Ofcom's future approach to mobile markets and spectrum

Conclusions paper

Contents

1. Overview

1.1 Mobile internet access has become an essential service for people and businesses.[1] We expect demand for mobile data to continue to grow as greater use is made of data-hungry services and as new technologies enable new uses. All types of wireless network will need to evolve to meet future demand and to deliver the quality of experience customers need.

1.2 Alongside Wi-Fi, mobile networks play an important role in delivering internet access. We have been considering our future approach to mobile markets and the role of spectrum in enabling mobile internet growth. We published discussion papers on each of these areas in February 2022.[2] In this document, we set out our conclusions, taking account of the responses we received.

Our future approach

Competition among mobile network operators (MNOs) has driven the delivery of good outcomes for customers over the last ten years, supported by a range of public policy interventions. Looking ahead, we continue to see competition as a key driver of good outcomes. But in the medium term, the technological and market developments that are taking place may change competitive dynamics. In light of this, **we will step up our work to monitor how well mobile markets are functioning as they evolve, the outcomes being delivered and risks to those outcomes**. This monitoring will help ensure we can intervene effectively, where necessary, in potentially fast-moving markets.

Network quality is likely to be of growing importance to customers.[3] We will continue our work to **develop better information on network quality**, including using crowdsourced data. This will inform our own future work, and help customers make better decisions about which provider they use, which should in turn encourage providers to better meet customers' needs on quality.

We are also taking steps to **clarify our future regulatory approach to markets and the allocation of spectrum**, to provide greater certainty to encourage investment. We are confirming that:

- following the introduction of a range of new rules in recent years, we have moved to a new phase of our consumer work, with a greater emphasis on holding providers to account in relation to compliance with those rules, and on their delivery of the Fairness for Customers commitments.[4] But we remain ready to act should problems emerge;

- with any future interventions, we will set out more explicitly how they are likely to impact on how the market functions, including on investment to meet future customer needs. We expect to publish a consultation on updating our impact assessment guidance early next year;

---

[1] Mobile internet access covers all wireless connectivity services, including mobile services, (traditional voice and SMS, and mobile data), and internet access delivered over other wireless networks, such as Wi-Fi.
[2] Future Approach to Mobile Markets, Ofcom, 2022; and Meeting Future Demand for Mobile Data, Ofcom, 2022.
[3] Network quality is multi-dimensional, encompassing coverage, reliability and performance (which in turn includes speed and responsiveness).
[4] Britain's biggest broadband and phone firms to put fairness first, Ofcom, 2019.

- we do not have a fixed position on mobile consolidation. Our stance on any future merger would be informed by our view on the effectiveness of competition that can be expected after the merger, rather than just the number of competitors;
- we expect technology upgrades and densification, including the use of mmWave and small cells, to play an important role in enabling MNOs to meet future demand for mobile data, both up to 2030 and beyond, as well as creating the potential for innovation; and
- we will consider where and when additional spectrum may be needed and will take other competing uses into account in our future spectrum management decisions. We are currently evaluating the best use of the upper 6 GHz band,[5] and favour a 'no change' outcome in relation to a potential IMT identification of the band at WRC-23.[6] We will consider international developments and engage with relevant stakeholders as needed, prior to consulting on proposals for the future use of the band in the UK.

We want people and businesses to be able to use mobile services where they need to do so

1.3   We want to see well-functioning markets that are the primary means for the delivery of the following outcomes:

- Quality, value for money, and choice to meet different customers' needs.
- Widespread availability of mobile internet access to keep people and businesses connected wherever they live, work, and travel.
- Innovation and investment in new technologies and reliable, resilient networks to meet the future needs of customers and the country.
- Support for customers who may be vulnerable, including those that are financially vulnerable.

MNOs will need to consider a range of options to meet growing customer demand, requiring significant ongoing investment

1.4   While we expect customers to continue to use more data, the future rate of data growth is uncertain. Data usage is likely to be driven by increased use of existing applications that require higher bandwidth. It is also likely to be driven by potential new applications that entail higher data consumption, such as augmented and virtual reality, as well as commercial or industrial applications like machine-to-machine communications. In addition, the overall demand for data across the network will vary by time of day, by location and whether it is from indoors or outdoors.

1.5   MNOs are likely to use a range of approaches to deliver more capacity to meet this demand, including technology upgrades; making more extensive use of their spectrum holdings; and increasing the number of sites where additional capacity is needed

---

[5] See Update on the upper 6 GHz band, Ofcom, 6 December 2022.
[6] World Radiocommunications Conference (WRC) is an ITU-R led 4-yearly congress where countries and administrations discuss any necessary changes to the Radio Regulations.

(densification). We also expect that MNOs will continue to use alternative solutions to manage traffic, such as making use of Wi-Fi, where it is available, particularly for indoor data traffic.

1.6   We anticipate that densification, (including greater use of small cells and mmWave, which we plan to award in 2024), is likely to be needed and could represent a step change compared to the way MNO networks have evolved in the past. We recognise there is some concern about the cost, complexity, and scale of small cell deployments.

1.7   While making additional mid-band mobile spectrum available can play a role in helping MNOs meet customer demand, particularly towards the end of this decade, on its own additional mid-band spectrum is unlikely to be sufficient to meet all demand in the next decade if recent data growth rates continue. We also need to take account of growing demand for spectrum across other services when making decisions on making additional spectrum available for mobile.

1.8   Overall, significant investment in mobile networks will be required to increase capacity and provide the network quality needed to meet future customer needs. This is in addition to the need to deliver the Shared Rural Network (SRN) and the new regulatory provisions set out by Government to improve network security.

We expect competition to continue to play a key role in delivering the outcomes we want to see

1.9   MNOs face a challenging investment climate, and some have questioned whether the market will deliver significant investment in the coming years. However, we consider that the MNOs have commercial incentives to continue to invest to improve mobile networks, particularly where demand for mobile data is high. While MNOs have said that their financial performance in recent years has not been supportive of investment, they have all undertaken significant investment: a total of £2.7bn a year on average over the last five years. In addition, their business plans show that they plan further significant investment over the next few years, to deliver increased capacity and widespread rollout of 5G, with some looking to launch 5G standalone (5G SA) shortly. [7]

1.10   We recognise though, that the current economic climate creates greater uncertainty and challenges to financial performance. This may dampen MNOs' incentives to invest and could slow down the rollout of 5G.

Significant technological and market developments could bring opportunities as well as potential risks over the medium term

1.11   Mobile markets are undergoing considerable change, driven in part by technological developments. We expect the supply chain to become more complex, with a range of

---

[7] So far MNOs have deployed 5G using the 4G core, 5G SA will rely on a new 5G core, offering improvements in particular in terms of responsiveness, therefore potentially enabling more innovative use cases.

participants likely to play a greater role. This includes the potential for hyperscalers to provide cloud infrastructure in core mobile networks, tower companies and neutral hosts to provide more mobile network infrastructure, a range of players to provide private networks, and for Apple and Google to provide a platform on which customers can choose their mobile provider.

1.12   These changes could boost innovation and efficiency. However, they may also raise potential risks to the delivery of good outcomes. Under certain circumstances, competition among MNOs may weaken, or, if new players significantly expand their position in the mobile value chain, this could distort competition.

There may also be potential wider benefits to society from having mobile networks of higher quality than the market will deliver

1.13   Where there are benefits to society from having wider coverage or higher quality networks than commercial investment will deliver, public policy intervention may be needed. There are already measures in place to deliver further improvements in 4G coverage,[8] though some gaps will remain, and public funding may be needed if these are to be addressed.[9]

1.14   Looking ahead, the deployment of 5G SA may enable new uses, including some that rely on very high speed or responsiveness. As demand for new uses grows, we expect providers to have commercial incentives to meet that demand in densely populated areas. While we expect areas with low population density to experience improvements in quality, commercial investment alone may not enable all new uses on mobile networks in such areas.

1.15   At this stage, it is too early to tell whether there would be significant wider benefits to society from enabling all these new uses on mobile networks in less densely populated areas. However, as demand for new uses emerges, the evidence of any potential wider benefits will become clearer. This is something we will keep under review.

Our future approach

1.16   We will need to be agile in response to future changes in mobile markets. To facilitate this, we will do more to ensure we maintain a sound understanding of how mobile markets function and to monitor outcomes and potential risks. We recognise that people and businesses are likely to increase their use of wireless data networks in general, including fixed, Wi-Fi and mobile networks, and private networks. We will also continue to monitor data demand and how networks evolve to meet that demand, to understand where and how demand is growing.

1.17   We are also taking steps to clarify our future approach to mobile markets and spectrum, to support investment. We have recently published a consultation on clarifying the net

---

[8] Such as the Shared Rural Network (SRN) and the Scottish Government's 4G Infill programme.
[9] Though for at least some of these not spots, the additional costs of serving them may exceed the benefit of doing so.

neutrality framework[10] through revised guidance, and a statement which sets out our future approach to digital markets.[11] In addition we have recently launched a market study to assess whether the market for cloud services in the UK is working well for consumers and businesses, both now and in the future.[12]

1.18   We remain open minded with regards to options for additional spectrum for mobile use, if needed. This includes looking at the upper 6 GHz band and particular bands in the 7-24 GHz range for existing and new (including 6G) applications. Any options we consider may not necessarily involve making available nationwide licences for spectrum.

1.19   We are publishing this document alongside an update on the upper 6 GHz band, in which we set out our current position in preparation for WRC-23.[13] We highlight that the case between licence exemption (to support uses such as Wi-Fi) and commercial mobile is finely balanced. There is uncertainty around future developments that could shift the balance towards either approach. To keep options open, we favour a 'no change' outcome which would better support either use. We will consider international developments and engage with relevant stakeholders as needed, prior to consulting on the proposals for the future use of the band in the UK.

---

[10] Consultation: Net neutrality review, Ofcom, 21 October 2022.
[11] Digital markets in the communications sector, Ofcom's approach to competition and consumer issues in internet-based communications markets, Ofcom, 22 September 2022.
[12] Cloud services market study, Call for inputs, Ofcom, 6 October 2022.
[13] See our update on the upper 6 GHz band.

2. Background

2.1   In February 2022 we published two discussion papers alongside each other and invited comments on these from stakeholders.

- Our **Future Approach to Mobile Markets**[14] paper set out our initial views on the main developments that may take place across mobile markets over the next five to ten years; their potential implications for the delivery of good outcomes; and what our approach should be in light of these developments.
- Our **Meeting Future Demand for Mobile Data**[15] paper set out initial thoughts and encouraged longer-term thinking beyond 2030, about how public mobile networks may need to evolve to meet future demand. We sought input on the level of future demand for data delivered through mobile networks; opportunities and challenges associated with network densification in the UK; and where spectrum could play a part (noting increased demand for spectrum from other users too).

2.2   Given the links between these two policy areas, we are publishing our conclusions for both in this document. We have considered responses received from stakeholders, as well as further evidence we have gathered, including through statutory information requests, stakeholder meetings, and publicly available sources. We focus here on our future approach and have not sought to cover all the background information that we set out in our discussion papers.

2.3   We have given careful consideration to whether our conclusions will have a particular impact on people sharing protected characteristics, as required under the Equality Act 2010 and Northern Ireland Act 1988 as well as considered the impact on additional groups of citizens and consumers that Ofcom has identified pursuant to its general duties under section 3 of the Communications Act 2003. We do not consider that our conclusions have equality implications under any of the Acts.[16] The analysis and evidence supporting our approach can be found throughout this paper.

Links with other work

2.4   There is a range of other work that relates to the issues considered here. This includes our review of the net neutrality framework, on which we recently published a consultation,[17] our digital markets strategy,[18] our work to improve consumer information on mobile coverage and performance and on affordability. There are several related spectrum projects, including our consultation on making available millimetre wave (mmWave)

---

[14] Future Approach to Mobile Markets, Ofcom, 9 February 2022.
[15] Meeting Future Demand for Mobile Data, Ofcom, 9 February 2022.
[16] Further detail is set out in section 149 of the Equality Act 2010 and section 75 of the Northern Ireland Act 1998.
[17] Net neutrality review, Consultation, Ofcom, 21 October 2022.
[18] Digital markets in the communications sector, Ofcom's approach to competition and consumer issues in internet-based communications markets, Ofcom, 22 September 2022.

spectrum for mobile networks, [19] our positioning on the upper 6 GHz band in preparation for the World Radiocommunications Conference, 2023 (WRC-23), which has been published alongside this paper, [20] and our work on future mobile technology such as 6G.

2.5 We have not directly considered issues relating to network security and resilience [21] nor environmental sustainability issues, [22] which fall outside the scope of this work and are being considered separately as part of other ongoing Ofcom work.

2.6 In addition, we continue to work with, and provide technical advice to, the Government as it progresses its Wireless Infrastructure Strategy (WIS), [23] which will set out the Government's vision for wireless infrastructure in the UK and a new policy framework to encourage innovation, competition and investment in 5G and future networks; and its wider strategic priorities in relation to radio spectrum management.

2.7 We also continue to work closely with the CMA, which has published its findings in its market study into mobile ecosystems [24] and continues to prepare for a new pro-competition regime for digital markets.

Structure of this document

2.8 The structure of this paper is as follows:

- **Section 3** outlines the outcomes we want to see mobile markets deliver and how well those outcomes have been delivered to date.
- **Section 4** considers how well mobile markets are likely to deliver the outcomes we want to see in the future.
- **Section 5** sets out our future approach to mobile markets and spectrum.

2.9 At Annex 2 we set out the practical barriers to densification through small cell deployments and at Annex 3 we discuss market developments that received particular stakeholder comment.

2.10 We set out mobile pricing data analysis over the period 2019-2022 at Annex 4. This builds on our pricing trends report, [25] includes analysis of customer level data, and provides an indication of the analysis that we plan to do next year.

---

[19] Enabling mmWave spectrum for new uses, Consultation, Ofcom, 9 May 2022.

[20] See our update on the upper 6 GHz band.

[21] We are working with the UK Government to implement our responsibilities under the new Telecommunications (Security) Act 2021 ("Telecoms Security Act"), which received royal assent on 17 November 2021, the security duty monitoring and enforcement provisions of which came into force on 01 October 2022, Ofcom begins new role overseeing security of telecoms networks.

[22] We are engaging with our industry stakeholders to understand their approach to running their businesses sustainably, and how they are affected by climate change and wider pressures to become more sustainable. Ofcom has no formal duties in relation to the environment, but we are undertaking research to understand the energy intensity of communication technologies. We have also provided some consumer advice on the energy efficient use of communications devices.

[23] Wireless Infrastructure Strategy, Call for Evidence, DCMS, November 2021.

[24] Mobile ecosystems, Market Study final report, CMA, 10 June 2022.

[25] Pricing trends for communications services in the UK, Ofcom, 1 December 2022.

3. The outcomes we want mobile markets to deliver

3.1   In this section we set out the outcomes we want to see, the role of spectrum in enabling the delivery of these outcomes and outline how mobile markets have delivered good outcomes, supported by public policy interventions.

The outcomes we want to see

3.2   We want people and businesses across the UK to have internet access they can rely on. As set out in our Plan of Work 2022/23, we enable wireless services in the broader economy and promote competition to support investment in strong, secure networks, get everyone connected, and deliver fairness for customers.[26]

3.3   These priorities are reflected in the range of good outcomes that we want to see.

- Quality, value for money, and choice for customers to meet different customers' needs.
- Widespread availability of mobile internet access to keep people and businesses connected wherever they live, work, and travel.
- Innovation and investment in new technologies and reliable, resilient networks to meet the future needs of customers and the country.
- Support for customers who may be vulnerable, including those that are financially vulnerable.

3.4   We think that the primary means for delivering these outcomes should be a well-functioning mobile market that comprises the following two elements:

- competition among providers to meet customer demands relating to price, quality and new services; and
- customers making informed choices about service and provider (including by being able to switch between providers easily).

3.5   The Government's current ambition is for the majority of the population to have access to a 5G signal by 2027. As part of the WIS, it plans to articulate a clear vision for how wireless infrastructure can become an integral part of the fabric of the UK's economy by 2030.[27]

---

[26] Ofcom's plan of work 2022/23, Ofcom, March 2022.
[27] Wireless Infrastructure Strategy: call for evidence, 2021, DCMS, 17 November 2021.

Spectrum enables mobile internet access and the delivery of the outcomes we want to see

3.6   Spectrum is essential to deliver mobile services. MNOs require a balance of spectrum holdings to provide coverage and capacity, and to meet demand for different services in different locations. [28]

3.7   To date, we have made significant amounts of spectrum available for different generations of mobile technology (3G, 4G, and 5G) to be deployed and to meet increasing growth in demand for data from consumers and businesses. As a result, the UK MNOs hold around 30% of all spectrum below 3.8 GHz. We are also planning to make more spectrum available for mobile use, in particular in the high frequency 'mmWave' bands. [29]

3.8   The way in which we have managed mobile spectrum helps ensure its efficient use, generating positive outcomes for people and businesses. In particular, we have used spectrum auctions to make available spectrum efficiently, promote a competitive mobile market and improve mobile coverage. [30] Additionally, we have taken steps to enable a wide range of organisations to access mobile spectrum on a local basis, to help promote innovation, including through shared access licences. [31]

3.9   However, access to spectrum is important for a range of other uses and services too, including Global Positioning Systems (GPS), weather forecasting, TVs, space and satellite applications and licence exempt uses, such as Wi-Fi, which enable valuable wireless broadband and other innovative services. [32]

Mobile markets have delivered good outcomes, supported by public policy interventions

3.10   In our Future Approach to Mobile Markets paper, we explained that competition among providers (the four MNOs BT/EE, Three, Virgin Media O2 and Vodafone, as well as Mobile Virtual Network Operators and resellers), has helped deliver good outcomes over the last ten years, supported by a range of public policy interventions.

3.11   **Competition on quality has driven significant ongoing investment in mobile networks**. [33] This has enabled 4G roll-out, providing faster, more reliable data, as well as greater

---

[28] In general, lower frequencies are best for delivering wider coverage and carrying signals deeper indoors; while higher frequencies have greater capacity to carry data, enabling more applications, but are less able to provide wide coverage.

[29] The current 'pipeline' of spectrum includes plans to award part of the 1.4 GHz band (1492-1517 MHz) and plans to make mmWave available. This is discussed in more detail in Section 5.

[30] For example, we have set caps on individual MNO spectrum holdings to avoid large asymmetry of spectrum holdings and included a coverage obligation to serve 98% premises in the 2013 auction of 800 MHz spectrum.

[31] in particular, the 3.8 – 4.2 GHz band, 1800 MHz and 2300 MHz bands were made available in 2019, alongside 26 GHz spectrum for indoor applications.

[32] The demand for spectrum to enable other services, such as satellites (increasingly Low Earth Orbit satellites) and fixed point to point links, is constantly evolving. We therefore monitor demand for spectrum and ensure optimal use, considering the requirements of incumbents and potential users.

[33] In February we found that, between 2012 and 2020, there was investment of around £2.5bn each year. Future Approach to Mobile Markets, (paragraph 4.11), Ofcom, 09 February 2022. We provide an updated figure in Section 4.

network capacity to carry increasing data volumes. More recently, competition has been driving investment in 5G, which has initially been focused on improving network capacity to meet demand in congested urban areas.

3.12 **Competition has helped deliver widespread 4G coverage, supported by public policy interventions.** There is now widespread 4G coverage outside premises, though there are differences in coverage between urban and rural areas, and across the UK's four nations. [34] The Shared Rural Network (SRN) will further improve 4G coverage by reducing partial and total not spots in rural areas, particularly in Scotland and Wales. [35] The Scottish Government's 4G Infill Programme is also funding new mobile masts in rural locations with no existing 4G mobile coverage. [36] In their responses, the Scottish and Welsh Governments and Citizens Advice Scotland raised concerns that these initiatives would not go far enough to reduce 4G not spots. [37] We recognise that some not spots will remain after current programmes have been rolled out and further public funding may be needed if these are to be addressed. [38] However, the cost of serving some of the remaining areas is likely to be very high, while the benefit may be relatively limited due to low usage.

3.13 A wider issue is whether quality of experience in areas where people and businesses go is sufficient to meet people's needs. Over the past ten years, competition among MNOs has helped drive improvements in quality. Our evidence suggests that **quality of experience is generally good for most customers, but can be patchy in places**. In response, Three said that international comparisons suggest that the UK has poor quality of experience by European standards, that markets with three MNOs have better networks than those with four MNOs, and that the UK market needs to consolidate to ensure that MNOs have the scale needed to invest in high quality networks. [39] As noted in February, there are challenges in making reliable network quality comparisons across different countries and some studies focus narrowly on speed rather than a more comprehensive set of metrics. In addition, our own empirical analysis has not found evidence of a positive link between market concentration and quality outcomes. [40]

3.14 We also noted that, although quality is important to customers, there is a greater focus on price as a basis of competition. This is in part because providing information to allow

---

[34] As of September 2021, individual operators' 4G coverage outside rural premises are 93-97%, whereas each MNO has coverage outside more than 99% of urban premises; MNOs provided 4G geographic coverage ranging from: 92-94% in England; 87-92% in Northern Ireland; 57-73% in Scotland; and 72-84% in Wales, Ofcom Connected Nations Report, 2021.

[35] Each MNO has agreed to provide coverage across 88% of the UK landmass by June 2024, and 90% by January 2027. Coverage in Scotland should rise to 91% from at least one operator and 74% from all four operators, in Wales it should rise to 95% from at least one operator and 80% from all four operators. See GOV.UK for full figures.

[36] This is a £28.75 million initiative delivering 4G infrastructure and services in up to 55 mobile not-spots in rural and remote parts of Scotland. Scottish 4G infill programme: progress update - gov.scot (www.gov.scot)

[37] In addition, potential concerns have been raised about future differences in 5G coverage between urban and rural areas. We discuss this further in Section 5.

[38] Some respondents suggested that coverage could be further improved by including new coverage obligations in future spectrum auctions. However, these obligations are more suited to lower frequency nationwide awards. Other stakeholders called for geographical variation in regulation to address local issues (noting the approach taken in relation to wholesale markets in the fixed sector). However, we do not regulate wholesale markets in mobile sector and so do not have the same regulatory levers for regulating to incentivise investment.

[39] It also suggested that markets with three MNOs perform much better on quality of experience.

[40] Market structure, investment and quality in the mobile industry, Ofcom, 2021.

customers to make informed choices is challenging, particularly as customers have different needs. Coverage projections from MNOs are informative but do not always correspond with people's lived experience of networks. In light of this, we said that we are developing better information on network quality for customers. A number of respondents agreed that better information on coverage and network quality is needed,[41] and we discuss this further in Section 5.

3.15 **Customers have a range of choices and we have taken steps to improve engagement.** Most customers have a wide choice of mobile providers and tariffs when looking to switch. We have introduced a number of measures to help improve consumer engagement such as by introducing end of contract notifications, annual 'best tariff' notifications and simplifying the process of switching mobile provider. As part of Ofcom's ex-post evaluation programme we assessed the impact of end-of-contract notifications (ECNs). We found that there is some evidence that engagement among mobile customers has improved, and that there has been a significant reduction in overpayment by bundled out-of-contract mobile customers since the commitments took effect.[42] We note that Virgin Media O2 and Vodafone questioned whether such measures are having a material impact yet. We will monitor the longer-term effects to help ensure customers are able to secure a good deal, and more generally our ex-post evaluation programme will continue to assess the impact of our work.

3.16 In February we noted that, **in general, between 2015 and 2020 mobile prices fell and customers were, on average, getting more for less.**[43] However, we also noted that prices appeared to be rising for low-use, pre-paid and some pay-monthly customers, and that some customers would see in-contract prices rises in the next few months.

3.17 However, pricing outcomes have been less positive for customers in 2022.

- Many existing customers experienced large in-contract price rises of over 10%, driven by high inflation and the inflation-plus in-contract price rises used by many of the main providers.[44]
- The upfront prices of new contracts have been broadly stable.[45] However, prices for lower-use customers rose and the main mobile providers were offering fewer low-use one-month tariffs.[46]

---

[41] Including, the Advisory Committee for Scotland, AP Wireless, BT/EE, BBC, Cellnex and Virgin Media O2.

[42] In November 2021, we published a review of the impacts of end of contract notifications and pricing commitments by broadband and mobile providers. This found that engagement among mobile customers had been broadly stable in recent years, but there is some evidence that engagement is now increasing. The proportion of mobile customers who were out-of-contract fell slightly from 27% in 2019 to 25% in 2020, Helping customers get better deals - A review of the impact of end-of-contract notifications and pricing commitments by broadband and mobile providers.

[43] Between 2015 and 2020, the amount of data people used increased over three and a half times (369%), while prices fell by around one fifth (22%) in real terms. Pricing Trends Report 2021, Ofcom, July 2021.

[44] These price rises affect those customers who joined or upgraded to a tariff that had above inflation in-contract price rises in 2022. Pricing trends for communications services in the UK, Ofcom, 01 December 2022.

[45] See Annex 4.

[46] Annex 4.

3.18   As we set out in Section 5, we have recently set out concerns about potential inflation-plus in-contract price rises in April next year,[47] and launched an industry-wide enforcement programme into whether in-contract price rises were set out clearly enough by providers before customers signed up.[48]

3.19   To understand more fully what prices customers are paying and who is most affected by price rises, we need to look at the actual prices paid by customers using customer-level data. We have recently collected such data for 2019–2021 and set out an initial data analysis as a proof of concept at Annex 4. Next year, we plan to publish a fuller analysis of the data gathered. We will also consider the case for collecting customer-level data on a recurring basis.

3.20   **Financially vulnerable customers are more likely to rely on mobile services and to have lower satisfaction in some areas**. People who are on lower incomes or more financially vulnerable can be more likely to rely solely on mobile for their internet access, less likely to be satisfied with their mobile service and more likely to have cause for complaint than other customers.[49] We are working to help ensure that vulnerable customers can get the support they need. Our work on affordability is focused on the support offered by providers, in particular the availability and take-up of social tariffs.[50]

3.21   **Business customers have a choice of provider and their satisfaction with mobile services is high overall.** New research found that around three quarters of small and medium-sized enterprises SMEs (74%) agreed that they had a good choice of provider, and also that the large majority of SMEs (89%) are satisfied with their overall mobile experience. However, the research also found that rural SMEs are more likely to be dissatisfied with mobile reliability than urban SMEs.[51]

---

[47] Providers must think carefully about price rises, Ofcom, September 2022.
[48] Enforcement programme into in-contract price variation terms , Ofcom, 01 December 2022.
[49] Future Approach to Mobile Markets (paragraphs 4.34-4.37), Ofcom, February 2022.
[50] Affordability of communications services, Ofcom, September 2022.
[51] 89% are satisfied with their mobile experience compared to 82% for landlines and 83% for internet services; 12% of rural SMEs are very dissatisfied with mobile reliability or signal strength, compared to 3% of urban SMEs. SME consumer experience in the communications market, Ofcom, October 2022.

4. Future delivery of good outcomes by the market

4.1   In this section, we set out that:

- we expect quality to become increasingly important for customers as they use more mobile data;
- significant investment will be needed to meet customers' future needs;
- we expect competition to continue to play an important role in driving investment overall, though in the medium term, significant technological and market developments may change competitive dynamics, and it is unclear what the impact will be; and
- there may also be potential wider benefits to society from having higher quality mobile networks than the market will deliver, although the evidence on this is currently limited.

We expect quality to become more important for customers, as they use more mobile data

4.2   We expect the quality of mobile services to become more important as customers' dependence on mobile services grows, and as their needs evolve.

4.3   In our Meeting Future Demand for Mobile Data paper, we highlighted that mobile data traffic has grown significantly in recent years, at an average of around 40% year-on-year.[52] We expect people's and businesses' use of data to continue to grow, driven by greater use of existing applications and potential new applications (that may require higher data consumption or lower latency, such as augmented and virtual reality, as well as commercial or industrial applications like machine-to-machine communications).

The future rate of growth of mobile data is uncertain

4.4   However, there is a high degree of uncertainty about how much data customers will use in the future, and therefore about the nature and extent of investment needed to deliver it. This reflects uncertainty over future applications and technology developments, and the extent to which customers will use national mobile networks, private mobile networks and Wi-Fi to meet their connectivity needs.[53]

---

[52] This figure represents the average year-on-year growth from 2017 to 2021. See p.9 of Mobile Networks and Spectrum: Meeting Future Demand for Mobile Data, Ofcom, 2022.
[53] The degree of uncertainty increases over time, particularly beyond 2030. There is also uncertainty about future pricing, such as whether there will be an increase in the price of packages with high or unlimited data allowances, to help manage customer demand.

4.5 In light of this uncertainty, we have considered three different scenarios for growth in mobile traffic up to 2035 (see Figure 4.1). [54]

- **Low growth:** 25% increase per year to 2030, 20% increase per year from 2030–2035.
- **Medium growth:** 40% sustained increase per year to 2035.
- **High growth:** 55% increase per year to 2030, 60% increase per year from 2030–2035.

Figure 4.1: Data traffic growth over time in our low, medium and high scenarios[55]

4.6 A number of stakeholders agreed with our general approach. Some said that the medium growth scenario aligned with their own forecasts and analysis, though others disagreed. [56]

4.7 Since publishing our Meeting Future Demand for Mobile Data paper, some recent evidence indicates that in the last year data growth in the UK fell below the previous year-on-year trend of around 40%. [57] However, traffic growth can be subject to significant fluctuations, [58] and it is too early to assess whether this recent evidence marks a new trend of lower data growth. Therefore, overall, we consider that the above range of scenarios remains appropriate but acknowledge that the growth rates towards the top of our range of scenarios seem less likely in the next few years. [59] We also recognise that these scenarios

---

[54] These scenarios are intended to cover a wide range of possible growth rates to account for the uncertainty in future growth paths. They are not forecasts or predictions.

[55] Note: multiples are relative to 2021 monthly mobile data traffic (571 PB), some figures rounded. 2035 bars shaded to indicate significant uncertainty; Y axis is logarithmic, starting at 500.

[56] Nokia said the medium growth scenario may be an underestimate and Ericsson suggested the high growth scenario may be understated. Conversely, others, including Google, said that the high-growth scenario seems unlikely.

[57] For example, Vodafone reported a 26% increase between Q2 21/22 and Q2 22/23 (see here); Three reported a 24% y-o-y increase in *average data usage per customer* per month in June 2022 (see here, please note that data usage per customer does not necessarily reflect total data traffic); and Virgin Media O2 reported data traffic levels increasing 34% y-o-y (see here). The latest of our quarterly Telecommunications Market Data updates indicates a 24.1% growth in data traffic from Q2 2021 to Q2 2022. However, this dataset differs from the Connected Nations data that we use to develop our scenarios, reflecting differences in the way the data is collected and aggregated and so should not be taken to imply that recent growth is below our low growth scenario.

[58] For example, based on when new data-intensive applications emerge and gain popularity or on changes in existing applications (for example, we previously saw an impact from a shift towards video autoplay features).

[59] In our Meeting Future Demand for Mobile Data paper, we suggested that *"the low growth and high growth scenarios represent what we see as the possible extremes."* We still consider it unlikely that the long-term growth trend will fall below our low growth scenario.

are nationwide averages and encompass a wide range of traffic growth rates across different areas.

Significant investment will be needed to meet customers' future connectivity needs

4.8   Mobile networks will need to evolve to meet future demand and deliver the quality of experience needed by people and businesses. MNOs will need to invest to deploy the **capacity** needed to carry more mobile traffic, as well as in **new technologies**, including 5G standalone (5G SA). 5G SA can offer broader capabilities than existing non-standalone 5G networks, including very high responsiveness (ultra-low latency), advanced virtual network (slicing) functions, [60] and potentially improved coverage. [61] These capabilities, in particular very high responsiveness, may be required to enable certain new applications over mobile, such as advanced Augmented Reality (AR) / Virtual Reality (VR) and robotic applications over mobile networks, (although they can also be delivered by other technologies such as Wi-Fi).

4.9   In addition, MNOs will need to deliver the Shared Rural Network (SRN) and the new regulatory provisions set out by Government to improve network security. They also need to remove High Risk Vendors from their networks and have a joint ambition with Government for 35% of the UK's mobile network traffic to pass through Open Access Network (O-RAN) by 2030. [62]

There are several ways in which MNOs could meet growing demand for data

4.10   There are several ways in which MNOs could provide additional capacity over the next ten years, including:

- **more extensive deployment of existing spectrum holdings, and making use of planned spectrum releases**, for example MNOs are already adding 3.4 – 3.8 GHz spectrum to sites;
- **investment in technology upgrades to increase the amount of data that can be carried over a given amount of spectrum** (spectral efficiency), for example by migrating from earlier generations of mobile technology to newer ones (e.g. from 2G or 3G to 4G and 5G) or by moving to more advanced antenna systems such as Multiple Input Multiple Output (MIMO) [63] with a larger number of transmit/receive elements; and

---

[60] Network slicing is a feature of 5G SA networks. It allows an MNO to create multiple virtual networks (slices) on top of its common shared physical infrastructure. The virtual networks are then customised to operate with specific quality of service and meet the specific needs of applications, services, devices, customers or operators.

[61] Connectivity is often limited by uplink power from the mobile device to the base station. 5G SA may be able to provide greater coverage as the mobile device does not need to share uplink power between both 5G and 4G carriers as it does in 5G NSA.

[62] New Open RAN Principles published to build stronger telecoms supply chain, DCMS, 2022 [last accessed 30/11/2022]

[63] Multiple Input Multiple Output (MIMO) helps to improve capacity, speeds and reliability by exploiting the multiple signal paths between the base station and user.

- **increasing the number of sites in areas where additional capacity is needed (network densification).** This could be through both macro densification and through the deployment of small cells, [64] including the use of mmWave given the large bandwidths available. This may have some added benefits in facilitating ultra-low latency applications when combined with edge computing.

4.11   The suitability of these options will vary depending on the specific circumstances, including, for example, the level, location and distribution of demand in a given area; the extent to which existing spectrum is being used on a site; [65] and the generation of mobile technology. Solutions that deliver capacity outdoors may differ from those needed to address demand indoors, but they may be complementary. [66] In some circumstances alternative solutions that manage demand rather than increasing mobile capacity, for example seeking to offload demand onto other technologies such as Wi-Fi, may be more appropriate.

Densification is likely to be important to meet growing demand for data, whether additional mid-band spectrum is made available or not

4.12   Based on our growth scenarios, whilst additional mid band spectrum could delay or reduce the need for densification, our analysis suggests that network densification is likely to be needed in most cases to support a sustained growth in mobile data demand. [67] In particular, if traffic grows faster than our medium growth scenario, additional mid-band spectrum may not significantly reduce the need for densification. We discuss our spectrum pipeline and potential for new spectrum bands over and above the pipeline in Section 5.

4.13   Stakeholders seemed to broadly agree with our analysis of small cell numbers required to meet the demand profile of our medium growth scenario. [68] However, the MNOs said that small cells are disproportionately more costly than macro sites. BT flagged that small cells are an expensive capacity solution due to the large numbers of cells required relative to a macro, and Three noted that the opex costs associated with small cells are far higher than macros sites covering the same area. [69]

---

[64] Small cells are low power base stations with a limited range. Macro cells are higher power base stations that provide a greater coverage area. Although in practice, MNOs deploy a range of base station sizes and power. In some locations, deploying further macro cells may be difficult due to potential interference from other nearby sites.

[65] Though it may not always be possible to deploy all available spectrum, due to factors such as the size and weight of the active equipment, whether the site is shared, and the type of passive infrastructure used.

[66] For example, densifying and using higher frequencies to increase outdoor capacity may free up capacity in lower frequency bands, allowing macros to better enable indoor coverage 'outdoor-in'. On the other hand, indoor solutions can use more bands and might be more efficient.

[67] Our analysis suggest densification would be required in dense areas and increasingly in less busy ones, between 2025 and 2030 in our medium growth scenario. A high growth scenario would require densification earlier and across a wider range of areas. However, in a low growth scenario, only a relatively modest number of small cells might be required up to 2035.

[68] Stakeholders did not argue the number of small cells required would be significantly more than our estimates that each MNO may need several thousand small cells in busy areas by 2030 with the number needed across the whole country potentially reaching 30 to 50 thousand by 2035 if traffic grows in line with our medium growth scenario. We also received some confidential analysis of potential small cell requirements, which we have considered as part of our analysis.

[69] Several stakeholders suggested that the current state of the UK mobile market limits the ability for MNOs to invest in their networks, meaning widespread densification may not be feasible.

4.14   We recognise that the number of small cells deployed by UK MNOs is currently less than those deployed by MNOs in a number of other countries, such as the US and South Korea, as UK MNOs have to date delivered capacity in other ways. However, UK MNOs are increasing their small cell deployments. For example, in March 2022, EE reported the deployment of 200 new small cells in high demand areas with plans for hundreds more over the next 18 months.[70] Similarly, in June, Virgin Media O2 reported the deployment of over 1,300 small cells across London.[71]

There are practical barriers that may pose challenges to densification, but we expect these to reduce over time

4.15   The MNOs also identified practical barriers to densification on this scale. These barriers, which are discussed in Annex 2, included site access, identifying and accessing fibre, and the potential for greater power consumption.

4.16   Whilst these practical barriers are unlikely to fully disappear, we expect many of them to reduce over time. Factors that we expect to reduce barriers include Government initiatives as part of DCMS' Digital Connectivity Infrastructure Accelerator (DCIA),[72] the continued roll-out of fibre, and a maturing small cell equipment ecosystem. In addition, the future data growth rates will affect the level of densification needed[73] and the continued emergence of 'neutral host' models and additional sharing may further mitigate some of these barriers. Neutral host models are discussed in Annex 3.

We expect competition to continue to play a key role in driving investment overall

4.17   Mobile markets have delivered good outcomes to date, with competition among MNOs playing a key role in driving investment, providing capacity and quality, value for money, and choice to meet different customers' needs.[74] Given the need for significant ongoing investment, as well as the potential for substantial change across mobile markets, we have considered whether competition in mobile markets is still likely to deliver good outcomes for customers over the next five to ten years.

---

[70] EE boosts coverage in major towns and cities through new small cell deployments, 07 March 2022 [Accessed 11/10/22].
[71] These deployments have been developed in partnership with a number of neutral hosts and infrastructure providers, including Cellnex UK, Freshwave and Ontix; Virgin Media O2 accelerates industry's largest rollout of small cells to deliver cleaner, greener and more flexible 5G network solutions, 30 June 22 [Accessed 11/10/22].
[72] Digital Connectivity Infrastructure Accelerator programme, Guidance, DCMS, 23 June 2022.
[73] Our analysis suggested that in the low growth scenario, making more efficient use of existing spectrum along with technology upgrades could be sufficient to satisfy demand, until at least 2035.
[74] We have also noted the important role that public policy interventions have played, for example in extending 4G coverage beyond what the market will deliver.

MNOs have incentives to continue to invest, driven by competition among them

4.18   MNOs have started to deploy 5G to provide increased capacity as well as for potential new services, predominantly in areas of high demand. However, MNOs have said that the case for deploying 5G is challenging, with considerable uncertainty over the extent to which they can make a return on their investment. In particular, the MNOs have said that:

- the prospect of monetising 5G mobile services by charging consumers higher prices for 5G compared to 4G is limited, at least for the time being. The strength of the business case therefore relies on the demand for new types of uses enabled by 5G SA, but these new uses are either still under development or not yet proven.[75] MNOs have suggested that this risks lower investment and lower quality networks being deployed, which will not offer the full features of 5G; and

- the investment needed to deliver 5G SA is greater than for previous generations. In particular, MNOs have said 5G SA will require a greater level of capex, which may make scale more important. Some MNOs consider that this may weaken the business case for investment by smaller operators.

4.19   We recognise that MNOs may currently have limited scope to charge a premium for use of 5G technology, since in the absence of 5G SA, 5G delivers a similar service to 4G. As such, this may lower the incentives to invest compared to the case where customers are prepared to pay a premium for 5G.[76, 77] Nevertheless, we still consider that competition provides commercial incentives for MNOs to continue to invest in improving their networks, for two main reasons.

- First, as we set out above, investment will allow MNOs to respond to increases in demand for data by increasing capacity to reduce congestion on their networks.[78] This should reduce the likelihood of their customers switching to rivals (as a result of poor quality) and potentially increase their ability to attract customers from their rivals. We would expect MNOs to set prices in a way that recovers the costs of such additional investments.

- Second, while there is currently uncertainty about future demand for new uses enabled by 5G SA, (including uncertainty over how much of that demand MNOs will capture), this uncertainty is likely to reduce over time. We expect some MNOs to start to launch 5G SA shortly. As well as providing additional capacity where 5G is not

---

[75] Some MNOs referred to the impact of competition from private network providers on the business case for 5G investment. This is discussed in Annex 3.

[76] We do not consider that this represents a market failure since well-functioning firms are driven to invest to meet customer needs. As such, the strength of investment incentives is expected to vary according to the strength of customer demands (as evidenced by their willingness to pay).

[77] We note that, in our review of the Net Neutrality framework, we have proposed to issue updated guidance that would allow providers to offer premium services with higher quality. Consultation: Net neutrality review, Ofcom, 21 October 2022.

[78] Some stakeholders, including Three, suggested that rather than invest, MNOs would choose to let the network congest. However, we do not consider that it would be sustainable for MNOs to let significant congestion persist on their network in a competitive market.

deployed today, 5G SA will provide a testbed for new applications to emerge. As evidence of demand emerges, this will inform the need for, and benefit from, further investment and reduce uncertainty for MNOs.

4.20   In addition, while we recognise that economies of scale [79] are a feature of mobile networks which incentivises MNOs to acquire more customers to increase scale and lower average costs, it is currently unclear whether economies of scale will become more or less important in the future. For example, we have not yet seen evidence that the importance of economies of scale is changing as part of 5G deployments. [80] We observe that 5G is currently being used to deliver additional capacity by adding more equipment and deploying more spectrum to existing sites, increasing variable rather than fixed costs. [81]

Recent industry performance suggests that there is scope for MNOs to earn positive returns from future investment

4.21   MNOs have said that their financial performance over recent years is not supportive of investment.

4.22   Investment decisions will primarily be based on expected future returns. [82] Those decisions are likely to be informed by a range of evidence including the economic outlook, cost of capital, relative strength of competition, and anticipated changes across the value chain. [83]

4.23   However, historical performance can also play a role in those decisions and give an indication of how well existing investments have performed to date, which is a useful reference point. It can be used as a sense check of future expected performance and impacts the cash available for investment.

4.24   Measuring the UK mobile sector's historical performance is not straightforward, in part because of data limitations. [84] Nonetheless, we have looked at economic returns [85] to understand whether market dynamics enable MNOs to earn sufficient returns to continue investing (i.e. to earn returns above the cost of capital).

4.25   MNOs did not agree with our focus on economic returns.

---

[79] Whereby high fixed costs mean that average costs fall as output/scale increases.

[80] Vodafone submitted a report by Frontier Economics on the importance of scale in the 5G era. This suggested that factors on both the cost and demand side mean that the minimum viable scale for operators to deploy a fully-fledged 5G network nationwide – 'Full 5G' in their terminology – will increase compared to previous technology generations. However, our view is that it is not yet clear what the socially optimal level of 5G roll-out will be. In addition, the report does not demonstrate that scale becoming more important is the only plausible outcome, and instead there are factors that could reduce the importance of minimum viable scale.

[81] As demand grows, if this results in a higher proportion of total costs being variable, the importance of scale could reduce.

[82] For example, using forward looking measures such as expected Net Present Value (NPV) or expected Internal Rate of Return.

[83] Cashflow considerations will also affect whether positive NPV projects will be undertaken in practice. For instance, in public companies, a transparent, stable dividend policy and maintaining an investment grade credit rating can be an important factor for investors, so competing demands on cash may constrain the ability of providers to make investments even when there is a positive business case to do so.

[84] See paragraph 6.13 of Future Approach to Mobile Markets, Ofcom, 9 February 2022.

[85] Economic returns reflect the opportunity cost of assets today rather than what was spent historically.

- They did not agree that goodwill should be excluded from capital employed, because it can represent a revenue generating asset which a company may have needed to acquire. As such, they considered that further analysis should be undertaken to assess whether goodwill is consistent with the true economic value of assets at the time of acquisition. Otherwise, they believed that there is a risk of systematically overestimating economic returns.
- They said that if current replacement values are used for spectrum (instead of historical values), this approach should be applied to all assets on the balance sheet.

4.26   The aim of our analysis is to give a broad picture of MNOs' financial performance. We have not undertaken the extensive exercise of estimating the economic value of goodwill at the time of acquisition to adjust our estimates of economic returns. Instead, we have continued to exclude all goodwill from our estimates in line with our approach in the Future Approach to Mobile Markets paper.[86, 87] Similarly, while we have revalued spectrum holdings to their current replacement values, we have not undertaken the extensive exercise of revaluing all other assets to their current replacement values, given that it is unlikely to alter our results materially.[88]

4.27   We have, however, updated the analysis to include information for 2021, and to correct for a minor error.[89] Given that use of spectrum by 5G technology has now generated revenue, we have also included spectrum used by 5G technology in the asset base.[90]

4.28   We find that average industry returns (on an economic basis) have been above the cost of capital over the last three years (see Figure 4.2).[91] This indicates that firms in the industry can, on average, cover their costs and earn a sustainable rate of return.

4.29   However, financial returns vary across MNOs. Specifically, the two smaller MNOs (Three and Vodafone) earned returns below the cost of capital between 2019 and 2021 and Three's return on capital employed (ROCE) has been declining over this time period. This contrasts with the two larger MNOs that have earned returns above the cost of capital.[92]

---

[86] Goodwill is not a separately identifiable asset but is a balancing figure between the purchase price and the fair value of the assets. To understand whether market dynamics allow operators to earn sufficient returns, it is therefore generally appropriate to exclude it from the calculation of the capital employed. This approach avoids the risk of capitalising the value of any excess profits that the business is able to generate, which may be reflected in the purchase price and hence the purchased goodwill.

[87] This is consistent with the CMA's approach to calculating historical profitability, as part of market studies or investigations. For example, the asset valuation principles are discussed in the CMA's 2016 energy market investigation (Appendix 9.10), paragraphs 13-19.

[88] Three of the four MNOs (EE, O2 and Three) say they review the estimated useful life of fixed assets annually and adjust residual values accordingly. For Vodafone, given the bulk of its assets relate to network infrastructure and asset lives vary between 5-40 years it is unlikely that a revaluation of these assets will result in a substantially different value from their book value for the bulk of these assets. For example, if network infrastructure had a useful life of 30 years but this was reassessed to 40 years, the value of the asset wouldn't change significantly.
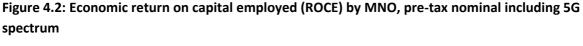
[89] BT/EE identified that £202m of 4G spectrum had been eliminated from the asset base when calculating accounting ROCE for EE. This impacted Ofcom's estimate of accounting ROCE but did not impact Ofcom's estimate of economic ROCE in the Future Approach to Mobile Markets paper.
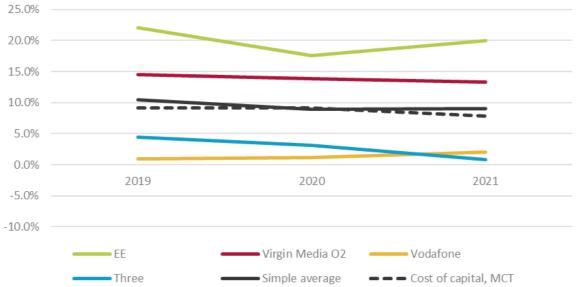
[90] Given 5G spectrum has only been utilised over the past few years, we present our ROCE analysis including 5G for the period 2019-2021.

[91] Our calculations are published alongside this document.

[92] Although we do note that O2's ROCE has fallen slightly over the period.

4.30   We will not have financial results for 2022 until 2023, but note that some MNOs implemented above inflation in-contract price increases in 2022.[93] However, given costs have also increased due to rising inflation the impact on ROCE for 2022 is currently uncertain.

Figure 4.2: Economic return on capital employed (ROCE) by MNO, pre-tax nominal including 5G spectrum

Source: Ofcom calculations based on publicly available information from financial statements[94] and Ofcom Annual Licence Fee (ALF) decisions. The cost of capital (pre-tax nominal) comes from Ofcom's charge control decisions for mobile call termination (MCT) over the relevant period.[95]

4.31   MNOs have said that we should not draw conclusions about incentives to invest based on average industry returns, because of the weaker financial performance of two MNOs.

4.32   We consider that some variation in financial returns is to be expected in a market where there are significant economies of scale and competitors of different sizes, and where those competitors have different strategies. Our estimate of average industry returns being above the cost of capital suggests that there is scope for the smaller MNOs to improve their financial performance and earn returns above the cost of capital through continuing to compete (and invest).

4.33   That said, we recognise that this is uncertain and that alternative scenarios exist where, despite continuing to compete (and invest), an MNO may be unable to increase revenues and/or lower costs to earn returns above the cost of capital. If an MNO's financial returns

---

[93] More information on pricing is contained in Annex 4 Pricing.

[94] For the period 2019-2020, financial statements for EE Limited, Vodafone Limited, Hutchison 3G UK Limited and O2 Holdings Limited. In 2021, O2 Holdings Limited did not produce group consolidated financial statements therefore Telefonica UK Limited was used instead.

[95] The pre-tax nominal figure of 7.8% is our most up to date view of the cost of capital as of 30 March 2021, but we recognise macroeconomic conditions have changed materially since that assessment (e.g. higher interest rates, higher inflation), and that future returns may need to be assessed against a different cost of capital.

were below the cost of capital for a sustained period of time, this could reduce its incentives to invest. We return to this risk below, at paragraphs 4.46 - 4.48.

MNOs are investing significantly and have plans to continue to do so over the next few years

4.34   While MNOs have said that their financial performance in recent years has not been supportive of investment, they have all undertaken significant investment over the same period, in particular to provide additional capacity. Between 2017 and 2021, they invested a total of £2.7bn a year on average (see Figure 4.3).
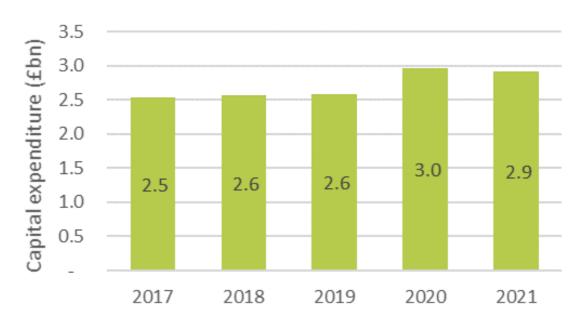
Figure 4.3: Capital expenditure excluding spectrum across all MNOs 2017-21[96]

Source: Company financial statements from Companies House (Vodafone Limited, Telefonica UK Limited, EE Limited and Hutchison 3G UK Limited).

4.35   MNOs' confidential business plans also suggest they will be undertaking further significant investment to improve their networks over the next few years, including:[97]

- to continue the deployment of 5G: While MNOs have initially been deploying 5G in high traffic urban areas (on a non-standalone basis),[98] they plan to expand their deployment of 5G in the coming years.; and

---

[96] Data includes non-network specific capital expenditure (e.g. IT systems/software upgrades, property/facilities and customer focussed capital expenditure). In our Connected Nations 2021 UK Report, we provided network capex information for 2019 and 2020 (this excluded non-network specific capital expenditure). Capital expenditure includes an element of fixed network capital expenditure (from EE and Vodafone).

[97] Since the publication of our Future Approach to Mobile Markets paper, we have gathered updates (where available) to business plans using our formal information gathering powers.

[98] This involves deploying 5G RAN alongside the existing 4G RAN and 4G core. This investment delivers improvements to the network, in particular an increase in capacity, which supports the current uses of mobile services such as video streaming, gaming and general web browsing.

- to upgrade to 5G SA, in at least parts of the network, with some MNOs looking to launch 5G SA shortly. 5G SA (alongside other technologies) can enable new use cases that require the fastest speeds, highest capacity, and very high responsiveness.

4.36 MNOs have cautioned that their business plans could be revised and should not be relied upon as evidence that there will be ongoing significant investment in mobile networks. For example, they have said that where overall profit levels fall (or fall below expectations), this will directly impact the budget available for investment and business plans. [99]

4.37 We would expect MNOs to adjust investment plans in response to changing expectations about the future and the strength of customer demand. We note that the economic climate has become more uncertain and that this could impact the business case for future investments and result in a slowing down of network improvements. [100]

The level of service available across the country may vary

4.38 Some MNOs have indicated that there is a risk of a gap emerging between the 5G networks that are deployed and those needed to deliver the full benefits of 5G across the UK. For example, Vodafone suggests the need to have 95% geographic coverage, using mid-band spectrum across more sites, with increased backhaul capacity, low latency and edge computing to unlock the full benefits of 5G. [101]

4.39 As the regulator, our focus is on promoting competitive markets, for example, to drive investment to meet customers' future needs, and on identifying significant market failures, (including where there is social value from further investment) rather than determining the level and nature of deployment (including of 5G) that should be delivered in the UK.

4.40 We recognise that MNOs' commercial incentives to deploy 5G (including 5G SA) differ across the country, which will affect the timing of when 5G services become available at different locations. Furthermore, even as 5G SA becomes available, MNOs may not have commercial incentives to deploy this using mid and high frequency spectrum at all locations. In low demand areas, such as rural locations, services will largely rely upon low frequency spectrum as deployment of higher frequencies would not be cost effective or deliver the full benefits of 5G SA to many of the customers in those areas without significant densification. [102]

---

[99] Some MNOs have said that business plans are typically based on a set of positive assumptions, but these should not be taken for granted and can plausibly be adjusted as part of annual reviews. We acknowledge that business plans will be based on a set of assumptions and that changes to those assumptions could mean investment plans are scaled back. However, the business plan information we have gathered has been approved at Board level and therefore provides a good indication of the likely scale of investment at least over the next few years. Moreover, while there have been some changes to business plans since we published our Future Approach to Mobile Markets paper, based on updated information, the overall direction of those plans is of significant investment continuing over the next few years.

[100] This could for example reflect greater uncertainty over whether MNOs will be able to monetise their investment.

[101] See Vodafone response to Future Approach to Mobile Markets paper, p.20.

[102] There is more high frequency spectrum so it can support higher speeds and provide higher capacity than lower frequency spectrum. However, it doesn't propagate as far leading to smaller cell sizes. As we set out in paragraph 4.10, the mix of spectrum and densification varies depending on the type of location. However, where a particular new use requires the high peak data rates that can only be achieved with high frequency spectrum, this will be more difficult and more costly to achieve in areas of lower density where cell sizes are typically larger.

4.41   There may therefore be some geographical variation in customer experience, (though we note that in areas where less mid band spectrum is deployed, we would also expect there to be less demand, and consequently the capacity available to individual users may not be dissimilar). We expect customers in low demand areas to experience improvements in performance, however there are scenarios in which some areas may not experience the very high speeds that mid and high frequency spectrum bands are capable of. Later in this section we discuss whether there might be wider benefits to society from having mobile networks of higher quality than the market will deliver.

In the medium term, technological and market developments may change competitive dynamics, and it is unclear what the impact will be

4.42   As outlined in our Future Approach to Mobile Markets paper, we expect to see a range of changes across the mobile value chain over the next five to ten years, (see Figure 4.4). Many of these will be facilitated by technological developments, such as deployment of 5G SA, network virtualisation and use of cloud infrastructure,[103] deployment of privacy enhancing technologies,[104] further development of Open RAN,[105] and eSIMs.[106]

4.43   We expect the supply chain to become more complex, with a range of participants likely to play a greater role. This includes the potential for:

- hyperscalers to increase their role in providing cloud infrastructure in core mobile networks;
- tower companies and neutral hosts to play a growing role;
- smaller vendors to provide Open RAN equipment;
- a range of players to provide private networks, including equipment vendors, system integrators, hyperscalers, and other businesses with strong IT and networking capabilities; and
- Apple and Google to provide a platform on which customers can choose a mobile provider.

4.44   In Annex 3, we discuss further market developments that stakeholders particularly commented on in response to our Future Approach to Mobile Markets paper.

---

[103] The use of software applications that deliver network functions that were traditionally carried out by proprietary, dedicated hardware, and the use of cloud infrastructure in place of traditional core mobile infrastructure.
[104] A suite of technical measures designed to give online users the benefit of additional privacy protection by enhancing the encryption of web traffic.
[105] Initiative to build RAN products based on an open architecture and on disaggregating hardware from software by using commercial off-the-shelf hardware and software-defined technologies.
[106] An embedded-SIM, is a form of programmable SIM that is embedded directly into a device, thereby removing the need for a physical SIM card in the device.
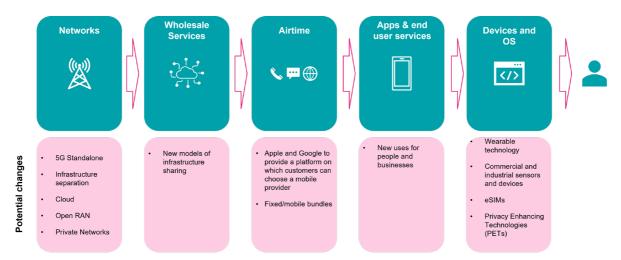
Figure 4.4: Summary of the mobile value chain and potential changes

Networks	Wholesale Services	Airtime	Apps & end user services	Devices and OS

Potential changes

- Networks:
  - 5G Standalone
  - Infrastructure separation
  - Cloud
  - Open RAN
  - Private Networks

- Wholesale Services:
  - New models of infrastructure sharing

- Airtime:
  - Apple and Google to provide a platform on which customers can choose a mobile provider
  - Fixed/mobile bundles

- Apps & end user services:
  - New uses for people and businesses

- Devices and OS:
  - Wearable technology
  - Commercial and industrial sensors and devices
  - eSIMs
  - Privacy Enhancing Technologies (PETs)

4.45 Overall, it is uncertain how these changes will affect competitive dynamics in mobile markets. We explore this uncertainty further below.

Competition among MNOs may evolve

4.46 There is uncertainty about how competition among MNOs will evolve. We may see strong competition continue and, as part of this, the two smaller MNOs could improve their financial performance and sustain ongoing investment. MNO returns could be buoyed by the new opportunities created by the deployment of 5G SA, with scope to charge higher prices to customers for different or new services.

4.47 However, there is also a risk that competition among MNOs weakens. This could happen if one or more of the smaller MNOs become weaker competitors, and are less able to exert a strong price constraint on other operators. A weakened MNO may also be less able, or have less incentive, to invest as fully in its network than a larger, stronger player. If so, it may opt to scale back investment to reduce its costs, which could affect its future quality of service and potentially its ability to retain or gain market share. In turn, this may weaken the incentives of rival operators to invest in improving their networks, leading to weaker competition and poorer outcomes for customers.

4.48 Another scenario is that, over time, customers could become less engaged. For example, where customers perceive that choosing a service and provider is complex, they may find it difficult to engage effectively. This could make it difficult for MNOs to compete for market share, making it less important to maintain a high quality network to attract and retain customers. This may weaken incentives for MNOs to compete, including by investing further in their networks. In Section 3 we set out customers making informed choices about service and provider as one of the important elements of a well-functioning market.

There is uncertainty about the impact that a wider range of players may have on competition

4.49   There is also uncertainty over the impact that other players might have on competitive dynamics in mobile markets. [107] To illustrate this we set out some potential scenarios below.

4.50   **Hyperscalers may begin to provide cloud services as part of mobile network infrastructure.** The hyperscalers are the three largest providers of public cloud infrastructure globally and as a result may benefit from significant economies of scale and scope in the provision of cloud services. [108] As the public cloud sector matures, MNOs may move some or all of their network functions to the public cloud and, when doing so, they may choose to use hyperscalers' services.

4.51   A greater role for hyperscalers here could bring benefits, such as lower network costs and access to better technologies and innovations, which could lower MNOs' costs – the savings from which could be passed on to customers. However, if hyperscalers were able to develop a strong position in the provision of cloud to MNOs, competition problems could result.

4.52   In October, we launched a market study to assess whether the market for cloud services in the UK is working well for consumers and businesses, both now and in the future. While not specifically focused on the provision of cloud to MNOs or other communications providers, this study will explore how competition is working within the market for public cloud infrastructure services more generally, and how that competition might evolve in the future. [109] Any issues for communications providers would stem at least in part from competition in public cloud infrastructure.

4.53   **Apple and Google could provide a platform on which customers buy mobile services**. The rollout of eSIMs may enable Apple and Google to embed the ability for customers to select (and switch) mobile provider into their mobile operating systems, on a choice screen or app (see Annex 3). [110] This could bring benefits for customers by, for example, making it easier for them to switch provider and by using the customer data they collect on prices and quality to help customers make more informed choices. [111]

4.54   However, given the strong loyalty to iOS and Android it is also possible that Apple and Google would not face sufficient competitive constraints, which could allow them to

---

[107] For example, the potential for the evolution of the value chain and the expanded role for Big Tech leading to good outcomes is recognised by TechUK who suggest that innovation across the entire telecom's ecosystem is a key driver of good outcomes for mobile customers. See TechUK response to the Future Approach to Mobile Markets paper.
[108] Our definition of hyperscalers include the three largest cloud providers: Amazon (via its subsidiary AWS), Google and Microsoft, though broader definitions could include a wider set of firms.
[109] Absent a market investigation reference, we will be required to report publicly with our findings within 12 months of our launch i.e., by October 2023. See, Cloud services market study, Call for inputs , Ofcom, 6 October 2022.
[110] Similarly, the way in which third party apps for choosing mobile operator - which in this scenario would compete with Apple and Google – are allowed, presented, or constrained in their operational performance will have an impact on the charges that Apple and Google would be able to levy on MNOs for inclusion on a choice screen.
[111] For example, customer data collected by the customer's device could allow Apple or Google to make network recommendations based on their habits, or where they use their device.

charge mobile providers elevated commissions for prominence on their choice screen/app.[112] If so, these commission costs would be likely to be passed, at least in part, onto consumers in the form of higher prices. These commercial arrangements and the prominence of particular providers or tariffs could also make it difficult for consumers to make informed choices.

4.55 **Independent infrastructure providers could become more important in the provision of infrastructure for mobile networks.** Independent infrastructure providers (tower companies or neutral hosts) can support network deployment, for example by reducing the MNOs' network capex or providing infrastructure where it is too complex for MNOs to deploy themselves.[113] However, there are possible risks of bottlenecks developing upstream, for example, if a tower company or neutral host provider were to gain market power as a result of controlling a key site, or series of sites.[114]

4.56 **Privacy enhancing technologies could become more widely adopted**. Privacy enhancing technologies (PETs) are a suite of technical measures designed to give online users the benefit of additional privacy protection by enhancing the encryption of web traffic. Various PETs have started to be introduced by Big Tech companies over the past 12 to 18 months,[115] including Apple's iCloud Private Relay (APR).[116] APR was launched on a 'default-off' basis,[117] so take-up is limited at this stage. However, if PETs were to become the default option and widely used, MNOs might not receive sufficient traffic information to optimise their networks. This could lead to inefficiencies, additional costs, and a lowering of network quality, and competition concerns could arise in the future.

There may also be potential wider benefits to society from having mobile networks of higher quality than the market will deliver

4.57 We expect the market to continue to deliver improved network quality where providers can monetise their investment. However, the quality of experience provided is likely to vary. Some areas may have a patchy quality of experience that makes it difficult to use applications requiring a consistent high quality of service. In addition, there are scenarios where some lower demand areas of the country may not experience the very high speeds that mid and high bands are capable of (as set out above).

4.58 Some stakeholders have suggested that there could be broader social value from investment beyond what is delivered commercially. They have put forward examples of new uses that would rely on the very high speeds and responsiveness enabled by 5G SA,

---

[112] Providers may have to pay these elevated commissions or risk losing market share.
[113] For example, Virgin Media O2 notes that the neutral host model has the potential to support provision of mobile connectivity in areas where it would otherwise be too costly or complex for multiple networks to be deployed, Virgin Media O2 response to Future approach to mobile markets paper p.21.
[114] We discuss this further at Annex 3.
[115] Companies such as Microsoft, Cloudflare, Mozilla and Google are among this group.
[116] About iCloud Private Relay – Apple Support (UK)
[117] This means that users need to proactively turn on the service for it to work.

and which they consider would bring wider benefits to society. [118] Some have also suggested that if those new uses are not widely available, then the deployment of 5G might lead to a widening of the digital divide. [119]

4.59 Many of the examples put forward by stakeholders were based on applications that have yet to be launched. Therefore, it is too early to judge the demand for these, and the broader social value that they might bring. Moreover, where there is evidence of demand (i.e. willingness to pay) we would expect commercial investment to meet this demand as part of a well-functioning market.

4.60 Nevertheless, there may be cases where there is broader social value from investing in mobile networks beyond what is delivered commercially. We consider that three criteria should be used to assess the scope for wider benefits from investing in mobile networks (and 5G): that the benefits should be external, [120] significant, and reliant on mobile connectivity. [121] We have used these criteria to consider a range of potential uses of 5G SA. [122] In light of this, we consider there are two main types of wider benefits that could arise in the future.

- **Positive externalities** from environmental benefits linked to transport activities and consumption of energy or natural resources. For example, some applications of 5G might reduce car travel and/or congestion leading to less fuel consumption and lower greenhouse gas emissions. [123, 124]

- **Wider social benefits** which improve the overall well-being of society such as greater social inclusion, improved health, and public safety outcomes. Social inclusion is typically considered a desirable policy outcome and reflects the importance of individuals feeling connected, valued, and able to fully participate within society. An example might be 5G supporting outdoor use of AR/VR enabling people that are neurodiverse, less mobile or elderly to join an activity remotely, thereby enabling social

---

[118] For example, Tech UK, Vodafone and BT/EE referred to the wider benefits of 5G networks. BT/EE's and Tech UK's responses cited road safety and efficiency enabled by 5G – including services providing information to drivers about imminent dangers such as red-light violations, hazard, collision, and traffic jam warnings, as a potential positive externality. Tech UK also offered as an example greater healthcare consumption enabled by 5G – including through medical device tracking, emergency communications, remote healthcare for diagnosis and treatment, and remote surgery. In addition, as a social inclusion benefit, Vodafone cited greater enabling of the use of haptic technology in diagnostics, as well as allowing those with visual impairments to use touch simulation when communicating remote.

[119] For example, the Institute of Engineering and Technology (IET) told us that there is likely to be a "a failure of competition to address the potential 5G digital divide" in which those in low demand areas potentially not experiencing the same very high speeds and responsiveness as in high demand areas. The Scottish Government urged Ofcom to "consider prioritising the need for a minimum level of connectivity throughout the UK if we are to avoid widening the digital divide".

[120] An externality is a cost or benefit that accrues to a third party that is not reflected in the price.

[121] See Box 6.5 of the Future Approach to Mobile Markets paper, Ofcom, 9 February 2022.

[122] Separately, the Government has noted that digital infrastructure will be important for unlocking new opportunities for growth and is considering more broadly its vision for how wireless infrastructure can make a significant contribution to the Government's growth and levelling up agendas. Wireless Infrastructure Strategy: call for evidence, DCMS, 2021.

[123] However, it is worth noting that if 5G increases output or productivity, this could increase overall energy consumption.

[124] For example, connected and autonomous vehicles (CAVs) could bring wider environmental and safety benefits. However, this is not clear cut as many CAV uses may not need 5G, and other technologies could be used as an alternative in some cases. There is also uncertainty over how CAVs will evolve and the technology underpinning autonomous cars is not yet mature.

inclusion. Wider rollout of higher quality connectivity may also support a wider range of social and business activities in lower demand areas, bringing them closer to those in higher demand areas, which should contribute to communities in those lower demand areas being more sustainable.

4.61   At this early stage of 5G deployment, it is difficult to assess whether the potential wider benefits would be significant. This is particularly because 5G SA, and the new uses it will enable, are not yet available. However, as these become available and as uncertainty over future uses reduces, evidence on this should come to light. This is something we will keep under review.

5. Future approach to mobile markets and spectrum

5.1   In this section we set out our future approach to mobile markets and spectrum.

- We will actively monitor how mobile markets evolve.
- We will continue to develop a richer understanding of network quality to inform policy and customers.
- We are clarifying aspects of our future regulation and our plans around spectrum for mobile networks.

We will actively monitor how mobile markets evolve

We will step up our work to understand the impact of technological and market developments on competition and the outcomes being delivered

5.2   We continue to see competition in a well-functioning market driving good outcomes in mobile markets.

5.3   We have set out that there is a range of technological and market developments taking place. These developments could bring benefits, increasing innovation and efficiency. However, under certain circumstances, they could raise potential risks to the delivery of good outcomes in the medium term.

5.4   In light of this uncertainty, we will step up our work to monitor mobile markets to ensure we:

- continue to have an up-to-date understanding of how markets are functioning as they evolve, and of important future changes;[125] and
- actively monitor the outcomes that are being delivered and the potential risks we have identified, such as those set out in Section 4.

5.5   This increased emphasis on understanding and actively monitoring mobile markets will help ensure we can continue to quickly identify and act on problems that arise as mobile markets become more complex.

5.6   We are already taking steps to better understand digital markets, including potential bottlenecks across the wider ecosystem, for example, in relation to cloud,[126] and will also continue work closely with other regulators to support competition across the wider digital regulatory landscape, in line with our Digital Markets Strategy.[127]

---

[125] Through, for example, Ofcom's work on horizon scanning.
[126] Cloud services market study, Call for inputs, Ofcom, 6 October 2022.
[127] Digital markets in the communications sector, Ofcom's approach to competition and consumer issues in internet-based communications markets, Ofcom, 22 September 2022.

5.7   In addition, the customer-level pricing data we recently collected from the main mobile providers is giving us a much richer understanding of the choices customers make and the prices they pay (see Annex 4). We plan to carry out and publish further analysis in 2023 based on the customer-level pricing data we recently collected. To effectively monitor outcomes in the mobile market, we will also consider the case for collecting customer-level data on a recurring basis.

We will continue to monitor mobile data traffic growth as an input to future spectrum decisions

5.8   Future MNO spectrum needs will depend on several factors, including the growth rate of data traffic. The cost of meeting demand without additional spectrum beyond the current pipeline will depend on actual data demand growth; for example in February, we set our scenarios for traffic growth and considered the implications for the number of sites needed. In our medium growth scenario, tens of thousands of small cells per operator may be required by 2035, and would be more challenging than a few thousand under our low growth scenario. Data demand growth will depend on a range of factors such as future use cases and the extent to which alternative connectivity technologies, like Wi-Fi, are used. In addition, technological developments will influence how networks can evolve and the spectral efficiency that can be achieved to meet this demand.

5.9   We will continue to monitor data demand and the way in which networks evolve to satisfy it. However, MNO spectrum needs are not the only consideration – we will continue to consider the needs of alternative users and technologies and the potential impact on incumbents, in addition to any other evidence as it emerges before any decision on making additional spectrum available for mobile.

We will publish better information on network quality to inform consumer decisions as well as Ofcom policy

5.10   There is currently limited information that customers can use to assess which is the best network to be on. This may lead to customers making decisions that do not best meet their needs.

5.11   Measuring and reporting on network quality is complex. Tools, such as our own mobile checker[128] and those provided by operators, rely on MNOs' modelled predictions of mobile signal strength. These give customers a generally accurate view at an aggregate level of whether a mobile signal can be received at a given location. But the underlying predictions cannot fully account for local factors that affect signal strength such as terrain and buildings, nor do they provide insight into how particular types of mobile service will perform.

---

[128] View mobile availability - Ofcom Checker

5.12   We think that it is important that customers are sufficiently informed about the likely quality of services available in different places, so they can make informed choices about services and providers. These informed choices play an important role in driving competing providers to invest in the quality that meets customer needs. We also think that, as customer needs evolve to rely more heavily on mobile, and as new uses become available, it will be ever more important that customers understand the quality of experience they can expect, and which providers can offer it in the places they want to go.

5.13   Therefore, we are continuing our work on mobile reporting, to develop better evidence on network quality, including by using new crowdsourced data. This will enhance our own understanding of network quality, and will also enable us to give consumers better information to choose the services and providers that best meet their needs. As part of this we aim to update our mobile checker with crowdsourced data in 2023.

5.14   We will also continue working with industry to improve the accuracy and consistency of coverage information that Ofcom and the industry currently provide, and explore how real world-data can best provide customers with more information about the mobile performance they can expect to receive.

We are clarifying our future approach to mobile markets

5.15   MNOs have said that regulation, either introduced by Ofcom or other bodies, has not been supportive of investment because it has reduced their financial returns by imposing additional costs and reducing their commercial flexibility to generate revenues.

5.16   Some MNOs have gone on to suggest that, if we were to change our approach to regulation to enable them to increase their profitability (e.g. by reducing or removing ALFs), this would improve their incentives to invest and result in additional investment.

5.17   Investment decisions are primarily driven by competition and expectations about future returns from any investment, against the counterfactual of not investing. However, as set out in paragraphs 4.22-4.23, we recognise that recent financial performance can affect expectations of future returns and the cash available for investment.

5.18   Measures to increase the current profitability of MNOs will not necessarily improve incentives for future investments or result in more investment. For example, where increased profitability is achieved through reduced competition, this could instead result in higher costs for consumers without offsetting benefits in the form of investment in, say, higher quality services.

5.19   Nonetheless, we recognise that regulation can influence investment incentives by affecting the expected future returns of potential investments, and the uncertainties associated with making those investments. We are therefore taking steps to clarify aspects of our future regulatory approach to encourage investment and help MNOs and others to better navigate the uncertainty generated by changing market conditions.

We recently set out our approach to competition and consumer issues in digital markets and are consulting on proposals to clarify the net neutrality framework

5.20   In September we published our Digital Markets Strategy,[129] which outlined how we intend to engage more directly with digital issues affecting communications markets and highlighted our areas of focus (including a market study into cloud).

5.21   In October, and in line with our Digital Markets Strategy, we published our Net Neutrality consultation.[130] In this we proposed to clarify the net neutrality framework to enable internet service providers (ISPs) (including MNOs) to innovate and manage their networks more efficiently, which will support efficient investment in mobile networks.[131, 132] More specifically, we proposed:

- new guidance clarifying that ISPs can offer premium packages, for example offering low latency, as long as they are sufficiently clear to customers about what they can expect from the services they buy;
- guidance to clarify when they can provide 'specialised services' to deliver specific content and applications that need to be optimised, which might include virtual reality and driverless vehicles;
- guidance to clarify when ISPs can use 'traffic management' measures to manage congestion on their networks so that a good quality of service is maintained for consumers; and
- to update our guidance to make clear we will generally allow zero-rating offers, while setting out the limited circumstances where we might have concerns.

5.22   We have invited comments on our proposals by 13 January 2023 and intend to set out a statement in autumn 2023.

We have moved to a new phase of our consumer work, with greater emphasis on holding providers to account for compliance with existing rules, and on their delivery of the Fairness for Customers commitments

5.23   MNOs have pointed to the large number of consumer initiatives that have recently been introduced. They have suggested that this creates uncertainty over the extent to which further interventions will be introduced going forwards.

5.24   Our recent consumer initiatives have helped address a range of concerns, and we expect these initiatives to deliver significant benefits for consumers over time. In addition, the

---

[129] Digital markets in the communications sector, Ofcom's approach to competition and consumer issues in internet-based communications markets, Ofcom, 22 September 2022.

[130] Net neutrality review, Consultation, Ofcom, 21 October 2022.

[131] An internet service provider (ISP) is a company that provides end-users with access to the internet.

[132] This follows on in part from concerns raised by MNOs that the net neutrality framework limits their ability to set retail packages to respond to growth in demand for content or to seek to recover costs from content providers driving that growth. The MNOs have also said that with the current framework it is unclear how innovative 5G services can be delivered.

Fairness for Customers commitments have set clear standards for providers, and our expectation is that providers will embed them in their thinking to ensure they treat their customers fairly. These initiatives aim to protect customers and support their ability to engage effectively in the market and to get a fair deal.

5.25   Having set these clear standards, we have shifted our focus to promoting effective compliance, and monitoring and understanding the impact of our recent interventions. Overall, we want to see providers complying with existing rules and delivering against the Fairness for Customers commitments, without the need for further intervention. However, should problems emerge, we will be ready to engage. [133]

5.26   In line with this, we do not have plans to introduce new consumer pricing rules. However, we have recently set out concerns about some providers' in-contract price rises, [134] and we will be monitoring pricing developments very closely. We have also launched an industry-wide enforcement programme into whether in-contract price rises were set out clearly enough by providers before customers signed up. [135]

5.27   We recognise that inflation is a wider macroeconomic problem that affects providers' costs as well as customers', albeit to different extents. However, if an increase in prices is seen to be delivered in a way that is unfair – such as resulting in unexpected price increases for customers in their minimum commitment period – this could undermine confidence in the market and reduce customer engagement to the detriment of both competition and the outcomes we want to see.

We will set out more explicitly the impact of future policy changes on the market, including investment

5.28   In February, we proposed to set out more explicitly the impact of future policy proposals on investment, to underline its importance. In response, several MNOs highlighted the importance of considering the cumulative impact of regulation on investment in mobile markets, rather than looking at the incremental benefit of each regulatory proposal on its own.

5.29   We expect to publish a consultation on updating our impact assessment guidance early next year. One of the improvements we are looking to make is to be more explicit about what we expect to happen as a result of any intervention (and by when), including the impact we expect to see on the functioning of the market and, as part of this, on investment. In addition, we are also planning to continue our work to assess the impact of our interventions after they have been implemented as part of our ex-post evaluation programme.

---

[133] Should a new consumer concern arise, we would consider our Fairness Framework when assessing whether or not we should intervene. Making communications markets work well for customers, A framework for assessing fairness in broadband, mobile, home phone and pay TV, Ofcom, 23 January 2020.
[134] Providers must think carefully about price rises, Speech by Lindsey Fussell, Ofcom's Group Director of Network and Communications, at the Connected Britain conference, 22 September 2022.
[135] Enforcement programme into in-contract price variation terms, Ofcom, 1 December 2022.

5.30   We note the points made by MNOs about considering the cumulative impact of regulation when considering future interventions and will provide further explanation of our approach when we consult on our updated impact assessment guidance.

We do not have a fixed position on future mobile consolidation

5.31   MNOs and other stakeholders have previously perceived that Ofcom has an entrenched position against future mobile consolidation. In addition, in response to our Future Approach to Mobile Markets paper, Three said that consolidation is needed in the UK so that all MNOs have the required scale to invest in high-quality networks; and it put forward evidence that it said indicated that markets in Europe with three MNOs have delivered better outcomes to those with four MNOs. Since then, Vodafone has said it is holding discussions with Three over a potential merger. [136]

5.32   In the UK, it is the CMA that assesses mergers. However, the CMA as a matter of course engages with sectoral regulators in relation to mergers in regulated sectors.

5.33   We continue to take the view that the question of whether a particular merger is likely to result in a substantial lessening of competition will turn on the effectiveness of competition that can be expected in the market after the merger, rather than just the number of competitors. Our stance on a potential merger would therefore be informed by the specific circumstances of that particular merger, taking into account how markets are evolving and functioning. [137]

5.34   We are therefore confirming that any future mergers would need to be assessed on a case-by-case basis, rather than on a presumptive view of the appropriate number of competitors.

We are clarifying our plans around future spectrum for mobile networks

5.35   In the context of continued growth in mobile data traffic we have already identified a pipeline of further spectrum for mobile. [138] The pipeline consists of:

- **mmWave:** We consulted on our specific proposals to make the 26 GHz and 40 GHz bands [139] available for new use earlier this year and are considering stakeholder responses; our next publication will be in Q4 2022/23; and

---

[136] Vodafone Confirms Discussions in the UK (investis.com) [Accessed 28/10/22].

[137] While Three has put forward evidence that three-player MNO markets in Europe have delivered better outcomes, we do not consider this as conclusive of the benefits of consolidation in the UK. For example, we have reviewed empirical studies that examine the link between consolidation and investment and found that these do not provide evidence that service quality increases when markets become more concentrated.

[138] Our assessment is that, taking into account the needs of alternative users and incumbents, mobile use represents the most efficient use in these bands.

[139] The 26 GHz band (24.25-27.5 GHz) and 40 GHz band (40.5-43.5 GHz) are both identified as future 5G bands in Europe; in July 2022, we consulted on making mmWave spectrum available for new uses, including for mobile technology. Our next publication will be in Q4 2022/23.

- **1.4 GHz:** We plan to award part of the 1.4 GHz band (1492-1517 MHz), for downlink-only wireless broadband (supplemental downlink). This spectrum can supplement sub-1 GHz for coverage and deep indoor services.

MNOs have said that additional mid-band spectrum would be required to meet future demand in an economically feasible manner

5.36 MNOs all said that providing additional spectrum to mobile would be a more cost-effective solution to meet future demand than densification of macro cells and small cells using mmWave. In particular, MNOs said that mid-band spectrum, such as the upper 6 GHz band, would be particularly useful given its capacity and coverage characteristics. For example, BT noted it could be used on the macro layer to boost capacity in less dense areas and deployed on small cells in denser areas.

5.37 We recognise that deploying additional mid-band spectrum on existing sites has a different cost profile for MNOs than densification alone (particularly from an opex perspective), but the extent of any cost savings is currently unclear. In addition, the costs of spectrum should also be considered as part of the overall cost profile.

5.38 Whilst mid-band spectrum was the focus of many responses, MNOs also said the allocation of other bands, such as the 600 MHz, may help meet future demand, particularly in less populated areas or deep indoors. Other stakeholders, such as Nokia and Ericsson, flagged the potential for mobile operators to use higher frequency bands, including in the 7-24 GHz and sub-THz bands. We discuss these bands further below.

It is unlikely that additional spectrum, beyond the existing pipeline, could be made available for use much before the end of the decade

5.39 It takes time for new spectrum to be made available. We first need to assess the possibility of compatibility with current users of the spectrum. If compatibility were not possible, and we conclude that mobile would be the optimal use[140] of the spectrum, then clearance of the existing use would be needed. It could therefore take 5 years or more before MNOs could start deploying.[141]

5.40 Further delays may occur if the base station ecosystem (and penetration) of compatible user equipment is limited due to a lack of widespread international adoption.[142] It could also take some time for device penetration to grow, limiting the benefits in the short-term.

---

[140] 'Optimal use' means that spectrum is used in a way that maximises the benefits that people, businesses and other organisations derive from its use, including the wider social value of spectrum use. In this context, this includes the potential benefits of cost savings to MNOs and network quality improvements for consumers, alongside the disbenefit of clearing incumbents and the opportunity cost of forgone with alternative uses.

[141] In many cases we are required to give five years notice of revocation although in certain cases or specific locations it may be possible to expedite this process, for example through agreements with the incumbents.

[142] A lack of international harmonisation may play a part, however, if few countries have allocated a band, the ecosystem may remain nascent even if harmonised.

5.41   Regardless of our decisions relating to specific bands, such as the upper 6 GHz, if there is continued data growth, other options to satisfy growing demand will be needed towards the end of this decade.

We expect future authorisation approaches to evolve in line with demand

5.42   In line with our Spectrum Management Strategy,[143] when authorising new spectrum use, we will consider further options for localised access. As a result, future allocations and auctions may not be on an exclusive and nationwide basis, which may mean it is limited to certain geographies or shared with other users. We also expect any additional spectrum will *complement,* not replace the need for, denser networks making using of higher frequency spectrum.

5.43   However, we will consider making additional spectrum available if it becomes clear that there is demand and doing so would represent its optimal use. In which case, we would seek to move quickly to do so given the time required for spectrum to be cleared and allocated.

Regardless of spectrum-related decisions, we expect a shift in how MNOs deploy their network to meet growing demand

5.44   As discussed in Section 4, densification is one of several ways in which MNOs could provide additional capacity. Densification means that spectrum can be reused in a given area, allowing more data to be carried over the same quantity of spectrum.

5.45   Additional mid-band spectrum could delay or reduce the need for densification, particularly if traffic grows below our medium growth scenario. However, it may not reduce the need for densification much at or above our medium growth scenario.[144]

5.46   In addition, most wireless traffic today is generated indoors, and it is reasonable to expect that indoor data demand will continue to grow significantly, with many future data-hungry applications likely to be used primarily indoors. Meeting this demand using 'indoor-in' may be more efficient[145] than using networks where indoor coverage is achieved using networks also providing outdoor coverage, such as MNOs currently do.

5.47   In practice, MNOs are likely to use some combination of different solutions, depending on the specific circumstances, rather than a focus on one solution such as high-power 'outdoor-in' mobile. With or without additional mid-band spectrum, it seems clear that

---

[143] Our Spectrum Management Strategy was published in February 2021, and sets out Ofcom's areas of increased focus, including 'licensing to fit local and national services'.

[144] MNOs currently access 1152 MHz of mid-band or low frequency spectrum. Addressing traffic growth somewhere between our medium and high growth scenarios, based solely on new mid-band spectrum and technology upgrades, is infeasible, as we estimate it could require an additional several GHz per operator to address the level of demand in these scenarios by 2035.

[145] Indoor base stations would operate closer to the user and reduce propagation and building losses, which are likely to increase as buildings get greater thermal performance. Indoor deployments could include indoor base stations or using alternative solutions; for example, deploying mobile technology operating using unlicensed spectrum (NR-U), or through other technologies altogether such as Wi-Fi. Developments such as Wi-Fi Passpoint may facilitate seamless access, increasingly enable MNOs to offload mobile traffic.

densification and, where suitable, the use of higher frequency spectrum, will be important in enabling sufficient capacity to meet future data traffic.

In the context of WRC-23, we currently favour "no change" in the upper 6 GHz band allocation, and plan to consult on the use of the band shortly

5.48   The upper 6 GHz (6425 to 7125 MHz) band has been flagged by stakeholders for both mobile and licence exempt uses (such as Wi-Fi). We consider that there is value in making this band available for either mobile or licence exempt use, to increase capacity and enable innovation.

5.49   The band is being considered for identification for International Mobile Telecommunications [146], [147] in the forthcoming WRC-23. We currently favour 'no change' as our assessment is that, on balance, the potential risks associated with 'no change' are less than the risks associated with an IMT identification, (this is discussed further in our Update on the Upper 6 GHz Band paper). [148] We will consider international developments and engage with relevant stakeholders as needed prior to consulting on proposals for the future use of the band in the UK, noting that an IMT identification is not necessary for a potential commercial mobile use of the band. A full discussion of our current thinking is available in our Update on the Upper 6 GHz Band paper.

5.50   In the meantime, we are continuing our analysis of the benefits in making the band available for licence exempt use, for mobile use, or in a hybrid fashion.

We consider that 600 MHz will be needed by DTT until 2030 and probably beyond

5.51   The 600 MHz band is being promoted by some in the mobile industry as a means to improve quality of coverage in rural areas and to help provide deep indoor coverage (this is due to the characteristics of radio signals at these frequencies). However, we note that the amount of spectrum in this band is limited. The 600 MHz band sits within the 470-694 MHz frequency range currently used for digital terrestrial television (DTT) to deliver Freeview services to millions of UK homes, and for use by PMSE and White Space devices.

5.52   WRC-23 is considering a review of the spectrum needs of existing services in the frequency band 470-960 MHz and possible regulatory actions in Europe, the Middle East and Africa (region 1). However, the UK Government has put in place legislation to enable Freeview licence extensions until 2034, subject to a break clause in 2030. We maintain our view that there is a need for DTT to continue until at least 2030 and probably beyond, in the UK. Our preliminary view is that 'no change' at WRC-23 would meet the UK's interests recognising the national usage of the band.

---

[146] Identification of a band for IMT signals that the band is being prioritised internationally for licenced mobile use.
[147] IMT is the name used internationally (especially in the ITU) for commercial mobile broadband applications using 3G, 4G and 5G technology.
[148] See our update on the upper 6 GHz band.

We are engaging with industry to understand whether more spectrum might be needed for the next generation of mobile technology/6G

5.53   The process of defining the capabilities and requirements of '6G' is already underway at an international level and the first deployments are likely to commence around 2030. If we were to conclude that MNOs required further spectrum beyond the current pipeline, it would be desirable that the new spectrum is well suited for 6G technology.

5.54   Some manufacturers of mobile network equipment are investigating a range of spectrum bands they believe could be suitable for 6G technologies with a view to proposing some 'candidate' bands to be considered for international harmonisation, for a potential agenda item ahead of WRC-27.

5.55   The GSA (Global Suppliers Association), which represents some of the largest equipment vendors, has called on regulators to consider spectrum within the 7 to 24 GHz band. They suggest that this would give a good balance of coverage and capacity and would be suitable for deployment on macro networks – particularly if the available spectrum was in the lower half of this range (7 – 15 GHz).[149] In the UK, this spectrum is currently used by a range of services, including Ministry of Defence (MoD) and civil radar systems, satellite networks, point to point wireless links and programme making and special events (PMSE).

5.56   Other spectrum bands are of interest, including 'sub-Terahertz' spectrum – between 94 and 300 GHz. These bands offer extremely wide bandwidth and capacity, but only over short distances (a few tens of metres). Whilst Terahertz spectrum could enable some unique applications in the fields of sensing and imaging, there remains technical challenges to deploying this spectrum to provide cellular mobile services.

5.57   We expect industry to refine their proposed candidate 6G bands over the coming months, ahead of WRC-23, as the conference will agree the agenda for WRC-27, where decisions on spectrum for 6G are likely to take place if an agenda item is agreed.

5.58   We are engaging with industry to understand their rationale for needing more spectrum for 6G and the nature of spectrum that 6G will require. We are also undertaking our own analysis of existing spectrum use in the bands of interest to assess the opportunities and challenges of making spectrum available. This work will inform the position we take going into WRC-23.

---

[149] GSA Presentation: Setting the Scene: Building the 6G Connectivity Ecosystem, 6G Global Summit, September 2022.

A1. Glossary

Term	Definition
2G	Denotes the second generation of mobile network technology (GSM).
3G	Denotes the third generation of mobile network technology (UMTS).
4G	Denotes the fourth generation of mobile network technology (LTE).
5G	Denotes the fifth generation of mobile network technology (NR).
5G non-standalone (5G NSA)	Non-standalone 5G refers to the deployment of a 5G Radio Access Network (e.g., base stations, antennas), radiating both 5G and 4G combined with a 4G core network (which manages control and signalling information).
5G standalone (5G SA)	5G built on a 5G core and 5G RAN. The 5G core virtualises network functions and provides the full range of 5G features.
Active infrastructure	The electronic components or elements of the mobile network (i.e., active layer). For example, base stations and servers.
Annual Licence Fee (ALF)	Fees set and charged by Ofcom for the continued use of spectrum, typically after an initial 20-year period.
Augmented Reality (AR)	An enhanced version of the real physical world that is achieved through the use of digital visual elements, sound, or other sensory stimuli delivered via technology.
Big Tech	The set of largest companies in the information technology industry. This includes Amazon, Apple, Facebook, Google and Microsoft, as well as other technological giants, such as Samsung.
Core	A network of interconnected nodes which forms the backbone of a communications network. It manages functions such as authentication, authorisation, connectivity, and call routing.
Cloud	A type of computing where users have ubiquitous access (i.e., independent of the user location) to scalable computing resources, such as processing and storage, that allow for reduced management on behalf of the user.
CTIL	Cornerstone Telecommunications Infrastructure Limited, a 50/50 joint venture between Virgin Media O2 and Vodafone that owns and operates the MNOs' network sites.
Dark fibre	A service which allows telecoms providers to lease only the fibre element of leased lines from a supplier, allowing them to attach equipment of their

	own choosing at either end to 'light' the fibre and use it as the basis for offering a range of leased lines products.
DAS	Distributed Antenna Systems (DAS) are an infrastructure of cables, amplifiers and antennas installed to distribute mobile signals from a dedicated base station to several antennas, distributing coverage and capacity over an extended area.
Densification	Increasing the number of sites in areas where capacity is needed.
EBITDA	Earnings Before Interest, Taxes, Depreciation and Amortisation.
End of Contract Notification (ECN)	Messages that providers are required to send to customers that let them know about their best deals when their contracts come to an end.
eSIM	An embedded-SIM, is a form of programmable SIM that is embedded directly into a device, thereby removing the need for a physical SIM card in the device.
Fixed Wireless Access (FWA)	Wireless networks (both national mobile networks and separate independent networks) that provide an alternative to wired networks to deliver traditional fixed broadband services.
GB	Gigabyte. A unit of data (1 gigabyte = 1024 megabytes).
GHz	Gigahertz. A unit of frequency (1 gigahertz = 1000 megahertz).
High-band spectrum	Frequencies above 24 GHz (also referred to as mmWave).
Hyperscalers	The three largest cloud providers: Amazon (via its subsidiary AWS), Google and Microsoft.
IMT	International mobile telecommunications.
IoT, IIoT	Internet of Things, Industrial Internet of Things. Describes the network of physical objects - "things"- that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet.
Internet service provider (ISP)	A company that provides end-users with access to the internet.
Latency	A measure of delay in transmission over a transmission path.
Machine-to-Machine (M2M)	A broad term to describe any technology that enables networked devices to exchange information and perform actions without manual assistance.
Macro Cells	Macro cells are higher power base stations that provide a greater coverage area. They are usually located in outdoor masts or towers
Mast	Radio masts are typically tall structures designed to support antennas for telecommunications and broadcasting.

Mid-band spectrum	Frequencies between 1 GHz and 24 GHz.
MIMO	Multiple-input and multiple-output. The use of multiple antennas at both the transmitter and receiver to improve communication performance. Massive MIMO refers to a MIMO system with a large number of antennas.
MHz	Megahertz. A unit of frequency (1 megahertz = 1,000,000 Hz).
MBNL	Mobile Broadband Network Limited (MBNL) is a 50/50 joint sharing venture between EE and Three. It provides a shared site portfolio which supports both shared (3G) and non-shared (2G-5G) technologies.
mmWave	The range of spectrum above 24GHz (but below 100 GHz).
Mobile device	Any portable device capable of connecting to a wireless network (e.g. smartphones and wearables).
Mobile ecosystem	A collection of hardware and software broadly comprising of mobile devices, mobile operating systems and applications.
Mobile network	A network that uses any of the 1G-5G technologies.
Mobile internet access	Comprises all wireless connectivity services, including mobile services, (traditional voice and SMS, and mobile data), and internet access delivered over other wireless networks, such as Wi-Fi.
Mobile Network Operator (MNO)	A mobile provider that owns its own national public mobile network.
Mobile provider	Provider of mobile services. Includes MNOs and MVNOs.
Mobile Edge Computing (MEC)	A decentralised form of cloud computing where data is stored and processed close to the edge of the mobile network, i.e., the physical location where users connect with the mobile network. Also known as Multi-access Edge Computing.
Mobile services	Connectivity services that mobile providers supply to their customers over mobile networks. Includes voice, SMS and data.
Mobile traffic	The data transmitted through the (public) mobile networks.
Mobile Virtual Network Operator (MVNO)	A mobile provider that does not own the wireless network infrastructure over which it provides mobile services to its customers.
Net neutrality	The principle that all traffic is treated equally, so that users of the internet (rather that their service provider) can control what they see and do online.
Neutral host	An independent third party that provides network infrastructure for use by multiple providers.

Network slicing	Network slicing is a feature of 5G SA networks. It allows an MNO to create multiple virtual networks (slices) on top of its common shared physical infrastructure. The virtual networks are then customised to operate with specific quality of service and meet the specific needs of applications, services, devices, customers or operators.
NR-U	New Radio Unlicensed.
Online communications services	Number-independent interpersonal communications services (e.g. WhatsApp, email, etc.).
Online services	Services provided via the internet, for example messaging via WhatsApp, or navigation via Google Maps.
Open Radio Access Network (Open RAN)	Initiative to build RAN products based on an open architecture and on disaggregating hardware from software by using commercial off-the-shelf hardware and software-defined technologies.
Operating system	Software that controls the operation of a device and directs the processing of programs.
Passive infrastructure	The non-electronic components or elements of the mobile network (i.e., non-active layer). For example, sites and towers.
Partial not spot	An area covered by at least one, but not all mobile networks (see also total not spot).
Pay as you go (PAYG)	A type of mobile tariff in which customers purchase a set amount of credit towards mobile minutes, messages, and data.
Private network	A mobile network that has been dedicated to a closed group of people and/or devices.
Radio Access Network (RAN)	The equipment on a collection of cell sites of a mobile network that connects customer devices (e.g., handsets) and mobile phone masts using radio spectrum.
Return on Capital Employed (ROCE)	Operating profit (measured as earnings before interest and tax) divided by capital employed.
Shared Rural Network (SRN)	A deployment agreed between the UK Government and the UK's four MNOs to upgrade networks and share infrastructure and sites to help improve 4G mobile coverage in rural areas.
Small Cells	Small cells are low power base stations with more limited range. They are usually located at "street-level", i.e., Lampposts, traffic lights, dedicated smaller masts or indoors.
SMS	Short Message Service, the communications protocol which allows text messages to be exchanged between mobile devices.

SME	Small to medium sized enterprise.
Spectrum	The electromagnetic spectrum. Where we refer to spectrum in this document, we typically refer to the radio spectrum, which forms the lower part of the wider electromagnetic spectrum, just below infrared and visible light.
Subscriber Identity Module (SIM)	A small smart card type device that has details of the mobile subscriber and so enables the network to recognise and authenticate the subscriber.
THz	A measure of spectrum frequency. One terahertz is 1000 GHz. THz may also refer to the ITU-designated band of frequencies from 0.3 to 3 THz.
Total not-spot	An area which is not covered by a mobile network (see also partial not spot).
Upper 6 GHz [band]	The range of spectrum from 6425 – 7125 MHz.
Virtual reality (VR)	The use of computer technology to create a simulated environment.
Virtual Network Functions (VNFs)	Software applications that deliver network functions that were traditionally carried out by proprietary, dedicated hardware.
Wearable	A mobile device that can be worn as an accessory (e.g., smartwatch)
Wi-Fi	A wireless networking technology that allows computers, mobile devices, and other equipment to interface with a wireless router.
Wireless network	Any network that uses wireless technology, including mobile networks and Wi-Fi networks.
Wireless technology	Technology that allows devices to communicate without a physical connection.
WRC [-23/27]	World Radiocommunications Conference – Ofcom represents the UK at WRCs which are held approximately every 4 years.

A2. Practical barriers to densification through small cell deployments

A2.1   In our February discussion paper[150] we estimated that each MNO may need several thousand small cells in busy areas by 2030. Our analysis suggests thirty to fifty thousand could be required by 2035 if traffic grows in line with our medium growth scenario.

A2.2   In addition to economic barriers, discussed in Section 4, stakeholders highlighted a number of practical barriers associated with densification. In this annex, we discuss these practical barriers and how they may evolve over time. Whilst these practical barriers are unlikely to fully disappear, we expect many of them to reduce over time, meaning they will become less of a constraint on densification.

Identifying and accessing suitable sites can be challenging

A2.3   Stakeholders flagged that small cells, particularly those using higher frequencies such as mmWave, have a very short range, meaning that they need to be carefully positioned to materially offload traffic from the macro layer. As a result, stakeholders flagged difficulty accessing appropriately positioned sites as a barrier to deployment.

A2.4   In many cases, local authorities are involved in enabling the deployment of new sites or access to existing sites. Typically, when building something new, local authority acceptance is required through the planning permission process. Additionally, local authorities own many of the street assets that small cells might be deployed on,[151] including assets such as lampposts.[152]

A2.5   Recent changes to the General Permitted Development order[153] sought to streamline the deployment of certain new assets.[154] An increasing range of deployments, including masts of certain sizes,[155] fall under the order, meaning the full planning permission approval process is not required. However, all new ground-based masts are still subject to *prior approval* by the local planning authority, meaning local authorities can assess (and refuse) the deployment on items such as the siting and the appearance of the mast.

---

[150] [Meeting Future Demand for Mobile Data](#), Ofcom, 9 February 2022.

[151] Though in some cases street furniture may be owned through a private finance initiative.

[152] For example, Virgin Media O2 has [deployed more than 1,300 small cells in London](#), which are *"usually bolted to existing street furniture, such as lampposts, avoiding the need to build new street infrastructure".* Virgin Media O2 is also trialling deployments on bus shelters and payphones.

[153] [The Town and Country Planning (General Permitted Development) (England) Order 2015](#), Legislation.gov.uk.

[154] [Changes to permitted development rights for electronic communications infrastructure: Government response to the technical consultation](#), GOV.UK, Updated 7 March 2022

[155] Detailed specifications include characteristics such as height and width. The specifications to qualify under the order depend on factors such as whether they are ground-based or building-based, and on the classification of land they are deployed on.

A2.6   Unlike new masts, small cell equipment (referred to as 'small cell systems' in the order)[156] do not require prior approval and can be deployed without the permission of local planning authorities. However, where the assets on which small cell equipment needs to be deployed are owned by the local authority, then the local authority can make the decision of whether to allow access.

A2.7   In many cases, we understand that local authorities are facilitating access to sites to enable mobile connectivity. However, stakeholders noted difficulty in getting approval from some local authorities to deploy masts or access assets. Discussions with stakeholders suggest reasons for refusal included aesthetic concerns and in some cases a lack of understanding of the need for, or requirements of, deployments.[157]

A2.8   We understand that DCMS is actively seeking to support local authorities with additional information, through events and webinars covering technical issues, in addition to the wider societal benefits of digital connectivity. DCMS's Digital Connectivity Infrastructure Accelerator (DCIA) is also seeking to reduce the local authority administrative burden and resource demands by sharing best practice and standardising contracts between small cell providers and local authorities.[158] The DCIA is also specifically developing and sharing best practice and guidance for what happens when assets are under private finance initiatives.

A2.9   Through the DCIA, DCMS is piloting ways to make it easier for MNOs and neutral hosts to identify and access publicly owned sites. These pilots have developed digital asset mapping platforms, including information on available assets such as height, power supply and location, making it easier for infrastructure providers to identify suitable assets. Alongside these pilots, DCMS is seeking to support the national adoption of digital asset management, including through information sharing and the establishment of an early adoption group.

A2.10   We recognise the importance of access to sites in the right location to enable effective deployments. Through DCMS's work to educate and reduce barriers, and as the benefits associated with 5G become increasingly clear, we expect local authority approval to become less of a barrier. We will work with the Government where possible to support these initiatives and overcome barriers.

A2.11   The ability of MNOs to identify the most suitable location for a site is also important. Cellnex UK noted that operators may sometimes struggle to accurately model propagation in the physical environment to identify optimal deployment, suggesting that better urban asset and spatial information to enable 3D mapping would significantly benefit the MNOs, enabling better radio planning. We are aware that many of our stakeholders are

---

[156] Planning legislation sets out the definition for 'small cell systems', which includes size and transmit power specifications. Stakeholders have said that the way power levels are defined currently has caused issues. However, we understand that DCMS are working to update the specifications so that they align with the intention of enabling small cell deployments.

[157] For example, we heard anecdotal evidence of a Local Authority offering alternative lampposts for deployment in a less busy area due to aesthetic concerns, despite the fact that small cells need to be deployed in busy areas which generate the most data demand.

[158] Digital Connectivity Infrastructure Accelerator programme, Guidance, DCMS, 23 June 2022. Contract standardisation seeks to promote non-exclusive, open access contracting rather than exclusive concession agreements.

incorporating the most recent and high-resolution topographic datasets to improve their asset management, radio planning and coverage predictions. We will continue to engage and encourage stakeholders to further enhance their data quality and modelling capabilities.

Stakeholders flagged potential issues with small cell interference, equipment size and compatible device availability

A2.12   Stakeholders flagged that small cells using the same frequencies as the macro layer risk causing interference. BT said this interference may degrade the performance of the macro network to the point that it is no longer efficient to introduce further small cells without dedicated frequencies. Deploying a particular set of frequencies on many small cells may quarantine its use on the surrounding macro layer. mmWave spectrum (which we plan to award in 2024) will help, as it could be deployed on small cells reducing the need to share spectrum with macro cells.[159]

A2.13   Several stakeholders, including Three, said that the current size, weight, and cost of small cells are barriers to widespread deployment as they are too big or heavy for certain street assets, or that each small cell can only leverage a subset of an MNO's spectrum portfolio as a result.

A2.14   However, we believe it is reasonable to expect equipment to continue to develop over time. Some issues, such as size, may improve as technology develops. Additionally, the small cell equipment ecosystem hasn't been a barrier to widespread deployment in some overseas markets such as the US and South Korea.[160]

A2.15   Another issue raised with us is whether a sufficient number of devices will be compatible with mmWave spectrum to enable it to be used on small cells and to carry significant data. There are some 26 GHz compatible small cells and devices already available internationally[161] and we expect the ecosystem available in the UK to grow once spectrum is made available.

A2.16   The current mmWave-compatible device penetration in the UK is extremely low and we anticipate a slow initial growth.[162] However, on some networks, a high proportion of total data demand comes from a small number of users and so a comparatively low penetration of mmWave compatible devices could make a significant impact if it included those users.

---

[159] mmWave's propagation characteristics mean it might be less likely to be used on macros than lower frequency spectrum.

[160] Whilst this shows that deployments are *practically* feasible, we acknowledge a different investment environment in the US, driven by higher average revenue per user (ARPU) limits the value of drawing direct parallels in *economic* feasibility.

[161] According to data from the GSA, there are 107 commercially available mmWave devices, including 47 phones; GAMBoD database, Global mobile Suppliers Association GAMBOD [accessed 01/12/22].

[162] Given the multi-year phone replacement cycle and the fact that lower-tier phones may take time to include mmWave chips.

Stakeholders report difficulties with the availability of, and information on, fibre backhaul

A2.17 Several stakeholders said that the availability of fibre for backhaul may impact deployment. Three noted that there currently isn't enough fibre available at the density necessary for large scale small cell deployment. Where fibre is not available, MNOs or neutral hosts can deploy additional fibre, but this can be costly. Alternatively, they can use microwave backhaul. However, Three said that microwave links can be less reliable than fibre and come with practical issues, including the need for line of sight and potentially an increase in the size and cost of the mast.

A2.18 However, we expect that fibre availability is likely to increase over time as fibre roll-out continues, including deployments by Openreach, Virgin Media O2 and smaller broadband infrastructure networks operators. If new fibre is provided for some small cell deployments, then other deployments may be able to share it, potentially reducing the fibre cost per small cell as deployments increase.

A2.19 Stakeholders also said that issues can remain even when fibre is available; Cellnex UK suggested that some fibre owners were reluctant to price and supply dark fibre, with a preference instead to supply managed ethernet services. This meant that in some cases deploying new fibre was cheaper than securing dark fibre from existing providers. However, we agree with Cellnex UK's assessment that this is likely to improve as the market matures.

A2.20 Stakeholders noted that it is not always possible or easy to identify whether fibre is available in a given location when acquiring or accessing a site. Whilst identifying the dark fibre portfolio of larger providers such as Virgin Media O2 and BT is possible, the same is not true for many smaller players, resulting in the need to engage directly and request information, increasing the administrative burden of deployment. That said, as the number of small cells grows, fibre providers will have a greater incentive to make their services more attractive and information more accessible.[163]

Energy efficiency and power consumption

A2.21 Stakeholders flagged concerns relating to the potential impact of the power consumption of an extensive small cell deployment, highlighting a study that argues the associated power consumption without additional spectrum (requiring additional small cells) could be more than twice the case where additional mid-band spectrum was utilised.[164]

A2.22 We understand that energy efficiency and power consumption is an important consideration for MNOs. Whilst densification may result in greater power consumption in

---

[163] For example, where small cell deployments are small scale, and dark fibre is sought on an 'ad hoc' basis, fibre providers have little incentive to invest in ways to make information available and easily accessible. If small cell deployments become commonplace, supplying fibre for small cells may become a core service, incentivising improved information sharing.

[164] Identifying Mid-Band Spectrum Needs, GSMA, July 2021; results vary between 1.6x and 2.8x depending on the city considered.

certain circumstances, there are many different ways to densify a network and the impact on power consumption depends on the specifics.[165] For example, deploying indoor-in solutions may prove more energy efficient than outdoor-in solutions as indoor solutions have less building losses to contend with. Additionally, future networks may be more intelligent in their power usage, for example by only enabling features that a user requires at a given time or by reducing power consumption outside of peak hours.

Further mitigations

A2.23   We also expect shifts in how the MNOs operate. MNO strategies and processes are geared toward macro deployments and upgrades, with small cell deployments typically done on a limited scale in most cases. As densification becomes more important, it is likely that MNOs will adapt their approach to enable them to respond more efficiently.

A2.24   Stakeholders also highlighted emerging 'neutral host' models that could help mitigate some of the barriers to densification, reducing the burden on MNOs by negotiating access to sites, providing backhaul and in some cases installation. Neutral host models can also facilitate sharing, which may enable multiple MNOs to deploy on these sites in demand hotspots. Sharing, even without a neutral host, may also serve to reduce some of the barriers. We discuss neutral host and sharing models in more detail in Annex 3.

---

[165] While not reporting specifically on power consumption, Virgin Media O2 reported that the deployment of a significant number of small cells in London (over 1,300 live sites) has helped accelerate rollout in a more environmentally friendly way. Virgin Media O2 accelerates industry's largest rollout of small cells to deliver cleaner, greener and more flexible 5G network solutions, 30 June 2022 [Accessed 11 October 2022].

A3. Market developments over the next 5 - 10 years

A3.1   In Section 5 of our February Future Approach to Mobile Markets paper, we set out a number of potential future market developments. In this annex, we respond to areas that received particular stakeholder comments:

- the deployment of private networks;
- infrastructure sharing; and
- Apple and Google providing a platform on which customers can choose their mobile provider.

Private network deployments are likely to grow

A3.2   A 'private network' is a mobile network that has been dedicated to a closed group of people and devices. Its features can be configured to meet specific customer needs (e.g., performance and security), [166] and it can be delivered in three main forms.

- **Dedicated private networks**. A mobile network utilising infrastructure completely separate to a public network.
- **Hybrid public-private networks**. These networks use some standalone infrastructure on the premises of the client which is operated in conjunction with a MNO network.
- **Network slice on an MNO network**. These are virtual networks relying on the public 5G SA network infrastructure. [167]

A3.3   MNOs can deploy private networks using their licensed spectrum allocations. Shared Access Licences are the primary route for other providers to deploy private networks, including in the 3.8 - 4.2 GHz band – though MNOs can also use these licences. [168]

A3.4   There is broad consensus that there will be growth in this market, and this was echoed in responses to our Future Approach to Mobile Markets paper. However, at this early stage of 5G deployment, limited demand may in part be due to a limited understanding of what private networks can offer.

---

[166] The choice of mobile technology and the configuration of mobile connectivity are agreed between the network provider and the client. Other forms of wireless connectivity are available for enterprise customers, for example Wi-Fi.
[167] Also known as network slicing. It allows an MNO to create multiple virtual networks (slices) on top of its physical infrastructure. The virtual networks are then customised to operate with specific quality of service and meet the needs of specific applications, services, devices, customers or operators. Network slicing requires a 5G standalone network (where the network core is 5G).
[168] These licences allow anyone to access spectrum on a first-come-first-served basis, and provide indefinite access to spectrum at a relatively low cost (up to £800 a year for a full 100 MHz channel). Ofcom has issued more than 900 shared access licences since new rules were introduced in 2019, around half of which can be considered as supporting private network type solutions, though in many cases each private network accounts for multiple licences. Including legacy licenses, there are over 1,600 active licenses in the shared access bands.

Some non-MNO respondents said that they faced challenges in providing private networks

A3.5   Non-MNO respondents suggested that they may face challenges in providing private networks in competition with MNOs.

- **Offering mobile connectivity beyond the private network.** In some circumstances private network providers may wish to offer connectivity beyond the range of the dedicated private network, for example to track assets in transit.[169] In these cases, the provider may need to negotiate with an MNO to obtain connectivity to do so. Netmore stated that this was a potential barrier faced by new entrants.[170] However, it is not clear that MNOs would be unwilling to offer contracts to enable asset tracking and similar services.[171]

- **Using shared access licences.** Some stakeholders said that it takes too long to obtain a shared access licence. We are currently in the process of updating our licensing system to automate the provision of licences as part of our Licensing Platform Evolution (LPE) project. Others have raised concerns that the power limits are too low in some circumstances.[172] The power limits are set to manage interference with other users in the band, including other shared access users, but we have sought to be flexible around power-levels on a case-by-case basis, depending on the circumstances of the site.

- **Lack of devices compatible with the shared access spectrum range.** There were also calls from respondents for us to support the harmonisation of 3.8 GHz to 4.2 GHz band across Europe and internationally, which would support a wider ecosystem of compatible devices. We are involved in current work within the European Conference of Postal and telecommunications Administrators (CEPT) on this band with the aim of agreeing appropriate technical conditions, compatible with uses in the UK.

Some MNOs have raised concerns about competition from other private network providers

A3.6   Virgin Media O2 and Vodafone raised concerns about the impact that competition from non-MNO private network providers could have. First, they have suggested that **such providers may focus on competing for high value 5G customers to 'cherry-pick' the**

---

[169] For example, this could involve tracking a container as it leaves the private network in a port towards its delivery destination, where an operator may want to continue to monitor data like temperature and security in transit.

[170] See Netmore response to Future approach to mobile markets paper. The Ofcom Advisory Committee for Scotland also questioned whether there was a need for regulation to support connections between networks.

[171] Commercial roaming agreements may be used. This is different to potential issues related to securing two-way roaming agreements between private networks offering connectivity to residential customers in not spots and MNO networks.

[172] One respondent suggested that Ofcom should increase the power limits for non-rural outdoor use in the sub-6GHz Shared Access licences to allow for outdoor private network deployment. This theme is consistent with findings from a recent UK5G and Real Wireless study, commissioned by DCMS. See Upper n77 (3.8-4.2GHz band) market study, An exploration of issues emergent from the 5G Trials and Testbeds Programme, A UK5G report for DCMS delivered by UK5G and Real Wireless, April 2022.

higher revenue opportunities, and in doing so reduce MNOs' incentives and ability to deploy 5G across national mobile networks.[173]

A3.7 However, we have not seen strong evidence that MNOs need to win a sufficient share of private network business to be able to deploy 5G effectively on their national networks. In addition, MNOs may be in a strong position to compete with other private network providers, as they are better able to offer connectivity beyond the range of the private network and have spectrum that is supported by a wider ecosystem of devices than other private network providers.

A3.8 Second, Virgin Media O2 and Vodafone have suggested that **there is not a level playing field between MNOs and other private network providers**, in particular because the Telecommunications Security Act (TSA) applies to MNOs but not to the latter.[174] As the TSA only applies to providers of public networks or services, any provider offering a dedicated private network, with no crossover with a public network or services, would not be required to ensure that private network complies with the TSA. All providers will face costs associated with network security, and adherence to TSA measures could be marketed as a commercial differentiator.

We may see more infrastructure sharing

A3.9 There are changes happening to MNO network sharing arrangements, increasing restructuring and commercialisation of MNOs' network assets, and new models of neutral hosts developing.

Network sharing arrangements between the MNOs continue, but are evolving

A3.10 Network sharing arrangements between the MNOs have been a feature of the mobile sector over the last 10 years. They include arrangements between:[175]

- BT/EE and Three: MBNL, a joint venture established in 2007 that manages and operates a set of macro sites that are used by both MNOs and manages active sharing of 3G network in some rural areas; and
- Vodafone and Virgin Media O2: CTIL, a joint venture established in 2012, owns and operates a set of macro sites that are used by both MNOs. In addition, Vodafone, and Virgin Media O2 have arrangements relating to sharing active equipment that sits outside of CTIL.

---

[173] Virgin Media O2 response to Future approach to mobile markets paper, p.22 and Vodafone response to Future approach to mobile markets paper, p.4.

[174] The TSA creates general duties for providers of public or safety/critical telecoms services, including an obligation to take security measures to reduce the risk of security compromise. Under the TSA, providers of public communications networks or services will have to incorporate new security procedures in their public mobile networks or services and will incur a mixture of Capex and Opex costs, some of which will be ongoing.

[175] In addition, all four MNOs have agreed with the Government to invest in extending (and sharing) rural macro cell sites as part of the Shared Rural Network (SRN).

A3.11   By entering into network sharing agreements, MNOs can reduce their average costs by benefitting from economies of scale (for example, through reducing the total number of sites or equipment needed, as well as other costs relative to deploying multiple separate networks).

A3.12   However, by entering such agreements, MNOs give up a degree of control over their network, particularly when sharing active equipment in addition to the passive sharing of sites. As a consequence, this can affect investment decisions and potentially have implications over network design and upgrades (e.g., choice of network equipment, whether and when network upgrades can be made); and how the MNO is able to manage its network quality. This may in part be driving the move towards a greater emphasis on passive sharing in network sharing arrangements.[176]

MNOs continue to restructure and commercialise their network assets

A3.13   There is a trend – both in the UK and overseas – towards greater separation of network assets as MNOs seek to monetise their assets. In the UK, we have seen the following:[177]

- Three recently agreed to sell its tower assets (including its interest in towers managed by MBNL) to Cellnex, which is the largest independent provider of towers in the UK;[178]
- Vodafone and Virgin Media O2 have agreed to commercialise their towers infrastructure in CTIL.[179] This means that CTIL will be offering wholesale access to other MNOs to run their own services (similar to a neutral host); and
- further to this, Vodafone subsequently transferred its 50% shareholding in CTIL's towers business to its new Europe-wide spin-off company, Vantage Towers, in which Vodafone sold an initial stake of c.19% through an IPO. More recently, Vodafone has reduced its shareholding still further, through entering into a strategic partnership with a consortium of long-term infrastructure investors.[180] In addition, there has been speculation that Virgin Media O2 is looking to sell its stake in CTIL.[181]

A3.14   There were different views from stakeholders about the impact of such changes. Three indicated that where MNOs give control of passive elements of the RAN to independent tower providers, this can lower barriers to entry, as the infrastructure can be made available on a wholesale basis to multiple operators.[182] However, AP Wireless raised

---

[176] Active sharing within MBNL is limited to 3G, which is becoming less important. Vodafone and Virgin Media O2's active sharing arrangements are progressively being unwound in larger urban areas. See video statement by Vivek Badrinath (Vantage Towers CEO) that mentions this will result in 2,000 sites becoming passive-shares, available at Cornerstone | Vantage Towers

[177] Virgin Media O2 indicated that these trends reflect MNOs looking for ways to improve their capability to fund 5G rollout by reducing costs and better monetising their assets, Virgin Media O2 response to Future approach to mobile markets paper, p.20.

[178] See Anticipated acquisition by Cellnex UK Limited of the passive infrastructure assets of CK Hutchison Networks Europe Investments S.À R.L.: Final report, CMA, March 2022.

[179] Vodafone and Telefónica commercialise Cornerstone, the UK's largest tower company, Cornerstone, January 2021.

[180] Vodafone plc has transferred its stake in Vantage Towers into a joint venture with a consortium of long-term investors that will hold up to 50% of the shares. Vodafone enters into a co-control partnership with GIP and KKR for Vantage Towers, Vodafone, 9 November 2022 [accessed 9/11/22].

[181] Rumour of Telefonica UK tower asset sale resurface, Mobile World Live, 13 September 2021 [accessed 8/11/22].

[182] Three response to Future approach to mobile markets paper, p.81.

concerns that the commercialisation of MNOs' infrastructure and the sale of Three's passive infrastructure to Cellnex resulted in growing market power among a small number of players. [183] In Section 4 and below, we briefly discuss the risk of upstream bottlenecks emerging in the event of a company gaining market power in relation to access to key sites.

New neutral host models are developing

A3.15 A neutral host is a third-party that deploys network infrastructure and provides access or capacity to MNOs on a wholesale basis. Neutral hosts initially focused on providing passive infrastructure (e.g., towers and masts). However, we are beginning to see the growth of different models, including in the small cell and the Distributed Antenna System (DAS) [184] space. For example:

- Cellnex UK has installed shared infrastructure, with antennas, cabinet space, dark fibre and power at 90 locations throughout the borough of Hammersmith and Fulham. The cabinets are designed to fit up to four MNO small cells. [185]
- Virgin Media O2 has deployed more than 1,300 sites across London, with several neutral host partners including Cellnex UK, Freshwave and Ontix. These small cells are usually bolted to existing street furniture, such as lampposts. It has also trialled, with Freshwave, a small cell solution for bus shelters built for multi-operator use, should there be demand. [186]
- Freshwave and BAI Communications have installed a multi-operator DAS in the 22 Bishopsgate skyscraper [187] and the London Underground [188] respectively.

A3.16 Neutral hosts could help overcome some of the barriers to network deployment outlined in Section 4 and Annex 2, by for example:

- negotiating access to sites, providing backhaul and installation. In many cases, this may also facilitate the sharing of infrastructure and equipment [189] (thereby lowering average costs) and reducing the coordination issues between MNOs;

---

[183] AP Wireless response to Future approach to mobile markets paper, p.3.

[184] Distributed Antenna Systems (DAS) use cables, amplifiers and antennas installed across an area to distribute mobile signals, typically from a dedicated base station, but sometimes from a repeater or small cells.

[185] Connected Street Infrastructure in London: Leading the way in connecting Small Cell assets to dark fibre, Cellnex UK [Accessed 27/10/22].

[186] Virgin Media O2 accelerates industry's largest rollout of small cells to deliver cleaner, greener and more flexible 5G network solutions, Virgin Media 02, 30 June 2022 [Accessed 27/10/22].

[187] Connecting the City of London's tallest skyscraper , Freshwave [Accessed 27/10/22].

[188] Connecting the Capital – how BAI Communications and TfL are building shared infrastructure to connect people and businesses and create a smarter London, BAI Communications, 4 August 2022 [Accessed 27/10/22].

[189] While we note that there are technical issues relating to sharing active equipment, work is being done to overcome these, particularly for indoor deployments. UK MNOs have agreed Joint Operator Technical Specifications (JOTS) for a Neutral Host In-Building (NHIB) solution. This sets out agreed technical requirements for shared in-building solutions using small cell base stations. In theory, these standards should make the sharing of active equipment easier and potentially be extended to outdoor solutions that may open up additional opportunities for network sharing generally (including through neutral hosts).

- acting as a single contact with asset or building owners rather than them dealing with each MNO individually. In some cases, this may enable access to sites which MNOs would have been unable to access otherwise; and/or
- using their specialised knowledge (e.g., in specific types of deployments), experienced workforce and stakeholder contacts to reduce costs and time taken to deploy.

A3.17   However, some stakeholders suggested that sharing models facilitated by neutral hosts may be problematic in certain cases: some types of street furniture are not able to support the weight of multiple MNOs' active equipment, or shared active equipment which can be larger and heavier. This is in addition to the general reduction in control associated with sharing, discussed earlier.

Some stakeholders have suggested that neutral hosts could raise competition concerns

A3.18   Some MNOs have flagged possible competition concerns where neutral hosts have exclusive access to certain assets such as street furniture, (through for example an 'exclusive concession agreement' with a local authority), which could enable them to charge high prices to the MNOs.

A3.19   We recognise that this is a potential scenario (as discussed in Section 4). At present there are likely to be few locations where providing coverage would rely solely on a single neutral host. In addition, we understand that local authorities may be moving away from offering exclusive access agreements towards open access agreements, and note that the DCIA is actively encouraging standardised, open-access non-exclusive contracts between neutral hosts and local authorities.

A3.20   We also note that, where the alternative would have been no coverage because it would not be economic for MNOs to provide coverage on an individual basis, neutral host provision might enable MNOs to expand their coverage.

Apple and Google provide a platform on which customers can choose a mobile provider

> **eSIMs will enable customers to switch provider on their mobile device and to use more than one provider**
>
> Typically, when customers switch mobile provider, they need to physically insert a new SIM card into their mobile device. With eSIMs, the SIM is embedded into the device and is not tied to one specific network. Customers can therefore switch provider directly on their device, by updating the eSIM wirelessly. In addition, eSIMs can hold multiple profiles (e.g., mobile airtime or data plans), enabling customers to take services from different providers at the same time.
>
> Customer awareness of eSIMs is likely to be low at present and, generally, providers have not yet sought to actively promote eSIM use among residential customers. Nonetheless, within the next five to ten years, we expect most consumers will be using eSIMs instead of physical SIMs, with physical SIMs eventually being phased out. As consumer awareness of eSIMs increases, we may see customers taking services from more than one provider for international roaming, to try out a new provider for a short period of time, and potentially to be able to switch between providers to get the coverage they need.
>
> eSIMs could also lead to automated switching services, where consumers are automatically signed up to new deals based on those factors a customer considers important – such as the headline price, contract length, data allowances and so on.

A3.21   The deployment of eSIMs (see Box A1) could enable Apple and Google to enter into the distribution of mobile services. In particular, Apple and Google may use their mobile operating systems (OS) to offer platforms on which customers can choose their mobile provider, for example, by setting up a 'choice screen' accessible through the settings menu (Apple has already developed iOS in this way for eSIM-enabled iPad users to choose and purchase mobile services) or an app. [190]

A3.22   A choice screen or app provided by Apple or Google could offer consumers an easy and convenient way for them to compare providers across a number of different factors, including quality. This in turn could lead to a more competitive market, with MNOs incentivised to invest and compete more intensely on aspects of quality.

A3.23   However, the CMA found that Apple and Google have "substantial and entrenched market power" in the provision of mobile ecosystems. [191] As a result, a risk exists that Apple and/or Google leverage their market power into the distribution of mobile services, which could lead to the following outcomes.

---

[190] Apple and Google are unlikely to face significant cost or technical challenges in developing their OSs in this way, and the ability to earn commissions from mobile providers for inclusion on the choice screen / app may make this a commercially attractive option.

[191] Mobile ecosystems, Market Study final report, CMA, 10 June 2022.

- **Reduced or less transparent choice for consumers**. Consumer choices can be strongly influenced by the way in which different service options are presented to them, due to behavioural biases. Apple and Google could steer customers to use their choice screens, for example by presenting these as the default way to choose and purchase mobile services, or by making it more complicated to install mobile profiles onto an eSIM through other means. Customers may then choose one provider over another based on their prominence on the choice screen or app, which could in turn be based on how much a provider is prepared to pay Apple or Google. In addition, if limited information were presented to customers when choosing a provider and tariff on the choice screen / app, they may make poor decisions.

- **Higher prices caused by an increase in mobile providers' distribution costs** due to elevated commissions charged by Apple or Google. Providers may have limited ability to negotiate down those costs given Apple's and Google's strong negotiating power. Mobile providers that are unwilling or unable to pay Apple or Google a sufficiently high amount may have a lower listing position or be delisted. Providers may feel limited in their ability to walk away from such agreements given the volume of business that could be distributed by Google and Apple.

A3.24 Some MNOs have noted that concerns may arise if Apple and Google were to expand into the distribution of mobile services. For example, BT and Three both felt that large digital firms could become gatekeepers to consumers, restricting or steering consumer choice. [192] [193]

A3.25 Whether the risks outlined above will materialise remains uncertain for now. [194] However, strong behavioural effects matter here - consumers often tend to rely on default and prominent options presented to them, which Apple and Google are in a strong position to influence. We also note that similar concerns to those set out above have been raised in relation to the gatekeeper role played by Apple and Google over other aspects of mobile ecosystems, such as app stores. [195]

The CMA's Digital Markets Unit could help mitigate potential risks to consumers

A3.26 The Government will be introducing legislation to give the CMA's Digital Markets Unit (DMU) new powers to challenge monopolies and increase the competitive pressure to innovate. It will be able to address both the effects and root causes of market power held by the most powerful digital tech firms, helping promote competition in UK digital

---

[192] BT response to Future approach to mobile markets paper, p.15
[193] Three response to Future approach to mobile markets paper, p.88
[194] Apple and Google have yet to use their OSs as a platform on which customers can choose provider and service.
[195] Mobile ecosystems, Market Study final report, Chapters 4 and 6, CMA, 10 June 2022.

markets. [196] The DMU's new powers should be able to address the potential competition concerns in the digital markets, before they materialise. [197]

A3.27   We will continue to monitor developments in this area. Should harms arise, we would consider which regulator would be best placed to act, in line with our recent paper on digital markets. [198]

---

[196] A new pro-competition regime for digital markets, DCMS and BEIS, May 2022.
[197] Mobile ecosystems market study (Appendix M: examples of practices that could be addressed by SMS Conduct Requirements), CMA, June 2022.
[198] Digital markets in the communications sector, Ofcom, September 2022.