Ofcom Consultation

Meeting future demand for mobile data

About Ericsson

Ericsson enables communications service providers to capture the full value of connectivity. The company's portfolio spans Networks, Digital Services, Managed Services, and Emerging Business and is designed to help customers go digital, increase efficiency and find new revenue streams. Ericsson's investments in innovation have delivered the benefits of telephony and mobile broadband to billions of people around the world. The Ericsson stock is listed on Nasdaq Stockholm and on Nasdaq New York. www.ericsson.com

Ericsson welcomes the opportunity to respond to Ofcom's document 'Meeting future demand for mobile data – 9th February 2022'

Ericsson Summary

We live in a rapidly changing world on the cusp of a new era of possibilities. That naturally brings uncertainty, but also a wealth of exciting opportunities. Over the next decade, several forces will shape our world and how we live and work, from the climate crisis through to technological advancements such as AI. Having a robust ambition in mobile connectivity and a pathway to deliver a Digital Strategy will be critical to success in terms of GDP, upskilling/transforming the workforce, attracting inward investments as well as cyber security, and achieving net-zero emission targets.

Leveraging the innovative 5G systems over the coming decade, this wireless infrastructure will be pivotal to delivering the UK's digital connectivity. 5G technology is different to the previous generation of wireless technology and has the potential to ensure that anyone and anything can connect anywhere and at any time, enabled by nationwide coverage, massive data rates and the low latency needed for all applications. With limitless connectivity, consumers and business will use applications and be able to focus on their tasks without any concern for lost or poor connectivity. Mobile networks will need to adapt to demands as they develop and change, interact with applications to understand their needs, and support diverse types of devices. This will require the continued expansion of wireless communication, targeting full coverage, closing the digital divide, while supporting a dramatically higher number of devices that will be embedded throughout society.

Wireless connectivity will enable immersive learning experiences and access to quality training, acquiring new skills and knowledge will become an enriching lifelong journey for everyone. It will fundamentally reshape the way enterprises design, produce and deliver their products and services. Wireless technology has the opportunity to support the move towards a low-carbon economy across many industries and society.

Consultation questions

Future demand for data through mobile networks (as opposed to demand for data more generally).

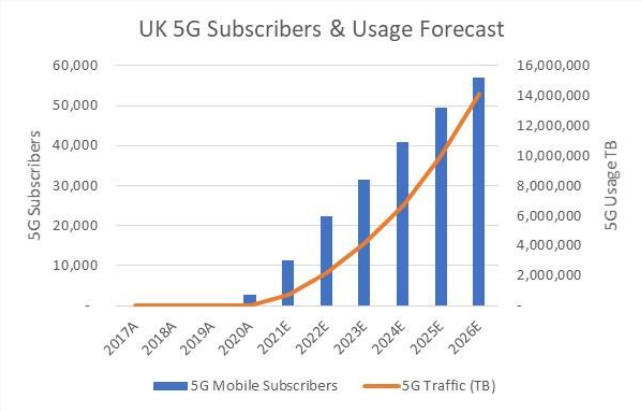
Ericsson forecasts a continued increase in data demand. As Ofcom's stated, '*there is considerable uncertainty about the growth rate of future demand*'. Given the rapidly changing world we live in, this uncertainty principle applies to forecasts for any service, not only mobile.
Ericsson sees a similar trend to Ofcom in relation to data increase, i.e., mostly where people live and work. However, we also see the need to continually assess rural areas to ensure that there is digital equality, meaning that while the capacity and quality of services extends digitalisation possibilities in urban areas, it is critical to ensure that rural areas are not left behind.

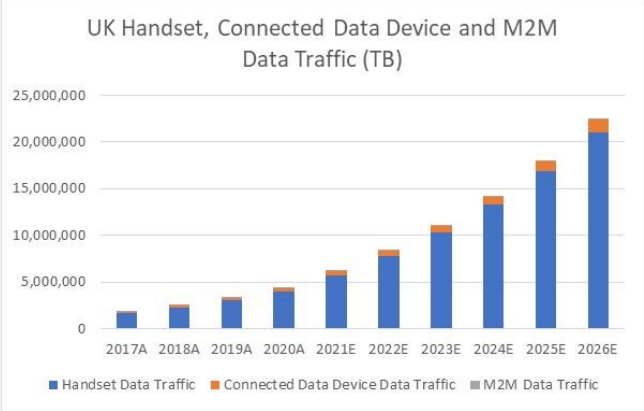
In the analysis, Ofcom considers three scenarios:

- **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

Following trends for the last ten years and considering the potential innovation of 5G, Ericsson believes that the low growth scenario is unlikely. In addition, the high growth scenario is probably understated.

As shown in figure 1, the MNOs are expecting 38% CAGR 2021-26 in 5G subscribers and 80% CAGR 2021-26 in 5G data usage. Nationwide wireless network capacity, coverage, and security is of utmost importance to ensure that individuals, both as customers and citizens, as well as businesses, are not left behind. The need for spectrum across all bands to meet the capacity demands is set to increase at a rapid rate.





Source: Global data and Ericsson analysis

Figure 1 - 5G Subscriber and Usage Forecast (LHS) and Mobile Data Forecast (LHS)[1]

According to the Ericsson mobility report[2], total global mobile data traffic – excluding traffic generated by fixed wireless access (FWA) – is estimated to reach around 65EB per month by the end of 2021 and is projected to grow by a factor of around 4.4 to reach 288EB per month in 2027. Including FWA traffic, this takes the total mobile network traffic to around 80EB per month by the end of 2021, and 370EB per month by the end of 2027.

The potential opportunities and challenges associated with network densification in the UK.

As stated by Ofcom, new spectrum is not the only way for network operators to increase capacity. Indeed, densification is a tool that can help; however, it will not be able to resolve the capacity demands in urban areas alone.

A critical component is the cost-efficient deployment of dense networks. The current mobile cell site grid was established during the deployment of 2G and 3G. More Macro cell sites are required to take full advantage of the 5G socioeconomic benefits. However, there are numerous deployment barriers that need to be addressed, including access to new sites, planning, and mast height. With today's power-efficient lightweight RAN portfolios designed to simplify rollout, it should be quicker and more cost-effective to deploy new macro sites. Tightening the macro grid inter-site distances (ISD) is common practice among operators. The minimum ISD is technically limited by needing to manage interference only. This gives the opportunity for macro densification.

The architecture and technology choices in a 5G network are about delivering the right connectivity where users need it, while maximizing the available spectrum assets. Mid-band spectrum covers the 1–7GHz bands, and services on mid-band spectrum are often delivered from macro towers on outdoor radios serving indoor and outdoor environments. The increase in capacity comes from the use of wider bands, and higher 5G coverage and capacity per band are enabled by new radio (NR) technologies.

Where the 5G macro network cannot penetrate buildings indoors, 5G indoor small cell radios are required to deliver high per-user capacity and rate coverage everywhere. This will also improve performance in the macro network by offloading the traffic generated in hotspots. The 5G network platform creates a wireless environment where both indoor and outdoor networks perform perfectly and seamlessly, enabling the best end-user experience. Locations that require high-quality indoor 5G experiences fall into two broad categories:

[1] Source: Ericsson analysis and Globaldata.

[2] Ericsson Mobility Report

Consumer for locations such as airport terminals, shopping malls, and underground stations; and Enterprise and Public places like hospitals, convention centres, factories, and offices.

As indicated by Ofcom, small sites in mmWave while offering large capacity, they have reduced coverage. mmWave deployment is suitable for very dense areas, which will help to release capacity needs in terms of mid-band range in such areas. However, sustained coverage cannot be maintained by mmWave, and additional mid-band spectrum is needed to complement. In fact, mid-bands can expand the mmWave coverage by the implementation of carrier aggregation of both bands.

Network energy performance will be critical, an acceleration in traffic should not mean accelerated energy usage. Sustainability is at the top of all agendas. Wireless communication already plays an important role here, and there is clear potential to further accelerate its contribution in enabling increased efficiency in the use of resources and support of new ways of living, making it a tool for sustainable change. A recent MIT/Ericsson report, Decarbonizing industries with connectivity & 5G[3], describes the potential for wireless infrastructure to support the reduction of carbon emissions in the Energy, manufacturing, and transportation sectors.

Nationwide wireless network capacity, coverage, and security is of utmost importance to ensure that individuals, both as customers and citizens, as well as businesses, are not left behind. To achieve the full potential of 5G users will need a consistent minimum throughput of around 20Mbps with a time to content of less than 1.5 seconds as outlined in the Ericsson Mobility Report November 2021[4]. Service providers are aware that a good user experience is key for driving customer satisfaction, thereby reducing churn and improving financial return. The Ericsson study to measure and benchmark the network performance required for a positive user experience suggests this minimum level 20Mbps should be possible at anytime and anywhere.

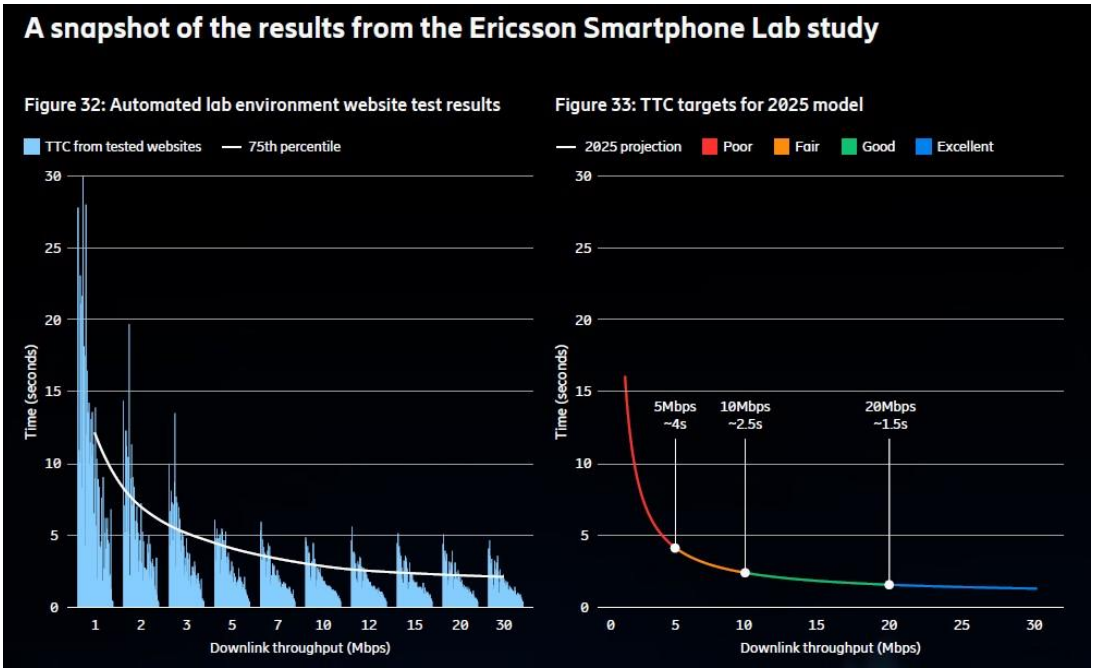


Figure 2- Measure and Benchmark of network performance required for positive user experience using Time To Content (TTC) from Ericsson Mobility report November 2021

[3] MIT, Ericsson report Decarbonizing industries with connectivity & 5G

[4] Ericsson Mobility report November 2021 Time-to-content: Benchmarking network performance

The GSMA report, 5G Mid-Band Spectrum Needs – Vision 2030[5] already assumes densification among other enhancements in mobile networks as a pre-requisite to calculate the total spectrum needed in the mid-band range. Densification alone cannot address the capacity demands across cities.
The GSMA analyses compares the radio network cost and power consumption of addressing the 2025-2030 demands by small cells only, with the alternative of a combined strategy of densification, technology evolution with new spectrum. As an example, Paris is analyzed and concluded that the economic cost would be around 4.4x and power consumption would increase by 2.2x by only densifying the networks with small cells (note that the study assumes the maximum level of macro grid densification and complete network evolution in all sites to 5G).

Whether there are specific frequency ranges which should be considered for mobile access to support capacity provision in the future.

Spectrum is a scarce resource and available spectrum is hard to find. In fact, "free of use" spectrum does not exist in practice.

The architecture and technology choices in a 5G network are about delivering the right connectivity where users need it, while maximizing the available spectrum assets. Different 5G spectrum bands provide different capabilities:

1. Low-band 5G spectrum comes from a mix of re-farmed spectrum from early mobile generations (1G, 2G) and previously unused bands. This type of spectrum is suitable for building out a foundation for 5G coverage.

2. Mid-band spectrum covers the 1–7GHz bands and includes existing 3G/4G bands, as well as new spectrum licenses for mobile services. The increase in capacity comes from the use of wider bands, and higher 5G coverage and capacity per band are enabled by new radio (NR) technologies. This can address the capacity demands across cities and help to bridge the digital divide between cities and busy towns and villages.

3. High-band (also known as mm wave frequencies) spectrum is completely new for 5G and enables the launch of services with high performance in dedicated zones. The coverage for 5G services in this spectrum band is less than the coverage provided by low- and mid-band spectrum but serves larger zones than Wi-Fi hotspots.

Services on low- and mid-bands can be delivered from existing and new macro towers and can also serve indoor environments from outdoor radios. Delivering services on high bands relies on a combination of radios on towers and small cell poles to cover outdoor areas, while indoor coverage is achieved by deploying indoor small cell solutions. 5G services will be seamlessly delivered over all three bands as they become increasingly available over time.

Ofcom has already allocated 416.6 MHz of shared access spectrum bands within the mid-band range (i.e. 1800 MHz, 2300 MHz, and 3800 to 4200 MHz band), with the possibility to deploy low power indoors in all these bands. As figure 3 below shows, there is already a large amount of spectrum available for these types of applications in spectrum ranges with similar achievable performance considering that the definition of 50m radius licenses should translate into tremendous re-use of the same spectrum block. Looking at the chart its

[5] GSMA 5G Mid-Band Spectrum Needs – Vision 2030

seems disproportionate to allocate more spectrum to shared or unlicensed use when compared to the allocated MHz for national Mobile Network Operators.

Given the number of licenses that have been issued for local shared licenses in the mid-bands and the remaining unused spectrum, it is not clear why there is the need to include additional spectrum bands with the same characteristics. Figure 2 below is a table of the shared licences as of the 18th of February 2022.

Considering this, we would respectfully recommend Ofcom not to allocate more spectrum on a shared basis at this point in time, and the current proposal for the upper 6GHz should be delayed until the 2023 World Radiocommunication Conference (WRC-23) has concluded and determined the future access to the upper 6 GHz range (6425-7125 MHz).

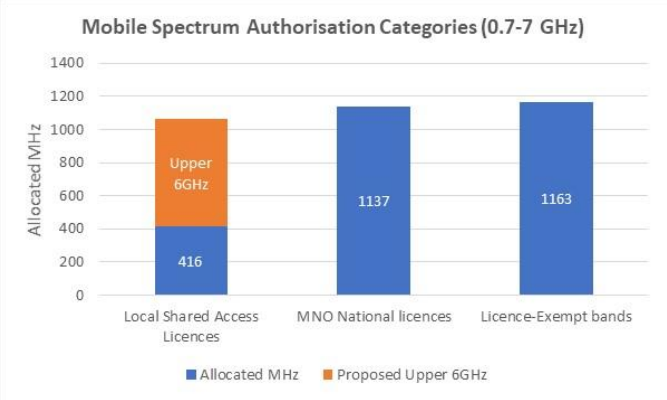


Figure 3 - Mobile Spectrum 0.7-7 GHz[6]

Shared Access licence (February 18, 2022)		
Band	Low Power	Medium Power
1781.7-1785/ 1876.7-1880 MHz	838	111
2390-2400 MHz	29	0
3.8-4.2 GHz	156	245
24.25-26.5 GHz	1	0

Source: Ofcom license information

Figure 4 - Number of Shared Licences[1]

Ericsson agrees that there are different factors to boost capacity with current spectrum:

- Upgrade networks to the latest technology to improve spectral efficiency.
- Macro cell densification.
- Small cell densification (both indoors and outdoors)

However, there are technical limitations for macro cell densification (to avoid interference between cells). Small cells densification (indoor and outdoor) are to be further exploited by operators, however, there are also technical limitations (i.e., interference). While small cell densification can help to "offload" traffic from macro cells, it is also not an economically viable option on its own to address capacity needs towards 2030. MmWave spectrum will help to address high capacity needs in specific places (i.e., very dense areas). However, we would like to emphasize that opposite to what Ofcom states in the consultation, densification on mmWave spectrum is not economically feasible for MNOs to address increased capacity needs across cities. Additionally, we don't envision mmWave to be largely used in rural areas for the same reason (i.e., not economically viable). In other words, while mmWave will help to "offload" capacity in certain areas in the city it is unlikely to be used to address capacity needs across the cities. More mid-band spectrum will be required as well to ensure operators do not run out of spectrum. Thus, Ericsson cannot fully agree with Ofcom's statement:

> *Without additional spectrum or small cell densification using mmWave operators could run out of capacity in some areas by around 2025.*

[6] Source: Ericsson analysis and Ofcom data

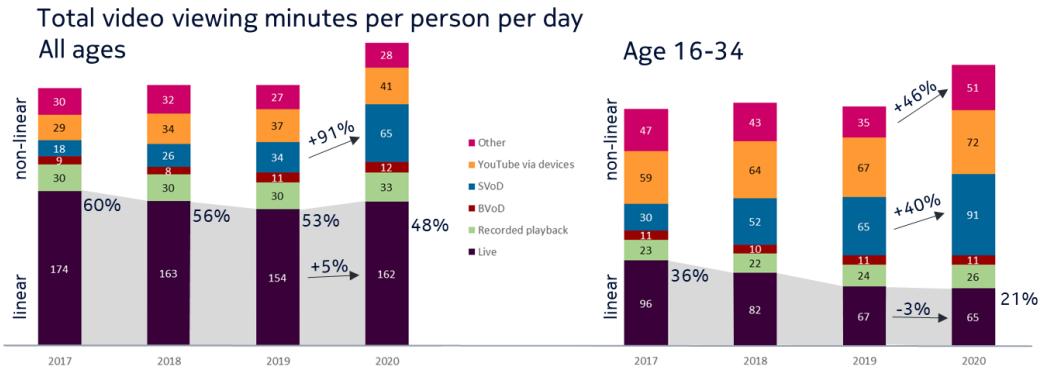
Indeed, even with small cell densification and mmWave spectrum, operators will run out of spectrum sometime between 2025-2030. The year will depend on the uptake of the different use cases.

We note that Ofcom indicates that spectrum available today together with spectrum in Lband and mmWave that will soon be considered is enough to address demand towards 2030. However, Ericsson is of the view that this will not be sufficient towards the end of the decade (2025-2030). In fact, GSMA estimates that 2 GHz of additional mid-band spectrum is needed for the 2025-2030 timeframe[7]. Assumptions behind this report are aligned with Ofcom's thinking, as an example, it assumes that all sites are upgraded to 5G (using the most efficient use of spectrum), it includes macro cell densification as well as small cell densification in mid-bands (both indoors and outdoors) and additionally it assumes usage of mmWave spectrum. In the UK, there is only one additional mid-band spectrum, 6425-7125 MHz, that can be considered to address the future nationwide capacity requirements.in the 2025 -2035 timeframe.

Considering the spectrum demand increase and the different technological tools available for operators, Ericsson believes that a combination of site upgrades to 5G, (indoor/outdoor) macro and small cell densification, mmWave spectrum and additional mid-band spectrum in the upper 6 GHz is needed.

Ericsson understands the need for spectrum by other technologies and, in particular, the request by WiFi of upper 6 GHz. Ofcom indicates in the consultation the availability of 14 GHz of spectrum (57-71 GHz) for SRD, which should be exploited, in the same way as mobile operators (will) make use of mmWave in the UK, i.e., for more localized capacity hungry use cases.

Mid-bands can be relevant for 5G FWA bringing fixed infrastructure to less populated areas. However, when looking in particular at the deep rural areas, low band spectrum is the only economically feasible alternative for operators. While we think on capacity increase for cities, we must do the same for rural communities, otherwise the digital divide will just increase. In this regards, 600 MHz is the option under consideration. While we understand that there is a need for DTT to continue until at least 2030 and probably beyond, in the UK, we also understand the declining usage of DTT, as indicated in Ofcom's Media Nations report [8]. See figure 5.



Source: Ofcom media nations data

Figure 5: Ofcom media nations data 2021, total video viewing minutes per person per day.

[7] GSMS report - Estimating the mid-band spectrum needs in the 2025-2030 timeframe

[8] Ofcom report - Media nations: UK 2021

6G is also mentioned by Ofcom. Ericsson sees 6G starting to be commercially available around and beyond 2030. It is early days, but we see that 6G will enhance and realize some of the 5G use cases with the emergence of new concepts such as connecting the cyber physical world[9]. Ericsson alongside the industry has started to explore the potential of 6G[10]. Ericsson agrees with Ofcom's proposal to consider further 7-20 GHz range and 'Terahertz' bands above 100 GHz. Ericsson suggest to initially focus on the lowest parts of those ranges 7-15 GHz and sub-THz (e.g., W and D band).

Ofcom states that making additional spectrum available for high-power outdoor mobile use would likely require clearing bands of existing users.

Ericsson and the mobile industry continue working towards improving inter-service spectrum sharing with incumbents in the band when possible. The bands that are to be considered for coverage and capacity expansion are as follows: -

6425-7125 MHz. Ofcom mentions a number of services allocated on a primary basis: satellite, fixed links. These services are being studied within CEPT PT1[11] as well as ITU WP 5D[12], while studies are not finalized, we would like to emphasize the following:

- FSS UL: While at the beginning of the WRC cycle there were many concerns in relation to sharing with FSS UL, there is a positive conclusions both from industry (e.g. WP5D 1032[13], Ericsson) and administrations (e.g. WP 5D 1042[14] by France);
- FSS DL: studies both from industry and administrations show that this can be solved with separation distances (e.g., WP 5D 1017[15], Ericsson). Although we understand this is not an issue in UK.
- FS: we noted the map included in the 6 GHz consultation with the locations of fixed links. As a FS supplier, Ericsson believes that co-existence can be solved on a case-by-case via coordination. This coordination can be done with an appropriate licensing regime.

Ofcom mentions RAS allocated on a secondary basis, although sharing needs to be analyzed, it can be solved on a national basis with geographical separation. EESS is also of importance for Europe, although we note that today EESS sensors are already operating while receiving interference from such services. The sensors leverage on interference mitigation techniques that allow retrieval of useful data from EESS observations even when subject to interference.

Sub-700 MHz. While sharing of DTT and 5G spectrum in the same geographical area has been proven not to work, we recognize that DTT is very differently used across Europe (i.e., some countries having no DTT, while others heavily relying on it). The UK appears to have a steady decline of DTT usage. Ericsson supports the finding of a flexible solution within CEPT that allows countries to follow different strategies and timelines.

[9] Ericsson white paper – 6G connecting a cyber-physical world.
[10] Ericsson vision for 6G and the journey there
[11] CEPT ECC PT1 IMT matters
[12] ITU Radiocommunications working party 5D - IMT systems
[13] ITU-R WP5D contributions: 1032
[14] ITU-R WP5D contributions 1042
[15] ITU-R WP5D contributions 1017