Vodafone Response to Ofcom Consultation:

Award of the 700 MHz and 3.6-3.8 GHz spectrum bands

Executive Summary

Vodafone supports Ofcom's twin goals of efficiently awarding spectrum required to support compelling 5G services, and improving mobile coverage. However, the two topics are largely unrelated, and in seeking to combine the two into a single initiative, Ofcom will fail to achieve its goals for either.

Ofcom's proposed coverage obligation, targeted at two of four operators, will at best improve coverage for only half of consumers. In fact, if Vodafone's reading of likely bidding behaviour is correct, only one quarter of consumers will benefit. The proposals will fracture the sector into coverage and non-coverage operators, and thwart Government aspirations for mobile service to reach 95% of UK geography – assuming the aspiration is for all citizens rather than those who choose a particular supplier. Worse, Ofcom's proposals will distort the award of spectrum, leading to inefficient allocation with both an opportunity cost and impact on Treasury revenues, the ramifications of which could outstrip the positive benefit that Ofcom predicts will result from improved coverage – Ofcom has failed to incorporate this into the impact assessment. This is a poor choice – disproportionate, inconsistent with Ofcom's duties and simply is not good enough when there are alternative solutions being offered by operators to improve coverage for all UK citizen consumers that have no impact on the award of spectrum.

5G represents the future of mobile communications. However, ✂. Ofcom must take action to safeguard against this.

In this response, we set out that there is an alternative approach that limits the award to spectrum hence assigns it efficiently, but mandates participation in a collaborative industry scheme – with effective Ofcom and Government oversight – to improve coverage for everyone. We urge Ofcom to cease its myopic dogma of auction bidding to take on coverage obligations, and instead to work with all of industry.

In the event that Ofcom is locked into an auction of coverage obligations, then we set out an alternative auction scheme that at least prevents the spectrum award being distorted, and allows greater flexibility in setting coverage obligations via the usage of regional awards.

In the absolute worst case that Ofcom rejects these better options, we provide suggestions that could at least mitigate the damage to competition that the current proposals could inflict.

✂

Contents

Introduction

Vodafone welcomes the opportunity to comment on Ofcom's latest proposals for the award of spectrum in the 700MHz and 3.6GHz spectrum bands. Award of this spectrum in an efficient and timely manner is essential to the UK's aspirations for continued leadership in the deployment of 5G technologies. The decisions made in the design of this award will have profound implications for the shape of mobile competition in the UK market for the next twenty years, given this is likely to be the last "mainstream" spectrum that will be auctioned for many years. Therefore, given its belief in the benefit of having four credible national mobile wholesalers, Vodafone is disappointed that Ofcom appears to be sleepwalking towards ✂ The resultant spectrum assignments will limit competition in high-bandwidth services offered to UK citizen consumers: Ofcom will fail in its statutory duties.

This response sets out that the auction as proposed would not achieve Ofcom's objectives of improved coverage and services for all. The critical problem is that Ofcom's proposals will hand insurmountable advantages to two operators, leaving the remaining two sidelined:

- BT will be awarded discounted spectrum because it is the only operator able to take on Ofcom's proposed coverage obligation and implied spectrum subsidy, this ability being a direct result of previous Government subsidies. As we will set out, Ofcom's proposed auction design will lead to an inefficient allocation of spectrum, both in the 700MHz and 3.6GHz bands.

✂. The likelihood is that Ofcom's proposals will bifurcate the market, damaging competition. We recognise that improving coverage is important, and Ofcom may conclude the price to be paid in terms of competitive harm is worth it for the gain in coverage. But Ofcom's analysis does not properly set out and test that question, and could not be used as it stands to support a final decision.

It needn't be this way. There are better and more proportionate ways for Ofcom to achieve its twin (but unrelated) goals of improving mobile coverage for everyone, and efficiently assigning spectrum in order that it ends up in the right hands to provide compelling 5G services. Ofcom can achieve this without risking the competitive market it has a duty to promote. There is no need to sacrifice spectrum efficiency in order to achieve improved coverage (and in any case, Ofcom's approach will fail to achieve that goal for most consumers). There is no need to risk destruction of what Ofcom accepts is a highly competitive mobile market. In this response, Vodafone sets out how Ofcom can meet all its regulatory goals.

This document is broken into three parts. In Part A, we set out how the proposals will fail to achieve Ofcom's statutory duties. Part B provides alternative approaches: we start with a proposal that fundamentally changes the paradigm that Ofcom should use to drive coverage, in the event that this Ofcom rejects these ideas, we propose a better auction format, and in the event that even that is unacceptable, we propose changes to mitigate the damage that the Ofcom proposals would cause. Finally, in Part C we provide answers to the consultation questions.

Part A: Flaws in Ofcom proposal

A.1 Improving coverage

It is time to get real about coverage. Everyone, whether a regulator, an MP, a member of the public or even employee of a mobile network operator, has found themselves singing the "*hello, hello, can you hear me now?*" song, as coverage glitches out when on the train or driving down a country lane. Everyone knows those locations where you wait a moment before initiating a call because coverage is poor. Everyone knows that location where streamed music breaks up, or a streamed video starts to buffer. Everyone wants this irritation to go away: the discussion is about how best to achieve that. This involves trade-offs, including whether we are prepared to pay the cost both in financial terms and in societal terms for example by welcoming more mobile masts.

The difficulty of improving coverage

Mobile network operators have to balance the revenues generated by heavily used masts with the costs of those that are less frequently used. Currently, fewer than half of deployed mobile masts generate sufficient revenues to cover their costs, and addressing not spots by adding extra masts will reduce that proportion further.

As Vodafone set out in its response to Ofcom's March 2018 consultation on coverage[1], operating a mobile network is not a venture which is attractive to investors, and even in that context the UK is not an attractive investment opportunity. Operators may be profitable, but Ofcom's own assessment indicates that the market remains highly competitive: there is no sufficient slack in the current commercial model to add hundreds/thousands of non-profitable masts. The highly competitive market in urban markets means that operators have little scope to divert investment to fund the introduction of marginally used masts. It is therefore inevitable that improving coverage needs a step change to current paradigms, including partnership between the public and private sector.

There is a need to understand the difficulty of providing good coverage in rural areas. One would not expect to drive into the country, pick a random field then with permission build a house, and get electricity at the type of connection charge associated with an urban area. Mobile masts are no different: there are significant challenges associated with site acquisition, getting planning consent, and then getting power connected at an economic rate (we consider that reaching Government aspirations of reaching 95% of geography will require new approaches, such as solar power and satellite backhaul). People want good mobile coverage, but ideally, they would like it without ever seeing a mast, let alone one with solar arrays and satellite dishes. We understand that, but ultimately a decision often needs to be made between a vista and a good mobile

[1] Vodafone Response to Ofcom Consultation "Improving mobile coverage - Proposals for coverage obligations in the award of the 700 MHz spectrum band" June 2018 – and we note that since the earlier response, the Vodafone share price has declined by 30%, in part due to fears about regulatory costs.

signal. The approach of imposing obligations puts the onus on mobile operators to win over the hearts and minds of local residents to allow mast build out: this is unfair, and there needs to be a wider debate and agreement at a community level of whether residents value the view or mobile service more highly – it should not be imposed top-down.

Benefits of improved coverage

As Vodafone requested Ofcom has now performed an impact analysis of whether the costs of improving coverage can be justified by the benefits that will accrue. Already, this has shown that Ofcom is unable to definitively justify increasing coverage to 92%. Ofcom will concede, however, that its impact analysis has a series of shortcomings:

1. Ofcom's analysis does not quantify the harm of spectrum being allocated inefficiently;
2. Ofcom does not properly analyse the harm to competition arising of two operators being perceived as "coverage" providers. Ofcom's analysis assumes that the coverage operators' market share will increase by 50% in rural areas[2], but there is a lack of analysis of any dangers of a consequent duopoly developing in these areas (two operators collectively having 60% market share). This issue is more concerning if the perception of improved coverage extends beyond those customers that would directly benefit, to the wider mobile user-base – the implications of this don't appear to have been addressed by Ofcom[3];
3. A key underpinning of Ofcom's analysis is the RAND report, which indicates a Willingness To Pay (WTP) for improved coverage of around £24.70 for customers without good quality 3G/4G services. Such metrics should be treated with caution, particularly when scaled up to large volumes of users. In the context of Partial Not Spots (PNS), AnywhereSIM[4] offers PAYG packages of unlimited voice/sms and 4GB of data for £30, which operate across three of the four mobile networks hence boost coverage from that of a single operator to the composite of these. A comparable PAYG from a single operator would cost around £10[5], implying a marketplace premium of £20 to enjoy coverage above individual operator levels. If the average WTP for customers in PNS truly was £24.70, then one would expect AnywhereSIM's offering to be a roaring success: in reality it remains a niche service;

---

[2] Consultation A12.54 – a growth in typical market share from 20% to 30%.

[3] Given the improved rural coverage by the obligation holders will effectively be state funded, there is no reason to suspect that they would need to raise prices to their customers to fund fulfilment of the obligation. It therefore follows that in urban areas, there will be four operators offering competing services at a pricing level dictated by competitive forces, but two of these will have the added bonus of "*and we guarantee that our service will work when you visit your family & friends in the country*". It is quite plausible that this will disrupt competition at least to some extent, that has not been addressed by Ofcom.

[4] https://anywheresim.com/

[5] https://www.vodafone.co.uk/mobile/pay-as-you-go-plans/big-value-bundles

4. Ofcom's assumption that 340,000 premises would benefit from better coverage[6] is highly speculative.

    a. It is indisputable that 140,000 additional premises will gain coverage from the winning operator, but many (or most) will already have coverage from another operator, hence derive a benefit from increased competition rather than better mobile coverage *per se*.

    b. The central case that 200,000 premises already having good outdoor coverage will gain indoor coverage requires further justification. For this outcome to happen implies an increase in signal strength of at least 10dB at the homes concerned: Ofcom's assumption suggests that in the case of Vodafone this would occur at around 17% of the premises[7] to which we currently provide good outdoor but not indoor coverage. This is not impossible, but absent detailed modelling, seems optimistic and not an assessment that could be made in a robust way without further evidence than the consultation currently provides. Once again, that volume of premises would need to be scaled according to whether the coverage operators' competitors already provided good indoor coverage. Also, for the majority of these homes there will already be good indoor *voice* coverage[8], and so the benefit would only reflect improved indoor *data* services: given that 98% of premises have effective fixed broadband[9] capable of providing Wi-Fi to mobile handsets, the incremental benefit for these homes must be considerably lower than for those homes where improved coverage provides both mobile voice and data that was previously absent;

5. Ofcom's analysis assumes a £2/month benefit for the generality of rural customers of the operators with coverage obligations[10], and that 50% of their rural customers would benefit[11]. This appears to be an assumption without any validating or supporting data. This is important, because it is multiplying the values together that results in £287M of the benefit that Ofcom considers will arise from the obligation. The evidence base behind these numbers appears to be lacking.

This implies that Ofcom's findings are highly sensitive to these assumptions, and undermines the extent to which those findings are a suitable basis for Ofcom's decision-making.

---

[6] Consultation para A12.52

[7] Calculated as Vodafone having good outdoor 4G coverage at 99% of premises and indoor of 93.6% of premises according to Figure A11.1 of the consultation, with an assumption of around 24M UK homes. We note that these figures are as at September 2018 and by the time that the obligation applies the number of premises in not spots would fall, meaning that Ofcom's assertion of 200k further premises benefiting requires even more justification.

[8] Figure A11.1 of the consultation suggests that for Vodafone this is overwhelmingly the case, given 98.6% of premises have good indoor voice coverage.

[9] Connected Nations 2018, https://www.ofcom.org.uk/__data/assets/pdf_file/0020/130736/Connected-Nations-2018-main-report.pdf : we acknowledge that this drops to 88% in rural areas, but Ofcom has not demonstrated that it has carried out any analysis to quantify the overlap between properties with poor fixed broadband service and poor mobile data coverage.

[10] Consultation, para A.12.75

[11] Consultation, para A.12.69

We stress that Vodafone does not doubt that material benefits will arise from improving mobile coverage. Our point is that as things stand, the benefit asserted by Ofcom is at best a rough estimate, so extreme care needs to be exercised when introducing measures where the costs are anything like the perceived benefit. Using broad brush assumptions on benefits and failing to properly assess or quantify the adverse impact of policy measures could easily leave Ofcom imposing coverage measures that impose a net cost on consumers.

What are we trying to achieve?

Ofcom frequently uses the metric of percentage of the country with 4G coverage by all four mobile operators as an indicator of the overall state of coverage. But while it creates good headlines as the number is inevitably lower than other metrics, this metric is meaningless, to both operators and consumers:

- Network operators can have little influence over the metric. It is inevitably set by the coverage of the operator with the smallest footprint. Nothing that the other operators can do will influence that figure.
- Changes in the metric don't imply a better experience for indvidual consumers. Individual consumers will either have network coverage from their own provider or they won't. Whether the other network providers have coverage in the location where the consumer's standing is irrelevant to them, indeed it's unlikely that they'd even be aware, short of delving deep into settings on their handset. What matters to an individual is the coverage of their operator, not the composite coverage of others.

Using that metric does, however, shine a spotlight on how the coverage obligation set out in the consultation would fail to improve communications for all UK citizen consumers. If Ofcom's proposals work as intended, two operators will accept an obligation to take coverage to 90% of UK geography. This will make absolutely no difference to Ofcom's much-cited metric of "percentage of country served by all four networks", because two networks will not be awarded subsidised spectrum as a reward for accepting such an obligation, so their coverage will not improve (as we will go on to describe, a more likely outcome is that customers of just one operator will see improved coverage and the majority will see no change).

Ofcom's analysis of material obtained from network operators via statutory Information Requests is highly informative. Ofcom finds that operator coverage levels will be in the range 80-84% at the time of the auction, while data from the Connected Nations[12] indicates that locations where there is good 4G coverage from at least one operator is currently at around 91%. The logical conclusion must be that an operator accepting discounted spectrum in return for taking on the coverage obligation will fulfil that obligation in

[12] Connected Nations 2018 Key findings (page 1), https://www.ofcom.org.uk/__data/assets/pdf_file/0020/130736/Connected-Nations-2018-main-report.pdf

large part by filling PNSs (areas where there is coverage from other operators but not the operator in question) rather than Total Not Spots (TNS – areas where no operator provides coverage):

- If we accept that there is 5% of the country where nobody believes it practicable to provide coverage[13], then the ratio of PNS to TNS is around 2:1.
- An operator that seeks to provide coverage will tend to do so where there are people (the premises component of the obligation forces this in any case) and where costs are lowest. As neither of these vary according to the identity of the operator, they're highly likely to prioritise where other operators have been able to justify investment.

In summary, the figures lay bare that the subsidy that Ofcom seeks to provide via these proposals aims to reduce PNS, rather than bringing mobile services to locations where there are currently none. In some ways, this isn't a bad outcome – it is better than an alternative where most additional coverage is provided to empty fields, for example – but what is an extremely poor outcome is an effective State subsidy that will target one or two operators to deploy where their competitors have service, while providing no improvement for the remaining UK consumers.

An optimist would say that this could be mitigated, as the remaining operators would then be incentivised to improve their coverage. This is the thinking behind previous auctions, for example the coverage obligation taken on by Telefonica in the 2013 award of 800/2600MHz spectrum. However, there is a key difference this time around. Whereas fulfilling the coverage obligation for 800MHz required additional investment, the terms of the obligation were set at a level that other operators could stretch their commercial model to provide coverage at a similar level to the obligation holder. This time, however, Ofcom is proposing to set an obligation which will cost hundreds of £million to fulfill. There is no way that commercial build by operators with no coverage obligation will seek to replicate the state-subsidised coverage. Put another way, there is no credible theory of competition that would have operators who are facing costs pressures in areas of dense network build finding so much advantage in matching rural coverage that they can justify building their networks 'as if' they had a coverage obligation, even though they had missed out on the subsidy and paid full price for their spectrum in the auction. Even if they did so, they would be uncompetitive nationally (with a higher cost base) since they had not received a discount to their spectrum price in the auction.

It follows that the outcome of Ofcom's approach is either at least half of UK citizen consumers being penalised as a result of their choice of network operator (compromising Ofcom's coverage objective), or alternatively that customers change supplier because of the perceived benefit of better coverage (compromising Ofcom's competition objective, resulting in wider destruction to the highly competitive UK mobile market). Neither is an acceptable outcome.

[13] Government aspiration is 95% geographic coverage.

Coverage obligations force Ofcom to make unenviable arbitrary judgements

Obligations framed in the context of a requirement to achieve a particular percentage geographic coverage inevitably force Ofcom to make arbitrary judgements and place it in the position of having to emulate operator network planning teams.

Arbitrary judgements

With a well-executed impact analysis[14], it is possible for Ofcom to determine the benefits accruing from improving coverage to a given level, for example that coverage of good quality mobile services should increase to 90%. However, what are "good quality mobile services"? Ofcom has determined this should be 2Mbps data, but this is an arbitrary decision.

There is then a further level of arbitrariness, in that to transform this into an obligation where it is possible to measure performance quantitatively, it is necessary to determine a required signal threshold. However, coverage models are by their nature statistical, so it is necessary to choose a signal level that when predicted for a geographic pixel can provide a given confidence level of 2Mbps data being possible. Ofcom chooses a 95% confidence factor which results in a threshold of -105dBm, and we would not disagree with that, but this is once again an arbitrary judgement and Ofcom could have just as easily chosen 85% or 90% as its preferred confidence level. That would make profound differences to the obligation; Ofcom has informally shared information suggesting that its drive tests indicate that changing the confidence level between 85% and 95% results in thresholds in the order of -115dBm to -95dBm[15]. To put it another way, today's cited 80-84% geographic coverage levels could be expressed as 90% geographic coverage, if a different (arbitrary) choice of confidence factor is used. This is not a minor technical issue - the arbitrary choice of confidence factor that Ofcom is forced to make in order to impose a "percentage of geography" coverage obligation drives (using Ofcom's numbers) £700M of State subsidised investment. In this context, Vodafone is somewhat surprised that Ofcom chooses not to codify the requirement, and in the draft licence merely refers to a "high level of confidence"[16].

Is Ofcom a network operator?

In order to make its arbitrary choice of the level of the coverage obligation, Ofcom also puts itself in the position of having to emulate operator network planning teams. It needs to choose a coverage level, then set a reserve price that will allow operators to bid for the obligation. It cannot set that reserve price without forming a view on implementation costs, but Ofcom is not an operator and hence cannot assert expertise. It can only seek to put itself in the position of an operator as best it can in order to assess costs. This is an unenviable position - if it gets it wrong, there are significant implications:

---

[14] For the avoidance of doubt there are shortcomings in the one presented by Ofcom
[15] We note that on those graphs -105dBm measured equated to a 90% confidence level, and hence would seek to explore this issue further with Ofcom.
[16] E.g. Schedule 1 to 700MHz licence, para 11

- If the reserve price isn't negative enough, there will be no bidders.
- In the worst case[17], where the number of bidders are lower than or equal the number of obligation lots, the lots will sell at reserve price: Ofcom's attempt to be a network operator will determine what windfall gain the winning bidders get at the taxpayers' expense (given their costs will inherently be lower than the reserve price).

Ofcom will always be in an unenviable situation unless it can find a reserve price where there are more bidders than there are coverage lots. However, this is all but impossible given the benefits identified in Ofcom's analysis.

As we set out in Section B.2, there are ways that Ofcom can avoid these issues. Rather than seeking to achieve an arbitrary percentage obligation, the obligation could come in the form of a requirement to participate in a collaborative coverage improvement scheme with Ofcom oversight. Using that approach, rather than imposing the *output*, the obligation would be ensuring that the "coverage improvement machine" worked *efficiently*. It would mean that the cost/benefit of coverage would not need to be decided once and for all (in Ofcom's eyes, £700M for two operators to achieve 90% coverage). Instead, Government and Ofcom could set the pace of improvement according to the funding going into the efficient machine: if coverage is not improving quickly/sufficiently enough, add more funds. There would be no need for Ofcom to pretend to be an operator, or for it to make arbitrary decisions.

Destruction of the prospect of cooperation

The other important consideration that is currently missing from Ofcom's impact assessment is the question of what impact Ofcom's proposals would have on the existing arrangements that underpin recent coverage improvements – specifically, network sharing.

When compared to Vodafone's alternative proposal set out in Section B.2, Ofcom's approach will lead to deployment of more mobile masts than are really needed, and stifle Government aspirations to expand coverage beyond 90%. For more than a decade, Ofcom has acted mindful of the link between the position of the four national wholesalers and their incentives to engage in network sharing. Without Ofcom's efforts to ensure that no single operator could dictate the terms of access to the others, the existing commercially-driven arrangements for network sharing might never have been established. In the T-Mobile/Orange merger, a specific theory of harm considered and addressed by the European Commission was the undermining of competition that might arise if the competitive parity that supported and incentivised network sharing was undermined.[18] Operators have been engaging in good faith to facilitate greater sharing of masts: it is a mutually beneficial exercise.

---

[17] Vodafone believes the proposals represent that worst case.
[18] Case No COMP/M.5650 - T-MOBILE/ ORANGE REGULATION (EC) No 139/2004 MERGER PROCEDURE paras 82-110, http://ec.europa.eu/competition/mergers/cases/decisions/m5650_1469_2.pdf

However, following the award of the coverage obligation;

- two operators will be seeking to improve coverage (having each received potentially £350M of subsidy in the form of cheap spectrum), and
- two operators will possess the masts that the obligation-holders would like to share in order to fulfil that obligation.

The UK will no longer have an equilibrium of all four operators needing to improve coverage resulting in mutual benefit in sharing masts. Why would the operators with the masts wish to share with the coverage-obligation holder, when they are a competitor that's just been handed a huge subsidy and is desperate to roll out coverage? Ofcom will have taken potential cooperation and redrawn battle lines.

Similar considerations apply to extending coverage from 90%-->95%. Ofcom and Government seek to get operators around a table to discuss how best to improve coverage from 90% to 95%, but if two operators' coverage is only in the low-80s%, why would they have any interest in such an initiative given the other operators have received a *de facto* public subsidy to exceed that? If the non-benefiting operators wanted to extend coverage it would be into the PNS areas where more people live, rather than the more marginal areas covered by the 90% to 95% aspiration.

✂

Realistically, Ofcom's proposals will not only direct coverage to two network operators, they will remove any incentive for the other two operators to be involved in coverage initiatives. If Ofcom's approach was the only way that coverage could be improved, perhaps that would be no more than an unfortunate but necessary side effect. However, that is not the case, there are compelling alternatives that do not have these drawbacks and that would enable Ofcom to preserve an environment in which commercial drivers to infrastructure sharing remained fully engaged. Ofcom is inadvertently heading down a road where it disenfranchises at least two (and probably three) operators – and their customers – from the coverage debate. It should change tack before it's too late.

A.2 The risk to 5G

A2.1 Background

All four national wholesaler networks have acquired sufficient spectrum via the 3.4GHz auction to launch 5G services. There is a need to distinguish, however, between the launch of early 5G services, and the subsequent high bandwidth, low latency applications which will distinguish fully-fledged 5G from earlier generations of mobile service. It is widely recognised that such services will require large blocks of contiguous sub-6GHz spectrum;

- Mm-wave spectrum will have an important role to play, but its propagation characteristics mean that it is best suited to ultra-urban deployments; it is not a substitute for lower-frequency spectrum.
- Fragmented spectrum in the 3.4-3.8GHz band is an imperfect substitute for contiguous spectrum. As we have set out at length to Ofcom[19], it would be wrong to conclude that, for example two blocks of 50MHz are of equivalent worth to a single 100MHz block;
    - In the short-medium term, M-MIMO antennas do not support a tuning range sufficient to aggregate spectrum at the top and bottom of the 3.4-3.8GHz bands[20]. As we have explained, ✂
    - Even in the longer term, M-MIMO panels operating across such a wide frequency range will be power inefficient when compared to a contiguous block. This will cost Vodafone 5% more to power the affected panels, and we estimate would result in at least 500 tonnes of additional CO_2 emissions per year. Whilst Ofcom does not have eco responsibilities within its statutory duties, it is surely incumbent on it not to worsen climate change via its spectrum strategy, hence compromising national policies.
    - User terminals are not typically able to support aggregation of uplink carriers, and we see little prospect of this changing, even in the long term. This means that the user experience for interactive services over fragmented spectrum will be inferior when compared to a network utilising a contiguous block of spectrum, and overall spectrum efficiency will be compromised as the uplink on one of the aggregated carriers will be idle.

  We note that Ofcom has gone some way to acknowledging this in the consultation, recognising that performance will be up to 15% lower on aggregated blocks than the same amount of spectrum used as a contiguous block[21]. ✂

[19] For example response by ✂ to questions by ✂, submitted on 4th September 2018.
[20] We note that the auction is referred to as the 3.6GHz band. Given the spectrum on offer is in the range 3680-3800MHz, than a description of 3.7GHz would be more accurate.
[21] Consultation para 5.258.

We note[22] that Ofcom considers it need not be concerned about extreme asymmetry of 5G-ready spectrum because existing bands such as 2.3GHz and 2.6GHz can be refarmed for 5G NR usage. This is an incorrect conclusion, certainly in the short-medium term and probably in the long-term too:

1. The cited bands do not currently support 5G NR capability. They may, indeed probably will do in the medium to long term, but this is irrelevant to an operator holding such 4G spectrum at a time when they are seeking to match competitors with superior 5G-ready spectrum stocks. Using 2.3/2.6GHz as a supply-side substitute for 3.4/3.6GHz spectrum only works if a comparable ecosystem exists in the form of both network and user equipment: it does not. It could be argued that UK operators are part of global companies that have the power to drive suppliers to create an ecosystem, but that argument doesn't stand up to any scrutiny: no global vendor will provide equipment – particularly terminals – to specifically support the UK market (and given other countries are able to provide adequate contiguous 3.4/3.6GHz spectrum there is no other market demand). Ofcom has offered no evidence of future availability of 5G equipment in these bands.

   Consider, in contrast to the consultation, the competition analysis undertaken for the 2.3/3.4GHz award (in which Ofcom researched when the ecosystem would be available for each band). This led Ofcom to conclude that there was a need to break its analysis into Transitional Periods; stakeholders did not question that approach - it was only the precise timing of those Transitional Periods that led to subsequent legal challenge.

   Vodafone is very concerned at the relatively light nature of the analysis done to support this auction. Ofcom cannot now seek to brush the timing of 5G ecosystems under the carpet: a proper analysis would show that the 2.3/2.6GHz bands will not support 5G NR for considerable time to come – this is understandable given international competitor markets are delivering more effectively on the requirement to support large contiguous 5G blocks in the 3.4/3.6GHz bands so there is little demand for 2.3/2.6GHz NR support in those markets.

   The correct approach now would be for Ofcom to assess competition concerns during a Transitional Period where the only 5G-capacity bands are 3.4/3.6GHz. Consistent with Ofcom's previous analysis, a single operator holding upwards of 37% of that spectrum should present competition concerns.

2. Even in the longer term, there are considerable technical constraints in prospective 5G NR deployments using the 2.3/2.6GHz bands. 5G NR capacity bands are predicated on the usage of M-MIMO technology. The physical form factor for M-MIMO is inversely proportional to the frequencies deployed, which means that when compared to 3.4GHz, a given sized panel operating at 2.6GHz will support a smaller antenna array, or conversely a given antenna array size will require a far larger

[22] Consultation para 5.210.

unit. Table A.1 below illustrates by providing characteristics of typical LTE equipment from two of our vendors. As can be seen, equipment in the 2.6GHz band is larger, heavier and uses more power. Ofcom needs to be careful of treating the spectrum bands as direct substitutes, even in the long term.

Table A.1 – M-MIMO antenna characteristics

	2.6GHz		3.4GHz	
Characteristic	Supplier 1	Supplier 2	Supplier 1	Supplier 2
Array size	8 x 8	8 x 8	8 x 8	8 x 8
Physical size (mm)	✂	✂	✂	✂
Weight (kg)	✂	✂	✂	✂
Power consumption (W)	✂	✂	✂	✂

It is therefore clear that while the spectrum awarded in the 3.4GHz auction is sufficient to launch 5G services, ✂ operators will be seeking to acquire further spectrum in the 3.6GHz band to align with the aspirations set out by regulators, industry trade bodies and 5G equipment vendors – for example:

- The European Commission Implementing Decision regards the relevant technical conditions applicable to the 3400 – 3800MHz frequency band states

  "There shall be spectrum available providing the opportunity to access sufficiently large portions of contiguous spectrum, ***preferably 80-100 MHz,*** *for wireless broadband electronic communications services"*[23]

- GSMA's 5G Public Policy Position has as its most important item contiguous spectrum:

  "*5G needs a significant amount of new harmonised mobile spectrum.* ***Regulators should aim to make available 80- 100 MHz of contiguous spectrum per operator*** *in prime 5G mid-bands (e.g. 3.5 GHz)"* [24].

[23] https://ec.europa.eu/digital-single-market/en/news/commission-decides-harmonise-radio-spectrum-future-5g Annex of the Implementing decision, para B.3

[24] https://www.gsma.com/spectrum/wp-content/uploads/2018/11/5G-Spectrum-Positions.pdf

- Ericsson agrees:

  "*Ericsson says that at least 100 MHz is needed "on a per carrier basis" in order to fulfil mobile broadband use*" [25]

- As does Huawei:

  "*C-band is the golden spectrum for 5G. It has been released or will be released for operators in countries worldwide. Continuous large bandwidth (100 MHz per operator) will be the cornerstone for 5G business success."* [26]

In summary, we do not see a scenario where one or more of the incumbent national wholesalers sit this auction out because they have sufficient 5G spectrum.

Ofcom highlights that there is nothing special about 100MHz and that it has seen no application which specifically demands 100MHz. It would appear that Ofcom is isolated in this thinking. Vodafone does not argue with the assertion that there's no specific application demanding 100MHz that is known about at this time, but what is clear is when such applications emerge – and they will – competitor nations will have made that volume of spectrum available in contiguous blocks, and the UK will suffer if such services are restricted to one or two of its operators.

It is widely predicted (and Vodafone believes) that the future lies in the ability to offer consumers both high headline speeds and high capacity (in the context of being able to support a large volume of users at high average data rates). Ofcom recognises this; in the collaborative work that it has undertaken with industry around providing more useful coverage information, it has socialised the idea that maps should not just focus on coverage, but also the quality of that coverage in terms of ensuring that high data rates can be sustained at times of high customer usage. ✂

Figure A.1 – ✂

Some might also argue that mm-wave spectrum will mitigate spectrum asymmetry in the 3.4/3.6GHz bands. However, this conclusion is wrong: mm-wave will undoubtedly play an important role in the 5G ecosystem, but its application will be largely in short-range ultra-urban deployments, rather than the wider-scale urban application for which the 3.4/3.6GH bands will be used.

In summary, the 3.4/3.6GHz band is vital – and largely unmatched - in setting the competitive landscape for mobile services. Ofcom's decisions should be based on a view that is wider than a niche nascent 5G market, and focused on buttressing and strengthening the foundation of the competitive mobile market for the next ten to twenty years. It is against this background that we set out our fears of a damaging bifurcation of the 5G mobile market.

[25] https://advanced-television.com/2018/05/01/ericsson-pushes-fcc-for-5g-access-to-satellites-c-band/
[26] https://www.huawei.com/en/press-events/news/2018/7/Huawei-C-Band-100MHz-Operator

A2.2 ✂: BT

This section explains the basis for Vodafone's expectation that, under Ofcom's proposals, the predictable outcome will be that BT will ✂. Our concern is that BT will be able to secure a potentially inefficient quantity of 3.6GHz spectrum by virtue of the advantage it has in bidding for the coverage lot.

BT's data network coverage is currently marginally better than that of other operators, in large part due to having deployed 800MHz spectrum onto a mast grid optimised for the 1800MHz band[27]. However, over the coming years BT's coverage will be boosted markedly by the implementation of the Emergency Services Network (ESN), which will be accomplished using the assistance of hundreds of £million of State aid. In our response to the earlier consultation on coverage obligations for the auction, Vodafone highlighted that this means that it will cost BT significantly less to meet Ofcom's proposed coverage obligations than it will other operators. Vodafone's revised analysis suggests that this is still the case with the modified proposals in the consultation, and other operators would not be able to unilaterally bid to take on the second coverage obligation within the window of the reserve price suggested.

As we set out in Annex 1, Ofcom's analysis of the effect of ESN is deeply flawed. Ofcom is wrong to suggest that operators can close the gap created by ESN via commercial investment, and wrong to believe that other operators can benefit from masts deployed to support ESN to any meaningful extent. ✂

Ofcom will be well aware that Vodafone has a different perception of the costs associated with complying with the coverage obligation. ✂ hence, the second coverage obligation will go unsold.

We therefore expect BT to be the sole bidder on the obligation, if Ofcom increased the (negative) magnitude of the reserve price at all, the effect would simply be to increase the benefit that BT would accrue from the differential between its costs and that reserve. As such, we do not seek to change Ofcom's mind on the costs to fulfil the obligation, but that should not be taken as any endorsement of the numbers by Vodafone.

An auction with the proposed format means that there will be a single operator with a coverage obligation, so, far from meeting Government's and Ofcom's aspirations of improving coverage for all, it is only the customers of BT who will benefit from their network having received a subsidy. This will be a subsidy awarded as a direct consequence of BT already having received State aid to put it in a unique starting position. Taxpayers will be funding BT's network twice.

Whereas Ofcom's original proposals would have resulted in distortion of the outcome of the award of 700MHz spectrum, however, the latest proposals risk damaging spectrum efficiency in the award of the 3.6GHz band too. We provide simplified worked examples in Boxes 1 & 2 below of how the combination of a negatively-priced coverage obligation with positively priced spectrum serves to distort the efficient

[27] We note that there is already effectively a state subsidy to provide that denser grid – BT's 1800MHz spectrum is charged 26.5% less in Annual Licence Fees per MHz of spectrum than the 900MHz used by Vodafone[27], because benchmark market data suggests that the band is worth less due to higher deployment costs

distribution of spectrum. The matter is somewhat analogous to a supermarket "two dine for £10" deal - meal, sides and wine for £10.

- The first customer to the counter is not that bothered about wine, certainly not enough to pay the usual price for a bottle. They would quite like to eat though, so the "two for £10" is for them because they're effectively getting the wine for (close to) zero cost.
- The second customer isn't hungry, so the "two for £10" deal is of no interest. They're really thirsty though so value the wine highly and are prepared to pay the full asking price.
- If there is only one bottle left on the shelf, the first customer would take it home as part of their deal, perhaps storing it for if they ever fancy a glass in the future. The second customer clearly valued the wine more, but because of the deal, they lost out.

The outcome is that the supermarket didn't actually sell the wine to the person who'd value it highest. If the deal was the only way the supermarket could sell the meal, then perhaps getting less than optimal value for the wine wouldn't matter; but if there was another way that the supermarket could get full price for the meal as well as the wine, then the meal deal is a bad outcome for the supermarket too. As we will set out in Section B.2, there is a different, better way that Ofcom could achieve its coverage objectives. The second person need not miss out on their wine.

Vodafone commissioned Charles Rivers Associates (CRA) to investigate our concerns that a CCA where BT (and only BT) was pretty much guaranteed to be awarded a discount on spectrum in return for taking on a coverage obligation would result in an inefficient award of spectrum. Their analysis, set out in Annex 2, suggests that our fears are well founded, showing:

- That combining coverage obligations and spectrum allocation into a single stage leads to a material risk of bid shading, hence distortion of the auction outcome and inefficient allocation of spectrum. It is demonstrated that in any case where the positive price constraint would apply (i.e. where the bid price for coverage obligations is greater than that winning bidder's value for spectrum), then they are incentivised to bid for more spectrum than is efficient.
- In contrast, that separating out coverage obligations and spectrum allocations into separate stage removes the majority of incentives to bid shade.
- That the level of aggregation risk, which pushes Ofcom towards the proposed format, is limited.
- But that in contrast the level of exposure risk of a bidder not knowing whether their partner in a joint mast venture is also bidding for the coverage obligation is significant, and that Ofcom is wrong to neglect this.

To be clear, the auction rules as proposed would lead to BT gaining discounted spectrum because of having already received State aid for ESN: BT may ✂

BOX 1 : Worked example of auction inefficiency

We assume four bidders with the following valuations. Bidders 1 and 3 already have abundant high frequency spectrum; Bidders 2 and 4 already have abundant low frequency spectrum. Bidder 1 has the lowest cost of meeting the coverage obligation and has a network share with Bidder 3. Prices are in millions; reserve prices are nominal.

In the first scenario, Bidder 1 will try to meet the coverage obligation without the co-operation of Bidder 3:

Bidder 1 Values

- 700 MHz : 250m per 2x5 MHz lot up to 2x10 MHz
- 3.6 GHz: 20m per 5 MHz lot up to 60 MHz
- Cost of coverage: 200m

Bidder 2 Values

- 700 MHz : 50m per 2x5 MHz lot up to 2x10 MHz
- 3.6 GHz: 300m for a package of 50 MHz
- Cost of coverage: 700m

Bidder 3 Values

- 700 MHz : 200m per 2x5 MHz lot up to 2x10 MHz
- 3.6 GHz: 10m per 5 MHz lot up to 60 MHz
- Cost of coverage: 800m

Bidder 4 Values

- 700 MHz : 100m for 2x10 MHz, **or** 70m for 20 MHz SDL
- 3.6 GHz: 330m for a package of 60 MHz
- Cost of coverage: 600m

The efficient outcome is as follows:

Bidder 1	2x10 MHz 700, 10MHz 3.6, Coverage Lot	**Value:** 250*2 + 20*2 -200 **= 340m**
Bidder 2	2x10 MHz 700, 50MHz 3.6	**Value:** 50*2 + 300 = **400m**
Bidder 3	2x10 MHz 700	**Value**: 200*2 = **400m**
Bidder 4	20MHz SDL 700, 60 MHz 3.6	**Value:** 70+330 = **400m**

If all bidders bid straightforwardly (in accordance with value), then the prices and surplus for each bidder would be

Bidder 1	30m (offered by Bidder 4 for 700) + 20m (offered by Bidder 3 for 3.6) - 350m (subsidy for coverage lot) but this is increased to a nominal amount by the positive price constraint.	**Surplus: 340m**
Bidder 2	30m (offered by Bidder 4 for 700) + 200m (offered by Bidder 1 for 3.6) = 230m	Surplus: 170m
Bidder 3	30m (offered by Bidder 4 for 700)	Surplus: 370m
Bidder 4	Nominal for SDL +220m (offered by Bidders 1 and 3 for 3.6) = 220m	Surplus: 180m

However, Bidder 1 has an incentive **not** to bid straightforwardly. If Bidder 1 only bids for the large combined package of 2x10 700 + 60MHz 3.6 + Coverage lot, this is the alternative outcome:

Bidder 1	2x10 MHz 700, 60MHz 3.6, Coverage Lot	**Value:** 250*2 + 20*12 -200 = **540m**
Bidder 2	2x10 MHz 700	**Value:** 50*2 = **100m**
Bidder 3	2x10 MHz 700	**Value**: 200*2 = **400m**
Bidder 4	20MHz SDL 700, 60 MHz 3.6	**Value:** 70+330 = **400m**

If bidders 2-4 bid straightforwardly (in accordance with value), then the prices and surplus for each bidder would be

Bidder 1	30m (offered by Bidder 4 for 700) + 300m (offered by Bidder 2 for 3.6) + 20m (offered by Bidder 3 for 3.6) - 350m (subsidy for coverage lot), increased to nominal.	**Surplus: 540m**
Bidder 2	30m (offered by Bidder 4 for 700).	Surplus: 70m
Bidder 3	30m (offered by Bidder 4 for 700)	Surplus: 370m
Bidder 4	Nominal SDL + 300m (offered by Bidder 2 for 3.6) + 20m (offered by Bidder 1 for 3.6) = 320m	Surplus: 80m

By this distortion, Bidder 1 increases its surplus by 200m, while reducing the total value of the spectrum allocation to all bidders by 100m. Assuming that the social value of efficient usage is roughly 10 x the value to bidders, the social cost of this inefficiency will be about **£1 billion.**

BOX 2 : Worked example of auction inefficiency
In this revised scenario, Bidders 1 and 3 share the costs of meeting the coverage obligation, using a network share:

Bidder 1 Values

- 700 MHz : 250m per 2x5 MHz lot up to 2x10 MHz
- 3.6 GHz: 20m per 5 MHz lot up to 60 MHz
- Cost of coverage: 100m

Bidder 2 Values

- 700 MHz : 50m per 2x5 MHz lot up to 2x10 MHz
- 3.6 GHz: 300m for a package of 50 MHz
- Cost of coverage: 700m

Bidder 3 Values

- 700 MHz : 200m per 2x5 MHz lot up to 2x10 MHz
- 3.6 GHz: 10m per 5 MHz lot up to 60 MHz
- Cost of coverage: 100m

Bidder 4 Values

- 700 MHz : 100m for 2x10 MHz, **or** 70m for 20 MHz SDL
- 3.6 GHz: 330m for a package of 60 MHz
- Cost of coverage: 600m

The efficient outcome is as follows:

Bidder 1	2x10 MHz 700, 10MHz 3.6, Coverage Lot	**Value:** 250*2 + 20*2 -100 = **440m**
Bidder 2	2x10 MHz 700, 50MHz 3.6	**Value**: 50*2 + 300 = **400m**
Bidder 3	2x10 MHz 700, Coverage Lot	**Value**: 200*2 - 100 = **300m**
Bidder 4	20MHz SDL 700, 60 MHz 3.6	**Value:** 70+330 = **400m**

If all bidders bid straightforwardly (in accordance with value), then the prices and surplus for each bidder would be

Bidder 1	30m (offered by Bidder 4 for 700) + 20m (offered by Bidder 3 for 3.6) - 350m (subsidy for coverage lot) but this is increased to a nominal amount by the positive price constraint.	**Surplus: 440m**
Bidder 2	30m (offered by Bidder 4 for 700) + 200m (offered by Bidder 1 for 3.6) = 230m	Surplus: 170m
Bidder 3	30m (offered by Bidder 4 for 700)	**Surplus: 270m**
Bidder 4	Nominal for SDL +220m (offered by Bidders 1 and 3 for 3.6) = 220m	Surplus: 180m

However, Bidders 1 and 3 now **both** have an incentive not to bid straightforwardly. If they each bid only for the large combined package of 2x10 700 + 60MHz 3.6 + Coverage lot, this is the alternative outcome:

Bidder 1	2x10 MHz 700, 60MHz 3.6, Coverage Lot	**Value:** 250*2 + 20*12 -100 = **640m**
Bidder 2	2x10 MHz 700	**Value:** 50*2 = **100m**
Bidder 3	2x10 MHz 700, 60MHz 3.6, Coverage Lot	**Value**: 200*2 + 10*12 -100 = **420m**
Bidder 4	20MHz SDL 700	**Value:** 70 = **70m**

If bidders 2 and 4 bid straightforwardly (in accordance with value), then the prices and surplus for each bidder would be

Bidder 1	30m (offered by Bidder 4 for 700) + 330m (offered by Bidder 4 for 3.6) - 350m (subsidy for coverage lot) = 10m	**Surplus: 630m**
Bidder 2	30m (offered by Bidder 4 for 700).	Surplus: 70m
Bidder 3	30m (offered by Bidder 4 for 700)) + 330m (offered by Bidder 4 for 3.6) - 350m (subsidy for coverage lot) = 10m	**Surplus: 410m**
Bidder 4	Nominal SDL	Surplus: 70m

These distortions increase Bidder 1's surplus by 190m and Bidder 3's surplus by 140m; but they reduce the total value of the spectrum allocation to all bidders by 310m. Again, assuming that the social value of efficient usage is roughly 10 x the value to bidders, the social cost of this inefficiency will be about **£3.1 billion.**

Ofcom appears to recognise that its approach could lead to inefficient allocation of spectrum[28], but considers it a price worth paying for improved coverage. However, is this inefficient allocation actually a price worth paying? A rigorous impact analysis would subtract the costs associated with inefficient allocation of spectrum from the benefits of improved coverage in order to determine a net benefit. Indeed, when carrying out such an analysis Ofcom should not simply determine the loss of auction revenues (in order to determine the loss in bidder value) to offset any benefits of improved coverage, but instead should recognise that the societal benefit of spectrum far outstrips what mobile operators pay at auction.

Research by Analysys Mason for the Department of Digital Culture, Media and Sport (DCMS)[29] suggests that consumer surplus amounts to 90% of the benefit accrued from spectrum, with supplier surplus making up the remainder. As such, there is a 9:1 leverage effect between the price paid for spectrum and societal benefit. It is not for Vodafone to act as expert regulator and reconstruct Ofcom's impact analysis taking this into account; we would expect that of Ofcom itself. As an indicative impact of the scale, however, taking a scenario where 3.6GHz auction values mimic those of the 3.4GHz band, that would imply a yield of around £930M. If the effect of combining the coverage and spectrum auctions is to allow spectrum to be sold to anyone other than those who value it most highly such that the auction yield (supplier surplus) drops by 5%, the leverage effect suggests that the reduction in value to the economy could be over £400M.

All of the above, however, presupposes that spectrum inefficiency is an inevitable consequence (or at least risk) of improving coverage. It is not. As will be set out in Section B.2, coverage can be improved without distorting the award of spectrum.

A.2.3 ✂

[28] Consultation para 7.98; strangely Ofcom appears to consider it a good thing that bidders increase the amount of spectrum they bid on solely to be able to get the maximum coverage discount, which is a sure sign that the spectrum is not being assigned efficiently.

[29] "Impact of radio spectrum on the UK economy and factors influencing future spectrum demand" p17, https://www.gov.uk/government/publications/impact-of-radio-spectrum-on-the-uk-economy-and-factors-influencing-future-spectrum-demand

A.3 A failure of Ofcom's statutory duties

It is recognised that Ofcom faces a balancing act to fulfil its statutory duties; what serves to achieve one goal could jeopardise another. Vodafone asked Towerhouse to analyse whether the proposed approach set out in the consultation would provide a balanced outcome of Ofcom's statutory duties. As set out in Annex 3, Towerhouse consider that:

1. Ofcom has wrongly convinced itself that it has a primary statutory duty to improve mobile coverage, versus it being a desirable policy goal.
2. It has thus elevated improving coverage to be of greater importance than its statutory duties, and failed to balance this with its actual statutory duties, including the promotion of competition.
3. It has failed to carry out a proper impact analysis, which would take a series of possible approaches, notably addressing coverage as a separate exercise to the award of spectrum, and assess these against its statutory duties.
4. It has confused its actual statutory duty to promote competition with one of *not harming* competition.
5. In assessing the impact on competition, Ofcom has omitted any consideration of the effect of the coverage obligations. It has failed to address the possible bifurcation of the market via
    a. The incorporation of coverage obligations into the award impacting the efficient allocation of spectrum or
    b. The awarding of coverage subsidies to a subset of operators affecting the degree of competitive intensity.

As such, the proposals set out are vulnerable to legal challenge.

A.4 Conclusions

5G represents the future of mobile communications. Yet the award proposals risks competition in the UK 5G marketplace. We have profound concerns that ✂:

- BT will be awarded subsidies in return for providing coverage that it is uniquely well-placed to provide, solely because of State aid already received for ESN. As if this was not enough, the specifics of the auction design are such that BT will be incentivised to inflate the amount of spectrum it purchases – in effect the subsidy comes in the form of discounted spectrum – and deprive competitors of spectrum. Ofcom understands this, indeed appears to have chosen the auction design because of this.

✂. Ofcom must think again.

Part B: A better approach

B.1 Introduction

In Part A we set out why Ofcom's current proposals are flawed. There are better ways.

In Section B.2, we explain that given that there is a clear failure of the market to deliver improved coverage, there is a need for intervention, a need for a paradigm change. Auctioning coverage obligations will not improve coverage for all consumers, but instead a collaborative industry engagement process, with effective oversight by Government and Ofcom, holds the promise of improved coverage for all. As a positive side effect, this will also remove potential distortions to the award of spectrum. We urge Ofcom to engage with Government to seize the opportunity being presented.

Should Ofcom not be ambitious enough to take this approach, there are ways in which it can change the auction format in order to not damage competition as much, and award spectrum in an efficient manner. We set out these alternatives in Section B.3.

In the event that Ofcom has painted itself into a corner with an ill-conceived approach of a Combinatorial Clock Auction (CCA) of spectrum and coverage obligations, and is unable or unwilling to consider better alternatives, then in Section B.4 we set out measures that could mitigate the competitive damage that the proposals would wreak.

B.2 Cooperation best improves coverage

Part A to this response highlighted that the proposed auction design simply doesn't achieve Ofcom's policy goals with respect to coverage. The best-case outcome is that both coverage lots are sold, hence there will be two operators seeking to provide 90% coverage. This will enshrine a situation where **half of UK citizens see no improvement in rural coverage**, or alternatively will damage competition as customers switch to state-subsidised coverage operators. There is a better way that improves coverage for all UK citizens – cooperation.

Vodafone believes that the coverage obligation that Ofcom should impose on all operators as part of the auction is to actively participate in an all-party coverage improvement scheme.

In autumn 2018, all mobile operators were tasked by DCMS to discuss together what can be done to improve coverage. Industry has been actively negotiating since then, with all operators (we thought) acting in good faith. By early February, although there were differences on points of detail[30], there was a broad consensus on the overall "shape" of a solution;

- An umbrella Single Rural Network Company ("SRNco") would oversee the exercise. Vodafone believes that (similar to the management of DMSL), this would have executive oversight by both Ofcom and DCMS. The SRNco would collate operator footprints and identify not spots requiring coverage, then programme manage removal of them.
- Total Not Spots (TNS) would require new mast infrastructure. This is foreseen as being predominately being shared amongst the existing mast share ventures CTIL and MBNL, but we do not rule out the usage of neutral hosts. Although there was debate about future 4-way MOCN[31] or MORAN[32], the baseline to get the initiative going was a 2x 2-way MORAN reflecting existing mast joint ventures. To reduce costs, only 800MHz LTE would be deployed, with a potential overlay of 900MHz 2G or 3G in order to provide 999 services with location information[33].
- Many Partial Not Spots (PNS) could be removed by simply sharing existing mast infrastructure. Details had not been finalised, but this could either be based upon standard commercial arrangements, on pricing reflecting incremental costs, or more probably on a "costs lie where they fall" basis (subject to each operator benefiting equally from the arrangement). The involvement of SRNco would act as a catalyst to identify PNSs and the appropriate existing masts to remove them.
- Some PNSs – termed "Restricted PNS" – could not be readily removed by the use of existing mast infrastructure. Examples are masts that are inherently unsuitable for sharing (telegraph, monopole), or masts where the only available antenna locations were either too low to provide meaningful coverage, or were e.g. within tree clutter. For these locations, new masts would be required.
- Prioritisation would be based on the number of operator-uncovered pixels addressed by each deployment, with a weighting factor for those pixels containing premises and transport corridors. The scheme would be set up such that the coverage uplift for operators would be (broadly) the same.
- TNS and Restricted PNS would require funding beyond what operators can commercially provide.

  We note that the issue of funding for Restricted PNS could be controversial as it is (arguably) providing funds for operators to roll out to where other operators have already commercially done so. However, this has to be examined in the context of the proposed auction design – Ofcom is clear

[30] For example BT believed that total not spots should be prioritised over partial not spots.
[31] Multi Operator Communications Network
[32] Multi Operator Radio Access Network
[33] UK implementations of VoLTE do not yet support location information for 999.

that a majority of the coverage resulting from the 90% obligation will serve to close PNS, hence Ofcom/Government is already accepting of the principle of awarding what are, in effect, subsidies to remove PNSs – the difference with the cooperative scheme is that they're offered to the industry as a whole rather than targeted at a subset of operators.

The exact format of funding would be for agreement with Government and Ofcom. However, Vodafone's proposal is that if Ofcom were to reduce ALFs, we would commit to providing an identical amount of funding into SRNco. We would expect all participating operators to contribute the same amount.

- The scheme did not seek to achieve an arbitrary coverage target. The commitment was that via SRNco, Government and Ofcom would be able to supervise the efficient deployment of funds to remove TNS and Restricted PNSs, and have executive oversight of every sharing decision for PNSs.

  In essence, the SRNco funds would initially be used to fund the rollout, and subsequently be used to operate the TNS and Restricted PNS masts. Ofcom would know that the funds are being efficiently spent, and could manage the rate/level of additional deployment via adjustment of the ALF discount. We note that in 2022 there will be a significant increase in the levels of ALF as the 3G spectrum licences become liable for annual fees.

We consider that the scheme that was devised better achieves Ofcom's policy goals than an arbitrary coverage obligation that doesn't improve the not spot situation for at least half of those customers affected. ✂

If Ofcom were to remove the proposed coverage obligation and instead have active participation in SRNco as a licence condition for the spectrum award, this would ✂

It is instructive to consider the costs and benefits that would accrue under the competing alternatives of auction obligations and cooperative schemes:

Costs

a) To be optimistic, for the purposes of this comparison we assume that both of the coverage lots under the Ofcom scheme will sell. Given the two winning bidders cannot know about their mast-share partner's bidding intentions[34], then the cost assumptions behind the two bids would be based upon rolling out their own mast networks – i.e. the costs factored into the bids would imply two mast network rollouts. The winning bidders can also have no surety of being able to share competitors' existing masts in PNSs[35], and no surety that they'd be able to share mast build costs with the other winning bidder to reach TNS.

b) In contrast, in the cooperative scheme, a large number of the required masts will in fact be existing competitor masts being made available for sharing – the SRNco approach incentivises mutual sharing of existing assets. For the remaining locations, only one mast grid will be needed, compared to the two mast grids in the individual obligation case.

It follows that the cost of the cooperative scheme would be lower than the combined costs of the coverage obligation approach. Note that we do not assert that the cooperative scheme can get all operators to 90% for 2x Ofcom's proposed reserve price = £700M, as we do not agree Ofcom's assessment of the absolute costs.

Benefits

a) To be optimistic, for the purposes of this comparison we assume that both of the coverage lots under the Ofcom scheme will sell. Thus, there would be improved coverage for around half of those customers experiencing not spots under the Ofcom proposal (no improvement for the remaining two operators' customers).

b) In contrast, the cooperative scheme would clearly benefit all customers experiencing not spots.

It therefore follows that in comparison with the obligation approach, the cooperative approach yields double the benefits for less cost.

The cost/benefit analysis is more complex than this, however. If there are fewer than three bidders for the coverage obligation[36], then the winning bidders will secure that obligation at reserve price, i.e. a *de facto* discount/subsidy of £350M each. However, the cost for the winning bidders to fulfil the obligation will not be £350M, but some lesser amount (otherwise they wouldn't have rationally bid for the obligation lot). This means that they will be rewarded by the delta between £350M and their individual cost base. As such, the

[34] (absent collusion which would be against the auction rules)
[35] i.e. if their mast venture was CTIL they could not assume access to MBNL masts, and vice-versa.
[36] Which, as we set out earlier in this section, is almost certainly the case.

coverage obligation will result in a net gain of that delta to those operators – funded by the tax payer. In contrast, the cooperative scheme results in no net monetary gain to any operator – all funding is direct to SRNco, and dedicated to providing improved coverage. In effect, when compared to the cooperative scheme, Ofcom's obligation approach is enriching (certain) operator shareholders.

In conclusion, via a cooperative scheme Ofcom has the opportunity to improve coverage for all, while allocating spectrum efficiently. There seems little justification for ploughing ahead with the current auction proposals that achieve neither.

B.3 Auctioned obligations must be separated from spectrum

As set out in the previous section, the best outcome for all UK consumers would be if Ofcom were to separate out initiatives aimed at improving coverage from the award of spectrum (or impose the obligation in the way we propose – through a common licence condition). If Ofcom is minded to maintain coverage lots in the auction, then it should look again at its approach to the auction. As explained in Section A.2.2, the proposed CCA approach will likely lead to distorted bidding behaviour, resulting in inefficient assignment of spectrum. It is also sub-optimal for providing coverage, because it locks Ofcom into imposing obligations to the same winner on a national basis, precludes fine-tuning of the obligation lots to ensure they're sold, and precludes bidding vehicles for joint implementation of coverage.

Vodafone strongly believes that if coverage obligations/discounts are to form part of the award process, then they should be detached into a separate stage of the auction. Under this model, there would be three stages to the auction:

1. Award generic spectrum lots - as set out in our answer to Question 5 we favour the usage of Simultaneous Multiple Round Auction (SMRA) for this stage, but the precise format isn't relevant to the principle we set our here,
2. Given the results of the first stage, award specific frequencies, and
3. Award discounts based upon operators accepting coverage obligations. In line with Ofcom's approach, we would anticipate that the maximum discount awarded would be amount due from the first two stages (or a reserve price, whichever is lower), i.e. the overall positive price constraint proposed by Ofcom would prevail. However, if this proves a barrier to bidding, it is open to Ofcom to allow discounts to Annual Licence Fees (ALFs) as an alternative to a discount to the auction price.

The principal advantage of this approach is that it leaves the award of spectrum "uncontaminated" by the possibility of prospective licence holders inefficiently bidding for spectrum on the basis that they will receive a discount for providing coverage.

By separating out bidding for coverage obligations, Ofcom is able to further refine that stage:

i. Whereas Ofcom's proposal foresees bidding for UK-wide coverage obligations, breaking coverage into a separate stage makes it easier, for example, to have regional obligations. Participants are more likely to bid for such obligations because they would be less onerous, i.e. winning bidders would not be seeking to mass deploy additional masts on a UK-wide basis.

   Further, this would better reflect the reality of mast-share joint ventures: for example under the Beacon arrangements between Vodafone and Telefonica, Vodafone is responsible for Wales and Telefonica for Scotland north of the central belt: logically each would be better able to justify taking on obligations in these areas.

   Also, this regional approach would remove the "all-or-nothing" aspect of Ofcom's approach. As we have outlined in Part A, we consider it very likely that BT will be the sole bidder for the coverage obligations as framed by Ofcom. With regional licences, it could be that additional bidders emerge for some regions (we note that this removes the potential for BT to be sure that it would acquire a national coverage obligation at the reserve price hence bid for spectrum inefficiently in the previous stages).

   Finally, unless an operator secured obligations nationally, regional coverage obligations lessen the prospect of operators being perceived as "coverage" and "non-coverage" providers.

ii. Ofcom's proposal dictates that the bidders for spectrum must be the same bidders as for coverage discounts. Imagine the hypothetical case[37] that Vodafone and Telefonica were prepared to fulfil a coverage obligation jointly, but were not able to take on that responsibility individually. There is no way to accommodate this joint approach in the CCA structure envisaged by Ofcom – the only ways to achieve it would be for Vodafone and Telefonica to either negotiate beforehand that one or the other would bid and they'd then apportion the obligation and discount, or for them to form a joint bidding vehicle for the auction process. The first approach would fall foul of auction rules of bidder collusion, while in the second approach the joint bidding vehicle would be excluded from the auction as it would breach the spectrum cap (when Vodafone and Telefonica's holding is collectively assessed).

   In contrast, if bidding for coverage obligations/discounts is in a separate stage to the spectrum award, then there is no need for the bidders in each stage to be the same. In our example, having

[37] We stress that this is a hypothetical case and there have been no discussions associated with the idea, because as we subsequently explain to put this into action would breach the auction rules.

got to the end of the second stage and knowing the maximum discounts that could be awarded, Vodafone and Telefonica could agree to bid jointly and apportion the consequent discount as they see fit[38]. Such joint bidding would increase competitive intensity, hence potentially reduce the discounts that Ofcom needs to provide to make the obligations attractive. It would even be open to Ofcom to allow different types of bidding via joint vehicles – for example the joint vehicle could bid on one coverage obligation on the basis that its members would collectively meet the obligation (i.e. at 90% of UK geography at least one of the members would provide coverage), or bid on both obligations on the basis that individual members would each reach coverage to 90% of geography.

iii. By having a separate stage, Ofcom would be able to adjust the obligations to make them more compelling. If a regional obligation proved unattractive so there were no bidders or a single bidder (so it would sell at the reserve price). Ofcom would have the option to restart the stage with the obligation watered down. If it was clear that only one or two bidders could meet the positive price constraint hence making a conclusion at the reserve price inevitable, Ofcom could lower the size of the obligation (and reserve price as required) in order to produce a competitive award. Unlike the current proposal, Ofcom would not need to second guess the balance between a coverage obligation which is onerous enough to have an effect, but relaxed enough to attract sufficient bidders: it could have a second bite of the cherry and it is less likely that the process would fail as a whole.

Vodafone believes that if coverage is to form part of the auction, the advantages above are compelling. Ofcom appears to have taken a cursory look at a similar approach[39] but convinced itself that it isn't appropriate. We disagree:

- Ofcom believes that a bidder might only bid for spectrum if it knows that it can be funded by an offsetting coverage discount. However, this is the absolute confirmation of the concern that we have set out in Part A. If that bidder was only inflating their desire for spectrum in order to have spent sufficiently to achieve the positive price constraint, then by definition it is unlikely to be the most efficient recipient of that spectrum. In making this argument, Ofcom is confirming that it is willing to sacrifice the efficient award of spectrum in order to impose coverage obligations. That might be an appropriate policy approach if a) there weren't other ways of achieving improving coverage that did not impact Ofcom meeting its statutory duties to promote competition and efficiently manage spectrum and b) a rigorous impact assessment had been undertaken to ensure that the potential damage to the UK economy of inefficiently assigned spectrum was outstripped by the benefit to the economy of improved coverage. Ofcom has demonstrated neither. In effect, Ofcom rejected the idea of a separate coverage auction stage because it would result in the efficient award of spectrum, whereas its preferred alternative allows it to award spectrum inefficiently as a

[38] We note that a short pause between the second and third stages would accommodate this.
[39] Consultation paras 7.118 – 7.130

means to improve coverage (when there are alternative ways of achieving the coverage goal). It is a most curious regulatory judgement, to say the least, and one that Ofcom must reconsider.

- **Ofcom believes that a new entrant may favour being able to bid for 700MHz and the coverage obligation together as there is a relationship between their requirement for each.** In this thought process, a new entrant may only want 700MHz capacity if they have a coverage obligation, and vice-versa. Of course, we cannot rule out any possibility in an auction, but this seems to be a quite bizarre scenario to drive an auction design. There have been four national mobile operators in the UK for nine years, and any pressure has been to reduce that number to three rather than there being a prospect of a fifth competitor. For Ofcom's concern to hold true, not only would there need to be a new entrant, but also one that is prepared to meet a 90% obligation from a blank sheet of paper starting position (keeping in mind that the incumbent operators struggle to get the economics to work for expanding from around 82% to 90% in this timeframe). Clearly, this is such an edge-case scenario that Ofcom cannot let it drive the choice of auction format.

- **Ofcom believes that one of the incumbent operators may favour being able to bid for 700MHz and the coverage obligation together as there is a relationship between their requirement for each.** The logic here is that one of the existing operators may need the 700MHz spectrum in order to consider taking on the coverage obligation. We do not rule that out, but the sequential approach would allow that operator to have spectrum surety before the coverage obligation is awarded. For there to be an issue, the reverse would need to be the case – that an operator would only need 700MHz *because* they'd taken on a coverage obligation. This is extremely unlikely to be the case: the coverage obligation will drive the operators into marginal geographies, and it is not credible that the only reason (or even a significant reason) for their desire for 700MHz spectrum is to serve those areas…the intrinsic value associated with providing service in those areas simply could not have a meaningful effect on the operator's valuation of 700MHz, which will substantially be driven by providing 5G coverage to the operator's existing footprint. Note that we don't rule out that a cash-constrained operator could wish to fund their 700MHz spectrum from a coverage discount, but per our first bullet above that would result in spectrum being awarded to an operator that doesn't have the highest valuation.

- **Ofcom believes that negotiations to form a joint bidding vehicle which didn't reach fruition could reveal valuation information that impacted individual bidding in the coverage stage.** We do not rule out this possibility in theory, but Ofcom needs to examine the practicable situation. For Ofcom's concern to arise, two parties would need to be in failed negotiations, and both of those parties would then individually bid for the coverage obligation (otherwise any confidential information divulged would be of no relevance as it wouldn't relate to an active bidder in the coverage stage). ✂

- **That bidders would strategically acquire more spectrum than needed to reduce competition for the coverage obligation stage.** There are two interpretations to this, firstly that an operator might do this

to deprive competitors of 700MHz spectrum required to fulfil the obligation, and secondly that an operator might acquire more spectrum than it requires in order to make it impossible for competitors to achieve the positive price constraint in the coverage stage.

On the first aspect, if 700MHz spectrum was the only way to fulfil the coverage obligation then this concern would be legitimate. However, it is not. It is clear that the coverage obligation will be fulfilled by using whatever spectrum stocks bidders have available. As Ofcom confirms in its analysis of Competition Concern 2d, all operators have adequate stocks of low frequency spectrum (indeed as set out in the response to Question Three, Vodafone considers that Ofcom has placed the boundary of what constitutes low frequency spectrum in the wrong place so all operators have more than adequate stocks). It therefore follows that a strategy of depriving competitors of access to 700MHz spectrum to prevent them fulfilling the coverage obligation is doomed to failure.

The second aspect would rely on the bidder concerned being prepared to bid beyond their intrinsic valuation for the spectrum, that they could acquire sufficient spectrum that they drove out competition for the discount, and that they had awareness of achieving the goal. The payoff for achieving this strategy would be the differential between the discount achieved for the obligation if there were more than two bidders, and discount achieved at the reserve price. We consider that it is unlikely that this payoff would be sufficient to cover the additional cost of driving up the spectrum price. Even if it were, though, it is unlikely that they would know whether they were successfully pursuing the strategy: to know that they were succeeding, they would need to know the prospective prices that would be paid by competing bidders. Whether Ofcom chooses a CCA or SMRA format, it is unlikely that his would be the case. Finally, our proposal of regional obligations means that the bidder concerned would need to achieve this feat not just for a single coverage obligation, but instead for a series of lower-priced coverage obligations. In any case, Vodafone's suggestion of variable coverage obligations set with reference to the positive price constraint to promote competition in bidding for those obligations would defeat the strategy.

Vodafone considers that the approach set out in Section B.2 would be far deliver the best outcome for UK consumers. However, if Ofcom insists that coverage obligations must form part of the award of spectrum, we urge it to adopt the model set out in this section as least damaging.

B.4 Mitigation of the existing approach

Vodafone is concerned that despite the issues we have set out with Ofcom's proposed approach, and the credible alternatives that have been set out above, Ofcom has already convinced itself that the proposals in the consultation document are the only way forward. Our pessimism is not diminished by the decision to consult on the detailed auction rules before respondents have had the opportunity to comment on the

policy proposals. As we set out in Part A, the most likely outcome is a distorted award of spectrum allowing BT to secure more spectrum than is efficient given its intrinsic valuation, ✂

Contrary to the aspiration of improved mobile coverage for society as a whole, it will narrowly be improved for BT's customer base. This could damage competition, particularly when combined with BT securing inefficient levels of spectrum at a discounted price.

✂

Little can be done to mitigate the risk presented by BT having advantages in the fulfilment of the coverage obligation due to the State aid it has received for ESN, within the CCA format put forward by Ofcom. However, we do consider that there are small steps that Ofcom could take. We note that the proposals dictate that a minimum of 500 new masts be deployed, and according to Vodafone's analysis, ✂. If Ofcom is serious about improving coverage for all UK consumers, however, there are modifications that it could make to the requirement for 500 new masts:

1. The 500 sites must exclude any associated with ESN State aid,
2. The masts concerned must be built as suitable for sharing by other mobile operators and
3. The fees for sharing the masts should be cost oriented, based around the incremental (not fully allocated) costs of occupying the mast.

BT will doubtless argue that this is unfair and that having taken on a coverage obligation, it should not have to build its mast network to benefit competitors. Ofcom should reject such objections Firstly, BT will be recovering the costs of its build via the discount it gains on spectrum in the auction – nothing in this modification takes away that discount which in effect is aid to improve coverage, provided by the State. Secondly, having acquired this discount/aid, it would be highly unfair if BT were to seek to exclude other operators from benefiting at fair pricing, and highly unfair if it were to seek to levy charges that basically recovered costs that have already been borne by the State in the form of the discount to spectrum fees. As set out in Annex 1, BT has a history of stifling access to masts that have been built with the benefit of State aid, so Ofcom should address this issue now rather than when it subsequently arises.

Part C: Answers to Questions

Question 1: (Section 4) Do you agree with our proposals on the coverage obligations as set out in this section? Please give reasons supported by evidence for your views.

No, Vodafone does not agree with Ofcom's proposals.

As set out in Part A to this response, the effect of combining targeted coverage obligations with the award of spectrum is to distort the efficient allocation of spectrum (we note that a generic coverage obligation would have a lower impact on competition than one that is targeted at a subset of operators).

Distorting the award of spectrum, and as a consequence potentially damaging competition, could only be an acceptable outcome in a situation where a regulator is seeking to improve mobile coverage, there is no alternative to incorporating coverage obligations into the spectrum auction, and the consequences for competition are outstripped by the societal benefit. However this is not the situation that Ofcom is facing – as we set out in Section B.2, operators have stated a willingness to work collaboratively, with Ofcom oversight, to meet its policy aspirations with respect to coverage.

By focusing coverage obligations and hence subsidies on a subset of operators, Ofcom will bifurcate the market into operators with improved coverage (that are subsidised to build out their networks), and operators locked into coverage that is at a commercially viable level.

- If there was a level playing field and operators had a similar level of baseline coverage, then it could be argued that operators would make the commercial decision of which side of the fence to fall: whether to accept discounted spectrum in return for improving coverage. But even then, it is apparent that an arbitrary decision by Ofcom to award two coverage obligations represents a command/control approach to regulating the shape of the market.
- If one or more operators had superior baseline starting coverage by virtue of commercial investment, then we would have fewer concerns.

However, neither of the above scenarios are what we face. Despite Ofcom's best efforts to deny that there's an issue, the situation is clearly that BT is already receiving significant State aid to boost its coverage footprint. As a result, it is uniquely placed to bid for the coverage obligation, leading to it being rewarded with spectrum at a discount price. This is a positive feedback loop fueled by public money. It is a reward given because BT has already been rewarded – ✂. As we set out in Annex 1, the bases that Ofcom uses to determine that there is no issue do not stand up to scrutiny.

Notwithstanding Vodafone's objections to the entire approach adopted by Ofcom, we offer the following observations on the proposed obligation:

Cost to fulfil the obligation

Ofcom will be aware that Vodafone disagrees with Ofcom's assessment of costs. We note, for example, that in Annex 14 of the consultation operational costs are assumed to remain constant in nominal terms[40] with a justification that the Business Connectivity Market Review proposed that backhaul have a charge control of CPI-CPI. This may be the case, but Ofcom cannot credibly suggest that other components of operational costs such as rent, power and manpower will stay constant even in real terms, let alone nominal terms.

As set out in Part A, we continue to disagree with Ofcom's cost analysis, but do not seek to change Ofcom's mind. What matters is not Ofcom's judgement of the costs, but what bidding operators consider the likely costs to be. It does not matter whether Ofcom believes the costs are lower than operators assess; operators will bid (or not) for the coverage obligations, and they will be sold or left unsold, based upon their assessment of the costs. For the avoidance of doubt, Vodafone does not consider Ofcom's cost assessments realistic.

Technology neutrality

Ofcom's choice of a signal strength of -105dBm to support assured access to 2Mbps data services utilising LTE (4G) technology is correct. We note that Ofcom is open to the usage of NR (5G) technology to provide an equivalent service level. However, why the focus on 4G; why is UMTS (3G) excluded? It is possible to provide 2Mbps sustained utilising UMTS technology and while we wouldn't deploy new masts solely using 3G, it seems bizarre to treat a geographic pixel as being a not spot because it receives signal strength sufficient to provide 2Mbps from an existing mast using 3G but has a poorer 4G signal.

As Ofcom will be aware, permitted transmit levels for L800 are lower than for technology using the 900MHz and 1800MHz band[41]. It could, and in due course probably does, make sense to refarm the 900/1800MHz bands to LTE technology, but in imposing that the good quality data service be provided using 4G technology, but the equivalent service using 3G technology is unacceptable, Ofcom is making a technology choice for mobile operators.

For the avoidance of doubt, Vodafone agrees that fulfillment via LTE and NR is probably the best approach, and is the approach we took in modelling costs to fulfil the obligation. However, we do consider that it is wrong for regulators to make decisions around technology choice – that is a matter for operators.

90% obligation

We note the choice of a 90% geographic obligation, which is a reduction from 92% based upon a reconsideration of the costs and benefits. As we set out in Part A, there are significant weaknesses in

[40] Consultation, A14.87 c)
[41] 61dBm/5MHz compared to 65 dBm/5MHz (or carrier, according to technology)

Ofcom's impact analysis, and at best it can only be a rough indication of the benefits of improving coverage (gross of any disbenefit due to inefficient allocation of spectrum and damage to competition).

However, Vodafone questions whether there has actually been a material relaxation in this aspect of the coverage obligation, given the exclusion of Extended Area Sites (EAS). Ofcom estimated that usage of EAS sites would provide 2-3% geographic coverage[42], which broadly accords with our own conclusions – in our modelling for the earlier coverage consultation we assumed a 1.99% geographic uplift (0.04% population) from these sites. Ofcom is correct to remove coverage provided by EAS masts from the coverage obligation, as it is far from clear that these will be universally shareable. However, if 2-3% of coverage is removed from Ofcom's original 92% proposal, we are left basically with the 90% that is now proposed. It is therefore perplexing that Ofcom dedicates so much attention to justifying a reduction (by saying that the benefits of getting from 90% to 92% are not borne out by the costs), when in fact on a like-for-like basis it doesn't actually reduced the scope of the obligation to 90% - Ofcom has merely changed from "*92% including EAS*" to "*90% excluding EAS*".

Ofcom's Connected Nations data[43] shows that the coverage obligation will largely serve to remove operator partial not spots: Ofcom considers operator coverage at the time of the auction will be 80-84% per operator, and that 91% of UK geography has coverage from at least one operator. It therefore follows that in reaching 90%, the winning operator will in the main be rolling out to areas where its competitors already provide coverage. We believe that Ofcom needs to be more candid in public communications that the impact of the obligation on removing total not spots will be limited. There is also a need to recognise that the subsidy provided via the obligation lots will be in exchange for the winning operator(s) largely rolling out coverage where other operators already have already commercially deployed. This is not a bad thing if it improves coverage – what is flawed is to target that subsidy at a subset of operators. Vodafone predicts the sole winner will be BT: if so, Ofcom will need to explain why £350M of public subsidy has been provided for BT to roll out coverage to locations where one or more of Vodafone, Telefonica and Three have already commercially rolled out. Our preferred alternative makes the subsidy work for the collective good.

Leaving this to one side, we note that the approach adopted by Ofcom gives it the unenviable task of determining "once and for all" the level of a geographic coverage obligation that (it hopes) will deliver the maximum coverage benefit while being viable within the reserve price it sets for the obligation lots. Too high and nobody will bid, too low and it will face accusations of failing the rural population. It need not be this way. If Ofcom were to adopt the alternative we set out in Section B.2, it could work with operators collaboratively to determine the optimal cost/benefit point, with flexibility during implementation. If it were to adopt the alternative we set out in Section B.3, it would at least have the freedom to vary the level of the coverage obligation during the auction to ensure that multiple operators were willing to fulfil it. The

[42] Consultation, para 4.111
[43] Connected Nations p6, https://www.ofcom.org.uk/__data/assets/pdf_file/0020/130736/Connected-Nations-2018-main-report.pdf

approach adopted by Ofcom paints it into a corner of second guessing operator costs, with no necessity to be there.

140,000 premises

Ofcom proposes to require the "winning" licensee of the coverage lot to provide service to 140,000 premises above the winning operator's current footprint. On the face of it, this is a worthwhile approach as it provides a broadly level playing field with all operators facing similar costs to achieve this, and the benefit accrued being similar regardless of which operator takes on the obligation. We are therefore supportive, and consider it superior to the premises obligation that was originally proposed.

There are, however, some problems with the approach. Rationally, an operator intending to bid seriously on the coverage obligation would halt rollout between now and the auction. Otherwise, for every home that was served using a newly deployed mast during 2019, the net effect is to cause the winning bidder to have to serve an additional home in the 2020-4 period[44]. Paradoxically, in seeking to improve coverage, Ofcom is potentially damaging prospects for rollout in the short-term. This issue is difficult to overcome, but one approach could be that rather than taking the winning operators' actual coverage as the baseline after the auction, Ofcom should take the greater of that coverage, and their predicted coverage as put forward in the responses to the S.135 requests issued by Ofcom in the spring of 2018[45]. This is less than ideal as the S.135 requests related to coverage at June 2019, but it will at least curb the worst excesses of delaying rollout.

500 new masts

The requirement to deploy at least 500 new masts in rural areas is ✂

In principle, then, the benefit of this obligation – other than preventing the worst excess of an obligation-holder seeking to deploy a hugely high mast to cover large swathes of unoccupied land to reach 90% - is to ✂

Vodafone considers that it would be better to require at least 500 masts *for which there has been no State contribution,* and ✂

At the very least, there should be a requirement that the winners of the coverage obligation lots should be forced to build masts in a format suitable for sharing, and that other operators are then only charged the incremental costs of that sharing (the common costs having *de facto* already been paid by Ofcom in the form of the discounted spectrum awarded in exchange for taking on the obligation).

---

[44] Because the alternative is for the operator to defer making the mast operational until 2020, in which case the home concerned would count towards the operator's 140,000 premises requirement hence lower the cost of achieving it.
[45] This would provide an honest view of what operators considered they'd deploy during 2019, prior to becoming aware that deferring build to game the system could be beneficial.

Question 2: (Section 5) Do you agree that we have identified the correct competition concerns?

The answer to this Question should be read in combination with the concerns that have been raised in Part A to this response.

Vodafone agrees with the competition concerns identified as far as they go, but considers that Ofcom has omitted to consider two competition areas:

1. Issues arising from the coverage obligation applying to a subset of mobile operators, and
2. Issues arising from the inefficient allocation of spectrum.

We consider each of these in turn.

Coverage obligation

The effect of the obligation will be to bifurcate the market into operator(s) with an obligation to serve 90% of geography (who will be awarded a *de facto* subsidy), and other operators with no such obligation. If the award is successful (by Ofcom's criteria), then this will be a two-operator/two-operator split, but Vodafone expects that a more likely outcome is a BT/everyone-else split. We do not see any analysis from Ofcom in the consultation as to whether this presents a competition concern – for example Potential Concern 1 addresses whether one or more of the operators will fail to be credible, but it is not market credibility that presents a concern, rather that the effect of the two-tier market will serve to damage competition.

Imagine that Ofcom is correct, and there are two successful bidders for the coverage obligation lots. In rural areas, people would be faced with a choice between two operators that have received funding to improve coverage (so that their coverage in broad terms equates to what other operators can achieve in combination), or the other two operators that have provided coverage to a commercial level. All things equal, the more likely rural consumer choice is the two operators providing coverage. Ofcom acknowledges this – in assessing the benefit of improved coverage it posits that the operators with an obligation will see an increase in market share between 10% and 15% in the rural areas concerned[46].

Clearly this is a change to market structure in those locations, albeit in a subset of UK geography. However this subset will be considerably in excess of the 6-10% addressed by the obligation itself, because this figure only addresses the geographic pixels with poor coverage, whereas the geography where the market will be impacted also incorporates those areas with good coverage that are interspersed with not spots.

The potential impact on the market is wider than this, however. A useful analogy is electric vehicles. As these have poorer range and take longer to refuel than their petrol/diesel counterparts, it is well recognised that an element of "range anxiety" holds back market penetration. For most users, the range is perfectly adequate for most of the time, but buyers are deterred from purchasing because of the infrequent times where the lack of range would be an inconvenience. In reality, the purchaser may never need to travel

[46] Consultation, A12.54.

beyond the range of the electric vehicle, but is deterred from purchasing because they perceive it will be an issue if they ever do need to travel further. Translating this to the mobile coverage situation, a consumer in an urban environment could be faced with packages from multiple operators, and make a choice based upon the benefit that when they visited relatives in the country, the operator with the coverage obligation is able to assure ongoing connectivity in a way that the operator who did not receive the subsidy cannot. The coverage obligation, targeted at rural customers, could have an impact on competition in the wider market.

Ofcom has not examined this issue. It has not, for example, conducted market research to determine whether people in areas of good mobile coverage could be influenced to select a mobile provider based on their infrequent visits to rural areas. It has not analysed what the impact on competition could be if two operators were to increase their market share by 10-15% at the expense of the remaining operators. It has not determined whether a four-operator model with two strong and two weak operators meets Ofcom's definition of a thriving competitive mobile market.

Inefficient allocation of spectrum

We explained in Part A that the nature of the award envisaged by Ofcom could mean that spectrum may not be efficiently allocated. We believe that Ofcom understands and accepts that there is a (policy) price to be paid for combining spectrum and coverage. For the avoidance of doubt, Vodafone considers that there is no need for an award process that potentially results in the inefficient allocation of spectrum if our alternatives are considered, but given that Ofcom is proposing such an approach, it is incumbent on it to verify that the inefficient spectrum allocation does not damage competition.

The result of the design put forward by Ofcom is that an operator that values spectrum most highly could be deprived of access to that spectrum, because an operator with a lower valuation combines this with a promise to provide coverage. Presumably, the operator with the high spectrum valuation must do so because it is able to better monetise the resource; it could have more customers (or believe it could acquire more), or it could have plans to provide compelling services that would result in larger revenues than its competitor. Because that operator is deprived of access to the spectrum, the services it can offer will be less compelling than would otherwise have been the case – it could result in network congestion, or there could be innovative services requiring high amounts of spectrum that will not be brought to market because the operator with a lower need for the spectrum obtains it. Clearly, this would have a competitive impact, and one that should be of interest to Ofcom.

Put another way, the approach of awarding spectrum via an auction process is favoured because it leads to spectrum being placed in the hands of those who value it most. We question whether Ofcom has lost sight of that fundamental logic behind the usage of auctions – if the paradigm is broken, then it is questionable whether an auction is the correct approach. We would expect that at the very least Ofcom should have a competition concern of spectrum – one of the most costly components of running a mobile service – falling into the hands of those who don't value it most highly.

Question 3: (Section 5) Do you agree with our assessment of these competition concerns, and our proposed measure for addressing them? Please give reasons supported by evidence for your views.

We refer Ofcom to the answer to Question Two, and also to Part A of this response. We have the following additional comments on Ofcom's analysis and proposed measures:

Concern 1 - Prospect of fewer than four credible MNOs

Vodafone notes Ofcom's preferred model of four credible mobile network operators, and consider that if Ofcom is to veer from that course, then an in depth stand-alone policy study would need to be undertaken. We do not consider that there is a risk that via this award, one or more operators would cease to be credible from a spectrum perspective. We do, however, consider that Ofcom risks damaging the competitive intensity of the marketplace and refer you to our response to Question Two for an explanation of why. This is a significant risk and one that Ofcom must address.

Concern 2a – Weakened competition through significant asymmetry of overall spectrum

Vodafone agrees that significant asymmetry of overall spectrum holdings creates a risk of damaging competitive asymmetry. We note that Ofcom has converged on a figure of 37% of overall spectrum as being the point at which it would have concerns.

Ofcom concludes that such an outcome is "fairly likely"[47] if it fails to take measures to prevent it; we are doubtful of that as even BT, with current holdings of 295MHz, would need to acquire more than 120MHz, i.e. 60% of the spectrum on offer, in order to reach the level that concerned Ofcom – to achieve such an asymmetric outcome of the auction would imply extreme bidding behaviour. That said, this point also proves that imposing a safeguard cap of 37% is unlikely to have any practicable impact on the auction outcome unless there was extreme bidding behaviour, so Vodafone supports Ofcom maintaining this measure.

Concern 2b – Weakened competition through significant asymmetry of capacity spectrum

Following Telefonica's acquisition of 40MHz of 2.3GHz spectrum at the last auction, Vodafone considers that Ofcom need not have any worries on this topic.

Concern 2c – Weakened competition through significant asymmetry of 5G spectrum

Vodafone disagrees with Ofcom's conclusions on this topic. We believe that Ofcom's analysis is guilty of under-estimating the importance of 5G, and confusing spectrum required for early 5G deployments with that which will be demanded for fully-fledged 5G services over coming years.

As noted in Vodafone's response to Question One, Ofcom frames all of its requirements for coverage in terms of requiring 4G signal strengths (with a caveat that 5G is acceptable). 2G and 3G are considered to be yesterday's technology – regardless of whether it is possible to deliver the mobile data speeds that Ofcom

[47] Consultation Figure 5.1

desires using 3G, it makes no mention of them because its focus, and the focus of the market, is 4G. If we fast-forward a few years, it is a reasonable expectation that when Ofcom considers what is important for the provision of mobile services, it will similarly focus on 5G and consider 4G to be (then) a legacy technology worthy only of a footnote. 5G is all that will matter.

Against that backdrop, competition in 5G services is critically important, and Ofcom cannot depend on an approach of *"well if there's insufficient competition in 5G then 4G will be a substitute so it doesn't matter"*. If there was a market failure in the provision of 4G services today, would Ofcom be happy to rely on the availability of 3G services to overcome the competition issues? Unlikely.

All operators have got sufficient spectrum from the recent award to launch 5G services. ✂

Figure C.1: ✂

As set out in Part A to this response, usage of frequencies in the 2.xGHz band is not an effective substitute in the short-medium term, because there is no eco-system to support 5G services. The analysis which Ofcom sets out in Figure 5.6 of the consultation is flawed, because it presents no analysis of when there will be an ecosystem to facilitate refarming of existing bands to 5G, in comparison to when the "wide range of 5G services" will be required. ✂. Ofcom may disagree, but it has failed to provide evidence to back up its stance.

Even in the longer term, the physics of constructing M-MIMO panels mean that the alternative bands cited in Figure 5.6 of the consultation will not support equivalent performance to usage of 3.xGHz technology.

Ofcom is wrong to conclude that there are no dangers in asymmetry of 5G [capacity] spectrum and wrong in failing to adopt the approach taken in the 2.3/3.4GHz competition analysis, and repeated in Ofcom's consideration of concern 2a), of dividing time into "transitional periods" reflective of whether there is substitute spectrum available. Properly framed, Ofcom would conclude that there is a danger if a single party has more than 37%[48] of 5G capable capacity spectrum, and that for the transitional period running from 2020 until perhaps 2024, "5G capable capacity spectrum" means spectrum in the range 3410-3800MHz, as spectrum in other bands cannot support 5G services.

Taking this approach would cap spectrum holdings in the band at 140MHz. Three's spectrum holdings at the time of writing would preclude it from acquiring further spectrum, but it is entirely possible – as Three suggested of BT in the Judicial Review into the 2.3/3.4GHz award[49] - for Three to divest spectrum in advance of the auction if it wished to participate.

[48] As Ofcom's chosen metric.
[49] Case No: CO/4042/2017 AND CO/4260/2017 between Hutchison 3G UK Ltd / British Telecommunications Plc and Office of Communications, Judgement, 20/12/17, para 157 https://www.judiciary.uk/wp-content/uploads/2017/12/h3g-v-ofcom-full-judgment2.pdf

Concern 2d – Weakened competition through significant asymmetry in low frequency spectrum

Vodafone agrees with Ofcom's conclusions on this concern, but not with the reasoning behind it.

Ofcom defines the concern as being if spectrum symmetry produces differences in coverage capabilities, which harm competition. It then goes on to define the relevant spectrum as being that below 1.5GHz, based upon a criteria of being capable of providing deep indoor coverage.

We do not deny that the propagation characteristics of the 900MHz band with respect to indoor coverage are better than those of the 1800MHz band – this is ultimately why the Annual Licence Fees for 900MHz are 36% higher than for 1800MHz on a unit basis – but that clearly does not preclude the 1800MHz band being used to form a low frequency coverage layer.

Ofcom's choice of 1.5GHz as the boundary aligns with a criterion of "ability to provide deep indoor coverage", but it is the choice of that criterion itself which is arbitrary, lacking justification and inconsistent with the rest of Ofcom's analysis of coveraeg. The entirety of Ofcom's analysis around how the coverage obligation should be set, and the eventual thresholds that Ofcom committed itself to, are framed around providing good outdoor coverage. If Ofcom is concerned about levels of deep indoor coverage, then the coverage obligations should be set around that metric; only then can have it competition concerns around whether operators have the right spectrum to achieve that definition of coverage. The obligations are not framed around deep indoor coverage, because Ofcom knows full well that indoor voice coverage levels are acceptable, and for indoor data there is a ready supply-substitute in the form of Wi-Fi using a fixed broadband connection.

The coverage obligation associated with this spectrum award is outdoor data at 2Mbps. Any competition analysis around the spectrum required to provide coverage must be on the same basis. The analysis presented in the consultation around the performance of various frequencies in providing indoor coverage (e.g. Figures 5.8 and 5.9) is of great technical interest, but ultimately irrelevant when applied to what Ofcom has chosen as the coverage metric. Using the correct metric of 2Mbps outdoor, it is clear that there is little difference between the performance of 900MHz and 1800MHz, so any competition analysis should encompass that (and probably the 2100MHz band too). When spectrum holdings in this range are considered, it is abundantly clear that Ofcom need have no worries about spectrum asymmetry.

Question 4: (Section 6) Do you agree with our proposal to proceed with a conventional assignment stage?

Vodafone disagrees with Ofcom's conclusions.

Before commenting on the proposals, we would first highlight that Ofcom will likely have a duty to ensure that large contiguous blocks are made available for operator usage. The European Electronic Communications Code[50] states that:

> *1. By 31 December 2020, for terrestrial systems capable of providing wireless broadband services, Member States shall, where necessary in order to facilitate the roll-out of 5G, take all appropriate measures to:*
>
> *(a) reorganise and allow the use of* ***sufficiently large blocks*** *of the 3,4-3,8 GHz band;*
>
> *....*
>
> *3. Measures taken pursuant paragraph 1 of this Article shall comply with the harmonised conditions set by technical implementing measures in accordance with Article 4 of Decision No 676/2002/EC*

In addition, the subsequent implementing decision states[51]:

Within the 3 400-3 800 MHz frequency band:

..

3. there shall be spectrum available providing the opportunity to access sufficiently large portions of contiguous spectrum, ***preferably 80-100 MHz****, for wireless broadband electronic communications services;*

So, far from being a matter for industry to resolve, Ofcom has an important role to play too. Vodafone is therefore disappointed that we have got to the stage where industry is collectively running out of ideas to resolve the issue. ✂

As far as the auction is concerned, in the consultation Ofcom puts forward three options:

1. Restrict winners of small amounts of spectrum to either the top or bottom of the band,
2. Bidders agree assignments on a commercial basis, as a possible alternative to the assignment stage, and
3. Contingent bidding in the assignment stage.

[50] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L1972&from=EN , Article 54 (Vodafone emphasis)
[51] https://www.opengateitalia.com/wp-content/uploads/2019/01/CE_Implenting-Decision.pdf , section B (General Parameters), (Vodafone emphasis)

We note that these options are not mutually exclusive, and on this basis Vodafone believes that for the greatest chance of success in defragmenting the band, Ofcom should implement all of them:

- At the beginning of the assignment stage, sealed bids would be placed for specific frequencies
    - A constraint would be made that winners of small amounts of spectrum would be placed at one end of the band or the other and not have the ability to bid for central frequencies.
    - Bids could be placed contingent on being adjacent to specific other winners. We note that Ofcom should be allowing this in any case, to reflect the realities of mast joint ventures.
- The assignment stage would then be paused for an agreed negotiation period, to allow for [Ofcom facilitated] negotiations between the winning bidders to achieve a mutually acceptable frequency allocation. Subject to the consent of participants, this negotiation could be extended to include all frequencies in the 3410-3800MHz range.
- If at the end of the negotiation period there is no commercial agreement on the assignment of specific frequencies, then Ofcom would proceed to process the sealed bids received, to determine the detail of frequencies to be assigned.

Vodafone is somewhat mystified that in the consultation at paras 6.66-6.67 Ofcom recognises the benefits of the options that it has set out, but in para 6.68 then concludes that the minor issues it identified (such as delaying the auction outcome by a matter of days/weeks) are such that it should abandon this innovative thinking. We do not see the downside in adopting the approach above; it doesn't increase the scope for strategic bidding, as bids will already have been placed prior to the negotiation, and the worst-case outcome appears to be that the negotiations fail and the auction outcome is delayed by a week or two. We urge Ofcom to reconsider.

Question 5: (Section 7) Do you agree with our proposal to use a CCA design for this award?

The response to this Question should be read in conjunction with Parts A and B of this response.

In Part B, Vodafone sets out that (in order of priority) Ofcom should remove a coverage lot approach from the auction process (see Section B.2), or that if a coverage lot forms part of the auction then it should be accomplished via a sequential process (see Section B.3), or that if the current proposal is adopted then Ofcom should place a mandate on the winning bidders of the coverage lot to share masts (see Section B.4).

Auction format if aintaining existing approach

The proposal by Ofcom to incorporate coverage and spectrum into a single auction stage probably makes the choice of a CCA format inevitable. However, are we likely to see a true "auction" in the context of the coverage lots?

✂

It seems clear that there would likely be only one or two bidders for the two coverage obligation lots. What we have therefore is not an auction, but ✂. In that scenario, Ofcom could just as easily ask the question directly (contingent on the bidder securing sufficient spectrum to fulfil the positive price constraint) and avoid the complexity of a CCA.

Indeed we can demonstrate where there are almost no circumstances whatsoever in which Ofcom's proposed CCA design would lead to a superior outcome over an alternative two-stage design (with a first stage to allocate spectrum, followed by a further auction stage for coverage obligations).

We will assume, for simplicity, that there is only one bidder[52] B who is interested in acquiring the coverage obligation at the negative reserve price (call it –S, where S is the maximum level of subsidy offered to meet the obligation).

Define Q_E to be the efficient package that B would win in an auction without subsidies, and P_E to be the price that B would pay for that efficient package. We have two cases:

1. $P_E >= S$ In that case, B has no incentive to distort the CCA format auction, as they can fully realise the whole subsidy by winning the efficient package Q_E. More formally, since B will receive the same subsidy S for either Q_E or any alternative package more expensive than P_E (and will receive a subsidy <=S for any package less expensive than P_E) it is most profitable for B to win Q_E.

   However in this case, Ofcom could just run a first stage to determine who won what. B would naturally win Q_E at price P_E. Then Ofcom could run a separate coverage stage starting at –S and bidder B would win it and receive the full subsidy. There is no benefit from the CCA here.

2. $P_E < S$ In that case, B cannot realise the full subsidy from winning Q_E. Instead B's optimal outcome is to distort their demand up to (at least) a package X_E, structured so that X_E is more valuable to B than any sub-package of X_E (including Q_E) and the value to other operators of the excess spectrum (X_E - Q_E) is ($S-P_E$). The auction clock rounds will allow B to identify this package with a reasonable degree of accuracy.

   In an auction free of subsidies, bidder B would have to pay $P_E + (S-P_E) = S$ for this package (by the CCA second price rule); after the subsidy, B would pay zero for the package, so by assumption, winning X_E is more profitable to bidder B than any sub-package. There might be scenarios where B prefers and wins an even larger package than X_E e.g. if there is escalating value from foreclosing competition at very large packages, so the efficiency distortion might be even worse.

   We can see in case 2 that in an auction which separated the main stage and coverage stage, bidder B might not be able to benefit fully from the subsidy S, since Ofcom would be only able to offer P_E and bidder B might perhaps be unwilling to take the obligation at $-P_E$. However, this is precisely the case where selling the subsidy causes an inefficiency allocation of spectrum. When the social

[52] The case for two such bidders is very similar, and just requires notation for each separately.

impact of the inefficiency is considered, it is perhaps 10 x (S-P_E) compared to a social value of achieving the coverage obligation of ~S.

We can conclude from this, that unless there are very finely balanced circumstances where

i) P_E is extremely close to S
ii) Bidder B would **not** accept a coverage obligation at -P_E
iii) Bidder B **would** accept a coverage obligation at -S

then Ofcom's proposal of combining coverage and spectrum into a CCA will lead to socially inferior results over splitting them out. Even in this highly unusual combination of circumstance, it would almost certainly be better (and safer) for Ofcom to slightly reduce the coverage obligation until bidder B was willing to accept it at a subsidy P_E very slightly less than S. A coverage stage in which the extent of the coverage obligation was variable, as well as the price, would of course facilitate this, and would be much easier to achieve in a two-stage mechanism, rather than a single stage mechanism. We conclude that there is no case where Ofcom's CCA mechanism offers any benefit over a two-stage mechanism.

Auction format for sequential spectrum and coverage stages

In the event that Ofcom accepts the proposals set out in Section B.3, then for the spectrum stage, Ofcom is able to re-examine whether a CCA or SMRA format is optimal. Whilst CCA has advantages in the context of allowing bidders to express a desire to obtain a particular package of spectrum, we are becoming increasingly aware of shortcomings in the approach. Vodafone commissioned CRA to review recent academic evidence on this point, and identify practical shortcomings that have arisen where the CCA format has been adopted. Their analysis, in Section 4 of Annex 2, identifies:

- That CCA causes problems for bidders with budget constraints. The difference in the price of bids placed and prices paid in CCA format auctions are substantial. This can distort bidding incentives because budget-constrained bidders may bid only to their budget hence the relative level of bids an bear little resemblance to bidders' relative spectrum valuations.
- The CCA format is vulnerable to departures from surplus maximising preferences, for example to raise competitive rivals' costs.
- That prices paid in CCA format auctions are very sensitively to missing and "strategic" bids. As the number of packages is exponential to the number of lots, the number of required bids can be massive. However, bidders may lack the incentive or ability to submit bids for all packages, and any missing bids, be it via error or intent, has a material impact on the price paid. Furthermore, the possibility of such deviations from full and truthful bidding may open the door for further strategic deviations, thus negating the theoretical advantages of CCAs.

We would support a CCA format auction if there was a compelling reason to adopt this approach. For example, if there was a strong aggregation risk that a bidder for 700MHz spectrum would value it materially differently according to whether it acquired stocks of 3.6GHz spectrum, then the package bidding approach of a CCA would be sensible. However, that doesn't appear to be the case for this particular award. So long as bidders are able to lay down a minimum amount of spectrum that they would wish to acquire (per the process in the 2.3/3.4GHz auction), there seems little aggregation risk and so an SMRA format, which makes securing business approvals for bidders far easier, is preferable.

Question 6: (Section 7) Do you have any comments on the proposed detailed rules for our CCA design?

Apart from our general concerns with the proposed CCA format, Vodafone has some specific concerns about two aspects. These are related to experimentation with the CCA format, and information policy.

First, while the CCA is a fairly well-established design, there is no (or negligible) precedent for auctioning a combination of positive-priced and negative-priced lots simultaneously. To the extent that Ofcom is promoting this, it is setting up a high-value, high-stakes "experiment", and is prepared to subject the entire mobile industry (and wider society) to the consequences if this experiment happens to go wrong. We would strongly caution Ofcom against doing that, in particular in light of the consequences of their previous "experiment" with floor packages in the 2013 4G auction. The UK mobile industry is still living with the odd (and probably inefficient) packages at 800 and 2.6 GHz that emerged from that auction.

Second, we are concerned about the highly restrictive information policy that Ofcom proposes to adopt in the upcoming auction. Ofcom appear to have considered some of the opportunities for strategic bidding (such as spiteful bidding) that have been discussed in the literature, and propose to provide bidders less information so that they have less opportunity for bidding strategically. We have several comments here. References are to papers cited by CRA in Annex 2:

1. We consider that Ofcom's proposal is unlikely to work. Janssen (2015), and Janssen and Karamychev (2016a, 2016b) show that the incentives for spiteful bidding (deliberately inflating demand and increasing competitors' prices) remain present, even if there is no information at all provided beyond the fact that there is another clock round, and that lot prices will increase in that clock round.

2. Ofcom's proposal greatly increases the complexity of bidding in the supplementary round. Bidders will not have remotely sufficient information available to calculate a "knock out" bid, sufficient to allow them to secure their final primary round package, or something close. Bidders will have to take real (hopefully calculated) risks with their auction budget:
    i. Do they assign the entire budget to increasing the bid for their final round package, and so obtain the best chance of securing it? (RISK: The bidder could perhaps have secured much more for their money, because there was significant unsold spectrum at the end of the primary rounds.).

ii. Or do they make a minimal increase in their final round package bid, and save the rest of the auction budget for attempts at larger packages, ones which might perhaps be winnable because there was unallocated final round spectrum and/or other bidders may not have bid high enough to secure their own final primary round packages? (RISK: The bidder may exit the auction winning nothing at all).

3. Ofcom's proposed activity rule (the complexity of relaxed bids, chain bids etc.) does not sit easily with the restrictive information policy. The normal justification given for this complex rule is that it allows a final round cap to be implemented, and the final round cap allows calculation of minimal "knock out" bids in the supplementary round. Since Ofcom is proposing to remove the calculation advantages to bidders of the final round cap, it is not obvious there is any real balance of benefits from having the relaxed activity rule.

4. There is a concern in the literature (Bichler, Goeree, Mayer, Shabalin 2014; Bichler, Goeree, Goetzendorff 2018) that CCAs fail to deliver efficient results because of their complex bidding language and a problem of "missing" packages. Many packages that would have helped find an efficient auction outcome are just never bid for, because bidders do not have the resource or ability to bid for every possible package, and do not know it would be advantageous to make bids for some of the most crucial packages. Adding to the "fog" of the primary rounds by not revealing accurate supply and demand information, and then not revealing whether demand has undershot supply (and to what extent, and in which bands) is likely to make this inefficiency worse. Bidders are even less likely to make a full set of package bids somewhere in the crucial range which would allow auction efficiency to be improved.

5. A CCA with very limited information reduces in the limit to a pure sealed-bid Vickrey auction (with a bit of a tweak to implement core pricing). The literature on why the pure Vickrey format is unworkable in practice is quite extensive (see Ausubel and Milgrom 2006 for a recent review). It is our view that any change in information policy which moves the auction format further away from an SMRA and further towards a pure sealed bid Vickrey auction is likely to make the problems of complex bidder decision-making and inefficient outcomes significantly worse.

Question 7: (Section 8) Do you agree with our proposed approach to coexistence in the 700 MHz band? Question 8: (Section 8) Do you have any comments on the proposed licence obligation and guidance note (annex 19)?

This is an area that Ofcom has a duty to get right. The level of interference caused by the deployment of LTE in the 800MHz band was far lower than originally forecast, and against any metric the original measures imposed on winning bidders was disproportionate. Until the slimmed down procedures and KPIs were

introduced, it would have almost been cheaper for the mobile operators to pay each impacted householder to move house than to operate the mitigation scheme. Massive volumes of filters were purchased, only to be subsequently scrapped. Vodafone has contributed some £40M to a scheme that in large part has served to improve the quality of Digital Terrestrial Television (DTT) installations rather than narrowly fixing issues caused by LTE deployments.

Along with the other mobile operators, Vodafone requested Digital Mobile Spectrum Ltd (DMSL) to provide guidance to Ofcom on the best approach to mitigating interference to DTT from deployment in the 700MHz band. DMSL has provided that as a separate response to Ofcom's consultation, and we endorse that response.

Question 9: (Section 9) Do you agree with our proposed approach to managing interim protections for registered 3.6-3.8 GHz band users?

Vodafone broadly agrees with the proposals.

We note that satellite usage of the band will be time limited, and December 2020 represents the backstop. ✂. As such, depending upon the timing of the award and subsequent rollout by operators, interim protection could be a moot point.

For masts that are anywhere near point-point links, Vodafone agrees that it would be prudent for Ofcom to check that there are no coexistence issues. However, given the location of the fixed links concerned, this leaves a huge swathe of the UK for which an unnecessary administrative stage will be needed. It may therefore be more appropriate to specify that only planned masts within 100km of the links concerned go through the check process.

We further query the absolute requirement that masts be submitted in batches of 100 or more. This could compromise operational flexibility, where masts are either omitted from a list or need to be deployed on an expedient basis. It would be sensible to allow each licensee a finite number of "expedient" requests that do not meet the 100 mast minimum criteria, potentially with the facility to levy a (cost-based) fee for expedient applications where that number is exceeded.

Question 10: (Section 9) Do you agree with our 3.6-3.8 GHz in-band restriction zone proposals?

Vodafone agrees with these proposals.

Question 11: (Section 9) Do you agree with our view that we do not need to include any specific conditions in 3.6-3.8 GHz licences to mitigate the risk of adjacent band interference?

Vodafone agrees with these proposals.

Question 12: (Section 10) Do you agree with the non-technical conditions that we propose to include in the licences to be issued after the award of the 700 MHz and 3.6-3.8 GHz bands?

As set out in Part A, Vodafone is surprised that Ofcom has not properly codified the coverage obligation, simply referring to the obligation holding providing coverage "with a high level of confidence"[53]. It has stated elsewhere that this means a 95% confidence factor, but this isn't actually embedded into the licence requirements. This needs fixing, as it has profound cost implications (and conversely leaves Ofcom vulnerable to an obligation holder gaming the system).

On the whole, Vodafone otherwise agrees the proposed conditions:

- An initial term that runs for 20 years from the availability of the spectrum is sensible (in the alternative, 20 years from the grant of the licence makes equal sense and bidders would adjust their valuation for the 3-6 months difference in the point at which Annual Licence Fees would apply).
- Ofcom is correct not to put explicit "use it or lose it" terms in the licences. Firstly, the parallel consultation on sharing provides the policy framework for Ofcom to over-license where spectrum is unused. Secondly, it is open for licensees to trade unused spectrum, meaning it could be considered a crude form of compulsory-purchase if the freedom to trade-away unused spectrum was impeded.
- The information requirements in the draft licences appear largely consistent with those specified in other licences (notwithstanding that Ofcom has to-date requested this information via Information Requests under Section 135 of the Communications Act and Section 32A of the Wireless Telegraphy Act, rather than drawing upon the licence conditions themselves).

  However, condition 3(e) which deals with prospective mast deployments is new, and unacceptable in its current form. The condition calls for information to be provided on *"apparatus to be established, installed or used within such timeframe and in such areas as Ofcom may reasonably request".* This is vague, as the timeframe is undefined. Vodafone considers that forecast information for one year hence would be appropriate, but it is unduly onerous to ask for anything more. As the

[53] See e.g. para 11 of the Schedule to the draft 700MHz licence, at Annex 22 of the consultation.

condition as written is vague, it means that prospective bidders are being asked to make huge financial commitments where the associated obligations are unclear.

Subject to there being no interference with mobile telephony services, we acknowledge that it is efficient usage of spectrum for Arqiva to continue to provide Digital Terrestrial Television (DTT) services in the centre-gap until such a time that the winning licensee(s) wishes to use that spectrum. We consider that three months' notice is sufficient from the mobile operator side, but question whether Arqiva will be able to withdraw the DTT mux at that level of notice period. We also query whether the licence fee regime put forward by Ofcom is appropriate. Fundamentally, Ofcom will be having its cake and eating it. The centre-gap licensee will have paid a market-based fee for the spectrum during the award. Yet Ofcom plans to continue to charge Arqiva an ALF to use the spectrum. Plainly this cannot be right, and the relevant Arqiva ALF should be passed to the centre-gap licensee (in the alternative, the ALF could be passed to whatever organisation the licensees put in place to provide interference mitigation services, or Ofcom could continue to receive the ALF but the licence term for the centre-gap would commence at the point that the licensee served notice to Arqiva).

Finally, Vodafone notes that specimen licences are provided only for 700MHz and 3.6GHz licences, i.e. a single specimen licence is provided that covers both the paired-700MHz and centre-gap 700MHz usage. A better approach would be to create specimen licences for each case, because the approach adopted leaves redundant terms – for example condition 3(g) (rollout information) is relevant only to the centre-gap licensees, and 7(b) (uplink power) applies only to the paired spectrum. It is assumed that the intent to operate a mitigation scheme applies equally across holders of the paired and centre-gap licences but this is not explicitly stated. Distinct licences for each type of spectrum would make the situation far clearer.

Question 13: (Section 11) Do you agree with the technical licence conditions we propose?

Vodafone agrees the proposed technical conditions, but notes that industry dialogue to agree frame structures in 5G NR terms may be beneficial.

Annexes

Annex 1: Emergency Services Network (ESN)

This annex describes the advantage that BT gains by being the lead implementing mobile operator for ESN, and how Ofcom's thinking fails to adequately address the issue.

The contract to provide the Emergency Services Network (ESN) was awarded to EE (now BT) by the Home Office. Under the contract, BT will add some 500 sites to its network, of which 291 will be benefit from State aid. ✂

Nonetheless, in November 2018 Vodafone undertook a deep-dive exercise to examine whether it was feasible to share a sample of ESN sites. Of ✂ sites examined, ✂ (i.e. ✂%) of them were unsuitable for sharing because they had been built for sole occupancy by BT. The situation for the remainder was that there was insufficient information for ✂ of the sites, with ✂ (i.e. ✂%) where sharing could theoretically be possible (however, as will be explained, this positive outcome was illusory).

The reason why the majority of masts were non-shareable varied on a site-by-site basis. Figure 1.1 below shows how some sites are built with sharing in mind, whereas with others it is not possible. Retrofitting is expensive, largely because essentially the work involved is to demolish and rebuild the sites.

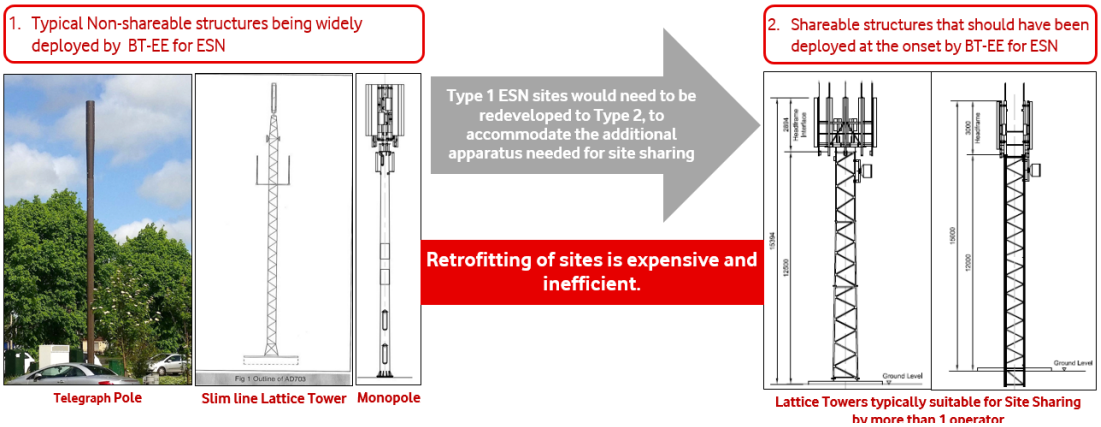

Figure 1.1 – mast configurations

Whereas in a minority of locations the decision of mast type could have been forced on BT[54], in others it was entirely BT's choice. We contend that if BT had engaged with industry earlier, many ESN sites would be usable by all operators. Sadly, this was not the case and the mast design was on the whole finalised before we were asked to provide input – see Figure 1.2.

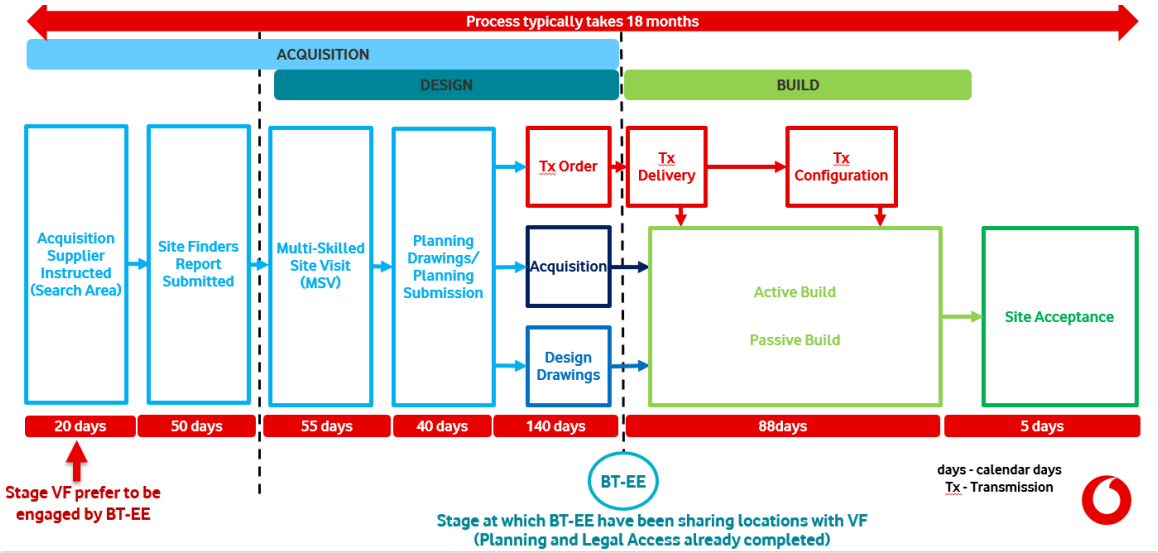

Figure 1.2 – plan and build process

We are therefore left with ✂ sites – ✂% of the sample – that are *notionally* suitable for sharing. However, whilst these masts may have been physically capable of accommodating other operator antennas, closer inspection revealed that the height of the available capacity varied considerably, as set out in Table 1.1 below.

Table 1.1 – height of available capacity

Height above ground level	Number of masts
<10M	✂
≥10M but <15M	✂
15M	✂
>15M	✂

[54] For example in Vodafone's response to the earlier 700 coverage obligation, we highlighted (Section 2.3) how masts in the Yorkshire Dales had been built as single-occupancy at the insistence of local planners.

The antenna height of a mast in relation to its surrounding obstacles is a critical factor in determining its suitability. With lower antenna height, Vodafone's coverage would be substantially worse when compared to BT's, as shown in Figure 1.3. The available height also has knock-on ramifications for backhaul: typically these sites will be in rural areas where fibre backhaul isn't viable, but if the available antenna space is in the tree-line, it make microwave backhaul impracticable too. Unless masts have space available at above 15M, in general they're not suitable for sharing.

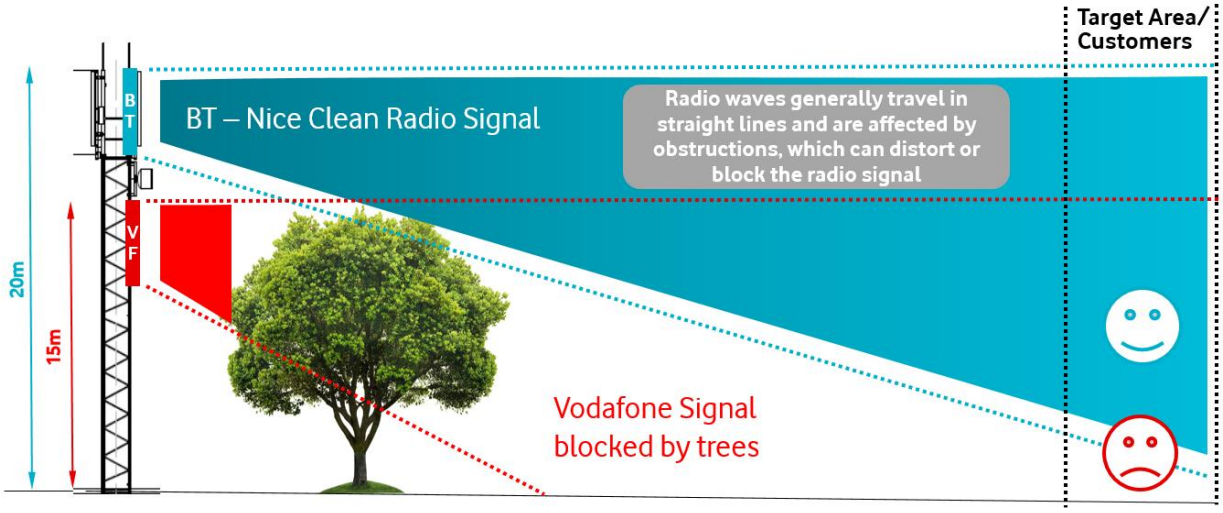

Figure 1.3 – impact of antenna height

An example of the issues faced can be seen by looking at site 74288, as shown in Figure 1.4 below. As can be seen, whereas antennas at 20M will be above the tree-line, the scraps left for other operators are smothered by local tree clutter so in practical terms the site is unsuitable for sharing.

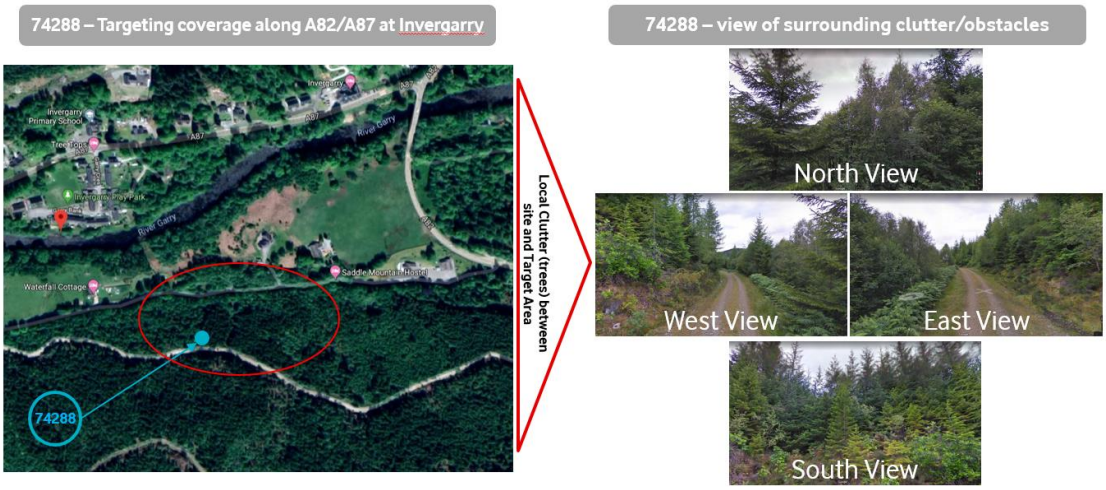

Figure 1.4 – site 74288

We are therefore left with just ✂ sites – barely 10% of our sample – that have actually been built by BT as suitable for sharing. In these locations, despite benefiting from State aid, BT's approach has been to adopt their standard rate card, meaning that Vodafone would be contributing to the common costs of that mast which BT has already recovered from the Home Office. In summary, the presence of ESN sites does not move the needle for Vodafone, whereas their usage will significantly ease the task of BT achieving the coverage obligation in the most difficult terrain.

In the consultation, Ofcom cites a series of reasons why it need not be concerned about the effect of ESN on setting the coverage obligation. Vodafone contends that none of these stand up to scrutiny;

- That the arrangement between BT and the Home Office may unwind over a twenty-year period[55]. That is indeed the case. But it may also not unwind. Ofcom can only deal with the evidence that it has in front of it, and the BT-Home Office ESN arrangement is a fact. It will remain a fact for the period when the winning bidder(s) of the coverage lot would need to roll out the network to meet that obligation, so is highly material when operators consider whether they should bid for that lot. Whereas BT knows it is receiving State support to improve its coverage, other operators can only speculate that a review of the ESN arrangement may change their cost base at some point in the future. That is no basis for a commercial enterprise to make a spending commitment running to hundreds of £millions.
- At the expiry of the current ESN contract, all operators would have the opportunity to access the ESN sites that are transferred back to the Home Office[56]. Once again, this is speculative. We cannot know for sure that years down the line, the Home Office will take ownership of the sites versus renew the arrangement with BT. Even in the event that the Home Office did take ownership, Vodafone's analysis above shows that only 10% of them would be suitable for multi-operator occupation. We can speculate that an arrangement could be reached to convert the BT antennas to a MORAN[57] or to serve a MOCN[58] in order to make the coverage available to all operators' customers, but that can only be speculation. Once again, no operator could sensibly make a commitment to reach a given level of coverage on the basis of an aspiration of what might happen when a competitor's contractual agreement expires.
- That there is no certainty that BT will continue to offer commercial service at the ESN sites once its contract expires[59]. On the topic of what happens at contract expiry, we repeat our comments in the previous two bullets. Notwithstanding this, is it credible that BT would take existing coverage and remove it?

[55] Consultation para 4.73.
[56] Consultation para 4.76.
[57] Multi Operator Radio Access Network
[58] Multi Operator Core Network
[59] Consultation para 4.74.

First of all, it would only then be facing the operational costs of provision. It is possible – though unlikely – that the operational costs alone would make the masts commercially unprofitable, but to be clear, approximately half of operator masts are already unprofitable. The question that operators face when determining whether a mast is deployed (or continues in operation) is not narrowly whether that individual mast is profitable, but whether the grid of masts supported as a whole is profitable. In this context, the question faced by BT would be whether the cost/revenue profile of that mast is so extremely unfavourable that they cannot justify keeping it live. We struggle to comprehend that the operational cost (shared with whatever successor organisation is running ESN) would be sufficient to tip any meaningful volume of masts over the threshold to decommission. Even if it was the right decision in a narrow commercial sense, we need to look at BT's incentives in this situation. BT would undoubtedly face a press and political backlash for reducing its coverage footprint in rural areas: its public image would be damaged.

In summary, it isn't credible for Ofcom to suggest that the counterfactual to coverage obligations is that BT might choose to shrink its state-sponsored coverage footprint in the future.

- That operators might roll out coverage on a commercial basis to match BT's ESN coverage[60]. Current operator coverage levels are set by an equilibrium of costs to deploy versus revenues. By definition, the State subsidised ESN masts were not commercially viable for BT (otherwise no State subsidy would be needed). On what basis are they to be come miraculously commercially viable for other operators? There would be a slight change to commercial viability in that the competing mobile operators stand to lose some customers because BT is able to provide coverage in the location concerned, but if there is a material competitive impact (sufficient to significantly change site viability) caused by the State intervention of funding ESN, then this is something that Ofcom should be extremely concerned about, something on which Ofcom should be taking action before the damage arises.
- That the advantage of the ESN masts only amounts to 2% of geography[61], and that there would be no substantial differences between the operators[62]. ✂ However, one shouldn't confuse small percentage changes in coverage with small amounts of cost. Absent sharing of costs, to replicate this, other operators would need to deploy an additional ✂ sites, resulting in a capital cost of some £✂M together with an annual operating cost of approaching £✂M/yr[63]. This is the difference between it being practicable to bid for the coverage obligations, and being impracticable.

Much as it would be convenient for Ofcom to pretend that ESN doesn't affect its design of the forthcoming award, it does. It is abundantly clear that BT is best positioned to bid to take on the coverage obligation, and

[60] Consultation para 4.75.
[61] Consultation para 4.77, implied content of the redacted figure in para 4.78.
[62] Consultation para 4.81.
[63] As set out in our response to Q1, we don't believe it credible that these operational costs would not escalate, as Ofcom's analysis implies.

abundantly clear that in large part this is because of the subsidies it is receiving for ESN. Ofcom cannot preside over a process that blatantly favours one operator, while meeting its statutory duties to promote competition. It needs to change tack.

Annex 2: Ofcom's proposal of coverage obligations and auction format for the forthcoming 700 MHz / 3.6-3.8 GHz auction - Report for Vodafone by Charles Rivers Associates

✂

Annex 3: Ofcom's statutory duties – Analysis by Tower House

✂

Vodafone UK
March 2019