GTI White Paper on Future Spectrum Demand of 6GHz Band

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Document History

Date	Meeting #	Version #	Revision Contents
23-8-2021		V0.0	The draft skeleton version of GTI white paper of future spectrum demand of 6GHz Band
03-11-2021		V0.1	The draft skeleton confirmed
30-11-2021		V0.2	Drafts of chapter 3, 4, 5, 6, 7
09-02-2022		V1.0	Draft white paper 1.0
16-2-2022		V1.1	Draft white paper 1.1 with conclusions
18-2-2022		V2.0	Draft white paper 2.0 for complete version

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2 Executive Summary

GTI as open platform driving for 5G global development and evolution, have been studying the 5G spectrum strategy to facilitate further mobile applications and demands for our future development, taking into account the world wide spectrum development for 5G, especially the new spectrum that could fulfill our next 5-10 years traffic growing demand. This white paper updates the global market development progress, application trends, analyzes the spectrum needs and addresses how new spectrum could benefit both the new market of mobile networks and the industry innovations.

3.5 billion 5G subscribers are forecasted in 2026. 5G is the pillar for digital transformation, enhanced mobile broadband and FWA, which will play important role for industry digital transformation and smart society for healthy and sustainable world. 5G will continue to contribute to GDP growth, new businesses and use cases with new jobs. Additional indirect and productivity benefits bring the total contribution of the mobile industry to almost $4.4 trillion.

5G as the platform of innovation and digital backbone of society will help to facilitate digital industry transformation covering different use cases and applications in manufacturing, transportation, retail, Agriculture, logistics. 5G delivers social value across many areas like healthcare, energy/utilities and smart city and creates more immersive entertainment and more engaging education.

The white paper endorsed the methodology used by GSMA in their white paper “Estimating the mid-band spectrum needs in the 2025-2030 time frame” to calculate the spectrum needs from various 5G use cases like connected vehicles, video camera and sensors together with human users applications. It shows the downlink area traffic demand and spectrum needs in selected cities and

FWA deployment cost saving vs. FTTH in rural areas.

The white paper concludes that additional spectrum is needed for IMT/5G to provide the capacity for innovation and future development. Harmonization of the 6 GHz spectrum for IMT is imperative to sustain future capacity needs for affordable connectivity. Without 6GHz band as upper mid-band spectrum, we can not fulfill the spectrum needs to satisfy our traffic demand and service capacity requirement for the 5G use cases and applications for 2025-2030 time frame that we address in the paper. 3GPP has started the work towards building an ecosystem in 6GHz for 5G NR. Sharing studies started in ITU—decision on IMT for 6GHz will be taken in WRC-23 Proposed way forward. GTI will follow and contribute to the ITU process and push for global 6GHz IMT ecosystem.

3 Abbreviations

Abbreviation	Explanation
AI	Artificial Intelligence
APT	Asia Pacific Telecommunity
AR	Augmented Reality
EDGE	Enhanced Data GSM Evolution
eMBB	Enhanced Mobile Broad Band
FTTH	Fiber To The Home
GDP	Gross Domestic Product
GSA	Global Supplier Association
GSM	Global System of Mobile Communication
GSMA	GSM Association
IMT	International Mobile Telecommunication
IoT	Internet of things
ITU	International Telecommunication Union
LTE	Long Term Evolution
MTC	Machine Type Communication
NR	Next generation Radio
UNESCO	United Nations Educational Scientific and Cultural Organization
URLLC	Ultra-Reliable Low Latency Communication
VR	Virtual Reality
WCDMA	Wideband Code Division Multiplex Access
XR	Extended Reality

4 Introduction

Looking at the global market development, 5G has been widely deployed in the world. It is integrated into thousands of industries, connecting people, machines, data and applications, for the whole social life and production in various industry, bringing digital transformation and intelligence and improving the efficiency of social governance, production efficiency, and ultimately drive the development of the world economy. In the whole digital process, 5G as the wireless channel of data transmission, has become the essential needs of this digital society, and the full deployment of 5G network, spectrum planning and licensing is the most important aspect of 5G network deployment and evolution. Based on the original available spectrum of 1.9GHz, WRC-19 successfully identified the IMT mm wave spectrum of 17.25 GHz for the first time, giving the IMT system a new experience in a wider and more frequent band.

However, considering the new business and demand of digital society, the growing mobile data flow, the need for 5G new spectrum to carry out the next step of consideration on what aspects of the new spectrum challenges, what the cost efficient 5G network deployment could further benefit the market extension, fast product development and ecosystem building up are the key issues for the industry to have a clear vision and preparation for the way forward.

GTI as open platform driving for 5G global development and evolution, have been studying the 5G spectrum strategy to facilitate further mobile applications and demands for our future development. It's very critical for GTI to start the study and take into account the world wide spectrum development for 5G, especially the new spectrum that could fulfill our next 5-10 years traffic growing demand. This white paper will update the global market development progress, application trends, analyzes the spectrum needs and addresses how new spectrum could benefit both the new market of mobile networks and the industry innovations.

Mid-band spectrum has more advantages for balancing both coverage and capacity. China proposed the new agenda items for WRC-23 in APT preparatory meeting for WRC-19 to study frequency matters for identification of IMT in the frequency range of 5925-7125MHz, or part thereof, for the future development of IMT. 6GHz is key to contribute to the mid-band spectrum needs. It is globally allocated already to mobile service on primary basis and it's similar in terms of radio propagation characteristics like 3.5GHz with larger contiguous blocks available and potential for wide economies of scale. Therefore, GTI would like to support this band for IMT to meet the traffic growing demand for future.

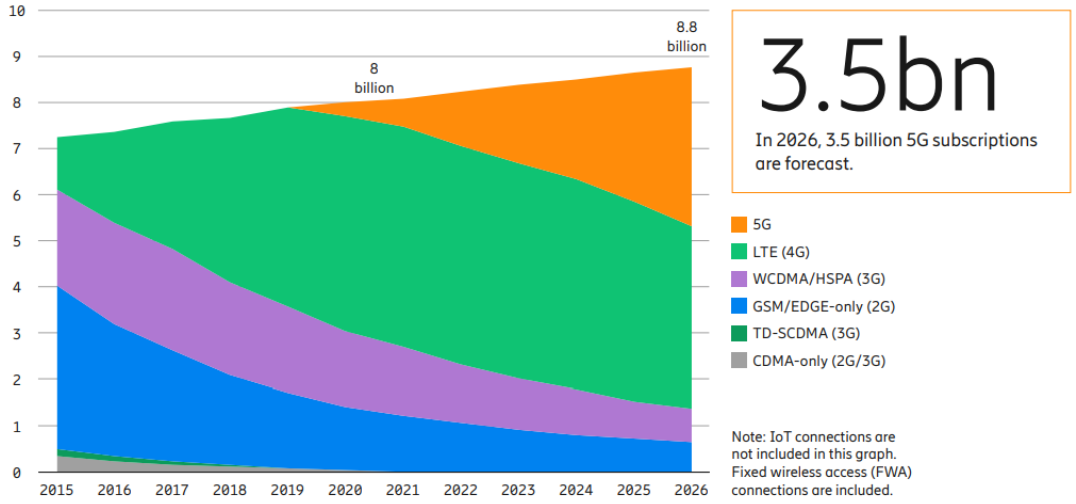
Based on the study in the white paper, we would like to conclude a GTI proposal of the future 5G 6GHz spectrum demand and strategy for developing the products and our view towards WRC-23 AI 1.2 as well.

5 Mobile Subscription Forecasts Including Percentage of 5G Subscription Forecast

According to the progress of 5G global development in wide variate of countries and regions, the speed of 5G growth is much higher than it was in 4G launch. It shows industry continues drive innovations and develop new technology to improve better user experience and creating new applications especially expansions to various vertical markets. According to our statistics, there are 159 Operators Launched 5G Commercial Services, 443 Operators in 133 Countries & Regions are investing in 5G networks in the form of tests, trials, planned and actual deployments. More and

more type of 5G smartphone launched commercially supporting more frequency bands. According to Ericsson Mobility Report[1], before the end of this year, we will have surpassed half a billion 5G users in the world, 5G subscriptions are expected to reach 580 million. 5G subscriptions with a 5G-capable device grew 70 million during the first quarter, to reach around 290 million. Currently, North East Asia has the highest 5G subscription penetration, followed by North America, Gulf Cooperation Council countries and Western Europe. In 2026, it is projected that North America will have the highest share of 5G subscriptions of all regions at 84 percent. 5G subscription uptake is expected to be faster than that of 4G following its launch in 2009. 5G subscriptions are estimated to reach 1 billion 2 years earlier than 4G. Key factors include China's earlier engagement with 5G compared to 4G, as well as the timely availability of devices from several vendors. By the end of 2026, we forecast 3.5 billion 5G subscriptions globally, accounting for around 40 percent of all mobile subscriptions at that time. 4G will remain the dominant mobile access technology by subscription over the forecast period. During Q1 2021, 4G subscriptions increased by approximately 100 million, exceeding 4.6 billion, equaling 58 percent of all mobile subscriptions. It is projected to peak during the year at 4.8 billion subscriptions before declining to around 3.9 billion subscriptions by the end of 2026 as more subscribers migrate to 5G. The net addition of mobile subscriptions was quite low during Q1 2021, at 59 million.

Figure 1: Mobile subscriptions by technology (billion)



Today, there are around 8 billion mobile subscriptions. It is estimated that this figure will increase to 8.8 billion by the end of 2026, of which 91 percent will be for mobile broadband. The number of unique mobile subscribers is projected to grow from 5.9 billion in Q1 2021 to 6.5 billion by the end of the forecast period. Smartphone penetration continues to rise, and subscriptions associated with smartphones account for about 76 percent of all mobile phone subscriptions. At the end of 2020, there were 6 billion smartphone subscriptions. This number is forecast to reach 7.7 billion in 2026, which will account for around 88 percent of all mobile subscriptions at that time. Subscriptions for fixed broadband are expected to grow around 4 percent annually through 2026.3 FWA connections are anticipated to show strong growth of about 20 percent annually through 2026. Subscriptions for mobile PCs and tablets are expected to show moderate growth, reaching around 450 million in 2026.

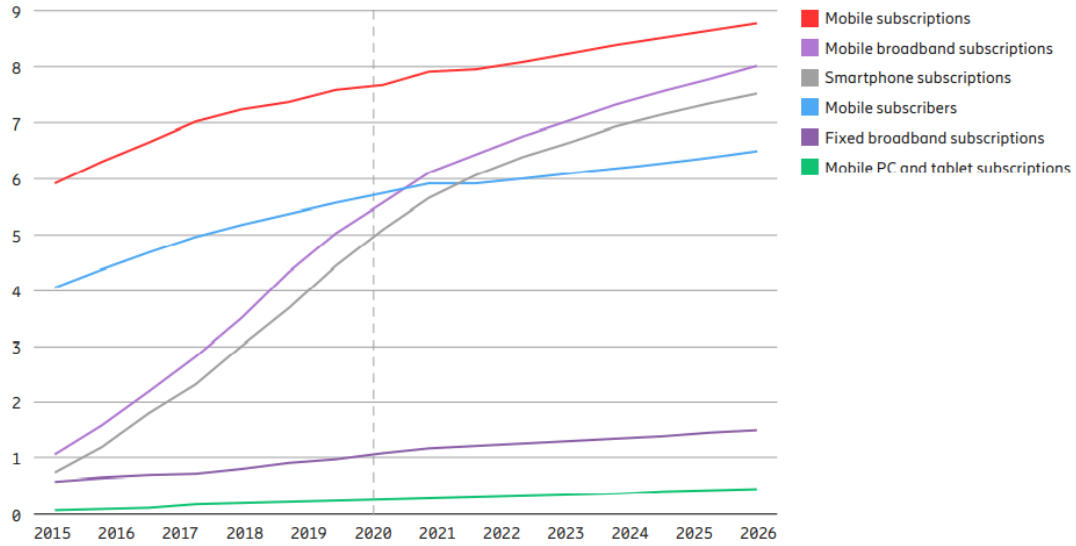


Figure 2: Subscription and subscriber (billion)

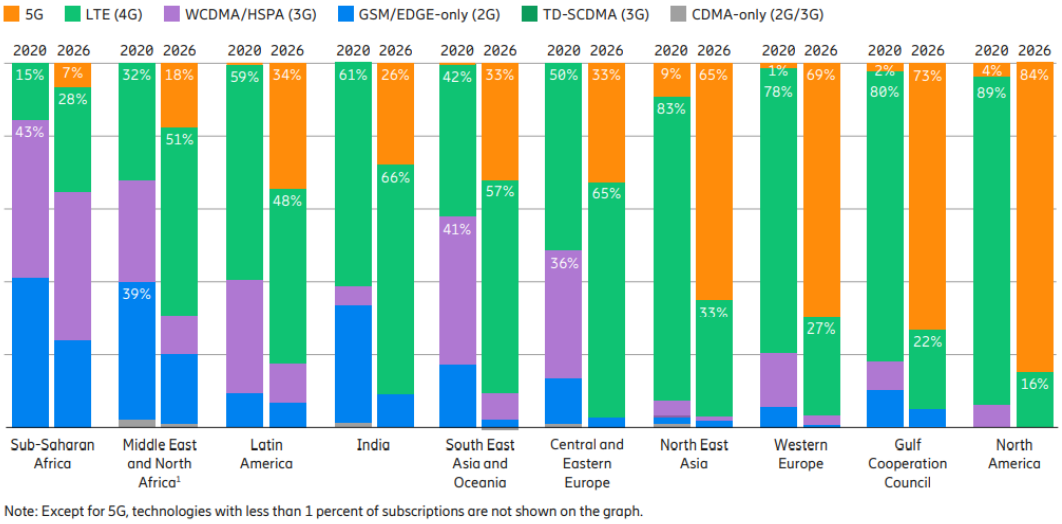


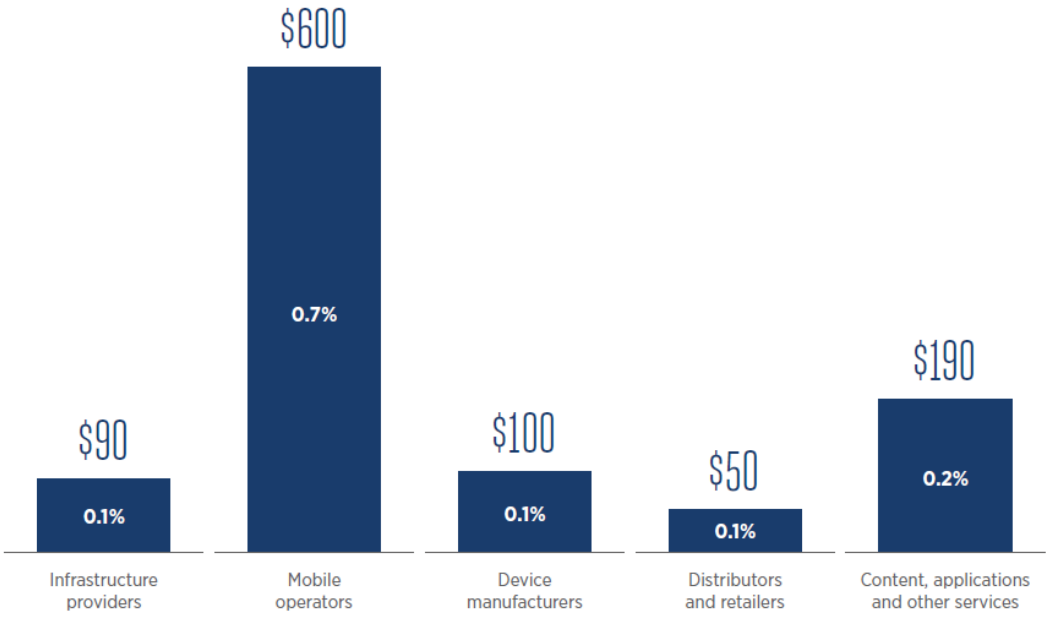
Figure 3: Mobile subscriptions by region and technology (percent)

6 Mobile broadband contributions to the global economic development, driving innovations and digital transformation for industry and society

Mobile communication is one of the most significant technological developments in recent history. It has transformed the ways of communication, information acquisition, entertainment and to execute business. Specifically, the positive impact of the 4th Industrial Revolution and its related emerging technologies will be fully realized through the wide-scale deployment of 5G communication networks in combination with other connectivity solutions. The key functional drivers of 5G will unlock a broad range of opportunities, including the optimization of service delivery, decision-making and end-user experience [2].

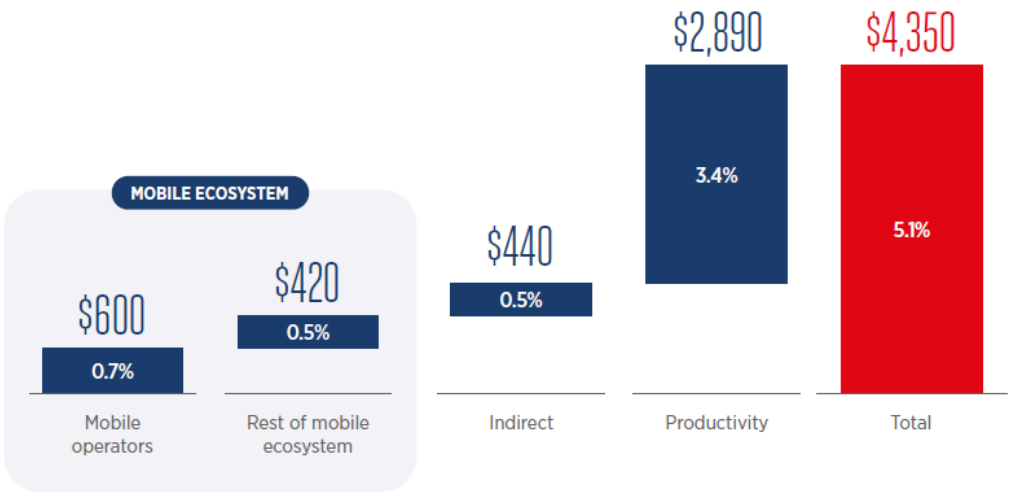
There is a significant effect from mobile broadband on GDP both when mobile broadband is first introduced and gradually as mobile broadband diffuses throughout different economies [3]. According to the World Economic Forum white paper [4], in the last two decades, mobile technology accounted for approximately $10 of every $100 increase in income per capita. During 2000–2019, global income per capita increased by $3,000, with mobile accounting for $300 (or 10%) of this gain. In the next 10 years, 5G could enable 2.1% of global income growth.

According to the Mobile Economy 2021 by GSMA Intelligence [5], in 2020, mobile technologies and services generated $4.4 trillion of economic value added (5.1% of GDP) globally. This figure will grow by $480 billion by 2025 to nearly $5 trillion as countries increasingly benefit from the improvements in productivity and efficiency brought about by the increased take-up of mobile services. 5G is expected to benefit all economic sectors of the global economy during this period, with services and manufacturing seeing the most impact.



(Billion, percentage of GDP (2020), Source: GSMA Intelligence)

Figure 4. The global mobile ecosystem directly generated more than $1 trillion of economic value in 2020, with mobile operators accounting for over half of this figure



(Billion, percentage of GDP (2020), Source: GSMA Intelligence)

Figure 5. Additional indirect and productivity benefits bring the total contribution of the mobile industry to almost $4.4 trillion

As the world emerges from the Covid-19 pandemic, connectivity will be crucial to helping economies recover and become more resilient to future shocks. This will come in the form of timely access to services with enhanced productivity, and efficiency through 5G enabled digital transformation of industries. With the digital economy set to be at the heart of a post-Covid-19 world, the urgency to bring unconnected communities online has never been greater.

7 5G—the platform of Innovation, the Digital Backbone of society

5G will not be just another next decade generation upgrade, but a sustaining platform of Innovation for building digital backbone of future competitiveness and better societies.

5G is completely reshaping both our professional and personal lives. 5G connectivity enables diverse use cases on a truly global and massive scale across licensed, unlicensed and shared spectrum. It enables ubiquitous connectivity of any end user device or sensor using strict performance metrics that are predicated upon a cloud native service-based architecture. Today, there is an explosive set of hundreds of envisioned use cases ready to be explored with 5G, edge computing, IoT and AI. These new use cases range from basic services on enhanced mobile broadband (eMBB) such as AR/VR, to the exotic, immersive and futuristic scenarios that rely upon ultrareliable low-latency communication (URLLC) network slices [6]. Comprehensive collection of current use cases illustrates the creative means to apply 5G and related solutions [7][8][9][10].

According to Ericsson report 5G for business: a 2030 market compass, it is estimated that industry digitalization will generate an estimated USD 700 billion addressable market opportunity for service providers by 2030. And that is only 47 percent of the total 5G-enabled value [11].

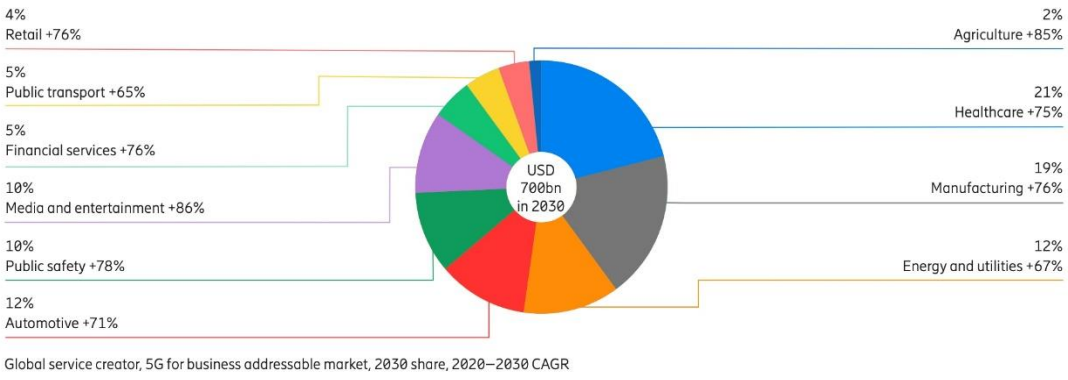


Figure 6: Share and growth rate for global total 5G-enabled B2B opportunity for service providers

Here the use cases are categorized and described in three aspects, transforming industries, advancing societies and Elevating experiences.

1. **Transforming industries**

5G will help to facilitate industry transformation and secure superior economic growth.
5G is an important disruptive technology that will drive digital innovation in industries. The technologies within 5G were and continue to be designed to vastly expand network capacity. So cars, utility grids, appliances, medical devices, industrial machinery, homes, cities, farms and more can all be connected. And 5G will reduce delays and improve reliability, thereby enabling mission-critical tasks such as remote surgery, self-driving cars and enhanced public safety, to make possible secure connections. The industries already starting to be changed by 5G include:

- **Manufacturing**

The manufacturing industry is expected to advance rapidly through faster and effective inspections due to predictive intelligence enabled by 5G.
Technologies of industrial automation and advanced manufacturing are proven effective to produce quality housing at scale without the challenges faced historically. 5G's strong focus on massive machine-type communication (MTC) and the internet of things (IoT) connectivity could further advance future smart factories with robot-oriented design and management, sensor-driven components and production lines, and help accelerate the implementation of productivity-improving technologies for construction industry.

- **Transport/Mobility**

Connected transport will eventually become possible with 5G: vehicles are connected to move in an efficient and integrated system with minimal human interaction. A combination of low latency connectivity, fast data transfer and massive bandwidth to support increased device density will deliver the reliable and real-time connection required. Key benefits will include improving safety by decreasing the number of incidents associated with human error and improving transport efficiency by calculating the most efficient pathways available to a vehicle.

- **Retail**

Technology and automation are now at the heart of how the entire retail value chain is evolving. Use cases in retail involve a few key technologies: sensors, trackers, computer vision, AI, advanced analytics, and smart interfaces. More than 90 percent of them will come to life with advanced connectivity like 5G.

- **Agriculture**

5G technologies' promise of expanding and accelerating connectivity without sacrificing battery life will be particularly beneficial to farmers, and are already improving veterinary diagnostics, crop protection, reduction of fertilizer use and smart irrigation systems that conserve water. 5G is also expected to provide new solutions to the disparity between broadband Internet connections in cities and those in some rural areas, the geographical digital divide [12].

- **Logistics**

Novel Industry 4.0 technologies are used to enable agile supply chains, with reduced management, energy and storage costs. 5G technology as a global unified connectivity solution, allows connectivity throughout all the scenarios where logistics processes take place, each having their own challenges.

2. Advancing societies

5G can deliver social value across many areas, mainly through contributing to good health and well-being, in addition to enhancing infrastructure, promoting sustainable industrialization and fostering innovation. Also include contributing to responsible consumption, enabling sustainable cities and communities, and promoting decent work and economic growth.

- **Healthcare**

5G has the ability to contribute significantly to healthcare and societal well-being. Powerful tools/methods such as advanced analytics, Internet of medical skills/remote surgery, Image transfer, AR/VR-enabled healthcare, disease management, Wearables and ingestible and Drone-enabled medical service delivery would significantly improve the experience of healthcare and social well-being. Healthcare could look very different in a decade's in large part due to enhanced connectivity.

For individuals, enhanced connectivity will foster the wider use of remote patient monitoring, which can help people manage long-term conditions. M-Health (mobile health) and the wider introduction of telemedicine result in increased accessibility to quality healthcare. Preventive healthcare measures (wearables and ingestible) lead to decreased long-term healthcare costs. Health systems should be able to use enhanced connectivity to achieve more efficient information sharing and optimize the use of limited resources.

- **Energy & Utilities**

Every previous new generation of mobile networks has increased energy consumption and carbon emissions until now. 5G is the most energy efficient standard ever developed and will help break this trend in the mobile sector [10]. 5G opens cutting-edge ways of improving safety and sustainability.

- 5G is being deployed to make energy and water use more efficient, cities are preparing to use 5G to monitor air and water quality in real time
- Smarter electricity grids are implemented for greatly reduced carbon emissions
- Faster deployment of emergency services to accidents
- Connected sensors that can detect and warn of natural disasters early
- Drones becoming a key tool to accelerate and support emergency situation response

- **Smart City**

5G will enable a new wave of smart city development. By providing higher data rates, increased traffic capacity, ultra-low latency, and high connection density, 5G offers opportunities for urban innovators striving to create smart city services in the pandemic era and beyond. It empowers

innovation in smart mobility, remote work, online education, and remote-health care services.

3. Elevating experiences

- **Entertainment/media/education**

5G sets the stage for more immersive entertainment and more engaging education.

- Greater realism in VR, AR and extended reality (XR) with lighter devices
- Delivering sensory experiences, like touch, through devices
- More engaging methods of teaching through immersive content
- Immersive virtual meetings to boost remote team productivity
- Stable and reliable connectivity in crowded spaces
- New angles and interactions for live and remote event spectators

All of the use cases prove that 5G isn't just a new generation of mobile networks – it's transforming the world. Faster connectivity speeds, ultra-low latency and greater bandwidth is transforming industries, advancing societies and dramatically enhancing day-to-day experiences. Services that we used to see as futuristic, such as e-health, connected vehicles and traffic systems and advanced mobile cloud gaming have arrived. With 5G technology, we can help create a smarter, safer and more sustainable future [6].

8 Additional Mid-band spectrum needed for society

5G NR (New Radio) is the radio access technology developed by 3GPP for IMT-2020 networks and relies on the assignment of individual spectrum licenses (i.e., to operators), which are required to ensure the quality of service to the end users, including for enhanced mobile broadband (eMBB) and fixed wireless access (FWA), but also verticals use cases such as Industry 4.0 and automotive communications.

Spectrum need in Urban

To calculate the additional mid-band spectrum needs, we endorsed the methodology used by GSMA in their white paper "Estimating the mid-band spectrum needs in the 2025-2030 time frame" [13].

It adopts the urban environment assumption to deliver the 100 Mbit/s user experienced data rate in downlink and 50 Mbit/s in the uplink as ITU-R requirement for IMT-2020, for ensuring citywide speed coverage. It assumes that 5G tariff plans will use unlimited data volumes, instead of selling data volume, 5G mobile operators sell speed (Mbit/s), i.e. the user experienced data rate. 5G is to deliver fibre-like connectivity anytime. It will calculate the area traffic density demand and area traffic capacity supply in cities. The excess demand over the capacity supply will be the forecast of the need for additional upper mid-band spectrum, which suitable for 6GHz spectrum demand.

To calculate the area traffic density will use population density in cities as a proxy. Traffic coming from connected vehicles, video camera and sensors could be a multiple of traffic generated by

human users and therefore calculating traffic demand by population density of user experience data rate actually will give a conservative estimate for future spectrum needs.

The traffic demand density in cities will use the following modelling for the assumptions:

- High traffic demand with all kinds of access types
  The population density in cities is triggered by both human and non-human users as a proxy for mobile area traffic demand density. Furthermore, these traffics are generated by, for example, connected vehicles, cameras or video-based sensors occurs where people are located, and is in addition to the traffic generated by human users. Hence, tying traffic demand per capita to the 100 Mbit/s downlink and 50 Mbit/s uplink requirements generates a realistic estimate for future area traffic demand which takes account of all use cases.
- 10% to 25% concurrent service requirement
  The mobile area traffic capacity requirement is coming from increased concurrent bandwidth demand from both human users and other use cases. This is presented in the form of an activity factor ranging from 10% to 25%.
- High-bands, indoor mid-band small cell and WiFi offloading factor
  The higher the percentage of traffic offloaded to high-band spectrum (indoor mid-band small cell, wifi), the lower the demand for additional upper mid-band spectrum. A range of high-band offload factors from 10% to 45% was assumed. This is a wide range which reflects uncertainty over the timing and deployment density due to differences in population density, speed of network evolution and other factors between cities.

Aiming for a realistic estimate of spectrum needs from 2025 to 2030, the following conservative assumptions with respect to area traffic capacity supply will be reached:

- The “baseline spectrum” for each city includes spectrum already in use by mobile operators as well as expected future assignments in the period of 2021 to 2025. Regarding future spectrum assignments, not only spectrum that is on the current roadmap in different countries, but also spectrum that could be added to the roadmap by 2025. Depending on the specific city among the 36 cities addressed, the baseline spectrum amount varies from 725 MHz up to 1,420 MHz.
- Depending on the country, within the 2025 to 2030, mobile operators will have made the investment to use all “baseline spectrum” for 5G.
- Each operator will deploy three outdoor small cells per each of its macro sites, invest in MIMO upgrades, install indoor small cells, and deploy high-band (mmWave) spectrum on outdoor and indoor sites.

Spectrum demand model results in Urban

Using the methodology and parameters in combination with the population it was modelled the needs for additional upper mid-band spectrum to meet the downlink and uplink area traffic demand in a sample of larger cities in different regions in the 2025-2030 time frame.

The key variables that explain the demand for spectrum are:

- Population density;
- The activity factor; and

- The percentage of traffic offloaded to high bands.

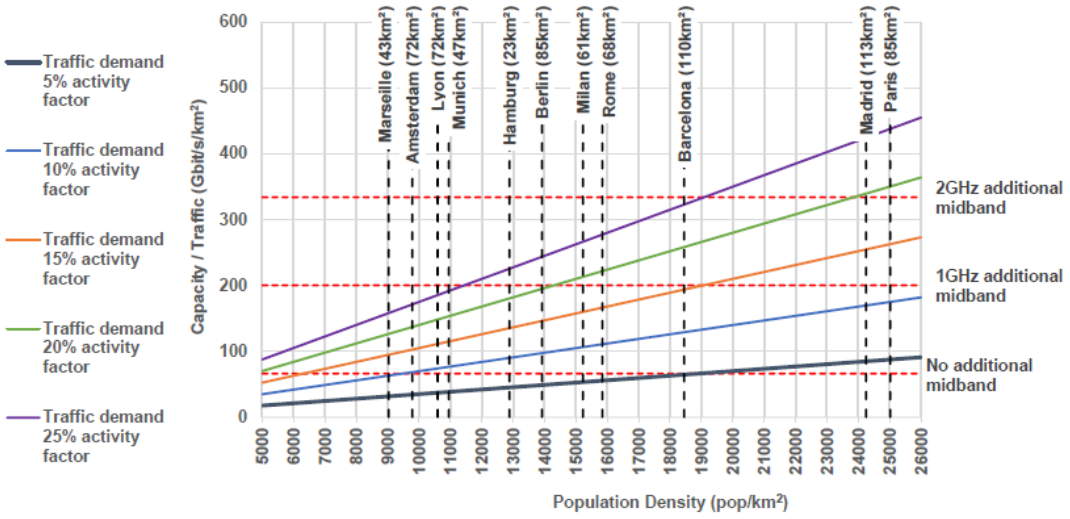


Figure 7: Downlink area traffic demand and spectrum needs

Mid-band spectrum for FWA in rural area

Fixed Wireless Access (FWA) is one of the 5G use cases. As a result of the performance improvement of LTE-A and now 5G NR, FWA is experiencing rapid growth world-wide. The Global Mobile Suppliers Association (GSA) identified 401 operators in 164 countries selling FWA services based on LTE. In addition, of the 75 operators that have announced 5G launches worldwide, GSA counted 38 operators that have announced the launch of either home or business 5G broadband using routers. Of these 38, GSA identified 31 operators selling 5G-based FWA services.21

The figures from the GSA are corroborated by research from Point Topic. “Wireless (mostly FWA) and FTTH connections were the fastest growing categories, having increased by 22.7 per cent and 14.1 per cent respectively between Q4 2018 and Q4 2019.”.

Closing the rural connectivity using 5G FWA requires far less investment compared to FTTH. However, the FWA business case is highly dependent on the number of connections that can be supported per cell tower. In turn, this is a function of the amount of spectrum that can be deployed on a cell tower to deliver fibre like broadband FWA using 5G NR technology.

Making available additional upper mid-band spectrum extends beyond Urban area is one of important candidate for FWA. Additional upper mid-band spectrum provides a sustainable path to bridge the urban-rural digital divide.

- In countries that have good urban and suburban broadband infrastructure, there is often a lack of broadband in many rural small towns and villages. FWA relying on additional mid-band spectrum would make it possible to overcome the urban-rural digital divide in a time frame consistent with national broadband development plans. Importantly, additional spectrum would provide sufficient bandwidth to ensure that FWA will also be able to address the needs for fixed connectivity as a long-term solution for rural areas.
- In lower-income countries where affordability is key, the economic benefits associated with additional mid-bands are even more apparent. There are 1.1 to 1.2

billion households worldwide without broadband access and FWA is the fastest growing method of bringing fixed broadband to the unconnected due to the limited availability of copper and fibre broadband.

- Upper mid-band spectrum has a key role to play in providing fibre-like access via 5G at an affordable cost. The ITU and UNESCO Broadband Commission for Sustainable Development 2025 Targets make this explicit: "By 2025, entry-level broadband services should be made affordable in developing countries, at less than 2% of monthly gross national income per capita."5 Using additional mid-band spectrum for 5G would make a key contribution towards attaining the United Nations Sustainable Development Goals and the Broadband Commission 2025 targets. Alternative solutions based on satellite or fibre typically have higher costs and, therefore, outside the affordability of many.

Comparing the cost of FTTH and 5G FWA in Europe

The investment cost savings if FWA instead of FTTH is used to bring 100 Mbit/s connectivity to rural households.

- For an additional 2GHz of spectrum, an investment saving of 79% on €53 billion amounts to €42 billion. 5G IMT has a capital expenditure avoidance value of €42 billion, for FWA alone, i.e., not counting the capex avoidance value for mobile 5G.
- If only 1 GHz of additional mid-band spectrum is made available, the investment cost saving is 75% amounting to €40 billion.

Although providing rural coverage using FWA is much cheaper compared to FTTH, in most rural locations there will be no business case to provide 100 Mbit/s or higher speeds. This means the €42 billion saving is a reduction in the subsidies and not an indication that 100 Mbit/s FWA might be turned into a spectrum licence obligation.

In assessing the cost savings of FWA in upper mid-bands vs. FTTH we have not added in any spectrum licence fees. The reason for this is our objective to calculate the difference in the network investments comparing FWA with the FTTH solution. This would translate into real savings in public subsidies regardless of whether there is any cost of spectrum.

Relative cost difference FWA vs FTTH	Base Line	Plus 1 GHz	Plus 2 GHz
Cost per household covered @ 100 Mbit/s	56%	75%	79%
Cost per household covered @ 150 Mbit/s	33%	63%	68%
Cost per household covered @ 300 Mbit/s	-33%	26%	36%
Cost per household covered @ 1 Gbit/s	-344%	-146%	-113%

Figure 8: FWA deployment cost saving vs. FTTH in rural areas

9 Additional spectrum needed for mid-band 2025-2030

From the forecast of spectrum needed for mid-band 2025-2030 for the selected cities, 1-2GHz

additional spectrum is needed for IMT/5G to provide the capacity for innovation and future development. Lack of mid-bands spectrum would require costly and sometimes non-economically viable network densification to offer the necessary capacity with continuous coverage. Thus, harmonization of the 6 GHz spectrum for IMT is imperative to sustain future capacity needs for affordable connectivity [14]. Without 6GHz band as upper mid-band spectrum, we can not fulfill the spectrum needs to satisfy our traffic demand and service capacity requirement for the above 5G use cases and applications.

6GHz is globally allocated already to the mobile service, on a primary basis , will be a good balance between coverage and capacity. It is similar propagation characteristics like 3.5GHz and could achieve good coverage similar like 3.5 GHz. And more important it gives Large contiguous blocks available supporting 5G services to help the operators selling speed with high user experience data rate any time and deliver fiber like connectivity for the rural area FWA services.

10 Conclusions

5G is taking off with ever-fast speed. 3.5 billion 5G subscribers were forecasted in 2026. 5G is the pillar for digital transformation, enhanced mobile broadband and FWA, and it will play important role for industry digital transformation and smart society for healthy and sustainable world. 5G will continue to contribute to GDP growth, new businesses and use cases with new jobs.
We endorsed that 1-2GHz additional mid-band spectrum is needed for city-wide coverage in 2025–2030 which was studied by GSMA in their white paper “Estimating the mid-band spectrum needs in the 2025-2030 time frame”. It will support to solve major cities traffic density challenge for operators to offer good user experience and high speed fiber like data access any time.

The 6GHz band is a key band to secure the future spectrum needs, without 6GHz such high upper mid-band we can not fulfill the additional spectrum needs for 2025-2030 time frame as we forecast. 3GPP has started the work towards building an ecosystem in 6GHz for 5G NR. Sharing studies started in ITU—decision on IMT for 6GHz will be taken in WRC-23 Proposed way forward. GTI will follow and contribute to the ITU process and push for global 6GHz IMT ecosystem.

11 References

[1] Ericsson Mobility Report. https://www.ericsson.com/en/reports-and-papers/mobility-report
[2] GSMA: “Mobile technology and economic growth”. Available at https://www.gsma.com/betterfuture/wp-content/uploads/2020/11/Mobile-technology-and-economic-growth_web.pdf
[3] Edquist et. al: How important are mobile broadband networks for the global economic development
[4] World Economic Forum: “The Impact of 5G: Creating New Value across Industries and Society”. Available at https://www3.weforum.org/docs/WEF_The_Impact_of_5G_Report.pdf

[5] GSMA: "The Mobile Economy 2021". Available at https://data.gsmaintelligence.com/research/research/research-2021/the-mobile-economy-2021

[6] Global Future Council on New Network Technologies 5G: Society's Essential Innovation Technology, May 2020,https://www3.weforum.org/docs/WEF_Global_Future_Council_on_New_Network_Technologies_2020.pdf

[7] The Impact of 5G: Creating New Value across Industries and Society, January 2020, https://www3.weforum.org/docs/WEF_The_Impact_of_5G_Report.pdf

[8] 5G-Next Generation Networks Programme Repository of use cases The Impact of 5G: Creating New Value across Industries and Society, November 2019, https://www3.weforum.org/docs/WEF_The_Impact_of_5G.pdf

[9] 5G Outlook Series: Enabling Inclusive Long-term Opportunities, January 2021, https://www3.weforum.org/docs/WEF_5G_Outlook_Series_Enabling_Inclusive_Long_term_Opportunities_2021.pdf

[10] Nicola Brittain, 5G use cases: 31 examples that showcase what 5G is capable of, September 2021, https://www.5gradar.com/features/what-is-5g-these-use-cases-reveal-all

[11] Börje Ekholm, Davos 2020: How to foster innovation in the 5G-enabled digital economy, January 2020, https://www.ericsson.com/en/blog/2020/1/davos-2020-innovation-in-5g-enabled-digital-economy

[12] Don Rosenberg, 5G is about to change the world in ways we can't even imagine yet, January 2020, https://www.weforum.org/agenda/2020/01/5g-is-about-to-change-the-world-in-ways-we-cant-even-imagine-yet/

[13] Estimating the mid-band spectrum needs in the 2025-2030 time frame. https://www.gsma.com/spectrum/wp-content/uploads/2021/07/Estimating-Mid-Band-Spectrum-Needs.pdf

[14] Demands and benefits of regulating 6 GHz band, June 2021, https://www.telecomreview.com/index.php/articles/reports-and-coverage/5074-demands-and-benefits-of-regulating-6-ghz-band