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Annex 16 - Report for Three UK

The difficulties Three faces in winning PSSR spectrum absent appropriate competition measures

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Contents

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1 Executive summary

1.1 Introduction

The UK Government has committed to release large amounts of spectrum through a policy known as the Public Sector Spectrum Release (PSSR) programme. Ofcom is planning an auction of 190MHz of spectrum across the 2.3GHz and 3.4GHz bands (the PSSR auction). Hutchison 3G UK Limited (Three) has commissioned Analysys Mason Limited (Analysys Mason) to produce this report considering Three's chances of winning spectrum in this auction.

We have two key concerns about Three's ability to win an appropriate amount of spectrum in the upcoming PSSR auction:

- [✂][1] [✂][2] [✂].
- [✂]

Our approach to this project is based on three interrelated workstreams:

- assessing the likely level of the intrinsic value of the PSSR spectrum to each mobile network operator (MNO)
- quantifying the strategic investment value[3] [✂]
- looking at examples of where strategic investment is likely to have occurred in other European auctions.

1.2 Intrinsic value of the PSSR spectrum

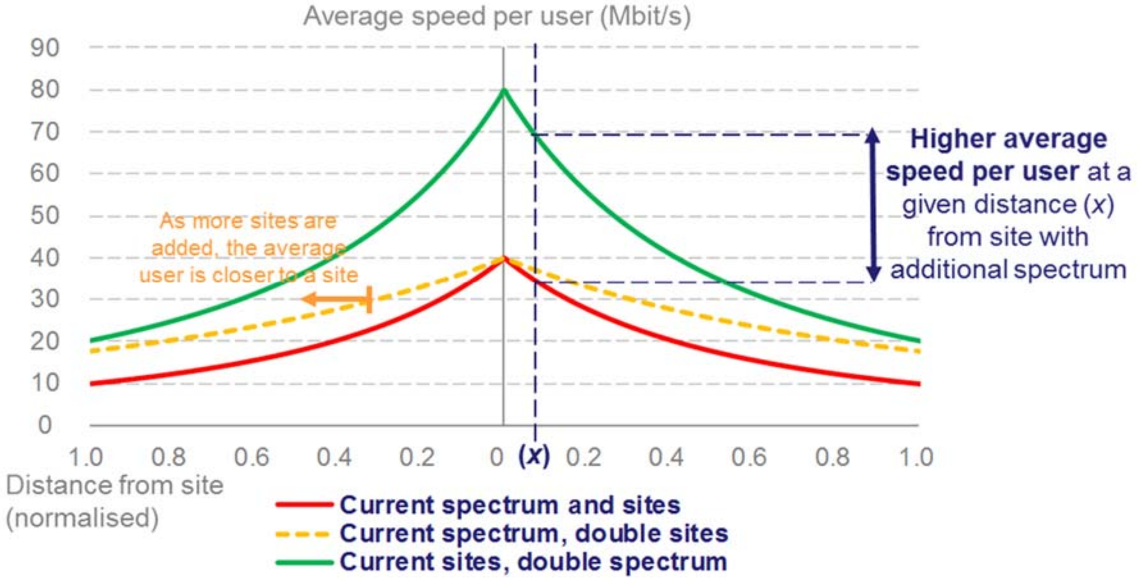
The PSSR spectrum offers benefits to MNOs in the provision of capacity, which can be defined as providing a certain volume of data to users of the service at a particular average speed. In the absence of additional spectrum, the total volume of traffic that can be carried by the network *may* (in theory) be achieved profitably through adding more sites, although it is not certain. However, network performance benefits associated with providing higher average speeds to users are much harder to replicate without spectrum. Therefore average user speeds and possibly some portion of network volume increases cannot, in general, profitably be replicated by building new sites. This drives **commercial value** associated with acquiring new spectrum, as illustrated in Figure 1.1.

1 We discuss in Section 2.2 that Ofcom defines this as "the present value of additional profits a bidder expects to earn when holding the spectrum compared to not holding it – in the absence of any strategic considerations to obtain spectrum to reduce competition in mobile services from the existing level".

2 In this document we refer to the merged entity consisting of BT and EE as BTEE.

3 We discuss in Section 2.2 that Ofcom defines this as "the present value of additional expected profits earned from bids aimed at affecting the future structure of competition in mobile services by depriving one or more competitors of spectrum".

Figure 1.1: Illustration of how average speed per user varies with distance from the site when doubling number of sites and when doubling spectrum holdings (in turn) [Source: Analysys Mason, 2016]



We have estimated ranges of intrinsic value for each MNO for each amount of spectrum potentially available to bidders in the PSSR award. This approach captures the level of uncertainty in the modelling. The lower and upper ends of the calculated ranges do not represent strict lower and upper limits on the value of the spectrum to each MNO (for example due to likely differences in the approach to calculating private values), but rather separate low and high estimates for the commercial values based on different combinations of input parameters, which we consider likely to bound a range based on conservative estimates. In making assumptions underpinning our calculations we have been asked by Three to reflect as far as possible our understanding of Ofcom's view of the market, as set out in its relevant consultations and statements, even where this conflicts with Three's views on the market (i.e. so that our conclusions are based on modelling reflecting our understanding of Ofcom's view of the market).

These ranges of total intrinsic value are summarised for a set of the (likely) most important spectrum packages in Figure 1.2. The lower end of the intrinsic value range is shown in solid colour, while the range of additional intrinsic value up to the upper end of the range is shown in faded colour.

[✂]

Figure 1.2: [✂]

[✂]

1.3 Strategic investment value for the PSSR spectrum

Part of the value of the spectrum is in enabling better network performance and therefore MNOs will have the ability to pursue different commercial strategies (i.e. deliver different levels of network performance) depending on how much PSSR spectrum they win. Strategic investment value may therefore arise because an MNO with a larger share in spectrum may have a different expected future profit if an MNO with a smaller share in spectrum is restricted to a lower network performance strategy, which in turn may arise if the latter is restricted to winning a smaller amount of spectrum.

[✂]

[✂]

Figure 1.3: [✂]

[✂]

Figure 1.4: [✂]

[✂]

1.4 Examples of strategic investment value in other auctions

Strategic investment is not merely a theoretical construct, but rather something which can and does happen in practice. There are likely to be various examples of past auctions where bids have been placed based on strategic investment value. In some cases, these bids may have been successful in acquiring the spectrum in place of an MNO bidding based on pure intrinsic value considerations, while in others they may not have been successful. Even in cases where strategic investment bids have been successful, examples are difficult to identify with certainty. However, we have identified three potential examples of strategic investment in spectrum auctions:

- the Austrian multi-band auction in 2013
- the Danish 800MHz auction in 2012
- the DECT guard band auction in the UK in 2006.

For example, following the 2013 auction in Austria, the parent company of Al Telekom stated that: *"This new spectrum offers Telekom Austria unique strategic advantages. Having* ***acquired 67% of the immediately available low frequency 800MHz*** *spectrum, Telekom Austria Group is in an unparalleled position to roll out a leading LTE network across Austria. This fully supports Telekom Austria Group's high value strategy and network quality leadership and allows Telekom Austria Group to protect its fixed-line as well as its mobile customer base, in particular in rural areas.* ***Moreover, the spectrum distribution has significantly reduced the viability of a potential new mass market mobile virtual network operator (MVNO)****."*[4]

4 Telekom Austria newsroom, October 2013, see http://www.telekomaustria.com/en/newsroom/2013-10-21-telekom-austria-group-acquires-spectrum-for-a-total-of-eur-1-030-million-in-austria

1.5 Conclusions

[✂]

2 Introduction

The UK Government has committed to release large amounts of spectrum though a policy known as the Public Sector Spectrum Release (PSSR) programme. Hutchison 3G UK Limited (Three) has commissioned Analysys Mason Limited (Analysys Mason) to produce this report considering Three's chances of winning spectrum in the upcoming auction associated with the PSSR spectrum.

2.1 Background to the PSSR auction

As part of the PSSR programme, spectrum (a total of 190MHz) previously held by the UK Ministry of Defence (MOD) in the 2.3GHz (40MHz) and 3.4GHz (150MHz) bands is to be awarded for mobile use. It is important that the impact of the PSSR award on future competition in the UK mobile market is carefully considered by Ofcom. In particular, spectrum is an important asset in the provision of mobile services and a distribution of spectrum that is too asymmetric may lead to a reduction in the level of competition in the market. This in turn could have a negative impact on consumers, who benefit from intense competition driving service providers to offer higher qualities of service at lower prices.

Ofcom recognises the need to preserve competition by avoiding distributions of spectrum that are so asymmetric as to hamper competition and has considered these factors in relation to the PSSR award during its consultation process. Ofcom's proposals to date in relation to measures to preserve competition can be summarised as follows:

- In November 2014,[5] Ofcom proposed to impose a 37% spectrum cap on total mobile spectrum holdings after the auction, based on an assessment of the impact of asymmetric spectrum holdings between the UK mobile network operators (MNOs).
- In May 2015,[6] Ofcom proposed to run the auction before merger decisions on two potential market mergers (BT/EE and Three/O2) were reached with no competition measures, but to withhold 60MHz of spectrum from the auction to address any competition concerns should they arise after the auction.
- In October 2015,[7] Ofcom issued a statement setting out its intention to run the auction with no competition measures based on a 'balance of probabilities' assumption about the Three/O2 merger going ahead.

5 See http://stakeholders.ofcom.org.uk/binaries/consultations/2.3-3.4-ghz-auction-design/summary/2_3_and_3_4_GHz_award.pdf.

6 See http://stakeholders.ofcom.org.uk/binaries/consultations/2.3-3.4-ghz-auction-design/statement/statement.pdf.

7 See http://stakeholders.ofcom.org.uk/binaries/consultations/2.3-3.4-ghz-auction-design/statement/pssr-statement.pdf.

- In November 2016[8], Ofcom issued its third consultation on the PSSR award wherein it proposed to apply a 255MHz cap to "immediately usable" spectrum, representing 42% of spectrum Ofcom defines as "immediately usable". This cap would have the effect of preventing BTEE from acquiring any spectrum in the 2.3GHz band but would not affect any other operator or impose any constraints on BTEE's acquisition of spectrum in the 3.4GHz band.

In this report, we do not focus on what might constitute appropriate competition measures but instead focus on the difficulties that we believe Three will face in winning PSSR spectrum in the absence of appropriate competition measures.

2.2 The difficulties that Three faces in winning PSSR spectrum

As part of its previous consultation process on awarding the PSSR spectrum, Ofcom has considered that spectrum offers value to MNOs that can be split into two main categories:[9]

- **Intrinsic value** – defined by Ofcom as "the present value of additional profits a bidder expects to earn when holding the spectrum compared to not holding it – in the absence of any strategic considerations to obtain spectrum to reduce competition in mobile services from the existing level".

- **Strategic investment value** – defined by Ofcom as "the present value of additional expected profits earned from bids aimed at affecting the future structure of competition in mobile services by depriving one or more competitors of spectrum".

Ofcom based its October 2015 PSSR decision not to impose competition measures, such as a spectrum cap, on its views that:

- MNOs with less spectrum are likely to have the highest intrinsic valuations for spectrum
- it is unlikely that a competitor with a lower intrinsic value would be willing to outbid a higher value bidder for strategic reasons, due to the large volume of spectrum being auctioned and the lack of certainty that strategic bidding would reduce competition (as a result of the simultaneous multiple round auction (SMRA) format and pricing rule proposed for the PSSR award).

In its most recent consultation in November 2016 Ofcom has recognised that MNOs with least spectrum may not always have the highest intrinsic value for additional spectrum and that harmful strategic investment could take place[10]. However, Ofcom's proposed competition measures do not appear to significantly mitigate these risks.

In this report, we do note analyse the impact of Ofcom's proposed competition measures, but investigate and quantify the likely extent of difficulties that Three will face winning PSSR spectrum

8 See https://www.ofcom.org.uk/__data/assets/pdf_file/0026/93545/award-of-the-spectrum-bands-consultation.pdf

9 Award of the 2.3 and 3.4GHz spectrum bands: competition issues and auction regulations, Ofcom, November 2016 third PSSR consultation, Paragraph 4.162.

10 See Award of the 2.3 and 3.4GHz spectrum bands: competition issues and auction regulations, Ofcom, November 2016 third PSSR consultation, Paragraph 4.166, for example.

absent appropriate competition measures. In particular, we have two key concerns about Three's ability to win an appropriate amount of spectrum in the upcoming PSSR auction:

- [✂][11][✂]
- [✂]

Our scope of work involves modelling both the intrinsic value of the spectrum to each MNO and the strategic investment value [✂]. In carrying out such a modelling exercise a number of assumptions are required. In making these assumptions we have been asked by Three both to:

- take a conservative approach (i.e. so that changes in parameter values in the direction that is more likely to be realistic should not have a high chance of altering our conclusions); and
- reflect as far as possible our understanding of Ofcom's view of the market, as set out in its relevant consultations and statements, even where this conflicts with Three's views on the market (i.e. so that our conclusions are based on modelling reflecting our understanding of Ofcom's view of the market)

2.3 Structure of this document

Our approach to this project is based on three interrelated workstreams:

- assessing the likely level of the intrinsic value of the PSSR spectrum to each MNO
- quantifying the strategic investment value [✂]
- looking at examples of where strategic investment is likely to have occurred in other European auctions.

The remainder of this document is laid out as follows:

- Section 3 sets out how we have modelled the intrinsic value of PSSR spectrum and presents our modelling results
- Section 4 discusses the possibility of strategic investment value arising for some MNOs, describes our approach to modelling this value and presents our modelling results
- Section 5 presents examples of strategic investment taking place in past auctions in Europe
- Section 6 summarises our findings and concludes on the difficulties that Three faces in winning PSSR spectrum absent appropriate competition measures.

11 In this document we refer to the merged entity consisting of BT and EE as BTEE.

3 Intrinsic value of the PSSR spectrum

In the first of our three workstreams, we assess the level of intrinsic value likely to arise for each MNO. We split the intrinsic value into **technical value** and **commercial value**, which we define below. We develop a framework for the calculation of ranges of commercial value and we estimate (but do not model) reasonable ranges of technical value for each MNO for the PSSR spectrum, based on certain assumptions about the factors driving network costs.

In this section, we begin by discussing how intrinsic value arises, and how it breaks down into its component (technical and commercial) parts. Next, we introduce the framework developed for calculating commercial value, including details of assumptions made, inputs to and outputs from our commercial value model. Finally, we present our estimates of reasonable technical values and combine these with the calculated commercial values, to obtain resultant ranges of intrinsic values estimates for each MNO for each possible amount of spectrum that could be won in a PSSR spectrum auction without any restrictions imposed by competition measures.

3.1 How intrinsic value arises

3.1.1 The benefits of additional spectrum

Spectrum provides benefits to MNOs by improving both the **coverage** and **capacity** of the mobile services they offer. The PSSR spectrum is relatively high frequency and we therefore assume that the benefits of this spectrum relate to capacity.

Capacity can be defined as providing a certain volume of data to users of the service at a particular average speed. An increase in the capacity of a mobile network can mean that greater data volumes can be provided to users; that a given volume of data can be provided at a higher average speed; or both. The capacity of a network in a given location can therefore be thought of as consisting of two component parts:

- A **total volume** of data that can be carried by the network in that location.
- An **average speed** at which that data can be provided in that location.

Spectrum can be used to improve network capacity through increasing network volume but also through increasing average user speeds. If an MNO does not hold sufficient spectrum to meet network demand, it can in theory build more sites to try and achieve the same network capacity. However, the approach of expanding network capacity using sites instead of spectrum has several inherent difficulties:

- Acquiring or leasing suitable locations for new sites can be difficult, time consuming and costly.

- There are limits to the extent to which capacity can be increased by building sites because, once sites are placed too close to each other, significant interference issues arise. This interference will reduce the capacity offered by each site, making the approach of adding capacity using sites even more costly.
- It may not be profitable for an MNO to fully replicate the increase in network capacity offered by additional spectrum as users will only pay so much for additional capacity (which is factored into calculations of how much MNOs will pay for spectrum).

The first two points may be significant, but in this document we focus only on the third. A separate analysis to understand the additional impact of the first two points may be useful, but is beyond the scope of our current assignment.

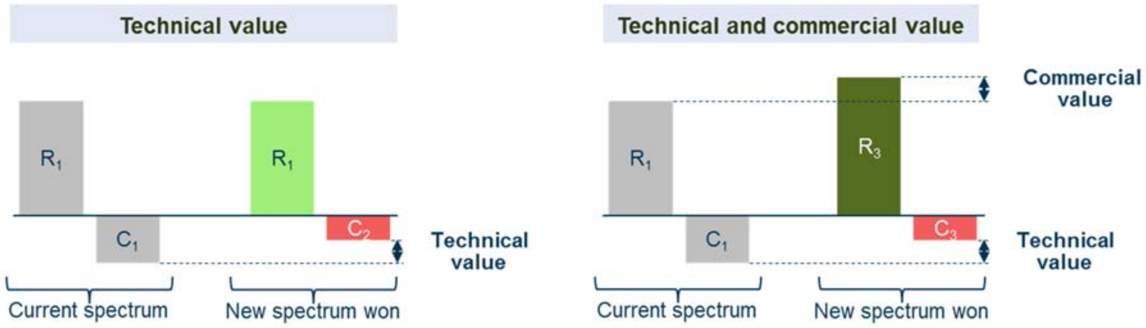
3.1.2 The components of intrinsic value

Figure 3.1 considers, in this context, the revenue and network cost impacts on an MNO of winning new spectrum compared to continuing with its current spectrum holdings. We introduce at this point the notions of technical and commercial value, which together make up the intrinsic value of the spectrum.

- **Technical value** corresponds to the present value (PV) of network cost savings achievable by an MNO in its most profitable network deployment with additional spectrum compared to its most profitable deployment without additional spectrum, noting that the network capacity may differ in the two deployments.
- **Commercial value** corresponds to the PV of additional revenues and non-network cost savings achievable by an MNO when holding additional spectrum, arising due to any differences in network capacity, which result in a difference in **network performance**, between the most profitable network deployment with the additional spectrum and the most profitable network deployment without it. Equalising network performance between these two scenarios drives the commercial value of the spectrum. In other words, better network performance (e.g. higher average user speeds) may lead to higher revenues or reduced non-network costs (e.g. lower churn or acquisition costs).

Double counting is avoided so long as any improvement in network performance achieved through the building of more sites is taken into account when deriving the commercial value (i.e. the commercial value needs to correspond to the difference in performance in the network with more spectrum compared to the network with more sites).

Figure 3.1: Illustration of how technical and commercial value associated with future spectrum award arises[12] [Source: Analysys Mason, 2016]



If it were profitable for an MNO to fully replicate the network capacity offered by new spectrum by building a greater number of sites, then the value of the spectrum would be all technical. This is illustrated on the left-hand side of Figure 3.1, where the (technical) value of the spectrum is given by $C_1 – C_2$.

However, in the [✂] event (as we explain below) that it is not possible for an MNO to fully replicate with sites the increase in network capacity offered by additional spectrum (i.e. there is a difference in network performance between the two scenarios), there will be both technical and commercial value components to the spectrum. This is illustrated on the right-hand side of Figure 3.1 where the technical value is given by $C_1 – C_3$ and the commercial value is given by $R_3 – R_1$.[13]

3.1.3 The reasons commercial value arises

In the absence of additional spectrum, the total volume of traffic that can be carried by the network *may* (in theory) be achieved profitably through adding more sites, but network performance benefits associated with providing higher average speeds are much harder to replicate without spectrum. Therefore, average user speeds and possibly some portion of network volume increases cannot, in general, profitably be replicated by building new sites, hence driving commercial value associated with acquiring new spectrum.

This is illustrated in Figure 3.2 below, which shows how individual users will experience different speeds at different distances away from their nearest site depending on the amount of spectrum that the MNO holds. The higher peak speed adjacent to the site achievable with more spectrum (green line) can never be replicated by building more sites (yellow line) unless the network were very heavily loaded.[14] However, what is striking is that even at distances further away from the site, the

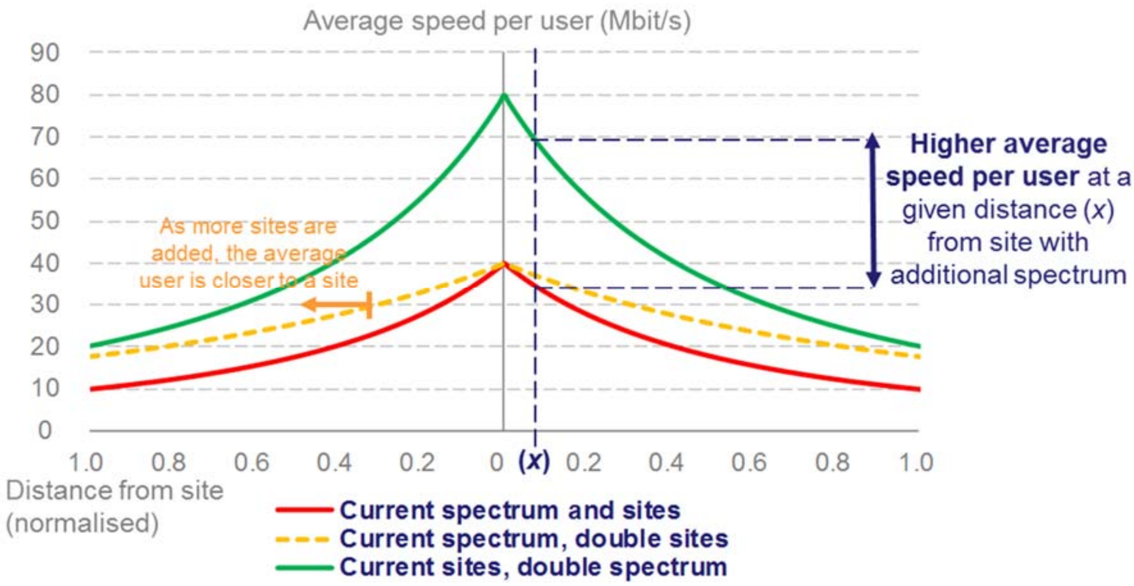
12 Note that R and C values in the diagram correspond to revenue and network costs (excluding the cost of spectrum acquisition) respectively.

13 We note that the commercial value may consist of either an increase in the PV of revenues, a decrease in the PV of non-network costs or a combination of the two. For simplicity in this illustration we assume that the commercial value consists of only a revenue component.

14 We note that the diagram considers a single user and that by adding more sites, on average the distance of users from their nearest site will decrease. However, our view is that the benefit for some users of being closer to their nearest site is likely to be substantially outweighed by the additional speed benefits that are provided by additional spectrum. In particular, the average distance from the nearest site is only likely to decrease by a relatively small

advantage in user speeds offered by holding more spectrum remains substantial. This 'real-world' difference is what is likely to be important to most users.

Figure 3.2: Illustration of how average speed per user varies with distance from the site when doubling number of sites and when doubling spectrum holdings (in turn) [Source: Analysys Mason, 2016]



This observation tallies with what we see in the market today. For several years, MNOs have marketed their services based on peak download speeds theoretically achievable on their networks. Although this approach continues to be useful for MNOs, mobile subscribers now consider average data speeds to be more important. For example, EE's marketing demonstrates the perceived importance of average user speeds in its eyes by highlighting relative network performance between MNOs in its marketing materials. Examples include: "*It's official: Our 4G network is 50% faster than any other (Speedtest™ by OOKLA)*" and "*(EE is) 79% faster than O2, 75% faster than Three, 50% faster than Vodafone*".[15]

Aggregating spectrum into larger downlink carriers raises peak data speeds but also, more generally, helps to provide the higher average speeds valued by many users. Providing this better user experience can lead to additional revenues for MNOs, for example through an increased share of gross additions (SOGA) or through higher ARPU.

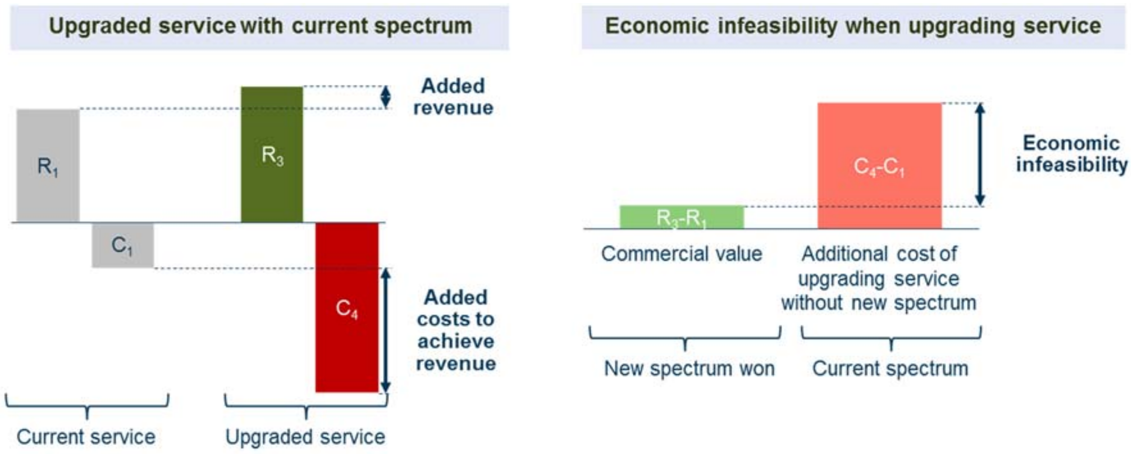
In summary, the higher network performance achieved through winning additional spectrum generates a commercial value, which may be difficult to replicate without having sufficient spectrum. Figure 3.3 illustrates this point by showing that the costs ($C_4 – C_1$) of replicating the higher

amount, unless a very high number of additional sites were to be added, and this in turn is only likely to lead to modest speed increases, as illustrated in Figure 3.2. Conversely, additional spectrum is likely to increase average end-user speeds substantially.

15 Obtained from the BTEE website in July 2016.

network performance that additional spectrum would offer, were it available, do not outweigh the revenue benefits of offering the higher network performance ($R_3 – R_1$).

Figure 3.3: Illustration of costs to upgrade service with current spectrum and the likely economic infeasibility to do so without winning additional spectrum [Source: Analysys Mason, 2016]



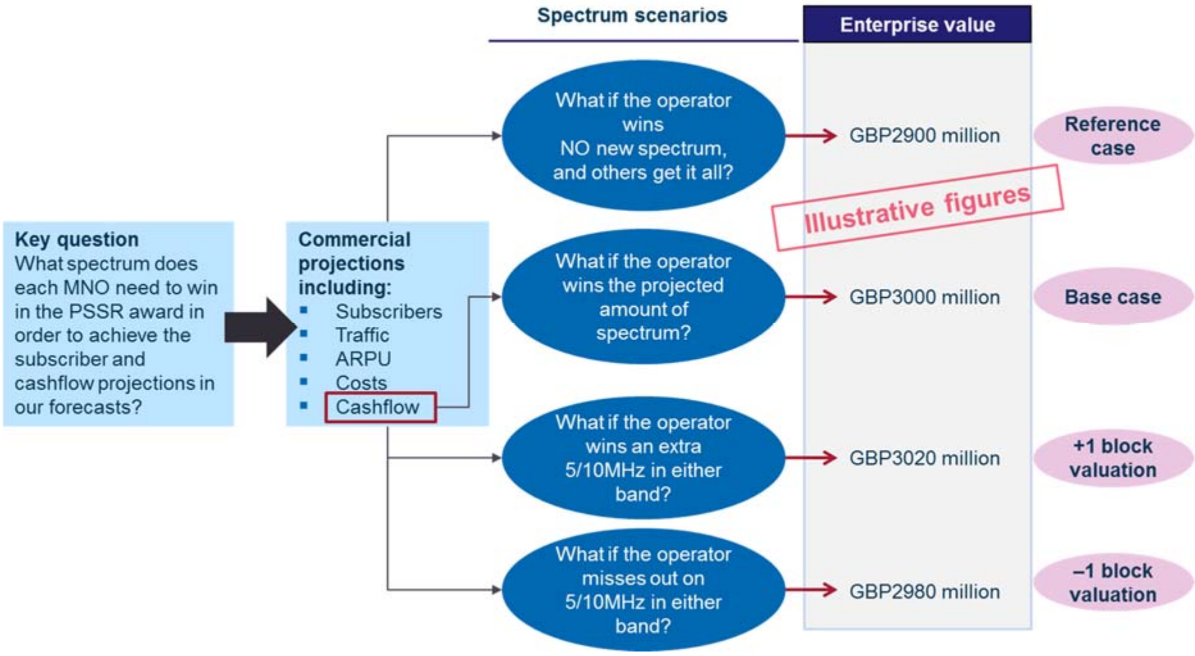
This means that upgrading the network performance to the same level, but in the absence of additional spectrum, is economically infeasible – and it would be unprofitable to attempt to do so. Network performance is therefore likely to be different where less spectrum is won and so is determined to a large extent by the amount of spectrum an MNO holds.

3.2 Framework for calculating the commercial value of the PSSR spectrum

Under our modelling framework, commercial forecasts for each MNO are tied to a base case spectrum holding; commercial performance varies as winnings deviate from this base case. As illustrated in Figure 3.4, the approach followed to calculate commercial value consists of determining the change in enterprise value[16] when winning more or less spectrum (referred to as spectrum scenarios) compared to the amount of spectrum expected to be won in order to meet the commercial forecasts for that MNO (referred to as the base case scenario). We consider variations in future spectrum winnings in the 2.3GHz band (in lots of 10MHz up to 40MHz) and in the 3.4GHz band (in lots of 5MHz up to 150MHz), giving a total of 155 possible packages or spectrum scenarios. The enterprise value for each of these spectrum scenarios is then compared to a reference case where no future spectrum is won to determine the value of the spectrum.

16 Note that it is not necessary to calculate the full enterprise value for each MNO but rather a component of it which may vary depending on the spectrum holding.

Figure 3.4: Illustration of approach for calculating commercial value associated with different spectrum scenarios compared to a base case scenario[16] [Source: Analysys Mason, 2016]



3.2.1 Setting a base case spectrum scenario

As part of our spectrum valuation modelling, we have made use of published forecasts of subscriber numbers and developed forecasts for other market parameters, such as ARPU, for each MNO. However, subscriber and market share forecasts do not tend to make explicit assumptions about MNOs' spectrum holdings or the results of auctions. Instead, these forecasts tend to implicitly assume that spectrum auctions do not distort the market or result in material changes in market positioning. We have used forecasts from Analysys Mason Research's Datahub and GSMA Intelligence which are, indeed, not explicit about the expected outcome of the PSSR award.

For our modelling it is necessary to define a base case for each operator, such that the base cases for all four operators define an auction outcome that is consistent with the market outcome indicated by the market forecasts used. We note that the impact of the choice of base case on the calculated spectrum valuations is not large. Its purpose is simply to specify a consistent starting point for our calculations. What really matters in the approach we follow is the difference between the base case forecasts (whichever spectrum holdings those forecasts correspond to) and the forecasts in an alternative spectrum scenario (i.e. where more or less PSSR spectrum is won).

In this context, we have developed base cases which assume a PSSR auction outcome that is likely to be as consistent as possible with the market forecasts described above. In particular, we have taken a balanced view that the total amount of PSSR spectrum is equally distributed among the four existing MNOs. Hence, we have assumed an award of 10MHz of 2.3GHz and 40MHz of 3.4GHz in each MNO's base case[17] (referred to as scenario 10+40). This 'spectrum-neutral' position (i.e. each MNO wins an equal amount of future spectrum) enables us to make use of published market projections, which appear to assume future spectrum holdings do not distort the market positioning of the MNOs. The other forecasts we have developed (i.e. for ARPU and non-network costs) are based on this assumed post-auction spectrum distribution.

3.2.2 Key steps in calculating commercial values

We have assumed that spectrum in both the 2.3GHz and the 3.4GHz bands will be suitable for future use in the macrocell layer in the network, in a similar manner to other spectrum bands already held by the MNOs.

The 2.3GHz band has similar propagation characteristics to 2.1GHz and 2.6GHz. Furthermore, the device and network equipment ecosystems for 2.3GHz are developing. The 3.4GHz spectrum propagates significantly less far and has a currently less developed ecosystem than 2.3GHz. However, there is enough certainty around the ecosystem and propagation to still imply that a similar mode of macrocell network usage is possible. Additionally, the 3.4GHz band may be suitable for use in other modes, such as:

- small cell usage (this may be possible for smaller carrier sizes)
- self-backhaul solutions
- 5G – The 3.4GHz band may also become a key band for 5G but there is currently insufficient information available to be able to construct an accurate 5G valuation model
  - if the band were to be used for 5G, it is possible that the commercial value would be higher than the values we calculate
  - should 3.4GHz become suitable for use for 5G, the larger MNOs would likely have larger values associated with the 3.4GHz band.

Based on MNOs' likely intended usage of the two available bands, similar steps are needed to calculate the commercial value in each band. For a macro network use case, the commercial value calculation for each band can be broken down into three components:

- understanding how the performance of the network will improve or degrade as a result of changes in PSSR spectrum holdings
- understanding the extent to which customers value such improvements or degradations in quality, and what this means for MNOs' financial performance
- understanding the additional deployment costs associated with utilising the PSSR spectrum in order to provide greater network performance.

17 We understand that a base case of 10+40 for each MNO adds to more than the total spectrum bandwidth available for auction, but we feel that assuming 35MHz of the 3.4GHz for some MNOs is unrealistic, as in practice they are likely to target bandwidths in multiples of at least 10MHz or 20MHz in the two bands.

We summarise our considerations related to each of these three components in the following sub-sections.

Network performance varies with PSSR spectrum awarded

We define a relative network score metric to measure how each MNO's network performance varies depending on its PSSR spectrum holdings. The aspect of network performance influenced by PSSR spectrum holdings is likely to be based around **average user speeds**. The average user speed experienced on the network of each MNO could, in theory, be measured (ex-post) or forecast based on simulation (ex-ante), and the MNO assigned a **network score (NS)**, which would vary based on holdings of PSSR spectrum.

Likely commercial performance would then be determined through comparing an MNO's NS to the other MNOs in a given spectrum award scenario. As such, a **relative network score (RNS)** for each MNO can be defined as a normalised measure of that MNO's NS relative to the NS of the average of the other MNOs. Detailed technical analysis could be employed to forecast how the NS might change for each MNO with different amounts of PSSR spectrum, and then calculate a change in RNS based on the expected PSSR holdings of other MNOs. However, due to a lack of detailed data on other MNOs' network configurations, we have instead employed a simpler approach using **downlink spectrum share[18] as a proxy for average data speeds**, which we describe in more detail in Section 3.3.2. The latter is a conservative assumption as the RNS values would vary even more starkly between MNOs if we had adjusted spectrum share for average traffic per user for each MNO, as described in more detail in Section 3.3.1. Figure 3.5 shows the current downlink spectrum shares for each MNO.[19]

Figure 3.5: Summary of current spectrum holdings and spectrum share by MNO [Source: Analysys Mason, 2016]

(MHz downlink)	800MHz	900MHz	L-Band	1800MHz	2.1GHz	2.6GHz FDD	2.6GHz TDD[19]	Pre-award total	Pre-award spectrum share
Three	5.0	–	20.0	15.0	15.0	–	–	55.0	**16.6%**
BTEE	5.0	–	–	45.0	20.0	50.0	10.5	130.5	**39.4%**
Vodafone	10.0	17.5	20.0	5.8	15.0	20.0	14.0	102.3	**30.9%**
O2	10.0	17.5	–	5.8	10.0	–	–	43.3	**13.1%**
Total	30.0	35.0	40.0	71.6	60.0	70.0	24.5	331.1	**100%**

18 We consider downlink spectrum share to be a more relevant metric than the total spectrum share. This is because it is differences in download speeds that are likely to be most appealing to consumers, whilst capacity constraints are less acute for the uplink.

19 Frequencies used in TDD configuration are assumed to have 70% capacity reserved for downlink traffic, in line with Ofcom's proposed frame structure for 2.3GHz, which includes small time gaps between downlink and uplink frequency blocks. Low-power restrictions on 5MHz TDD of each MNO's spectrum holdings in the 2.6GHz TDD band mean that this spectrum is not included in our figures.

Translating changes in RNS to changes in commercial metrics for MNOs

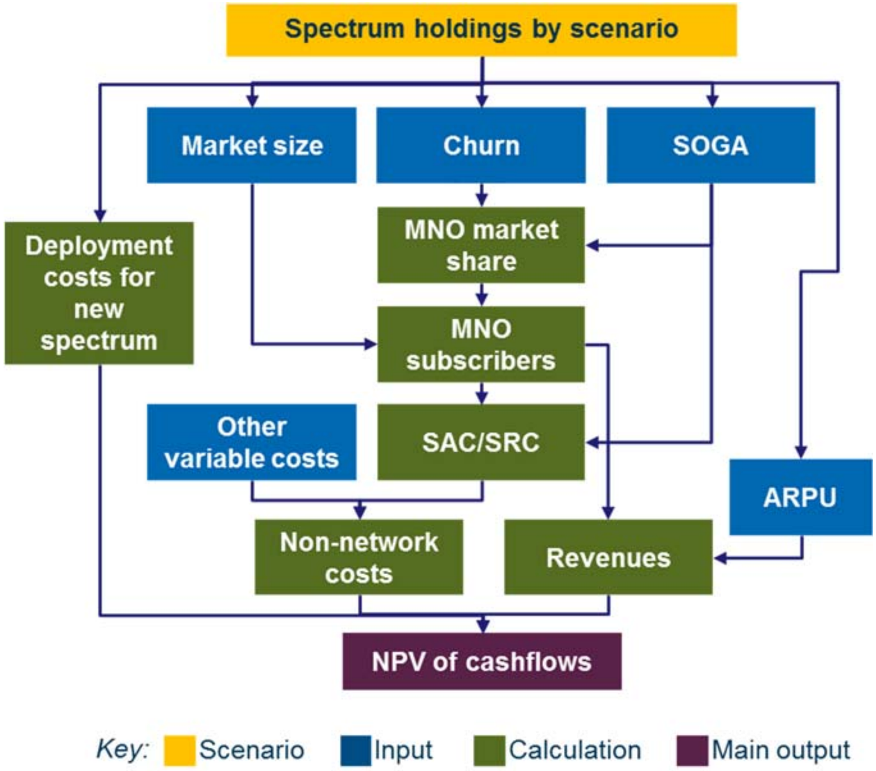
For a given change in RNS, the commercial value model defines a corresponding change in key commercial metrics. The commercial metrics affected by a change in relative network performance could include ARPU, churn, SOGA or subscriber acquisition or retention costs (SAC/SRC). We describe our approach to defining such a change for two of these metrics (SOGA and churn) in Section 3.3.3. Although there could also be an impact on ARPU and SAC/SRC, this would likely offset part of the calculated impact for churn and SOGA. In other words, better network performance will allow for improved commercial performance, but MNOs' choice of strategy will have a bearing on how this improved commercial performance manifests itself. For example, offering an improved service at the same price may lead to more subscribers but alternatively could allow the MNO to increase prices sustainably or to decrease its spend on acquisition and retention to achieve the original volume of subscribers. Mixes of these different strategies will likely also be possible, but there are likely to be trade-offs between prices, subscriber volumes and operating costs. We have chosen to focus our calculation on assuming that the commercial performance improvement manifests itself as an improvement in subscriber volumes via decreased churn and increased SOGA.

Changes in these commercial metrics are used to differentiate between the commercial value associated with different spectrum scenarios as illustrated in Figure 3.6 and noting the following:

- the model runs from year-start 2017 to year-end 2036 (20 years) and calculates revenues and non-network costs over this period for different amounts of spectrum held
- the net present value (NPV) of these revenues and costs is calculated in each case (in 2016 real terms) using the regulated WACC (of 9.1% pre-tax nominal) set by Ofcom[20]
- the difference in NPVs between a given spectrum scenario and the reference case (no new spectrum won) represents the commercial value of that amount of PSSR spectrum
- commercial benefits accrue over a five-year period from 2018, with diminishing benefit in Years 4 and 5 (this is described in more detail in Section 3.3.2)
- a terminal value is not calculated since:
  - an Annual Licence Fee (ALF) will arise beyond the end of the licence period and will partially offset the value derived from the spectrum
  - there is some risk for MNOs in basing decisions on what to pay for spectrum on benefits that will only arise more than 20 years from now.

20 See Annex 10 in Ofcom's Mobile call termination market review 2015 here http://stakeholders.ofcom.org.uk/binaries/consultations/mobile-call-termination-14/statement/Annexes_7-13.pdf.

Figure 3.6: Overview of the modelling approach to calculate commercial value [Source: Analysys Mason, 2016]



Consideration of additional network costs for deploying PSSR spectrum

We have assumed that each MNO would deploy the PSSR spectrum on [✂-number] sites, based on our discussions with Three. We assume that each MNO would identify a performance benefit on a similar number of sites, regardless of the variation in the total number of sites in their networks. Of these sites, we assume that 50% would be upgraded for data volume reasons, which drive technical value, rather than network performance reasons, which drive commercial value. The deployment costs associated with these upgrades are outside the scope of the commercial value calculation and are instead netted off the estimated gross network cost saving benefits to form the technical value. Hence, in our commercial value calculation, we model deployment costs for [✂-number] sites.

The deployment costs per site assumed in our model are shown in Figure 3.7. After an initial fixed cost of GBP11 500 per site for a carrier of up to 40MHz, deployment costs are assumed to increase by 25% of this initial cost for each increment of up to 40MHz in the carrier size.

Given that the initial fixed cost is the same for any amount of spectrum up to 40MHz, it is likely to be much more cost effective for operators to deploy larger carrier sizes of 40MHz or above. Where the benefits of a deployment of a smaller amount of spectrum are substantial, such as for 2.3GHz, there may still be considerable value in carrier sizes smaller than 40MHz. However, for 3.4GHz, where the benefits are relatively smaller, carrier sizes of 40MHz (or above) are likely, on this basis, to be preferable to smaller carriers (e.g. 20MHz).

Deployment is assumed to occur in 2017 (i.e. as soon as spectrum becomes available) across all sites, with carriers operational throughout the licence period. Opex is assumed to primarily comprise power and vendor fees and is, therefore, set at 5% of capex (assuming no price inflation in nominal terms).

Figure 3.7: Summary of deployment costs per site with increasing carrier sizes for each band [Source: Analysys Mason, 2016]

Band	Carrier size	Capex (GBP/site)	Annual opex (GBP/site)
2.3GHz	Up to 40MHz	11 500	575
3.4GHz	Up to 40MHz	11 500	575
3.4GHz	45–80MHz	14 375	719
3.4GHz	85–120MHz	17 250	863
3.4GHz	125–150MHz	20 125	1006

3.3 Inputs to and outputs from the commercial value model

In the sub-sections below we discuss the key inputs and assumptions made to calculate commercial value, followed by a summary of the resultant commercial values for different spectrum scenarios.

3.3.1 Key market and MNO-specific commercial metrics

Calculation of commercial value requires base case forecasts of parameter values for various commercial metrics.

Forecast subscriber numbers for each MNO and across the market are shown in Figure 3.8. We have modelled a near-constant market penetration of circa 113% (excluding MVNO subscribers) based on forecasts published by Analysys Mason Research. Alongside a growing population, this results in total subscribers growing at a CAGR of 0.49% over the 20-year licence period. Historic market shares are based on figures published by GSMA Intelligence, while forward-looking market shares are determined by forecasts of churn and SOGA for each MNO, assuming the following:

- each MNO's churn rate converges to the market average rate in the short term
- SOGA for each MNO remains at 2015 levels, which we calculate based on historic churn rates and subscriber numbers.

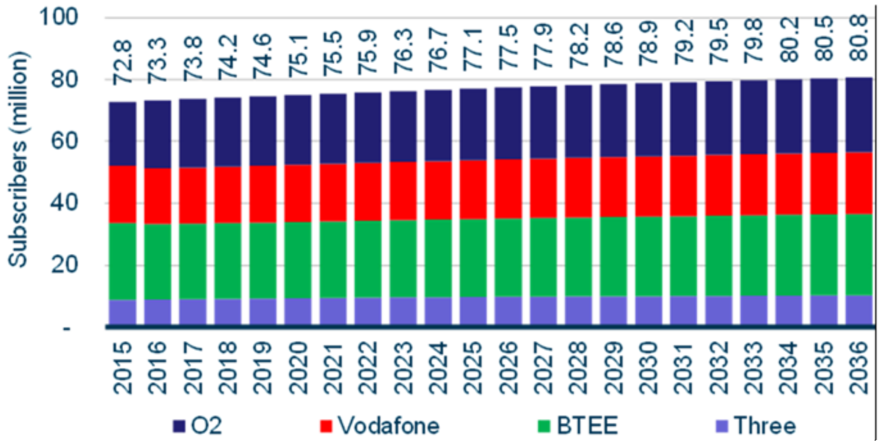


Figure 3.8: Summary of forecast subscribers by MNO and market total[21] [Source: Analysys Mason, 2016]

Historic ARPU values have been calculated from Analysys Mason Research data and split into the market segments considered in our commercial model, as shown in Figure 3.9. We have conservatively[22] forecast each MNO's retail ARPU (i.e. excluding MVNOs) to remain flat (in nominal terms) within each subscriber segment,[23] resulting in total revenues growing at the same rate as the MNO's forecast subscribers.

GBP/sub/month	Three	BTEE	Vodafone	O2
Contract handsets	20.81	29.03	27.12	29.27
Pay as you go (PAYG) handsets	2.98	4.15	3.88	4.19
Contract mobile broadband	7.89	11.01	10.29	11.10
PAYG mobile broadband	3.98	5.56	5.19	5.61
Blended average	**14.56**	**19.89**	**19.18**	**18.49**

Figure 3.9: Summary of modelled ARPU by market segment and blended average[21] in 2015 [Source: Analysys Mason, 2016; GSMAi, 2016]

SAC and SRC values have been derived from SAC and SRC figures published by EE (obtained from GSMA Intelligence). SRC values reported for EE were also adjusted to account for the proportion of retained subscribers for which EE incurs retention costs, estimated at 20% of year-average subscriber base (based on confidential operator data relating to other MNOs). These SAC and adjusted SRC values for EE are then used to calculate SAC and SRC values for each MNO, representing the same proportion of ARPU as for EE.

21 All calculations exclude MVNO subscribers and revenues from handsets and other devices.

22 If ARPU were forecast to increase over time, this would make each subscriber more valuable to MNOs and would tend to increase the commercial value associated with the PSSR spectrum (and the absolute difference between the commercial value arising for each MNO).

23 Note that changes in the relative size of subscriber segments may mean that overall ARPU levels change year on year.

Other non-network opex per subscriber was estimated so as to achieve modelled cashflow margins similar to reported EBITDA margins for Three, with non-network opex assumed to constitute the same proportion of ARPU for other MNOs.[24]

All non-network costs varying with subscriber number are forecast to remain constant (on a per-subscriber basis in nominal terms) over time.

3.3.2 Determination of the RNS

We approximate changes in RNS under different spectrum scenarios based on the resultant change in percentage spectrum share of each MNO.

The RNS is a measure of the average user speeds on an MNO's network relative to other MNOs. We approximate RNS for each MNO based on its share of total market downlink spectrum,[25] varying by spectrum scenario, as shown in Figure 3.10. We note that the number of sites, number of subscribers and the average traffic per subscriber may also affect the average user speeds in practice. However, we take a conservative approach of not adjusting spectrum share as our measure of network performance; average traffic per user per site is currently significantly higher on Three's network than on other MNOs' networks and such an adjustment would, hence, tend to decrease the commercial value to Three relative to other MNOs.

[✂]

Figure 3.10: [✂]

A change in spectrum share is assumed to lead to a change in network performance (measured by RNS). An improvement in commercial performance will arise as a result of this improved network performance. We model a commercial value to arise through an impact on the MNO's SOGA and churn rate, following the change in network performance associated with the award of a fixed amount of PSSR spectrum (modelled through the change in spectrum share or RNS). This is discussed in more detail in Section 3.3.3.

When calculating the change in an MNO's spectrum share we also account for the usefulness of the spectrum awarded. Valuation of future spectrum holdings needs to account for usefulness of the spectrum in terms of network footprint varying by band. Due to coverage properties, a maximum network footprint of [✂][26] is achievable with 3.4GHz spectrum, relative to 100% with 2.3GHz spectrum and other spectrum already held by MNOs. The impact on spectrum share of future winnings in the 3.4GHz band therefore needs to be adjusted by a [✂]% factor in order to replicate

24 We note that there may be some difference in the categorisation of reported operating costs between SAC, SRC and other opex by different MNOs. However, the split between these three categories of cost does not make a significant difference to our modelled results and in any case we would expect the variable costs per subscriber to represent a similar proportion of ARPU for each MNO however these costs are accounted for.

25 We model each MNO independent of others (i.e. a change in an MNO's spectrum share is independent of other MNOs' spectrum share). Therefore, spectrum shares shown are not necessarily additive for each spectrum scenario – we do not explicitly consider how the remaining PSSR spectrum is distributed between the other MNOs.

26 This estimate has been provided to us by Three's Network team, reflecting the simulated relative footprint of the two bands based on macrocell deployment using Three's network. We assume that this factor would be similar for other MNOs on their respective networks. We also note that the [✂]could potentially be increased if there were to be substantial small cell deployment making use of 3.4GHz spectrum.

the usefulness of equivalent winnings in the 2.3GHz band – this normalisation is already applied to the spectrum share chart shown in Figure 3.10.

We have also considered whether likely device penetration needs to be factored into this normalisation given the relatively recent development of ecosystems in these bands. [✂] However, consumers most likely to be responsive to changes in network performance are likely to also be early adopters of the latest devices. Therefore, we only adjust for differences in network footprint between the bands in our calculation of commercial value. We note that there may be some implications of the later device availability in 3.4GHz for Three and O2's ability to compete in the short term without any 2.3GHz spectrum. We discuss this further in relation to our calculation of strategic value in Section 4.

The spectrum awarded is modelled to result in a commercial benefit. We assume commercial benefits arise only in the short to medium term before other future spectrum awards or technology developments impact the landscape. Specifically, commercial benefits accrue over a five-year period from 2018, with diminishing benefit in Years 4 and 5, as shown in Figure 3.11. We note that this is a conservative assumption; increasing the duration of the impact would result in higher valuations for all MNOs and increase the absolute differences between them.

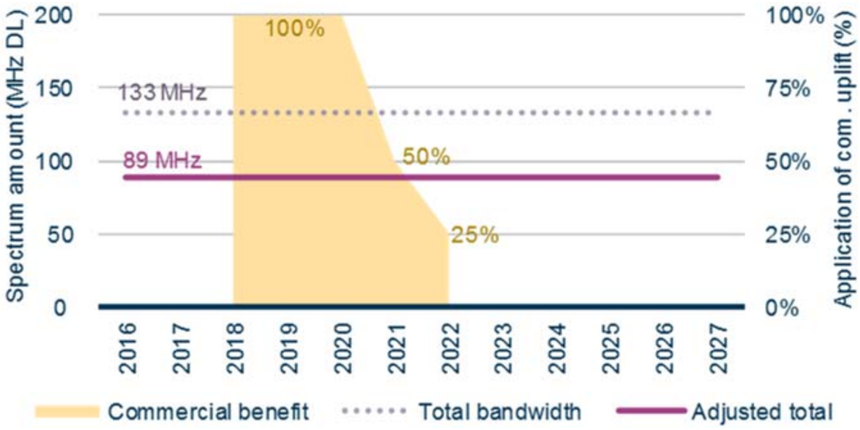


Figure 3.11: Adjusted amount of total PSSR spectrum[19] and timespan of commercial benefit [Source: Analysys Mason, 2016]

3.3.3 Determination of the change in commercial performance resulting from changes in network performance

A change in an MNO's RNS is likely to influence a subset of its subscriber base. Our estimate of the size of the segment of subscribers that are likely to be influenced by a change in an MNO's RNS is informed by consumer survey data. More specifically, Analysys Mason's Connected Consumer Survey 2016[27] found that:

[27] The Connected Consumer Survey 2016 was conducted during July and August 2015, in association with Survey Sampling International (SSI) and On Device Research.

- Among subscribers looking to move to a new mobile service (gross adds), 13% of them will base their decision of where to go next primarily on "*higher data allowance*",[28] as shown in Figure 3.12.

- For customers looking to churn, "*poor data speeds*" is a key factor in the decision of 19% of customers (but there are other factors)[29] as shown in Figure 3.13.

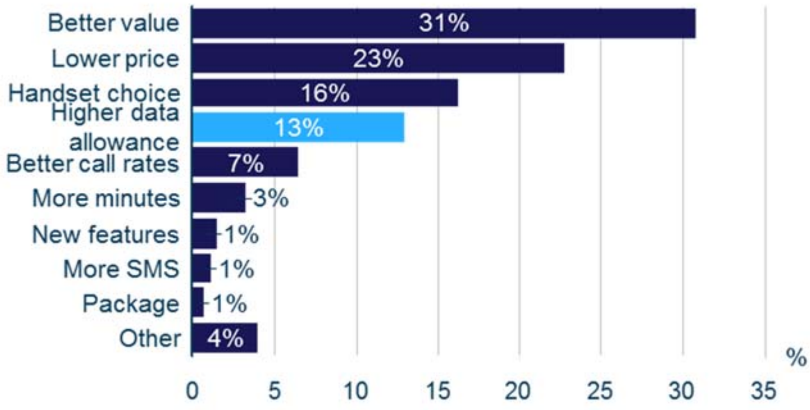


Figure 3.12: Key factors driving decisions on next mobile plan[27, 28] [Source: Analysys Mason, 2016]

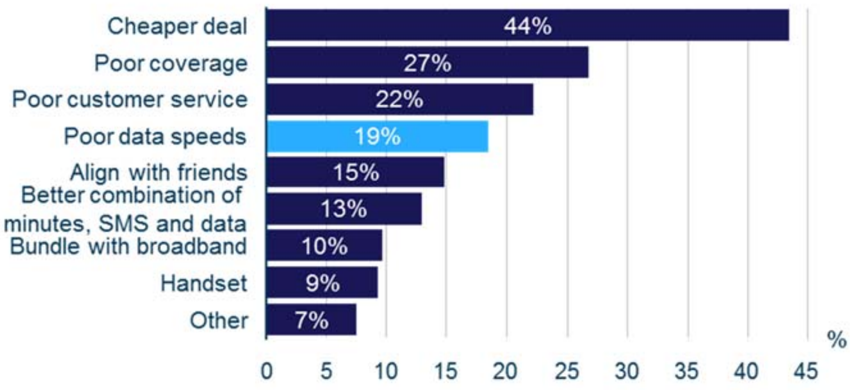


Figure 3.13: Key factors driving decisions to churn[27, 29] [Source: Analysys Mason, 2016]

These findings provide a reasonable indication of the relationship between service speed and decisions to join or leave. The "*higher data allowance*" criterion selected by 13% can be used as a proxy for user speeds since both data allowance and speed are likely to appeal to a similar set of subscribers. The "*poor data speeds*" criterion selected by 19% as a key factor to churn is not a perfect indicator of segment size (because respondents could select up to three reasons), but it does suggest that at least 19% of consumers consider this factor to be very important.

28 Based on responses from 963 participants to the question 'Why do you intend to change your mobile provider'.

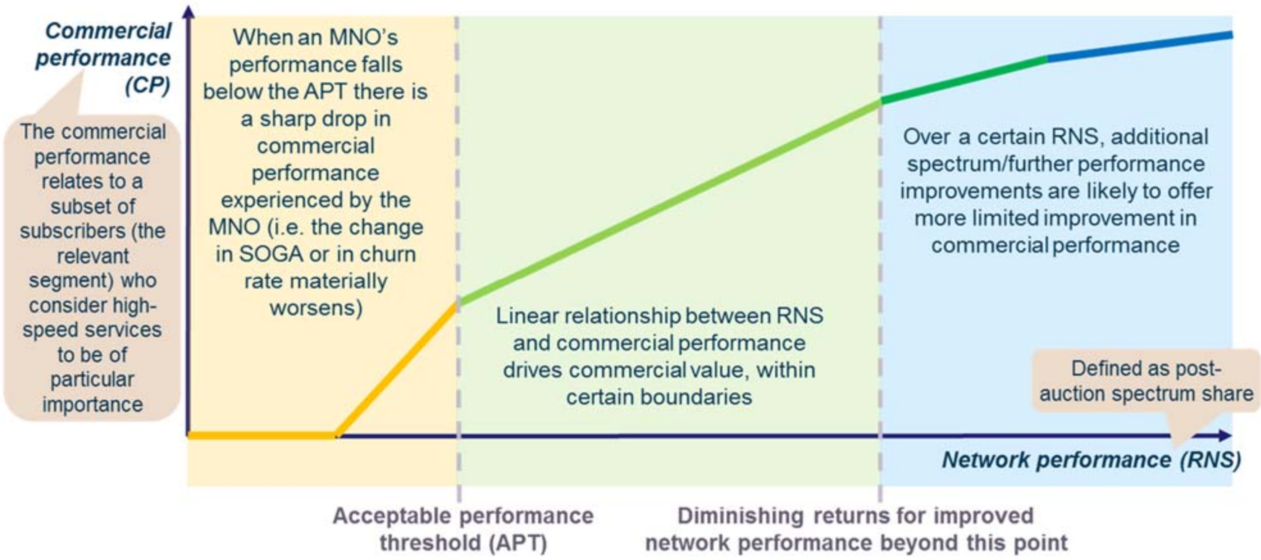
29 Based on responses from 1984 participants to the question 'Which of the following factors will most attract you to your next mobile plan'.

We anticipate that data speed is likely to become increasingly important to consumers in the next few years. On balance, we consider that 13% of mobile subscribers is a conservative estimate of the size of segment that is likely to be sensitive to changes in network performance.

More specifically, when modelling impact on commercial performance, we conservatively assume that only two thirds of the 13% segment of the pool of market gross adds that are sensitive to the average data speeds are actually able to be influenced by the speeds likely to be offered by each MNO. This is because we assume that the remaining third are not as responsive to likely changes in network performance by MNOs because of an imperfect ability to assess the relative network performance of each MNO (e.g. being influenced by a marketing campaign run by an MNO offering relatively weaker network performance). Similarly, we take the same conservative approach for churners by assuming that only two thirds of this relevant segment can be influenced, with the remaining third likely to be determined to churn independent of potential network performance improvements or able to be influenced so as not to churn due to an existing commercial relationship despite the weaker network performance.

As network performance increases, we model an increase in commercial performance based on a parameterised piecewise linear ‘performance curve’, as illustrated in Figure 3.14.

Figure 3.14: Schematic of modelled relationship between commercial benefit and change in network performance or RNS [Source: Analysys Mason, 2016]



The commercial performance associated with a change in network performance following the PSSR spectrum award is calculated based on changes arising when the amount of spectrum won differs from the base case. We model the change in network performance to have an impact on the MNO’s SOGA and churn rate within the relevant market segments as identified above. The extent of the impact is determined by two different parameterisations of the piecewise curve illustrated in Figure 3.14 and discussed in Section 3.3.4.

Note that, when calculating post-auction spectrum share for each MNO, we assume that all future spectrum winnings are aggregated by band. This would mean that award of a second 10MHz would not be more valuable than the first 10MHz awarded; however, inclusion of network deployment costs of the new spectrum, as discussed in Section 3.2.2, may result in higher value for the second 10MHz in some spectrum scenarios.

3.3.4 Parameterisation of the performance curve

We model the likely increase in commercial performance experienced by an MNO as a range of potential commercial values. This approach captures the level of uncertainty in the modelled relationship between the potential commercial benefit experienced by an MNO and its likely network performance in the future following the award of PSSR spectrum.

In order to calculate the range of likely commercial performance, we calculate commercial values for two sets of parameters for the piecewise linear curve, which we refer to as “lower end of range” and “upper end of range”. The parameters used for both curves are summarised in Figure 3.15. These parameters do not represent strict lower and upper limits on the value of the spectrum to each MNO (for example due to likely differences in the approach to calculating private values), but rather separate low and high estimates for the commercial values based on different combinations of input parameters. These parameter values have been chosen such that we consider the lower and upper ends of the range likely to bound a reasonable range of estimates based on conservative assumptions. Throughout this process we have kept the scope of our assignment in mind. In particular we have been asked to develop a model based on our understanding of Ofcom’s view of the market and some of our input assumptions therefore do not accurately reflect Three’s views. [✂]

The ‘upper end of range’ is defined by keeping the same gradients for section 1 (up to the APT) and sections 4 and 5 (into the section of diminishing returns) but applying a steeper gradient in the middle sections 2 and 3 of the curve.

Figure 3.15: [✂][30][✂]

The resultant range in commercial performance leads to a range of commercial values differing by spectrum winnings for each MNO. The same two sets of parameters are used for all MNOs. Due to the MNOs’ relative spectrum share changing with different amounts of PSSR spectrum won, the two parameter sets behave differently for different MNOs. The resultant range in the two estimates of commercial value can be quite low in some cases, or reasonably high in other cases.

The resultant commercial benefit in terms of change of SOGA and churn rate is calculated from the change in commercial performance between a given spectrum scenario and the spectrum awarded in the base case. Figure 3.16 shows examples of calculating resultant change in SOGA and churn

30 Note that RNS = relative network score, as a measure of future network performance; CP = commercial performance measure; Gradient = change in CP per unit of change in RNS.

rate for a few selected spectrum scenarios for Three and BTEE. For each spectrum scenario, we calculate an RNS (based on the MNO's spectrum share post-award) and a resultant commercial performance measure (CP). The delta in CP between a spectrum scenario and the base case is multiplied by the size of the relevant subscriber segment. As discussed in Section 3.3.3 above, a segment size of 8.7% is used in order to calculate the commercial uplift for SOGA and in the rate of churn (two thirds of the 13% relevant market segment).

Figure 3.16: [✂]

			[✂][31]	[✂][31]			[✂][31]	[✂][31]

31 [✂]

3.3.5 Outputs from the commercial value model

Following the approach described above, our resultant estimates of commercial values vary significantly by MNO and spectrum scenario, [✂]. Figure 3.17 shows the range of commercial value for selected spectrum scenarios over a 20-year licence period. The lower end of the commercial value range is shown in solid colour, while the range of additional commercial value to the upper end of the range is shown in faded colour.

The commercial value seen by each MNO varies over a range of values depending on the modelled relationship between commercial benefit and RNS. [✂]. We have also tested our model over shorter periods of time (5 and 10 years) and found that the relative valuations between MNOs are largely insensitive to the time period; [✂].

[✂]

Figure 3.17: [✂]

[✂]

3.4 Implications for intrinsic value of the PSSR spectrum

In order to calculate a range of intrinsic values for each MNO, estimates of technical values are also required. This section describes our approach to estimating a range of technical values and the resultant estimates of intrinsic values for the spectrum.

3.4.1 Approach to estimating ranges of technical value

Commercial value forms only part of the total intrinsic value of the spectrum. Hence, we have complemented our calculated range of commercial values with an estimated range of technical values for each MNO for each possible amount of future winnings of PSSR spectrum.

Calculating technical values is outside the scope of our assignment and, therefore, our estimates of technical value are not outputs of a model but are instead inferred based on the factors set out below.

- Our qualitative understanding of the level of constraint in providing required data volumes that each MNO is likely to be faced with informs the relative level of technical value for each MNO. In particular, we understand that Ofcom has suggested throughout its consultations on the PSSR award that those operators facing the greatest capacity constraint are likely to have the highest technical value. We do not necessarily agree with this conclusion , and we understand that Three does not, because in reality there are a number of complicating factors. However, we have based our estimates of technical value on our understanding of Ofcom's view of the market, in line with our scope of work.[32].
- Our qualitative understanding of the likely benefits offered to MNOs by different amounts of spectrum in different bands informs the relative level of technical value between bands and by spectrum block.
- Our views on the likely range for the total intrinsic value of the spectrum help to inform the overall level of our estimates.

We describe the rationale behind these qualitative considerations in more detail in Figure 3.18 below.

Figure 3.18: [✂]

- [✂][33][✂][✂][34][✂][✂][35][✂]

[32] [✂]

[33] [✂]

[34] [✂]

[35] [✂]

3.4.2 Estimated ranges of technical values

As with our commercial value calculations we provide a range of technical value estimates, summarised in Figure 3.19 for key spectrum packages. This range should not be seen as forming strict upper or lower bounds on the possible technical value of each block of spectrum, but rather defines a reasonable set of values within which we expect that the true technical valuation is most likely to lie, based on the assumptions set out above.

Figure 3.19: [✂]

3.4.3 Outputs from calculation of spectrum intrinsic value

We estimate ranges of intrinsic value by combining our estimated technical values (see Section 3.4.2) with the calculated commercial values (see Section 3.3.5). The lower and upper end of the range of technical values we estimate are combined (respectively) with the lower and upper end of the range of commercial values we have calculated to generate lower and upper ends of a range of total intrinsic value for each MNO for each amount of spectrum. These ranges of total intrinsic value are summarised for a set of the (likely) most important spectrum packages in Figure 3.20.

Following this approach, our resultant estimates of intrinsic values vary by MNO and spectrum scenario. Figure 3.20 shows the range of intrinsic value for selected spectrum scenarios for a 20-year licence period. The lower end of the intrinsic value range is shown in solid colour, while the range of additional intrinsic value up to the upper end of the range is shown in faded colour.

[✂]

Figure 3.20: [✂]

[✂]

4 Strategic investment value for the PSSR spectrum

In the second of our workstreams, we analyse the potential for strategic investment value to arise [✂]. In this section, we begin by discussing how strategic investment value arises. Next, we introduce the framework developed for calculating strategic investment value, including details of assumptions and inputs to the strategic investment value model. Finally, we present our estimates of ranges of strategic investment values [✂].

4.1 How strategic investment value arises

[✂]Therefore, the MNO with larger spectrum share could succeed with a strategic investment if its combined intrinsic value (P_1) and strategic investment value (P_2) are larger than the intrinsic value of the MNO with smaller spectrum share (i.e. if $P_1+P_2 > V$). If $P_1 < V$, then the reason that the MNO with a larger spectrum share would win the spectrum would be down to the existence of its strategic investment value (P_2). This is illustrated in Figure 4.1 below.

We note that it is not necessary for an MNO with a larger spectrum share to completely foreclose an MNO with smaller spectrum share from acquiring any new spectrum in order to derive strategic investment value.[36]

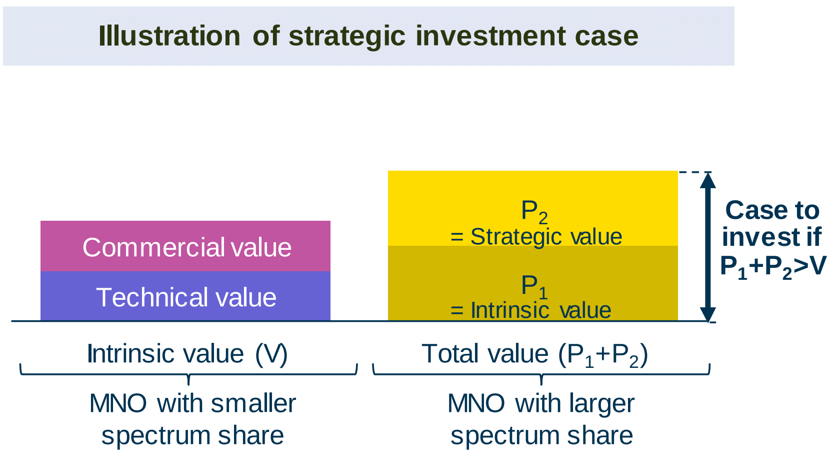


Figure 4.1: Illustration of when strategic investment may arise[37] [Source: Analysys Mason, 2016]

4.2 Framework for calculating the strategic investment value of PSSR spectrum

[✂]

36 As noted by EE in its response to Ofcom's consultation on annual licence fees for 900MHz and 1800MHz, see for example Ofcom's summary of the response in paragraph A8.148 of its statement.

37 Note V = intrinsic value; P = change in operator profit following acquisition of new spectrum (excludes the cost of spectrum acquisition).

Figure 4.2: [✂][38][✂]

[✂] [✂]

- [✂][39][✂]
- [✂][39] [✂]

[✂]

[✂][40]

[✂]

4.3 Figure 4.3: [✂][✂]Inputs to the strategic investment value model

[✂]

[✂][41][✂]

[✂][42]

- [✂][43][✂]

Figure 4.4: [✂]

4.4 Outputs from the strategic investment value model

[✂]

Figure 4.5: [✂]

[✂]

Figure 4.6: [✂]

38 [✂]

39 [✂]

40 [✂]

41 [✂]

42 [✂]

43 [✂]

[✂]

[✂]

Figure 4.7: [✂]

[✂]

Figure 4.8: [✂]

[✂]

5 Examples of strategic investment in other auctions

In the third of our workstreams, we present examples of cases where strategic investment may have taken place in past auctions.

Strategic investment is not merely a theoretical construct, but rather something which can and does happen in practice. [✂]

Auctions are often designed to try and prevent strategic bidding, and this can often be done successfully. Nonetheless there are likely to be various examples of past auctions where bids have been placed based on strategic investment value. In some cases, these bids may have been successful in acquiring the spectrum in place of an MNO bidding based on pure intrinsic value considerations, while in others they may not.

Even in cases where strategic investment bids have been successful, examples are difficult to identify with certainty. This is because an MNO is rarely likely to publicly admit that it engaged in strategic investment as this would be to the detriment of a competitor and potentially consumers. Furthermore, the bodies responsible for running spectrum auctions, usually national regulatory authorities, are not incentivised to publicly state that strategic investment has occurred and that the spectrum has been assigned inefficiently or contrary to what is likely be most beneficial to competition.

We have, however, identified three potential examples of strategic investment in spectrum auctions, which we discuss in the remainder of this section.

5.1 Austria's multiband auction in 2013

The Austrian regulator, RTR, auctioned 28 blocks of 2×5MHz in the 800MHz, 900MHz and 1800MHz bands in a multiband auction in October 2013. Before the auction, a total of 2×103.2MHz of spectrum in these bands was shared between three MNOs, with T-Mobile holding the greatest share at 37%. Figure 5.1 summarises the spectrum holdings by the Austrian MNOs before and after the auction.

Figure 5.1: Overview of spectrum holdings by MNOs in Austria before and after the multiband auction in October 2013[44] [Source: Analysys Mason, 2016; Telekom Austria, 2013]

Band	A1 Telekom (before)	A1 Telekom (after)	T-Mobile (before)	T-Mobile (after)	Three Austria (before)	Three Austria (after)
800MHz	–	2×20MHz	–	2×10MHz	–	–
900MHz	2×20.2MHz	2×15MHz	2×12.8MHz	2×15MHz	2×0.8MHz	2×5MHz
1800MHz	2×15MHz	2×35MHz	2×25.4MHz	2×20MHz	2×29MHz	2×20MHz

44 See http://www.telekomaustria.com/en/newsroom/2013-10-21-telekom-austria-group-acquires-spectrum-for-a-total-of-eur-1-030-million-in-austria.

Band	A1 Telekom (before)	A1 Telekom (after)	T-Mobile (before)	T-Mobile (after)	Three Austria (before)	Three Austria (after)
Total	**2×35.2MHz**	**2×70MHz**	**2×38.2MHz**	**2×45MHz**	**2×29.8MHz**	**2×25MHz**
Overall share	*34%*	*43%*	*37%*	*32%*	*29%*	*26%*

In the auction, A1 Telekom successfully won sufficient spectrum to capture 43% of total available spectrum post-auction. This reduced the absolute amount of spectrum held by Three Austria from 2×29.8MHz to 2×25MHz despite the introduction of an additional 2×36.8MHz into the market (mainly in the 800MHz band). T-Mobile was only able to acquire an additional 2×6.8MHz.

The auction raised the highest prices seen in any 4G auction in Europe. Annex 8 of Ofcom's statement on annual licence fees for 900MHz and 1800MHz spectrum suggests that for 2×140MHz of spectrum across the 800MHz, 900MHz and 1800MHz bands, a total of EUR2015 million was paid, which corresponds to EUR0.85/MHz/pop. Ofcom's assessment was that UK-equivalent lump-sum values for 900MHz and 1800MHz spectrum respectively were GBP37.8 million and GBP23.0 million. These compare to the next highest values achieved across the rest of Europe of GBP30.6 million for 900MHz in Romania and GBP16.0 million for 1800MHz in Sweden.

Prices for 800MHz spectrum were similarly high, which could be interpreted as evidence of strategic bidding since it indicates a risk that Telekom Austria may have bid above its intrinsic value for the spectrum. Following the auction, Telekom Austria, the parent of A1 Telekom, acknowledged the strategic advantage it had gained in reducing the spectrum available to its competitors, suggesting that foreclosure of competitors drove its bidding behaviour:

"*This new spectrum offers Telekom Austria unique strategic advantages. Having* ***acquired 67% of the immediately available low frequency 800MHz*** *spectrum, Telekom Austria Group is in an unparalleled position to roll out a leading LTE network across Austria. This fully supports Telekom Austria Group's high value strategy and network quality leadership and allows Telekom Austria Group to protect its fixed-line as well as its mobile customer base, in particular in rural areas.* ***Moreover, the spectrum distribution has significantly reduced the viability of a potential new mass market mobile virtual network operator (MVNO)****.*"

Telekom Austria newsroom, October 2013[45]

Post-auction, Telekom Austria is the only MNO that could viably roll out a strong rural mobile broadband offering with its strong sub-1GHz holdings and large 800MHz carrier. Before the auction, Three Austria had indicated that it would use LTE in new bands to compete against the fixed line rural broadband market (dominated by Telekom Austria), but its award of 2×5MHz would make this very unlikely.

45 See http://www.telekomaustria.com/en/newsroom/2013-10-21-telekom-austria-group-acquires-spectrum-for-a-total-of-eur-1-030-million-in-austria.

Telekom Austria's statement with respect to reducing the viability of MVNO entrants, points to a strategic approach that intends to compete on services but also to **foreclose competitors**. Ofcom and the UK MNOs extensively analysed bidding in the Austrian auction as part of the 900MHz and 1800MHz annual licence fees consultation process in the UK. In particular, there was considerable discussion of whether prices were high due to strategic investment, as Ofcom acknowledged was possible in paragraph A8.67 of its final statement: "*…there was a risk of overstatement in the 800MHz price due to the possibility of strategic investment, or intrinsic value bidding*". Although Ofcom eventually concluded in paragraph A8.128 that "*the relative prices in the Austrian auction were at least as likely to reflect intrinsic valuation of spectrum in Austria as to reflect strategic bidding*", Ofcom has nonetheless acknowledged **a material possibility that at least some bidding was based on value arising due to strategic investment**.

5.2 Denmark's 800MHz auction in 2012

In June 2012, the Danish Business Authority (DBA) auctioned 2×30MHz of 800MHz split into four lots of 2×5MHz and one lot of 2×10MHz with usage restrictions due to interference with DTT. Coverage obligations were included but MNOs could bid for exemptions to these. Wide variations in prices paid per block of 800MHz spectrum in Denmark suggest bidding was designed to exclude Three from the band.

The 800MHz auction had the following outcome:

- TDC won 2×20MHz for DKK627 million (GBP63 million)
- TT-Netvaerket (Telia and Telenor joint bid) won 2×10MHz at the bottom of the band and suffered significant encumbrance due to DTT co-existence obligations for DKK111 million (GBP11 million)
- Three Denmark (Hi3G) was unable to win any 800MHz spectrum, leaving it with only 2×5MHz of sub-1GHz spectrum compared to 2×29MHz for TDC and 2×30.8MHz for TT-Netvaerket.

Spectrum holdings and share pre- and post-auction are summarised in Figure 5.2.

Figure 5.2: Summary of spectrum holdings by MNO in Denmark before 800MHz auction in June 2012[46] [Source: Analysys Mason, 2016; ENS, 2012]

Band	TDC	Telia[47]	Telenor[47]	Hi3G
900MHz FDD	2×9MHz	2×2.6MHz 2×9.2MHz	2×9MHz	2×5MHz
1800MHz FDD	2×11.8MHz 2×10MHz	2×11.8MHz 2×11.8MHz	2×7.2MHz 2×12.2MHz	2×10MHz
2.1GHz FDD	2×15MHz	2×15MHz	2×15MHz	2×15MHz
2.1GHz TDD	1×5MHz	1×5MHz	1×5MHz	1×5MHz
2.6GHz TDD	2×20MHz	2×20MHz	2×20MHz	2×10MHz

46 See http://www.ens.dk/en/Telecom-and-Spectrum/Spectrum/Auction-and-Public-Tender-Licences/800-MHz-Auction.

47 Bid jointly as TT-Netvaerket.

Band	TDC	Telia[47]	Telenor[47]	Hi3G
2.6GHz FDD	–	1×15MHz	1×10MHz	1×25MHz
Total pre-auction[48]	**2×69MHz**	**2×73MHz**	**2×74MHz**	**2×61MHz**
Share pre-auction	*25.0%*	*26.2%*	*26.7%*	*22.0%*
800MHz FDD	2×20MHz	2×5MHz	2×5MHz	–
Total post-auction[48]	**2×89MHz**	**2×78MHz**	**2×79MHz**	**2×61MHz**
Share post-auction	*29.1%*	*25.3%*	*25.7%*	*19.9%*

Post auction, the TT-Netvaerket operators held 48% of sub-1GHz spectrum, 53% of FDD spectrum overall and half of all TDD spectrum, while TDC held 2×20MHz (two thirds) of the valuable 800MHz band. Our understanding is that the difference in prices paid by TDC and TT-Netvaerket is likely to be justified by the co-existence obligations, meaning that TDC's bid for a second 2×10MHz had the effect of excluding Hi3G from winning any 800MHz. It is open to question whether TDC's bid was based on strategic investment value or intrinsic value, but we note that it is very unusual for one MNO to value a second 2×10MHz more than a competitor values a first 2×10MHz in the 800MHz band.

5.3 UK's DECT guard band auction in 2006

The 2006 DECT guard band[49] auction shows signs of strategic bidding having occurred. In 2006 Ofcom awarded 12 licences to share 2×3.3MHz in the DECT guard band.

The award was made via a single round sealed bid auction. Bidders could bid different prices depending on how many operators would ultimately share the spectrum (between seven and twelve). Twelve of the fourteen bidders bid the same price irrespective of how many licensees there would be, but BT and Cable & Wireless chose to bid more for an outcome with fewer licensees, as shown in Figure 5.3.

Figure 5.3: Bid values for BT and Cable & Wireless depending on the number of shared licensees for the DECT guard band[50] [Source: Analysys Mason, 2016; Ofcom 2006]

Number of shared licensees to be awarded spectrum	Bid value for BT	Bid value for Cable & Wireless
7	GBP305 112	GBP281 100
8	GBP295 112	GBP281 002
9	GBP275 112	GBP101 002

48 Assumes that 70% of TDD spectrum can be used for downlink traffic.

49 The DECT guard band is located in the higher frequencies of the 1800MHz band and acts as a 'guard band' between spectrum used by mobile networks and that used by cordless home phones.

50 See http://media.ofcom.org.uk/news/2006/ofcom-awards-12-licences-following-spectrum-auction/ and also http://stakeholders.ofcom.org.uk/binaries/consultations/talk-talk-licence-variation/summary/variation-concurrent-spectrum-access-1781-MHz-licence.pdf.

Number of shared licensees to be awarded spectrum	Bid value for BT	Bid value for Cable & Wireless
10	GBP275 112	GBP51 002
11	GBP275 112	GBP51 002
12	GBP275 112	GBP51 002

The bids of BT and Cable & Wireless could have been based on intrinsic values being perceived to be higher when sharing with fewer other operators, but we do not see any strong technical justification for this and note that twelve other bidders did not consider this to be the case.

Our view therefore is that it is at least as likely that BT and Cable & Wireless considered it worthwhile to strategically invest in order to restrict the number of competitors they may face in the future, whatever the technical characteristics of the service which the band would have ended up being used for.

6 Conclusions

6.1 Conclusions based on consideration of intrinsic value

[✂]

6.2 Conclusions based on consideration of intrinsic and strategic investment value

[✂]