POLICYIMPACT PARTNERS

# HOW DO POLICYMAKERS ACHIEVE THE BEST OUTCOME IN THE 6 GHZ BAND?

## Background

The licence-exempt community has long been working toward a new spectrum allocation in support of licence-exempt technologies. The ecosystem strongly supports opening the 6 GHz band (5925-7125 MHz) for licence-exempt use, while protecting incumbent services, predominately fixed satellite and fixed services, and allowing them to continue and even extend their operation without restrictions.

As a result, licence-exempt services are set to gain the first major influx of radio spectrum since the World Radio Conference in 2003 provided access to the 5 GHz band. Numerous jurisdictions around the world are making all, or part, of the 6 GHz band available on a licence-exempt basis, while others have consultations pending. Standards and certifications are being completed, and a variety of licence-exempt 6 GHz equipment is now available on the market.

Relatively recently, the IMT community has begun claiming that at least some of the 6 GHz band is needed for licensed 5G. In a 2025-2030 vision paper published in July 2021, the GSMA calls for an additional 2 GHz of mid-band spectrum for 5G to meet the performance targets for the technology set by the ITU. However, it was originally decided that the so-called pioneer bands for 5G – 700 MHz, 3.6 GHz (3.4-3.8 GHz) and 26 GHz (24.25-27.5 GHz) – would be sufficient to meet these targets.

In any case, work on 3GPP standards relating to licensed 5G in the 6 GHz band has only just concluded, and no equipment exists now, nor will it anytime soon. Most of the IMT community's focus for mid-band spectrum has been on the 3 GHz band – a band which is rapidly opening for 5G and is projected to be in widespread use around the world.

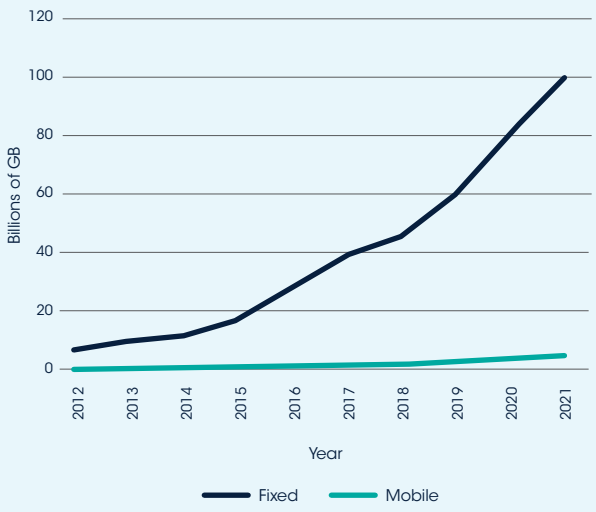
This Q&A document seeks to answer policymakers' questions, as they think about how to best enable access to the 6 GHz band (5925-7125 MHz) in support of national broadband goals and economic benefits generally.

## 1: To what extent are Wi-Fi and IMT complementary, necessitating an outcome that spectrum policy must support both?

IMT (4G, 5G) and Wi-Fi are complementary technologies that work together to meet citizens' and businesses' connectivity needs. Regulators should ensure each of these technologies has access to sufficient and appropriate spectrum. While IMT technologies are designed to meet the connectivity needs of people moving around, Wi-Fi is designed to meet the connectivity needs of people within a single locality. The vast majority of internet traffic is generated and consumed by users that are located inside homes, offices and other buildings, and using Wi-Fi.

Fixed network/Wi-Fi traffic continues to see strong year-on-year growth (see chart). In 2021, 95% of internet traffic in Germany was transmitted over fixed networks and just 5% over mobile networks, according to a report[1] by regulator BNetzA (see chart).

GERMANY – TOTAL DATA ON FIXED AND MOBILE NETWORKS




*Source: Tätigkeitsberichte Telekommunikation*

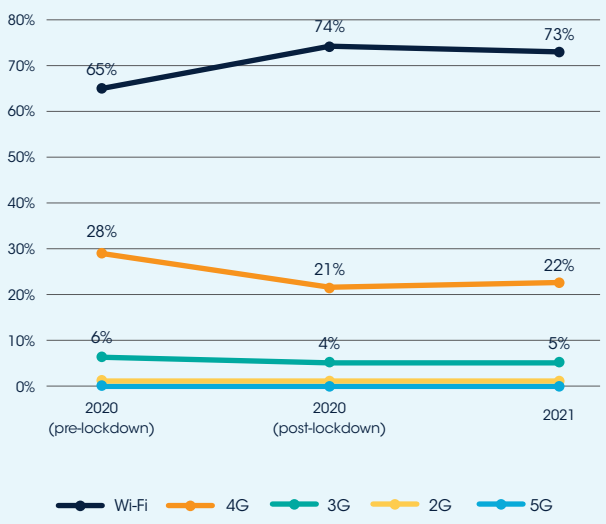
[1] Source: Tätigkeitsberichte Telekommunikation

Approximately, 92% of fixed broadband traffic in Europe is relayed via Wi-Fi, according to ASSIA[2]. These numbers show the absolute volume of traffic handled by Wi-Fi is far greater than that handled by cellular technologies. In Germany, at least, the breakdown by technology is approximately 88% Wi-Fi, 7% Ethernet and 5% cellular.

In developed markets, people tend to use fixed networks/Wi-Fi for productivity-related tasks, such as video conferences and exchanging large files, in the workplace and for watching television and movie or playing games on-demand in the home. Cellular networks, by contrast, are typically used by people on the move to check social media, watch short videos or exchange messages[3].

Even smartphones make much greater use of Wi-Fi than cellular connectivity. For example, UK regulator, Ofcom's analysis[4] of crowdsourced data from Android smartphones found that 73% of the traffic they generated travelled over Wi-Fi and 27% over mobile networks between January and March 2021 (see chart) – the latest figures available.

AVERAGE NETWORK SHARE BY TECHNOLOGY IN UK




*Source: Ofcom*

Despite the enormous growth in Wi-Fi traffic over the past two decades, no new mid-band spectrum was made available on a licence-exempt basis between 2003 and 2020. As a result, congestion has been increasing, impacting the end-user experience. More and more governments, including those of Brazil, Canada, Saudi Arabia, South Korea and the U.S., have recognized the urgent need for licence-exempt access to the entire 6 GHz band (5925-7125 MHz), while others have taken the initial step of making at least part of the 6 GHz band available on a licence-exempt basis.

Without sufficient spectrum for Wi-Fi, users will not be able to fully leverage the performance of gigabit fixed access networks, in particular fibre-to-the-home (FTTH), and advanced internet apps. The latest standard, Wi-Fi 6, can support a variety of demanding use cases, such as UHD video streaming, smart home automation, hotspot access, automation of city-wide services, augmented/virtual/extended reality (AR/VR/XR) applications, health monitoring, wearables and seamless roaming. Moreover, Wi-Fi 6 is the only cost-effective option to distribute gigabit connectivity within schools and hospitals for eEducation and eHealth services. In some cases, 5G and Wi-Fi 6 will work together to deliver an AR/VR/XR service, with the former providing the internet connectivity to a smartphone and the latter connecting the smartphone to the user's headset to support an array of consumer and enterprise use cases. The two technologies can also work together to support other industrial and enterprise applications, such as factory robots and sensors, healthcare monitors, and wireless medical equipment.

The 3.8-4.2 GHz band should provide ample capacity for 5G to cover those use cases that really need licensed spectrum. Mobile network operators (MNOs) greatly benefit from Wi-Fi's capacity to offload traffic from cellular mobile devices; if this capacity were not available, IMT/5G networks would be more costly, as mobile operators would need to deploy many more small cells in dense urban areas to offer gigabit throughput and provide adequate quality of service, and this would be to mobile users only. Because of the attenuation of signals from outdoor 5G base stations (building entry loss), 5G indoor coverage and performance would be severely limited. To penetrate building walls, 5G services need to consume high levels of power. As a result, connecting an indoor device to an outdoor base station will use a disproportionate amount of energy, while also resulting in shorter recharge cycles, increased battery wear, and additional electronic waste.

[2] Source: ASSIA Reports - ASSIA (assia-inc.com)

[3] Source: Data gathered by Sandvine from about 160 2 fixed and mobile service providers worldwide in 1H2021

[4] https://www.ofcom.org.uk/research-and-data/telecoms-research/mobile-smartphones/mobile-matters

Providing 5G gigabit connectivity indoors would require the deployment of a completely new small cell infrastructure, parallel to the existing Wi-Fi one which will be prohibitive from both a commercial and an environmental point of view. These small cells would also need to be backward compatible with the huge existing base of Wi-Fi equipment.

## 2: What is the evidence that Wi-Fi requires access to the full 1200 MHz?

Since the WRC-03 (2003) decision to enable access to new spectrum in the 5 GHz range, there have been revolutionary changes in Wi-Fi technology, use cases, and demand. Wi-Fi is now an absolutely critical link in the broadband connectivity chain – it has become essential to enable businesses and people to get online in urban, suburban and rural areas.

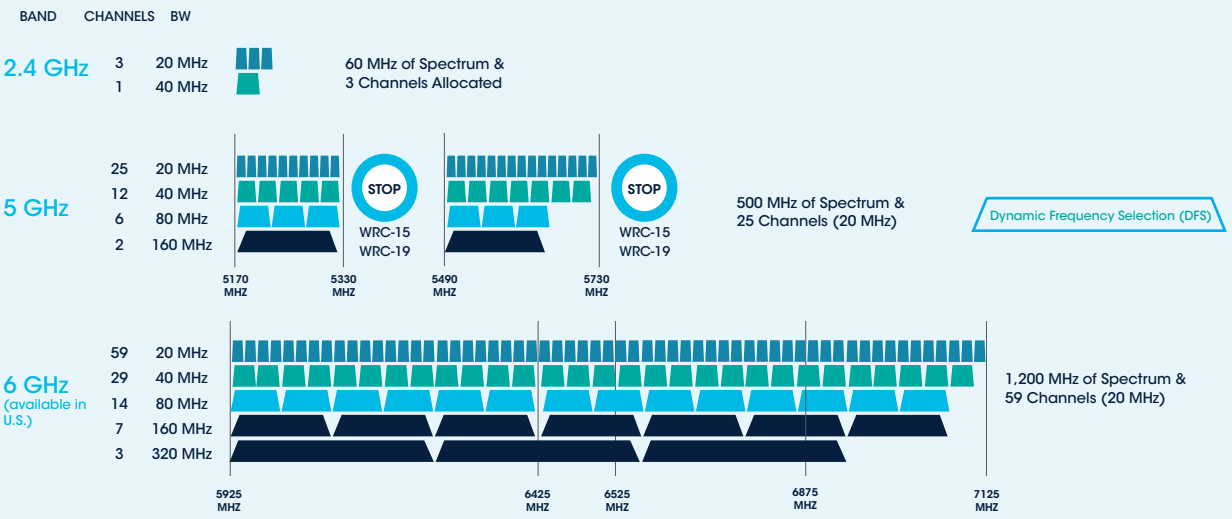
At the same time, the devices running on Wi-Fi networks have become increasingly powerful with each generation making greater demands on Wi-Fi network capacity from video resolution, processing power, camera capabilities and more. As usage of extended reality and holopresence services grows, Wi-Fi will be transmitting vast amounts of data to the headsets and handsets used to access these services.

With a technical architecture that is device-centric and not centrally managed, Wi-Fi has become ubiquitous, enabling it to benefit from enormous global economies of scale. More than 18 billion Wi-Fi devices will be in use in 2022 (360 times as many Wi-Fi devices as were in use in 2003), with 4.4 billion new devices shipped every year, according to research firm IDC[5].

Studies by Quotient, Qualcomm and ASSIA have each pointed to major spectrum shortfalls for licence-exempt technologies, with ASSIA highlighting how congestion in both the 2.4 GHz band and the 5 GHz band has been impacting quality of service. From these studies, it becomes obvious that even the recently added 480 MHz of licence-exempt spectrum in the 6 GHz band will not be sufficient to satisfy the mid- and long-term capacity needs. Given the important role that Wi-Fi plays for the broadband ecosystem and its continuing growth, there is a need to make the full 1200 MHz in the 5925-7125 MHz (6 GHz) band available on a licence-exempt basis to support the ever-increasing demand and enable European nations to meet their broadband goals and objectives for a digital society.

In particular, Wi-Fi 6E, and the forthcoming Wi-Fi 7 standard, need access to the full 1200 MHz to utilize the full extent of their capabilities and support evolving and emerging innovative use cases, now and in the future. Opening only 480/500 MHz of the 6 GHz band would mean that Wi-Fi networks in dense deployments would have to continue employing small channel bandwidths, as only one 320 MHz channel or three 160 MHz channels would be available. With access to the full 1200 MHz, a larger number of these wide channels could be accommodated (see graphic), significantly improving the performance available to each user.

### THE 6 GHZ BAND CAN ACCOMMODATE MULTIPLE 160 MHZ & 320 MHZ CHANNELS




*Source: Broadcom*

[5] Source: https://www.wi-fi.org/news-events/newsroom/wi-fi-alliance-2022-wi-fi-trends

Wider channel bandwidths increase spectrum efficiency and deliver high-bandwidth applications and services while maintaining the ability to share spectrum with incumbents and other licence-exempt systems. A shortage of wider channels would have a detrimental impact on real-time video services and high-bandwidth immersive services, such as augmented reality, virtual reality, and extended reality (AR/VR/XR) services. Enterprise use cases (in manufacturing, education, healthcare and other sectors) requiring different data rates, latencies, and quality of service within one deployment depend on the large number of channels and the diversity of channel widths (20/40/80/160 MHz) that become available with 1200 MHz of spectrum.

In the near future, Wi-Fi 7 will rely on access to 320 MHz channels to further improve latency, throughput, reliability and quality of service relative to Wi-Fi 6E. In acknowledgment of the importance of licence-exempt spectrum for the digital society of the future, U.S. regulator FCC stated: "Making the entire band available for these unlicensed operations enables use of wide swaths of spectrum, including several 160-megahertz channels, as well as 320-megahertz channels, which promotes more efficient and productive use of the spectrum, and would also help create a larger ecosystem in the 5 GHz and 6 GHz bands for U-NII devices."

In addition to applications utilizing the low power indoor (LPI) and very low power (VLP) Wi-Fi flavours that have been authorized in Europe, there are numerous use cases that could benefit from standard power (SP), sometimes also referred to as 'higher power' Wi-Fi. Subject to the results of appropriate sharing studies, it may be possible in future to deploy outdoor SP Wi-Fi systems to support use cases in manufacturing, logistics, agriculture, and rural broadband/community networks, or for enhanced indoor coverage in higher education, hospitality, healthcare, and other sectors. Standard power typically operates in conjunction with an automated frequency coordination (AFC) geolocation capability, which is aware of incumbent user operations and can safely authorize licence-exempt operation on available channels at a particular location while protecting the incumbents from harmful interference.

As the AFC will block certain frequencies in order to protect incumbents, access to the full 1200 MHz will be important to ensure there is a sufficient number of available channels to support standard power operation.

## 3: What are the socio-economic benefits of making the 6 GHz band licence-exempt?

Licence-exempt usage throughout the full 6 GHz band will yield many socio-economic benefits, such as helping to address the digital divide, improving rural connectivity, accelerating innovation, and delivering greater quality of service to the users. With Wi-Fi embedded in a wide array of client devices, from laptops to tablets and smartphones, consumers can choose the right device capabilities and price for them. Businesses also make extensive use of Wi-Fi to cover a variety of applications and use cases, be it for in-office communication, in the hospitality sector, in healthcare and education, in large public venues, and in logistics and industrial settings where Wi-Fi is used to provide remote monitoring and control of machinery and appliances within factories, warehouses and other facilities.

Assuming regulators open the full 6 GHz band, the US$3.3 trillion of value Wi-Fi added to the world's economy in 2021 will rise to US$4.9 trillion in 2025, according to research[6] conducted by Telecom Advisory Services for the Wi-Fi Alliance.

Licence-exempt spectrum promotes innovation and competition by lowering barriers to entry, helping small and medium enterprises (SMEs) in particular. If regulators allow for technical innovation, individuals and companies can choose the technology that best suits them. As users do not need to pay licence fees to use the spectrum, Wi-Fi is one of the most cost-effective ways to provide connectivity.

Regulators have flagged the benefits of licence-exempt technologies. For example, ISED in Canada has said: "Making the full 6 GHz band available for licence-exempt use as soon as possible will maximize the social and economic benefits that Canadians will derive from this spectrum…The additional licence-exempt spectrum will provide the improvements needed in Wi-Fi throughput for homes and businesses and reduce congestion between neighbours living in close proximity. The additional spectrum will also support the ability for small wireless internet service providers to provide cost-effective enhanced broadband connectivity in rural and remote areas."

In rural areas lacking wireline, fibre or cellular infrastructure, Wi-Fi can deliver local broadband connectivity using fixed wireless or satellite broadband links to provide backhaul.

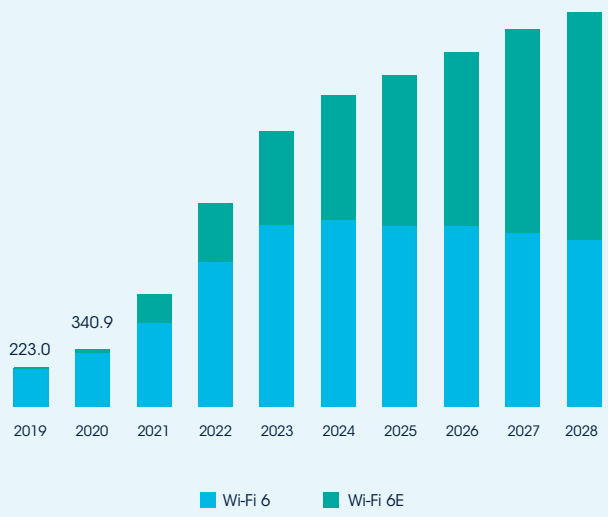
[6] https://www.wi-fi.org/file/global-economic-value-of-wi-fi-2021-2025

## 4: When will 6 GHz Wi-Fi equipment be available?

A wide range of 6 GHz Wi-Fi equipment already is available. The Wi-Fi Alliance has named Wi-Fi 6 products capable of operating in the 6 GHz band as "Wi-Fi 6E" devices and released a certification plan for global interoperability as of January 2021. As of August 2022, there were approaching 800 client devices and access points supporting Wi-Fi 6E, including more than 390 laptop models, 120 desktop PCs, dozens of consumer and enterprise access points, and more than 60 smartphones, as well as 21 smart televisions, according to Intel[7].

As the market grows, economies of scale are kicking in, ensuring that Wi-Fi 6E will be highly affordable. The Wi-Fi Alliance projects more than 350 million Wi-Fi 6E devices will enter the market in 2022. As with previous generations of Wi-Fi, the technology is set to be included in almost every phone, tablet and laptop, as well as other appliances, such as printers, televisions, cameras and wearables. Grand View Research has forecast that the Wi-Fi 6E chipset market will grow rapidly (see chart). It projects that almost 4 billion Wi-Fi 6E chipsets will be shipped in 2028 globally, with an annual CAGR of 40.9% from 2021 to 2028.

**NORTH AMERICA WI-FI 6 AND WI-FI 6E CHIPSET MARKET**
2019-2028 (Million Units)




*Source: https://www.grandviewresearch.com/industry-analysis/wi-fi-6-wi-fi-6e-chipset-market-report*

In short, the Wi-Fi 6E ecosystem is expanding fast. That buoyancy is underpinned by the Wi-Fi 6 certification program, which ensures devices comply with the IEEE 802.11ax standard no matter where they are deployed. In simple terms, this certification ensures they will work and work well.

## 5: Does licensed 5G require more mid-band spectrum? Why the 6 GHz band? What is the evidence? What are the alternatives?

Today, Europe's 5G networks are operating well below capacity. A study of mobile data usage in 2021 by Rewheel found that, even in the top 5% of the busiest sectors, 5G traffic runs at only 7.7% of capacity on average[8]. In other words, usage of 5G to date shows that additional mid-band spectrum is not required.

The large amount of spectrum below 5 GHz that has already been identified for IMT could, and should be, harnessed to improve coverage, before specifically identifying more spectrum for IMT. Successive WRCs have identified specific frequency bands for the deployment of IMT systems (see table below) and this spectrum constitutes a good mix of 'coverage' bands (below 5 GHz) and capacity bands (mmWave spectrum above 24 GHz). In all three ITU Regions, IMT has access to at least 1368 MHz of prime spectrum below 5 GHz – far more than is available for WAS/RLAN.

Much of this IMT spectrum isn't being used today. In Europe, for example, the EU's 5G Observatory shows:

- Currently, only 64% of the 700 MHz band, 75% of the 3.6 GHz band, and less than 30% of the 26 GHz band have been assigned.
- In the 700 MHz and 3.6 GHz bands, the number of 5G base stations is less than 5% of the number of corresponding 4G base stations.

As the 3.6 GHz band isn't being heavily used, it won't be congested anytime soon. Even when the utilization of 3.6 GHz increases, adjacent mid-bands could provide ample additional capacity for 5G to cover the use cases that need a licensed technology.

[7] Disclaimer: This data is compiled from vendor websites, press releases, and third-party device reviews. Intel provides this assessment for informational purposes only, does not guarantee its accuracy, and it is subject to change without notice.

[8] Analysis based on the 82 5G networks considered in EU27 by Rewheel research's study "Mobile data usage in 2021 and 4G & 5G operator capacity potential", published in March 2022. https://research.rewheel.fi/downloads/Mobile_data_usage_2021_capacity_potential_170_operators_50_countries_PUBLIC_VERSION.pdf

## FREQUENCY BANDS IDENTIFIED FOR IMT IN THE THREE ITU REGIONS

| Frequency Bands identified for IMT (MHz) | Footnotes identifying the band for IMT in the Radio Regulations | | | Bandwidth (MHz) |
|---|---|---|---|---|
| | Region 1 | Region 2 | Region 3 | |
| 450-470 | | 5.286AA | | 20 |
| 450-698 | - | 5.295, 5.308A | 5.296A | 228 |
| 694/698-960 | 5.317A | 5.317A | 5.313A, 5.317A | 262 |
| 1 427-1 518 | 5.341A, 5.346 | 5.341B | 5.341C, 5.346A | 91 |
| 1 710-2 025 | | 5.384A, 5.388 | | 315 |
| 2 110-2 200 | | 5.388 | | 90 |
| 2 300-2 400 | | 5.384A | | 100 |
| 2 500-2 690 | | 5.384A | | 190 |
| 3 300-3 400 | 5.429B | 5.429D | 5.429F | 100 |
| 3 400-3 600 | 5.430A | 5.431B | 5.432A, 5.432B, 5.433A | 200 |
| 3 600-3 700 | - | 5.434 | - | 100 |
| 4 800-4 990 | - | 5.441A | 5.441B | 190 |
| 24 250-27 500 | | 5.532AB | | 3 250 |
| 37 000-43 500 | | 5.550B | | 6 500 |
| 45 500-47 000 | | 5.553A | | 1 500 |
| 47 200-48 200 | | 5.553B | | 1 000 |
| 66 000-71 000 | | 5.559AA | | 5 000 |

***Note:*** *An IMT identification does not preclude the use of this band by any application of the services to which it is allocated and does not establish priority in the Radio Regulations. In effect, it is up to each country to determine which bands will be made available for IMT in each country/region depending on national/regional requirements.*

Most countries in the EMEA region are considering making the 3300-3400 MHz, 3800-4200 MHz and 4800-4990 MHz bands available for licensed spectrum use. Whilst not all countries can make all of these bands available due to existing usage, this is a significant potential resource for licensed mid-band spectrum in the medium term for many EMEA countries.

Those African countries employing the 3700-4200 MHz band for fixed satellite services can still make use of the 3300-3700 MHz band for 5G. That additional amount of spectrum will be sufficient to ensure that each mobile operator can get access to 100 MHz contiguous spectrum and therefore offer a high quality of service in the areas where their networks are deployed. In areas with low or no network coverage, the priority should be to roll out networks and leverage the existing European 5G priority bands and/or existing IMT identified bands.

Although the U.S. has made the entire 6 GHz band licence-exempt, the mobile operators there have plenty of spectrum to meet demand for 5G. For example, leading US telecoms operator Verizon is seeing strong growth in 5G fixed wireless access connections in the C-band (3.7–4.2 GHz). In July 2022, Hans Vestberg, Chairman and CEO of Verizon Communications, told analysts on an earnings call[9]: "The capacity in the network is there, there's no problem. … we have deployed 60 MHz of the C-Band. We have, in average, 160. So, we have so much more to go."

In summary, there is no need to also consider the 6 GHz band for IMT, particularly as the less favourable propagation characteristics make it less suitable for wide area coverage.

[9] https://www.verizon.com/about/investors/quarterly-reports/2q-2022-earnings-conference-call-webcast

## 6. If additional mid-band spectrum is not made available for IMT, will the cost of public mobile network deployments increase, or will we see a degradation in network quality?

The simple answer is No. The cost of deploying public mobile networks is related to several factors, including the amount that operators need to pay for the spectrum, the cost of the infrastructure they are deploying and the density of their networks. If mobile operators pay a licence fee for 6 GHz spectrum, that will increase their costs. The cost of developing and deploying 3GPP equipment that can support the 6 GHz band will also have a negative impact on operators' business cases, potentially pushing up prices for end-users.

The amount operators need to spend on 5G infrastructure will depend on the level of demand for 5G, which will depend on many variables, including whether high-quality Wi-Fi is available. The most efficient way to deliver high-speed connectivity indoors will be to use Wi-Fi, which is optimised for this use case. If Wi-Fi has access to sufficient spectrum to meet this demand, operators will not need to spend large sums trying to improve indoor 5G coverage.

More broadly, it is up to mobile operators to price their services in a way that enables them to cover their costs. As demand for 5G rises, operators will be able to amortise the additional costs of deploying 5G across more users.

## 7: What are the benefits or the opportunity costs of Wi-Fi and 5G in the 6 GHz range?

Reserving a portion of the 6 GHz band for a later decision on whether to allow IMT (or not) would forego the immediate economic gains that would have accrued from opening the full 6 GHz band to licence-exempt operations.

In an August 2020 report[10], Coleago Consulting estimated 5G will not be deployed in the 6 GHz band for at least a decade. During that time, the global economy could forego trillions of euros of economic value that could be generated by Wi-Fi 6E.

UK regulator Ofcom has forecast that Wi-Fi demand in residential environments could grow between six and ten times between 2020 and 2030, driven by increased video quality and the adoption of virtual reality devices. In public venues, such as arenas or concert halls, demand could increase up to 15 times over the same period[11].

With Wi-Fi traffic doubling every three years[12], Wi-Fi will need all 1200 MHz available in the 6 GHz band in both the consumer and enterprise markets.

For much of the past decade, the IMT community has called for 100 MHz per operator in the 3 GHz range to support 5G needs. As regulators globally have made the 3 GHz band available for 5G, a wide variety of compatible equipment is available on the market. The IMT community is now calling for the upper 6 GHz band to be identified for IMT, with the GSMA recommending regulators "support harmonized mid-band 5G spectrum".

But countries representing more than 40% of the global gross domestic product (GDP) have opened, or have proposed opening, the full 6 GHz band for licence-exempt use[13]. As a result, these frequencies will not be harmonized for licensed 5G. In fact, an identification of the upper 6 GHz band for IMT could disrupt global harmonization efforts for licence-exempt use and potentially cause major economic damage.

Many regulators believe that withholding the upper 700 MHz of the 6 GHz band for future consideration for IMT is inadvisable. ISED in Canada said such a move would "hinder access to affordable broadband services for Canadians in rural and urban areas and would negatively impact the opportunities for innovation." In Saudi Arabia, the CITC has said that the 3 GHz band "will be sufficient to cover the mid-band spectrum needs of IMT for the foreseeable future. The existing mid-bands for exclusive IMT use have robust ecosystems already as well as superior propagation characteristics."

[10] See section 7.3 of the report: The 6 GHz Opportunity for IMT – "recognizing the 10+ year timeframe anticipated for 5G at 6 GHz"

[11] See UK Ofcom Improving Spectrum Access for Wi-Fi, July 2020, at ¶ 3.24, available at https://www.ofcom.org.uk/__data/assets/pdf_file/0036/198927/6ghz-statement.pdf

[12] Source: ASSIA, State of Wi-Fi Report

[13] http://dynamicspectrumalliance.org/wp-content/uploads/2021/08/6GHz-License-Exempt-Band-Why-1200-MHz-and-Why-Now.pdf

## 8: Can a licence-exempt 6 GHz band support a 5G future?

Yes. The best way to harness 6 GHz spectrum for the benefit of 5G is to authorize licence-exempt use throughout the entire 1200 MHz of the 6 GHz band. Such a move would allow for mobile offload and 5G NR-U operation. Licence-exempt technologies support a substantial amount of mobile traffic offloads for indoor environments, saving operator capital expenses and conserving licensed mobile spectrum. Further, even after permitting licence-exempt use, incumbent fixed services can remain in the 6 GHz band, meaning these links will be available to support 5G networks.

Regulators globally have recognized the important and critical role that licence-exempt technologies, such as Wi-Fi, play in furthering the 5G market and cite this as a reason to allocate the entire 6 GHz band to licence-exempt use.

## 9: Should WRC-23 identify the upper 6 GHz band (6425-7125 MHz) for IMT?

No, the World Radiocommunication Conference in 2023 (WRC-23) should adopt a no-change position. If WRC-23 were to identify the upper 6 GHz band (6425-7125 MHz) for IMT, the 6 GHz band will be fragmented. An IMT identification in 6425-7125 MHz, which typically aims at harmonizing the use of the band around a specific ecosystem, cannot achieve this goal, as it would only concern Region 1. Even in Region 1, many countries have other priorities in the band (incumbent systems and support for licence-exempt technologies). Saudi Arabia, for instance, already opened the entire 6 GHz band for licence-exempt use, and on the request of several European countries, the conditions for potential licence-exempt operation in the upper 6 GHz band are being studied by the CEPT.

Note, it isn't realistic for the upper 6 GHz band to be used simultaneously by Wi-Fi indoors and by IMT outdoors. Such a scenario would present technical, operational and commercial challenges:

- WAS/RLAN was designed to share spectrum with incumbents, while IMT was not.
- Coexistence studies between IMT and WAS/RLAN have never been conducted.

Given the enormous demand for Wi-Fi connectivity, it is important to make the upper 6 GHz band available on a licence-exempt basis today.

For WRC-23 agenda item 1.2, a no-change outcome would not necessarily preclude IMT use of the bands in future. Other bands have been used for IMT in Europe without the need for an IMT identification in the Radio Regulations.

## 10: What are the repercussions of introducing licence-exempt technologies in the 6 GHz band?

Low power indoor (LPI) and very low power (VLP) licence-exempt equipment can coexist with incumbents without any further mitigation measures. For standard power (also referred to as 'higher power') and outdoor operation, mitigation techniques exist which have already been outlined by many regulators worldwide. The licence-exempt industry has no objection to reasonable, evidence-based mitigations and has saluted the decisions of regulators around the globe to make the whole 6 GHz band available on a licence-exempt basis with such conditions.

In our view, the same regulatory conditions, relating to indoor and outdoor usage and power levels, can be applied across the whole 6 GHz band.

In jurisdictions that still have concerns about the impact on incumbent services, we support the timely conduct of the necessary sharing studies. In the EU, for example, a new ECC work item will assess WAS/RLAN/Wi-Fi coexistence with incumbent services operating in 6425-7125 MHz in CEPT.

## 11. There are claims that 5G is more spectrally efficient than Wi-Fi 6. Is that the case?

The theoretical peak spectral efficiencies of Wi-Fi 6 and 5G NR are essentially the same. In real world deployments, spectrum efficiency is chiefly determined by the network topology, rather than the underlying technology. In practice, most 5G networks, which are optimised for wide area coverage and have to balance several objectives, are unlikely to be as spectrally efficient indoors as a Wi-Fi network optimised to support this use case. That matters, because "more than 70% of services in 4G occur indoors, and industry predictions show that this percentage will surpass 80% as 5G spread service diversity and extends business boundaries," according to Huawei[14].

More broadly, licensing spectrum excludes most users and therefore undoubtedly reduces overall usage of the spectrum in question. In that sense, licensing spectrum reduces efficiency.

Tellingly, licence-exempt services are hugely popular with consumers, partly because they enable the end-user to decide how to connect to broadband in their homes or public spaces. Mobile networks in Germany delivered 5.2 million GB per MHz of spectrum allocated in 2021[15]. By comparison, Wi-Fi, operating exclusively over 2.4 and 5 GHz during 2021, delivered approximately 167 million GB[16] per MHz per year, i.e., Wi-Fi used the available spectrum 32 times more efficiently than mobile networks.

To penetrate building walls, 5G services need to consume high levels of power. As a result, connecting an indoor device to an outdoor base station will use a disproportionate amount of energy, while also resulting in shorter recharge cycles, increased battery wear, and additional electronic waste.

It is also the case that low power, mainly indoor, RLAN services, such as Wi-Fi, can share more easily (than outdoor 5G can) with other services, such as satellite earth-to-space links.

The ITU-R Radio Regulations (Section 0.3) states that spectrum: "*must be used rationally, efficiently and economically*", reflecting the fact that there are several important metrics with regard to the efficient use of spectrum, such as economic, or environmental impact, as well as pro-competitive benefits.

## 12. Will the benefits of 6 GHz Wi-Fi not be highly dependent on the availability of high-speed fixed broadband?

Both the availability and uptake of high-speed fixed broadband are growing quickly in most countries. In Europe, the number of subscribers to FTTH/B (fibre-to-the-home or building) services is set to rise to 197 million by 2026, almost double the 99 million in 2021[17], according to the FTTH Council for Europe (see chart). At the same time, the number of homes passed will jump to 302 million in 2026 from 204 million in 2021, as telcos lay more fibre in the ground.

Both Wi-Fi access points and cellular base stations increasingly depend on fibre for backhaul to the internet or other networks. The availability (and capacity) of these backhaul links will be a limit on the amount of traffic either technology can transmit to and from the internet. In other words, both 5G and Wi-Fi will be constrained by the quality of the fixed-line infrastructure/fixed wireless links in the vicinity.

However, as things stand today, the end-user experience of Wi-Fi is far more likely to be determined by the local radio conditions and interference from other users, than the backhaul capacity. This is particularly true in the case of public Wi-Fi hotspots (of which there will be 628 million[18] worldwide by 2023) and in apartment buildings where multiple Wi-Fi networks may overlap.

But spectrum congestion can also be a major issue in less densely populated residential areas where householders are increasingly using Wi-Fi to connect all kinds of devices from tablets and televisions to printers and music systems. The graphic below shows data from early 2021 collected by ASSIA, which works with about 40 internet service providers to optimise fixed and wireless connections. While congestion was still growing in line with traffic in Europe, ASSIA warned that the region is approaching a tipping point and will soon experience congestion issues (similar to those in North America).

In a report published in June 2021[19], ASSIA concluded that "the 5 GHz band is now saturating, and more Wi-Fi spectra is needed. Rapidly growing traffic results in increased congestion and interference, which can be mitigated by wider channels and more channels to reduce congestion and interference, respectively."

[14] Source: Indoor 5G Scenario Oriented White Paper, October 2019

[15] Derived from data from Tätigkeitsberichte Telekommunikation

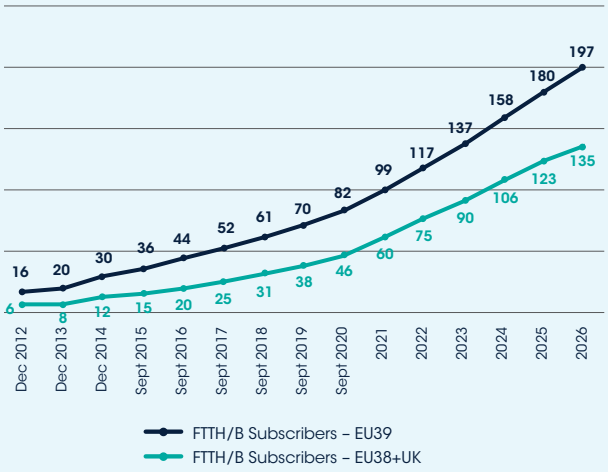
[16] This estimate assumes that 90% of the fixed-line traffic recorded by BnetzA travels over Wi-Fi

[18] Source: Cisco forecast

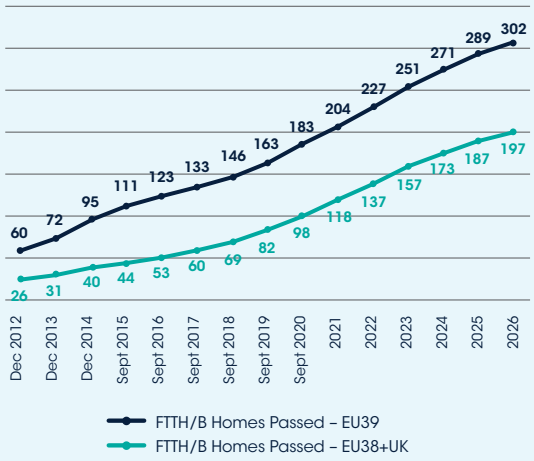
[19] Source: ASSIA Reports - ASSIA (assia-inc.com)

## AVAILABILITY AND UPTAKE OF HIGH-SPEED FIXED BROADBAND IN EUROPE

**FTTH/B Subscribers Forecasts** (million)
Comparison EU27+UK / EU38+UK




**Evolution of FTTH/B Homes Passed** (million)
Comparison EU27+UK / EU38+UK




*Source: IDATE for FTTH Council EUROPE*

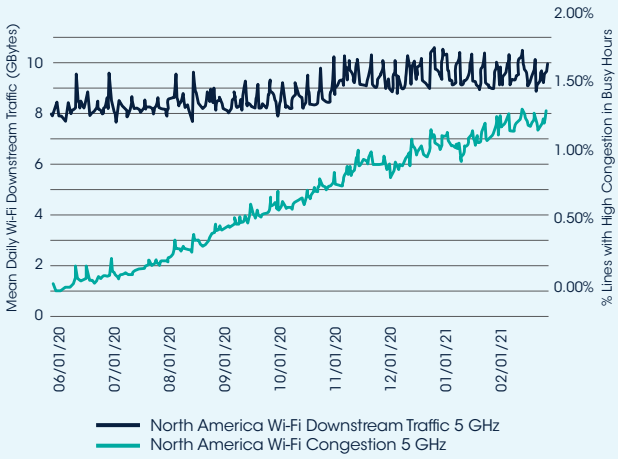
***Note:*** *An IMT identification does not preclude the use of this band by any application of the services to which it is allocated and does not establish priority in the Radio Regulations. In effect, it is up to each country to determine which bands will be made available for IMT in each country/region depending on national/regional requirements.*

In short, there simply isn't sufficient licence-exempt spectrum available to ensure users enjoy a good quality of service. Making the entire 6 GHz band available on a licence-exempt basis will alleviate this congestion.

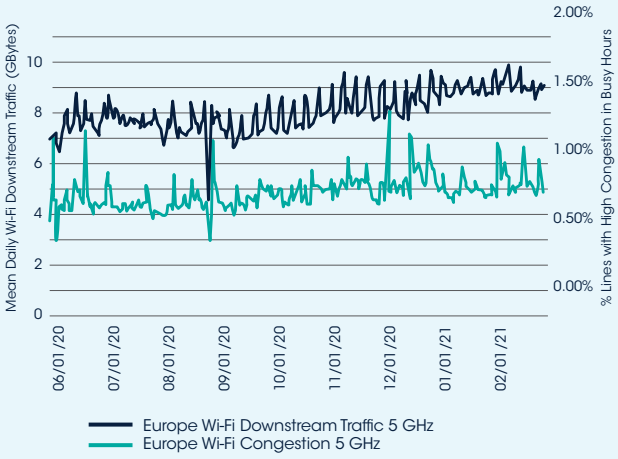
Note that some Wi-Fi 6 traffic will be entirely local in the sense that it will travel between two devices in the vicinity of each other – transmitting video images from a smartphone to a VR/AR headset, for example. For these use cases, there is no need for a high-speed fixed line.

## RISING WI-FI CONGESTION IN NORTH AMERICA AND EUROPE

**North America**
Congestion grows much faster than traffic




**Europe**
Congestion still grows linearly with traffic




*Source: ASSIA*

## 13. Don't users get significantly better speeds and reliability, and lower latency on 5G than on Wi-Fi?

If they have access to sufficient spectrum, both Wi-Fi and 5G NR equipment can provide a very high quality of service, both in terms of data rate and latency. Wi-Fi 6E is capable of delivering up to 9.6 Gbps. The actual throughput will depend on the spectrum available and the level of congestion. In locations where 5G is providing a better experience than Wi-Fi, that would suggest that 5G has a significant spectrum advantage.

Licence-exempt services are hugely popular with consumers as they can then decide how to connect to broadband in their homes or public spaces. In crowded spaces, Wi-Fi is also likely to provide a better end-user experience: whereas cellular technologies have been designed to deliver coverage, Wi-Fi has been designed to deliver capacity/density.

More broadly, with public wide area networks, the requirement to synchronise networks makes it impossible to both avoid interference and have flexible networks. An operator that attempts to offer very low latency would have to create interference to other operators, or to its own network, unless every network nationally operates at very low latency, which is not efficient for macro-cells. The configuration of a nationwide network is the result of compromises between coverage, capacity, latency and the cost of the network. As a result, it is not realistic to expect public wide area 5G networks to deliver low latency.

It is frequently stated by IMT proponents that industrial applications such as factory robots and sensors, but also Augmented Reality (AR), healthcare monitors, wireless medical equipment, and other enterprise applications would need to operate in licensed spectrum because of stringent QoS requirements. While there may be some very specific applications that could benefit from a licensing regime, the large majority of the mentioned applications can be realised with licence-exempt technologies, and specifically Wi-Fi 6E and Wi-Fi 7.

In order to use spectrum most efficiently, applications necessitating a licensed regime could instead utilize the 3.8-4.2 GHz band, which was made available for use by private and local networks and that is already supported by 5G NR.

Stringent QoS requirements that in the past might have justified the use of licensed technologies typically exist in enterprise environments where networks are carefully managed. Unlike previous generations of Wi-Fi, Wi-Fi 6/6E and Wi-Fi 7 are based on OFDMA technology and are thereby able to achieve very high QoS levels, particularly in managed networks. There are various other QoS-enhancing mechanisms and features, particularly in Wi-Fi 7, such as multi-link operation that will improve throughput by aggregating links, enhance reliability by transmitting multiple copies of the same frame in separated links, decrease channel access delay by selecting the first available link in terms of latency, and enable isolation of time-sensitive traffic from other network traffic.

## 14: Will 6G require new spectrum?

The first question to be answered is "What will 6G be"? Will it be a network of networks and not tied to a particular technology, or will it be just another 'G' (IMT-2030)?

Reserving spectrum for what may be the IMT 'flavour' of a future would undermine the objective to use spectrum as efficiently as possible. Moreover, existing IMT spectrum could be employed by 6G using dynamic spectrum sharing techniques (which allows the use of both 4G and 5G on the same spectrum).

6G spectrum requirements are not defined yet, but experience suggests that each generation needs much wider channels than previous generations to deliver a step increase in performance. 3G leveraged 5 MHz channels, 4G leveraged 20 MHz and 5G 100 MHz. The upper 6 GHz will not be able to support much wider channels than the 3.6 GHz band.

Furthermore, propagation in the upper 6 GHz band is inferior to that in the 3.6 GHz band. Mobile operators would always use the band with the most favourable propagation characteristics to deploy their new network. This is what happened in Europe where 4G was deployed in the 1800 MHz band rather than in the 2600 MHz band. The EU 5G Observatory also indicates that 5G is mostly being deployed in lower bands, rather than in the 3.6 GHz band (only 3% of EU base stations are equipped with 3.6 GHz).

IMT services in the upper 6 GHz band would also suffer from severe restrictions, according to ITU studies. Coexistence with incumbent services requires a stringent limitation of base station density, deploying the base stations below rooftop and deploying only in urban and suburban areas. Even if EMEA administrations were to remove all fixed links from the upper 6GHz band, a costly and damaging process, they would still need to protect satellite services.

Finally, making the upper 6 GHz a priority band for 6G would prevent harmonization and reduce economies of scale, as well as weaken alignment on a low-cost ecosystem. That would impact both end-users and innovators.

In summary, selecting the upper 6 GHz band as a 6G priority band would significantly and negatively impact 6G's innovation potential.

## 15: To what extent can IMT and Wi-Fi co-exist with incumbent services in the 6 GHz band?

The European Commission Implementing Decision (EU) 2021/1067 of 17 June 2021 established the regulatory conditions necessary for the operation of wireless services in the 5945-6425 MHz frequency band. The decision was taken following extensive technical studies which determined that low power indoor and very low power portable licence-exempt networks (e.g., Wi-Fi) can co-exist with incumbent satellite and fixed services.

Whilst technical studies on the operation of 5G/IMT services in the upper 6 GHz band are ongoing, they will almost certainly conclude that incumbents in the upper 6 GHz band will need similar levels of protection. Such requirements would allow licence-exempt networks (e.g., Wi-Fi) to operate in the band, but would make deployments of 5G/IMT networks commercially unviable.

The satellite industry is very concerned about potential interference from IMT services. On announcing that it will make the entire 6 GHz band available on licence-exempt basis, the FCC, the U.S. regulator, noted: "The fixed satellite service commenters […] strongly reject the contention of CTIA and Ericsson that satellite services would not need to be relocated because new licensed services would not cause harmful interference to the satellite services."

In any case, the results of the IMT coexistence studies need to be supplemented with further research to make an informed decision on the future of the upper 6 GHz band. Indeed, each national administration needs to assess the extent to which the assumptions and criteria used in the studies apply to their own country. In many cases, the national regulatory authority will have to consider whether to run the studies with the actual data for their country (e.g. location of the fixed links, more precise assumptions on the likely density of IMT base stations, etc.).

Even if the technical studies suggest IMT services could coexist with the incumbent services, it will still be necessary to assess whether the technical constraints of coexistence would be enough to support commercial mobile services that bring socio-economic benefit to citizens and businesses. Note, such constraints will most likely curb the funds governments would hope to raise for the spectrum licences.

Together, satellites and Wi-Fi bring connectivity to people and communities that are underserved by cellular and fixed-line networks. If the 6 GHz band is licence-exempt, Wi-Fi networks will be able to harness the spectrum to enable people in underserved areas to share the broadband connectivity delivered by satellites.

## 16: How sustainable are Wi-Fi and IMT technologies?

Digital technologies and connectivity are playing a pivotal role in curbing greenhouse gas emissions, as well as humans' broader impact on the environment. Connectivity can be used to capture real-time information that can be used to make all kinds of processes more efficient and less energy-intensive.

For example, digital connectivity can reduce the need to travel, by enabling people to fulfil tasks and conduct meetings remotely, rather than driving or flying. As it can deliver high-speed and very responsive connectivity, Wi-Fi 6E is well suited to delivering high-resolution video streams and VR/AR services that can help people interact effectively without being physically present in the same location. VR/AR is increasingly used for training and education and to help field engineers make repairs or install new equipment. Most of these applications will be used indoors, where Wi-Fi is the technology of choice. In outdoor scenarios, Wi-Fi will be widely used to connect smartphones to VR/AR headsets.

In cases where travel is necessary, Wi-Fi can help make public transport more appealing, thereby reducing congestion and emissions caused by private cars. Wi-Fi can make travel time more enjoyable and productive for passengers by providing onboard connectivity on trains, buses, trams, and stations. Wi-Fi connectivity is now a standard feature on board trains in developed markets.

At the same time, Wi-Fi is becoming more efficient, thanks to new features, such as target wake time and the OFDMA radio interface, which reduce power consumption. Most Wi-Fi networks operate at much lower power levels than cellular systems, so they could be the most energy-efficient connectivity option in many scenarios.

Indeed, the French regulator ARCEP found that the combination of fibre and Wi-Fi is the most efficient solution in terms of energy consumption, performance, and flexibility. Energy efficiency will be particularly important in light of the emerging energy crisis caused by the conflict in Ukraine, while also helping the EU to achieve its sustainability targets. Employing Wi-Fi, rather than IMT, in the 6 GHz band will require less power, helping Europe to make better use of scarce energy resources.

The ITU has forecast that the energy used by mobile networks around the globe will emit 73.0 Mt CO2 equivalent (CO2e) in 2025, compared with 35.2 Mt CO2e for fixed networks. Considering the share of mobile data and fixed broadband lines in Europe, around 4.8 Mt CO2e will be emitted from fixed networks and 10 Mt CO2e from mobile networks in the EU. That suggests fixed networks produce less than half the CO2e of mobile networks, even though they transport more than ten times the amount of data.

Furthermore, Wi-Fi 6 introduces new features to support IoT deployments, such as support for large numbers of simultaneous connections, which can then be used to monitor environmental conditions. With the new features in Wi-Fi 6, more IoT devices will be able to send more information and use less power.