Cisco Systems Belgium
sprl/bvba
Pegasus Park
De Kleetlaan 6A
B-1831 Diegem
Belgium
Direct: +32 2 704 60 00
www.cisco.com

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VIA EMAIL (cnect-rspg@ec.europa.eu)

Radio Spectrum Policy Group
RSPG Secretariat, office L-51 05/DCS
European Commission
1049 Brussels
Belgium

Cisco Comments on Draft RSPG Opinion

The Development of 6G and Possible Implications for Spectrum Needs and Guidance on the Rollout of Future Wireless Broadband Networks (RSPG23-026 FINAL)

Introduction

Cisco Systems Inc. (Cisco) appreciates the opportunity to comment on the Radio Spectrum Policy Group's draft opinion on the development of future 6G strategies.[1] We applaud the RSPG's proactive effort to support the development and deployment of 6G in Europe and agree that the technology has the potential to be a dramatic improvement over 5G's already exciting capabilities. To fulfill that potential, 6G operations will require appropriate spectrum, among other things. Cisco agrees with the RSPG's observation that, before considering new spectrum resources for future 5G or 6G operations, Member States must first examine the utilization of spectrum already allocated for 5G-based services. In doing so, Cisco strongly recommends that Member States take a measured approach, considering multiple factors including spectrum usage trends, current and anticipated network technologies, network deployments, and the impact of any spectrum allocations on other wireless technologies. If Member States ultimately determine that new spectrum for 6G is necessary, however, such spectrum should not be in the 6 GHz band (5.925-7.125 GHz), which is vital to the future of the license-exempt wireless networks that carry the vast majority of internet traffic and are critical to the EU's 2030 Digital Decade goals.

Discussion

Cisco is a business-to-business company with a broad portfolio of services and hardware and software products. Our products allow businesses and their employees easy and secure access to information anywhere in the world, at any time. Cisco's focus as a company is to securely connect everything to make anything possible.

Cisco is fully committed to the EU's successful achievement of its 2030 Digital Decade Targets, including that all Europeans have access to both 5G communications and Gigabit

[1] Radio Spectrum Policy Group, "The Development of 6G and Possible Implications for Spectrum Needs and Guidance on the Rollout of Future Wireless Broadband Networks [DRAFT]," RSPG23-026 FINAL (14 June 2023) (Draft RSPG Opinion).

connectivity by 2030. 5G and license-exempt technologies like Wi-Fi have complementary roles in enabling digital innovation across communications service providers, enterprises, the public sector, and various verticals in Europe. Cisco is heavily invested in both 5G and Wi-Fi and believes that each technology can uniquely contribute towards enabling innovation.

The choice of technology will depend on the specific use case and associated economics. For example, enterprises may rely on 5G networks for large coverage areas (which are often outdoors) where high-speed mobile handoffs must take place without major latency impacts, and for applications and data requiring highly secure connections. 5G has also had some success delivering fixed broadband services.

Importantly, however, even in 5G environments, these same enterprises typically rely on Wi-Fi once data enters a building. Wi-Fi is the technology of choice for most local area, low-power broadband networks. Wi-Fi is relied on nearly everywhere—homes and offices, universities, hospitals, sports and entertainment venues, factories and other industrial settings—for high-speed, inexpensive indoor and outdoor wireless connectivity. And the use of Wi-Fi to offload 5G traffic illustrates how different technologies, spectrum bands, and access models work in parallel to maximize connectivity. Greater coordination and collaboration between Wi-Fi and 5G are also supported by standards and industry consortia embracing both technologies.

Even within the 5G ecosystem, there is increasing diversity. As the Draft RSPG Opinion notes, private networks using 5G are becoming increasingly common.[2] And the boundaries between previously separate technology families are falling away as Cisco and other vendors announce products that integrate 5G and Wi-Fi for enterprises using Private 5G.[3] Significantly, it has been Cisco's experience that "[e]very opportunity, and every problem we've solved [using Private 5G], has required Wi-Fi and 5G to work hand-in-hand."[4] This is not expected to change with the evolution to 6G.

At bottom, Cisco believes that each type of broadband technology has a role to play in connecting EU citizens and businesses. We urge policymakers to adopt a spectrum allocation approach that encourages the development of a variety of communications technologies that fit a variety of use cases.

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[2] The Draft RSPG Opinion and its Informative Annex 1 refer to numerous examples of enterprises adopting private networks using either 5G or unlicensed spectrum. *See, e.g.,* Draft RSPG Opinion at 5; Draft RSPG Opinion, Informative Annex 1 (Draft RSPG Opinion Annex 1) at 9, 11, 15-19, 27, 31. In the United States, 5G technology deployments for private networks are accelerating as enterprises work with existing operators—and often operating their own networks—using the 3.5 GHz Citizens Broadband Radio Service ("CBRS") band and the related Spectrum Access System ("SAS") framework.

[3] *See* James Blackman, "Just-In-Time Cisco Warns Against Private 5G Silos," RCR Wireless News (Mar. 23, 2023), https://www.rcrwireless.com/20230323/private-networks/just-in-timecisco-talks-wi-fi-style-5g-and-danger-of-another-network-silo.

[4] *Id.*; James Blackman, "HPE Takes a Seat in the Private 5G Dining Car – And Sees No Telcos Aboard," RCR Wireless News (Mar. 14, 2023), https://www.rcrwireless.com/20230314/private-networks/hpe-takes-a-seatin-the-private-5g-dining-car-and-finds-no-telcos-aboard.

With this context, we agree that as the EU progresses towards its Digital Decade goals, it is timely to review the anticipated spectrum needs for 6G, the next generation of wide-area wireless communication. With the evolution of radio access, device and network technology, 6G is expected to outperform 5G in terms of supported bandwidth, throughput, latency and the number of connected devices. While 6G is still in its early stages, numerous use cases for the technology are already under discussion. These use cases will likely utilize holographic communication, artificial intelligence services, and real-time sensing that Qualcomm has predicted will deliver artificial and virtual reality (AR/VR) that "more seamlessly merge the physical, digital, and virtual worlds."[5]

To achieve these capabilities, 6G networks will require sufficient spectrum resources, among other things. But as the Draft RSPG Opinion and its Annex observe, some Member States and Mobile Network Operators (MNOs) anticipate spectrum capacity issues well before 2030.[6] While additional spectrum may be needed at some point, Cisco agrees with the Draft RSPG Opinion's observation that, before identifying new spectrum bands for 5G and 6G networks, Member States should first examine whether "current spectrum [could be used] more efficiently…."[7] Specifically, before allocating new spectrum bands for 5G or 6G, policymakers should clearly understand the following**:**

1) What spectrum bands have been allocated for 5G and have they been assigned? For those bands, what is the current and projected spectrum usage for 5G/6G networks?[8]
2) What technology currently serves most of the overall data volume in the Member State? What are the historical, current, and future usage projected trends? Where does the most data usage occur? What are the indoor vs. outdoor data usage statistics for a given technology? Are there important current or future use cases that cannot otherwise be achieved cost efficiently through another technology?

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[5] *See* Dr. John Smee, Sr. Vice President, Engineering, Qualcomm Technologies, Inc., "It's 2022 and We're Already Thinking about the Evolution of 5G Advanced to 6G," (November 29, 2022), *available at* https://www.qualcomm.com/news/onq/2022/11/its-2022-and-were-already-thinking-about-the-evolution-of-5g-advanced-to-6g.

[6] Draft RSPG Opinion at 4 ("additional capacity needs for mobile networks may arise on the national level during this decade"); RSPG Draft Opinion Annex 1 at 28 ("Several Member States have indicated in the survey that a need for additional mobile spectrum resources may occur in a couple of years."); *id.* ("MNOs suggest that additional spectrum resources are required, especially in urban areas to enable the current network grid to deliver the required coverage and capacity.").

[7] Draft RSPG Opinion at 4-5 (emphasis added).

[8] The current spectrum landscape was the wireless industry's vision only a few years ago. Regulators should clearly understand why and how this spectrum fails to meet the industry's anticipated needs. *See, e.g.*, GSMA, "GSMA: 5G at Risk if Mobile Operators Don't Get Access to the Right Spectrum" (November 5, 2018) ("Regulators that make available 80-100 MHz of spectrum per operator in prime 5G mid-bands (e.g. 3.5 GHz) and around 1 GHz per operator in vital millimeter wave bands (i.e. above 24 GHz), will best support the very fastest 5G services.").

3) What is the current penetration of devices capable of supporting LTE/5G bands in the Member State? Where is the Member State in the typical device refresh cycle?
4) What is the status of efforts by the relevant MNOs to move their customers to 5G networks and reuse existing LTE bands for 5G, while ensuring sufficient spectrum capacity to serve incumbent LTE only devices/users without compromising the user experience?
5) What is the status and timeline for the relevant MNOs' deployment of 5G Standalone (SA) networks?
6) What is the status of MNO efforts to introduce and develop Voice over New Radio (VoNR) in customer networks to transit subscriber voice services from Voice over LTE (VoLTE)?
7) What is the current coverage, spectrum efficiency, and capacity deployed in the current MNO radio network? What is the status of the MNO radio network infrastructure deployment grid and is densification technically and economically possible?
8) Have MNOs adequately considered and implemented advancements in RAN technology and solutions that can help improve coverage, capacity, and spectral efficiency? These may include beamforming, Multi Component Carrier-Uplink and Downlink Carrier Aggregation, MU-MIMO, higher order modulations, etc.
9) Has the Member State considered allocation/agreement on spectrum for Non-Terrestrial Networks (NTNs) for Direct to Device communication in 5G? NTNs can provide coverage and act as a backup layer for connectivity during non-availability of terrestrial network due to natural disaster, network outage or any unforeseen circumstances when terrestrial networks are under any form of external attack.
10) Has the Member State adequately considered deregulatory measures and other governmental incentives to reduce costs for MNOs and encourage network buildout?

Any analysis of future spectrum requirements must begin with the bands that have already been identified for 5G, examining first whether Member States have assigned the spectrum to licensees, and then whether MNOs have efficiently utilized that spectrum. The EU has identified several primary and pioneer bands for 5G, but as Annex 1 to the Draft RSPG Opinion acknowledges, numerous European countries have yet to assign even the most important bands for 5G applications.[9] As the 2022 DESI Report states, "spectrum assignment,

[9] *See, e.g.,* Draft RSPG Opinion Annex 1 at 8 (This [3.6 GHz] frequency band has been largely assigned in EU Member States….") (emphasis added); *id.* ("Despite harmonisation (EC Decision) and Policy initiative (EECC), RSPG noted that mmWave 5G bands have not been authorised in many Member States. In 2022, there is no clear indication of the market demand in some Member States."). *See also* European Commission, European 5G Observatory, "5G Observatory Quarterly Report 16" at 29-30 (July 2022), *available at*

an important precondition for the commercial launch of 5G, is still not complete; only 56% of the total 5G harmonized spectrum has been assigned."[10] Therefore, while it should not rule out identifying new spectrum bands for 5G and 6G, the RSPG should not recommend that Member States do so until all their relevant 5G spectrum has been assigned for use.

But even for those Member States where this spectrum has been fully assigned, regulators should also review whether that spectrum is efficiently utilized before identifying new spectrum for 5G/6G. That review should consider issues like whether MNOs have implemented network technologies that increase efficiency, the status of efforts to transition customers and spectrum from LTE networks and applications to 5G, and whether current and future use cases might not be possible on a cost-effective basis without new spectrum resources.[11]

The Draft RSPG Opinion observes that greater efficiencies might be achieved through densification, noting that "MNOs can densify their networks in existing harmonised bands…."[12] While we recognize that extensive densification investments may present financial challenges for some MNOs, targeted densification efforts might be both feasible and effective. For example, multiple studies have shown that mobile traffic peaks requiring the provision of additional capacity are limited to a small percentage of urban areas and only for short periods of time.[13]

The RSPG also should consider encouraging MNOs to adopt network sharing and other technological solutions to address their spectrum needs. For example, MNOs could adopt network slicing to increase their spectrum efficiency for critical outdoor services, while allowing free video services (which make up a disproportionate amount of mobile traffic[14]) to

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https://5gobservatory.eu/wp-content/uploads/2022/08/QR-16_Final_PDF.pdf (listing status of EU Member States' assignments of "pioneer bands").

[10] European Commission, 2022 Digital Economy and Social Index (rel. July 28, 2022) (2022 DESI Report), *available at* https://digital-strategy.ec.europa.eu/en/policies/desi.

[11] For example, this analysis could review whether use cases involving private networks or indoor operations might be achieved more efficiently via shared or license-exempt spectrum, rather than high-power exclusively licensed spectrum bands.

[12] Draft RSPG Opinion Annex 1 at 28. The Draft RSPG Opinion also observes that MNOs might also "use additional new harmonised mmWave spectrum expected to be made available in the coming years (42 GHz)." *Id.*

[13] *See, e.g.*, Fengli Xu, Yong Li, Huandong Wang, Pengyu Zhang, Depeng Jin, "Understanding Mobile Traffic Patterns of Large Scale Cellular Towers in Urban Environment," IEEE Xplore (April 2017), *available at* https://ieeexplore.ieee.org/document/7762185; Ofcom, "Connected Nations 2020, Scotland Report" at 2, *available at* https://www.ofcom.org.uk/__data/assets/pdf_file/0021/209442/connected-nations-2020-scotland.pdf; Ofcom, "Connected Nations 2021 – England Report" at 17, *available at* https://www.ofcom.org.uk/__data/assets/pdf_file/0022/229720/connected-nations-2021-england.pdf.

[14] Cam Cullen, Sandvine, "Sandvine Releases 2019 Mobile Internet Phenomena Report," (Feb. 18, 2019) ("YouTube is 38% of worldwide mobile traffic…. Facebook properties account for over 20% of all mobile traffic."), *available at* https://www.sandvine.com/press-releases/sandvine-releases-2019-mobile-internet-phenomena-report.

operate at slightly lower resolution during busy periods. Carriers should also carefully refarm their existing spectrum after evaluating load balancing and traffic steering amongst available LTE bands and ensuring enough capacity to serve existing LTE devices based on their band support. Finally, as Annex 1 to the Draft RSPG Opinion notes, Dynamic Spectrum Sharing (DSS) may present an opportunity for MNOs to migrate their existing 4G spectrum to 5G NR as demand for 5G services increases.[15] Given the current pace of 5G adoption in Europe,[16] such a measured approach might make good business sense.

Member States should also consider their own role in meeting the 2030 Digital Decade 5G target. To the extent network efficiency measures may be technically or financially difficult for some carriers to adopt, the RSPG should urge Member States to reduce MNO expenses by eliminating red tape and complexity in line with the spirit of the Gigabit Infrastructure Act.[17] Member States should support MNOs tapping into existing public funding resources and tax credits, as well as utilizing government infrastructure. In addition, regulators should increase their efforts to harmonize their processes and relax regulations on issues like net neutrality and permitting.[18] These onerous and inconsistent regulations undermine MNO attempts to develop new use cases and Average Revenue Per User (ARPU) streams that could fund network efficiency efforts.

If new spectrum is ultimately deemed necessary, regulators should consider whether Europeans may benefit most from a shared or "lightly licensed" approach. The United States has adopted a successful sharing regime for the 3.5 GHz band, with deployments growing at about 12 percent per quarter over two years. The 3.5 GHz sharing rules protect incumbent government operations, while offering priority spectrum access for licensed users as well as general license-exempt access, subject to government and licensed users. According to a recent study, as of January 1, 2023, there were nearly 288,000 active CBRS devices transmitting across the United States, predominantly transmitting outdoors in rural areas via

[15] Draft RSPG Opinion Annex 1 at 11. While DSS may present some efficiency issues, the NR component of the band shared with LTE can be used for cross-carrier scheduling in combination with a midband TDD band. *See, e.g.*, Chengrui Wang, Sen Xu, and Jinean Xin, "The Cross-Carrier Scheduling in LTE-NR Dynamic Spectrum Sharing," IEEE Xplore (published March 15, 2022), *available at* https://ieeexplore.ieee.org/document/9730277. In this sense, DSS can be particularly useful as a transition to 5G. By using cross-carrier scheduling, MNOs can build high-capacity outdoor 5G.

[16] According to a recent GSMA/ETNO study, less than 25% of Western European mobile traffic currently traverses 5G networks. GSMA/ETNO, "European Spectrum Policy for the Digital Decade – options for the new Radio Spectrum Policy Programme," at 4 (03 July 2023). A March 2022 study found that even in the top 5% of the busiest sectors, 5G traffic runs at only 7.7% of capacity on average. "Mobile Data Usage in 2021 and 4G and 5G Operator Capacity Potential," REWHEEL/research (March 2022), *available at* https://research.rewheel.fi/downloads/Mobile_data_usage_2021_capacity_potential_170_operators_50_countries_PUBLIC_VERSION.pdf.

[17] *See, e.g.*, European Parliamentary Research Service, Briefing: EU Legislation in Progress, "Gigabit infrastructure act," *available at* https://www.europarl.europa.eu/RegData/etudes/BRIE/2023/749783/EPRS_BRI(2023)749783_EN.pdf.

[18] *See* Connectivity Toolbox, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2020.305.01.0033.01.ENG.

license-exempt permissions.[19] Annex 1 to the RSPG Draft Opinion notes several other spectrum sharing approaches that may be worth broader consideration and adoption.[20]

But if Member States ultimately determine that additional exclusively licensed spectrum is necessary to achieve the EU's Digital Decade goals for 5G and make 6G widely available within the EU, Cisco strongly advises against any suggestion that the upper 6 GHz band (6425-7125 MHz) should be allocated for IMT.[21] Instead, as explained below, that spectrum should be identified for license-exempt use.

License-exempt spectrum is central to the EU's Digital Decade goals because it is the most common form of wireless connectivity. Fixed networks deliver the vast majority of all European internet traffic[22], and over 90 percent of that traffic is relayed via Wi-Fi.[23] As the Annex to the RSPG Draft Opinion notes, license-exempt spectrum is also central to mobile networks because it is used to offload traffic from those networks and free up licensed spectrum capacity.[24] According to one study, more than 80 percent of mobile device traffic originates or terminates indoors on Wi-Fi.[25]

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[19] Kelly Hill, "Six CBRS Deployment Trends, according to SAS Data," RCR Wireless (May 2, 2023), available at https://www.rcrwireless.com/20230502/spectrum/six-cbrs-deployment-trends.

[20] *See* Draft RSPG Opinion Annex 1 at 11-12. Such a lightly licensed model could be ideal for enterprise users. In addition to mid-band spectrum, Cisco believes such users will need high and low-band spectrum to support key use cases and foster innovation. Access to spectrum will provide enterprises equal opportunity to compete internationally to create the services that are best suited for their individual needs and opportunities. *See* RSPG Draft Opinion at 5.

[21] *See, e.g.,* Draft RSPG Opinion Annex 1 at 28 ("The upper 6 GHz band is under consideration noting the conflicting demand from WAS/RLAN.")

[22] Dynamic Spectrum Alliance, "How Do Europeans Connect to the internet" at 8 (2022) ("Mobile networks only deliver traffic equivalent to 5% of the fixed network traffic…."), *available at* http://dynamicspectrumalliance.org/wp-content/uploads/2022/06/DSA-WhitePaper-How-do-Europeans-connect-to-the-Internet.pdf.

[23] *Id.* at 4, 8.

[24] Draft RSPG Opinion Annex 1 at 25 ("Unlicensed spectrum is already used by the end-users, especially in indoor environments. This leads to off load of traffic from mobile networks.").

[25] Dynamic Spectrum Alliance presentation, "6 GHz Band for Wi-Fi: Source of value for consumers, industry, GDP and social impact" (June 2022) (6 GHz Band for Wi-Fi). Wi-Fi also has important outdoor applications. Wi-Fi is used outdoors in mobile vehicles (e.g., airplanes, cruise ships), often connected to mobile wireless or satellite backhaul. People expect seamless Wi-Fi connections wherever they go, and Wi-Fi is frequently used for outdoor use cases like municipal Wi-Fi, campus networks, sports venues, industrial sites, and broadband service.

In the United States, once the FCC standard power rules for the 6 GHz band are finalized, Cisco plans to take advantage of the outdoor Wi-Fi opportunity with state-of-the-art devices and services focusing on industrial and campus Wi-Fi uses. *See, e.g.,* Vikas Butaney, "Cisco announces first outdoor Wi-Fi 6E ready access point and enhancements for industrial remote operations," (May 24, 2022), *available at* https://blogs.cisco.com/internet-of-things/cisco-extends-industrial-iot-portfolio-to-bring-reliable-wireless-connectivity-and-enable-remote-operations-anywhere.

As these statistics suggest, Europeans depend on license-exempt connectivity everywhere, all the time, whether the underlying broadband connection is fixed, mobile, or satellite. They do so because license-exempt technologies like Wi-Fi are ubiquitous, reliable, and inexpensive. The average European household now has 17 connected devices[26], and that number continues to increase. Those devices connect via Wi-Fi – not 5G – inside the home.[27] According to research firm IDC, there will be 19.5 billion Wi-Fi devices in use globally by the end of 2023.[28] Moreover, consumers are not only using more devices but are using those devices for applications that require greater spectrum resources, like AR/VR and high-definition streaming.

Contrary to the Draft RSPG Opinion Annex's suggestion,[29] license-exempt is not mainly a consumer-oriented technology. Enterprises also rely heavily on license-exempt spectrum. In fact, enterprises are among the most dense users of WAS/RLAN for internet access and, increasingly, for Internet of Things (IoT) connectivity. Current and future generations of Wi-Fi will support cutting-edge applications with 80 and 160 MHz channels and 10 milliseconds (ms) latency. These capabilities, particularly in dense deployments, will transform many sectors, such as collaborative design in VR[30], telehealth patient care and virtual clinics[31], high-quality social gaming experiences[32], and specialized immersive training, including military operations and heavy equipment handling.[33]

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[26] *See, e.g.,* John Foetsier, "Smart Home : Apple is the Fastest-Growing Connected Device Company," Forbes (August 31, 2022), *available at* https://www.forbes.com/sites/johnkoetsier/2022/08/31/smart-home-apple-is-the-fastest-growing-connected-device-company/?sh=d501aa07dd48.

[27] Simon Sherrington, Analysys Mason, "Operators and Vendors Need to Plan for More Conservative Mobile Data Growth in the Near Future" at 2-3, 4 (1 August 2023) ("Within the home – even when they have unlimited mobile data packages – users don't tend to switch to their mobile networks. They typically continue to use devices connected to their home fixed broadband and Wi-Fi for extended TV viewing.); ("Eventually, metaverse use cases could involve vast numbers of customers, with cloud processing of fully immersive environments and services requiring very low latency and very high bandwidth. However, most of the usage will take place indoors where a combination of fibre and Wi-Fi seems much more suited to the service requirements."), *available at* https://www.analysysmason.com/research/content/articles/cellular-data-traffic-rdnt0/.

[28] *See* https://www.wi-fi.org/beacon/the-beacon/wi-fi-by-the-numbers-technology-momentum-in-2023

[29] Draft RSPG Opinion Annex 1 at 25 ("Use of unlicensed spectrum is mainly targeted towards consumers use and non-critical systems and is less suited for enterprise customers.") *See also id.* at 26 ("Unsurprisingly, the view of MNOs [in Luxembourg] goes rather in the direction that Wi-Fi has some weaknesses that makes it unsuitable for enterprise and industrial applications and that Wi-Fi in unlicensed bands may be a sufficient solution for consumers but is less suited for enterprise customers.").

[30] https://www.nvidia.com/en-au/design-visualization/technologies/holodeck/; https://hardware.webex.com/capabilities/hologram.

[31] https://xrhealth.com.au/; https://www.hopkinsmedicine.org/news/articles/augmented-reality-guides-surgeries-for-johns-hopkins-patients; https://www.cisco.com/c/en/us/solutions/collaboration/healthcare.html.

[32] https://zerolatencyvr.com/.

[33] https://seriouslabs.com/

The Draft RSPG Opinion Annex 1 claims that "the spectrum needs for license exempt are covered already with the identified spectrum in Europe."[34] The trends described above demonstrate that this statement is incorrect. The ITU last allocated spectrum for license-exempt operations more than 20 years ago. Wi-Fi traffic now doubles every 3 years, to the point that the existing 2.4 GHz and 5 GHz Wi-Fi bands have become congested, putting at risk Europe's technological leadership and the ability of European citizens to take advantage of their high-speed fiber connections.[35] Indeed, without additional license-exempt spectrum, service quality will soon begin to suffer[36], affecting nearly every aspect of internet traffic, including future traffic on 5G and 6G networks.

For these reasons, the 6 GHz band will provide a critically needed infusion of spectrum for license-exempt operations. Many EU Member States have already allocated the lower 500 MHz of the 6 GHz band for license-exempt use. This will certainly help address the requirements of today's wireless networks. Further, the lower 6 GHz spectrum is greenfield in that no prior generations of Wi-Fi already operate in it,[37] which drives additional efficiencies.

But 500 MHz of license-exempt spectrum will not allow Member States to take full advantage of the capabilities of the newest generations of Wi-Fi, which can support channel sizes of up to 320 MHz. Densely populated areas may have hundreds of Wi-Fi networks per square kilometer, with dozens of networks operating in close proximity. As data demand continues to rise, these densely deployed Wi-Fi networks will need channel diversity (access to multiple different channels) to optimize operation and avoid congestion. With access to only 500 MHz additional spectrum, however, these networks will be stuck at 40 MHz channel sizes (state of the art in 2006) for enterprise networks that utilize a 7-channel reuse pattern.

Limiting license-exempt networks to only the lower 500 MHz of the 6 GHz band will result in constraints like those that currently exist in 5 GHz. Users will not get effective use of the wider channels available in the latest Wi-Fi iterations, particularly in dense deployments, and will not be able to fully support next-generation technologies at scale like augmented and virtual reality (AR/VR) and 8K video streaming. Enterprise grade wireless networks can

[34] Draft RSPG Opinion Annex 1 at 32.

[35] Dynamic Spectrum Alliance, "Lessons from the Assia Report on 'Wi-Fi and Broadband Data'" (October 2021), *available at* http://dynamicspectrumalliance.org/wp-content/uploads/2021/11/Lessons-from-the-Assia-Report-on-Wi-Fi-and-Broadband-Data.pdf.

[36] *See* John Cioffi, ASSIA, "State of Wi-Fi Reporting – DSA 2021 Global Summit" (June 8, 2021), *available at* https://dynamicspectrumalliance.org/wp-content/uploads/2021/06/2021-DSA-Summit_Spectrum-Value_John-M.-Cioffi.pdf

[37] The existing technology supporting Wi-Fi spectrum at 2.4 GHz and 5 GHz currently allows every Wi-Fi protocol since its inception to operate. The additional requirement of interoperability and burden of backward compatibility results in further reductions in efficiency and determinism which further negatively impacts voice and video quality when using the existing 2.4 and 5 GHz bands for Wi-Fi. The 6 GHz band would, for the first time, eliminate outdated and inefficient radio access technology, permitting the far more spectrally efficient Wi-Fi 6 (and above) to operate without the burden of legacy radios. This will dramatically improve the user experience and efficient use of the spectrum. This much-improved experience can only further the adoption of Wi-Fi technologies.

currently support real-time voice and video, which require latencies on the order of 100 ms. AR/VR have much tighter requirements, however, with latency requirements approaching 10 ms. As such, availability of the full 6 GHz band is not just about improving the Wi-Fi experience today, but also about enabling and supporting the applications of tomorrow.

As noted above, AR/VR use cases are already in development in areas like education, healthcare, training, and gaming. Limiting license-exempt operations to the lower 6 GHz band, however, will substantially limit the benefits of these use cases in terms of the number of users and the quality of service.

For example, one recent paper[38] explains that making only 500 MHz available for Wi-Fi operations will significantly constrain the number of AR/VR devices supported in school classrooms. The paper compares the performance of two schools – both operating 20-30 AR/VR headsets per classroom, with each classroom utilizing 160 MHz channels -- where one school is limited to 500 MHz and three 160 MHz channels, while the other school can access 1200 MHz scenario and seven such channels. The authors found that the 500 MHz scenario resulted in far fewer supported classrooms and AR/VR headsets, with a higher risk of degraded performance in terms of interference and latency, than the 1200 MHz scenario.[39]

AR/VR gaming is another example of how new license-exempt use cases will only achieve their true potential with access to the full 6 GHz band. Zero Latency is a Cisco customer that is at the leading edge of AR/VR social gaming. According to the company's testing using Wi-Fi 6E, it needs at least 80 MHz channels to provide a quality user experience with less than 10 ms latency. With only 500 MHz, Zero Latency cannot support multiple cells with 80 MHz channels while minimizing co-channel interference. In an environment like Zero Latency's VR arena that is highly sensitive to co-channel interference, the company has found that no more than four 80 MHz channels can realistically be utilized with only the lower 500 MHz of the 6 GHz band, translating to a maximum of 8 concurrent users in a given confined space. Increasing the number of users in this environment materially degrades the VR experience, as even a single interfering client with a data stream of 10 Mbps hurts the user experience.[40]

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[38] Morteza Mehrnoush, Chunyu Hu, and Carlos Adana, "AR/VR Spectrum Requirements for Wi-Fi-6E and Beyond," IEEE Access (December 27, 2022), *available at* https://ieeexplore.ieee.org/document/9994727.

[39] "[W]ith 500 MHz of spectrum availability, the capacity is 4 students per classroom with 4 classrooms per floor. When 1200 MHz is available, up to 22 students per classroom can concurrently use the VR headsets in 14 classrooms per school (whole school). The number of classrooms can be extended beyond 14 per floor without affecting the capacity of each classroom. The results highlight the significance of 1200 MHz spectrum availability for supporting AR/VR applications in high-density large-scale scenarios and 500 MHz of spectrum is not enough to support AR/VR applications." *Id.* at 133024.

[40] With only the lower 6 GHz band available for Wi-Fi, Zero Latency's gaming platform can only support 8 players. However, based on Zero Latency's projection, 16 players would be necessary to achieve a viable business case. If the company attempts to support more users with only the lower 500 MHz, the user experience would be significantly compromised due to narrower channels. For example, with the use of 40 MHz instead of 80 MHz channels, the streaming bandwidth for each user will drop from 50 Mbps to 30 Mbps. This places serious limitations on Zero Latency's economic and innovative potential.

Leading economies around the world and partners of the European Union have already determined that license-exempt operation should take place throughout the full 6 GHz band, including the United States, South Korea, Brazil, and Saudi Arabia. Europe cannot afford to miss out on the opportunity to take advantage of global harmonization in the 6 GHz band. As we explained in our comments in a previous RSPG consultation, new spectrum is useless without an equipment ecosystem. In response to decisions from the aforementioned countries, equipment manufacturers plan to ship more than 350 million Wi-Fi6E devices this year.

By contrast, according to a recent report from GSMA, no 6 GHz IMT ecosystem currently exists.[41] In fact, the only country so far to allocate the 6 GHz band for 5G/6G has yet even to publish conditions for its use.[42] As one European regulator stated late last year, "[i]t may be several years before operators can start to use the [upper 6 GHz] band for high power mobile, due to clearance and award timescales and device availability. As far as we are aware, there are no mobile chipsets available that can make use of the band."[43]

Future broadband connectivity will require a mix of complementary technologies – fiber, wide-area mobile wireless, fixed wireless access, license-exempt, and non-terrestrial networks. Cisco urges the RSPG to recommend policies that recognize the role and future needs of all these technologies. 6G and 5G have exciting potential, but before allocating new spectrum for their operations, Member States should confirm that existing spectrum resources are being efficiently utilized and that other measures cannot address the apparent spectrum needs. Taking such an approach ensures that Member States' scarce spectrum resources go where their citizens will need them most.

[41] GSMA, "The 6 GHz IMT Ecosystem: Demand Drives Scale" at 15 (August 2022), *available at* https://www.gsma.com/spectrum/wp-content/uploads/2022/08/6-GHz-IMT-Ecosystem.pdf.

[42] *See* "China Claims World First 6 GHz Allocation for 5G, 6G," Mobile World Live (June 28, 2023), *available at* https://www.mobileworldlive.com/featured-content/top-three/china-claims-world-first-6ghz-allocation-for-5g-6g/. *See also* "Frequencies for 5G in Russia," TAdviser, *available at* https://tadviser.com/index.php/Article:Frequencies_for_5G_in_Russia.

[43] Ofcom, "Update on the Upper 6 GHz Band," at 9 (6 December 2022), *available at* https://www.ofcom.org.uk/__data/assets/pdf_file/0028/248770/update-on-upper-6hz-band.pdf.

If there are any questions, please contact the undersigned.

Respectfully submitted,

Cisco Systems, Inc.

Scott Blue
Director -- Global Wireless Policy
scblue@cisco.com

Diane Mievis
Head of EU Sustainability and Telecoms Policy
dmievis@cisco.com

Bill Davenport
Senior Director, Technology and Spectrum Policy
bidavenp@cisco.com