Huawei response to the RSPG questionnaire on the "Long-term vision for the upper 6 GHz band"

We thank RSPG for the opportunity to provide feedback to this questionnaire on the long-term vision for the upper 6 GHz band (6425-7125 MHz).

Summary

Huawei has for many years heavily invested in the development of both MFCN (Mobile) and WAS/RLAN (Wi-Fi) technologies, with our research and development and standardisation efforts consistently focussed on the introduction of innovative products which are widely deployed globally.

Specifically, Huawei has been among the leading companies both in terms of contributions to IEEE Wi-Fi standards and the number of patents owned on Wi-Fi 6/6E[1,2] and Wi-Fi 7[3,4]. Huawei is a strong contributor to the development of Wi-Fi 8[5,6] which has now begun. Furthermore, Huawei has also been a leader in terms of contributions to 3GPP standards for LTE, 5G, and 5G-Advanced (3GPP Releases 16, 17, and 18)[7] and the number of owned patents on these Mobile technologies[8,9].

As a leading supplier of Mobile and Wi-Fi technologies, we hereby share our views on the long-term vision for the upper 6 GHz band, **leveraging our experience in both ecosystems**.

We note that in most countries many of the leading mobile network operators also provide the vast majority of fixed broadband connections (with huge ongoing investments in gigabit fibre connectivity) which are required to support Wi-Fi access to the end users.

The key request from industry is for administrations to ensure that Europe can leverage a sound spectrum strategy that will allow competitive fixed and mobile connectivity in the short, medium, and long term, avoiding any bottlenecks in mobile access networks (5G, 5G-Advanced, 6G), in fixed networks (10 GPON, 50 GPON, 100 GPON), and in WAS/RLAN connections (Wi-Fi-6/6E, Wi-Fi 7, Wi-Fi 8). This is fully aligned with the European administrations' desire to ensure balanced spectrum policies that promote efficient use of spectrum, and maximise benefits for end users.

We therefore suggest that – detached from any highly-polarized discourse – the European strategy for the 6 GHz band be based on an objective and thorough review of what can be achieved with Mobile and with Wi-Fi, and by considering the implications in the short/medium term in meeting the **European Union's Digital Decade Policy Programme (DDPP) 2030** connectivity targets, as well as any longer-term goals. Accordingly, we recommend the following three steps:

- Step 1 – Identify the alternative **policy options** for the upper 6 GHz band.
- Step 2 – For each policy option, identify the emerging **propositions** (proponents' views) for the evolution of both Mobile and Wi-Fi in the short, medium, and long term.
- Step 3 – **Assess** the identified propositions to determine the policy option that leads to the greater benefits for end users.

[1] "Essentiality report on Wi-Fi 6 Patents (2021)," NGB Corporation, November 2021.
[2] The work on the IEEE 802.11ax (Wi-Fi 6/6E) standard started in 2019 and was finalized in 2021.
[3] "Technology overview report - The journey to Wi-Fi 7. relevant patents | SEPs | major innovators | innovators' competitive technology strength," iCuerious Research Services, December 2023.
[4] The work on the IEEE 802.11be (Wi-Fi 7) standard started in 2019 and will be finalized in September 2024.
[5] "WI-FI 8: A quantum leap in connectivity - A whitepaper by iCuerious Research Services," October 14, 2023.
[6] The IEEE 802.11bn (Wi-Fi 8) standard is expected to be completed in 2028 / 2029.
[7] "3GPP contributions analysis – 2022 update," Omdia, November 2022.
[8] "5G standard essential patents (SEPs)," article from Copperpod Intellectual Property, February 2023.
[9] "Huawei and Qualcomm lead the 5G SEP race," article from IAM, October 2023.

With reference to step (1), the following policy options should be considered:

- **Policy option (a) –** Where the lower 6 GHz band is made available for WAS/RLAN, and the upper 6 GHz band is made available for MFCN.
- **Policy option (b) –** Where the entire 6 GHz band is made available to WAS/RLAN.
- **Policy option (c) –** Potential shared use of upper 6 GHz by MFCN and WAS/RLAN.

With regards to policy option (c), we are contributing with interest to the ongoing activities in ECC PT1 which consider the feasibility of a potential shared use of the upper 6 GHz band by MFCN and WAS/RLAN. While it is premature to draw any conclusion at this stage, based on the many inputs submitted so far, we have currently little confidence that any shared use would lead to a more efficient use of spectrum compared to either options (a) or (b) described above.

With reference to step (2), our response to the RSPG questionnaire in this document presents our understanding on the emerging propositions (proponents' views) in support of the three policy options.

And as for step (3), this document provides **facts and analysis which support the conclusion that the emerging propositions for policy option (a) would allow the achievement of EU's DDPP 2030 connectivity targets, as well as more ambitious longer-term targets for both MFCN and WAS/RLAN.** Whereas, policy options (b) and (c) would pose severe challenges for the performance of MFCNs towards the end of the decade and beyond.

As a vendor of equipment for fixed links, we also address the questions from RSPG directed to the stakeholders providing incumbent services with reference to the Fixed Service (FS).

Questions directed to the MFCN and the WAS/RLAN stakeholders

The RSPG intends to build a long-term vision for the upper 6 GHz band by providing policy recommendations on how to best organise the future use of this band in Europe with the goal to maximise the contribution of this part of spectrum to the achievement of digital connectivity targets for Europe, as laid down in the Digital Decade Policy Programme 2030 (DDPP). The DDPP highlights the importance of connectivity infrastructure and accordingly sets political targets for 2030, including for the deployment of networks with gigabit speeds. All end users at a fixed location should be covered by a gigabit network up to the network termination point and all populated areas should be covered by a next-generation wireless high-speed network with performance at least equivalent to that of 5G. In this context, please answer the following questions:

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

In what follows, we address the demand for WAS/RLANs and MFCNs in the upper 6 GHz band in delivering the EU's Digital Decade Policy Programme targets.

a) Demand for WAS/RLAN in the upper 6 GHz band

Here we tackle the question of the extent to which WAS/RLAN in the upper 6 GHz band is necessary to address the EU's Digital Decade Policy Programme 2030 target of delivering gigabit connectivity at fixed locations. To this end, it is important to quantify the throughputs which can be delivered by WAS/RLAN today using the spectrum already harmonised and available in the 2.4 GHz, 5 GHz, and lower 6 GHz bands.

A study by Huawei in April 2024 [1] is particularly pertinent in this respect. This study involves a detailed modelling of Wi-Fi 6/6E performance in a dense urban apartment setting within a 3-floor building, with

10 apartments per floor, and 4 rooms per apartment. Assuming the use of 3×20 MHz channels at 2.4 GHz, 5×80 MHz channels at 5 GHz, and 3×160 channels at lower 6 GHz (total of 940 MHz), the simulations indicate the following:

- The Wi-Fi throughput within an apartment is coverage-limited due to the propagation loss experienced by radio signals from the Wi-Fi access point (AP) to different rooms. Yet, even in a coverage-limited scenario with only a **single Wi-Fi AP** per apartment, the throughput per apartment exceeds **1 Gbit/s** and **1.5 Gbit/s** in **90%** and **50%** of locations, respectively.

- Throughput can be increased substantially through densification of Wi-Fi APs; i.e., by installing more than one Wi-Fi AP per apartment. Specifically, with **4 Wi-Fi APs** installed per apartment (one per room), throughputs of around **4 Gbit/s** and **7 Gbit/s** per apartment can be achieved in **90%** and **50%** of locations, respectively.

A recent extensive measurement campaign by system integrator Comtel [2] undertaken in a 3-floor hotel in Italy during February-March 2024 has shed further light on to the levels of performance which Wi-Fi 6/6E can deliver in practice. With the use of 4×80 MHz channels at 5 GHz and 3×160 channels at lower 6 GHz (total of 800 MHz), the measurements confirm the trends observed by Huawei as described above. Specifically, they demonstrate the following:

- **Isolated house/dwelling** – A first set of measurements replicated the environment of an isolated house/dwelling and involved Wi-Fi deployment in a so-called "target apartment" consisting of 4 adjacent rooms and with no Wi-Fi deployments in the other rooms of the hotel. Here, a total throughput of **1.5 Gbit/s** was measured as delivered by **1 Wi-Fi AP** serving **2 stations** in the same room. A reduced total throughput of **1.1 Gbit/s** was measured with the same single AP serving **8 stations** (2 in each of 4 adjacent rooms in the apartment), thereby confirming that the performance of Wi-Fi is **coverage-limited**.

  With **2,3** and **4 Wi-Fi APs**, each deployed in one of **4 rooms** in the target apartment and serving **2 stations** in each room, total throughputs of around **1.7**, **4.1** and **6.3 Gbit/s** were measured in the target apartment, respectively, demonstrating the impact of Wi-Fi AP **densification** in enhancing capacity.

- **Dense urban apartment environment** – A second set of measurements replicated a dense urban environment and involved the same target apartment but subject to interference from 1 Wi-Fi AP and 2 stations in each of up to 38 rooms surrounding the target apartment. Again, with **2,3, and 4 Wi-Fi APs**, each deployed in one of **4 rooms** in the target apartment and serving **2 stations** in each room, substantial total throughputs of **1.7**, **2.4** and **4.5 Gbit/s** were measured in the target apartment, respectively, demonstrating the impact of Wi-Fi AP **densification** in enhancing capacity even in a highly interfered environment.

The above measurements also provide an indication of the type of performance that can be achieved by Wi-Fi in other similar settings such as schools.

Conclusions for WAS/RLAN

Based on the above, we draw the following conclusions as to how the demand for WAS/RLAN capacity can be met from a technology and regulatory perspective.

Short to medium term (2030)

The availability of spectrum for WAS/RLAN is **not a bottleneck** for meeting the EU's Digital Decade Policy Programme 2030 targets for the provision of **gigabit connectivity** for end users at fixed locations. This is because as indicated by our modelling and Comtel's measurement campaign, the use of currently available spectrum in the 2.4 GHz, 5 GHz, and lower 6 GHz bands allows Wi-Fi to **readily deliver throughputs of 1 Gbit/s** or more within indoor premises – including in the highly interfered environments of dense urban apartments.

The results of modelling and measurements also indicate that the performance of Wi-Fi today is **coverage-limited** rather than capacity-limited. Tests also indicate that this limitation can be mitigated through **densification** of Wi-Fi APs within premises, where with APs installed in multiple rooms, Wi-Fi can deliver throughputs of **several Gbit/s** using existing bands.

While the Comtel campaign has assessed the performance associated with the deployment of multiple APs of the same kind in different rooms in the same apartment, more advanced solutions leveraging a centralized master-slave architecture are already being addressed in ITU-T[10] and in ETSI[11] and are being introduced in various markets[12]. With **fibre-to-the-room** (FTTR), the main FTTR Unit (MFU) performs smart channel assignments, throughput scheduling, power management, and autonomous self-optimization for the sub FTTR Units (SFUs) which are deployed in a distributed manner for better coverage and service experience. The adoption of point-to-multi-point ultra-thin transparent adhesive fibre[13] for in-premise fibre distribution networks (IFDNs) is facilitating deployments in existing and new homes [3].

Considering the status of fixed broadband deployments in the European Union today, we see that 55% of households had a fixed broadband subscription with a nominal speed of at least 100 Mbit/s in 2023, and 14% of households had a fixed broadband subscription of at least 1 Gbit/s in the same year [4]. Therefore, we consider that the EU's short to medium term efforts in delivering fixed gigabit connectivity should be focused towards the provision of **gigabit capacity fibre** or fibre-like **fixed wireless access** (FWA) for residential users and businesses.

Long term (beyond 2030)

Once AP densification is applied, new WAS/RLAN technologies (e.g. Wi-Fi 8) will in the longer term have the opportunity to exploit the much larger bandwidths which can be made available at mmWave frequencies to deliver extremely high throughputs and low latencies. Importantly, the very high wall loss at such frequencies would allow the Wi-Fi APs in different rooms to operate in an interference-free manner, and therefore deliver very high spectral efficiencies. Candidates mmWaves bands for WAS/RLANs include **47-71 GHz** which is being discussed at **IEEE 802.11bn / Wi-Fi 8**[14]. We recommend that other bands also be explored for this purpose within the **10-15 GHz** range, or the **28 GHz** band.

b) Demand for MFCN in the upper 6 GHz band

Here we tackle the question of the extent to which MFCN in the upper 6 GHz band is required to address the EU's Digital Decade Policy Programme 2030 target of delivering mobile communications with performance at least equivalent to that of 5G in all populated areas.

To this end, it is important to quantify the amount of spectrum required to deliver the 5G/IMT-2020 user-experienced data rate requirements of 100 Mbit/s on the downlink and 50 Mbit/s on the uplink as specified by the ITU-R [5].

Studies undertaken by GSMA and Coleago [6][7] have indicated that up to 2 GHz of mid-band spectrum is required to support a 5G mobile broadband user-experienced data rate of 100 Mbit/s on the downlink and 50 Mbit/s on the uplink in urban environments in towns and cities. The study assumes the use of the existing grid of urban base stations (BSs), complemented by some densification via small cells. Given the current availability of around 1 GHz of low- and mid-band spectrum in Europe, this amounts to a need for authorisation of around 1 GHz of additional mid-bands spectrum to deliver internationally approved 5G/IMT-2020 performance in Europe in areas where there is a high demand for capacity in

[10] FTTR use cases and architecture are defined in in ITU-T/SG15Q3 – see here.
[11] Industry Specification Group (ISG) Fifth Generation Fixed Network (F5G) – see here.
[12] FTTR is experiencing rapid taking up with 10 million FTTR units deployed in China and 120 k FTTR units deployed outside China as of today. "Movistar Spain launches FTTR service for improved home connectivity," December 2023, see here. "Telefonica launches fibre-to-the-room," December 2023, see here. Vodafone Portugal takes a la carte fibre-to-the-room," December 2023, see here.
[13] https://carrier.huawei.com/en/products/fixed-network/sub-solution-access/fttr-to-home.
[14] Work on mmWave spectrum for RLAN has started, for example in IEEE (802.11.bn / IMMW projects).

the 2025-2030 time-frame.

Beyond 2030, mobile communication networks in Europe will begin to transition from 5G/5G-Advanced to 6G. Although the performance requirements of 6G/IMT-2030 will not be specified by the ITU until 2026, it is expected that 6G will have higher user-experienced data rate requirements – and hence channel bandwidths – compared to 5G/IMT-2020. In a study [8] by the Global Mobile Suppliers Association (GSA), it is estimated that in order for 6G/IMT-2030 to deliver the data rates for mobile XR and holographic communications, around **1 GHz** of mid-band spectrum **per network** would be required. With 3-4 networks in a country, and with around 1 GHz of existing low and mid-band spectrum available in Europe, this implies **2-3 GHz** of **additional mid-band** spectrum for 6G/IMT-2030.

Conclusions for MFCN

Based on the above, we draw the following conclusions as to how the demand for 5G capacity can be met from a technology and regulatory perspective.

Short term

5G networks will continue to rely on **macro cellular coverage in mid bands** (i.e. the 3.5 GHz band in Europe), which provide a good balance between coverage and capacity for cost-effective coverage. Harmonised **mmWave spectrum** will be used, limited to use cases where devices are available (e.g. industrial modules, CPEs), but will not replace mid-band deployments because the required extreme densification would be economically and environmentally prohibitive.

Medium term (before 2030):

Some 5G/5G-Advanced mobile network BSs will begin to experience **service-impacting traffic loads** towards the end of the decade in the demanding environments of cities and large towns. While **some network densification** will gradually take place to relieve the pressure at certain locations, the extreme densification required for a geographically consistent quality of service will continue to be economically and environmentally unviable. Consequently, **additional mid-band spectrum** will need to be made available to address the demand for 5G/5G-Advanced in the second half of this decade, and the **upper 6 GHz** band is clearly the **only opportunity** for additional mid-band spectrum in Europe in this time-frame.

Long term (after 2030)

With the transition from 5G/IMT-2020 to 6G/IMT-2030 occurring from 2030, and given the technology-neutral nature of European spectrum authorisation, a world-leading and **competitive 6G** in Europe will naturally need to **start** from **macro-cellular** deployments in the entire **upper 6 GHz** band where a bandwidth of around 200 MHz per operator can be made available to accommodate the larger 6G channel bandwidths. There will be a further need to meet the **minimum performance requirements of 6G/IMT-2030** in order to support **future use cases** such as mobile XR and holographic communications, and this will require access to new mid-bands spectrum in addition to the upper 6 GHz band beyond 2030.

II) Provide information about the sustainability of the above explained demand, especially the: 1) Environmental impact assessment 2) Social economic impact

a) Environmental impact assessment

The relevant question here is as follows: How does the nature of authorisation of the upper 6 GHz band affect the environmental impact of delivering the European Union's Digital Decade Policy Programme 2030 connectivity targets?

The study [7] by Coleago estimates that, in the absence of additional mid-band spectrum compared to what is available today, the delivery of IMT-2020 performance levels in a city like Paris would require a ×4.1 increase in the number of 5G BSs, and a ×2.2 increase in power consumption. Such levels of densification are clearly not environmentally sustainable.

A more recent study [9] by Analysys Mason involved a detailed analysis which demonstrates that the carbon footprint of future 5G mobile networks is expected to be lower if additional mid-band spectrum is made available to meet IMT-2020 performance levels, by avoiding a significant additional densification of macro sites and outdoor small cells which would otherwise be required to meet the Union's DDPP 2030 target. This applies both in the dense urban area and in the rural town or village modelled in the study. That is to say, the carbon emission savings from having less network densification outweigh the incremental carbon emission costs of deploying and operating new mid-band radios at existing sites. The study also concludes that the availability of the upper 6 GHz band for Wi-Fi would not translate to any reduction in carbon emission, given that the DDPP 2030 connectivity targets can be met with the latest Wi-Fi technology using the bands already available for WAS/RLAN in Europe.

b) Socio-economic impact

In a study [10] in 2022, GSMA Intelligence quantified the cumulative economic benefits over the time frame 2022-2035 of three scenarios, where 1) the entire 6 GHz band is assigned to IMT, 2) the entire 6 GHz band is assigned to WAS/RLAN, and 3) the lower 6 GHz band is assigned to WAS/RLAN, and the upper 6 GHz assigned to IMT. The study indicates that Scenario 1 will deliver the largest benefits if fixed broadband technologies do not provide maximum user speeds above 5 Gbit/s. Scenario 1 will still deliver the largest benefits if fixed broadband provides maximum user speeds up to 10 Gbit/s and if a portion of Wi-Fi traffic is offloaded to mmWaves. Scenario 3 will deliver the largest benefits if fixed broadband supports maximum user speeds of 10 Gbit/s and there is no offload to mmWaves (the latter would represent inefficient use of spectrum). Scenario 2 was not found to be the most beneficial allocation in any of the considered analyses. That is, even in countries with very high Wi-Fi demand, and if fixed broadband speeds reach 10 Gbps, the lower 6 GHz band is sufficient to meet expected Wi-Fi demand.

III) Provide information about:
1) the possible role of the upper 6GHz for MFCN or WAS/RLAN
2) use cases, expected deployments (e.g. number of BS for MFCN) and timeframe

a) WAS/RLAN

WAS/RLANs – and specifically Wi-Fi networks – are important and indispensable for the provision of short-range communications. Wi-Fi is used today primarily indoors for surfing the web, audio-visual communications and video streaming, as well as a variety of consumer and industrial IoT applications.

That said, we consider the assignment of the upper 6 GHz band to WAS/RLANs to be an **unnecessary measure** precisely due to the **short-range** nature of the communications which they support.

Specifically, measurements indicate that spectrum availability is **not a bottle-neck** for WAS/RLAN to meet the Union's DDPP 2030 gigabit connectivity target at fixed locations, and that existing bands (2.4 GHz, 5 GHz, and lower 6 GHz) are sufficient for this purpose. Growth in demand for Wi-Fi traffic going forward can be readily addressed by the deployment of **multiple APs** within premises where necessary, facilitated by technologies such as **fibre-to-the-room** which are commercially available today. In the longer term (beyond 2030), further growth in demand for Wi-Fi traffic can be addressed through the use of **mmWaves** spectrum for **efficient** and **interference-free** short-range communications.

b) MFCN

In addition to the mid-bands that are available for MFCNs today (which will eventually be re-farmed for use by 5G), the upper 6 GHz band is required to achieve the **5G/IMT-2020 performance** levels specified by the ITU-R, and for the **economically efficient** and **environmentally friendly** delivery of high-capacity coverage by **macro-cellular** MFCNs across densely populated towns/cities and along major transport routes in the 2025-2030 timeframe. MFCNs in the upper 6 GHz will support indoor/outdoor mobile broadband, smart city, automotive and industrial use cases, as well as fixed wireless access (FWA).

MFCNs in Europe are expected to increasingly reach their capacity limits at high-traffic locations towards the end of the decade. The upper 6 GHz band would play a critical role in addressing the service-impacting high traffic loads which 5G/5G-Advanced macro BSs will experience at such time, particularly in densely populated urban areas. Accordingly, it is important for the upper 6 GHz to be harmonised for MFCNs in Europe in 2027.

Beyond 2030, European mobile operators will also be able to use the upper 6 GHz band for initial **6G/IMT-2030** deployments. The 700 MHz of bandwidth available in the upper 6 GHz band will contribute to the successful early launch of globally competitive **6G** MFCNs in Europe with access to an average of around 200 MHz per operator in a harmonised, coordinated and timely manner to exploit European economies of scale.

In parallel we are contributing with interest to the ongoing activities in ECC PT1 which consider the feasibility of a potential shared use of the upper 6 GHz band by MFCN and WAS/RLAN. One potential sharing scenario that is being proposed foresees coexistence between MFCN and WAS/RLAN enabled by imposing restrictions on the EIRP of MFCN BSs and thereby, according to the proponents of this approach, precluding MFCN indoor coverage or at least de-prioritising this with respect to WAS/RLAN indoor coverage. The mobile industry has expressed great concerns [11][12][13] in investing in network infrastructure under such constraints due to the prohibitive costs that would be required to build ubiquitous wide area (e.g. citywide) outdoor coverage, as well as the restrictions this would place on MFCN use indoors.

While it is premature to draw any conclusion at this stage, based on the many inputs submitted so far, we have currently little confidence that any shared use – policy option (c) – would lead to a more efficient use of spectrum compared to either policy options (a) or (b) as described at the start of this document.

Based on the above, we recommend that RSPG defines the short/medium-term and the long-term vision for the upper 6 GHz band by carefully assessing the propositions for the future evolution of both MFCN and WAS/RLAN corresponding to the alternative policy options for the upper 6 GHz band from technical and economic perspectives.

The following table presents our understanding of the emerging propositions (proponents' views) in support of the key three alternative policy options for the upper 6 GHz band. The facts and analysis presented in this document in response to the questions raised by RSPG provide elements to support a cost/benefits assessment of the propositions described. **These lead us to the conclusion that the emerging propositions for policy option (a) would allow the achievement of EU's DDPP 2030 connectivity targets, as well as more efficient use of spectrum and more ambitious longer-term targets for both MFCN and WAS/RLAN**.

<table>
<tr><th colspan="2"></th><th colspan="3">Emerging propositions
for the evolution of MFCN and WAS/RLAN</th></tr>
<tr><th colspan="2"></th><th>Proposition for policy option (a):
upper 6 GHz
for MFCN</th><th>Proposition for policy option (b):
entire 6 GHz
for RLAN</th><th>Proposition for policy option (c):
potential shared use*
of upper 6 GHz by
MFCN/RLAN</th></tr>
<tr><td rowspan="3">RLAN</td><td>Short term</td><td>2.4 GHz, 5 GHz, L6 GHz bands are sufficient for RLAN to meet current demand [1][2].</td><td rowspan="2">U6 GHz is urgently needed for RLAN to support XR use cases (e.g., in schools and stadiums), and the EU DDPP 2030 targets cannot be met otherwise.</td><td rowspan="3">U6 GHz is urgently needed for RLAN.

Once the MFCN ecosystem is ready to deploy, RLAN should share spectrum provided that MFCN BS EIRP is limited within the range of 50 to 60 dBm(/100 MHz)** considered sufficient to provide outdoor coverage, but with RLAN prioritised over indoor MFCN use.</td></tr>
<tr><td>Medium term
(up to 2030)</td><td>2.4 GHz, 5 GHz, L6 GHz bands are sufficient for RLAN to meet the EU DDPP 2030 connectivity targets. RLAN AP densification will provide enhanced multi-gigabit connectivity [1][2].</td></tr>
<tr><td>Long term
(beyond 2030)</td><td>Combined with RLAN AP densification, mmWaves will be deployed in RLANs to provide beyond gigabit interference-free connectivity and very low latency [3].</td><td>No additional proposals.</td></tr>
<tr><td rowspan="3">MFCN</td><td>Short term</td><td>5G/5G-A continue to use available low, mid, and mmWave bands.

3.5 GHz has primary role for macro-cellular MFCN coverage. The use of mmWaves is limited to use cases where devices are available (e.g. industrial modules, CPEs) but cannot deliver environmentally [9] or economically [10] viable contiguous coverage in towns and cities.</td><td rowspan="2">Mobile traffic growth is slowing down, and MFCNs do not need more spectrum.

Any demand for additional outdoor MFCN capacity will be addressed via network densification and by exploiting the existing spectrum more intensely, including mmWaves.

Indoor MFCN traffic will be offloaded to Wi-Fi.</td><td>Mobile traffic growth is slowing down, and MFCNs do not need more spectrum.

Any demand for additional outdoor MFCN capacity will be addressed via network densification and by exploiting the existing spectrum more intensely, including mmWaves.

Indoor MFCN traffic will be offloaded to Wi-Fi.</td></tr>
<tr><td>Medium term
(up to 2030)</td><td>Some MFCN BSs will experience service-impacting traffic loads towards the end of the decade.

Limited network densification will provide partial relief, but the required extreme densification is not viable and cannot replace the need for additional mid-bands. U6 GHz is needed to address 5G/5G-A MFCN congestion.</td><td>Once the MFCN ecosystem is ready to deploy, RLAN should share spectrum provided that MFCN BS EIRP is limited within the range of 50 to 60 dBm(/100 MHz)** considered sufficient to provide outdoor coverage, but with RLAN prioritised over indoor MFCN use.</td></tr>
<tr><td>Long term
(beyond 2030)</td><td>Need for additional mid-bands to support new use cases and to address IMT-2030 minimum performance requirements [8].

Large bandwidth in U6 GHz (e.g. ~200 MHz per network operator) will facilitate early macro-cellular 6G. WRC-27 may offer further opportunities at 7-8 GHz.</td><td>WRC-27 will offer additional mid-bands for macro-cellular 6G.</td><td>WRC-27 will offer additional mid-bands for macro-cellular 6G.</td></tr>
</table>

* Under on-going discussion at ECC PT1.
** Precludes macro-cellular deployments.

IV) Provide information about standardization and technology impact

WAS/RLAN

- In May 2021, IEEE completed the 802.11ax-2021 standard for Wi-Fi 6/6E products to operate over the entire 6 GHz band (5925-6425 MHz).

- IEEE is now working on the 802.11be standard for Wi-Fi 7 which is expected to be finalized by end of 2024. Wi-Fi 7 builds on Wi-Fi 6E and aims to improve data throughput, stability, and latency. While Wi-Fi provides access to multiple spectrum bands, devices prior to Wi-Fi 7 typically choose only one band to make transmissions. With multi-link operation (MLO), Wi-Fi 7 devices can simultaneously connect on multiple bands, enabling faster speeds through aggregation.

- IEEE 802.11bn – also designated Wi-Fi 8 – is to be the next 802.11 standard. Wi-Fi 8 will explore millimeter wave frequencies and more advanced antennas, and will continue to improve multiple access point coordination and transmission.

MFCN

- In June 2022, 3GPP completed the technical specifications of 5G NR band n104 for the upper part of the 6 GHz band (6425-7125 MHz) for licensed 5G services.

- Following WRC-23, 3GPP started the work (RP-240829) to add the Expected e.i.r.p. mask (defined for upper 6GHz IMT in WRC-23 Resolution 220) and related conformance testing to 3GPP specifications. Work planned to be finalized by Dec 2024.

- International interest generated by this MFCN band among industry (operators and suppliers) and administrations is driving the rapid consolidation of the ecosystem.

- Commercial 5G NR products in the 6 GHz band for both for the base station and user equipment are expected to be available from 2025.

Questions directed to the stakeholders providing incumbent services in the upper 6 GHz band

I) Explain impact of possible future usage of the upper 6GHz for MFCN and/or WAS/RLAN on existing services:

1) What are your current and future spectrum needs (before and beyond 2030) in the upper 6GHz band?
2) What impact on your service do you expect from the introduction of MFCN and/or WAS/RLAN in the upper 6GHz band?
3) What measures could improve compatibility from your perspective?

We consider that – in the absence of coordination measures – there can be a high likelihood of harmful interference from both MFCNs and WAS/RLAN to fixed links in the upper 6 GHz band when these technologies are deployed in the same areas. Studies at ITU-R [14] have indicated that protection distances of several kilometres (fixed link sidelobe) and up to several tens of kilometres (fixed link main-lobe) would be required to avoid harmful co-channel interference from MFCNs to fixed links in the upper 6 GHz band. Furthermore, based on the latest discussions at ECC SE45[15], it is our understanding that measurements suggest that pulsed/bursty signals of the type transmitted by Wi-Fi equipment may have a greater harmful impact than continuous/noise-like signals of equal power (used in traditional modelling), and that conclusions cannot be drawn on the impact of interference from WAS/RLAN to fixed links pending completion of on-going work and further investigations.

Accordingly, our current working assumption is that irrespective of whether the upper 6 GHz is assigned for use by WAS/RLANs or MFCNs, there will be a need for coordination with the existing fixed links in the band in the same geographic area, including through the use of geographic separation and/or separation in frequency, and in some cases migration to other bands (with the 2025-2030 timeframe in mind).

We note that such coordination can be performed more readily and reliably in the case of MFCNs, on the grounds that MFCNs will be licensed, and therefore details of their planned deployments – and potential aggregate interference – can be known well in advance, and any restrictions imposed by the coordination process can be readily implemented by the MFCN operators. However, implementation of such coordination would not be possible for the end-users of general authorised (licence-exempt) WAS/RLAN equipment, and would need to be implemented via appropriate automated coordination databases with the ability to leverage information provided to them on the locations and characteristics of the WAS/RLAN equipment.

Notably, a substantial proportion of fixed links in the upper 6 GHz bands are used by mobile network operators for the provision of wireless backhaul to MFCN base stations. However, as set out by a number of European mobile network operators[16], these fixed links do not have the capacity to support the evolution of 5G going forward, and will inevitably be replaced by fibre for backhaul – especially at location in (or close to) urban areas where MFCNs will be expected to be deployed in the upper 6 GHz by mobile operators.

[15] See section "4.1.2 Effect of interference from pulse/burst signals on FS receiver performance" in the draft ECC Report "Sharing and compatibility studies related to wireless access systems including radio local area Networks (WAS/RLAN) in the frequency band 6425-7125 MHz," July 2024. See here.
[16] ECC PT1(21)227r1, Multi-company input to ECC PT1 meeting #69, September 2021. See here.

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[1] "ECC PT1(24)_CG6GHz016, Wi-Fi performance in dense-urban apartments," Huawei, April 2024. See here.

[2] "2024-08-13 Comtel Wi-Fi indoor connectivity test - Lazise March 2024 - Test Report," Comtel, August 2024. See here.

[3] "FTTR (Fiber-to-the-Room) RLAN, Enhanced Gigabit QoE for residential and SMEs," Huawei optical product line presentation at the European Spectrum Management Conference in Brussels, June 2024. See here.

[4] "Digital Economy and Society Index (DESI) 2023 indicators,". See here.

[5] "Minimum requirements related to technical performance for IMT-2020 radio interface(s)," ITU-R M.2410 Report, November 2017. See here.

[6] "Vision 2030 - Insights for Mid-band Spectrum Needs," GSMA, July 2021. See here.

[7] "Estimating the mid-band spectrum needs in the 2025-2030 time frame, global outlook," Coleago Consulting, July 2021. See here.

[8] APG23-5/INF-26, "IMT-2030 (6G) spectrum needs analysis," GSA, February 2023.

[9] "Impact of additional mid-band spectrum on the carbon footprint of 5G mobile networks: the case of the upper 6GHz band," Analysys Mason, June 2023. See here.

[10] "The socioeconomic benefits of the 6 GHz band: considering licensed and unlicensed options," GSMA Intelligence, January 2022. See report here. See presentation here.

[11] ECC PT1(24)CG6GHz005, "Working Doc revisions on MFCN fundamental aspects," GSMA, Ericsson, Huawei Technologies, Nokia Corporation, February 2024. See here.

[12] ECC PT1(24)_CG6GHz022, "Variation of MFCN downlink throughput as a function of MFCN BS EIRP in the U6 GHz band," Huawei Technologies, July 2024. See here.

[13] ECC PT1(24)110, "6GHz MFCN downlink spectral efficiency considerations," Ericsson, May 2024. See here.

[14] "Report of the CPM on technical, operational and regulatory/procedural matters to be considered by the World Radiocommunication Conference 2023," ITU. See here.

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