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Response to the
Questionnaire on the Long-term vision for the upper 6 GHz band

I) Explain the demand for MFCN or WAS/RLAN in the upper 6GHz band before and beyond 2030

The future projections for Wi-Fi in the (upper) 6 GHz band indicate significant growth and widespread adoption in the coming years:

- Wi-Fi provides significant benefits to economies worldwide: The global economic value of Wi-Fi is estimated at more than $3.5 trillion; by 2025, that value is expected to grow to nearly $5 trillion.[1]
- Wi-Fi 6 and 6E devices are expected to dominate the market, with Wi-Fi 6E device shipments estimated to have reached 473 million in 2023. This represents a substantial increase as more countries allocate the 6 GHz band for license exempt use.[2][3]
- By 2025, it is estimated that Wi-Fi 6 devices will account for 79% of all Wi-Fi product shipments, with Wi-Fi 6E devices constituting 41% of those shipments.[4][5]
- The total number of Wi-Fi 6 devices is forecast to surpass 5.2 billion by 2025.[6]
- Wi-Fi 7 is on the horizon: The Wi-Fi 7 Market size is estimated at $1.28 billion in 2024, and is expected to reach $8.94 billion by 2029, growing at a CAGR of 47.32% during the forecast period (2024-2029)[7].
- The transition to Wi-Fi 7 will coincide with the increased adoption of Wi-Fi 6E, ensuring a smooth upgrade path and continued innovation in wireless connectivity.[8]

The demand for Wi-Fi in the upper 6 GHz band before and beyond 2030 is set to grow substantially. This growth will be driven by increasing data consumption, the proliferation of connected devices, the adoption of advanced Wi-Fi standards, the expansion of smart city and IoT applications, and the continuous evolution of wireless technologies. Therefore, the upper 6 GHz band will be essential in meeting the future demands for high-speed, reliable, and efficient wireless connectivity, making it a critical component of the global wireless ecosystem.

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[1] Wi-Fi Alliance: „Value of Wi-Fi", https://www.wi-fi.org/discover-wi-fi/value-wi-fi
[2] RCRWirelessNews: „What does global Wi-Fi 6 and 6E adoption look like?", 17. November 2023, https://www.rcrwireless.com/20231117/fundamentals/what-does-global-wi-fi-6-ad-6e-adoption-look-like
[3] Wi-Fi Alliance / The Beacon: „Wi-Fi 6 shipments to surpass 5.2 billion by 2025", https://www.wi-fi.org/beacon/the-beacon/wi-fi-6-shipments-to-surpass-52-billion-by-2025
[4] Wi-Fi Alliance / The Beacon: „Wi-Fi 6 shipments to surpass 5.2 billion by 2025", https://www.wi-fi.org/beacon/the-beacon/wi-fi-6-shipments-to-surpass-52-billion-by-2025
[5] Wi-Fi Alliance / The Beacon: „Wi-Fi® by the numbers: Technology momentum in 2023", 15 May 2023, https://www.wi-fi.org/beacon/the-beacon/wi-fi-by-the-numbers-technology-momentum-in-2023
[6] Wi-Fi Alliance / The Beacon: „Wi-Fi 6 shipments to surpass 5.2 billion by 2025", https://www.wi-fi.org/beacon/the-beacon/wi-fi-6-shipments-to-surpass-52-billion-by-2025
[7] Mordor Intelligence: „Wi-fi 7 Market Size", https://www.mordorintelligence.com/industry-reports/wi-fi-7-market https://www.mordorintelligence.com/industry-reports/wi-fi-7-market
[8] Wi-Fi Alliance / The Beacon: „Wi-Fi® by the numbers: Technology momentum in 2023", 15 May 2023, https://www.wi-fi.org/beacon/the-beacon/wi-fi-by-the-numbers-technology-momentum-in-2023

As technological advancements continue, data consumption is expected to grow exponentially. Emerging applications will require even greater bandwidth and faster connectivity, further increasing the demand for the 6 GHz spectrum.

With the establishment of fiber optics as the access technology of the future, both for professional and private use, and the further development towards 25G and 50G technologies that has already begun, the data rates and bandwidths available in the 6 GHz band are the perfect solution to bring these to the end user.

Beyond 2030, we can expect the development of new applications and technologies that are currently in their infancy or yet to be conceived. These innovations will likely require ultra-reliable, low-latency, and high-throughput wireless connections, driving the demand for the 6 GHz band even further.

Future advancements will also focus on sustainability and energy efficiency in wireless communication. The 6 GHz band, with its ability to support more efficient use of spectrum and reduced interference, will be crucial in meeting these goals, contributing to the overall demand.

As global standardization efforts continue, more countries will adopt regulations that allow the use of the 6 GHz band for Wi-Fi. This international harmonization will drive widespread deployment and further increase demand as global markets adopt and integrate this spectrum into their wireless infrastructure.

II) Provide information about the sustainability of the above explained demand, especially the:

1) Environmental impact assessment

Wi-Fi has played and will continue to play a significant role in promoting sustainability across various sectors. Its impact on environmental, economic, and social sustainability is profound, reflecting its potential to contribute to a more sustainable future.

From an environmental perspective, Wi-Fi technology aids in reducing carbon footprints through its facilitation of i.e., remote work and virtual collaboration. By enabling employees to work from home, businesses can decrease the need for commuting, which in turn reduces emissions associated with transportation. Low latency will enable real-time interaction between participants from remote regions in various activities, further reducing the need for travel - and the associated adverse environmental impacts - for direct interaction/face-to-face communication.

Moreover, Wi-Fi supports the proliferation of smart home technologies, which optimize energy usage. Smart thermostats, lighting systems, and appliances connected via Wi-Fi can adjust their operations based on real-time data, thereby conserving energy and reducing household carbon emissions.

2) Social economic impact

On a social level, Wi-Fi has revolutionized how people communicate and interact. It has enabled instant connectivity through social media platforms, video conferencing, and messaging apps, thereby shrinking the world into a global village. The ease of accessing information and

maintaining social connections, irrespective of geographical barriers, has fostered a more interconnected and informed society.

Wi-Fi has also had a transformative impact on education. It has enabled the rise of e-learning, making education more accessible and flexible. Students from remote or underserved areas can now access quality educational resources. This shift has not only enhanced educational outcomes but also contributed to bridging the digital divide, promoting greater social and economic equity.

Low latency and high bandwidth enable remote interventions - similar to telemedicine - in other service and technology areas. The improved ability for real-time interaction also offers new opportunities for the online production of music and art performances, for example.

Economically, Wi-Fi has been a catalyst for significant growth and innovation. It has been instrumental in the proliferation of the gig economy, enabling freelance work and remote jobs. Small and medium-sized enterprises (SMEs) have greatly benefited from Wi-Fi, which has leveled the playing field by providing affordable access to global markets, digital marketing tools, and online sales platforms. This democratization of business opportunities has spurred entrepreneurship and innovation, driving economic growth.

III) Provide information about:

1) the possible role of the upper 6GHz for MFCN or WAS/RLAN:

The upper 6 GHz frequency band represents a significant opportunity for the expansion and enhancement of Wi-Fi capabilities. This frequency range is part of the broader 6 GHz band, which has been identified as critical for the next generation of wireless communication technologies.

It offers significant advantages for the future of Wi-Fi, including enhanced capacity, faster data rates, lower latency, and improved security.

With regulatory support and the ongoing development of Wi-Fi standards, this band is poised to play a crucial role in meeting the growing demands for wireless connectivity in both consumer and enterprise applications.

One of the primary benefits of utilizing the upper 6 GHz frequency band for Wi-Fi is the potential for increased network capacity. As more devices connect to Wi-Fi networks, the existing spectrum bands, particularly the 2.4 GHz and 5 GHz bands, have become increasingly congested. The introduction of the upper 6 GHz band provides additional spectrum, which can significantly alleviate congestion and improve overall network performance. This additional bandwidth can support more simultaneous connections, higher data rates, and improved user experiences, especially in densely populated areas.

The upper 6 GHz band can support wider channels, up to 320 MHz. Without the allocation of the upper 6 GHz band for Wi-Fi, there is only a single 320 MHz channel in the European Union, which has important positive effects, but falls far short of the potential of the entire 6 GHz band. Only when the upper half of the 6 GHz band is also allocated to Wi-Fi will several overlap-free 320 MHz wide channels become available and the associated advantages be fully utilized.

Wider channels enable faster data rates, which are essential for high-bandwidth applications such as 4K and 8K video streaming, virtual reality (VR), augmented reality (AR), and other emerging technologies. Wide channels, in conjunction with OFDMA, have a higher spectral efficiency (i.e., more data throughput per time and bandwidth, bits/s/Hz). In addition, flexible utilization results from the use of resource units.

Additionally, operating in the 6 GHz band in accordance with latest Wi-Fi Standards, can significantly reduce latency, which is crucial for real-time applications like online gaming, video conferencing, and telemedicine. There are only at least Wi-Fi 6 products in the 6 GHz band.

Wi-Fi networks in the upper 6 GHz band can leverage the latest security protocols, such as WPA3, providing enhanced security features that protect against unauthorized access and cyber threats. In the 6 GHz band, the Wi-Fi 6E and Wi-Fi 7 encryption protocol/security standard WPA3 has been made mandatory.

Furthermore, because the 6 GHz band is relatively new for Wi-Fi use, it can benefit from less legacy interference and more modern technological implementations, leading to more reliable and efficient network performance due to a significantly reduced protocol overhead. This is only achievable by the use of new accessible spectrum overcoming the burden induced by the otherwise necessary support of the legacy protocols.

The incorporation of the upper 6 GHz band into Wi-Fi standards is a forward-looking move that helps future-proof wireless networks. As technology continues to evolve and the demand for higher data rates and more reliable connections increases, having access to a broader spectrum ensures that Wi-Fi can continue to meet these demands. This future-proofing is particularly important for businesses and industries that rely heavily on robust wireless communication infrastructures.

2) use cases, expected deployments (e.g., number of BS for MFCN) and timeframe

Devices that support the entire 6 GHz frequency band / the corresponding Wi-Fi standards are already available on the market. However, their real strength can only be demonstrated if the entire 6 GHz band can be used for Wi-Fi, because otherwise support for legacy devices is necessary. This is also one reason why the 5 GHz spectrum is not sufficient.

Use cases

The adoption of Wi-Fi in the upper 6 GHz band will impact smart homes and consumer electronics. As homes become increasingly connected with smart devices, from security cameras to voice assistants, the demand for high-speed and reliable Wi-Fi grows. The additional spectrum will support more devices simultaneously without performance degradation, facilitating the seamless operation of smart home ecosystems.

One of the primary use cases for Wi-Fi in the upper 6 GHz band is in high-density environments such as stadiums, convention centers, airports, and urban areas. These locations often experience significant network congestion due to a large number of simultaneous connections. The expanded spectrum in the upper 6 GHz band can accommodate more users with faster data rates, ensuring a seamless and efficient connectivity experience.

The ability to serve many users simultaneously with high efficiency only exists with the newer Wi-Fi standards. However, devices based on these standards can only (fully) exploit their strengths if they do not have to establish backward compatibility with legacy devices. This is essential in the 2.4 and 5 GHz bands, as otherwise there will be conflicts with devices that work according to the old standard versions. In the new frequency band (6 GHz), the new Wi-Fi standards have the opportunity to fully exploit these strengths, as they are not slowed down by legacy devices.

Enterprises and industrial sectors can significantly benefit from the deployment of Wi-Fi in the upper 6 GHz band. In office buildings, factories, and warehouses, the increased bandwidth and reduced latency can enhance productivity by supporting applications like real-time data analytics, high-definition video conferencing, and the Internet of Things (IoT). In industrial settings, reliable wireless connectivity is crucial for automation, robotics, and monitoring systems, where downtime or latency can lead to substantial operational inefficiencies and costs.

Healthcare is another sector where the upper 6 GHz band can make a significant difference. Telemedicine, which relies on high-quality video conferencing and real-time data transmission, can greatly benefit from the enhanced capabilities of Wi-Fi in this band. In hospitals and clinics, reliable wireless connectivity is essential for patient monitoring systems, electronic health records, and communication between medical staff.

The educational sector, particularly in the context of remote learning, stands to gain from the improved connectivity offered by the upper 6 GHz band. Higher data rates and reduced latency can enhance the delivery of online courses, virtual classrooms, and collaborative learning tools, ensuring that students and educators have a robust and uninterrupted online experience.

Expected Deployments

The deployment of Wi-Fi in the upper 6 GHz band will initially be driven by the introduction of consumer and enterprise devices compatible with Wi-Fi 6E and Wi-Fi 7 standards. Many Wi-Fi 6E and Wi-Fi 7 clients already exist today.

Leading technology companies are already releasing routers, smartphones, laptops, and other devices that support these standards, paving the way for widespread adoption. As these devices become more common, both consumers and businesses will begin to experience the benefits of the expanded spectrum.

To fully leverage the upper 6 GHz band, existing Wi-Fi infrastructure will require upgrades. This includes the deployment of new access points and routers capable of operating in the 6 GHz band. Enterprises, service providers, and public venues will need to invest in these upgrades to provide enhanced connectivity to their users. The transition will likely occur in phases, with high-priority areas and early adopters leading the way.

Public Wi-Fi networks in places like airports, stadiums, and city centers will also begin to incorporate the upper 6 GHz band to handle increased traffic and provide better service quality. Additionally, private networks in businesses and homes will adopt the new spectrum to support the growing number of connected devices and high-bandwidth applications.

Timeframe

Allocating the upper 6 GHz frequency band to Wi-Fi as soon as possible is crucial to address the escalating demand for high-speed, reliable wireless connectivity.

While the entire spectrum in the 6 GHz frequency band can already be utilized by Wi-Fi technology in other parts of the world, there is as yet no definition of this in Europe.

Where the upper 6 GHz frequency band has already been allocated, the first wave of compatible devices and infrastructure is already entering the market, and broader adoption is anticipated subsequently. It is expected that, by 2025, a significant portion of new Wi-Fi devices will support the upper 6 GHz band.

According to industry estimates, most chipsets installed in current Wi-Fi devices already support the entire 6 GHz band. An extension to the upper half of the band for devices that currently only support the lower 6 GHz band would be possible with a software update. Utilization of the entire 6 GHz band would therefore be possible very soon.

The spectrum in the upper 6 GHz band should therefore be ubiquitous as quickly as possible, fully integrated into the Wi-Fi ecosystem, and driving the next generation of wireless connectivity. Immediate allocation will ensure that technological advancements keep pace with user demands, fostering innovation, improving user experiences, and maintaining global competitiveness in wireless technology.

IV) Provide information about standardization and technology impact

The standardization and technological impact of allocating more spectrum in the upper 6 GHz frequency band for Wi-Fi is a transformative development in the realm of wireless communication. As the demand for high-speed internet and seamless connectivity continues to surge, the additional spectrum in the 6.425 GHz to 7.125 GHz range offers promising advancements for Wi-Fi technology.

Standardization Efforts

The standardization of the upper 6 GHz band for Wi-Fi use is being driven by organizations such as the Institute of Electrical and Electronics Engineers (IEEE) and the Wi-Fi Alliance.

The IEEE has been instrumental in developing Wi-Fi standards, including the latest Wi-Fi 6E (802.11ax) and upcoming Wi-Fi 7 (802.11be), which extend Wi-Fi functionality into the 6 GHz band. These standards define the technical specifications for using this new spectrum, ensuring interoperability and optimal performance across devices and networks.

The Wi-Fi Alliance, a global consortium of companies promoting Wi-Fi technology, has been actively certifying devices that operate in the 6 GHz band under its Wi-Fi CERTIFIED 6E program. This certification process ensures that devices meet stringent performance and security criteria, fostering confidence among consumers and businesses in adopting this new technology.

Technological Impact

The allocation of more spectrum in the upper 6 GHz band significantly enhances Wi-Fi performance and capacity. Wider channels, up to 320 MHz, become feasible, which drastically increases data throughput. This capability is vital for supporting high-bandwidth applications such as 4K and 8K video streaming, virtual and augmented reality, and large-scale IoT deployments. The additional spectrum also enables more simultaneous connections, reducing network

congestion and improving user experiences in crowded environments like stadiums, airports, and urban areas.

Operating in the upper 6 GHz band allows for reduced latency, a critical factor for real-time applications such as online gaming, video conferencing, and telemedicine. The higher frequencies used in this band provide more reliable connections with less interference from legacy devices operating in the 2.4 GHz and 5 GHz bands. This results in more stable and consistent network performance, essential for applications requiring low latency and high reliability.

Wi-Fi networks utilizing the upper 6 GHz band can incorporate the latest security protocols, such as WPA3. These advanced security features offer robust protection against unauthorized access and cyber threats, ensuring that data transmitted over these networks is secure. This enhanced security is particularly important for enterprise environments and applications involving sensitive information.

Conclusion

Regulatory bodies worldwide are recognizing the pressing need/potential of the 6 GHz band for license exempt Wi-Fi use. The Federal Communications Commission (FCC) in the United States has been a frontrunner, opening up the entire 6 GHz band for license exempt use. Similar regulatory actions are being taken in Europe, Asia, and other regions, paving the way for global adoption of Wi-Fi in the upper 6 GHz band. This regulatory support is crucial for creating a harmonized global spectrum, facilitating international interoperability and consistency in Wi-Fi performance.

The expansion into the upper 6 GHz band future-proofs Wi-Fi networks by providing the necessary bandwidth to accommodate future technological advancements and increasing data demands. As innovations such as smart cities, autonomous vehicles, and advanced industrial automation continue to develop, having access to this additional spectrum ensures that Wi-Fi networks can scale and adapt to these emerging needs.