



The 6 GHz IMT Ecosystem

Demand Drives Scale

August 2022





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GSMA Intelligence is relied on by leading operators, vendors, regulators, financial institutions and third-party industry players, to support strategic decision-making and long-term investment planning. The data is used as an industry reference point and is frequently cited by the media and by the industry itself.

Our team of analysts and experts produce regular thought-leading research reports across a range of industry topics.

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Executive summary

6 GHz market development

The definition of spectrum is vital to the mobile ecosystem. Harmonised spectrum enables the delivery of scale for networks and devices. In addition, the right spectrum management drives mobile development, delivering new technology generations and realising the \$4.5 trillion total economic value of the mobile industry in 2021¹.

Discussions and decisions by governments on the usage of the 6 GHz band (5925-7125 MHz) are ongoing. To date, approaches have ranged from assigning the full band for unlicensed use, considering the entire band for licensed 5G, or a hybrid option where the lower part (5925-6425 MHz) is dedicated for unlicensed use and the upper part (6425-7125 MHz) is licensed.

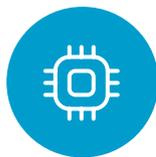
Against this backdrop, the role of IMT ecosystem development is a topic which cannot be ignored as 6 GHz spectrum management decisions are being made. Where robust 6 GHz IMT device and network infrastructure ecosystems are expected, decisions enabling IMT usage for the 6 GHz band will be justified. At the same time, slow or lacking ecosystem development would complicate support for 6 GHz IMT allocations.

To address this question, GSMA Intelligence embarked on a detailed cross-sectional evaluation of the future prospects and market readiness for a 6 GHz IMT ecosystem.

6 GHz Ecosystem



Network vendors



Chipset developers



Radio front-end suppliers



Device manufacturers



Mobile network operators

The evaluation was based on a series of interviews held in mid-2022, including executives and product strategy decision makers at major mobile network infrastructure vendors and mobile device component suppliers known to be considering and planning for the development of 6 GHz IMT solutions. Network infrastructure and radio vendors representing more than 90% of the global market were also included, as were major SoC and radio front-end suppliers which

support the market's major smartphone and mobile device makers.

Input from operators (including a survey of spectrum experts and subject matter experts from approximately 20 leading operators from across the globe) and lessons learned from the introduction of other new spectrum bands – including regulatory and technical processes – were used as a basis for the analysis.

¹ <https://www.gsma.com/mobileeconomy/>



6 GHz development principles

The research found that the outlook for the 6 GHz IMT ecosystem is robust, with the market aligned on the following principles:

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Technical barriers

There are no technical barriers to developing, and commercialising, 6 GHz IMT solutions. Device and infrastructure solutions can operate in the band, just like any other.
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Ecosystem readiness

Key players in device component and network infrastructure ecosystems are ready to develop 6 GHz IMT products in line with customer demand.
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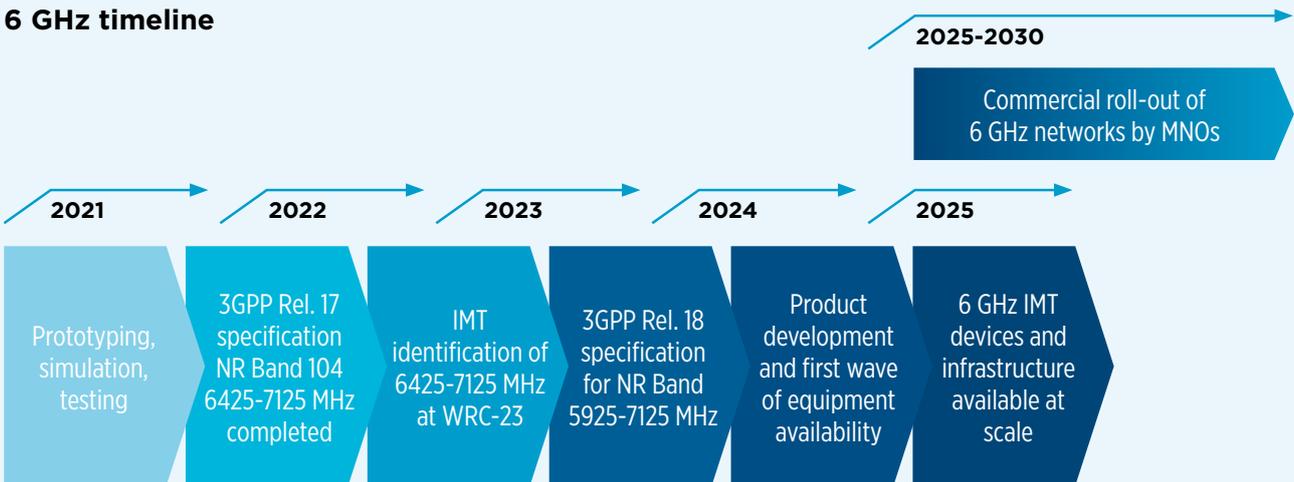
Development triggers

The main trigger for the commencement of product development will be operator demand, driven by WRC-23 and national regulatory decisions.
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Development timeline

From the start of development, ecosystem players expect that they could have solutions ready in 6 to 12 months.

6 GHz timeline





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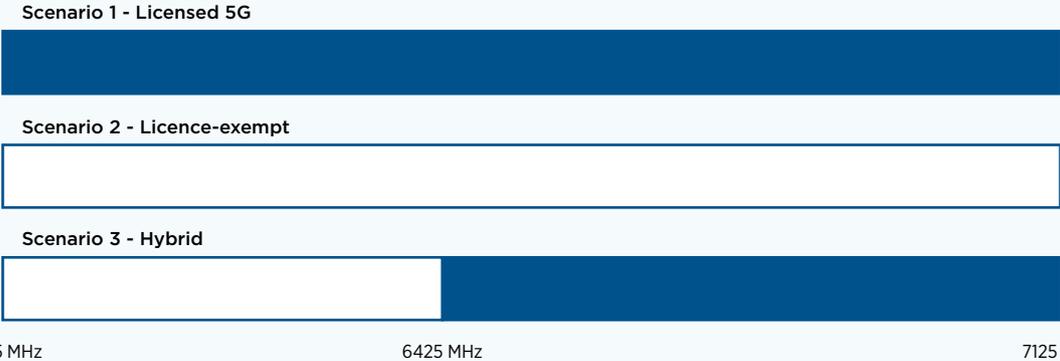
The 6 GHz range

Options for 6 GHz

The implications of 6 GHz decisions are immense. In part, this is because the 6 GHz band represents the largest remaining single block of mid-band spectrum for licensed mobile services in the foreseeable future. Also, rising consumer demand for all 5G use cases makes this a concern for all mobile operators.

The 6 GHz band has generally been considered for licensed 5G, licence-exempt or a hybrid approach allowing for the needs of both licensed and licence-exempt technologies.

6 GHz policy scenario analysis



The specific use of this spectrum carries clear cost-benefit implications. GSMA Intelligence research studied 24 countries² and made two core findings:

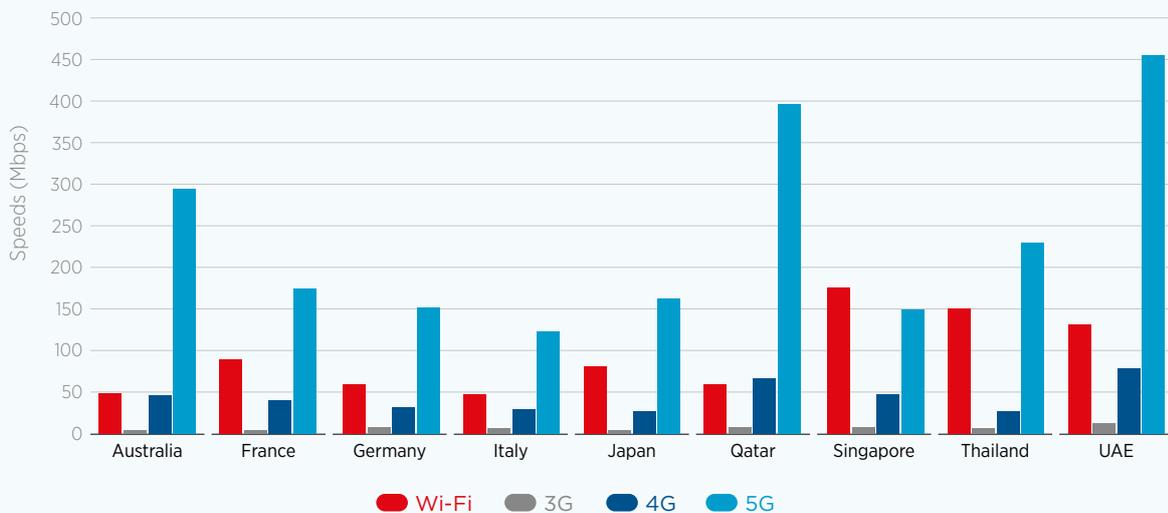
1. For all countries studied, the most benefit to society comes from assigning between 700-1200 MHz of 6 GHz spectrum to licensed 5G
2. For all countries studied, there is never a scenario where the allocation of the full 6 GHz band to unlicensed use generates the greatest benefit to society.

In addition to the amount of available spectrum, the study found that the optimal assignment policy largely depends on the infrastructure to deliver fixed fibre/cable broadband services in each market, along with the speeds that fixed broadband can offer consumers.

Consumers use more data on 5G relative to 4G, and there is evidence that less traffic is carried over Wi-Fi as mobile network speeds rise, and data allowances increase along with mobile network capacity. In 5G markets, consumers often get significantly better speeds than on 4G and Wi-Fi. Analysis of 5G users across several markets also show that consumers use more data than on 4G and, in some cases, less Wi-Fi.³

Speed comparison – download speeds for 3G, 4G, 5G and Wi-Fi (2021)

Source: GSMA Intelligence analysis, based on Speedtest Intelligence® data provided by Ookla®
Data is provided for the nine countries with 5G adoption greater than 2% at the end of 2021.



In order for both technologies to thrive, policy makers need to find the right balance in order to maximise socio-economic benefits.

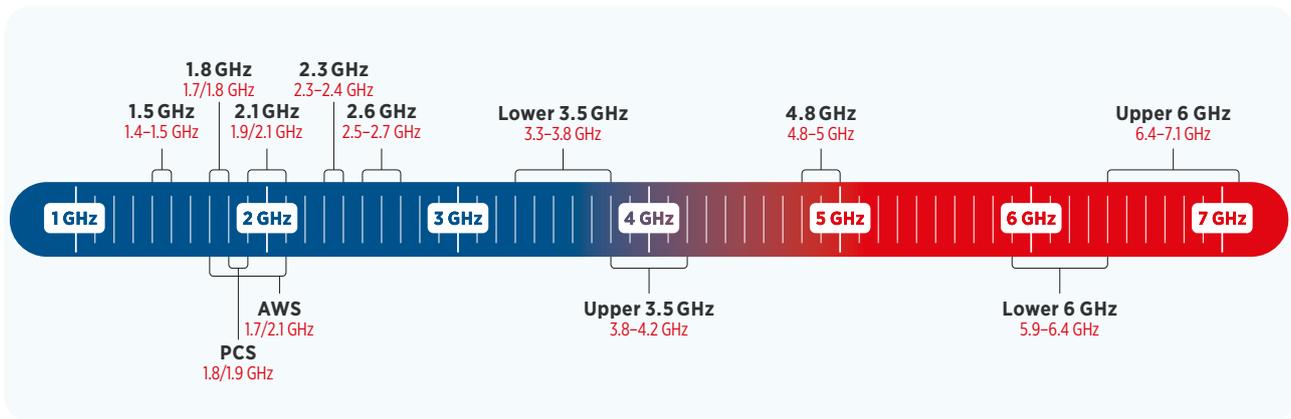
² [The Socio Economic Benefits of the 6 GHz Band, GSMA Intelligence, 2022](#)

³ For example, Ericsson (2021) shows that 5G users spend more time on a range of uses (including cloud gaming, streaming music and video and using AR/VR) and that one in five users upgrading to 5G have decreased Wi-Fi usage at home and other locations.

Gauging the 6 GHz IMT opportunity

5G networks bring substantial improvements over 4G networks, including higher connection speeds, greater capacity and lower latency. With this increased performance, 5G networks can also enable

new use cases and applications that positively impact many industry sectors and the economy as a whole.



5G requires spectrum in low, mid- and high bands to realise its full potential. The increases in bandwidth and capacity that numerous 5G applications require mean that mid-band frequencies provide an important role and allow capacity for city-wide coverage. Mid-band is therefore at the heart of 5G. As of Q1 2022, GSMA Intelligence data shows that 75% of 5G network launches have used mid-band spectrum⁴.

Beyond initial 5G launches, the need for mid-band spectrum will only grow. An average of 2 GHz mid-band spectrum is needed per country to deliver the ITU's IMT-2020 (5G) requirements⁵.

⁴ <https://data.gsmainelligence.com/api-web/v2/research-file-download?id=72941611&file=270622-Spectrum-Navigator-Q12022.pdf>
⁵ Coleago Consulting, "Estimating the mid-band spectrum needs in the 2025-2030 time frame", July 2021

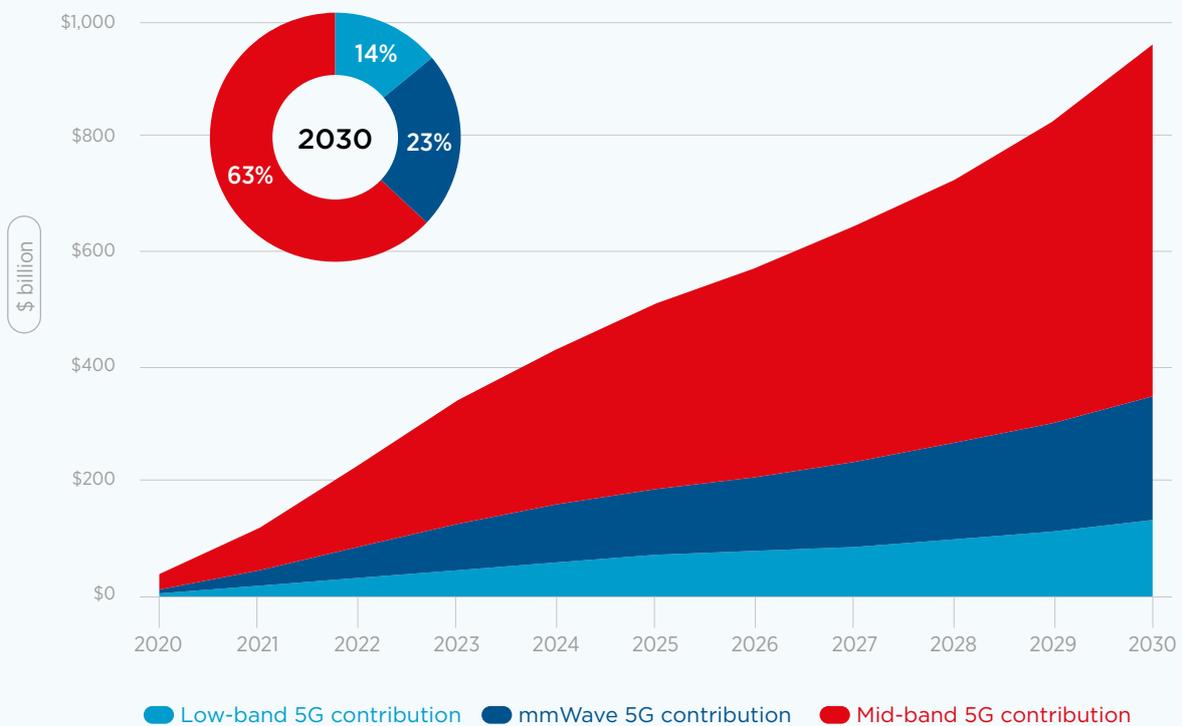


A recent study by GSMA Intelligence concludes that mid-band spectrum will drive more than \$610 billion in global GDP in 2030, producing almost 65% of the overall socio-economic value generated by 5G⁶. However, this can only happen if sufficient spectrum resources are assigned to mobile operators

to provide the capacity and performance needed to support growing mobile data traffic and advanced 5G use cases. On the flip side, up to 40% of the expected benefits of mid-band 5G could be lost if no additional mid-band spectrum is assigned to mobile services in the near future, according to the analysis.

Annual impact of 5G on GDP, by band, 2020-2030

Source: GSMA Intelligence



The future availability of mid-band spectrum is part of the discussions of the World Radiocommunication Conference 2023 (WRC-23). The range of spectrum bands that could offer such supplementary mid-band spectrum for 5G services in the medium term

is limited. Therefore, the 6 GHz range is seen by the mobile industry as the principal target for 5G expansion and the main means of meeting the 2 GHz goal.

6 <https://www.gsma.com/spectrum/wp-content/uploads/2022/02/mid-band-5g-spectrum-benefits.pdf>



02

The 6 GHz ecosystem

The road to market readiness

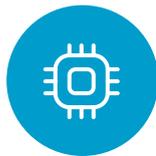
Economy of scale has been a hallmark of the mobile industry, where global networks, network infrastructure, and device ecosystem scale have resulted in services connecting more than 5.3 billion users. Global 5G connections have scaled in line with the diversity of 5G devices and will surpass 1 billion in 2022. Therefore, an important consideration in any spectrum assignment decision is ecosystem support for the band and whether sufficient network infrastructure and device solutions are available to support the target services and use cases.

The development of the 6 GHz IMT ecosystem must be understood as decisions on the band are being made. Its ecosystem development outlook is crucial to decisions enabling licensed 5G in the 6 GHz band, and vice-versa.

To understand the extent of ecosystem development for licensed IMT usage of the 6 GHz band, GSMA Intelligence engaged in detailed interviews with key ecosystem players across the IMT network infrastructure and device component sectors in mid-2022. This analysis included the core sectors which are integral to the development of 6 GHz IMT solutions.



Network vendors



Chipset developers



Radio front-end suppliers



Device manufacturers



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6 GHz development principles

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Technical barriers

There are no technical barriers to developing, and commercialising, 6 GHz IMT solutions. Device and infrastructure solutions can operate in the band, just like any other.



Ecosystem readiness

Key players in device component and network infrastructure ecosystems are ready to develop 6 GHz IMT products in line with customer demand.



Development triggers

The main trigger for the commencement of product development will be operator demand, driven by WRC-23 and national regulatory decisions.



Development timeline

From the start of development, ecosystem players expect that they could have solutions ready in 6 to 12 months.

Current market progress

6 GHz spectrum is the largest remaining contiguous block of mid-band spectrum that can be allocated to licensed mobile in most markets. Harmonisation of 6 GHz spectrum could therefore provide more

bandwidth and improve network performance. At the same time, the broad contiguous channels offered by the 6 GHz range could reduce the need for network densification.

Recent developments for 6 GHz 5G

- **Standards momentum.** 3GPP completed technical specifications of 5G NR band 104 as part of 3GPP Release 17 for the upper part of the 6 GHz band for licensed 5G services in June 2022. This provides a standardised basis for production of 6 GHz 5G equipment and devices. A new work item was also created for the specification of the full 5925-7125 MHz band in Release 18.
- **Co-existence.** Co-existence between 5G and other users of the band, including Fixed Satellite Services (FSS) is shown to be feasible by the many contributions submitted to ITU-R by administrations and industry to date.
- **Administration support for 6 GHz IMT⁷.** Administrations in all three ITU Regions have expressed support for all or part of the 6 GHz band to be used for licensed IMT services. These signal an expanding addressable market that will pave a solid foundation for ecosystem development

⁷ By July 2022 at the time of writing.



6 GHz IMT ecosystem drivers and challenges

GSMA Intelligence engaged with major ecosystem players across the IMT network infrastructure and device component sectors to understand whether

and when network infrastructure and device solutions will be available for the 6 GHz band.

The infrastructure and device component communities were aligned on several key points:

No technical barriers to 6 GHz IMT

There are no significant technical barriers to 6 GHz IMT solutions and services. On-going lab and field trials confirm this view⁸

3.5 GHz grid reuse

Simulations and trials indicate that 6 GHz IMT could effectively expand network capacity using the same infrastructure of 3.5 GHz IMT services, enabling cost-effective deployment.

Demand triggers exist

1. Operator demand is a pivotal trigger for economy of scale.
2. 3GPP standardisation momentum is a significant milestone in shaping up the scale of the 6 GHz IMT ecosystem.
3. Decisions taken at WRC-23 and by individual national regulators will influence how operator demand develops.

6 GHz infrastructure development

The following component timelines were indicated as areas with the potential to impact the product development timeline.

Item	Implication on timeline / Status
Baseband	No impact – available
Intermediate frequency	No impact – available
Antenna	Low impact – available at short notice
Filter	Low impact – available at short notice
Transceiver	Customisation needed – lead time 6 months
Power amplifier	Customisation needed – lead time 6 months

⁸ Joint Ericsson/Huawei/Nokia/ZTE presentation of 6 GHz IMT field trial and simulation results in 'Licensed 6 GHz for 5G: an opportunity for society', 2nd December 2021 (webinar).

03

Quantifying operator demand

To better understand operator demand, GSMA Intelligence surveyed spectrum strategy experts from a global sample of the industry's top mobile operators. We focussed on a number of key questions, including:

- The importance of access to 6 GHz spectrum for IMT networks.
- How likely operators are to deploy the spectrum.
- Planned 6 GHz IMT use cases.
- Impacts in case the 6 GHz band is not available for IMT services.

Timescale

The timely availability of 6 GHz spectrum will be a crucial factor and assignments need to be made according to market demand.

Some of the earliest adopter markets expected to show demand soon after ecosystem availability

around 2024-2025. Many markets will require the spectrum later, towards the end of the decade. Also, the majority of operators responded that 6 GHz spectrum would be required in the 2025-2030 timeframe with the highest portion considering 2027-2030 as likely to be the demand point.

Over what timescale would you require access to 6 GHz frequencies for IMT?

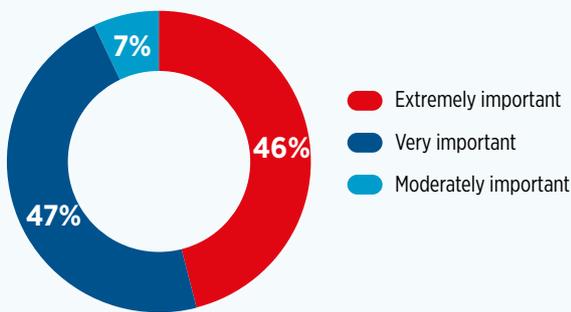




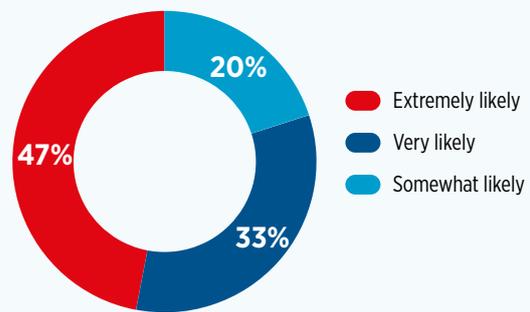
Importance of 6 GHz

The survey shows how critical 6 GHz is to the future of their IMT networks: 93% of those surveyed identify it as very or extremely important. It should not be surprising, then, that 80% of the surveyed operators feel it is very or extremely likely that they will deploy the band for IMT services.

How important is 6 GHz spectrum to the future quality and capabilities of your IMT networks?



How likely are you to deploy 6 GHz IMT in your networks?



NB - the lower values 'slightly/not important' and 'very/extremely unlikely' received 0%.

Deployment scenarios

What deployment scenarios are you considering for IMT-based 6 GHz services?



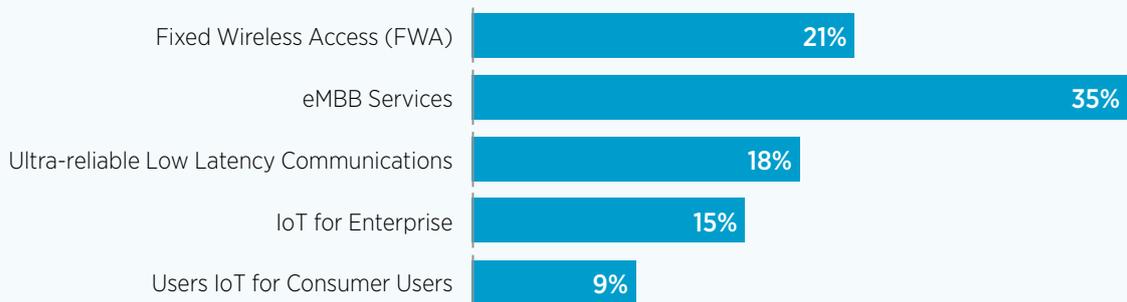


Use cases

eMBB services have been the primary use case for 5G launches to date. This holds true for 6 GHz plans; 73% of operators say eMBB is a planned 6 GHz IMT use case. The second most popular use case, cited

by 47% of operators, is Fixed Wireless Access (FWA). With FWA serving a role in diversifying operator revenues and helping to close the digital divide, the opportunities 6 GHz can enable are clear.

Which use cases do you plan for 6 GHz IMT?



Cell splitting and densification

Operators expressed common themes in answering how they would respond to a lack of 6 GHz spectrum.

Without access to 6 GHz spectrum for IMT services, network densification – including small cells and cell splitting – represents the most cited option for increasing network capacity, called out in 60% of responses. Operators also note that densification would be prohibitively expensive, arguing that use of 6 GHz for IMT services may be the only way to economically meet capacity demands.

04

6 GHz IMT timeline outlook

While evaluating the prospects for a 6 GHz IMT ecosystem, the timeline for any ecosystem development is a key consideration for operators, regulators, and solution providers. Building on input from the industry, such a timeline can be estimated in a straightforward manner.

Factors influencing 6 GHz timeline



Regulatory approval



Device and infrastructure R&D



Operator demand



Regulatory approval

The upper 6 GHz is being considered for IMT identification at WRC-23 and some national regulatory authorities are waiting for the outcome of the WRC-23 before proceeding to assign the band to mobile operators. The 6 GHz band already has a mobile allocation in the ITU Radio Regulations and

some countries have started to make decisions, such as China (licensed 5G) and the US (unlicensed use).

The existing mobile allocation also allows countries outside the footprint of the 6 GHz IMT Agenda Item at WRC-23 to make the same assignment.

Device and infrastructure availability

Our market engagement with component and infrastructure players indicated no difficulty in providing pre-production network equipment and handsets enabled for 6 GHz IMT between 6 and 12

months after receiving orders. With China already planning 6 GHz for IMT, some vendors are already developing for this market.

Operator demand

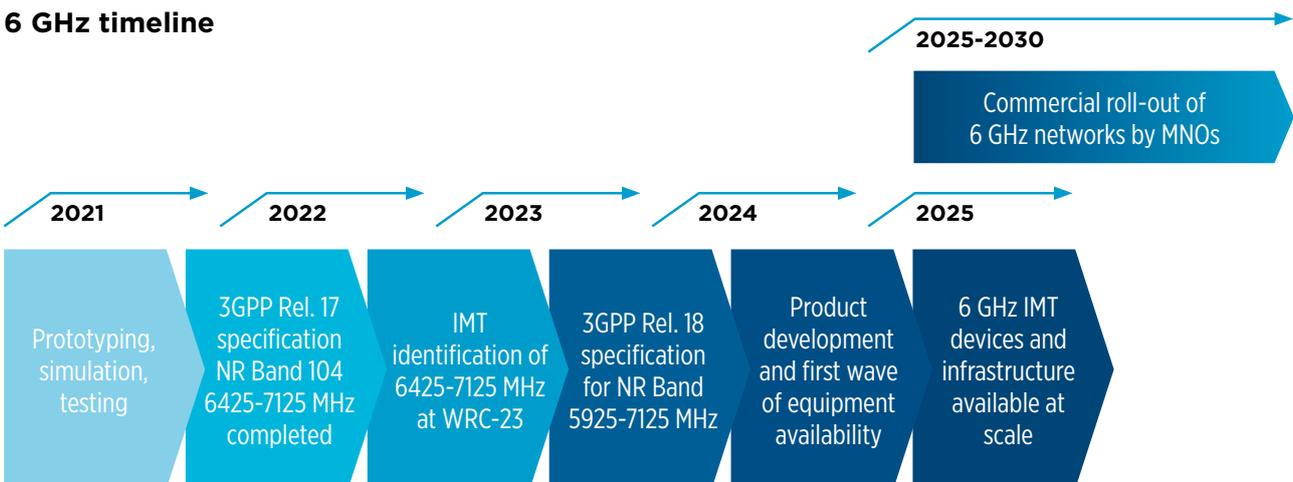
6 GHz is the last opportunity to obtain significant contiguous mid-band spectrum. Our operator survey has indicated strong demand for this band in line with prior studies of mid-band spectrum requirements⁹. This assumes that national regulators make cleared spectrum in the band available in a timely manner at reasonable prices.

Operators and vendors with whom we spoke indicated demand and deployments for 6 GHz IMT

emerging with scale in the 2025-2030 timeframe in their territories. Clear preference for licensed 6 GHz IMT has been expressed in some large markets to deliver the expected high number of 5G subscribers. This aligns with expected product availability worldwide in the 2024-2025 timeframe.

Taking all of these factors into account, a potential 6 GHz roadmap and timeline can be estimated:

6 GHz timeline



⁹ Coleago Consulting, "Estimating the mid-band spectrum needs in the 2025-2030 time frame", July 2021

China case study

Since the awards of commercial 5G licences in 2019, China has become the largest 5G market globally both in scale of deployments and consumer take-ups. The awards of mid-band frequencies across the 2.6 GHz and 3.5 GHz bands for 5G have played important roles in tackling the significant coverage and capacity challenges. Looking at the next stage of 5G expansion.

China has put its focus on the 6 GHz band and expressed strong interest to utilise 6 GHz (5925-7125 MHz) for IMT to satisfy the fast-rising demands for 5G.

To facilitate a conducive environment for the global 6 GHz IMT ecosystem to thrive, China is actively participating in compatibility studies in the ITU and APT including active contributions to the development of IMT characteristics such as RF and network deployment parameters for coexistence studies. The country is also contributing to important propagation measurement data for the revision of relevant ITU-R Recommendations on propagation models.

Coupled with its own sharing and compatibility studies between IMT and satellite as well as terrestrial services in the 6 GHz band, China has showed it is feasible for the 6 GHz IMT system to coexist with other incumbent services with the existing parameters, especially fixed satellite services. These results were echoed by a number of other administrations. It is important to note that although the study is for the upper 6 GHz band (6425-7125 MHz), the conclusions of the study should also be applicable to lower 6 GHz (5925-6425 MHz).

In parallel, China has also started the domestic coordination and preparation for the use of the 6 GHz band for IMT:

- In January 2022, the MIIT issued a public consultation to amend the frequency planning and radio frequency management of fixed service/microwave communication systems with a proposal to remove such uses from the 6 GHz band.
- In June 2022, the MIIT further issued the draft amendments to the “Regulations on Radio Frequency Allocation of the People’s Republic of China” that confirmed the removal of fixed/microwave systems from the 6 GHz band, taking a significant step forward in the preparation of the band for IMT.

China is expected to have more than 600 million 5G connections by the end of 2022.

05

Recommendations for the 6 GHz IMT ecosystem

Executing on the 6 GHz IMT opportunity will require support from policymakers.

Fulfil mid-band requirements

Regulators must carefully consider 5G spectrum demands in the timeframe to 2030, when 5G usage is expected to grow significantly, and correspondingly make more mid-band spectrum available where required. With 2 GHz of additional mid-band spectrum per country required for IMT, the 6 GHz band represents the largest remaining single block of mid-band spectrum that can be assigned to licensed mobile services in the foreseeable future.

Seize the opportunity to identify new IMT mid-band spectrum in 6 GHz at WRC-23

The 2023 World Radiocommunication Conference (WRC-23) will be important in guiding future access to the upper 6 GHz range (6425-7125 MHz). It provides the opportunity to harmonise the band across global markets and help continue development of the 6 GHz ecosystem. In the meantime, decisions on the future of the 6 GHz range should safeguard the band for 5G in advance of WRC-23.

Study the economic benefits of 6 GHz uses

The decision between licensed or unlicensed use of the 6 GHz needs to be carefully assessed and the economic impact clearly understood. GSMA Intelligence research has previously found that the unlicensed use across the 6 GHz band was never the most beneficial option in any of the 24 analysed countries. It is important for regulators to carry out a regulatory impact assessment of the 6 GHz band in order to come to an evidence-based decision.

Provide clear roadmaps for affordable mid-band spectrum

Access to affordable spectrum is required in a timely manner. Investment in a new spectrum layer is significant and greater certainty for operators will allow them to undertake mid- and long-term investment planning before rolling out networks and deploying new services. The result is a faster rollout of new technologies and innovative use cases, to the benefit of consumers, businesses, and the broader economy.



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