additional "line card" being installed on existing equipment housing.

4.112 We also stated that another benefit of WDM was that it is possible to deliver services over multiple interfaces such as Ethernet, SDH and some 'specialist' interfaces required by companies storing and archiving data (e.g. fibre channel). A dedicated Ethernet box would not offer the same flexibility as WDM equipment. If an end-user had a 1Gbit/s Ethernet service and wanted to upgrade for 1Gbit/s to 2Gbit/s, say, then a new piece of equipment would be required.

Demand-side substitution

4.113 In our retail product market definition, we proposed a combined MI retail product market consisting of a number of retail services. This retail product market included

[288] When we refer to 'dedicated' Ethernet equipment, we are referring to equipment designed primarily to deliver Ethernet interfaces installed at the customer's premise. Within a CP's core or backhaul network, a CP could provision this Ethernet service over shared fibre and network equipment. The key point with respect to 'dedicated' Ethernet equipment (as compared to WDM-based services) is that the Ethernet service cannot be easily switched to alternative interface types without first changing the customer premises equipment.

WDM-based services (at all bandwidth) and all other leased lines services (above 1Gbit/s) irrespective of the interface used. Hence, we included in our MI retail product market, WDM services (at all bandwidths) and AI and TI services (above 1Gbit/s).

4.114 Given that we found these services in the same retail MI product market, then the wholesale inputs used to deliver those retail services could be in a combined wholesale market if there was a sufficiently strong indirect constraint on the prices of the wholesale services arising from substitution at the retail level.

4.115 We explained that indirect constraints would arise if a hypothetical monopolist of the relevant focal product (i.e. a very high bandwidth wholesale Ethernet service) would find a SSNIP unprofitable due to retail customers switching away from retail Ethernet services in response to the increase in the price of the focal AI wholesale product. If there was sufficient switching at the retail level from Ethernet services to WDM-based services, then this would suggest that we should widen our wholesale product market to include both Ethernet services and WDM-based wholesale services.

4.116 We said that, in assessing possible indirect constraints, it was important to consider how retail prices would change in response to price increases at the wholesale level. We identified two main factors to consider:

- *the extent of pass-through:* whether the absolute increase in the wholesale input price would be reflected in full in retail prices and not 'absorbed' to any material extent by retail providers; and

- *the significance of those wholesale input prices to retailers' costs:* the extent of any percentage price increase at the wholesale level may be 'diluted' in terms of the percentage increase seen in retail prices.

4.117 If the retail market were fully competitive then we would expect any increase in the price of the Ethernet input to be passed on to retail customers in full. This is because the product in question would already be supplied at the competitive price (just sufficient to cover costs) prior to the hypothetical price increase. Hence, there would be limited scope for a competitive provider of a retail service to absorb any increase in input prices via a reduction in its retail margins. If the market were less competitive then there would be greater scope for retailers to absorb some of the increase in the price of a wholesale input. We considered the competitive market assumption appropriate for market definition purposes and so considered that wholesale price increases would be passed through in full.

4.118 However, we said that any wholesale price increase was still likely to be 'diluted' because the cost of a wholesale input may only be one element (albeit a significant one) in the cost stack associated with providing a retail service. While in absolute terms a price increase would be the same (e.g. a £10 wholesale price increase passed on in full would become a £10 increase at the retail level), the increase would not be the same in relative terms. The result was that we considered that a SSNIP (e.g. 10%) in the wholesale price would result in a less than 10% increase in retail prices due to this 'dilution' effect.

4.119 For the retail services (very high bandwidth Ethernet) we expected that in a competitive market the costs of wholesale inputs would form a significant component of any retail price. This was because the cost of equipment and digging and ducting were significant relative to retailing costs. On this basis, a SSNIP would be likely to translate into a significant increase in prices at the retail level. This would mean that

wholesale elasticity would be relatively close to retail market elasticity as dilution is low.

4.120 As such, we considered that switching from very high bandwidth Ethernet services to WDM services at the retail level would impose a sufficient indirect constraint on a wholesale provider of wholesale dedicated Ethernet services. On this basis a derived demand assessment (based on indirect constraints) would suggest including WDM and very high bandwidth Ethernet services in the same wholesale product market.

Direct demand side constraints

4.121 We noted that, even if indirect constraints were not sufficiently strong, it could still be possible to find a combined very high bandwidth wholesale product market (i.e. WDM and Ethernet services) if there was a sufficient *direct* demand side constraint.

4.122 Direct demand side constraints would arise if a CP using a wholesale Ethernet service to deliver a very high bandwidth retail leased line could instead switch to delivering this service over WDM (and vice versa). If sufficient CPs were willing to do so in response to a SSNIP applied to a wholesale Ethernet service, then this direct demand-side substitution would suggest identifying a combined very high bandwidth wholesale product market. We explained that, in addition to indirect constraints, direct demand-side substitution would provide a further reason to include Ethernet and WDM in the same product market.

4.123 We noted that a CP could fulfil the requirements for high bandwidth service using either a wholesale WDM service (such as BT's OSA or OSEA services) or using Ethernet leased lines services. In both cases, the end-user would be presented with identical Ethernet interfaces and the service delivered to the end-user would be indistinguishable.

4.124 We noted that the extent to which a CP chose standard Ethernet or WDM equipment with an Ethernet client interface would depend on the trade-off between costs and the likely bandwidth requirements of the end-user. If the cost differences between the two provisioning options were not large, then WDM equipment might always be preferred. If there were larger cost differences, then a CP might consider more carefully its customer's present and future bandwidth requirements and opt for a dedicated Ethernet circuit at 1Gbit/s and above in some cases and WDM circuits in others.[289]

4.125 We assessed the costs of WDM relative to Ethernet. This analysis suggested that there was not a significant cost premium for WDM services relative to Ethernet services above 1Gbit/s.[290] We concluded from our analysis that a WDM service could impose a competitive constraint on Ethernet services above 1Gbit/s. By contrast, when comparing the cost of providing WDM services to standalone Ethernet

[289] Such considerations were highlighted in our retail definition, but are only likely to apply where the costs differences between services are significant. Where cost differences are significant then it might suggest that:

- for many retail customers that know that their bandwidth will not grow significantly then standard Ethernet services using equipment dedicated to a particular bandwidth may be sufficient.
- if bandwidth requirements are likely to grow more quickly than a dedicated Ethernet service would not be very suitable as each time the customer exceeds the capacity a new fibre circuit must be added, which is potentially more costly and will have longer lead times.

[290] As noted in Section 3, we have compared the cost of dedicated Ethernet equipment to a simple WDM-configuration using a single chassis with the relevant Ethernet interface. This is because such a comparison is most relevant to any assessment of substitution between a dedicated point to point Ethernet service and a WDM-based equivalent.

equipment at 1Gbit/s, we observed that there was a more significant premium. Consequently, even if a SSNIP were applied to AI service (for services at 1Gbit/s and below), a WDM-based solution would not be a viable alternative as WDM would still remain priced at a premium to those AI services.

4.126 Hence, on a similar basis to our retail product market definition, for services above 1Gbit/s, our analysis of direct demand-side substitution suggested that a wholesale WDM service (such as BT's OSA) would be in the same product market as an Ethernet service. For AI services at or below 1Gbit/s, there was a sufficient step-up in the cost of deploying WDM equipment relative to Ethernet equipment such that we did not consider it would provide a sufficient constraint on Ethernet services at these lower speeds.

Supply-side substitution

4.127 Our assessment of demand-side substitution suggested a combined product market for WDM and AI services above 1Gbit/s. We also looked at supply-side substitution and competitive conditions, which provided further support to a combined product market.

4.128 We said that, for supply-side substitution to be relevant to our assessment we would require that CPs:

- were not currently providing a very high bandwidth service using dedicated Ethernet equipment; and
- could enter and begin supplying 'equivalent' Ethernet services relatively easily within a short-space of time (i.e. they have existing network capacity and capability to supply very high bandwidth services over Ethernet interfaces).

4.129 With these criteria in mind, we considered that a possible constraint could also exist from supply-side substitution. This was because some major OCPs such as [✂ ✂] appeared to supply all their retail customers (at least above 1Gbit/s) using WDM services. Therefore, on the basis of the data available to us, these major CPs did not appear to be active in a narrowly defined product market for very high bandwidth Ethernet services (i.e. delivered using dedicated Ethernet equipment above 1Gbit/s).

4.130 In those geographic locations where such CPs had network presence but were not active in the provision of high speed Ethernet, we considered that they could offer a competitive constraint on a hypothetical monopolist of wholesale Ethernet services. Where CPs had sufficient network presence, the value of the retail customers at very high bandwidths would make provision commercially attractive. We also observed that it was technically feasible to enter the market for the provision of Ethernet services using WDM presented with Ethernet interfaces.

4.131 However, we noted that, if an operator did not have significant network presence, then the high sunk cost associated with digging and ducting would be likely to create a barrier to supply-side substitution. On this basis, we considered that supply-side substitution might only offer a relevant further constraint in limited geographic locations therefore we did not attach much weight to supply-side substitution.

Competitive conditions

4.132 We also considered whether the available evidence on competitive conditions associated with the supply of WDM and AI services supported the definition of a single high bandwidth market above 1Gbit/s. We compared service share data both on a national basis and by geography to see if there were similar patterns of competition for AI and WDM services above 1Gbit/s.

4.133 We expected that competition would be more intense for end-users using higher AI bandwidths above 1Gbit/s or using WDM services. When we considered BT's share of supply, it was the same for both AI High and WDM irrespective of geography. BT's service share was around 50% of the market nationally for AI High and around 46% for WDM, compared to a 67% service share for AI Low services at 1Gbit/s and below. [291]

4.134 For AI High and WDM, we also observed a similar pattern in the overall variations in competitive conditions by different geographic locations. For example, BT had similar service shares in the London area for AI High and WDM services, which was likely to reflect OCPs' fibre presence and willingness to build out to higher value end-users. We therefore considered that the available evidence of the variations in competitive conditions for WDM services relative to AI services was consistent with a combined market for very high bandwidth services as suggested by our analysis of demand and supply-side substitution.

Barriers to interconnection for wholesale WDM services

4.135 We also considered whether interconnection for WDM-based services was in principle possible. We considered that question to be significant for our market definition because if interconnection were not possible we would need to revisit whether the focal product should be separated into terminating segments (as opposed to end-to-end circuits). If we did define our market solely on the basis of the latter then it would suggest that competition was only possible where operators could provide national circuits entirety on their own networks). We therefore assessed barriers to interconnection for WDM-based services.

The importance of barriers to interconnection to wholesale product market definition

4.136 We explained that, in leased lines markets, competition was often based around CPs supplying terminating segments (either self-provided or purchased from third parties) which they combined with their own core networks to deliver retail end-to-end services. In most cases, OCPs had existing core networks, but they needed connectivity from their existing networks to end-users to deliver a retail service. In many situations, however, the distances involved in building to an end-user would be too great (as CPs other than BT do not have ubiquitous networks). In those situations a CP might rely (to some extent) on third-party supply for wholesale leased lines. Where a CP bought a circuit from another supplier, there would need to be effective interconnection arrangements in place so that CPs could connect wholesale circuits supplied by a third-party to their own networks without there being any degradation in the service that the CP could provide to its downstream customer.

4.137 We noted that, if interconnection were not an option then in order to deliver retail WDM service between an end-user's sites, the OCP would have to self-supply the connectivity from its core network to each of the retail customer's sites. WDM-based

[291] Based on analysis of CPs' s135 submissions.

services would only be provided on an end-to-end basis. Therefore, our product market definition would be limited to wholesale end-to-end services.

4.138 On the other hand, if interconnection to a competitive core was in principle technically possible then a definition based around separate terminating segments and a separate core market would be more appropriate. We noted that there could still be other barriers to overcome in order for a CP to compete effectively downstream using its own core network combined with third-party provided terminating segments. For example, there could be an additional cost of interconnecting WDM circuits that would not be faced by a CP that could self-supply a WDM circuit on an end-to-end basis. But if interconnection was in principle possible, any remaining market power issues would then be more about leverage of market power which could be addressed by making available an effective interconnection product at appropriate prices.[292]

Assessment of barriers to interconnection

4.139 We noted that, in the case of WDM, there were some technical issues associated with interconnecting wholesale circuits, which could create barriers to end-to-end competition. In particular, some specific issues there were in relation to the interconnection of a WDM circuit, which had to meet the necessary standards (for example recognised standards such as Optical Transport Network (OTN))[293] to ensure that there was:

- inter-operability of WDM equipment available from different vendors; and
- the interconnection of wavelengths between equipment that supported the end-to-end service requirements (such as operation, network management and administration and circuit monitoring).

4.140 By contrast, for Ethernet leased lines services, the necessary interworking and interconnection standards were well established and (for the most part) allow CPs to maintain necessary operation, network management and administration and monitoring functions on an end-to-end basis even where they relied on wholesale third-party supply for some parts of their end-to-end requirements.

4.141 For WDM services, without the implementation of relevant standardised interconnection (as has been achieved for standard Ethernet services), it would be very difficult for a CP to interconnect with a third party to use its wholesale WDM-service. In principle, it was technically possible to provide 'work-arounds' to link different equipment together, but the cost of deploying such 'work-arounds' might make them commercially prohibitive.[294]

4.142 Our assessment of the development of interconnect products (based on discussion with major equipment vendors) was that the technical standards for OTN were now

[292] In particular, a firm with market power in the provision of terminating segments (where there may be significant barriers to competition) could be able to leverage that market power into core networks (even where the barriers to competition are much lower). This could result in the firm with market power in terminating segments not facing as strong a constraint on the price it could charge for WDM services that make use of a core network thereby making competition in core networks weaker.

[293] For a further discussion of OTN standards see Section 13.

[294] This entails installing transponders capable of taking an optical signal (where one WDM circuit ends) turning it into an electrical signal which is then converted back to an optical signal that would interwork with the WDM equipment of another CP.

sufficiently well defined. For example, we were told by ADVA that interworking between vendors was common. We therefore considered interconnection to be technically possible so that a retail service could, in principle, be delivered using a CPs own network and third-party links. Therefore, there seemed to be no 'inherent' technical requirement for WDM technologies to be restricted only to provision on an end-to-end basis. Therefore we considered it appropriate to analyse the MISBO market in terms of terminating segments (as opposed to end-to-end circuits).

4.143 Nevertheless, we noted that, even if interconnection standards (such as OTN) were fully supported on an ongoing basis, there may still be an additional cost of interconnecting WDM circuits that was not faced by CPs able to provide WDM circuits entirely on their own networks. If these interconnection costs were material then this could then create a situation whereby competition was less effective for WDM markets. On this basis, we proposed to take into account any competition issues that arose from a lack of effective or commercially attractive interconnection products in our SMP analysis and regulatory remedies.

Proposed conclusions

4.144 In light of our analysis, we proposed to identify a combined product market for terminating segments with any interface and delivering any service faster than 1Gbit/s, and for terminating segments delivered with WDM equipment at the end-user's premises (providing services at any bandwidth). We called this product market the wholesale Multiple-Interface Symmetric Broadband Origination (MISBO). Our proposed identification of a MISBO product market was made, in summary, for the following reasons:

- Derived demand arguments based on indirect constraints suggested that a hypothetical monopolist would be constrained in raising the price of wholesale Ethernet services due to switching downstream to alternative WDM-based solutions;
- Direct-demand side substitution would in any case suggest identification of a combined MISBO product market;
- Supply-side substitution might also be relevant in these markets, as there were providers of WDM-based services not supplying a standard wholesale Ethernet service which could potentially enter and begin supplying WDM-based services (where they have network presence); and
- The empirical evidence pointed to similar competitive conditions for WDM and Ethernet services and greater competition to supply higher bandwidth services (for Ethernet services above 1Gbit/s and WDM) than low bandwidth AI services.

Responses to the June BCMR Consultation

4.145 Below, we summarise the points made by respondents which are relevant to market definition for very high bandwidth services, and explain how we have taken them into account in our analysis.

4.146 Ten respondents specifically commented on our proposed identification of MISBO market. CWW, COLT, Everything Everywhere, MBNL, GEO, [✂], TalkTalk,

Telefónica, UKCTA, and Zen Internet all agreed with our proposals.[295] BT broadly agreed with the notion of there being a separate high bandwidth services market including WDM, but it had some specific concerns related to our MISBO definition. Sky also asked for clarity over our definition.

4.147 Virgin agreed that there was a need to define a new market to accommodate leased line products that have emerged during the course of the last market review period. Virgin noted that the introduction of MISBO moves away from a strict "by bandwidth" definition, but it agreed that there is substitutability between Ethernet and WDM products above 1Gbit/s and therefore this points to the products being in the same market. It also noted that the scalability of WDM services does not fit well with a rigid bandwidth based market definition, so it understood our approach in this review of including all bandwidth services in the market, despite the availability of 1Gbit/s WDM.

4.148 Sky considered that we had over-emphasised the significance of the equipment cost differential that, in part, informs our proposal that there are separate AISBO and MISBO markets. Sky's main concern however with Ofcom's approach was that the MISBO market definition 'overlaps' with AISBO so that it is not apparent whether or not certain leased line Ethernet services such as BT's EBD service would fall into both markets. Sky submitted that our product market definition is unclear in relation to 'single service Ethernet' products delivered over WDM.

4.149 Zen Internet agreed that it is important to include Ethernet at 1Gbit/s and above under the very high bandwidth classification as it was seeing steady growth in this area and it expected this to continue growing as pricing reduces and the bandwidth explosion continues to grow with fibre-based broadband services.[296]

4.150 BT agreed with the proposal to identify a product market for higher bandwidth services. However, it disagreed with some aspects of the proposed definition:

- the 'multiple interface' definition was potentially confusing, ambiguous and unnecessary. BT considered that we should avoid being so technology specific in the definition and consider the merits of a simpler bandwidth definition that MISBO refers to services of total bandwidth over 1Gbit/s.

- there should be an upper bandwidth limit for MISBO so that products with bandwidths above 10Gbit/s are not included. BT noted that it does not currently sell services above this speed, whereas other CPs do. It suggested that services above 10Gbit/s should be seen as a separate emerging market where competitive conditions are different and that should not be subject to regulation (we discuss bandwidth breaks for MISBO under Issue 5 below).

- connectivity to multi-tenant carrier-neutral data centres anywhere in the UK at any bandwidth with any interface should be excluded from all market definitions.

[295] COLT welcomed the identification of the MISBO product market, but it submitted the following comment with respect to MISBO: *"we strongly disagree with the suggestion that WDM is not included. Ofcom's reason for not including WDM is that it is a new technology. It is certainly not a new technology. It is a mainstream technology that has been in widespread use for years. We therefore strongly urge Ofcom to reconsider the treatment of WDM technology within the MISBO category, both from the perspective of product availability and pricing."* However, as we have not excluded WDM-services from our MISBO market definition we have not responded to this point further.

[296] Fibre to the cabinet or home.

4.151 BT noted that an unwarranted consequence of the MISBO definition is the possibility of re-regulating the market for very high bandwidth TI services. Such services are typically provided using technology such as DWDM and have been explicitly found by Ofcom to be competitive. BT argued that we should clarify that these services do not fall within the MISBO market and so are unregulated.

4.152 BT did not accept there is any essential difference between retail and wholesale markets for WDM services. BT considered that Ofcom had implicitly asserted differences between retail and wholesale based on whether a circuit is used to serve a customer or CP nodes rather than as a result of any analysis. BT was concerned in particular that we classified data centres, without justification, as a business customer rather than as CPs.

4.153 BT was concerned that our classification of a MISBO service suggested differences between customer sites and network nodes and that an end-to-end circuit between customer sites must be made up of two originating segments and maybe a trunk. BT submitted that the primary purpose of a WDM (or very high bandwidth technology) is to directly connect major sites. In its view all WDM services are end-to-end services between major network nodes, irrespective of whether this is a customer site or network node. As long as the sites are within the range limits of the optical technology, any equipment at any intermediate sites is a meaningless and unnecessary expense.

4.154 BT considered that our proposed solution to identify a market for MISBO services results in a mis-count of circuit ends, as we effectively multiply the number of ends associated with an end-to-end WDM service by segmenting the end-to-end service to include at least two terminating segments and possibly a trunk segment. BT also considered that we entered into an irrelevant and spurious consideration of interconnection between these segments.

Ofcom's view

4.155 As set out above, most stakeholders agreed with our proposals to identify a market for very high bandwidth services, but some asked for clarity over services within the MISBO market definition.

4.156 We therefore set out our further reasoning on the services included within our MISBO definition to provide clarity on our definition. We then discuss BT's comments on the distinction between retail and wholesale markets before then discussing BT's comments that suggested we define an end-to-end market for MISBO services delivered using WDM.

4.157 We discuss some of BT's comments in other parts of this Statement: bandwidth breaks (discussed under Issue 5 below) and issues over data centres (Annex 6).

4.158 We conclude below that it is appropriate to identify a very high bandwidth product market above 1Gbit/s (including WDM-services at all bandwidths) that is largely agnostic to the interface provided and hence covers all relevant services sold at these bandwidths. We also conclude that it is appropriate to use terminating segments as the basic building block for our assessment.

Reasons for including services above 1Gbit/s and WDM at all bandwidths within the MISBO product market

4.159 As set out above we proposed a market for very high bandwidth services which we called the multiple interface symmetric broadband origination services (MISBO) market. The MISBO definition in the June BCMR Consultation related to any leased lines service above 1Gbit/s irrespective of the interface over which it was delivered. In addition, we included within the MISBO product market definition any 'services delivered with WDM equipment at the customers' premises' at all bandwidths. This means that even if a 'WDM service' (as defined above) is only currently delivering a single 1Gbit/s wavelength over the available capacity we would include it as part of the very high bandwidth MISBO market.

4.160 BT criticised our definition for being technology specific (as it considered our market definition referred explicitly to WDM technologies). It argued instead that a simpler bandwidth break approach would be appropriate for our market definition (i.e. a very high bandwidth market to cover all leased lines services above 1Gbit/s).

4.161 We consider that our MISBO product market definition covers all relevant leased lines services used to deliver very high bandwidth requirements. Our starting point under Issue 2 was to examine (in light of our retail product market definition) whether there was a single wholesale product market for all leased lines services supporting very high bandwidths. Therefore, we do not agree that we have defined the market solely with reference to particular service type(s). Nevertheless, when we define the relevant product market at the wholesale level, we need to understand the products and services predominantly used to deliver higher bandwidth requirements and that are captured by this definition. Therefore, we considered it necessary for our product market definition to clarify the services included and that, for example, WDM services at any bandwidth would fall within the MISBO market. On this basis in setting our product market definition, we have referred to the products and services that are included.

4.162 BT's suggestion was for a simpler market definition whereby only services above 1Gbit/s are included in the MISBO market. However, we consider that the nature of products and services in the MISBO market does not fit well with a rigid bandwidth based market definition (this is a point recognised by Virgin in its response to the June BCMR Consultation as explained above). In particular, we consider that a customer that has gone to the effort and cost of installing WDM-services will be likely to have a requirement for services in excess of 1Gbit/s within a relatively short time frame. WDM-equipment installed at a customer's premises only currently delivering 1Gbit/s initially can be scaled very quickly to deliver multiple wavelengths and services.[297] Hence, if a customer has invested and paid for WDM-capacity at and between its premises, we consider that these services can and are being used to deliver very high bandwidth requirements and would therefore fall within the MISBO market. [298] If we adopted BT's approach of applying a simple break at 1Gbit/s then we would potentially include WDM-services in the low bandwidth market when it is clear that the customer has invested in a service of supporting for the very purpose of delivering current (or future) very high bandwidth requirements.

[297] For example, the capability of the WDM-equipment is many times 1Gbit/s (potentially160 wavelengths at 1, 10Gbit/s or higher).

[298] If the end-user or wholesale customer is only ever likely to need capacity below 1Gbit/s with a specific interface, it would be more efficient to purchase a single service 1Gbit/s link rather than paying for a WDM service. The latter would be more expensive and over-engineered for the end-user's bandwidth requirements. See for example, Section 3 where we compared the relative prices of WDM and AISBO services at 1Gbit/s.

4.163 Sky asked for clarification on how we might classify BT's EBD service (a wholesale Ethernet product that provides defined amount of Ethernet bandwidth (currently at either 1Gbit/s or 10Gbit/s) as this service relies on WDM technology as an upstream input).

4.164 We note that just because BT's EBD relies on WDM, it does not automatically mean that it should be classified as a fully functional "WDM-service". WDM is an upstream input to a number of leased lines services (for example it is used as a transmission medium for TI trunk services and a number of Ethernet leased lines services). The function fulfilled by EBD is as a single service Ethernet product and when a CP purchases this service from BT, the service provided does not come with the inherent capability to support multiple interfaces or to provide scalable bandwidth as is the case for a fully functioning "WDM-service". This is the trade-off that the CP faces in paying for a service such as EBD that provides single-service Ethernet (with associated cost benefits of using BT's networked Ethernet infrastructure) compared to a WDM-service. In the case of the latter, the customer pays for a complete WDM-service at its premises, and hence the full capacity of the WDM-equipment would be available to CP alone.[299]

4.165 We therefore classify EBD services as single service Ethernet. For our market definition, this means that services at 1Gbit/s would fall within the low bandwidth AISBO product market as it is not a WDM-service offering scalable bandwidth across multiple interfaces (i.e. the end-customer or wholesale CP does not pay upfront for use of WDM equipment for its sole use). Similarly, EBD services at 10Gbit/s would also be classified as 'single-service' Ethernet. Nevertheless, the MISBO product market includes single service Ethernet such as EBD services at 10Gbit/s and WDM-services as both provide capability to deliver very high bandwidths and our substitution analysis as set out above supports the inclusion of WDM-services and single service Ethernet above 1Gbit/s in the same market.[300]

4.166 BT also asked for clarification of our treatment of TI services at 622Mbit/s, 2.5Gbit/s and 10Gbit/s as these services can be delivered using WDM as an input. As discussed in Section 3, we have identified a product market for very high bandwidth TISBO services at 622Mbit/s. We also note that retail WDM services allow equipment installed at customer premises to support multiple wavelengths and different client interfaces including SDH. SDH carried on such WDM equipment would retain all of the characteristics of a native SDH service. Given the significant declines in the cost of WDM-equipment, the prices of TI services above 622Mbit/s will face a competitive constraint from WDM retail services and are included in the MI market.

[299] Reflecting the fact that WDM services may be purchased by wholesale customers, we have amended the definition used in the June BCMR Consultation so that it refers to customer's premises rather than end-user's premises. This point is discussed further in Section 13 in relation to our definition of WDM services.

[300] We consider that there are some differences in the nature of a single service Ethernet and WDM-service. Clearly WDM-services provide greater functionality in terms of scalability and the available evidence suggested it was a cheaper solution to deliver the highest bandwidth requirements. However, we consider that these services both fall within the market as they are capable of delivering very high bandwidth requirements. A CP offering a single-service Ethernet link at 1Gbit/s or 10Gbit/s may well deliver this using common backhaul infrastructure with WDM as an upstream input (as is the case with BT's EBD services and seen for other operators' backhaul networks). But as mentioned in the paragraphs above, the nature of this service is different to a scalable WDM solution whereby the costs of the WDM capacity and equipment are purchased and capacity reserved to an individual customer. Nevertheless, based on the reasoning as set out in the paragraphs above, both service types are capable of meeting very high bandwidth requirements and we consider that there should be a competitive constraint such that it is appropriate to include WDM and AISBO services (above 1Gbit/s) that would include BT services such as EBD 10Gbit/s in the MISBO market.

4.167 We consider that it is unlikely that a CP would choose to install a >1Gbit/s SDH service without WDM in the future. WDM will provide equivalent functionality and is likely to be cheaper over the long run particularly as a customer who needs very high bandwidth is likely to need more bandwidth in the future and the capacity of WDM services can be expanded at low incremental cost.

Distinction between retail and wholesale provision

4.168 BT submitted that we should not distinguish between retail and wholesale services associated with WDM circuits (and very high bandwidth services). BT argued that the implication of this distinction plus our identification of a terminating segments market meant that we had assumed that a wholesale circuit *must* be made up of at least two originating segments and a trunk, which had implications when we came to measure BT's service share. It also considered that we entered into an irrelevant and spurious consideration of interconnection between these segments.[301]

4.169 We consider that many of the concerns that BT raised (including those with respect to classification of nodes) confuse issues associated with the definition of MISBO services in the June BCMR Consultation with our method for counting WDM services (i.e. our treatment and classification of customer and network ends). We focus here on the issues directly relevant to our product market definition, namely BT's view that the market should be defined on an end-to-end basis (we discuss our approach to counting and classifying circuits in Annex 5).

4.170 BT's argument was that such distinctions between retail and wholesale services are not necessary, as the "WDM-service" sold to retail and wholesale customers would be indistinguishable. It would not matter to a provider of WDM-services whether it is dealing with a CP (e.g. CWW purchasing a WDM-service to connect together nodes on its network) or to an enterprise customer (e.g. Barclays Bank connecting its head office to a data-centre). Both would require end-to-end WDM solutions that provide the same WDM equipment and fibre between that equipment and would offer significant capacity between each site (whether it is a network or customer-end).

4.171 Fundamentally, we consider it is important for the purposes of this review to distinguish between wholesale and retail services (consistent with both the EC's Recommendation and the EC's Explanatory Note). We are interested in defining the MISBO product market appropriately so that we can assess the basis on which wholesale providers of these services compete with each other to deliver services to relevant downstream customers. It is important to be able to identify the source of market power at the wholesale level and target any remedies appropriately. If we were to automatically assume, as BT suggests, that competition occurs on an end-to-end basis then this could allow leverage (from the terminating segments market) across the entire end-to-end service to go undetected.[302]

[301] It argued that the asserted difference between retail and wholesale arises implicitly from the definition of sites as customer or network sites. BT considered that the very purpose of WDM technology (or any very high bandwidth technology) is to directly connect major sites and any site requiring such services would be a major network node.

Related to the above points on network and customer ends, BT was also concerned about our identification of a terminating/originating segment market for MISBO services.

[302] See, in this respect, paragraph 83 of the SMP Guidelines where it states that "where an undertaking has significant market power on a specific market, it may also be deemed to have significant market power on a closely related market, where the links between the two markets are such as to allow the market power held in one market to be leveraged into the other market, thereby strengthening the market power of the undertaking." We refer to this paragraph to illustrate the potential competition problem our approach avoids missing. However,

4.172 In this respect, we think it is necessary to consider whether interconnection is possible or whether the nature of WDM-service provision is such that competition can only feasibly occur on an end-to-end basis. We discuss this issue further in the following paragraphs.

End-to-end definition of WDM connectivity

4.173 The implication of BT's argument that the very high bandwidth market is for end-to-end circuits is that CPs could only ever compete for a circuit that they were able to provide entirely between two sites (e.g. two data-centres). This would only be possible where the CP had network sufficiently close at each end (and sufficient network capacity between those two points). If the focal product is the complete circuit (as opposed to the terminating segment), it would be more likely to suggest that an incumbent provider with extensive national footprint would have SMP because of the advantages of ubiquity and geographic leverage.[303] This approach could therefore potentially lead to a finding of SMP in the whole market (and hence remedies that were focused on end-to-end regulation) whereas the market power stemmed from the advantages the incumbent enjoys in the provision of terminating segments. If instead remedies sought to address market power for terminating segments then leverage could be avoided as CPs could potentially combine regulated inputs with their own network in order to provide end-to-end services competitively. Therefore, we think that it is appropriate to consider the potential for interconnection.

4.174 In the June BCMR Consultation, we examined the situation where a CP had its own network but was not "present" at one end. We considered whether it was technically feasible for such a CP to deliver an end-to-end service required by the downstream customer by:

- purchasing a wholesale circuit from a third party at that end; and
- interconnecting that service with its own WDM network.

4.175 As set out above, we noted that this was technically possible as relevant industry standards exist to permit the interconnection of WDM services.[304] The result of identifying an originating segments market is not, as BT asserts, about imposing artificial assumptions that segment a WDM-service into two terminating segments and a trunk. This is simply to reflect the fact that, in the absence of regulation, CPs without near-ubiquitous network nationally (as is the case with BT) could still in principle compete by combining their core networks with third party supply. We assess the extent to which this happens in practice in our market power assessment.

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as set out in our subsequent SMP assessment, we do not rely on the existence of leveraging to reach our conclusions on SMP.

[303] For example, an end-to-end definition for WDM service would imply that an OCP with network presence in London but not in the rest of the UK would be unable to compete nationally by purchasing a wholesale segment from a third party (by interconnecting with its own network). This would result in an incumbent being able to leverage its advantage in the rest of the UK into those locations where OCPs otherwise have the potential to compete. Hence, any circuits from London to the rest of the UK may well only be served by the incumbent.

[304] In BT's response to the June BCMR consultation it sought to distinguish between interworking and interconnection. We discuss these issues further in our assessment of wholesale remedies. However, our focus in this section is on the potential for interconnection (whereby CPs combine circuits purchased from third-parties) with their own infrastructure to deliver downstream end-to-end solutions.

Conclusion

4.176 In light of our analysis as set out above, we identify a combined product market for terminating segments with any interface and delivering any service faster than 1Gbit/s, and for terminating segments delivered with WDM equipment at the customer's premises (providing services at any bandwidth). We call this product market the wholesale Multiple-Interface Symmetric Broadband Origination (MISBO). Our identification of a MISBO product market is made, in summary, for the following reasons:

- Derived demand arguments based on indirect constraints suggest that a hypothetical monopolist would be constrained in raising the price of wholesale Ethernet services due to switching downstream to alternative WDM-based solutions.

- Supply-side substitution might also be relevant in these markets, as there are providers of WDM-based services not currently supplying a standard wholesale Ethernet service but that could potentially enter and begin supplying WDM-based services (where they have network presence). However, given the findings on the demand-side, we do not attach significant weight to this point.

- The empirical evidence points to similar competitive conditions for WDM and Ethernet services and a more competitive situation for higher bandwidth services (for Ethernet services above 1Gbit/s and WDM) relative to low bandwidth AI services.

  Our assessment of the development of interconnect products based on discussion with major equipment vendors is that the technical standards for OTN are now sufficiently well defined. We therefore consider interconnection is technically possible such that a retail service could, in principle, be delivered using a CP's own network and third-party links. Therefore, there seems to be no 'inherent' technical requirement for WDM technologies to be restricted only to provision on an end-to-end basis. We consider it appropriate to identify a separate MISBO product market (i.e. for WDM terminating segments).

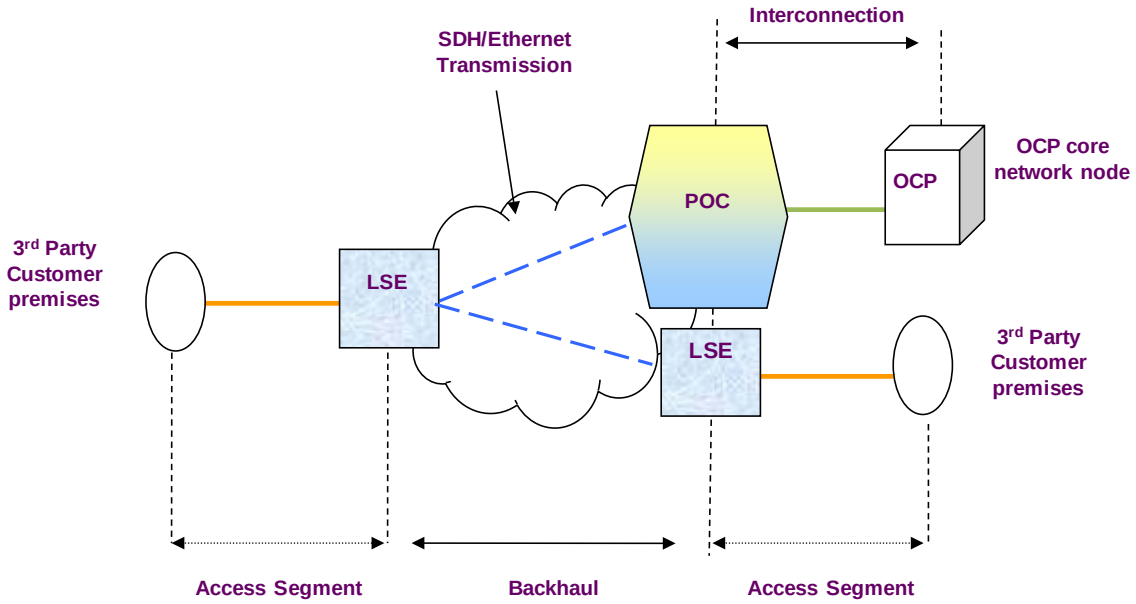
Issue 3: Wholesale access and backhaul

Our proposals in the June BCMR Consultation

4.177 Under this issue, we considered whether separate markets exist for access and backhaul for leased lines services or whether it was appropriate to base our analysis on supply of access and backhaul together (a combined "symmetric broadband origination" market).

4.178 Figure 4.3, reproduced from the June BCMR Consultation, shows a stylised depiction of the access and backhaul parts of the network.

Figure 4.3: Access and backhaul



Source: Ofcom 2012

4.179 In the June BCMR Consultation, we identified the following distinctions between access and backhaul segments:

- *Access segments*: these were typically the final network leg running from an end-user's premise (at the network termination equipment) to a local access node (typically this might be in a local serving exchange (LSE)).[305] We noted that CPs could provide access segments over radio access links, or copper and fibre-based links dedicated to that end-user.

- *Wholesale backhaul services:* these were circuits running from a local access node to:

  - another local access node (on the same CP's network) (so it would include inter-exchange connectivity circuits); or

  - a trunk node (on the same CP's network); or

  - another Communications Provider's point of connection (POC).

4.180 We then considered whether there was a case for separate access and backhaul markets in light of:

- *Technical assessment:* we looked at some of the general features of access and backhaul that would distinguish both services;

[305] We note that a backhaul network could in theory start from a point closer to the end-user, for example where a CP has installed equipment in a street cabinet. However, in most circumstances a local serving exchange is the first point (or the equivalent on an OCP's network) at which different traffic streams from individual end-users come together.

- *Demand and supply-side substitution:* we explained why we considered that demand and/or supply-side substitution did not support a combined access and backhaul market; and

- *Analysis of competitive conditions*: we considered whether the competitive conditions associated with providing access services were sufficiently similar to backhaul services to support a combined market.

4.181 On the basis of our assessment, we proposed to identify a combined market for access and backhaul. We termed these combined access and backhaul services as symmetric broadband origination.

Technical assessment

4.182 We briefly described the general differences in access and backhaul. We also set out some of the developments in CPs' networks that were important to our subsequent assessment.

4.183 We said that wholesale access services represent the 'local end' of a circuit and generally used dedicated fibre circuits from an end-user premise back to a local network node (often a local serving exchange or a CP's POP). Due to an access segment typically only serving a single end-user premise there were generally not the same economies of scale or scope as in backhaul (i.e. there was no ability to benefit from aggregating traffic for individual traffic streams in an access segment). The scope for use of common duct and fibre might also be more limited.

4.184 We noted that wholesale backhaul services were used to provide high capacity backhaul links between operators' network nodes. Therefore, for backhaul circuits, CPs often multiplexed circuits onto higher capacity links along with other traffic to be backhauled efficiently to a CPs' core network. Backhaul circuits were typically between network nodes where CPs had installed necessary transmission equipment to enable switching/multiplexing of their services.

4.185 We also stated that access and backhaul typically had a complementary relationship in that a retail circuit from A to B would typically require both an access and backhaul segment at both ends of the retail circuit. However, CPs would not always purchase (or self-supply) access and backhaul services in fixed proportions:

- retail customers might only require a short distance leased line service starting and ending in the same local area (therefore a CP would potentially only need to self-supply or purchase an access segment without making use of its main transmission network); or

- even if a retail circuit needed to include a wholesale access and backhaul segment, CPs might not purchase access and backhaul circuits as a bundle. In theory they might decide to self-supply either an access segment only or backhaul segment only or they might decide to self-supply both.

4.186 We looked at some of the main recent developments in BT's and OCPs' networks in order to provide greater context to our discussion of access and backhaul.

Developments in TISBO markets

4.187 In relation to TISBO markets, we argued that there had not been major changes in BT's or OCPs' deployments of SDH/PDH-based services. BT's major network SDH-

nodes (Tier 1 nodes) and technologies employed in its SDH/PDH network had not changed since the last review.

4.188 Similarly, for OCPs, we found that there had not been very much change other than greater consolidation in the market place. We noted that CWW had acquired Thus and some other smaller OCPs such as Your Communications. It had also taken on responsibility for managing wholesale circuits for OCPs or providing retail circuits that were previously provided by other CPs.

4.189 We considered that these changes had not significantly impacted on SDH/PDH network deployments. For example, the available evidence on OCPs' Point of Handover purchases suggested that there had been an overall decline in the installed base of POHs and BT had not received significant new orders of PPC POHs in recent years.[306] We had also not seen evidence of OCPs relying on alternative technologies to "emulate" TDM services on their backhaul networks. Where CPs had migrated, in general, it appeared to have been in response to retail customers migrating to new technologies (supported by Ethernet or ADSL technologies).

Developments in AISBO markets

4.190 We said that the main change in AISBO markets since the 2007/8 Review was BT's deployment of Ethernet services provided over newer network technologies. As part of this roll-out, BT had introduced three main services, EBD, EAD and EAD Local Access. We noted that EAD was in many respects a direct replacement for Openreach's point to point Ethernet services such as WES and BES services (using more modern equipment). On the other hand, BT's networked Ethernet services such as EBD represented a more fundamental change to its network topology as they introduced greater aggregation in backhaul and a new hierarchy of nodes in BT's Ethernet network.[307]

4.191 We noted that BT's introduction of its networked Ethernet services had required significant upfront investment in a new fibre network. BT had deployed fibre configured in local chains, which were always linked back to BT's main network nodes known as Openreach Handover Points (OHPs). The deployment of these chains allowed BT to provide resilient networked Ethernet backhaul services at a sub-set of BT's local exchanges (called access serving nodes (ASNs)), which were parented to BT's OHPs.

4.192 We said that this new network Ethernet service offered the potential for greater efficiencies in backhaul, by allowing multiple high bandwidth (1Gbit/s and 10Gbit/s) Ethernet backhaul circuits to be delivered over aggregated capacity, which could help drive down the cost of each unit of bandwidth. On each (1Gbit/s or 10Gbit/s) backhaul circuit, CPs could also aggregate traffic from different access segments (e.g. LLU traffic and Ethernet) although a CP would need to deploy their own switches and co-locate at BT's ASN to allow aggregation of circuits from BT's ASNs back to their own core networks.

[306] The data on BT's sales of POHs shows a significant decline in the volume. In terms of new orders, the data also shows that in 2010/11 BT had received three new orders and in the half-year (2011/12) only two new orders. None of these POH orders are for new Customer Sited Handovers. Therefore, this is supportive of the discussions we have had with OCPs that they have made limited changes to their networks since the 2007/8 Review to support the TI market.

[307] Networked Ethernet was available as a technology at the time of the last review, but no CP had yet deployed such a network on a large scale for backhaul links.

4.193 We suggested that BT's investment in networked Ethernet services could have implications for the scope of competitive backhaul. BT's investment in networked Ethernet had required significant upfront and sunk costs. The implication was that OCPs considering whether to invest in their own backhaul would need to achieve a sufficient level of traffic and utilisation of that capacity in order to justify comparable investment rather than buying backhaul from a larger operator such as BT.

4.194 We therefore suggested that, if the potential for CPs to achieve economies of scale and scope in backhaul was limited (i.e. CPs could be in a position of a relatively low retail share) then this could make the competitive conditions for access and backhaul more alike (i.e. it would be more likely that CPs would rely on BT both for their access and backhaul requirements). On the other hand, if OCPs were able to replicate these economies (i.e. where they were able to achieve sufficient scale) using their own networks then this could increase the scope for competitive supply in backhaul (as compared to access segments).

Demand and supply-side substitution

4.195 We noted in the technical assessment that access and backhaul typically had a complementary relationship. On this basis, we did not regard access and backhaul as demand-side substitutes. We also considered that supply-side substitution was unlikely to be relevant.

4.196 Therefore, we did not rely on demand or supply-side substitution in defining a combined product market. However, we considered that a combined product market could be appropriate if competitive conditions in the provision of access and backhaul were sufficiently homogenous, so that we would ultimately come to the same view on market power as we would if they were treated as separate markets. On the other hand, if CPs provided one service (e.g. backhaul) competitively, but not the other, then competitive conditions would be different.

4.197 We said that, in principle, CPs could find it economic to purchase access and backhaul separately, or to self-provide one and purchase the other. Therefore, we focused on the empirical question of whether competitive conditions were similar between access and backhaul, which was primarily motivated by practicality concerns.[308] We also considered that, where CPs purchase terminating segments, then it would be appropriate to regard these as the focal product for any market definition and subsequent market power assessment.

4.198 We also set out our analysis of the competitive conditions for access and backhaul services and why we considered that a combined product market definition was appropriate.

Analysis of competitive conditions

4.199 We considered it likely that, in a number of geographic locations, competitive conditions for access and backhaul were similar. On this basis, there would be no need to analyse market power in the supply of access and backhaul separately as each CP would either self-supply terminating segments to compete in downstream

[308] In particular, we did not consider that it would be necessary to identify additional markets for access and backhaul for AI, TI and MI services (at different bandwidths). If the result of considering access and backhaul separately for each segment would be the same as assessing terminating segments together for each market) then there is limited benefit in doing so.

retail markets or otherwise it would purchase combined access and backhaul products from another operator.

4.200 To illustrate this, we considered a CPs' decision either to self-provide or rely on third-party supply of a wholesale circuit in order to deliver a service to an end-user. We said that, in leased lines markets, self-provision would typically be based on a CP having network sufficiently near to the prospective retail customer. If it was sufficiently close to a retail customer to efficiently build out to that retail customer then a CP would be in a position to supply any access and backhaul together. Therefore, it would be in a position in some competitive areas to self-supply a combined access and backhaul circuit (i.e. a terminating segment), which we might term: ("scenario 1"). [309]

4.201 In other scenarios (such as in rural locations), if a CP did not have fibre presence sufficiently near to the end-user then it would be reliant on wholesale inputs from a third-party. In non-competitive areas, it would need a terminating segment product from another operator in order to offer retail services ("scenario 2").

4.202 We concluded that, within both the geographic area where the CP self-provides the access link (and has backhaul presence) and the geographic area where the CP is entirely reliant on a third party for access and backhaul, competitive conditions for access and backhaul would be similar. In one case there would be competition in both access and backhaul, in the other there would not be competition in either.

4.203 This left a single scenario ("scenario 3") where access and backhaul might be supplied separately. This is where CPs had network presence and could self-supply backhaul, but where they could not self-supply access segments.

4.204 It is only in this latter scenario where the competitive conditions might vary significantly between access and backhaul segments (and only in particular geographic locations). Therefore, we wanted to understand whether the available evidence suggested that the number of instances where backhaul might be supplied competitively (per scenario 3). If there was strong evidence that CPs were in a position to self-supply backhaul to a significant extent then it would suggest that competitive conditions (between access and backhaul) were unlikely to be broadly similar. This in turn would justify separate access and backhaul markets.

4.205 To answer the question whether there were separate access and backhaul markets, we focused our analysis on the situations where competitive backhaul was possible. To inform this assessment, we focused on CPs' interconnections at BT's network nodes (such as BT's local serving exchanges), as these were common points where CPs could co-locate and interconnect (both with BT and with each other). Therefore, our analysis focused on:

- *OCPs' fibre presence at local serving exchanges:* we considered OCPs' fibre presence at local exchanges as an indicator of the *potential* for an OCP to self-supply or offer competitive wholesale backhaul services (discussed further below based on data presented in Figure 4.4);

- *OCPs' purchases of separate access and backhaul:* we considered evidence on CPs purchases of access and backhaul products (including disaggregated products) from BT and OCPs; and

[309] In the June BCMR Consultation, we did not label the various competitive scenarios. However, we have done so in this part to aid our description and subsequent discussion.

- *Converged backhaul assessment:* we also assessed whether any changes likely in the timeframe of this review might increase (or reduce) the scope for competitive backhaul to emerge. We considered in particular the scope for the emergence of converged backhaul markets and the implications of this for our market definition.[310]

4.206 Our analysis therefore looked at whether there were *sufficient* numbers of wholesale providers able and willing to purchase access and/or backhaul separately and whether there were a sufficient number of providers able to offer competitive backhaul.

4.207 As there had been limited developments in TI networks reflecting the maturity of the technology and limited incentives for further investment (in light of the continued declines in the end-user base), we focused our analysis of competitive backhaul on AI markets. In general, for AI markets, our preliminary findings were that there was no strong evidence of significant purchases of access and backhaul on a separate basis (they continued to be purchased together). We considered also that there remained barriers to competitive backhaul including on a forward looking basis. We believed that competitive conditions were sufficiently similar, in general, for us to continue to combine access and backhaul in AISBO markets and TISBO markets.

OCPs' fibre presence at local serving exchanges

4.208 We assessed whether OCPs had their own fibre network near to or at BT's local exchange access nodes in order to pick up access circuits from BT. The greater the extent of alternative networks (e.g. at local exchanges) the greater the scope for self-provision of backhaul circuits. We assessed whether in fact CPs had network presence at access nodes close to end-users. If there was strong evidence of network presence and an ability for CPs to self-supply that was greater than applies for access segments, then we considered that this might indicate widespread differences in conditions for competition in backhaul (as opposed to access).

4.209 In the June BCMR Consultation (Table 20, reproduced as Figure 4.4 below), we presented available evidence on operator interconnection for each of the main levels in the BT network hierarchy and in particular for its metro nodes (part of its "core" network) and the lower tier Access Serving Nodes (ASNs) and local exchanges.[311]

4.210 For our assessment of connectivity at nodes and local exchanges we relied on information obtained from BT on its sales of 'external cable-link' circuits. BT told us that these circuits were used to connect services delivered to BT's exchanges to external fibre not owned by BT. We considered that the extent of cable link sales was a potential indicator that either:

[310] *Converged backhaul* would entail a communications provider (CP) using a single wholesale product to carry a number of different types (or even all) of its traffic between two end points, irrespective of the retail service from which that traffic is derived. The greater the opportunity to converge this traffic the greater might be the opportunity to generate sufficient economies of scale and scope to enable CPs to competitively supply their own backhaul.

[311] We note that in analysing this interconnection evidence that we have looked primarily at interconnection at local exchanges and other BT network nodes. We recognise there are other forms of interconnection, but we note that a CP's ability to purchase access separately and to self-supply backhaul is largely governed by where it has decided to interconnect with other CPs. By definition this is likely to be centred around key network hubs that emerged through time, which in the main are BT's core nodes and its local exchanges. Therefore, we think that it is important to focus on these key networks points.

- an OCP was either able to self-supply fibre at that location (i.e. the external cable link circuit was interconnected into an OCPs' own network); or
- it was purchasing backhaul from a third party provider.

4.211 For each level in BT's network, we showed: (i) the total number of BT nodes (ii) the number of those nodes where CPs buy cable link; and (iii) the average number of CPs at those locations where at least one CP was interconnected. If there were a high proportion of local exchanges where CPs were buying backhaul and a large average number of CPs at each location then we felt that this would *potentially* suggest that competitive supply of backhaul was widespread.

Figure 4.4: Implied operator co-location at different BT network nodes[312]

Network level	Number of nodes	Number of nodes where CPs interconnect with BT (based on Cable Link External purchases)	Average number of CPs buying Cable Link External
Metro node	107	102	4
Openreach handover points	56	56	3
Tier 1 nodes	67	67	4
Local exchanges	5,600	1,228	2

Source: Ofcom 2012, BT S135 data

4.212 Looking first at BT's main network nodes (for Ethernet these included: Metronodes and Openreach Handover Points and for SDH/PDH: Tier 1 nodes) we noted that there was extensive CP presence at the majority of these major nodes. The Openreach Handover Points and Tier 1 nodes were covered on average by more than two CPs. In general, we would expect fairly extensive CP presence as many CPs have core or trunk networks linked to BT's major nodes (potentially indicating that CPs were reliant on BT or other CPs for terminating segments from these network points).

4.213 We also looked for BT network nodes and local exchanges where there was evidence of OCP fibre being used to self-supply backhaul. We found that there was at least one operator purchasing an external cable link at just over 20% of BT's local exchanges (Figure 4.4 above shows this to be the case at 1,228 out of 5,600 local exchanges). This suggested that the extent of OCPs' self-supply of backhaul (or purchase backhaul from another provider) could be material. Across the 1,228 exchanges where external cables link were purchased, however, on average fewer than two OCPs were present (this was because in some cases an OCP might

[312] In Figure 4.4 (reproduced from the June BCMR Consultation), the 56 Openreach handover points relate to the 56 AI TANs.

purchase more than one cable link connection at a particular exchange). There were in fact a smaller number of exchanges (517) where two or more OCPs appeared to be present. This represented less than 10% of all of BT's local exchanges.

4.214 In many cases, it appeared that OCP presence (where they could provide competitive backhaul or were purchasing from another OCP) was concentrated in a handful of local exchanges. This evidence suggested that in most circumstances (i.e. apart from this handful of exchanges) backhaul would be supplied under similar competitive conditions to access. Moreover, while CP presence was one of the *necessary* conditions for infrastructure-based competition in backhaul, we considered that we needed to be cautious in concluding that the apparent presence of two or more OCPs was *sufficient* on its own to justify defining a separate backhaul market. For example, the OCP in question might have limited capacity at that location or the OCP might still rely on BT for resilient links from that local exchange (i.e. even if the OCP were self-supplying a circuit from that location, it might also have to purchase a second diverse route from a third-party).

4.215 We also considered wider evidence of OCPs' actual purchasing behaviour. This analysis focused on whether CPs presence at exchanges was having an impact on the access and backhaul products purchased from BT.

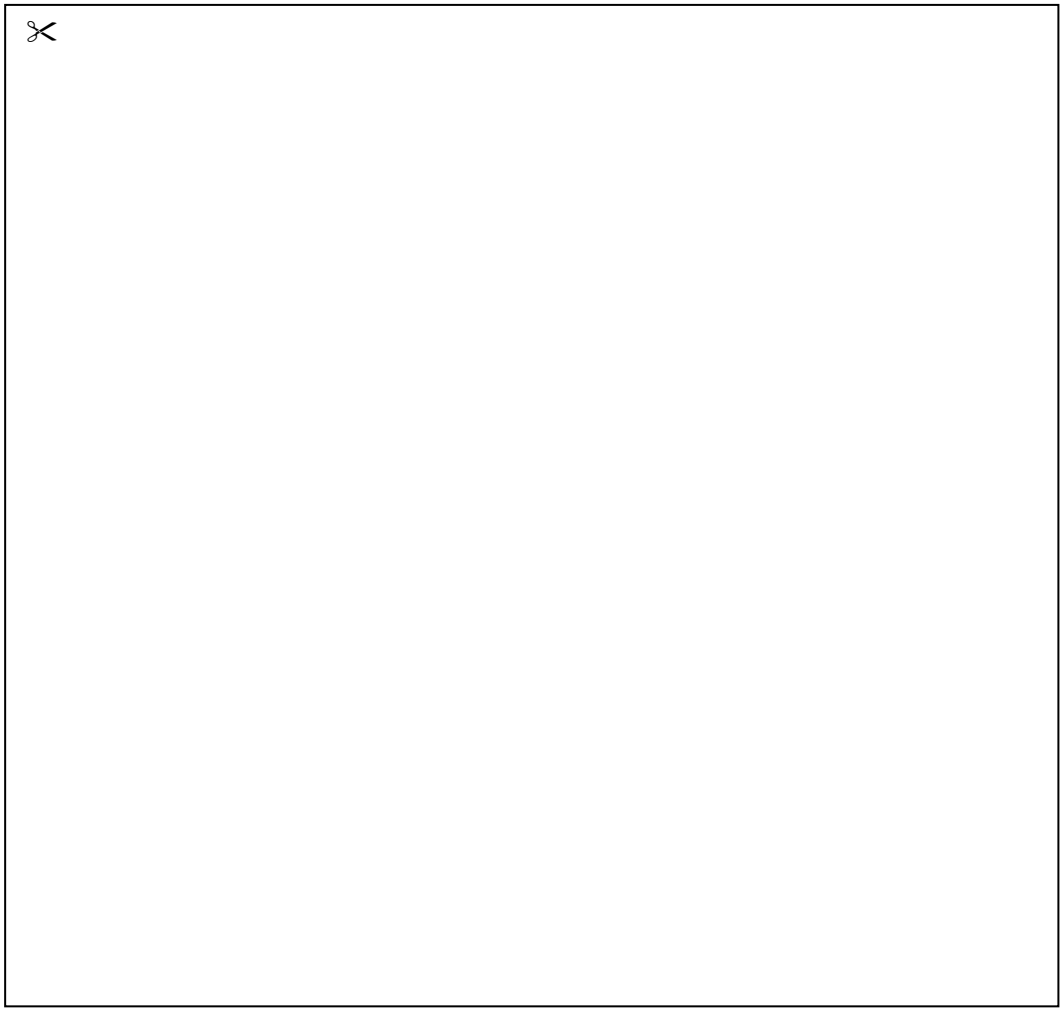
OCPs' purchases of separate access and backhaul

4.216 We found that some OCPs were interconnected with BT at local exchanges. In principle, this suggested that there could be some scope for competitive backhaul provision. If OCPs were using non-BT sources for backhaul, we expected to find that that, at those locations, OCPs were purchasing access services from BT (such as EAD LA) to use with their own backhaul, rather than purchasing that access service with an EBD service or purchasing EAD services to their point of presence.

4.217 We assessed the extent to which 'access only' products were sold to OCPs and whether the evidence suggested that OCPs were able to combine these access products with their own self-supplied backhaul (or purchases from third party suppliers). We considered in particular the take-up of 'access only' products relative to the take-up of 'combined' access and backhaul services.

4.218 We started by looking at a high-level at the overall sales of different products. We then looked in more detail at the purchasing behaviour of OCPs at the sub-set of local exchanges where there was apparently one or more CPs (as was suggested by the analysis of 'external cable link' reproduced in Figure 4.4 above).

[✂] Figure 4.5: BT's sales of Ethernet access and backhaul products



Source: Ofcom 2012, BT S135 data valid as at 31 March 2011

4.219 Figure 4.5 above, which is reproduced from the June BCMR Consultation, shows that [✂.]

4.220 We noted that WES and EAD type services would often include access and backhaul components to an OCP's POP, but that not all WES and EAD services necessarily included both an access and backhaul component. Therefore, even though the majority of Ethernet service purchases had been WES and EAD type services, it would not automatically have followed that we had a combined access and backhaul market. It would have been possible for an EAD, WES or WEES circuit in some cases not to include any backhaul. We noted two reasons why a circuit would not require backhaul:

- *Access only circuits:* in some cases the circuit might not require any backhaul (if the circuit was linking customer end points close to each other). But as these circuits types would not require a backhaul segment then they would not be relevant to our assessment of variations in competitive conditions between access and backhaul; or

- *Backhaul provided competitively from a CPs' POP:* it might be that a WES or EAD circuit was provided to a CP's own POP located close to the customer end-

point. In the latter case, it might be that a CP only required an access segment from BT (with backhaul self-supplied by the OCP).

4.221 We therefore conducted a more detailed analysis of the actual sales of WES, WEES and EAD type services and whether this indicated that access and backhaul were normally provided together. In particular, we considered BT's per circuit information on sales to major OCPs to estimate the proportion of circuits sold with access and backhaul components. We relied on geographic data associated with each circuit to estimate whether it contained both an access and backhaul segment. In particular, if both ends of a circuit started and ended in an area served by the same local exchange, we assumed the circuit was an "access-only" service. Likewise, if the end points of a circuit were in areas served by different local exchanges, we assumed that the circuit contained both access and backhaul elements.[313]

4.222 This analysis suggested that the majority of WES and EAD circuits (excluding LA variants) contained both an access and backhaul element. We estimated that 79% and 84% of EAD and WES circuits contained a backhaul element. Therefore, in the significant majority of cases, third parties were reliant on BT to provide terminating segments.

4.223 In this analysis, there were still a number of other circuits where providers were purchasing either separate access products (such as WESLA or EADLA) or backhaul only products. We estimated that around 12% of BT's external circuit sales were WESLA or EADLA variants. But even where BT was selling access tails such as EADLA our analysis did not suggest that significant numbers of CPs were self-supplying their own backhaul from BT's local exchanges. Therefore, the true extent to which an OCP only purchased an EAD LA circuit with no backhaul purchased from BT was likely to be lower than 12%.

4.224 The information on overall purchases by CPs of separate access and backhaul products and information on co-location suggested that the majority of CPs were reliant on combined access and backhaul services. Our analysis of overall purchases of access and backhaul circuits was therefore indicative of limited differences in competitive conditions for access and backhaul. This supported the definition of a combined access and backhaul product market.[314]

Competitive backhaul in specific geographic areas

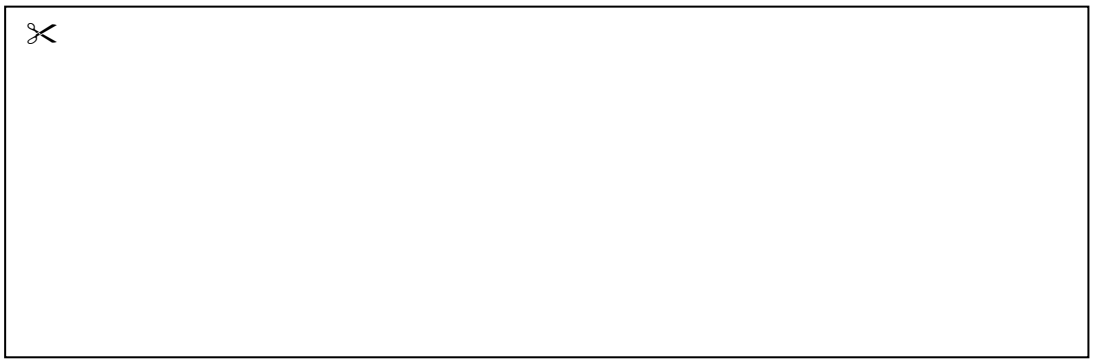
4.225 Nationally, the potential for competitive backhaul appeared limited. Nevertheless, in our analysis, we identified a sub-set of local exchanges where there was apparently quite concentrated OCP presence. In principle the scope for different competitive conditions by different geographic locations might be a reason to identify more than one separate geographic market. Although this analysis pre-empted somewhat our geographic market assessment, we considered it necessary to look at overall evidence of available competitive backhaul.

[313] As a further cross-check, we also looked at the distances of the circuits sold as a proxy for whether they might contain access and backhaul. Based on the s135 data, we calculated the average length of a circuit from a customer-end to the local exchange is approximately 1.5 km. This analysis suggested that the vast majority of wholesale circuits sold had circuit lengths beyond 1.5km and is consistent with the findings based on geographic data.

[314] We consider the implications of LLU backhaul for our product market definition in more detail under Issue 4b below where we discuss whether LLU backhaul is part of this product market.

4.226 In the June BCMR Consultation, we summarised the results of a number of key indicators of geographic variations in competitive backhaul. In our analysis, we focused on [✂] as these operators were LLU providers in a position to purchase separate backhaul products and were able to provide information on self-supply as well as the main suppliers of backhaul circuits. We considered that, if these providers relied to a significant extent on BT, then it would be unlikely that other CPs providing services to enterprise customers (i.e. those that needed end-to-end services with access and backhaul) would purchase significant volumes of backhaul separately to access circuits.

Figure 4.6: Analysis of main purchasers and sellers of separate backhaul products[315]



Source: Ofcom 2012, BT and OCP s.135 data

4.227 For these two LLU providers alone, BT accounted for [✂] of their backhaul circuit requirements. We considered that this evidence was consistent with our view that overall backhaul was not competitive in the vast majority of cases – with only a few local exchanges (fewer than [✂] of all local exchanges) where there could be competitive supply.

4.228 However, we noted that our analysis centred on LLU providers that had already invested in co-location. It was less clear that OCP presence at those exchanges would provide a material competitive constraint on BT's pricing of access and backhaul more generally. We observed, for example, that BT did not offer any specific geographic discounts in these locations (either aimed at LLU providers or purchasers of leased lines more generally). Furthermore, we noted that one of the LLU providers which purchased from OCPs at particular locations often also continued to purchase backhaul from BT at the same locations for resilience purposes.

Converged backhaul assessment

4.229 We said that another potential (and related) change which might alter the way in which access and backhaul were used on a forward-looking basis was the emergence of a converged backhaul market. We said that a converged backhaul market would arise if aggregated backhaul links were able to support demand from different traffic streams (i.e. supporting voice, leased lines and asymmetric broadband). This would allow an operator to achieve greater economies of scope and scale in backhaul segments and, in principle, this could alter the economics of provision of backhaul.[316] We considered that similar opportunities to converge traffic

[315] Data as at Q4 2010/11 (based on OCP's135 aggregate data on wholesale purchases).

[316] In relation to backhaul provision there is a higher upfront cost of investing in high capacity backhaul links on a prospective basis. This higher upfront investment is more likely to be commercially viable if a CP is able to

streams would not arise in access segments as they were dedicated connections to each end-user.

4.230 The conditions we identified for the emergence of a converged backhaul market included:

- the possibility that a CP could use a single backhaul product for all of its retail services e.g. leased lines, broadband, PSTN voice, mobile voice and mobile data;
- the use of the same links between access and end points for all types of traffic; and
- access and end points which were capable of handling different types of traffic simultaneously.[317]

4.231 However, we noted that, even if all the supply-side conditions for the provision of a converged backhaul product including co-location of nodes were met, it might still be that different services with different functional characteristics would be provided at different prices over the single converged backhaul links, and these would correspond to demand arising from different downstream services.

4.232 CP's responses to our formal S135 information request set out details of how they had configured their networks, the technologies used and the services supported over those technologies. Our assessment of this information was that there continued to be a split between the networks used to deliver TI and AI services. There was no reported use of circuit emulation or pseudo-wire solutions that would entail TI services being run over Ethernet.

4.233 However, there seemed to be stronger convergence of services onto the Ethernet platform in general. More retail business connectivity users were now served using Ethernet leased lines or VPNs (although there remained a substantial installed base of TI services). A number of other retail markets (i.e. other than leased lines markets) which had not previously been served using Ethernet circuits to backhaul traffic were also now doing so. For example, retail asymmetric broadband had often previously used ATM technologies for backhaul/core networks, whereas Ethernet had now become largely the technology of choice for backhauling asymmetric broadband traffic. Mobile operators were also in the process of moving their services to Ethernet.

4.234 We suggested that an implication of converged Ethernet backhaul could be that only the largest players (including BT) were able to fully exploit these economies of scope and scale. This might weaken rather than strengthen the scope for competitive backhaul and hence it would undermine the case for separate access and backhaul markets. For example, due to its large retail base, BT would be best placed to aggregate large amounts of traffic using converged backhaul, driving down its average backhaul costs. Therefore, potential competitors considering investment in infrastructure would have to overcome barriers associated with the ubiquity of BT's backhaul network, and increasingly also its lower backhaul costs. So this could potentially mean that CPs would only be able to reach the scale of traffic needed to

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leverage its traffic from a number of retail markets. For example, it might be possible for a CP that has unbundled a number of local exchanges to provide broadband services to residential customers and it can combine backhaul traffic from those customers with leased lines services.

[317] Where the converged backhaul product carries a number of different types of traffic, converged backhaul would require these three bullet points to apply for all of those multiple products.

achieve cost-competitiveness with BT in dense population centres and on only some of the routes between them.

4.235 We concluded that the current purchasing behaviour of CPs should be viewed against a background where convergence of different traffic streams over Ethernet was possible (e.g. LLU and leased lines backhaul). The available evidence suggested that this was not driving significant demand for disaggregated products or greater scope for CPs to self-supply. Given these economies of scale and scope this might lead some CPs to reduce the amount of self-supplied backhaul if they were unable to generate the same scale and scope as the largest players. Therefore, even though there may have been degree of convergence in the provision of backhaul we did not find evidence based on the available information that this had materially increased the level of competition for backhaul (relative to access segments).

Proposed conclusions

4.236 We proposed, in the June BCMR Consultation, to define:

- a combined access and backhaul product market on the basis of sufficiently similar competitive conditions for access and backhaul:
  - the evidence suggested that CP presence at local exchanges was not extensive;
  - there was limited evidence of CPs selling separate access and backhaul products, or demand for them; and
  - we did not see strong evidence of major purchasers of backhaul services making use of alternatives to BT.

4.237 We termed these combined access and backhaul services “symmetric broadband origination”. Consequently, and in light of our proposals under Issues 1 and 2, we proposed to identify (relevant) symmetric broadband origination product market(s) for AISBO, TISBO and MISBO respectively.

Responses to the June BCMR Consultation

4.238 Below, we summarise the points made by respondents which are relevant to whether there is a single market for access and backhaul or whether backhaul should be assessed separately (Issue 3), and explain how we have taken them into account in our assessment.

4.239 Four stakeholders (Virgin, TalkTalk, Telefónica and BT) that specifically commented on Issue 3 agreed that access and backhaul should not be classified as separate markets, though BT did not necessarily agree with all of our reasoning. Three other stakeholders with concerns over a combined market definition (CWW, Exponential-e and [✂]) highlighted differences in the nature of the competitive conditions for access and backhaul. In addition, Telefónica suggested that there was some potential for competitive backhaul provision in future but this was limited in practice.

4.240 BT noted the practical attraction of defining a combined access and backhaul market. BT argued that it sells dedicated capacity to its customers that could be used either as an access or backhaul segment making it difficult to classify circuits. It would be difficult to identify a dividing line between the two segments. It submitted that the terms access and backhaul are used in different ways by different CPs, making it

difficult from a practical point of view to identify separate markets which are a function of network topology. Hence, in BT's view we cannot identify an access segment on a common basis across each CP or market.

4.241 In relation to its concerns over our analysis, BT argued that our technical assessment assumed that access and backhaul are "concatenated segments" (i.e. segments that join together to form a combined service) and therefore by definition they are complements not substitutes. BT submitted that this finding is entirely endogenous to the definition of access and backhaul so it cannot be the basis for our market definition.

4.242 BT asserted that its local exchange locations (that we had used to inform access and backhaul) do not coincide with the locations where OCPs might aggregate traffic onto their own backhaul links. BT argued that the presence of BT's local exchanges is entirely coincidental and most CPs' network structures completely ignore them, or at best treat them as a 'customer' end point on their network. In effect, BT argued that the local exchange is largely irrelevant except in the case of LLU backhaul as CPs' networks will not feature a split at this point (i.e. local exchanges). If a CP connects a business customer directly, it will bypass BT completely for both access and backhaul. The point on a CPs' network at which it finds it efficient to aggregate access links onto backhaul infrastructure is unlikely to coincide with BT's local exchange locations (and will vary by CP and location).

4.243 [✂.]

4.244 [✂.]

4.245 [✂.]

4.246 Exponential-e disagreed with our proposal to combine access and backhaul in the same product markets. Exponential-e noted its response to the CFI where it had argued there is a marketplace for the three categories of Ethernet circuits that have different prospects for viable competition:

- Access circuits from business premises back to a BT exchanges: Exponential-e argued that these segments remain dominated by BT, with the vast majority of access circuit options only viable using Openreach infrastructure.

- Backhaul circuits from CP equipment located in BT exchanges to CP Points of Presence elsewhere: Exponential-e considered that the availability of non-BT backhaul infrastructure is becoming more prevalent in central London (but not all of WECLA), but UK wide backhaul is still dominated by Openreach (it considered that the sheer volume of Ethernet backhaul circuits that BT sells supported this view).

- Inter-Exchange connectivity to interconnect CP equipment located in different BT Exchanges: Exponential-e argued that this is a special form of backhaul subtly different to backhaul as described above. It noted that Ethernet solutions no longer only link back to a CP's core network but require "a partial mesh design" whereby circuits between local exchanges have become a substantial part of a CP's network. Exponential-e argued that, on a national basis, exchange to exchange connectivity is not competitive.

4.247 CWW argued that we should take into account the differences in the nature of supply by BT and OCPs. CWW was concerned that our analysis based on combined market

definition does not capture some of the specific differences relating to the demand and supply for access and backhaul. CWW noted that BT had built out a backhaul network primarily suited to its downstream activities to match the location of its aggregation nodes and not those of other CPs. It argued that the assessment of access and backhaul as a single market enables BT to mask differences in backhaul services provided for itself relative to the type of backhaul services CPs are likely to purchase.

4.248 CWW explained that in order to compete with BT at the wholesale level, operators have to overcome economies of scale and scope that BT enjoys in backhaul and can only do so at key locations. In this light major infrastructure players are refocusing their network presence at key BT local exchanges for the handover and aggregated backhaul of:

- LLU based inputs;
- EAD LA; and
- NGA and VULA.

4.249 CWW therefore argued that the natural points of aggregation for OCPs (given likely scale and scope they can achieve) will differ from BT's.

4.250 [✂] argued that there should be separate access and backhaul markets. [✂] noted that Ofcom comments in the June BCMR Consultation that CPs are likely to purchase access and backhaul together, but considered this was only generally true for TI products but less so for AI or MI services. [✂.]. [✂] also submitted that CPs face barriers to purchasing access and backhaul separately from BT as OCPs need to purchase an Access Locate space to combine and use AI circuits together within a BT exchange.

4.251 [✂] also expressed concern over our analysis of differences in competitive conditions between access and backhaul. It noted that, for our assessment of the degree of competition for backhaul, we had analysed the average number of CPs buying the external Cablelink product. [✂] considered that this approach was somewhat weak as it not take into account:

- a CP's ability to purchase (intra exchange) backhaul from the relevant BT network node on comparable routes available from BT; or
- whether in fact competitive backhaul is available from the CPs present.

Ofcom's view

4.252 We set out below why we consider it is appropriate to retain a combined market definition for access and backhaul. In the following paragraphs, we have focused our attention on arguments for separate access and backhaul markets based on differences in competitive conditions for AI services reflecting stakeholders' comments.[318]

4.253 We note that, in presenting the case for separate access and backhaul markets, a number of stakeholder comments focused specifically on the nature and availability

[318] Stakeholders advocating separate access and backhaul markets referred only to the developments in AI markets and either agreed (or did not object) to a combined access and backhaul definition for TI markets.

of BT's regulated wholesale services. In the context of our market definition, under the modified Greenfield approach, we need to consider competition in the absence of such regulated inputs. Therefore, we only consider points relevant to our product market definition issues below and we discuss the specific issues around the availability of appropriate regulatory remedies for BT's Ethernet services in Section 12.

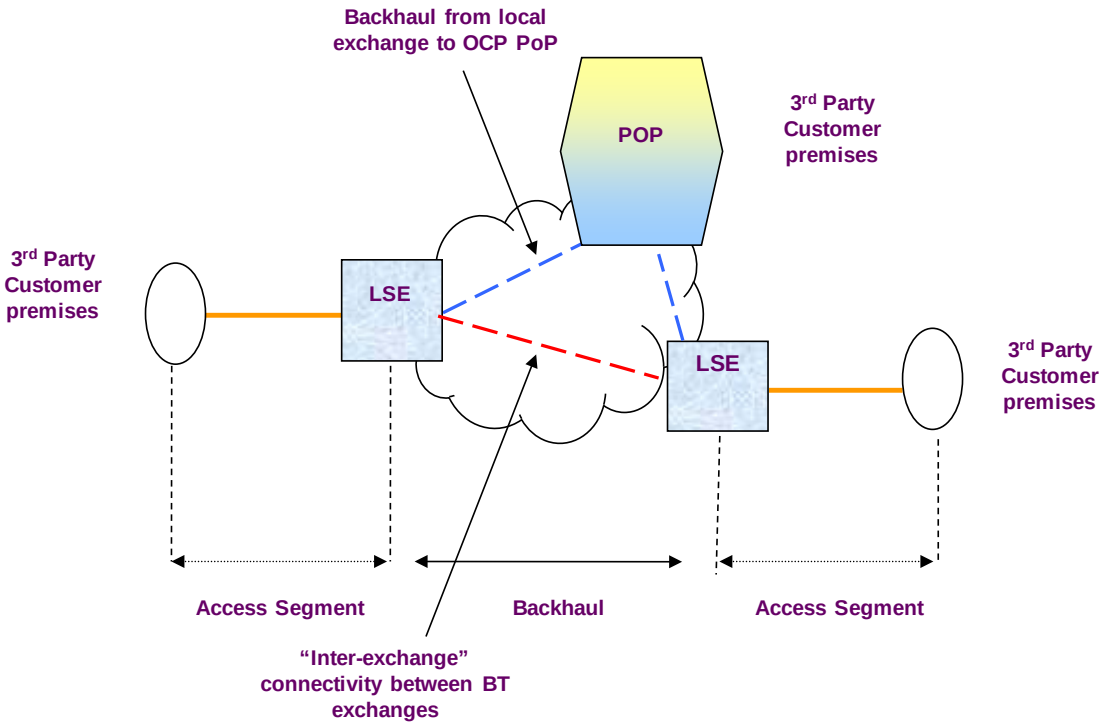
Consideration of different competitive conditions for access and backhaul

4.254 In the following section we consider arguments raised in particular by Exponential-e and CWW on differences in competitive conditions for access and backhaul. We conclude that these arguments do not undermine our conclusion that there are combined access and backhaul markets. Further, we explain that CWW's suggested approach is not an appropriate basis for defining separate access and backhaul markets. However, we have considered the points raised by both these parties further in our discussion of remedies for wholesale AI markets in Section 12.

Different competitive conditions for backhaul between exchanges

4.255 Exponential-e argued for a separate inter-exchange market, arguing that inter-exchange connectivity was less competitive than backhaul linking BT exchanges to an operator's own core network. It argued that non-BT backhaul was available in some areas such as central London (but not all of the London area), which suggests that it considers there to be a degree of competition for backhaul. It contrasted this with access segments (where it considered BT remained dominant nationally) and inter-exchange connectivity, which it again considered BT dominated. In Figure 4.7, we have shown the two categories of backhaul Exponential-e identified.

Figure 4.7: Illustrative diagram of backhaul and inter-exchange connectivity



4.256 Exponential-e asserted that there are distinct competitive conditions for backhaul circuits linking local exchanges (the red dotted line) and backhaul circuits linking back to an OCPs POP (the blue dotted lines). However, we do not consider that there are compelling reasons to treat these two types of backhaul differently.

4.257 First, there is a practical issue of distinguishing these circuits in some cases. This is because there will be a number of cases where a circuit could be used for either or both backhaul types. In Figure 4.7 above, we have depicted the CP's POP as a separate location to BT's local serving exchanges, so in this case it is easier to identify circuits that link BT exchanges and those that link a BT exchange to a CP's POP. However, in a number of cases, CPs have established interconnection at a BT exchange. In these circumstances there would be a degree of overlap in the definition as some circuits would fulfil the role of interexchange connectivity and backhaul to an OCP's POP.

4.258 In addition, we explained in the June BCMR Consultation below why we do not consider that there is scope for a separate and distinct inter-exchange connectivity market. In particular:

- we saw inter-exchange connectivity as a 'backhaul type' service;[319]
- we noted that the competitive conditions associated with the provision of 'inter-exchange' connectivity are unlikely to differ significantly from other forms of backhaul.

4.259 In relation to the latter point, in the June BCMR consultation we noted that the ability of CPs to provision backhaul between local exchanges and main network nodes is likely to coincide strongly with their network footprints, which in turn reflect aggregation opportunities. Therefore, we considered 'inter-exchange' connectivity to be a type of backhaul service and one for which the competitive conditions are likely to be similar to other forms of backhaul.

4.260 Exponential-e has not provided any firm evidence or reasoning to support the view that we should define a separate inter-exchange connectivity market. Indeed, when we consider the available evidence, it does not strongly support Exponential-e's arguments for separate inter-exchange connectivity markets. For example, if we consider the evidence on competitive conditions across the UK (as discussed in Section 5):

- we see that in high network reach areas[320] there is scope for competitive supply of both access and backhaul (e.g. in the WECLA).
- in the WECLA, we also observe that there are multiple providers with extensive network within reach of BT's local exchanges that could potentially provide competing inter-exchange connectivity (at least within those geographic areas).

[319] By definition, the main distinction between access and backhaul is that access links are typically dedicated to the end-user they serve reflecting limited aggregation opportunities. By contrast, backhaul is a product that might bring together a number of traffic streams (as the starting point for a backhaul circuit is often where the CPs can co-locate active equipment). It reflects the fundamentals of network design whereby CPs can combine individual circuits or traffic together and deliver them over more aggregated links where possible (and efficient) to do so. Therefore, inter-exchange connectivity is by definition likely to support multiple traffic between exchanges. On this basis, we consider inter-exchange connectivity to be more like a backhaul service (as the scope for aggregation is greater than for access segments).

[320] In our geographic market definition we identify high network reach areas based on locations where there is competing infrastructure from two or more CPs plus BT.

4.261 Therefore, we do not consider that the evidence of variations in competitive conditions would justify segmenting the market as Exponential-e suggests. Nevertheless, in light of our SMP findings in Section 7, we have taken into account the need for effective regulation of backhaul including inter-exchange connectivity in our design of regulatory remedies for AISBO markets.

The nature and scope of potential OCP backhaul provision

4.262 CWW argued that there is a risk that by defining a combined access and backhaul market we would mask differences between OCPs and BT (in terms of their ability to provide backhaul competitively).

4.263 We agree with CWW's view that what is likely to drive the competitive provision of backhaul relates to aggregation opportunities. In certain geographic areas with significant traffic concentrations and scope to supply different downstream markets, there is undoubtedly greater opportunity for aggregation of traffic streams and hence greater opportunities to realise economies of scale and scope needed in the competitive provision of backhaul. The need for sufficient scale is a fundamental driver for investment in backhaul (both for BT and OCPs).

4.264 So, at a general level, we agree with CWW's view that competition in backhaul is limited, which supports our decision to retain a combined product market. There is simply insufficient evidence that competitive backhaul has yet emerged, nor is there sufficient evidence that it will do so over the course of the three year review period.

4.265 CWW seems to suggest that there is some scope for competition in backhaul to emerge at some point in time over the course of the three year review period, but that this is limited to 1,000 or so BT exchanges for OCPs (although it did not provide specific details of the exchanges it thought were prospectively competitive). We do not consider it appropriate to identify separate access and backhaul product markets based on an analysis of the potential emergence of competitive backhaul in the absence of sufficient evidence. Such prospective analysis would involve, in our view, judgements subject to significant uncertainty as it would be reliant on, in particular:

- our view of the future scope of competitive deployment, including at specific exchanges ;
- detailed assumptions relating to deployment that may well vary by CP, geography and for each of the market segments (e.g. AI, TI, etc) being considered.

4.266 Consistent with the SMP Guidelines, our market definitions require an analysis of any available evidence of past market behaviour when assessing the future prospects of the relevant market.[321] In this respect, we consider it relevant that our analysis has not revealed evidence of the emergence of backhaul provision as an important stand alone wholesale product, or that competition from providers of backhaul as a stand alone wholesale product is playing a significant competitive role. Hence, our assessment, as informed by our analysis of existing market conditions, is that a competitive stand alone backhaul market will not emerge over the course of the three year review period.

4.267 CWW's comments on access and backhaul markets are not only about our approach to market definition. In particular, it was concerned that our market power assessment and our view on appropriate remedies for AISBO markets (taking into

[321] See, in this respect, paragraphs 27 and 35.

account any market power determination) should reflect the prospects (and limits) of competition going forward. We have therefore considered CWW's comments further in our discussion of remedies in Section 12.

Reliance on BT's network topology to define markets

4.268 BT had concerns about how we defined access and backhaul as it thought we placed undue reliance on its network topology in particular its local exchanges. BT considered that there was no reason to expect that BT's network points would coincide with the aggregation points where OCPs might aggregate their own access circuits onto their backhaul networks.

4.269 Related to BT's view that we defined access and backhaul only with reference to its local exchanges, BT was concerned that our finding that access and backhaul were likely to be complements rather than substitute services was "*endogenous*" to these definitions of access and backhaul. BT's argument was that we had defined access segments ending at a BT local exchange and backhaul starting at a local exchange to another network node. Given, in BT's view, that access segment was defined as always ending at the exchange and backhaul starting at the local exchange then there could be no 'overlap' in the two segments. Hence, with no 'overlap' possible between the two segments, this would always result in the two services as complements and there would be no scope for assessing substitution between access and backhaul (i.e. CPs providing proportionally more backhaul (i.e. shorter access segments) and vice versa)).

4.270 We do not consider that BT's concerns have practical significance. First, in relation to its concerns that we found access and backhaul to be complements rather than substitutes, BT's comment suggests that CPs might vary the relative amounts of access and backhaul and use more of one and less of the other (or vice versa) by changing the point at which traffic is first aggregated. According to BT, in this sense, there may be some limited scope for substitution between them. We consider that this is unlikely to be a major source of constraint on pricing of backhaul, but to the extent that it was a material constraint it would tend to point to a single market for access and backhaul, consistent with our conclusion.

4.271 Second, in relation to BT's concerns regarding network topology, BT's own conclusion in its response is that the nature of both access and backhaul is context specific (e.g. it varies by geography and CP) such that it would suggest combining the two services on practicality grounds.

4.272 In any case, we do not agree with BT's view that access and backhaul were defined only with reference to the BT network. For example, in discussing access and backhaul markets in the June BCMR consultation, we have recognised the complexity associated with defining access and backhaul services. We noted that our backhaul definition would generally refer to circuits either between a local exchange to a trunk network node or between local exchanges. But we also recognised that in practice the distinction between access and backhaul is more fluid and complex and will vary depending on the distribution of customer, topographical and commercial considerations.[322]

[322] Footnote 190 of the June BCMR Consultation.

4.273 Our assessment of competitive conditions was based on the general differences between access and backhaul [323] as well as evidence on CPs' purchasing patterns for these services. BT is historically the largest provider of access and backhaul services and we considered the evidence of differences in access and backhaul competition based on purchases of BT's services. Therefore, to assess the markets, we needed to consider access and backhaul with reference to BT's network to some extent.

4.274 In this context of assessing variations in competitive conditions, where CPs do not make use of BT at all and are able to by-pass BT's network entirely, then this is consistent with those CPs providing a competitive constraint for combined access and backhaul services. We have taken those constraints into account in our market power assessment but they do not suggest defining separate markets for access and backhaul.

Criticism of our analysis of competitive backhaul

4.275 [✂] highlighted that there were difficulties associated with purchasing access and backhaul together. It explained that this was related to the need for a CP purchasing a separate access segment from BT to invest in space at a BT exchange to link together access circuits purchased from BT to a backhaul circuit also purchased from BT. [✂] suggested that this generated a barrier to OCPs using separate access and backhaul markets (and by implication BT who located at its local exchanges so it was in a position to benefit from separate access and backhaul products). [✂] also made a number of comments on how effective the EOI obligations that are applied to AI services are working. We do not consider that [✂] comments suggest however that backhaul is competitive. They seem more focused on the effectiveness of ex-regulation which is a point we have considered in Section 12 in relation to AI remedies.

4.276 [✂] also raised some concerns over our assessment of competitive conditions at BT exchanges based on OCPs' purchases of external cable links. We do not consider, however, that [✂] concerns undermine our view that we should define a combined market. In particular, we did not consider that evidence we consider of OCP presence (based on information on their purchases of external cable link services in Figure 4.4) would necessarily translate into competitive provision of backhaul services. Indeed, reflecting these comments we went on to look at wider evidence of competitive backhaul provision (Figures 4.5 and 4.6). Our conclusion in the light of this evidence is that the extent of competitive backhaul available from OCPs does not support separate markets. [✂] does not provide evidence that suggests that we should come to an alternative view.

Conclusion

4.277 Our conclusion is that we retain our proposals for combined access and backhaul product markets. Consistent with our proposals in the June BCMR Consultation:

- we consider that there is a combined market on the basis of sufficiently similar competitive conditions for access and backhaul;

[323] At paragraphs 4.182 to 4.183 of the June BCMR Consultation, we highlighted that the main distinction between access and backhaul is that access links are typically dedicated to the end-user they serve reflecting limited aggregation opportunities. By contrast, backhaul is a product that might bring together a number of traffic streams (as the starting point for a backhaul circuit is often where the CPs can co-locate active equipment).

- there is evidence of CP presence at some local exchanges (but it is not extensive);
- demand for separate access and backhaul remains relatively nascent as the evidence suggests that CPs' on sales and purchases of separate access and backhaul products remain limited overall; and
- we do not see strong evidence of major purchasers of backhaul services making use of alternatives to BT.

4.278 Stakeholders' responses have not provided evidence of significant variations in competitive conditions to support an alternative product market definition. Therefore, on the basis of the above analysis, we have concluded it remains appropriate to define a combined product market for access and backhaul.

Issue 4: Symmetric broadband origination as an input to other retail services

Our proposals in the June BCMR Consultation

4.279 In the June BCMR Consultation, we noted that leased lines or technically similar circuits could be used to deliver retail services that fell outside of retail leased lines markets. We noted that mobile network operators connected most of their radio base stations to their switching centres using leased lines from other CPs. Similarly, we observed that most operators of broadband services relied on leased lines to backhaul broadband traffic from BT's exchanges (where they have co-location equipment to aggregate unbundled local loops) to their core networks.

4.280 We considered whether there were particular features of the demand for mobile or LLU backhaul that would justify identifying separate wholesale product markets for these services.

4.281 We structured our analysis of Issue 4 as follows:

i) Issue 4a: Leased line backhaul services to mobile operators and microwave links;

ii) Issue 4b: Backhaul services to LLU providers; and

iii) Issue 4c: Leased lines used as inputs to other services such as CCTV, broadcast and other niche applications.

4.282 We analysed whether leased lines used to serve these other retail markets fell within either or both of the AISBO and TISBO markets. Our proposal was to include mobile backhaul in the relevant AISBO and TISBO product markets and LLU backhaul in the relevant AISBO market. We considered that provision of leased lines to other services such as CCTV, broadcast and other niche applications fell outside of these markets.

4.283 In considering each of the above issues we noted that the our previous discussion of substitutability in retail markets (which informed our analysis of indirect constraints at the wholesale level) would not be relevant as RBS and LLU backhaul serve different retail markets from other TISBO and AISBO circuits.

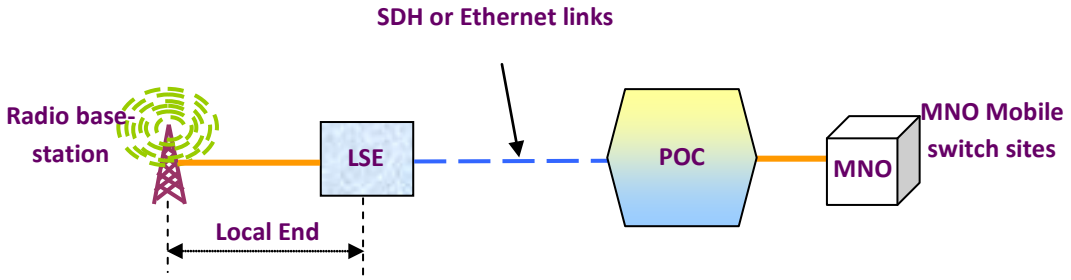
4.284 We note that BT also commented in its response to the June BCMR consultation that we did not include an assessment of leased lines used as inputs to various other

retail services such as VPNs. BT was concerned, in particular, of the impact this had on our subsequent measurement of circuit/end counts (used to calculate market shares). We do not agree with this point, as set out in paragraph 3.86 of the June BCMR consultation where we highlighted that we had *"made sure that any demand for wholesale TI and AI circuits arising from retail VPNs is taken into account when assessing wholesale market shares for our SMP assessment."* Therefore, we have considered relevant demand from other retail services in our assessment of wholesale markets (we discuss our approach to estimating wholesale service shares in more detail in Annex 5).

Issue 4a: Mobile backhaul

4.285 We defined mobile backhaul as the network connectivity between mobile network operators' (MNOs) 2G and 3G radio base stations and their core network.[324]

Figure 4.8: Mobile backhaul



Source: Ofcom 2012

4.286 We explained that the radio base stations (RBS) and the controllers such as MNO mobile switching centres were typically located at different physical sites and mobile backhaul provided transmission capacity between these two sites. This mobile backhaul might include a local end from the RBS site back to a local exchange and additional connectivity from a local exchange to a point of connection (POC) with the MNOs mobile switch site. In some cases, the traffic from multiple RBS sites was aggregated at one RBS site (a hub) before being transported to the controller site ("switch site"). These links joining RBS sites are also included within the definition of mobile backhaul.[325] The core mobile network connectivity between switch sites (for example MSC-MSC connectivity) was not included within the scope of mobile backhaul for market definition purposes (as this is more like a trunk or core network).

4.287 When discussing mobile backhaul, we used the term 'RBS backhaul' specifically to refer to mobile backhaul provided over SDH links. This was consistent with the use of 'RBS backhaul' term historically (for example BT used this as a product term for SDH-based leased lines sold to MNOs). When we referred to mobile backhaul over Ethernet links, we used the term mobile Ethernet backhaul.

4.288 We assessed whether mobile backhaul services provided using different technologies (i.e. RBS backhaul and mobile Ethernet backhaul) fell within the respective AISBO or TISBO markets or in separate mobile backhaul market(s). We

[324] In future this will also include 4G-enabled base stations, although the precise timing of LTE deployment is currently uncertain.

[325] In some cases, the radio base station controllers are located at a remote site, i.e. a site which does not have other switches such as MSC/MGWs and SGSNs/GGSNs. The network connectivity between such remote sites and switches are also included within the mobile backhaul definition used in this document.

proposed that mobile Ethernet and RBS backhaul be included in AISBO and TISBO markets respectively.

4.289 We considered the implications for our market definition of recent developments in the market, particularly MNOs' growing interest in purchasing higher capacity Ethernet backhaul links. Given these developments, we considered the implications of the growth in demand for Ethernet mobile backhaul in addition to the continued use of more traditional technologies such as SDH/PDH using RBS backhaul circuits. We also discussed the use of microwave links.[326]

4.290 For each of the technologies, we considered the following:

- *Technical assessment:* we considered whether any technical requirements existed for mobile backhaul using SDH/PDH or Ethernet equipment (in particular synchronisation requirements) that might differ from demand for typical leased lines uses;

- *Demand and supply-side substitution:* in the light of specific technical requirements for MNO backhaul, we considered whether any demand or supply-side substitution opportunities existed between, on the one hand AISBO and TISBO services, and on the other, mobile backhaul services; and

- *Analysis of competitive conditions:* we assessed whether any differences in mobile network connectivity requirements suggested that competitive conditions for mobile backhaul differed from those for other TISBO and AISBO services.

Technical assessment

4.291 We considered the specific technical requirements for mobile backhaul using either SDH/PDH or Ethernet equipment. We also discussed the underlying trends in mobile backhaul demand likely in the next three years or so, based on discussions we had had with MNOs.

4.292 One of the key trends we identified was the significant growth in mobile data demand. In Ofcom's Communications Market Report 2011,[327] we noted the increasing take-up of powerful mobile devices, the availability of fast mobile networks and the ever-growing availability of internet applications and services (many of which were mobile-specific). We noted that these factors were driving consumers to download and upload an increasing quantity of data on handsets, datacards and dongles. We noted that monthly data traffic per mobile connection in the UK increased by 108% between December 2009 and December 2010 alone. We expected that this growth trend would continue (or even to accelerate).

[326]The use of WDM in mobile networks is limited to core network connectivity in most instances. However, in a minority of cases WDM is used for backhauling traffic from radio base station controllers to core network nodes. In these instances, MNOs purchase dark fibre from other providers and manage the network connectivity using their WDM infrastructure. WDM based backhaul is unlikely to be used to a significant extent for mobile backhaul purposes because of the relatively low bandwidth requirements across most backhaul links. There is some uncertainty about future bandwidth requirements over backhaul with growing usage of data services on user devices and future roll-out of advanced 4G mobile technologies. We have nevertheless confined our analysis of mobile backhaul demand relative to AISBO and TISBO circuits at 1Gbit/s and below.

[327] http://stakeholders.ofcom.org.uk/market-data-research/market-data/communications-market-reports/cmr11/international/6.11

4.293 We said that MNOs were planning to respond to this data growth by upgrading their networks to the next generation of mobile technologies (4G/LTE) and installing higher capacity fibre-based links.

4.294 We noted that 4G mobile technologies support much faster download (and upload) speeds. Unlike previous generation networks such as 2G (or 3G), 4G networks were packet switched *only.* This was important to MNOs' choice of leased lines technology, as Ethernet was seen by mobile operators as particularly suitable for 4G applications. We said that the roll-out of 4G technologies was expected to occur in the timeframe of this review.

4.295 In addition, we observed that the growth in mobile data and expected 4G deployments was driving MNOs to deploy much higher capacity Ethernet backhaul links to a large number of their RBS sites. From our discussions with MNOs, we were not aware of any firm plans for mobile backhaul capacity at the densest locations in excess of 1Gbit/s (within the timeframe of this review). MNOs expected that there could be a number of sites in more rural locations where they would continue to meet forecast data requirements over existing capacity in the near term.

Mobile backhaul using SDH/PDH

4.296 We noted that mobile backhaul connectivity was currently, in the vast majority of cases, provided over SDH links. This transmission capacity could be provided over various media: microwave, copper or fibre. Self-provided microwave links were also sometimes used for RBS to RBS connectivity (typically at the edge of the network); with mobile operators typically purchasing wholesale links (over fibre or copper) for RBS site to switch site connectivity. However, as demand for data had grown, MNOs had begun to deploy Ethernet transmission links to their RBS sites to carry the increasing traffic generated at those sites.

4.297 Reflecting past availability and bandwidth and synchronisation requirements, mobile operators had tended to use digital PDH/SDH symmetric transmission over fibre and copper for their mobile backhaul. We said that these links typically carried backhaul traffic as E1 (2Mbit/s) or STM-1 (155Mbit/s) frames. The lower bandwidth 2Mbit/s links were predominantly used for connectivity between RBS sites back to BSC/RNC and the higher bandwidth 155Mbit/s links were typically used in MNOs' core networks and in some cases as high capacity links to backhaul traffic from a "hub" site that served a number of base stations.

4.298 We noted that the technical characteristics of RBS backhaul links did not differ from the SDH/PDH links used for other applications (e.g. in fixed networks). Both PDH and SDH were internationally agreed standards that were supported by network equipment vendors. Therefore, we did not consider that there was a basis (on technology grounds) to distinguish between demand for RBS backhaul and other forms of TISBO services.

Ethernet mobile backhaul

4.299 MNOs told us that they were beginning (or planning) to deploy Ethernet mobile backhaul. The main drivers of this Ethernet deployment were: its cost effectiveness in meeting the significant growth in data requirements of mobile networks; and its suitability for future 4G mobile networks.[328]

[328]For example, in Section 3, we show that BT's charges for 155Mbit/s PPCs are around three to four times that of 1Gbit/s Ethernet links.

4.300 We identified one of the challenges faced by MNOs in introducing Ethernet backhaul as the need to provide synchronisation information at RBS sites, a requirement arising from the need to manage customer mobility between cells.[329] Generic carrier Ethernet products would generally not meet the needs of mobile backhaul in all circumstances given the strict latency and jitter performance requirements. In principle, this suggested that Ethernet demanded for mobile backhaul would be a different type of product compared to generic Ethernet (e.g. Ethernet used by business leased lines customers) [330] due to the specific requirements of mobile backhaul including strict synchronisation. By contrast, synchronisation is inherent in RBS backhaul services as these services are based on TDM, which provides a common clock-source[331] to each cell site. We were aware that a number of MNOs that had deployed Ethernet had (as a transitional arrangement) retained 2Mbit/s TDM circuits for synchronisation purposes.

4.301 We noted that the Ethernet standards deployed in most carriers' networks did not support the particular requirements for synchronisation at base stations. Providers of mobile Ethernet backhaul were in the process of bringing synchronised Ethernet backhaul to the market to address the specific synchronisation requirements of mobile backhaul. Some stakeholders told us that they had already deployed in the UK a particular type of synchronisation over Ethernet backhaul known as IEEE1588.[332] The main alternative synchronisation method is known as Synchronous Ethernet (SyncE).[333,334]

4.302 We explained that SyncE was based on a well established SONET/SDH synchronisation model and therefore there were no standardisation constraints that prevent its adoption. But, to allow synchronisation between the base station and a reference clock-source, SyncE requires all intermediate network nodes to be SyncE compliant. We understood that Openreach was engaged with industry in developing a SyncE configuration that it expected would meet all its customer needs. [335]

4.303 In the absence of fully deployed Ethernet solutions that would support synchronisation, many MNOs that already had Ethernet backhaul to their RBS sites

[329]Accurate synchronisation of base stations to nanosecond accuracy is critical to minimise service disruptions and eliminate dropped connections as calls move between adjacent cells. Highly accurate frequency synchronisation also ensures that the radio spectrum is not spread into the adjacent channels. Without accurate synchronisation, the mobile technologies will not work to specifications, resulting in failed call setups, releases, handovers, and other network issues. For further discussion see:

http://www.ixiacom.com/pdfs/library/white_papers/MEF-MBH_Synch_HaughHirdRam-Draft_101208_1725_1.pdf

[330]Although synchronisation over Ethernet may also be required for non-mobile applications, mobile backhaul is currently the market driver for products that provide synchronisation over Ethernet.

[331]Telecoms networks rely on a hierarchical structure to deliver accurate timings. The hierarchy comprises a master or Primary Reference Clock (PRC) and the timing information from the PRC is distributed to Slave Clocks that reside at relevant points in the network. These master and slave clocks provide timing outputs for the rest of the network equipment to use. TDM and SDH-based systems, such as the RBS backhaul product, are designed in such way to natively propagate the clock signal from the PRC to the all the network nodes.

[332]CWW mentioned at the 31st October 2011 meeting with Ofcom that it provides an IEEE1588-based synchronisation solution for the mobile Ethernet backhaul solutions it supplies to Vodafone.

[333] Virgin recently announced that it would supply a SyncE solution to MBNL.

[334] ADVA (one of BT's equipment suppliers) told us that it will support both interfaces as MNOs are likely to use both for synchronisation and timing purposes.

[335] In the June BCMR Consultation, BT indicated to us that it was also planning to bring SyncE service to the market from 2012. However, in January 2013, BT announced that it has decided to delay launch of its SyncE product citing uncertainty about near-term demand. Hence, at the time of publishing this Statement, BT does not currently have immediate plans to launch a SyncE service.

predominantly used the Managed Ethernet Access Solution (MEAS) supplied by BT Wholesale. We said that BT had deployed an interim solution in its Ethernet product MEAS which uses 'Pseudowire' technology. This enables 2Mbit/s TDM circuits to be emulated over Ethernet connections in order to deliver synchronisation. However, this was seen as a short term solution pending the deployment of the more efficient synchronisation standards described above.

4.304 We summarised the position as follows. The general technical requirements for mobile backhaul (in particular synchronisation requirements) could be met by existing TI circuits. As demand for mobile backhaul bandwidth increased, MNOs would look to move to more cost effective Ethernet solutions (in terms of cost per Mbit) driven by increased mobile data demand from end-users and to support their next generation networks (4G/LTE). But the technical requirements of operating mobile networks would mean that MNOs would need to retain the capability for synchronous backhaul solutions that are inherent in TI technologies. Two different Ethernet standards known as Synch-E and IEEE 1588 had been developed to meet synchronisation requirements. In principle, these technical requirements to support synchronisation functions for mobile operators were different to those of enterprise customers (using existing Ethernet solutions).

4.305 In our demand and supply-side substitution analysis, we considered whether these differences in technical requirements for mobile backhaul would be significant enough to identify Ethernet mobile backhaul as a separate market to standard Ethernet services. Our proposed conclusion was that the differences were not sufficiently material to justify for separate identification of a separate market, and that Ethernet mobile and RBS backhaul be included in AISBO and TISBO markets respectively.

Demand and supply-side substitution

4.306 Having considered any differences in the technical requirements for mobile backhaul circuits compared to typical AISBO and TISBO circuits, we considered any evidence on the potential for demand and supply-side substitution between TISBO and RBS backhaul and AISBO and Ethernet mobile backhaul. In particular, we considered whether a hypothetical monopolist would find a SSNIP on RBS backhaul services unprofitable due to demand or supply-side substitution to TISBO (or vice versa). We then considered a similar question with respect to AISBO and mobile Ethernet backhaul. Finally, we considered substitution between RBS backhaul and mobile Ethernet backhaul.

TISBO versus RBS backhaul

4.307 We noted that RBS backhaul and TISBO relied on the same underlying inputs and that therefore the cost of providing these services should be the same. As there was also no technological distinction between SDH/PDH mobile backhaul and other forms of TISBO services, we concluded that it should be possible, technically, to use a TISBO service to deliver RBS backhaul (or vice versa). Therefore, a SSNIP imposed on RBS should be constrained by switching to TISBO services (or vice versa).

AISBO versus Ethernet mobile backhaul

4.308 We noted that, on the demand-side, the nature of mobile backhaul provision suggested a strong requirement for synchronised Ethernet. To provide mobile backhaul, BT essentially relied on the same wholesale inputs (e.g. EAD services) used to provide Ethernet leased lines and LLU backhaul. However, technically, a

standard AISBO service would not be a direct substitute for a synchronous Ethernet service as it would not be provided with the necessary clock source. As such, substitution to a 'standard' AISBO service would not be sufficient to make a SSNIP on mobile (synchronous) Ethernet unprofitable.

4.309 We reported that equipment vendors (such as ADVA and Cisco) had told us that there were no significant technical barriers to CPs accessing the equipment to support synchronous Ethernet (based on the 'state of the art' equipment). For example, our understanding that current generation Ethernet products used by BT (supplied by ADVA) and available to other CPs were ready to support synchronous Ethernet "out of the box". We saw this as an important point, as it suggested that synchronisation methods such as SyncE and 1588 would become essentially standard features of carrier Ethernet services over the next few years.

4.310 That being the case, as new Ethernet equipment was deployed, these synchronisation methods would be part of the standard Ethernet product. So in future it would, in principle, be difficult to draw a distinction between synchronised Ethernet and ordinary carrier Ethernet (i.e. a similar situation to TI where there is essentially no difference between PPCs and RBS circuits). This would tend to undermine the distinction between mobile Ethernet and AISBO services.

Supply-side substitution

4.311 We explained that, if CPs supplying AISBO services could easily enter the market for mobile Ethernet backhaul, then supply-side substitution could be relevant to our market definition (i.e. it could justify the inclusion of mobile Ethernet backhaul in the AISBO market).

4.312 We considered whether CPs' requirement for access to a clock-source could be an obstacle to the supply of synchronous mobile Ethernet backhaul (for a supplier with Ethernet equipment capable of supporting synchronous Ethernet). In principle, a CP currently providing TDM-based circuits (including to mobile operators) would have its own access to a clock source, so there would be no specific technological barrier to providing synchronised Ethernet circuits. We said that the fact that providers of AISBO services such as Virgin were shortly to begin supplying a synchronous Ethernet product suggested that there were no major technical hurdles to providing synchronous services.

4.313 Our analysis suggested that the requirements for synchronous Ethernet could be achieved using available Ethernet equipment. While this was likely to add an additional cost to Ethernet equipment (so that the equipment supported synchronous capability), this was unlikely to be a significant proportion of the cost of deployment (relative to the costs of installing fibre and Ethernet equipment). [336]

4.314 In summary, we considered that there was a strong case based on demand-side substitution to include RBS backhaul services in the TISBO market. For mobile Ethernet backhaul and AISBO, we considered that demand-side substitution was likely to increase as synchronised Ethernet became standard. We observed that CPs currently supplying AISBO services had entered the mobile Ethernet market and

[336] If there were a significant premium associated with synchronous Ethernet then it may be that CPs would seek to avoid the equipment costs of this feature for end-users that do not generally need it. We do not have detailed information on the likely costs, but from informal discussions with vendors, we do not consider that the costs of SyncE would be sufficiently large that a hypothetical monopolist would be able profitably sustain a price increase of 10% on 'standard' Ethernet.

were starting to provide mobile Ethernet backhaul solutions. This suggested that supply-side substitution could also provide a relevant constraint.

Synchronous Ethernet versus RBS backhaul

4.315 As well as considering the arguments for including RBS backhaul in the TISBO product market, and mobile Ethernet backhaul in the AISBO product market, we also considered whether technical similarities might point to a combined mobile backhaul market (i.e. the inclusion of RBS backhaul and mobile Ethernet backhaul in a separate mobile backhaul market). We noted that MNOs' requirements for synchronisation were quite similar for RBS backhaul and mobile Ethernet backhaul. However, we did not consider that this alone would justify a combined "mobile backhaul" definition. We saw future demand for mobile backhaul as likely to be focused on Ethernet solutions and as driven by the exponential growth in mobile data demand. We considered the competitive constraint that RBS backhaul / TISBO would exercise on mobile Ethernet backhaul (and vice versa) in this context.

4.316 We considered that the competitive constraint that RBS/TISBO would place on mobile Ethernet backhaul was unlikely to be very strong. MNOs had told us that their migration to Ethernet was motivated primarily by their planned future 4G network deployments and associated increasing network capacity requirements. There was a significant price premium for TI circuits above 2Mbit/s relative to Ethernet circuits and this made it unlikely that a SSNIP on Ethernet services (where demand is for higher bandwidths) would be constrained by the existing TISBO/RBS backhaul services.

4.317 We noted that Ethernet was now likely to be the technology of choice for new mobile backhaul demand. [337] Migration was occurring in order to meet higher capacity requirements, but a 'rump' of cell sites for which synchronous Ethernet was unlikely to be needed (or efficient) was likely to remain for the next three years or so. This suggested that mobile operators would retain RBS backhaul at certain cell sites, particularly if the capacity on existing RBS backhaul links could handle the forecast data requirements. We considered that, as 2Mbit/s SDH links were less expensive than Ethernet counterparts (i.e. Ethernet circuits at 10Mbit/s)[338], then it was unlikely that synchronous Ethernet would provide an effective constraint for those backhaul sites where high capacity links were not needed. In these circumstances, mobile operators would be unlikely to find mobile Ethernet backhaul an effective substitute for RBS links.

4.318 Therefore, we did not consider that a separate mobile backhaul product market definition was appropriate owing to the cost advantages of Ethernet at higher bandwidths and SDH at lower bandwidths.

Differences in competitive conditions

4.319 We considered whether there were differences in the nature of competition for the provision of mobile backhaul circuits (relative to AISBO or TISBO services). We noted that both leased lines and mobile backhaul services made use of essentially the same wholesale inputs, but some stakeholders had argued that differences in the ability of CPs to compete for mobile and business customers could justify a separate

[337] This is in light of 4G/LTE deployments and the cost of Ethernet on a per Mbit/s basis for higher speed backhaul services. For example in Section 3 we show that for a 100 Mbit/s Ethernet circuit the 'equivalent' PPC would be around four times as expensive.

[338] We compare 2Mbit/s SDH link to a 10Mbit/s Ethernet as this would be the minimum likely capacity of an Ethernet bearer circuit.

wholesale product market. We identified four possible reasons, in principle, why there might be differences in competitive conditions in the provision of mobile backhaul (compared to leased lines):

- technical barriers to interconnecting with multiple providers;
- the scale of first-mover advantages in the supply of mobile networks;
- the nature of mobile network demand and the location of some base stations (and hence demand for mobile backhaul) in more remote and difficult to serve areas; and
- the ability of MNOs to self-supply.

Technical barriers to interconnecting with multiple providers

4.320 We considered whether there were technical difficulties in procuring backhaul links from multiple providers in different locations, purchased on a site by site basis. In particular, it was put to us that one of the benefits of purchasing mobile backhaul services from a single operator was that it could facilitate end-to-end monitoring of the mobile network.

4.321 In principle, with better end-to-end monitoring functions, there could be a benefit in terms of service availability as any system faults could be rectified more quickly and network management functions could be integrated to a greater extent. However, the available evidence from industry bodies such as the Metro Ethernet Forum suggested that there were no significant technical barriers to interconnecting Ethernet services from alternative providers (and, at the same time, retaining monitoring and other functionality). Moreover, the empirical data showed that MNOs procured backhaul circuits from a number of CPs.[339] So there did not appear to be any intrinsic technical barrier to an MNO sourcing demand from more than one supplier.

4.322 We noted that any customer must make a trade-off between sourcing from a pool of competitive suppliers and minimising the overhead associated with managing more than one supplier relationship. But the issue was whether competitive conditions in the supply of wholesale leased lines to mobile operators were different to normal business customers. We did not consider it unique to MNOs that there could be certain benefits to supply by a single provider. Therefore, we did not consider that this justified a separate product market for mobile backhaul. There did not appear to be specific technical barriers to mobile networks interconnecting with more than one supplier that would distinguish mobile backhaul from other leased lines services.

First-mover advantage

4.323 We considered whether competitive conditions in the provision of mobile backhaul differed from other TISBO and AISBO services because BT had a greater 'first-mover' advantage arising from its ability to connect its ubiquitous copper and extensive fibre networks to most base stations in the UK.

[339] For example, prior to Vodafone's acquisition of CWW, it was purchasing mobile circuits from CWW. Virgin has recently agreed a £100 million deal to provide circuits to a number of mobile base stations on behalf of MBNL using SyncE.

http://www.virginmediabusiness.co.uk/News-and-events/News/News-archives/2011/MBNL/

4.324 We considered that, if BT had a first-mover advantage in relation to mobile backhaul, it was likely to be similar to any advantage BT had in supplying wholesale leased lines to connect to retail business customers. We illustrated this with an example of a site (be it a business site or a mobile base station) that BT was already supplying with fibre (or where it had fibre close by). A CP seeking to compete for a retail business connectivity consumer (for which BT had physical connectivity) would face a similar disadvantage to a CP seeking to compete with BT for provision of a circuit to a mobile site (where BT already has physical connectivity).

4.325 If a CP had fibre presence near to the retail customer or base station site then it might be willing to build out to that site. We considered whether the *extent* of any incumbency advantage was greater for RBS backhaul or mobile Ethernet backhaul markets than it was for other leased lines because of differences in the overall scale of mobile backhaul demand and the location of base stations.

The location of base stations

4.326 We said that competitive conditions for mobile backhaul might differ from those for standard leased lines (AISBO or TISBO services) to the extent that the geographic location of, and the nature of demand for backhaul from, mobile base stations differed systematically from those of the typical retail leased line customer. We noted that MNO networks were configured in a hierarchical structure whereby a group of RBS sites were often parented to a single core switch or node. Given this network configuration, MNOs might in general only seek to procure mobile backhaul for a group of cell sites parented to a single core node from a single provider. This is because if a single provider such as BT can offer connectivity to multiple cell sites in a particular locality (due to its ubiquity) it might also enjoy economies of scale associated with backhauling all of those circuits over the shared infrastructure. By contrast an MNO purchasing mobile backhaul on individual site-by-site basis from a number of wholesale providers would have limited scope to realise the same economies of scale in backhaul. This would mean that, for a wholesale provider to compete, it would need to have sufficient fibre presence for a significant number of cell sites within the footprint of that core node. BT's greater network presence might therefore prevent competition from emerging for mobile backhaul.

4.327 In addition, we noted that the location of base stations (and hence demand for mobile backhaul) could extend to more remote and difficult to serve areas. Given MNOs' national coverage requirements, mobile base stations were often in rural locations or areas where any network build might be subject to protracted and difficult planning processes or restrictions. Given the remote nature of those sites, it might be the case that fewer OCPs have a network presence to serve base stations in those areas than is the case for general businesses using services provided using leased lines.

4.328 However, our analysis of geographic markets suggested that, if OCPs did not have fibre presence in rural locations, then they were unlikely to be able to compete either for a mobile site or a business site. The observation that demand for mobile backhaul was in more remote locations and the fact that CPs might be required to serve a number of cell sites did not fundamentally alter the competitive picture. In particular, in our geographic market analysis, we proposed that fibre presence was only likely to be sufficient to provide an effective competitive constraint on BT in and around the London area (in a geographic area that we called the WECLA).

4.329 Therefore, to the extent that the available evidence suggested that competition to supply leased lines to businesses was unlikely to be effective, it also suggested that competition to provide connectivity to mobile base stations was similarly unlikely to

be effective. In the WECLA, the evidence showed that the relevant CPs had sufficient coverage of the area (based on their fibre presence) for a mobile network to be able to rely on an alternative provider for its backhaul needs to a large number of cell sites. Our geographic analysis did not indicate that competitive conditions for mobile sites were fundamentally different to other large business sites.

4.330 Overall, we did not consider that any of the above factors suggested fundamental differences in competitive conditions. There did not seem to be significant technical barriers to interconnecting with multiple providers (not also faced by enterprise customers). Further, we did not consider that the scale of first-mover advantages in the supply of mobile networks and the location of base stations suggested separate product markets.

Microwave links

4.331 We also considered whether competitive conditions might be different for mobile backhaul because of the possibility of self-supply by MNOs using microwave links. This could affect competitive conditions if MNOs were able to: (a) switch between microwave links and fibre-based circuits at the margin in response to a SSNIP; and (b) sufficient switching would occur to prevent a SSNIP being profitable on mobile backhaul services. We said that, if these two conditions were met, then this might suggest that competitive conditions in mobile backhaul supply differed from those in AISBO and TISBO markets.

4.332 However, we considered that microwave links were outside the market because they did not constrain fibre-based mobile backhaul prices, or vice versa. Consequently, the ability of MNOs to self-supply microwave links was unlikely to be a reason why competitive conditions in the provision of mobile backhaul might differ from the other services in the TISBO or AISBO markets.

4.333 In the June BCMR Consultation, we discussed the case for including microwave links in the same market as RBS backhaul in the light of:

- *A technical assessment:* we discussed the technical capabilities and some issues associated with the use of microwave links; and
- *Demand-side substitution:* we considered whether a hypothetical monopolist would be constrained in its ability to increase the price of mobile backhaul by the threat of MNOs switching to microwave links.

Technical assessment of microwave links

4.334 We said that, in our s135 information request to MNOs, we had asked them to provide details of the technologies they used in different parts of their networks. The information submitted by MNOs in response to our information request showed that microwave was used for the following types of network connectivity between the different types of mobile network nodes:

- RBS to RBS;
- RBS to Base Station Controller/Radio Network Controllers (BSC/RNC);
- BSC/RNC to Mobile Switch Sites, Media Gateway or Gateway Support Nodes (MSC/MGW/GSN).

4.335 We found that microwave was most typically used at the edge of the network or to 'daisy chain' RBS sites back to another RBS site that acts as collector hub. From this location, traffic from other RBS sites (provided over microwave) might then be backhauled to the core network (using fibre). In some cases, these RBS to RBS links were self-provided and predominantly carried 2Mbit/s SDH transmission. Some microwave links also carried Ethernet transmission.

4.336 In current network deployments, some MNOs made use of microwave to a significant extent while others had only very limited deployments.[340] On a forward-looking basis we expected that there would be far greater demand for fibre-based solutions. This is because we regarded 4G / LTE network deployments and continuing growth in data demand as driving significant increases in required backhaul capacity. MNOs told us that, in response to this, they planned to reduce the extent of fixed wireless usage for backhaul applications and to rely increasingly on fibre deployments.

4.337 Although microwave links were used for mobile backhaul needs, they could not meet MNOs' backhaul requirements in all cases and therefore, technically, microwave could not act as substitutes for mobile backhaul products under all scenarios. We identified a number of issues with microwave backhaul:

- requirement for line of sight connectivity;
- ability to support only lower capacity links compared to fibre-based backhaul;[341]
- significantly lower transmission range than fibre-based backhaul links;
- deployed microwave antennas are exposed and have higher risk of failure.

Demand-side substitution assessment

4.338 We discussed some of the issues relating to microwave for mobile backhaul with a major provider of microwave, MLL, who said it saw microwave as a complement to, rather as than a substitute for, fibre-based solutions. For example, where an MNO had microwave connectivity to link its RBS sites, one of the reasons for this might be that the local topology, planning and street work costs would not allow fibre or copper to be used as an alternative.

4.339 We said that there might be instances, however, where an MNO using fibre could in theory rely on a fixed wireless-link as an alternative (from a technical perspective). The question in these circumstances would be whether switching to microwave links would impose a sufficient competitive constraint on a hypothetical monopolist to make a SSNIP on fibre-based backhaul solutions unprofitable.

4.340 An MNO that already had in place a fibre-based link would also incur various costs in switching from fibre to microwave. These would arise from the line-of-sight

[340] We did not provide specific details for the various mobile operators due to commercial confidentiality. Moreover, we considered that the current installed base of fixed wireless links may not provide an accurate forward-looking picture. We noted, for example, that Orange and T-Mobile were currently consolidating their networks and they (along with Three) would increasingly rely on MBNL to manage their network infrastructure and provide capacity over shared infrastructure where possible. Moreover, the deployment of LTE and increasing data requirements is likely to be associated with much greater demand for fibre-based solutions.

[341] Although next generation microwave might support high bandwidths, it is not clear whether cost effective microwave backhaul supporting more than 1Gbit/s would become available during the period covered by this review. In addition, the same technical considerations are still likely to apply, such as overall performance guarantees and length of transmission ranges of microwave backhaul links.

requirements of microwave technology. We noted that many MNO sites would not meet these requirements and so would be unsuitable for self-provision through radio. MNOs would then need to incur significant investment costs in acquiring new sites to provide RBS backhaul circuits through microwave radio. Hence the threat of self-provision by these operators would only become effective if the costs of self-provision were below the costs of buying from BT.

4.341 We noted the implication that operators who had not designed their networks to use microwave would not be able to switch to microwave at a later date. We considered that the costs of switching to microwave were likely to prevent microwave links being an effective substitute in the provision of low bandwidth links where there was existing installed fibre. We also considered that microwave links would only provide an effective alternative to fibre/copper-based solutions where it was technically feasible. Furthermore, where it was feasible to use microwave, it was already likely to be in use and there was likely to be little opportunity for switching at the margin.

4.342 Hence we considered it unlikely that an MNO would switch to microwave provision in response to a SSNIP applied to RBS circuits over fibre/copper (or Ethernet mobile backhaul). The costs of doing so were likely to be prohibitive (and it might not be a technically feasible solution).[342] It was therefore unlikely that a SSNIP would prompt sufficient switching from fibre/copper links to wireless to impose a competitive constraint. On this basis, we proposed to exclude microwave links from both the AISBO and TISBO product market definitions.[343]

4.343 From a technical perspective there were limitations to microwave technology that made fibre the preferred and potentially the only viable technology choice for many backhaul applications. In other circumstances, however, fibre might not be feasible and therefore fixed wireless links might be the only option. However, the use of wireless was often limited to the edge of the network rather than the major backhaul links to MNOs core switches. On a forward-looking basis, we considered that increasing backhaul capacity would be needed. This suggested that fibre would be increasingly preferred in most circumstances. Microwave would continue to be seen as a complement for use where fibre deployment is not viable for operational or economic reasons.

4.344 On the basis of the above analysis, we considered that we should include Ethernet mobile and RBS backhaul in the AISBO and TISBO product markets respectively. We noted the potential for mobile backhaul to be provided using existing leased line inputs (including certain synchronised Ethernet products).

4.345 We therefore proposed that RBS backhaul be included in the TISBO product markets and mobile Ethernet backhaul in the AISBO product market. We did not include mobile backhaul over wireless links in the respective markets as we considered that its use would increasingly be limited to specific circumstances (e.g. where line of sight requirements can be met). These technical limitations and the costs of

[342]For example, we estimate that the price of a 2Mbit/s PPC is around £2,915 per annum for a 10km circuit. We would anticipate that, in a competitive market, an RBS backhaul service (that uses the same underlying inputs) should be priced in a similar manner. Therefore, it is unlikely that an MNO would seek to incur significant sunk costs of installing self-supplied microwave links in response to a SSNIP on a TISBO service (assuming that this was technically feasible).

[343]We have nevertheless discussed in our market power assessment the effect that the inclusion of self-supplied microwave links would have on BT's market shares. However, the possible limitations on the use of radio links suggest that there are limits to the competitive constraint that this form of connectivity might impose. Any constraint is highly likely to be very weak and, even if it did exist, is likely to be confined to higher bandwidths.

switching suggested that wireless links would not impose an effective competitive constraint.

Responses to the June BCMR Consultation

4.346 MBNL (representing EE and Three), Telefónica and KCOM argued that there was a case for separate market mobile backhaul market. BT agreed that mobile backhaul should not be in separate product markets but considered that we have not properly assessed conditions of competition for these customers. Vodafone made a number of comments on passive remedies for mobile backhaul that were also relevant to our product market definition.

Arguments from BT and KCOM that mobile backhaul is more competitive

4.347 BT agreed that mobile backhaul should not be in separate product markets but considered that we have not properly assessed conditions of competition for these customers. BT was concerned that mobile (and LLU backhaul) should not be defined by a specific, BT centric network topology.

4.348 In addition, BT made a number of observations regarding the mobile backhaul analysis :

- The analysis implicitly assumes a national market;
- The market only has four customers – two of which combined their purchases via MBNL;
- Operators tender periodically for large volumes backhaul requirement rather than individual circuits;
    - this suggests a bidding market in which consequential market shares provide no indication of market power; and
    - as it is a bidding market, this invalidates Ofcom's analysis, which considers switching as if each circuit were a separate purchasing decision.
- Four operators have the option of self-supplied microwave radio at the time of each tender and can target their bidding to the availability of competition, as was seen when Virgin secured a large contract with MBNL.

4.349 BT noted that timing for synchronisation purposes for mobile backhaul is a critical technical requirement. It noted that various solutions existed to deliver these services using Ethernet technology and there had not been any barriers to migration from TI to AI. It argued that AI is winning new contracts in each new bid cycle. The rate of migration from TI to AI is determined largely by the length of existing contracts, a factor completely outside the scope of any SSNIP test assessment.

4.350 It argued that mobile backhaul (including AI and TI and self-supplied microwave) had a specific geographic dimension and we should conduct geographic market assessment separately to an analysis of enterprise customers based on business locations. It asserted that the competitive geographic area for supply to mobile base stations is very substantially larger than the WECLA and is largely coincident with the Virgin footprint.

4.351 KCOM argued that our wholesale market definition should take account of differences in the competitive landscape in the Hull area. Given the more widespread use of radio backhaul solutions by MNOs in the Hull area, KCOM argued that Ofcom should look separately at TI 2Mbit/s services when considering market definition and assessing KCOM's market power.

Arguments from MNOs that mobile backhaul is less competitive

4.352 EE/MBNL considered that the competitive conditions for mobile backhaul are distinguishable from other leased lines given the way in which they are purchased. EE/MBNL noted that this could suggest a separate market, although it noted a reasonable alternative approach would be to recognise these differences in setting remedies.

4.353 EE/MBNL noted that reasons for these competitive differences included:

- the nature of BT's advantages in the supply of mobile backhaul; and
- limited alternatives such as self-supply and third party provision.

4.354 In relation to the first bullet, EE/MBNL submitted that the ubiquity of BT's network (combined with benefits achieved from the "any to any" connectivity it provides) means that it is likely, if not certain, to be one of the main providers for a UK mobile network. EE/MBNL noted that it relies heavily on BT's Managed Ethernet Access Service (MEAS) from individual radio sites to relevant MSC core nodes. [✂].

4.355 MBNL noted that it purchases backhaul from Virgin, and it noted that Virgin delivers a cost effective backhaul solution in the areas where it has a relevant network. [✂]. Therefore, EE/MBNL considered that BT will inevitably be one of the required backhaul providers for any UK network.

4.356 Telefónica seemed to accept some arguments for not identifying mobile backhaul as a separate market. However, it questioned in particular the effectiveness of any competitive constraint by alternative providers to BT [✂]. Telefónica submitted however that the observation of just one alternative supplier offering backhaul Ethernet services does not in itself indicate a healthy market needing no intervention or regulation, [✂].

4.357 Telefónica also highlighted that it and Vodafone have historically relied on BT for mobile backhaul to a greater extent than other mobile operators. Telefónica explained that this means that any alternative supplier trying to establish itself in the market faces not only the challenge that mobile operators need to re-invest significantly more capital expenditure to reach sites already connected by BT, but also the challenge of obtaining second wayleaves. Telefónica submitted that its own experience of trying to obtain wayleaves [✂] have proven to be real barriers to changing supplier. Telefónica argued that this often leaves microwave as an alternative, and this is a challenge due to [✂] (and given the technical and cost issues of microwave).

4.358 Telefónica submitted that the geographically distributed nature of mobile base stations (as noted in the BCMR), compared to other premises serviced by BT's AI and TI products, means that over the years the mobile industry has invested significantly in BT's access network outside the footprint required by the majority of other customers. Telefónica noted that this offers a first mover advantage to the

locations of base stations as reflected in the June BCMR consultation. Further, BT has obtained and used its own wayleaves at those base station locations.

The role of radio access links

4.359 BT saw that the threat of self-supply of microwave provides a competitive constraint when MNOs tender for their backhaul requirements. BT cited the report it commissioned from Analysys Mason, which it considered showed the extent of microwave deployment across Europe as evidence of the ability of MNOs to self-supply. BT saw no reason why the UK would be any different. BT asserted that the only difference between the UK and the rest of Europe is that the UK faces a degree of competitive supply of backhaul by CPs.

4.360 Telefónica noted our proposed finding that microwave links cannot meet MNOs' backhaul requirements in all cases and hence cannot act as an effective constraint for mobile backhaul leased lines in the context of the hypothetical monopolist test. It agreed with our identification of technical/ capacity limitations of microwave in a 4G environment as identified by Ofcom. Telefónica noted in respect of microwave links that [✂] [344]

4.361 Vodafone noted in respect of radio links, that it was feasible today for microwave technology to reach up to 400Mbit/s throughput. However, it identified the lack of spectrum availability in some frequency bands below 20 GHz as a significant issue. Microwave links that can provide more than 400 Mbit/s of transmission capacity have appeared recently in the market although these run at higher frequencies [✂]. Vodafone also noted that a significant limitation of this band is the maximum hop length, which is less than three kilometres. Vodafone concluded that higher capacity microwave is likely to be limited: it will have its place in a mobile operator's backhaul portfolio, [✂], but for longer or higher capacity routes it will be an ineffective and impractical substitute for fibre.

Other points raised

4.362 Vodafone did not comment specifically on our market definition for mobile backhaul, but raised a number of points related to its support for PIA remedies that are also relevant to our market definition. Vodafone noted that high capacity fibre is the strategic long-term solution for much of a mobile operator's backhaul network. It also considered that the view expressed in the June BCMR consultation that MNOs are likely to require links "of 100Mbit/s or 1Gbit/s" was incorrect in the medium or long term. Links of greater capacity are likely to be required, both for the last mile and deeper into the backhaul network.

4.363 Vodafone considered that there are no obvious alternatives open to the mobile operators for backhaul supply to high capacity mobile sites other than BT Ethernet and PIA. Vodafone argued that this was because there are limited alternative suppliers of fibre other than BT, particularly for the last mile, and outside a few urban areas.

Ofcom's view

4.364 In the following section, we focus our response on competitive conditions for mobile backhaul and whether this provides a case for a separate product market.

[344] [✂]

- Arguments that mobile backhaul is more competitive;
  - BT's arguments over bidding markets
  - Entry by Virgin
  - Constraints from self-supplied links
- Arguments that mobile is less competitive;
  - The nature of mobile operators' demand
  - BT's incumbency advantages
- KCOM's arguments for different product market definition in the Hull Area; and
- Other points raised.

Arguments that mobile backhaul is more competitive

Bidding markets arguments

4.365 BT asserted that mobile backhaul is a bidding market and argued that this would potentially invalidate our analysis of these markets. It noted for example that market shares are not necessarily indicative of market power and that MNOs' behaviour during these bidding processes reflects availability of alternative competing providers.

4.366 We consider that the use of competitive tender is not in itself a guarantee of effective competition nor that it should necessarily alter the approach to assessing markets. Various papers to UK competition authorities[345] have considered the implications for competition policy of markets characterised by auctions or bidding processes.

4.367 We do not consider that the existence of bidding processes, in and of itself, requires a fundamentally different approach to defining the relevant wholesale product markets.[346] Similarly with regard to BT's argument that caution should be attached to high market shares in a market characterised by bidding processes, we do not consider the existence of bidding processes signifies, in and of itself, the absence of market power. In this respect, as set out in our subsequent SMP assessment, we apply a number of criteria – i.e. not just a measurement of market shares – in order to undertake a thorough and overall analysis of the economic characteristics of all the relevant markets before coming to a conclusion as to the existence of SMP.

Competitive mobile backhaul provision

4.368 BT argued that MNOs are able to target their bidding activity according to the availability of competition. It argued that the geographic scope of Virgin's contract with MBNL and the geographic scope of self-supplied MNO links suggests a competitive geographic area for mobile base stations substantially larger than the WECLA (largely coincident with the Virgin footprint).

[345] See in particular "Bidding Markets", June 2005, Report prepared for the CC; Paul Klemperer, and "Markets with bidding processes: Economic discussion paper", May 2007, Report prepared for the OFT by DotEcon Ltd.

[346] See "Markets with bidding processes: Economic discussion paper", May 2007, Report prepared for the OFT by DotEcon Ltd, paragraph 4.16.

4.369 BT's main evidence to support greater competition for mobile backhaul is based on the Virgin contract, but (apart from BT's assertions that competition is more intense in a bidding context (as set out above)) it does not explain why Virgin's presence is likely to result in a competitive constraint substantially different to that seen in the enterprise market. [✂] some providers (such as Virgin) have provided, or are about to provide, mobile Ethernet backhaul solutions in addition to their existing Ethernet solutions they currently provide to enterprise customers). However, this does not suggest that Virgin can compete for mobile Ethernet appreciably more than it can for general wholesale Ethernet leased lines.

4.370 In addition, when we consider the scale of entry by third parties other than BT, while Virgin's sales are not insignificant in absolute terms, the evidence does not suggest that mobile backhaul is significantly more competitive than levels of competition seen for more generic leased lines. For example, from our discussions with MBNL we understand that it expects to have around [✂] cell sites and Ethernet (fibre) connectivity is being targeted to [✂]. The Virgin contract would currently provide connectivity to under [✂]. [✂].

4.371 The evidence shows that, where mobile operators are inviting bids for contracts, in the majority of cases BT has won those bids historically and continues to supply the majority of MNOs' backhaul requirements. [✂].[347] MNO responses have highlighted the limited competitive choices they face in the alternative to BT. BT's continued high share is likely to reflect the structural features of the market such as the need for diversity in backhaul and BT's ubiquity and first mover advantages in the supply of mobile backhaul (see discussion below and in our SMP assessment).

4.372 Therefore, in general this does not point to mobile backhaul being significantly more competitive than more generic leased lines backhaul based on the evidence on the entry of third parties into the mobile backhaul market. In our geographic market definition section we have nevertheless included a separate assessment for MNO base station sites.

Self-supplied radio links

4.373 BT argued that the extent of self-supplied backhaul across mainland Europe shows that the threat of competitive self-supply is a realistic prospect and not merely theoretical. BT also considered that MNO self-supply was a genuine threat that would impact on its pricing behaviour in the context of bidding for MNO contracts.

4.374 We consider that relying on evidence from European markets is not that informative for this market definition exercise, where we are considering the constraint that radio links could offer at the margin (in particular in the context of MNOs' possible response to a SSNIP applied to mobile backhaul services). The observation that there is substantial use of radio access links in European markets may simply reflect differences in the topology and network design in those markets (relative to the UK). In addition, historically the regulation and availability of effective leased lines solutions to MNOs in other countries may have been less effective and driven MNOs to rely on less efficient solutions (such as microwave links). More importantly, we have a statutory duty to define the relevant wholesale product markets appropriate to

[347] This figure is based on MNOs' responses to s.135 information request. BT share is based on its provision of access ends to MNOs relative to total third-party supply of access ends (i.e. excluding MNO self-supply).

our national circumstances[348] such that the varying extent of self-supplied backhaul across mainland Europe is irrelevant.

4.375 In this context of discussing microwave links, BT argued that the threat of the use of self-supplied microwave is used as leverage in each bidding cycle. However, we note that once the topology of the network has been fixed, MNOs would have limited incentive to change it. This is because sunk costs associated with investing in a particular network configuration would need to be written off and re-incurred, something that MNOs are unlikely to do in response to an attempt by a dominant provider of copper and fibre-based links to impose a SSNIP across those connections.

4.376 Our discussions with MNOs and analysis of their formal submissions show radio links are generally most useful at the 'edges' of their network, particularly where the topology and economics make it prohibitive to rely on fibre. MNOs have told us that when they rely on radio links from smaller cell sites, these eventually go directly (or indirectly via another cell site) back to aggregation points where traffic is backhauled across fibre routes to their core networks. MNOs have told us that on a forward looking basis given their deployment of 4G networks and given that mobile data demand will increase, so will their reliance on resilient fixed fibre-based links.

4.377 As we set out in the June BCMR consultation, there are limitations to radio links in providing aggregated backhaul. [✂]. Telefónica also highlighted the barriers to utilisation. As Vodafone suggested, radio access remains useful but it is not likely to be deployed for the main backhaul links.

4.378 Therefore, while radio backhaul may in a limited number of circumstances be an alternative to fibre provision this is unlikely – as BT asserts - to generate a significantly more competitive backhaul market than is seen for generic leased lines.

Arguments that mobile is less competitive

4.379 In contrast to BT, MNOs have put forward a number of reasons why they consider mobile backhaul to be less competitive than generic leased lines backhaul. In the June BCMR Consultation, we considered reasons why mobile backhaul might face differences in competitive conditions, including:

- technical reasons;
- commercial incentives; and
- the overall geographic scope and scale of backhaul demand.

4.380 We noted that there was no intrinsic technical barrier to MNOs using more than one operator to deliver mobile backhaul solutions.[349] Furthermore, while operators may see benefits from purchasing from a single supplier, we observed MNOs purchasing from more than one CP. [350] Indeed, in arguing for differences between mobile

[348] See section 79 of the Act. See also Article 15(3) of the Framework Directive.

[349] Ethernet technology is now designed to support operations, administration and monitoring functions on an end-to-end basis, even where circuits are interconnected.

[350] As we identified in the June BCMR Consultation, that MNOs (as with other leased lines users) may see benefits of having a 'one-stop' shop for all network connectivity as it simplifies the management overhead associated with handling more than one supplier. On this view, it would be simpler to stay with an existing provider rather than having to source connectivity requirements from rivals. However, these benefits need to be

backhaul and generic leased lines, most MNOs' comments in response to the June BCMR consultation have focused on the last of the points in the bullets above (i.e. the overall geographic scope and scale of backhaul demand). In particular, MNOs highlighted the impact that the nature of mobile backhaul demand has on the ability of rival operators to provide mobile backhaul competitively. We therefore consider further below the points raised by MNOs in support of differences in mobile demand and supply conditions:

- First, we consider the nature of mobile backhaul demand;
- Secondly, we discuss the possible first-mover advantages; and
- Finally, we discuss whether these factors are likely to result in fundamentally different competitive conditions for mobile backhaul (relative to generic leased lines).

4.381 Our conclusion is that the competitive conditions are not likely to be significantly different to those for other equivalent leased line services, including by geography (which we consider in more detail in Section 5).

The nature of mobile backhaul demand

4.382 The nature of downstream mobile services means that there is a need for extensive national mobile coverage. According to the MNOs this could create a possible difference in the ability for CPs to compete with the overall reach of BT's network (and its incumbency advantages from existing presence and wayleaves to most of the UK's existing mobile base station sites).

4.383 As BT [✂] explained in their responses, it is unlikely that mobile networks will seek to procure services on a circuit by circuit basis. This is related to the geographic spread of a large number of small sites and it is more efficient to groom traffic from individual cell sites over more aggregated backhaul links. MNOs must serve significant numbers of mobile base stations (in the tens of thousands) and often to more remote sites, this means that CPs competing for mobile backhaul must be able to offer significant connectivity to a number of base station sites. This is because delivering services to more than one site on the same network provides the opportunities for efficient aggregation of services over common backhaul links back to the core network. Hence, in order to enjoy those economies of scale, it is more likely that MNOs will require connectivity for a large number of base station sites, which may be distributed over a wide geographic area or even nationally.

First-mover advantages

4.384 MNOs argued that the geographically distributed nature of mobile backhaul demand and the need for competing CPs to be able to offer connectivity to a sufficient number of base stations (to realise the economies of scale) places BT at an advantage due to its position as the incumbent relative to competing providers.

4.385 Telefónica noted in particular that BT had first mover advantages due to the geographically distributed nature of mobile base stations and Telefónica's

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traded against the dis-benefits associated with limited choice and value associated with selecting a single supplier. MNOs have noted for example the benefits of greater competitive provision and operators are using alternatives where they can (see for example [✂]).

expenditure with BT to extend its access network. Telefónica noted that its base station sites are outside the footprint of most other CPs. This existing presence of BT at mobile base stations means that it has physical connectivity in those locations and wayleaves to most cell sites in the UK. Telefónica argued that this creates a significant barrier to competition that is not seen to the same degree for connectivity to enterprise customers.

4.386 BT did not agree that it had a first-mover advantage. It argued that each time MNOs bid for new mobile backhaul this entails a complete refresh in technology.

4.387 We do not agree with BT's view. It is certainly the case that MNOs are undertaking major investments in their networks in response to the challenge of increased bandwidth demand. For example, the need for increased bandwidths at lower cost and the move to 4G technologies is driving migration from TI to AI technologies.

4.388 We do not consider however that this will result in significant changes as BT suggested, such as changes to the main base station locations where traffic is backhauled. The 'refresh' in the technology used may result in a change of interface or operators moving from copper-based to fibre-based connectivity and some changes to MNOs' networks (for example developments such as 4G roll-out and the use of new spectrum frequencies may require changes in the location of base stations). But the mobile networks have invested significant amounts in existing locations and they are not going to undertake a fundamental refresh of their network topology as this would mean writing off and re-incurring significant sunk costs.

4.389 Hence, any incumbent operator with existing connectivity to existing base station sites will clearly have a first mover advantage based on barriers to entry that later entrants face from the cost of digging and ducting. Furthermore, as noted by Telefónica, there are significant costs to obtaining wayleaves that BT does not face where it is already present. This existing presence therefore gives a clear first-mover advantage that must be overcome by other CPs.

Evidence of variations of competitive conditions for mobile backhaul

4.390 The question we are considering in our product market definition is whether there is merit in defining mobile backhaul as a separate market distinct from our AISBO or TISBO markets. We think that there are some features of the mobile market that when combined with BT's first-mover advantages could point to mobile backhaul being less competitive (i.e. the MNOs' preference for multi-site purchases combined with remote sites where only BT might have network presence close by). On the other hand, we note that where other operators have network (predominantly to serve business customers) there is evidence that major CPs are able to enter to supply mobile backhaul to varying degrees (we consider the geographic scope of competing network in Section 5). The MNOs are also large, sophisticated customers making significant purchases which could imply some countervailing power where there are alternatives.[351] Therefore, on balance, the competitive conditions in mobile backhaul are likely to be similar.

[351] We discuss countervailing buyer power issues in more detail in Section 7, as we note that a number of factors could potentially counter the extent of any CBP that MNOs might seek to exert. In particular, if BT perceives the MNOs as competitors in downstream markets, it is unclear how far MNO could exercise any such power.

Different product market definition in the Hull area

4.391 KCOM argued that our wholesale market definition should take account of differences in the competitive landscape in the Hull area, given the more widespread use of radio backhaul solutions by MNOs.

4.392 We do not consider that the presence of radio backhaul links in the Hull area necessitates a separate product market definition. There may be slightly different patterns of demand for mobile backhaul relative to fixed links when compared to the average for the rest of the UK, but this does not suggest changing our market definition in that geographic area.

4.393 As with other parts of the UK, particularly within dense urban areas or specific geographic locations where the topology requires, mobile operators may use microwave links back to a collector node. From that collector node they then backhaul over fibre links. It appears to be the case that some MNOs tend to rely on radio links in the Hull area. However, our circuit data obtained from MNOs as part of our S135 information request suggests that [✂] In these circumstances, MNOs are reliant on KCOM for fixed backhaul connectivity and there would be limited scope (at the margin) to switch to radio backhaul links particularly as there is limited third party supply. Hence, even if a relatively large proportion of MNO's backhaul is delivered over microwave links, the economics are similar to elsewhere in the UK (i.e. there is not a strong constraint at the margin between microwave and fibre-based links).

Other issues

4.394 In our June BCMR consultation, we described mobile backhaul demand requiring capacity of up to 1Gbit/s in the next three years. Vodafone argued that our predictions for bandwidth demand in the June BCMR consultation were perhaps on the low side.

4.395 We note from MNOs responses that their requirements for last mile and middle mile connectivity may be significantly in excess of our predications in the June BCMR Consultation. Hence, they may look to deliver capacity over circuits that currently fall within our MISBO definition. Therefore, we consider that any relevant mobile backhaul sold to MNOs above 1Gbit/s would fall within the MISBO product market.

Conclusion

4.396 In the June BCMR Consultation we set out arguments for including mobile backhaul in the respective AISBO and TISBO product markets. We conclude that this remains appropriate.

4.397 Our assessment does not suggest that mobile backhaul is more competitive than other markets. On the one hand, the arguments made by MNOs support the competitive conditions in the supply of mobile backhaul being less favourable than for other leased lines markets. However, there is scope for competitive provision in certain geographic areas, which could allow MNOs to exercise countervailing buyer power or to switch supplier. Hence, in our geographic market assessment in Section 5, we have undertaken relevant cross-checks to ensure that markets where operators have high levels of network reach are also places where mobile backhaul could be served competitively.

4.398 We have not included mobile backhaul over wireless links in the respective markets as we consider that its use will increasingly be limited to specific circumstances (e.g.

where line of sight requirements can be met). These technical limitations and the costs of switching suggest that wireless links would not impose an effective competitive constraint.

Issue 4b: LLU backhaul

4.399 In the June BCMR Consultation we assessed whether Local Loop Unbundling ("LLU") backhaul services were part of the AISBO market. We described LLU backhaul services as providing a link between OCPs' LLU co-location facility and their core network nodes.[352]

4.400 We proposed to include LLU backhaul in the AISBO market. We noted that Ethernet circuits could be used by CPs either for LLU backhaul or as a terminating segment for retail AI services. Indeed, there was no distinction in BT's own Ethernet product set between circuits used for LLU backhaul and circuits used to support the provision of business connectivity services. We found that competitive conditions in the provision of AISBO services and LLU backhaul were sufficiently homogenous for a single market to be defined.

4.401 We also considered low bandwidth Ethernet services that were provided over copper-access links known as Ethernet in the First Mile (EFM). We said that, as with LLU, EFM services were provided using unbundled local copper loops. Therefore, we considered backhaul for EFM services together with LLU backhaul in this part of our wholesale product market assessment. We provisionally concluded that the backhaul element of EFM should fall in the AISBO market (as is the case for LLU backhaul).

4.402 We noted that, although LLU backhaul was predominately used to provide asymmetric broadband access, this asymmetry was only associated with the local end. The backhaul of traffic was provisioned on a symmetric basis using leased lines. Indeed, the Ethernet links to supply LLU backhaul services might also be used on a converged basis as inputs to the supply of a variety of other retail services, such as leased lines, symmetric broadband internet access and other data services. We said that LLU backhaul services could in theory be provided using traditional or alternative interfaces, but demand had tended to be for alternative interface circuits that, at higher speeds, would deliver lower cost per unit of bandwidth.[353]

4.403 We set out a number of reasons to include two wholesale products as part of a single product market. These included:

- direct demand-side substitution at the wholesale level;
- indirect demand-side substitution via the impact of wholesale price increases on retail prices and retail demand; and
- supply-side substitution.

4.404 Of these, one was ruled out immediately: indirect demand-side substitution via the retail level would not be relevant because LLU backhaul served a distinct retail broadband market (asymmetric broadband origination, typically ADSL or cable) to

[352]LLU backhaul connects a CP's co-location facility to its relevant point of handover. Presently most CPs have their co-location equipment at BT local exchanges. However, our LLU backhaul definition would include co-location at a point closer to the end-user, including at the street cabinet level. Similarly, the definition could include co-location at a point more distant from the end-user.

[353] See for example Section 3, where we compare the wholesale charges for AI and TI services.

retail leased lines.[354] In addition, for reasons set out in Annex 7 of the June BCMR Consultation, we also considered that supply-side substitution was unlikely to provide an effective constraint (in the absence of regulation).[355] However, we also noted that, even if substitution by itself was not sufficient for us to conclude that LLU backhaul and AISBO services should be included in the same product market, we could still do so if competitive conditions in the supply of LLU backhaul services and AISBO services were sufficiently similar.

4.405 We proposed to define LLU backhaul as part of the AISBO market. We based this on our assessment below of the following:

- direct demand side substitution at the wholesale level; and
- variations in competitive conditions in the supply of AISBO services and LLU backhaul.

Direct demand-side substitution

4.406 We noted that differences between Ethernet products intended primarily for LLU backhaul and others in BT's Ethernet product set had been reduced compared to earlier generation products such as WES and BES. Ethernet Access Direct services (which were point to point services) were typically used to provide leased lines but BT's product descriptions did not suggest there were limitations in the use of EAD.[356] While there might be some routing restrictions for EAD services, these restrictions were not based on whether the circuit was used to deliver leased lines (from an end-user's premise) or LLU backhaul (from a CP's co-location space).

4.407 We also noted that, in principle, Ethernet circuits could be used by CPs either for LLU backhaul or as a terminating segment for leased lines. Furthermore, BT had launched networked Ethernet backhaul services (such as BT's Ethernet Backhaul Direct service) which enabled CPs to deliver converged backhaul solutions (where they had invested in necessary equipment). Therefore, a CP could provide LLU backhaul and leased lines backhaul over a common Ethernet link.

4.408 Therefore, there appeared to be flexibility for these products to be used to provide backhaul for both asymmetric (e.g. residential and business broadband) and symmetric broadband services (e.g. leased lines). Indeed the data from our S135 request on CPs' provision of wholesale services showed that in some cases LLU providers (e.g. [✂ ✂]) might also lease wholesale backhaul circuits to other CPs ([✂ ✂]) to be used to supply business connectivity markets.

4.409 While LLU backhaul and AISBO were not identical, the backhaul elements of both an AISBO circuit and LLU were used for the same purpose (i.e. to provide fixed

[354] In our retail product market definition, we noted the differences between leased lines and broadband services offered to business were reducing but there were still some differences as evidenced by the pricing, marketing and service wrap associated with leased lines. On this basis, we can rule out the inclusion of LLU backhaul circuits on the grounds of indirect demand-side substitution arguments. In any case, even if we were to find retail broadband markets in the same market as leased lines services, it would not automatically follow that LLU backhaul would be in the AISBO market. This depends on the strength of the indirect constraint arising from downstream markets.

[355] In particular, for the most significant CPs in the market, we do not consider that there are any providers of LLU backhaul that are not also present in the supply of AISBO services.

[356] http://www.openreach.co.uk/orpg/home/products/ethernetservices/ethernetaccessdirect/ead/downloads/eadfactsheet.pdf

connectivity) and both used fixed circuits based on Ethernet technology to connect a local exchange or end-user to a relevant point of interconnection. Overall, our analysis supported the inclusion of LLU backhaul in the AISBO market.

Variations in competitive conditions

4.410 In the June BCMR Consultation, we also considered whether any differences in competitive conditions between LLU backhaul and AISBO might justify identification of separate product markets.

4.411 We identified the most significant change facing LLU backhaul as the growth in the demand from asymmetric broadband markets, which we expected to continue with the roll-out of next generation access. The delivery of much higher bandwidths to households and business would necessarily entail much higher backhaul capacity demand (ranging from 1Gbit/s to much higher speeds in local exchanges serving the largest number or premises). This broadband demand could then create demand for higher capacity leased lines outside urban areas where most of the leased lines demand from business customers is located. However, we did not consider that this observation alone would mean that we should identify a separate LLU backhaul market.

4.412 We considered that competitive conditions in the supply of Ethernet-based LLU backhaul links and in the supply of AISBO services were similar to a significant degree. The similarity arose because the same technology was involved in providing transparent transmission between a CP's POH and a point in the local access network. This similarity meant that the same type of entry barriers and economies of scale and scope were faced, especially those relating to digging and ducting.

4.413 In addition, service shares for LLU backhaul and AISBO services, which we estimated from data provided in response to our S135 information request, suggested that competitive conditions did not differ significantly between the two services. For example, for [✂] the evidence suggested that they relied on BT for [✂✂] of their total backhaul requirements (i.e. they only self-supplied or procured backhaul from third parties for less than [✂] of their circuits).[357] This compared to BT's share of the AISBO market (up to 1Gbit/s) of around 62% as of March 2011. These figures showed that BT's shares for LLU backhaul (to [✂]) and for other AISBO services were both well in excess of the threshold for assumed dominance of 50%. We said that, if we were to assess market power for LLU backhaul and other AISBO services separately, we would be likely to conclude that BT was dominant or had SMP in the supply of both services. We noted that there were some differences in our estimates of BT's shares for LLU backhaul and AISBO services, but we did not attach particular significance to these differences given the nature of our estimates.[358]

4.414 We also looked at whether the pattern of geographic variations in competition in the provision of LLU backhaul was different to the pattern observed in the provision of AISBO services. To assess whether competitive conditions were similar for AISBO services and LLU backhaul, we looked specifically at the WECLA (the area in and around London which we proposed to define as a distinct geographic market for some services). We considered the scope for competitive provision of backhaul from

[357] Based on the evidence in Figure 4.6, we consider that BT's share is likely to be up to [✂].

[358] We base our LLU service share estimates only on two LLU operators [✂] as we could more easily identify circuits used for LLU backhaul. For this reason, we consider that it is appropriate only to make fairly high level comparisons (i.e. that both for AISBO and LLU backhaul are well in excess of the threshold for a finding of dominance).

the local exchanges where LLU providers were present in the WECLA. This analysis confirmed that the network infrastructure which OCPs were using to compete to provide leased lines in the WECLA was also likely to provide scope for competition in the provision of LLU backhaul. In particular, we observed that two or more alternative operators were present in 98% of the 40 BT exchanges (where 46 MDF sites were located) within the WECLA and that at least one alternative operator was present in 100% of these exchanges. We considered that other factors which might generate geographic variations in competitive conditions for leased lines were also likely to apply to LLU backhaul. Hence, the comparison of shares, together with the similarity of entry and cost conditions, suggested that the competitive conditions between LLU backhaul and other AISBO markets were similar.

4.415 We provisionally concluded that there did not appear to be good reasons to think that competitive conditions in LLU backhaul in any given geographic area would differ from those for other AISBO services.

Ethernet in the First Mile (EFM)

4.416 In the June BCMR Consultation, we described EFM as a retail low bandwidth AI service aimed at business users. We said that the only real difference between EFM-based retail Ethernet and other low bandwidth AI services was the use of copper in the access segment (and corresponding lower costs of using existing copper access rather than new fibre).

4.417 In our retail assessment we included EFM in the AI market. We noted that the wholesale inputs used to deliver an EFM-based retail Ethernet service were bonded copper pairs (multiple copper access lines) and Ethernet backhaul. We also noted that copper access lines were available to all CPs due to the requirement on BT to provide unbundled local loops at regulated charges subject to charge controls (which was a remedy arising from BT's SMP in the wholesale local access market). Based on our assessment that LLU backhaul should be included in the AISBO market we proposed that any Ethernet backhaul for EFM services also be included in the AISBO market.[359]

4.418 We noted that LLU backhaul and other AISBO products made use of the same underlying Ethernet connectivity. We also observed that there was no clear distinction in BT's new Ethernet services between circuits used for LLU or leased lines backhaul. Furthermore, our analysis suggested that there were similar competitive conditions in the provision of LLU backhaul and AISBO services. The same type of entry barriers and economies of scale and scope were faced, especially those relating to digging and ducting. On this basis, we proposed to define LLU backhaul as part of the AISBO market.

Responses to the June BCMR Consultation

4.419 Only BT commented specifically on our proposals to include LLU backhaul within the relevant AISBO and TISBO markets. However, in discussing the MISBO market definition, TalkTalk considered that it will require MISBO services to serve LLU backhaul requirements in future.

4.420 BT agreed that LLU backhaul should not be in separate product market[360] but considered that we have not properly assessed conditions of competition for these

[359] This is on the assumption that EFM is provided over Ethernet backhaul links.

[360] Page 22 of BT's response.

customers. BT considered that LLU backhaul is defined by a very specific set of 2,000-2,500 competitive exchanges and the market is concentrated in the hands of two very large buyers. BT submitted that OCPs supplying business connectivity do not in general use BT's local exchanges as their primary aggregation points, so there is no OCP equivalence between LLU backhaul and backhaul of business connectivity. BT argued that the competitive conditions for LLU backhaul are distinct as the highly focused number of BT exchange sites makes the targeting of these sites by small infrastructure players that much easier.

Ofcom's view

4.421 No stakeholder has suggested that we change our product market definition in relation to LLU backhaul. However, BT commented that it saw competitive conditions for the supply of LLU backhaul as substantially different to the supply of access to general business service sites and the analysis of geographic boundaries is specific to this market.

Arguments that LLU backhaul is more competitive

4.422 We do not agree with BT's views that competition is *"that much easier"* for LLU backhaul. BT's main argument was that LLU backhaul faced different competitive conditions as it was confined to specific locations and demand was largely concentrated in the hands of Sky and TalkTalk.

4.423 Considering price differentials between LLU backhaul and other circuits, we do not see evidence that BT is pricing these services differently. As noted above, BT does not seek to distinguish LLU from other types of backhaul and it offers the same EAD and EBD services to LLU providers and OCPs.

4.424 While it is clearly the case that LLU backhaul is provided from specific locations (unbundled exchanges) and Sky and TalkTalk are indeed the largest consumers of these services, we do not see evidence of more extensive competitive provision. For example, in our discussion of access and backhaul, Figure 4.6, we highlighted that BT still accounts for [✂] of the LLU backhaul requirements from these two providers. There is limited self-supply or competitive provision by third parties.

4.425 However, the locations where CPs have competing network are likely to be in the largest urban centres. Also those locations where enterprise-focused CPs have invested in extensive network to deliver business connectivity will be the places where they will be most able to compete for LLU backhaul. This is because in these locations OCPs are likely to have extensive backhaul networks that either pass or are already interconnected with BT's exchanges. In this situation there are incentives to use that infrastructure to deliver similar backhaul connectivity to LLU providers as they do to enterprise and other retail demand making use of leased lines.

4.426 As noted in the June BCMR Consultation, there appears to be some convergence of Ethernet backhaul services from business customers using point to point Ethernet links, VPNs using Ethernet tails, EFM solutions and for the backhaul of mobile and broadband traffic. The economies of scope associated with converged Ethernet backhaul are important as they may limit the scope for competitive backhaul towards the dense population centres where OCPs have significant presence across a number of services. This is likely to make the competitive conditions for LLU

backhaul and generic leased lines services more rather than less similar.[361] Nevertheless, in our geographic section, we have considered specifically the scope competition related to LLU backhaul reflecting OCP presence both in our geographic and market power assessment.

Demand for MISBO services by LLU providers

4.427 We also note TalkTalk and Sky's comments over the use of very high bandwidth services (i.e. Ethernet services above 1Gbit/s) for LLU backhaul. To the extent that LLU providers utilise very high bandwidth leased lines going forward, then LLU backhaul using services above 1Gbit/s would also be part of the MISBO market.

4.428 We consider that the reasoning set out above related to the inclusion of LLU backhaul demand within the AISBO market would also hold in relation to MISBO services. For example, the services offered in the MISBO market do not differentiate between LLU backhaul providers and other operators; and we would expect limited differences in competitive conditions as the same type of entry barriers (digging and ducting) are likely to exist.

Conclusion

4.429 In light of our analysis in the June BCMR Consultation and stakeholder responses, we have concluded it is appropriate to retain our proposals to define LLU backhaul as part of the AISBO product market.

4.430 We consider that LLU backhaul and other AISBO and MISBO products make use of the same underlying connectivity. We observe that BT's new Ethernet services do not differentiate between circuits used for LLU or leased lines backhaul which reflects the technical similarities in the requirements for Ethernet connectivity used to support LLU backhaul and other leased lines services.

4.431 Furthermore, our analysis suggests similar competitive conditions in the provision of LLU backhaul and, respectively, AISBO and MISBO services. The same type of entry barriers and economies of scale and scope are faced, especially those relating to digging and ducting.

4.432 On this basis, our proposal is to define LLU backhaul as part of the AISBO and MISBO product markets.

Issue 4c: Leased line inputs for other retail applications

4.433 In the June BCMR Consultation, we noted that leased lines were used in a number of niche retail applications as well as to provide standard business connectivity services. These included:

[361] We note that in the context of its comments on access and backhaul, BT argued that the OCPs' aggregation points for supplying business sites (i.e. a location where traffic or circuits from a number of individual access circuits might be combined on higher capacity backhaul links) are not coincident with BT local exchanges where LLU backhaul is needed. But if BT's comments were correct then it might suggest that LLU backhaul would be less rather than more competitive than standard leased lines backhaul as:

- CPs may well be providing connectivity to business sites, by-passing BT's local exchanges entirely;
- If competitive provision of leased lines was not coincident with LLU exchanges then there would be less scope for competitive provision in LLU backhaul.

- *CCTV circuits:* dedicated Ethernet circuits used to backhaul traffic from CCTV camera locations to CCTV control rooms.

- *Broadcast circuits:* used by broadcasters to send data files and video clips and to stream live video to their newsrooms. These circuits could be permanent links in established broadcast locations (such as sites outside of the Houses of Parliament) or mobile broadcast units.

- *Street access circuits:* circuits used to deliver bandwidth from a local exchange to outdoor terminating units in remote street furniture such as lampposts and street cabinets. Once in place, these connections were then used with low-powered radio transmitters to deliver wireless networks in urban areas.[362]

4.434 We considered whether to include these services in either the AISBO or TISBO markets based on the following criteria:

- *Technical assessment:* we looked at the particular wholesale service requirements needed to meet demand for these retail services; and

- *Demand and supply-side substitution:* we considered direct demand or supply-side constraints arguments (as these services served retail markets separate to the AI or TI markets we did not consider derived demand arguments based on 'indirect' demand constraints);

4.435 As a consequence of the analysis below, we proposed not to include any of these services in either of the AISBO or TISBO product markets.

Technical assessment

4.436 We discussed the differences in the interface service types offered by CCTV, broadcast access and street access circuits.

CCTV circuits

4.437 We considered that CCTV circuits were in many ways technically similar to, but were not identical to, the dedicated Ethernet end-to-end services which were included in the AISBO market. We considered the key difference to be in the type of Network Terminating Equipment ("NTE") used. This NTE was designed to support specific Phase Alternate Line (PAL) video signals and to allow various signalling, monitoring and video compression capabilities.

4.438 We noted that use was increasingly being made of CCTV camera units and converters that enabled CCTV signals to be transmitted over IP and hence potentially over standard broadband connections. We discussed the potential implications of this for our market definition.

[362] Such wireless connectivity might be for public information points - such as cinema listings and parking information - connectivity at popular events and remote telemetry such as traffic congestion monitoring. Such services are often also used on a temporary basis, to provide increased wireless connectivity in particular locations (for example at music festivals). See for example, Openreach's product descriptions for further detail: http://www.openreach.co.uk/orpg/home/products/ethernetservices/streetaccess/streetaccess.do

Broadcast Access

4.439 We noted that, like CCTV circuits, broadcast access services were technically similar, but were not identical to, AISBO circuits, a key difference being the NTE used. In the case of broadcast access services, specialised NTE was needed to ensure seamless integration with the existing video equipment or networks of television, media and production companies.

4.440 We explained that this NTE was often configurable to support multiple video channels over a single fibre (either in one direction or multiple directions). Circuits could be provided to permanent or temporary (mobile) broadcast locations. The services offered were often required to support specific broadcasting interfaces.[363]

Street Access

4.441 As with broadcast access circuits, street access circuits were seen as addressing very specific retail demand requiring secure low-powered radio transmitters. We suggested that the reasons for using this type of connectivity might include concerns over security and vandalism and resilience in outdoor environments.

4.442 Street Access services could also be tailored to temporary outside broadcast applications. For example, BT offered local circuits to radio transmitters and associated mobile NTE (i.e. a van). Such services might be used to support additional mobile capacity or Wi-Fi for example at music festivals or other large public events.

Demand and supply-side substitution

4.443 In light of the above technical differences in NTE, we considered whether demand or supply-side substitution might suggest including any of these services in our AISBO market.[364]

CCTV

4.444 We considered that, to the extent that there were differences between the NTE used for AISBO circuits and CCTV Access circuits, then these and the costs of making the necessary adaptations were likely to limit demand-side substitution between them.

4.445 We noted that the use of CCTV camera units and converters that enable CCTV signals to be transmitted over IP technologies would enable an enterprise to use standard asymmetric broadband connections (such as ADSL) to deliver CCTV signals. We thought that the emergence of technologies that could be used to deliver CCTV circuits could in principle point to a wider market for CCTV (consisting of ADSL and standard CCTV interfaces).[365] This was because end-users on standard CCTV connections could potentially find IP-based solutions a good substitute. But the ability to use ADSL technologies to provide CCTV was not an argument for the inclusion of

[363] For example Openreach's service supports customer video signals at 270Mbit/s (SDI or ASI), 1.485 Gbit/s (HD-SDI) or 3GBit/s (HD-SDI) and 140Mbit/s framed data.

[364] We compare these services to AISBO as Openreach makes use of its Ethernet network to provide these circuits.

[365] It does not necessarily follow that CCTV circuits are part of an asymmetric broadband market. We note that there will be a large installed base of CCTV services; many customers would be unwilling to invest in new camera equipment or signal converters to enable them to rely on asymmetric broadband connections rather than existing CCTV circuits.

wholesale inputs to CCTV services in the same market as AISBO services. This was because ADSL services (which can now be used for CCTV) were not in general a good substitute for the Ethernet services that make up the AISBO market, and were themselves outside AISBO markets.

4.446 For supply-side substitution to be relevant to market definition, we noted that there must be providers of AISBO circuits, not supplying CCTV Access circuits, who would start supplying the latter rapidly and at low incremental cost in response to an increase in the price of CCTV circuits above the competitive level. We thought that the extent of the technical similarity of AISBO and CCTV Access circuits might suggest that supply-side substitution was, in theory, possible but that it was not in itself sufficient to establish that they were part of the same market.

4.447 Finally, we noted that BT's pricing of CCTV circuits was also distinct to other Ethernet access links. For example, the fixed annual rental charge for a CCTV circuit ranged from £550 to £700 per annum (compared to just over £2,000 per annum for an EAD Local Access circuit). This provided some evidence that the two services were sufficiently distinct that they were not in the same product market.

4.448 We therefore proposed to continue to identify CCTV circuits as a separate market.

Broadcast access circuits

4.449 Like CCTV circuits, broadcast access services were technically similar, but not identical to AISBO circuits, a key difference being the NTE used. In the case of broadcast access services, specialised NTE was needed to ensure seamless integration with the existing video equipment or networks of television, media and production companies.

4.450 Another difference between broadcast access circuits and leased lines was that broadcast access services could be used on a temporary basis, for example, for a major sporting event lasting a few weeks, using outside broadcast units. By contrast wholesale inputs used for leased lines were typically provided over dedicated fibre in fixed locations. Even permanent broadcast circuits in a fixed location were likely to be used by broadcasters in a different way to the leased lines used by business customers.

4.451 We thought that these technical differences limited the possibility of demand-side substitution between broadcast access circuits and AISBO circuits as broadcast circuits were presented with such specialist interface types.

4.452 The nature of broadcast access circuits (significant differences in interface and bandwidths) made price comparisons with standard AISBO services quite difficult.[366] We noted, however, that the annual fixed rental charge for a broadcast access circuit (with 140Mbit/s interface) ranged from £6,500 to just over £10,000 per annum (depending on the number of video channels supported). The fixed rental charges for an EAD 100Mbit/s and 1Gbit/s were just over £2,000 and just under £5,000 per annum respectively. The significant price differentials did not suggest including these services in the same market.

[366] We also note that the caveats associated with analysing markets based on BT's wholesale prices (as noted in Section 3).

4.453 We considered that this type of network access (broadcast access) was distinct from dedicated fixed leased lines connectivity and therefore that broadcast access circuits were outside the market.[367]

Street access circuits

4.454 We considered that, as with broadcast access circuits, street access circuits addressed a very specific retail demand in outdoor locations where there were concerns over security and vandalism and resilience. Consequently, the access element of these connections was likely to be addressing significantly different requirements to other circuits used for the delivery of dedicated fixed connectivity to business users.

4.455 Given these requirements for secure and robust access infrastructure, we did not think that standard leased lines connections would be a good substitute. On this basis, we considered that this type of network access was distinct from dedicated fixed leased lines connectivity and therefore was likely to be a reason why street access circuits were outside the market.

4.456 We also considered that BT's pricing of Street Access circuits was distinct to other Ethernet access links. For example, the fixed annual street access rental charge was around £600 per circuit per annum (compared to just over £2,000 per annum for an EAD Local Access circuit). BT also offered temporary street access services, for which BT charged around £9,500 per 1Gbit/s circuit provided (plus £1,500 for NTE housed in a van). These charges compared to an annual rental charge of £5,000 for a standard Ethernet access service (such as an EAD Local Access service).

4.457 We noted that the structure and nature of a one-off circuit charge for a temporary street access circuit were quite different to those of a permanent fixed link. But this served to demonstrate that these services were addressing fundamentally different demand to AISBO services. In the case of more permanent Street Access services, the pricing evidence showed significant differences to AISBO services. This provided evidence to support the identification of street access circuits as a separate market.

4.458 In light of our technical assessment and available evidence on demand and supply-side substitution we proposed not to include CCTV, Broadcast Access and Street Access services in our AISBO or TISBO markets.

Responses to the June BCMR Consultation

4.459 BT agreed that CCTV and broadcast access services are outside the market, but it considered that we should also exclude all other AISBO/MISBO circuits used in broadcast TV networks.[368] On the other hand, CWW argued that CCTV, broadcast access and street access services could fall within the AISBO market.[369] Geo and [✂ ✂] also questioned aspects of our proposals.

4.460 CWW argued that the nature of these applications and the very fact that they are 'niche' creates higher barriers to entry in comparison to generic AI services. Hence, a

[367] We note however that broadcast customers may make use of more generic leased lines products such as Ethernet links or WDM. In these instances we would include circuits sold to broadcasters in our wholesale product market definition.

[368] Paragraph 6d, page 22, (Response to Q2).

[369] Page 35 of non-confidential response.

provider would not find it economic to enter the market solely with the view to providing these niche services. It presented further arguments to include these services in the AISBO market:

- pricing today is based on competition rather than cost orientation obligations. For example with CCTV, access charges (which are competing with broadband alternatives) are particularly low.

- for broadcast access circuits charges are significantly above the standard AI charges. CWW argued that this reflected both the higher costs of the required NTE and BT's competitive position as the primary supplier.

4.461 CWW also noted that EAD is capable of being ordered to terminate at street furniture. CWW argued that there is no reason why EAD cannot be used to run CCTV. It is just that BT's own business has some specific requirements and it decided to develop specific products rather than enhance WES to meet them.

4.462 CWW noted that it uses its own fibre for CCTV, broadcast services or connecting wireless routers and it included those circuits in the information it provided Ofcom. It does not distinguish between these specific uses. It considered that BT's volumes for these circuits should be included to ensure that the market analysis is correct.

4.463 Geo was also concerned about the exclusion of Openreach's CCTV Access, Street Access and Broadcast Access. Geo noted that BT's Broadcast Access service offers HD services at 1.5 Gbit/s or 3 Gbit/s delivered via WDM terminal equipment, which are not distinguishable from other MISBO products any more than other specialist products, such as the MEAS product which is used for mobile backhaul circuits, are distinguishable from other Ethernet services. Geo submitted that had Broadcast Access circuits been included in our analysis this may have had an impact on the SMP analysis in the MISBO market, leading perhaps to a smaller area in which BT is found not to have SMP.[370]

4.464 [✂] noted Ofcom's proposal not to include CCTV, Broadcast Access and Street Access in either AISBO or TISBO markets (per paragraph 4.332 of the June BCMR Consultation) based upon analysis of demand and supply side characteristics, but it did not believe that sufficient evidence to support this conclusion had been presented.

Ofcom's view

4.465 BT called for all AISBO and MISBO services sold to broadcasters to be in a separate market, whereas Geo argued that broadcast services delivered via WDM terminal equipment are not distinguishable from other MISBO products any more than other specialist interfaces. [✂] and a number of other stakeholders' also questioned the evidence we relied upon not to include these services in the AISBO, TISBO or MISBO markets.

4.466 As set out above, in the June BCMR Consultation we noted:

- Technical differences that meant that the interfaces and equipment used to support CCTV, Broadcast Access and Street Access were different to generic leased lines; and

[370] Page 2 of response.

- Differences in the pricing structure reflecting the difference in the nature of these services.

4.467 As noted in the above paragraphs following a lack of comments on our proposals in the CFI, we did not consider wider evidence, such as the extent of any variations in competitive conditions for these services. However, in light of stakeholders' views we have sought to consider available evidence.

CCTV circuits

4.468 We think that our analysis of CCTV services as presented in the June BCMR Consultation is correct.

4.469 In relation to technical differences, we noted in the June BCMR Consultation that many existing CCTV circuits have traditionally been delivered across dedicated links with specific interfaces designed to deliver CCTV signals. However, CCTV technology has evolved and increasingly relies on IP-CCTV over standard broadband links (e.g. ADSL connections). In the June BCMR Consultation we argued that this development would tend to support rather than undermine the case for CCTV falling outside of either the AISBO or TISBO markets.

4.470 As noted by CWW, the emergence of IP-CCTV appears to be a driver for the competitive pricing of CCTV (over traditional technologies). In our retail assessment, we found that asymmetric broadband was not in either the AISBO or TISBO market, whereas CWW's argument suggests more intensive competition between asymmetric broadband and CCTV circuits. This suggests that the competitive conditions for the supply of CCTV differ to those seen for AISBO or TISBO markets in general.

4.471 Indeed, the available pricing evidence seems to support this view. For example, as we noted in the June BCMR Consultation, BT's fixed annual rental charge for a CCTV circuit range from £550 to £700 per annum (compared to just over £2,000 per annum for an EAD LA circuit).[371]

4.472 Hence, we consider that the available evidence, including developments such as increased competition from broadband, provide support for a separate market.[372]

MISBO services sold to broadcasters

4.473 Consistent with our proposals in the June BCMR Consultation, we conclude below that we do not consider it appropriate to identify a separate market for generic MISBO services sold to broadcasters.[373]

4.474 In support of this view, we note that vendors explicitly market their WDM equipment as capable of supporting multiple interfaces including broadcast applications.[374] We

[371] An alternative lower bandwidth Ethernet solution would be EFM, but according to our desk research presented in Figure 3.8 the lowest price of an EFM solution is £1,500 for 2Mbit/s.

[372] CWW was concerned that our circuit counts might include CCTV circuits, which we have excluded where these have been identified by CPs.

[373] In Footnote 229 of the June BCMR Consultation we noted that: *"... broadcast customers may make use of more generic leased lines products such as Ethernet links or WDM. In these instances we would include circuits sold to broadcasters in our wholesale product market definition."*

also consider that the relative costs of providing very high bandwidth services to broadcasts are not likely to vary significantly (on the basis that the services will use similar underlying inputs). Furthermore, given the likely value of broadcast customers, the conditions of competition are not likely to vary significantly between circuits sold to enterprise customers and broadcasters (they all require similar scalable capacity at very high bandwidths).

4.475 Therefore, we cannot identify specific features of generic MISBO circuits delivered to broadcast TV networks that suggest treating them differently. The circuits delivered to business enterprise customers and broadcasters are both supported by currently available WDM technology and the nature of these customers does not suggest fundamentally different competitive conditions in the supply of services to those customers. Hence, the available evidence does not provide a good basis for excluding these circuits from our assessment.

4.476 We note that broadcast customers may make use of more generic leased lines products such as Ethernet links or WDM. In these instances, we would include generic leased lines services circuits sold to broadcasters in our wholesale product market definition.

AISBO services sold to broadcasters

4.477 BT has argued that AISBO services sold to broadcasters are also in a separate market. We do not agree with this view:

- Broadcasters demanding AISBO services may not necessarily only use them for broadcast applications (they still require connectivity between their offices for other applications such as general transfer of data and voice).

- In addition, technology developments mean that some broadcasters are investing in their own media converter equipment. This allows them to convert broadcast signals such as DVB-ASI format[375] into IP/Ethernet format so that they can use generic 100Mbit/s and 1Gbit/s Ethernet connections to deliver or distribute content without further specialist broadcast interfaces.

4.478 Therefore, broadcasters making use of AISBO circuits for broadcast applications may simply require standard Ethernet circuits from CPs in the same way that business customers running their own applications make use of Ethernet circuits as access tails. Given that generic Ethernet could be used to supply to enterprise customers or broadcasters to provide necessary dedicated capacity, we do not think that the competitive conditions associated with providing services using Ethernet links are likely to vary between these customer types.

4.479 The move from specific broadcast access networks using specific broadcast access services (e.g. using DVB-ASI format) to native Ethernet services could in principle suggest that we include broadcast access circuits delivered with specialist interfaces within the AISBO market definition. However, we consider that any competitive constraint that exists would work in one direction (i.e. there would be an asymmetric

[374] See for example the marketing literature for equipment vendors: http://www.fujitsu.com/downloads/TEL/fnc/datasheets/flashwave7420.pdf and CPs such as Exponential-e: http://www.exponential-e.com/solutions/broadcast

[375] DVB-ASI format is an asynchronous serial interface format that can carry one or more compressed video (standard or high definition) or audio program streams.

constraint) as broadcast access services delivered with specific interfaces would not be a good substitute for AISBO services.

4.480 Hence, we propose to exclude broadcast access circuits as a constraint in the AISBO market. [376] On the other hand, AISBO circuits sold to broadcasters (with standard Ethernet interfaces) fall within our market.

Street access

4.481 In relation to street access circuits, these circuits are used to deliver bandwidth from a local exchange to outdoor terminating units in remote street furniture such as lampposts and street cabinets. Once in place, these connections are then used with low-powered radio transmitters to deliver wireless networks in urban areas.[377] As set out in the June BCMR Consultation:

- we consider that the nature of the service delivered over street access furniture serves fairly unique demand requirements – namely outside connectivity applications that required secure and rugged connectivity.[378]

- the structure of pricing for these services also suggested they are distinct from generic Ethernet services[379]

Defining niche markets separately

4.482 CWW argued that the fact that the services discussed above are niche services creates a higher barrier to entry in comparison to generic AI services. Hence, a provider would not find it economic to enter the market solely with a view to providing these niche services.

4.483 We recognise that entrants may be unlikely to construct a network solely to provide niche services such as those described above. This is because there are economies of scope in the provision of these and other services using, where possible, shared network infrastructure. This means that an operator which attempted to supply these niche services on a stand-alone basis would have higher costs than an operator providing a wider range of services and benefiting from economies of scope. Indeed, as noted earlier, economies of scope (and scale) are prevalent in telecoms networks and hence we observe that many CPs supply a range of network services (including leased lines) over common network infrastructure such as shared ducts and fibre.

[376] Given that the market is moving towards AISBO services, this provides some comfort that the price of broadcast access services would be constrained by Ethernet services.

[377] Such wireless connectivity might be for public information points - such as cinema listings and parking information - connectivity at popular events and remote telemetry such as traffic congestion monitoring. Such services are often also used on a temporary basis, to provide increased wireless connectivity in particular locations (for example at music festivals). See for example, Openreach's product descriptions for further detail: http://www.openreach.co.uk/orpg/home/products/ethernetservices/streetaccess/streetaccess.do

[378] http://www.openreach.co.uk/orpg/home/updates/briefings/ethernetservicesbriefings/ethernetservicesbriefingsarticles/eth04712.do

[379] BT's pricing of Street Access circuits is also fairly distinct to other Ethernet access links. For example, the fixed annual street access rental charge is around £600 per circuit per annum (compared to just over £2,000 per annum for an EAD Local Access circuit). BT also offers temporary street access services, for which BT charges around £9,500 per 1Gbit/s circuit provided (plus £1,500 for NTE housed in a van). These charges compare to an annual rental charge of £5,000 for a standard Ethernet access service (such as an EAD Local Access service).

4.484 This does not mean that all services capable of being provided over a shared network should be regarded as part of a single product market. As we explain in Annex 3, we define markets by identifying constraints on the price setting behaviour of operators arising from demand- and supply-side substitution, and we may also take into account homogeneity of competitive conditions. On this basis, we define a number of distinct product markets for various leased line services where these are not close demand- or supply-side substitutes and there are differences in competitive conditions, even though they may often be provided (in part) using a single shared network.

4.485 Similarly, on this basis, we find that street access, CCTV and broadcast access services are not within the AISBO market and would not constrain the prices of AISBO services, which is the key issue faced.[380] Therefore, we have excluded them from the AISBO product market.

Conclusion

4.486 In light of our technical assessment and available evidence on demand and supply-side substitution we conclude that it is appropriate not to include CCTV, Broadcast Access and Street Access services in the AISBO, TISBO or MISBO markets.[381]

Issue 5: Bandwidth

Our proposals in the June BCMR Consultation

4.487 We proposed a number of bandwidth breaks in retail AI, TI and MI markets. Under Issue 5, we considered whether these breaks also applied to wholesale AISBO, MISBO and TISBO services.

4.488 We therefore considered whether the logic underpinning the demand and supply-side analysis used to inform our retail product market definition applied at the wholesale level to AISBO, MISBO and TISBO product markets. We also considered whether any variations in competitive conditions lent support to our product market definitions.

4.489 Our preliminary conclusion was that the bandwidth breaks identified at the retail level for AI and TI services and MI services (above 1Gbit/s and WDM at all bandwidths) were appropriate for the related symmetric broadband origination services.

4.490 We explained why we thought it appropriate to derive the bandwidth breaks in wholesale terminating segment markets from the similar breaks we identified in downstream retail markets. On the basis of our retail product market definition, this suggested the following TISBO product markets:

- Low bandwidth TISBO (up to and including 8Mbit/s);
- Medium bandwidth TISBO (above 8Mbit/s up to and including 45Mbit/s);
- High bandwidth TISBO (above 45Mbit/s up to and including 155Mbit/s); and

[380] See paragraphs 4.443 – 4.458 and the further comments in paragraphs 4.465 – 4.481 for a discussion of demand- and supply-side substitution in relation to these services.

[381] As set out above, more generic leased lines services sold to broadcasters are not excluded from the AISBO or MISBO market definitions.

- Very high bandwidth TISBO (at 622Mbit/s).

4.491 We identified a low bandwidth retail AI product market at up to and including 1Gbit/s. Above 1Gbit/s, we identified a single market for all interface types including Ethernet and other interfaces and all WDM-based services. This suggested the following wholesale markets:

- Low bandwidth AISBO (up to and including 1Gbit/s); and
- MISBO (for WDM-based services at all bandwidths and leased lines services provided delivered with any interface above 1Gbit/s).

4.492 We noted that there was a close relationship between the bandwidth of a retail circuit and that of the wholesale circuit which a CP would use to deliver it, and this was reflected in our proposals for wholesale markets. Hence, where we defined separate markets for retail circuits of different bandwidths, we also defined separate markets for the wholesale circuits of the same bandwidths which were used to provide the retail services.

4.493 The definition of a retail low bandwidth AI market and a separate retail high bandwidth AI and WDM market reflected the fact that the equipment needed for services at above 1Gbit/s (e.g. 2.5Gbit/s and 10Gbit/s Ethernet and WDM-based solutions) was significantly more expensive than the equipment needed for services at bandwidths up to 1Gbit/s. Therefore, it would be inefficient for a wholesale provider to supply a low bandwidth retail customer with demand for 1Gbit/s or below with higher capacity equipment.

4.494 In addition, we explained that evidence on variations in competitive conditions supported the proposed bandwidth breaks for AISBO and TISBO markets. We did not consider it relevant to analyse competitive conditions in the supply of MISBO services by bandwidth because the modular nature of these services meant that variations in competitive conditions or a break in the chain of substitution above 1Gbit/s were unlikely.[382]

Bandwidth breaks for terminating segments

4.495 Our assessment of competitive conditions lent support to the breaks we identified for retail TI and AI and hence for AISBO and TISBO markets. In particular, the evidence suggested the following differences in competitive conditions:

- **Medium and High bandwidth TISBO services (34/45Mbit/s and 140/155Mbit/s):** for both markets we observed that competitive conditions in the London area were broadly similar (as both markets were competitive). For both 34/45Mbit/s and 140/155Mbit/s there was often little alternative to BT outside the metro areas. However, there were some apparent differences in the rest of the UK, reflected in BT having 74% share at 34/45Mbit/s and 49% share at 140/155Mbit/s. So it appeared that CPs had, in some cases, been able to overcome the high barriers to entry and expansion for 140/155Mbit/s. On this basis we considered that it remained appropriate to identify a break in the market between 34/45 and 140/155Mbit/s services.

[382] At any particular point in time an end-user will have an installed amount of bandwidth. However, given the scalable nature of demand from retail WDM customers, such bandwidth requirements can change quite quickly. On this basis it would be difficult to identify a break in the chain of substitution or to analyse competitive conditions meaningfully between customer types based on their current bandwidth demand.

- **High (155Mbit/s) and Very High (622Mbit/s) bandwidth TISBO services:** the competitive conditions for 155 and 622Mbit/s differed significantly. One reason for this difference was that the revenue available from even a single 622Mbit/s circuit made it more likely that it would be economic for a competing operator to supply a 622Mbit/s circuit than a 155Mbit/s circuit. The deterrent effect of sunk costs on potential entry was likely to be more significant in the latter market. This was supported by evidence that OCPs were able to self-supply 622Mbit/s circuits, which had resulted in low market shares for BT at the wholesale level. BT appeared to have around 5% of the market for TISBO services above 155Mbit/s, but around 49% of 155Mbit/s TISBO in the UK excluding the Hull area and the WECLA.

- **Low bandwidth TISBO services (up to and including 8Mbit/s):** there was strong evidence that circuits up to and including 2Mbit/s faced different competitive conditions to higher bandwidth markets. In particular, we estimated that BT had a very high share of the TISBO market (86% for the UK excluding the Hull area).

- **Low bandwidth AISBO (up to and including 1Gbit/s) and very high bandwidth MISBO services:** the analysis of current competitive conditions tended to support our proposed finding of separate markets. In the London area (the WECLA), our calculations suggested that BT's share of the wholesale AISBO services at 1Gbit/s and below was somewhere above 41% compared to only 15% for the MISBO market.[383] In the rest of the UK (excluding Hull), the competitive conditions were more similar on average, although we suggested that there might be pockets of competition in the MISBO market.

4.496 Overall, the evidence on competitive conditions in the supply of different bandwidth AISBO, TISBO and MISBO services supported the proposed wholesale product market definitions.

Responses to the June BCMR Consultation

4.497 Below, we summarise the points made by respondents which are relevant to Issue 5, and explain how we have taken them into account in our assessment.

4.498 CWW, Telefónica, Zen Internet and [✂][384] agreed with the proposed wholesale market definitions. BT accepted that there are breaks in the market, in particular between AISBO (1Gbit/s) and higher bandwidths.[385] It also made a number of other comments on our overall approach.[386]

4.499 BT did not object explicitly to the bandwidth breaks identified, but it considered that there should be a further break in the market for AI 1Gbit/s and services below 1Gbit/s. It also suggested that the competitive conditions for 1Gbit/s services are significantly different to services below 1Gbit/s, which may justify separate

[383] We noted in the June BCMR Consultation that, even if we did not combine AI services above 1Gbit/s with WDM, we would still observe similar competition conditions in London (and in the rest of the UK) for these services. We estimated for example that BT's service share in WECLA for AI high bandwidth services (above 1Gbit/s) was around 20% compared to 14% for WDM-based services.

[384] [✂] noted that the primary market separation should be at a physical one and not based on bandwidth breaks. However, it submitted that if bandwidth breaks are to remain, then the proposed breaks remain logical and it welcomed the inclusion of MISBO.

385 Paragraphs 1a and 1b, page 21.

[386] Paragraphs 77 – 81, page 136.

consideration of the AISBO market at 1Gbit/s particularly in the London and other metro areas (although BT did not argue explicitly for a break in the market at 1Gbit/s).[387] BT also argued that there should be an upper limit to the MISBO market (i.e. up to and including 10Gbit/s).

4.500 Although BT did not object to the breaks we have identified, it did not agree "with the methodology used and the prescription with which the definitions are applied". In particular, it argued that *"there is an inconsistency in the mapping of the retail bandwidth breaks in the wholesale market arising from the fact that TISBO, AISBO and MISBO have different relationships with respect to the end-to-end service:*

- *TISBO is a segment of an end-to-end connection – so it is a single origination segment;*
- *AISBO is generally an aggregate of all traffic to a site – it is an aggregate of origination segments; and*
- *MISBO is generally a direct interconnection between two major sites – it is not an origination service but instead it is an end-to-end segment*."

4.501 BT argued that TISBO bandwidth is incorrectly defined because *"…the origination segment is not the essential wholesale service, but it is the aggregate pipe which is not identified at all in Ofcom's analysis. However, it is the bandwidth of this wholesale aggregate pipe that should be tested for breaks in the market."*

4.502 BT considered that MISBO should be treated as a single service, wholesale and retail, so the retail analysis maps to the wholesale bandwidth breaks. However as set out under Issue 2 above, BT argued that there should be an upper limit to the MISBO market (i.e. up to and including 10Gbit/s).

4.503 BT suggested that AISBO bandwidth is *"the wholesale access pipe of aggregate bandwidth."* It stated that *"a co-incidence of two compensating errors in definition [means] that Ofcom's retail AI bandwidth breaks does indeed map to the wholesale analysis of bandwidth breaks".*

4.504 In relation to the AISBO market, BT explained its criticisms – in particular:

- BT argued that AI (wholesale) services are used to carry aggregate traffic to multiple sites, whereas we had compared the costs of bandwidths for individual point to point Ethernet links; and
- It highlighted issues associated with our assumptions as to how retail bandwidth demand maps onto demand/provision at the wholesale level.[388]

[387] See Paragraph1d, page 21. Also in Dotecon's report for BT it provided various arguments as to why our low bandwidth AI definition might be too broad. It argued that a consumer of a 1Gbit/s AI service is likely be very different, and paying a very different amount, to a consumer of a 10Mbit/s (or less) service. Incentives to build out to these customers will differ correspondingly. Therefore, it considered that once geography is considered, it is difficult to see that competitive conditions are necessarily similar at all locations at the two ends of the bandwidth spectrum.

[388] BT noted that the AI (wholesale) services considered are generally used to carry aggregate traffic to a site: while a PPC is a segment of a single end to end connection between a specific pair of end points. End to end connections, equivalent to PPCs, are not visible within multi-site Ethernet connections. Therefore, it did not

Ofcom's view

4.505 In the following paragraphs, we set out our response to BT's views as other stakeholders either agreed with our proposed bandwidth breaks or did not comment.

AISBO and TISBO product market definition

4.506 In relation to our identification of bandwidth breaks for AISBO services, BT did not object to our proposals to identify a break between 1Gbit/s and higher bandwidth services. It agreed that our retail product market definitions would map onto our wholesale product market definitions (even if it did not agree with our reasoning as to why this would be the case). Therefore, having confirmed in our retail assessment the bandwidth breaks for the retail product markets, we see limited practical significance to its comments on our AISBO definition. However, it commented on the case for assessing 1Gbit/s separately, which we discuss briefly below and in Section 3.

4.507 For the TISBO product market, having discussed this point with BT, our understanding is that it was arguing for an assessment of wholesale product markets based on the bandwidth of the 'bearer' circuits used to support the underlying connectivity. For example, if an operator were providing 45Mbit/s circuits from an end-user's two 'satellite offices' to a head office, the aggregate link supporting those two circuits to the head office location may well be an aggregated circuit (e.g. 155Mbit/s). One interpretation of BT's argument is that the potential for the aggregation of lower bandwidths on higher capacity links at the wholesale level could result in fewer bandwidth breaks (i.e. in a broader TI market at the wholesale level).[389] We consider, however, that a product market definition based on broader markets would be less appropriate than our more granular assessment which better captures differences in competitive conditions for TI markets. Our analysis in this review has shown there is a case for identifying separate TISBO product markets by bandwidth (as informed by our retail assessment) and further supported by evidence that there is greater competition at higher bandwidths than for lower bandwidths.

MISBO product market definition

4.508 BT argues that it is not currently selling the highest bandwidth services sold in the market, and that it remains an emerging market and hence the competitive conditions of 40Gbit/s and 100Gbit/s are different to 10Gbit/s. We consider that the nature of the services used to provide very high bandwidth requirements, in particular WDM services, is an important reason why, first, there should not be a break in the market between 10Gbit/s and 40 and 100Gbit/s (as BT suggests), and secondly, why we think that it is difficult to identify an upper bound to this market.

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consider that our analysis of retail markets had considering the 'real' retail AI services (mainly multi-site connectivity) at all, as captured by our focal product.

It argued that this will have an impact on bandwidth breaks as its wholesale Ethernet services (such as EAD) are significantly upstream from a true multi-site retail service. This means that the focal product that we analysed included a greater proportion of costs that are associated with the physical infrastructure dedicated to the particular customer site. BT argued that multi-site service shared infrastructure costs are likely to dominate bandwidth dependent costs (equipment) and because we only at look at EAD costs and do not consider multi-site services, our specific conclusions on AI bandwidth breaks at the retail level are invalid.

[389] As we note in Section 3, a similar argument would also apply to multi-site connectivity (i.e. whereby directionally this would point to broader markets by bandwidth).

4.509 Once WDM equipment is installed it gives the customer what we term 'scalable capacity', i.e. the ability to add multiple wavelengths of light over the same fibre. This means that additional bandwidth can be added relatively easily. As suggested by Virgin (see Issue 2 above) the scalability of WDM services does not fit well with a rigid bandwidth based market definition.[390] Therefore, any provider of WDM services (i.e. a CP providing 10Gbit/s over WDM) would effectively be "present" at all bandwidths up to the current upper limits achievable with that equipment. The wide range of bandwidths that WDM-services are capable of delivering means that we would find it difficult to find a break in the 'chain of substitution' for services at different bandwidths.[391]

4.510 BT argued that it does not sell WDM-services with wavelengths of 40Gbit/s or 100Gbit/s and only competing providers are offering WDM-services at those wavelengths. We have checked BT's own circuit information which suggests that although the maximum capacity of individual wavelengths provided to a particular customer site is often 10Gbit/s or below, the total bandwidth requirements of the customer to a particular site may well be above 10Gbit/s. This bandwidth requirement (above 10Gbit/s) to a particular site is supplied using multiples of either 1Gbit/s, 2.5Gbit/s or 10Gbit/s links. Therefore, BT is selling WDM services to end-users that are using multiple wavelengths to deliver a range of bandwidths above 10 Gbit/s. In these circumstances, a 40 or 100Gbit/s wavelength over the same link could offer a relevant constraint (and vice versa) where it is used, for example, to provide individual end-to-end capacity between two sites.

4.511 We note, in any case, that the mere fact that a particular CP does not currently offer WDM services at a particular bandwidth does not necessarily imply those services are in a different economic market. In this context, we consider that BT is still competing for bandwidths above 10Gbit/s as the WDM-services it provides to its customers are, by their very nature, capable of supporting multiple wavelengths (and the evidence on BT's retail sales is consistent with this view). It therefore follows that a CP currently providing a 10Gbit/s WDM-service would effectively be 'present' at all bandwidths up to the upper limits achievable with that equipment.

Assessment of the AISBO product market at 1Gbit/s

4.512 BT argued in its response to the June BCMR Consultation that there are differences in competitive conditions for AI 1Gbit/s services (in particular in London and other metro areas.[392] BT suggested that this justifies a separate product market for AI services at 1Gbit/s.

4.513 We have already considered BT's comments for a separate product market for AI services at 1Gbit/s in the context of our retail product market definition. In Section 3, we have concluded that it was not appropriate to define a separate product market. As our wholesale product market definition is based, in part, on derived demand from

[390] In particular the key reason for incurring the upfront cost of WDM-equipment is that it allows a wholesale customer to increase its capacity without installing new fibre and can allow up to 160 wavelengths (each with capacity of 1Gbit/s, 10Gbit/s or higher).

[391] By way of illustration, consider a business customer with WDM-equipment installed at its premises. This user could be using that capacity initially to support, for example, one wavelength delivering 10 Gbit/s. However, the equipment the customer already has installed has the potential to deliver far higher bandwidths. In this respect the customer could potentially add additional wavelengths to its existing service to deliver 4 x 10 Gbit/s (40Gbit/s) or 10 x 10 Gbit/s (100Gbit/s) services or far higher bandwidths. The customer could easily 'substitute' from using only 10Gbit/s to 40Gbit/s or 100Gbit/s or higher.

[392] Paragraph 26, page 10 of BT's response.

the retail level, we do not consider that it would be appropriate to define our wholesale market for AISBO services more narrowly (i.e. by identifying a separate AISBO 1Gbit/s market) than the retail product market for AI services (based on bandwidths).[393]

Ofcom's conclusions

4.514 In light of stakeholders' responses and our conclusion that the bandwidth breaks identified in our retail assessment inform the relevant wholesale product markets, we have identified the following breaks by wholesale product markets:

- Low bandwidth TISBO (up to and including 8Mbit/s);
- Medium bandwidth TISBO (above 8Mbit/s up to and including 45Mbit/s);
- High bandwidth TISBO (above 45Mbit/s up to and including 155Mbit/s); and
- Very high bandwidth TISBO (at 622Mbit/s).
- Low bandwidth AISBO (up to and including 1Gbit/s); and
- MISBO (for WDM-based services at all bandwidths and leased lines services provided delivered with any interface above 1Gbit/s).

[393] Indeed, it is more likely that the direction of travel would be to define wider markets at the wholesale level as there is the potential for lower bandwidth services to be delivered over higher capacity links. Our market assessment suggests that we identify a break between AISBO low and very high bandwidth services (MISBO).