

Re: RSPG23-026: DRAFT Opinion “The development of 6G and possible implications for spectrum needs and guidance on the rollout of future wireless broadband networks”

Dear Radio Spectrum Policy Group,

IEEE 802 LAN/MAN Standards Committee (LMSC) thanks the Radio Spectrum Policy Group (RSPG) for issuing the consultation on the DRAFT Opinion on “The development of 6G and possible implications for spectrum needs and guidance on the rollout of future wireless broadband networks” and for the opportunity to provide feedback on this topic.

IEEE 802 LMSC is a leading consensus-based standards developing organization, producing standards for wireless networking devices, including wireless local area networks (“WLANs”), wireless specialty networks (“WSNs”), wireless metropolitan area networks (“Wireless MANs”), and wireless regional area networks (“WRANs”). We also produce both standards for wired Ethernet networks and standards for Time Sensitive Networks (“TSNs”), and technologies produced by implementers of our standards are critical for all networked applications today.

IEEE 802 LMSC is a committee of the IEEE Standards Association and Technical Activities, two of the Major Organizational Units of the Institute of Electrical and Electronics Engineers (IEEE). IEEE has about 400,000 members in over 160 countries. IEEE’s core purpose is to foster technological innovation and excellence for the benefit of humanity. In submitting this document, IEEE 802 LMSC acknowledges and respects that other components of IEEE Organizational Units may have perspectives that differ from, or compete with, those of IEEE 802 LMSC. Therefore, this submission should not be construed as representing the views of IEEE as a whole<sup>1</sup>.

IEEE 802 LMSC supports the RSPG’s effort in developing 6G and encourages the RSPG to consider license exempt technologies, especially IEEE 802 technologies, as playing an important role in providing energy-efficient wireless broadband connectivity for Europe. Please find below the responses of IEEE 802 LMSC on the DRAFT Opinion.

### ***Response***

Regarding the DRAFT Opinion, IEEE 802 LMSC sees some misconceptions in the underlying assumptions reflected in Informative Annex 1 of the report that we would like to highlight and address. In doing so we would like to provide insights into the projected evolution of IEEE 802 wireless technologies as relevant for the 6G timeframe. Lastly, we would urge the RSPG to continue to evolve and emphasize the concept of technology neutrality in its positions.

Regarding the underlying assumptions, our response focuses on the following three misconceptions:

1. Technologies designed for license exempt usage (such as IEEE 802.11/Wi-Fi) are less suitable for Enterprise use,
2. License exempt technologies cannot deliver predictable QoS, and
3. Spectrum needs for license exempt usage are already covered for the 6G timeframe.

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<sup>1</sup> This document solely represents the views of IEEE 802 LMSC and does not necessarily represent a position of either the IEEE or the IEEE Standards Association.

## **Misconception #1: Technologies designed for license exempt usage (such as IEEE 802.11/Wi-Fi) are less suitable for Enterprise use**

**Chapter 5, section 5.1 states:** *“Use of unlicensed spectrum is mainly targeted towards consumers use and non-critical systems and is less suited for enterprise customers”.*

This comment points to a fundamental misunderstanding on the European and global role of wireless technologies such as IEEE 802.11/Wi-Fi and their critical role in enterprises today and in the foreseeable future, with further enhancements projected to roll out in the market between now and the year 2030. Enterprise wireless local area network (WLAN) is a constantly growing multi-billion Euro market. IDC publicly reported a quarterly revenue market size of USD \$2.8 billion (EUR 2.6 billion) for Q1 2023 and an annual market size of around USD \$9.5 billion (EUR 8.7 billion) for calendar year 2022<sup>2</sup>.

It is quite common that for carpeted office environments, Wi-Fi networking fully replaces wireline Ethernet networks for device connectivity. In those environments all enterprise applications (voice/video conferencing, office productivity applications, access to server/cloud-based systems etc.) run over the Wi-Fi network. Wi-Fi networking for enterprise users is not restricted to office environments. One European construction customer for example has deployed a software-defined branch solution including Wi-Fi for offices and for large and medium construction sites across Europe and beyond. Currently approximately 1,400 Access Points (APs) are in use on approximately 200 sites, providing connectivity for office areas as well as for construction sites. Wi-Fi is critical for both business operation and for the needs of the digitized construction site.

Below are a few publicly available examples where license exempt technologies are being used to support critical services in enterprise settings:

- Universities:
  - Cyprus University of Technology, Cyprus (<https://www.cisco.com/c/dam/en/us/services/collateral/se/cyprus-case-study.pdf>)
  - University of Michigan, USA (<https://wifinowglobal.com/news-and-blog/university-of-michigan-deploys-colossal-Wi-Fi-6e-campus-network/>,
  - Heilongjiang International University, China (<https://e.huawei.com/en/case-studies/enterprise-networking/2022/heilongjiang-international-university>)
- Stadiums:
  - Ghelamco Stadium, Belgium (<https://www.commscope.com/resources/case-studies/ghelamco-stadium/>)
  - Chase Stadium in San Francisco, USA (<https://www.hpe.com/psnow/doc/a00115219enw>)
- Container shipping terminals:
  - La Spezia Container Terminal, Italy (<https://www.cisco.com/c/en/us/products/wireless/ultra-reliable-wireless-backhaul/index.html#~:customer-stories>)
  - Port of Thessaloniki, Greece (<https://www.cisco.com/c/en/us/about/case-studies-customer-success-stories/thessaloniki-port-authority.html?dtid=odicdc000509> )

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<sup>2</sup> Source

<https://www.idc.com/getdoc.jsp?containerId=prUS50864423#:~:text=NEEDHAM%2C%20Mass.%2C%20June%2013,Worldwide%20Quarterly%20Wireless%20LAN%20Tracker> accessed 2023-08-04.

- Malta Freeport Terminal, Malta (<https://www.cisco.com/c/en/us/about/case-studies-customer-success-stories/malta-freeport-terminals.html>)
- Public transportation:
  - Cable Car Operation Cortina d'Ampezzo, Italy (<https://www.cisco.com/c/en/us/solutions/collateral/enterprise-networks/faloria-case-study.html>)
- Manufacturing:
  - Mettis Aerospace, UK (<https://wballiance.com/wireless-broadband-alliance-members-successfully-complete-first-phase-Wi-Fi-6-industry-4-0-trials-with-mettis-aerospace/>)
  - AWL, Netherlands ([https://www.arubanetworks.com/assets/cs/CS\\_AWL-Techniek\\_UK.pdf](https://www.arubanetworks.com/assets/cs/CS_AWL-Techniek_UK.pdf))

A manufacturing application example is Wi-Fi based data communication in automated logistics warehouses using dozens to hundreds of APs per installation. One European enterprise has 1,700 Wi-Fi network systems in operation globally, and some of these systems are serving an area over 70,000 square meters. The enterprise warehouse customers are in the food retail, healthcare, fashion, industry, and wholesale sectors. Wi-Fi is providing mission-critical services, with many operating on a 24x7 basis, providing high availability and quality of service.

A European senior care provider (healthcare application) has a WLAN installation with approximately 8,000 APs in 30 locations, primarily used today for care and documentation devices and voice over Wi-Fi. Applications are being added to the existing network to support patient tracking, alarming, electronic door locks, and other use cases, all to be deployed over a single Wi-Fi infrastructure. Wi-Fi is mission-critical and provides the required high performance, scalability, and quality of service.

Globally and across Europe, in university, stadium, transportation, healthcare, and manufacturing use cases, Wi-Fi networks using license exempt spectrum are being used in “enterprise” applications to support and deliver mission-critical networks. Examples abound in which the deployed Wi-Fi network, supporting in many cases thousands of APs, is mission-critical and provides a high performance, scalable network with quality-of-service support.

## **Misconception #2: License exempt technologies cannot deliver predictable QoS**

**Item 6 of the DRAFT Opinion** states: “Recognises, as for 5G, the role and need of license exempt or light-licensed spectrum for offloading some of the 6G traffic and to provide private and personal networks. This spectrum supports improved end-user connectivity, machine-to-machine and other applications, which do not require a predictable quality of service.”

**In Chapter 6, Section 6.3** ‘Role of license exempt spectrum use in 5G and 6G and spectrum issues’ it is stated:

*License exempt spectrum can be used to complement mobile networks in individually licensed spectrum, for example:*

- *to offload indoor traffic through WLAN*
- *in ad hoc cases of massive events (e.g. concerts, festivals, sports events)*
- *to provide end-user connectivity, fulfilling non-critical industry needs (i.e. M2M, private,).*

*Use of license exempt spectrum for wireless broadband services does not guarantee a certain QoS provided to the customer due to its susceptibility to interference. Therefore, license-exempt*

*5G and 6G spectrum can be a solution for applications that do not need their own spectrum and for which individually licensed spectrum would be too expensive.”*

In its writing, the underlying assumption for the RSPG appears to be that only through the use of licensed spectrum can predictable QoS be delivered and mission-critical applications supported.

IEEE 802.11 standard based Wi-Fi products are highly suited for low power indoor networks that support QoS applications. With today’s technology, implementations of the IEEE 802.11 standard can achieve multiple gigabit-per-second (Gbps) throughout, sub-10 ms latency, and packet losses lower than 0.1%.

For the Wi-Fi 6 generation of products, IEEE 802.11ax introduced a trigger mechanism where the Wi-Fi AP can schedule uplink transmissions of a client, enabling predictability of access. Moreover, if a Wi-Fi 6 AP knows the QoS (throughput, latency) requirements and capabilities of a client, the AP can schedule the clients accordingly<sup>3</sup>. IEEE 802.11be, known as Wi-Fi 7 in the marketplace, further enhances the ability to control the medium (e.g., through restricted target wake time service periods, a.k.a. rTWT, advertised in Beacon frames). These scheduling mechanisms introduced in IEEE 802.11ax and IEEE 802.11be work well to deliver predictable QoS in environments where the spectrum environment is controlled by a network manager, e.g., in industrial and manufacturing sites and stadiums. Additionally, IEEE 802.11be defines Multi-Link Operation (MLO) to further support high determinism and QoS, and wide channel bandwidths up to 320 MHz to support increased throughput and capacity.

In November 2023, the IEEE 802.11 working group will begin work on the major next generation MAC/PHY standard, namely IEEE 802.11bn, which is projected to be the basis for the Wi-Fi 8 generation of technologies with a projected market entry in the 2028 timeframe. A key theme for IEEE 802.11bn is driving further improvements to the reliability (as measured in throughput, latency, and packet loss) of Wi-Fi networking. The frequency range covered by the new standard will be 1 GHz to 7.25 GHz. In parallel, the IEEE 802.1 Working Group on Higher Layer LAN Protocols has completed and continues to develop TSN standards, components of which are applicable to wired and wireless networks. Work underway in the Internet Engineering Task Force (IETF) on deterministic networking (including Reliable and Available Wireless (RAW)) further supports QoS driven wireless applications and networks.

As described, there is no inherent disadvantage for IEEE 802.11 standards-based technology for the delivery of predictable QoS or for the support of mission-critical systems. In cases where highly stringent QoS requirements need to be met (e.g., manufacturing robotics), the amount of control that a network owner has over the wireless spectrum in the area of deployment may be a critical factor (for either license exempt spectrum or lightly licensed spectrum).

Due to the nature of internet traffic use, most data are generated and consumed in fixed and low-mobility environments. Importantly, more than 80% of overall traffic goes over Wi-Fi while on average less than 10% goes over the mobile network<sup>4,5,6</sup>. This highlights the key role played by

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<sup>3</sup> <https://www.wi-fi.org/discover-wi-fi/wi-fi-qos-management>

<sup>4</sup> Report: *How do Europeans connect to the internet?*, Dynamic Spectrum Alliance, June 2021. The report shows that 95% of internet traffic in Germany travels over fixed networks and 5% over mobile networks, while approximately 90% of fixed-line traffic is transmitted via Wi-Fi.

<sup>5</sup> Report: *State of Wi-Fi Report*, ASSIA, June 2021

<sup>6</sup> <https://www.euractiv.com/section/digital/opinion/why-the-eu-should-support-wi-fi/>

Wi-Fi technologies, independent of the mobile-network offload use case.

### *Network evolution in the 6G timeframe*

IEEE 802 LMSC would like to point out that the most likely scenario in the 6G timeframe will be that the vast majority of QoS sensitive, mission-critical wireless broadband data communication will be delivered through fiber access coupled with low power indoor wireless connectivity (mainly IEEE 802.11/Wi-Fi). The powerful combination of the multiple Gbps access speeds, low latency, and “end to end” power consumption benefits of fiber connectivity plus the highly dense deployment scenario of low power indoor wireless should be a key public policy consideration when planning for the 6G future.

As is the case for 5G, 6G standards will likely include modes for low power indoor operation, and architectures of low power 6G small cells, connected to fiber access for in-building connectivity appear likely. However, the predominant business model for licensed spectrum has long been based on macro cell deployments, which will still likely be the case in the 6G era, given the underlying Mobile Network Operator business economics.

### **Misconception #3: Spectrum needs for license exempt usage are already covered for the 6G timeframe**

**Section 6.3** of the DRAFT Opinion further states: *“License exempt spectrum could be used as the last few meters link for the FTTH network at homes or even from mobile smartphones devices to other devices, but will always be relying on the fixed or mobile networks to provide end to end connectivity to the users. Due to the license exempt spectrum usage, limited coverage, limited power to provide the last few meters link, the spectrum needs for license exempt are covered already with the identified spectrum in Europe”.*

The DRAFT Opinion does not provide any evidence upon which this assertion is made. Under the scenario whereby the vast majority of high throughput and application usage will be delivered through the combination of fiber and low power indoor wireless connectivity (mainly IEEE 802.11/Wi-Fi) in the 6G timeframe, the available indoor license exempt wireless spectrum will likely become the constraining factor in providing the required level of service to European consumers and businesses alike.

Industry studies<sup>7,8</sup> have concluded that a minimum of 3 non-overlapping 320 MHz channels will be required to effectively support Wi-Fi 7 for emerging delay-sensitive residential, enterprise, and industrial applications, such as AR/VR and industrial IoT, and in dense deployment scenarios such as stadiums.

In addition, it can be expected that in the 6G timeframe, fiber access speeds of higher than 5 Gbps will become commonplace and at that point the capacity of low power indoor wireless connectivity networks in dense deployment environments (residential, enterprise, public spaces) will become the bottleneck in the overall end to end infrastructure, unless a sufficient amount of license exempt spectrum is made available for dense deployment scenarios. In acknowledgment

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<sup>7</sup> <https://www.intel.com/content/dam/www/central-libraries/us/en/documents/spectrum-needs-Wi-Fi-7-whitepaper.pdf>

<sup>8</sup> M. Mehrnoush, C. Hu and C. Aldana, “AR/VR Spectrum Requirement for Wi-Fi 6E and Beyond,” in IEEE Access, vol. 10, pp. 133016-133026, 2022, doi: 10.1109/ACCESS.2022.3231229

of the need for more license exempt spectrum in Europe, the European Electronic Communications Committee (ECC) has launched two work items to study and determine the conditions for license exempt WAS/RLAN operation in the 6425 MHz to 7125 MHz band.

### ***Importance of Technology Neutrality***

Item 5 of the DRAFT Opinion calls out “technology neutrality” as applicable to 6G. The IEEE 802 LMSC notes that there are different definitions of “technology neutrality” and suggests that a reference be added for the intended definition<sup>9,10</sup>. A highly likely scenario in the 6G timeframe will be that the vast majority of QoS sensitive, mission-critical wireless broadband data communication will be delivered through the combination of fiber access coupled with low power indoor wireless connectivity (mainly IEEE 802.11/Wi-Fi). In addition, robust and high capacity outdoor 6G networks will be required, most likely realized through macro cell deployments of cellular networks, supporting critical mobility and many outdoor usage scenarios. IEEE 802 LMSC encourages the RSPG to not limit its vision of 6G to IMT-2030/3GPP licensed spectrum but to fully embrace the concept of technology neutrality in its considerations going forward. This will continue to enable European consumers and network owners to choose the mix of technologies that are best aligned with their needs on a “fit for purpose” basis. IEEE 802.11/Wi-Fi networks and applications are a key component of the set of technologies required to meet European Gigabit society objectives.

### **Conclusion**

IEEE 802 LMSC thanks the RSPG for the opportunity to provide this submission. We encourage the RSPG in future versions of the document and in deliberations going forward to address the three misconceptions in the DRAFT Opinion as identified in this submission to reflect that:

- In today’s world there is large scale and mission-critical use of license exempt technologies by enterprises and governments worldwide.
- Technologies designed for license exempt spectrum are capable of delivering predictable QoS based on current and future versions of standards.
- Additional license exempt spectrum will be required in Europe prior to the 6G timeframe to ensure that indoor wireless networks do not become the bottleneck in end-to-end service delivery.

Furthermore, we would like to urge the RSPG to adopt a wireless technology neutral approach, designed for the paradigm where the vast majority of critical data traffic will be delivered to end user devices through a combination of fiber network access and indoor wireless connectivity, complemented by highly capable outdoor wireless connectivity predominantly delivered through macro cell, cellular 6G networks. IEEE 802 LMSC kindly requests the RSPG to take into account our responses in its decision towards the development of 6G and possible implications for spectrum needs and guidance on the rollout of future wireless broadband networks.

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<sup>9</sup> The principle of technology neutrality from European Union's perspective as follows:

<https://joinup.ec.europa.eu/collection/common-assessment-method-standards-and-specifications-camss/solution/elap/technology-neutrality#:~:text=It%20guarantees%20freedom%20of%20choice,nor%20discriminate%20against%20any%20technology>

<sup>10</sup> Technology neutrality in the context of licensed spectrum, see <https://www.gsma.com/spectrum/wp-content/uploads/2019/06/Benefits-of-Technology-Neutral-Spectrum-Licences.pdf>

Respectfully submitted,

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