

Your response

| Question | Your response |
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| <p>Do you agree that the key potential market developments over the next five to ten years are those set out in Section 5? Are there any other key developments we should consider?</p> | <p>Yes, techUK agrees with the key potential market developments Ofcom has included in Section 5.</p> <p>Our view is that by 2030, wireless technology types will ultimately have evolved from “simpler” mobile and broadband access for homes and businesses, to a more heterogenous set of connectivity requirements and characteristics as demanded by the UK economy and society. Different types of wireless connectivity will be dependent on the capacity required, latency needs of specific use cases, and will need to cater to an increasingly diversified set of connectivity requirements – thus a technology “mix” is likely.</p> <p>Terrestrial mobile networks will play an important role in meeting the growing, and diversifying, demand for future connectivity in the UK as part of an ecosystem of wireless connectivity, including unlicensed Wi-Fi, Bluetooth and others.</p> <p>techUK agrees with Ofcom’s medium-growth scenario which suggests that total monthly data used on mobile networks could increase by a multiple of 20 by 2030 (40% per annum). Meeting this demand will require a significant expansion in network capacity and a strong understanding of the role mobile networks will need to play alongside other forms of wireless connectivity, such as Wi-Fi in order to maximise utility to consumers and business.</p> <p>At first, the traditional buildout of new technologies like 5G will happen from the core of the network to existing base station sites, initially focused on the more densely populated areas and primarily addressing mobile broadband use cases. Then, as usage demand, application, and use case needs are better understood by the connectivity industry additional coverage, capacity and QOS can be built out to support these needs. The roll out of 5G is very expensive to extend, and it will take time to extend the available coverage. We may see new and smaller players enter the UK market to supplement macro network deployment. The addition of a new generation of satellite networks could also extend 5G coverage and capacity to all areas, whether directly or by integrating into terrestrial networks.</p> <p>From 2G to 4G, a considerable part of traffic generated and consumed on mobile devices has been offloaded to W-Fi. As Wi-Fi capabilities accelerate with the roll out of Wi-Fi 6 and OpenRoaming¹ the share of traffic offloaded to Wi-Fi from mobile devices is expected to remain high and could increase to 70%. Other members expect Wi-</p> |

¹ WBA OpenRoaming - <https://wballiance.com/openroaming/>

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| | <p>Fi offload to be tempered as 4G and 5G mobile user experience improves in terms of speed and, availability of unlimited data plans. No matter what specific scenario plays out here, it is clear that mobile networks will need to work increasingly as part of an ecosystem of wireless connectivity solutions including Wi-Fi offering a wider range of capabilities for increasingly heterogeneous needs both for consumers and business needs.</p> <p>5G's success in delivering enhanced coverage will be dependent on its ability to address the economic and technical barriers that have prevented earlier wireless generations from being deployed to serve sparse rural communities and often heavily populated indoor spaces. Consequently, for both rural and indoor, 5G systems will have to deliver effective sharing capabilities that are essential to lower the barriers to deployment. Some members point to the virtualisation and centralisation of RAN activity as a key enabler of cost reduction, with site-based equipment reducing to RF and commercial off-the-shelf computing power, further augmenting higher levels of sharing – ultimately improving network economics. techUK welcomes the work the UK has done in regard to lowering barriers to indoor 4G adoption with its Joint Operator Technical Specifications and there is an opportunity to augment the JOTS framework to integrate the multi-vendor interfaces from the O-RAN Alliance to allow sharing in the open RAN era.</p> <p>The availability of additional spectrum to support the growing network capacity demand will be important. techUK members feel that this demand will require additional sub-1GHz— (low-band) — spectrum to deliver additional capacity deep in buildings and at cell edge in rural areas, additional mid-band spectrum to support extra network capacity in busy locations and millimetre wave spectrum for very high capacity in hot spots such as stadia or other places where there is a very high density of users, as well as for niche applications such as FWA and advanced services that require extremely high bandwidths such as AR/VR. Spectrum for satellite networks must also be considered and some members believe further spectrum for unlicensed Wi-Fi connectivity will be required.</p> <p>We also expect to see a significant growth in the deployment of enhanced private networks for enterprise and public services by 2030. While there is some level of uncertainty about the scale of this growth², reflecting the complexity and variation in deploying different types of private networks for different industry verticals, techUK members do expect this market growth to play a significant role in the future of the UK mobile market.</p> |
| <p>Do you agree that competition among MNOs is likely to</p> | <p>As Ofcom notes, competition among the UK's MNOs has delivered good outcomes for consumers in the UK in recent years. According to Digital Catapult, the UK is the number one country in Europe for the</p> |

² TelecomTV - Sizing the private 4G/5G opportunity is harder than it looks - <https://www.telecomtv.com/content/5g/sizing-the-private-4g-5g-opportunity-is-harder-than-it-looks-42075/>

continue to play a key role in the delivery of good outcomes, as outlined in Section 6?

development and uptake of advanced digital technologies, and third in the world after the United States and China.³ The UK also ranks second in Europe for the development of 5G progress.⁴ Maintaining this leading position will require focus on investment in UK digital infrastructure.

techUK members agree with Ofcom that no further retail regulation is needed. Investors require a stable regulatory framework where there is reasonable certainty that policy and regulatory interventions do not diminish after investment has been made.

techUK suggests Ofcom considers the following in its future approach to the mobile market:

- On profitability and investment: Ofcom itself notes not all MNOs have covered their cost of capital on a continuous basis, yet claims that, “at an industry level, financial performance appears to support investment.” Ofcom should recognise the reality of how investment decisions are taken, including the importance of past investment performance and investor sentiment. Competition between four MNOs has in the past driven each to invest to avoid losing their existing business, but this is not a long-term sustainable path to continuous significant investment (unless market dynamics were to change). Furthermore, members would like to see a pro-deployment environment fostered with help from Ofcom.
- A balanced approach to mobile consolidation: Ofcom should maintain its approach to potential mergers or acquisitions as judged on a case-by-case basis and on merit.
- A clear spectrum roadmap that does not rely on small cell deployment, but rather is underpinned by spectrum policy that supports innovation and investment in national mobile coverage and capacity.
- Use of reliable and comparable information on network quality

Some techUK members feel that there is a risk that government ambition on connectivity and good outcomes cannot be funded by the current “cheapest price is best” regime.

Do you consider that there are likely to be significant wider external benefits (externalities) from a quicker or more widespread rollout of high-quality networks than that which the

Widespread and high quality 5G will be a driver of increased productivity. It will also have a positive environmental impact, e.g., through reduction of the need to travel. Moreover:

- 5G networks are being built with sustainability in mind: 5G networks are up to 90 per cent more energy efficient per unit of traffic than legacy 4G networks, according to both Ericsson

³ Digital Catapult: Digital Future Index 2021-2022 - https://www.digicatapult.org.uk/wp-content/uploads/2021/11/Digital_Future_Index_2021_2022_-_Digital_Catapult.pdf

⁴ Ibid.

market is likely to deliver, as discussed in Section 6? If so, please provide clear examples to help explain your answer.

and Nokia.^{5 6} The ITU has also released recommendations for optimising 5G wireless network energy consumption, including (i) putting radio frequency units “into deep sleep” during periods of extremely low traffic and (ii) using enhanced AI-driven energy-saving solutions to direct users from less power-efficient spectrum bands to more power-efficient spectrum bands.⁷ These environmental benefits are not considered by 5G customers when making their purchasing decisions but could still bring significant benefits to society as a whole depending on 5G usage, thereby meeting Ofcom’s criteria for consideration as a 5G externality. What’s more, digitisation has the potential to help other industries meet net zero targets, bringing even wider societal benefits. Finally, such environmental benefits can be amplified through the retirement of legacy (3G) networks, adding to an overall decrease in energy demand of 10% to 2030⁸, so Ofcom and policymakers should also remove roadblocks for legacy retirement.

- Also, an EC commissioned report found that “*One of the key benefits (€10.5 bn) identified in rural areas [of the EU28 is the] ability of 5G to address the **digital divide** and overcome difficulties in providing broadband connectivity in more rural areas where current fixed networks struggle to provide adequate service*” (emphasis added).⁹ Whilst 4G may be sufficient to support today’s Broadband Universal Service Obligation, this report appears to envisage that Universal Service Obligations of the future may require 5G as data usage and use cases evolve, implying that ‘addressing the digital divide of the future’ could meet Ofcom’s criteria for a 5G externality.
- In addition, greater **healthcare** consumption enabled by 5G – including through medical device tracking, emergency communications, remote healthcare for diagnosis and treatment, and remote surgery – will be likely to lead to significant wider benefits to society, given that individuals consuming healthcare – especially private healthcare – rarely factor in the impact of their good health on nearby people public services and the economy as a whole.

⁵ Ericsson, Sustainability and Corporate Responsibility report 2021, page 3 - https://www.ericsson.com/492fee/assets/local/about-ericsson/sustainability-and-corporate-responsibility/documents/2022/ericsson-sustainability-and-corporate-responsibility-report-2021_eng.pdf

⁶ Nokia, “Nokia confirms 5G as 90 percent more energy efficient”, 2 December 2021 - <https://www.nokia.com/about-us/news/releases/2020/12/02/nokia-confirms-5g-as-90-percent-more-energy-efficient/>

⁷ International Telecommunication Union, Recommendation L.Sup43: Smart energy saving of 5G base stations: Traffic forecasting and strategy optimization of 5G wireless network energy consumption based on artificial intelligence and other emerging technologies, approved on 20 May 2021 - <https://www.itu.int/rec/T-REC-L.Sup43-202105-I>

⁸ Harnessing data to empower a sustainable future | Accenture p.10 - <https://www.accenture.com/acnmedia/PDF-164/Accenture-BT-ThoughtLeadershipReport2021-FINAL.pdf>

⁹ Publication Office of the European Union, “Identification and quantification of key socio-economic data to support strategic planning for the introduction of 5G in Europe”, 6 February 2017, page 9 - <https://op.europa.eu/en/publication-detail/-/publication/2baf523f-edcc-11e6-ad7c-01aa75ed71a1/language-en>

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| | <ul style="list-style-type: none"> Furthermore, it is also highly likely that improvements in 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 – will also generate significant wider benefits to society given that, for example, those drivers who purchase such information services are unlikely to fully account for safety benefits that such services provide to other road users (on top of themselves). |
| <p>Do you agree with our views on how competition across the value chain may evolve over the next ten years, and the potential implications for the delivery of good outcomes, as outlined in Section 6?</p> | <p>The UK already has very extensive 4G mobile coverage, with four competing national mobile networks providing high speed outdoor coverage of almost all populated areas. In aggregate thanks to the Shared Rural Network programme funded by Government this will by 2027 cover 95% of the UK geography. The UK already has some of the most extensive 5G mobile coverage in Europe, with the projection that there will be over 50% population coverage by 2023, less than five years from when the networks launched. However, 5G population coverage across Europe has lagged behind other large, advanced economies including the USA (76%) and South Korea (93%), and average mobile downlink speeds are almost three times as high in South Korea as in Europe.¹⁰ UK 5G coverage has also lagged behind UK 4G coverage: while c. 50% of the UK population now have 5G coverage from at least one MNO, by comparison UK 4G population coverage had reached 72% within the first two years of launch.¹¹</p> <p>Some members have highlighted that given the amounts of mid-band spectrum currently authorised for use in the UK by mobile communication networks, the target IMT-2020 user data rates as specified by ITU-R for 5G networks cannot be met over wide areas (across cities) in the UK in the 2025-2030 timeframe. These members consider that it is important for the UK to develop a roadmap for the availability of additional mid-bands spectrum in support of macro-cellular 5G networks and their evolution.</p> <ul style="list-style-type: none"> Geographically, traditional network architectures will require extensions of connectivity to smaller and smaller RAN elements, such as small cells. Various spectrum allocations will also be required to best ensure the speed/coverage ratios are adequate to support the broadest uses of 5G wireless connectivity in a particular geography: Low-band spectrum (<1 GHz) that provides lower speed/broader coverage, mid-band spectrum (1 GHz - 6 GHz range) for higher speed/narrower coverage and high-band (>6 GHz) for highest speed/shortest coverage. There are four broad member views on licensing structures that techUK would like to summarise: |

¹⁰ ETNO (2021), The state of digital communications, Figure 1-5 and Figure 1-6. - <https://etno.eu/library/reports/95-state-of-digi-2021.html>

¹¹ 4G: Ofcom, The Communications Market Report, 7 August 2014. 5G: Ofcom, Connected Nations 2021, December 2021 - https://www.ofcom.org.uk/data/assets/pdf_file/0031/19498/2014_uk_cmr.pdf

- Alternative licensing structures, such as the CBRS bands in the United States¹², could allow smaller players to provide extended coverage capabilities beyond the reach of macro network providers, as well as allowing the use by national operators to provide additional capacity, or support specialised applications.
- Some members consider that Ofcom’s shared access licensing is a more appropriate authorisation model than CBRS.
- Some members see licence-exempt spectrum as important for short-range connectivity, whether using Wi-Fi or 5G-NR or other technologies.
- Some members see spectrum for national networks as the main priority, supplemented by existing shared access spectrum bands that Ofcom has made available and licence-exempt spectrum.
- Fixed-mobile convergence is an increasing phenomenon and connectivity can be provided to mobile devices over mobile and fixed networks, using a combination of licenced and licence-exempt spectrum.
- At a service level broadcasting content is also increasingly consumed over a range of platforms and technologies, i.e., DTT and IPTV over fixed or mobile broadband networks.

To effectively provide the necessary coverage, bandwidth and speed, plus support the shortening of product release cycles from quarters to months or even weeks, some techUK members see 5G Open RAN as a key design element into flexible network deployments. Having the ability to abstract elements of the traditional baseband RAN units into component parts (e.g., CU/DU) and placing these elements closer to the customer along with the ability to connect/control smaller antenna footprints will be critical drivers of enhanced coverage, Quality of Service (QOS) and capacity. For local coverage and the delivery of good outcomes, unlicensed technologies such as Wi-Fi 6E and Wi-Fi 7 will be available to support high-density, high-bit rate, and low latency use cases. Wi-Fi 6E is already available today, and Wi-Fi 7 is scheduled to enter the market in 2025.

techUK recommends that Ofcom approaches its future regulation of the UK’s mobile market in the context of a complex ecosystem of networks and services, rather than a sequential “value chain”. While there are clear indicators of growth in terms of data demand, there will be differing use cases, geographies, business models and deployments that will require a multi-modal regulatory approach. This approach will ensure that the increasing role that hyperscalers, cloud providers and non-mobile operator players benefits consumers and businesses who use mobile technologies and services.

¹² Ericsson Citizen's Broadband Radio Service - <https://www.ericsson.com/en/small-cells/cbrs>

As set out in Section 6, do you agree that quality of experience will become more important in the future? Do you agree that developing better information on quality of experience for customers will help further the delivery of good outcomes?

Ofcom has defined a mobile internet access service that offers a good quality of experience if it meets the customer's connectivity needs. This includes in relation to factors such as coverage, reliability and performance. As there is such a wide variation in what a customer's connectivity needs may mean in practice, it is hard to provide detailed information on each experience and therefore quality. However, in answer to the first part of this question, techUK agrees that quality of experience will become more important in the future.

The impact of the COVID-19 pandemic is useful to consider in terms of accelerated digital transformation of the UK's economy and society. At the core of the British people's COVID-19 response was the way individuals, businesses, and Government utilised technology to create new ways of working, connecting, and shopping.

techUK expects many of the adaptations seen during the pandemic to have a long-lasting impact on wireless connectivity demand as the UK moves towards a full "digital society".

Wireless connectivity helped enable many people to work remotely; solving challenges around staying connected to colleagues, applications, and customers during the pandemic. Studies revealed that during the pandemic wireless connectivity, and specifically home Wi-Fi was seen as vital as electricity for sustaining a way of life to stay productive, informed, entertained, and connected. People rely on, and value, their home Wi-Fi more than ever.¹³ Wireless connectivity also supported access to a wide range of public services from health to education to justice. 58% of the global workforce are expected to be working from home for at least 8 days a month and that 98% of meetings in the future are expected to have at least one remote attendee.¹⁴ In 2030, it is likely we will see employees seek greater flexibility in ways of working and employers seek to leverage the benefits of collaboration technologies in terms of employee engagement, sustainability and widening talent pools.

Beyond hybrid work, techUK would like to point to a number of use cases that may impact wireless connectivity requirements by 2030:

- Health and social care: Enabling self-sufficiency and at home care via the provision of remote patient support will be a major consideration of future connectivity, as well as assisted living services, and ensuring health and social care settings are safe, innovative and efficient.
- Entertainment and at-home internet access: we expect an increase in consumer use of communications devices for more immersive experiences, driving up the volume of data moving across our networks, including connected home

¹³ Airties: Consumer expectations for home Wi-Fi, 2021 - https://insights.airties.com/consumer-expectations-home-wi-fi-report?utm_campaign=21Q3-consumer-survey-report&utm_source=press-release

¹⁴ Cisco: Embracing the hybrid workplace, 2021 - <https://www.cisco.com/c/dam/en/us/solutions/collateral/collaboration/embracing-the-hybrid-workplace.pdf?ccid=cc001191&oid=ebkco023382>

devices, AR/VR, and haptic controls which have demanding latency and throughput requirements.

- At-work use cases: we expect an increase in companies and public sector organisations to repurpose or reconfigure workspaces, including the deployment of more smart building solutions.
- Industry 4.0/Enterprise Internet of Things (IoT): a significant increase in the number of IoT devices used in a broad range of enterprise sectors such as ports and logistics, manufacturing, construction sites, utilities networks and public sector settings (like healthcare, as above). In the utilities sector we expect this to intersect with the need for greater resilience and cyber security, efficiency gains and the move to a net zero economy. The UK Digital Catapult has also identified opportunities for 5G in Industrial applications.¹⁵
- Transport: as part of the “smart” town or city, the UK’s transport networks will have increased their use of advanced connectivity by 2030, with the expectation that connected autonomous vehicles (CAVs) are increasing in their presence on UK roads. CAVs will require constant connectivity and failover methods to ensure instructions are fed to the cars, acted upon and relevant data exchanged back to the network.
- Agri-tech: the use of sensors, robotics, automation and remote tech in the UK’s agriculture sector will drive demand for high-capacity connectivity in this sector.

On the development of better information on quality of experience for customers to help further the delivery of good outcomes, techUK recommends Ofcom prioritises this to ensure the right regulatory approach. Mobile data traffic information should reflect differences in:

- Upstream and downstream traffic
- Device types: as Ofcom notes, the growth in use of devices such as IoT, wearables and sensors will need to be considered alongside smartphone traffic
- Interconnection between different networks and mobility between spaces (from outdoor cellular to indoor Wi-Fi as an example)
- Public spaces and private spaces and buildings, which may operate a separate network or system
- Geographical spread i.e., reflecting both rural and urban areas

Moreover, any network quality metrics must be:

- Rooted in real customer experience (not modelled)
- Less about peaks of network performance, more about consistency of actual customer experience

¹⁵ Digital Catapult: Industrial 5G – Toolkit for Business in a Digital Future, 2021 - <https://www.digicatapult.org.uk/news-and-insights/publications/post/industrial-5g-toolkit-for-business-in-a-digital-future/>

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| | <ul style="list-style-type: none"> • Technology agnostic – customers care about the experience, not how it is delivered • Flexible enough to deal with future innovations/lifting of performance standards/new use cases |
| <p>Do you think there is more that could be done to reduce barriers to customers receiving good indoor coverage (see Section 6)? If so, please outline what steps could be taken and what impact those steps would be likely to have.</p> | <p>Yes. Ofcom’s discussion paper, “Meeting future demand for mobile data”, recommends increasing the densification of small cells to significantly increase mobile network capacity. While techUK supports the intention to allow more small cell deployment to help achieve this increase, there are notable challenges in this approach.</p> <p>Firstly, outdoor small cell deployment is still a costly investment and may prove economically challenging in terms of improving indoor mobile coverage. Secondly there are often practical or commercial barriers to small cells deployment.</p> <p>Provision of additional sub-1GHz spectrum would enable improved indoor coverage as the available network capacity indoors would increase in proportion to the amount of spectrum available that penetrates well into buildings.</p> <p>Additional in building coverage solutions will also play an important role in improving indoor coverage in areas where it is feasible to deploy these, and they are commercially viable.</p> |
| <p>Do you agree that clarifying our future regulatory approach will help encourage investment, as outlined in Section 7?</p> | <p>Yes, techUK agrees that Ofcom should set out more explicitly how it has considered investment when making future policy decisions. We welcome Ofcom’s decision to focus on compliance, monitoring and understanding the impact of existing consumer pricing rules, rather than introduce any new consumer initiatives. As outlined in Answer 2, we welcome Ofcom’s stance on potential mergers (“potential merger would therefore be informed by the specific circumstances of that particular merger, taking into account how markets are evolving”).</p> <p>Some members feel strongly that Ofcom has a role to play in levelling the playing field in addressing the emerging market power of larger tech players. That said, techUK feels that innovation across the entire telecoms ecosystem, including services and applications, is a key driver of good outcomes for consumers of mobile technology.</p> <p>There are a number of important spectrum related barriers to 5G investment, most notably the high annual fees charged for mobile spectrum used to deliver the public networks and the absence of committed roadmap for additional spectrum bands for the longer term.</p> <p>The public mobile network operators, in addition to one-off auction payments that run into many billions of pounds, face recurring annual fees (ALFs) in excess of c.£325m each year. These ongoing fees are seen as unnecessary to secure optimal and efficient use of spectrum, particularly given the tradability of the spectrum licences and the increasing evidence of high value mobile spectrum trades. The ALFs</p> |

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| | <p>are akin to a tax on mobile networks and inevitably impact retained profits of operators, which in turn has a negative impact on the ability to invest in networks, leading to slower or less extensive deployments than would otherwise be the case, as well as risking higher consumer prices. These excessive and unnecessary spectrum fees should be removed or, at the very least, significantly reduced. Government could also consider how it could use auction revenues and spectrum fees to re-invest in the mobile industry where it is appropriate to do so, such as improving coverage where it is otherwise not economically viable as it has done in the Shared Rural Network programme.</p> <p>Beyond spectrum we are also concerned that Government recognises the changes in the industry structure, which are driven by technological developments in the way in which networks are built and provided; as well as in the services delivered over them. These changes mean that competition (between MNOs) is likely to become even more pronounced than to date and this is not consistent with a wireless network investment ambition that goes beyond the stable pace of investment the industry has delivered to date.</p> <p>As there is a direct link between profitability and investment, we consider it is important that Government looks more holistically at the wireless sector supply chain, including the changing barriers to entry. While these are falling across the board, there is the potential for new barriers to dampen incentives by network operators but also smaller over the top service providers to invest and innovate. Government needs to be mindful of these new types of bottlenecks and continue its work to address these new bottlenecks as they arise.</p> |
| <p>Are there any other potential barriers to the delivery of good outcomes over the next five to ten years that we have not considered? If so, please outline what these are likely to be, with supporting examples/evidence where possible, and any suggestions for how they might be reduced.</p> | <p>Currently Ofcom publishes pricing information in both its annual Communication Market Report¹⁶ as well as Telecoms Quarterly update.¹⁷ However, these regular publications on consumer outcomes do not have the right focus or emphasis because they focus too much on nominal mobile prices which do not provide information on trends in value for money for consumers. We suggest that Ofcom should publish quality adjusted (for example, per-GB) prices alongside nominal prices as well as the increase in input prices telcos face. Reporting metrics on input costs and quality adjusted prices can better support regulatory and policy decisions by ensuring such decision are holistic and robust.</p> |

¹⁶ Communications Market Report 2021 (ofcom.org.uk) - https://www.ofcom.org.uk/data/assets/pdf_file/0011/222401/communications-market-report-2021.pdf

¹⁷ Telecommunications Market Data Update Q3 2021 – Ofcom - <https://www.ofcom.org.uk/research-and-data/telecoms-research/data-updates/telecommunications-market-data-update-q3-2021>