Huawei welcomes the opportunity to provide the feedback to NKOM on the consultation on frequency need towards 2030.

1. Introduction

A 5G cross-industry vision is now well established and globally supported. Development of the 5G technology, radio solutions, and associated core network, is being led considering IMT-2020 ITU requirements and corresponding 5G service expectations. Subsequently, more restrictive service requirements drive 5G-Advanced network standards, as a natural evolution of 5G technology, currently being defined in frame of Release 18 of 3GPP with expected final completion in mid-2024. These namely include practically achievable 100 Mbps DL (downlink) speed in busy hours, peak speeds of 10 Gbps in DL and 1 Gbps in UL (uplink), significantly improved latency for handling XR (extended reality) and advanced industrial applications as well as extended support for sensing, positioning and IoT services. Commercialization of 5G-Advanced is expected during 2025-2030 period.

2. Role of mid- and high-bands spectrum in mobile network evolution

Mid-bands spectrum is extremely important for mobile networks as these frequencies provide a unique combination of capacity and coverage for wide-area services, as indicated in Fig. 1. Thus, an alternative assignment of these bands for local-area deployments must be carefully considered as no alternatives exist for wide-area mobile networks.

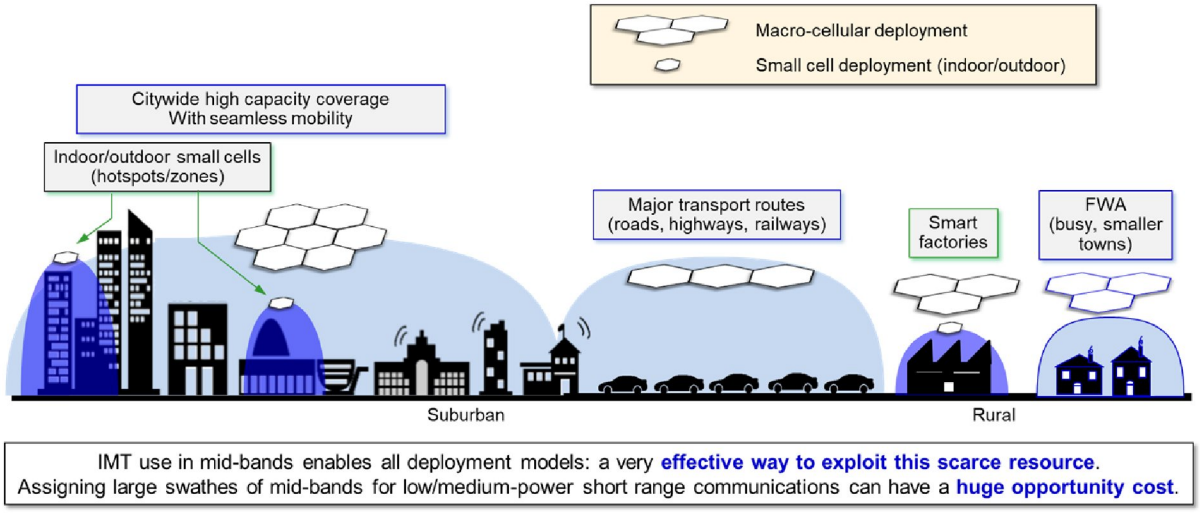

Fig. 1. IMT in bid-bands can address both wider area and local area deployment scenarios cost effectively. Ref: Vendors presentation at the 2nd European 6GHz webinar – Dec. 2021.

Mid-bands spectrum is currently being used on about 85% commercial networks globally. GSMA Intelligence [1] concludes that 5G is expected to generate $960 billion in gross domestic product (GDP) in 2030 on a global basis, with $610 billion of this being a result of deployments in mid-bands and representing almost 65% of the overall socio-economic value generated by 5G. According to the analysis, up to 40% of the expected benefits of mid-bands 5G could be lost if no additional mid-bands spectrum is assigned to mobile services. Therefore, we consider mid-bands as essential in evolution of mobile communication globally.

The role of high bands (mm-Wave) is essential to complement low- and mid-band spectrum and ensure a successful 5G deployment and evolutions. High-bands are expected to play an important role in enterprise network deployments supported by mobile network operators. Moreover, high-bands will provide a valuable offload capacity layer in dense urban hotspots and support in selected FWA scenarios. Although, up to date, only few commercial networks using mm-wave spectrum have been launched globally.

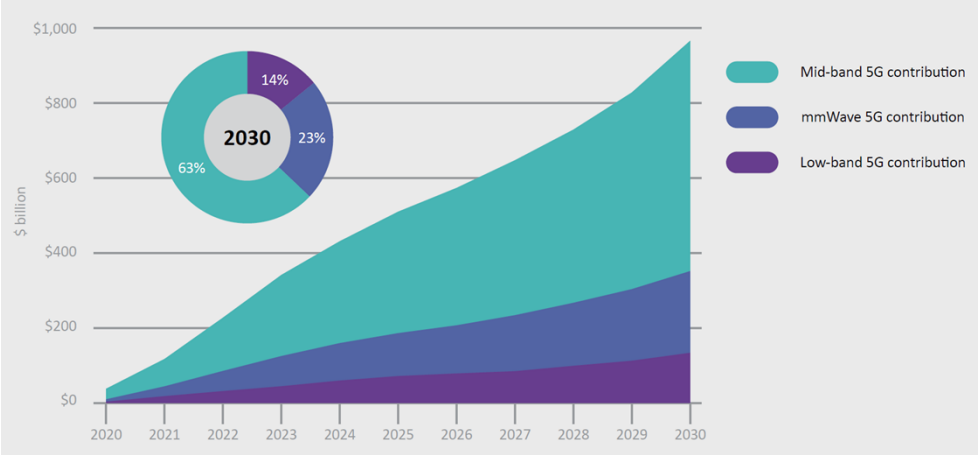

Fig. 2. Annual impact of 5G on GDP, by band 2020-2030. Ref. “The Socio-Economic Benefits of Mid-Band 5G Services” (Feb. 2022), GSMA Report [1].

3. Mid-band spectrum needs (in frame of 2025-2030)

The need for 5G spectrum is driven by the end users’ traffic growth and their increasing demand for quality (e.g. lower latency and higher reliability). Based on the ITU-R specifications for IMT-2020 , GSMA’s mid-bands spectrum demand modelling [1], [3] has provided an estimation for the spectrum needed to reliably deliver the fundamental IMT-2020 service requirements in an economically feasible manner in urban areas in the 2025-2030 timeframe. According to this study and corresponding GSMA reports, an average of 2 GHz of mid-bands spectrum will be needed in total in the 2025-2030 time frame, depending on markets [3][4]. Beyond urban areas, the additional mid-bands spectrum will address the digital divide, providing affordable high-speed fixed wireless access (FWA) broadband to small towns and villages, increase available capacity along major transport routes, and help address the connectivity needs of industrial use cases. Moreover, based on their detailed network capacity forecasts, 5G networks in cities will begin to experience service-impacting capacity limitations.

Specifically, the GSMA recommends [3] governments and regulators to:

a) Plan to make 2 GHz of mid-band spectrum available in the 2025-2030 time frame. This is the average value needed to guarantee the IMT2020 requirements for 5G;
b) Carefully consider 5G spectrum demands when 5G usage will be reaching its peak, and advanced use cases will carry additional needs;
c) Base spectrum decisions on real-world factors including population density and extent of fibre rollout;
d) Support harmonized mid-band 5G spectrum (e.g., within the 3.5 GHz, 4.8 GHz and 6 GHz ranges) and facilitate technology upgrades in existing bands.

Practically, operators can mitigate the demand for spectrum through building additional sites. Clearly, this leaded to unfeasible extreme network densification, hence it is not a preferred and environmentally-friendly option to cope with the absence of additional mid-band spectrum. GSMA study [4] estimates that if there is a deficit of 800-1000 MHz in the required mid-bands spectrum, the total cost of network ownership will be 3-5x higher over a ten-year period, and the carbon footprint 1.8-2.9x greater, both as a result of the extreme densification needed to deliver the target performance levels. Additionally, the quoted the study does not address the practical restrictions in acquiring the additional sites required within an already dense network grid, nor the technical challenges including harmful interference management and mobility management, nor the economic feasibility in terms of both CAPEX and OPEX resulting from such extreme densification. Expectedly in the absence of additional mid-bands spectrum, and given the above technical and economic limits to extreme network densification, mobile network operators would not be able to deliver the user experienced data rates of 100 Mbit/s downlink and 50 Mbit/s uplink.

4. <u>Call for balance between mid-bands spectrum for macro cellular (wide area) networks and low/medium power (local area) deployments</u>

There is a clear need for a European roadmap for wide-area / nationally licensed mid-band spectrum to address the needs of macro cellular 5G evolution towards 5G-Advanced and future cellular generations. Considering, currently identified spectrum in mid-bands, it is becoming apparent that the upper 6GHz band represents the only remaining mid-band opportunity in Europe:

a. Within the mid-band range (i.e. from 2 to 8 GHz), the upper 6 GHz frequency band is the only possible additional portion of wide contiguous spectrum that can be made available in Europe for macro cellular mobile networks in the foreseeable future;
b. ITU WRC-19 (World Radio Conference in 2019), has agreed to include the upper 6 GHz band (6425-7125 MHz) as an IMT agenda item for WRC-23 for EMEA and Russia (ITU Region 1) (AI - Agenda Item 1.2). The WRC-23 is now a key opportunity to identify this spectrum for IMT and is of great significance to the future sustainable development of the mobile communications industry (the evolution of 5G);
c. The “lower 6GHz band”: 5925-6425MHz is currently harmonized for RLAN (including Wi-Fi) in Europe based on ECC and EC Decision.

We recommend that upper 6GHz band should be identified as a fundamental mid-band pillar for cellular networks, hence we call for supporting IMT identification in this band. The use of the 6 GHz band for macro-cellular wide-area network deployments is key to ensure a suitable balance with spectrum assigned for local deployments.

To date, countries that have allocated spectrum in this band have taken divergent approaches: some have allocated the full 6 GHz band (5925-7125 MHz) for licence-exempt use, while others are considering the same band for licensed macro-cellular mobile networks; the largest group is considering to allocate the lower part of the band (5925/5945–6425 MHz) for licence-exempt use and the upper part (6425–7125 MHz) for licensed use. The international interest generated by this band among industry (operators and suppliers) and administrations is driving the rapid consolidation of the equipment ecosystem. 3GPP has concluded the technical specifications of 5G NR base stations and user equipment for 6425-7125 MHz [5] in 3GPP band n104, defining the band plan, system parameters including channel bandwidth, transmitter and receiver characteristics, as well as other technical requirements. Commercial 5G NR products in the 6 GHz band – both for the radio access network and user equipment – are expected to be available when national assignments of these frequencies occur.

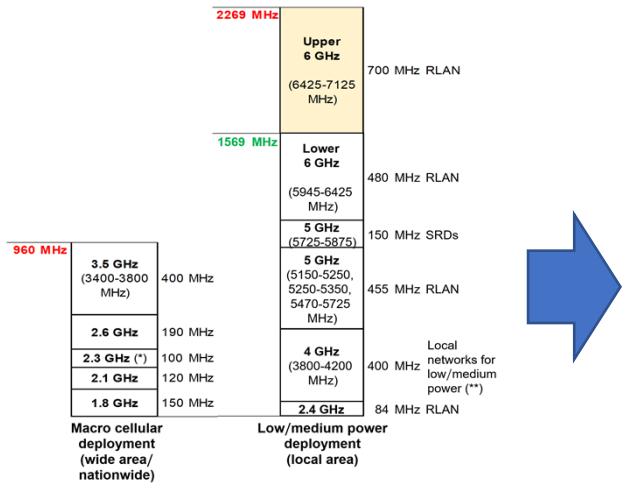

Fig. 3a. Mid-band spectrum allocation resulting in 2.4x imbalance between spectrum allocated for macro cellular (wide) and low/medium power (local) deployments.

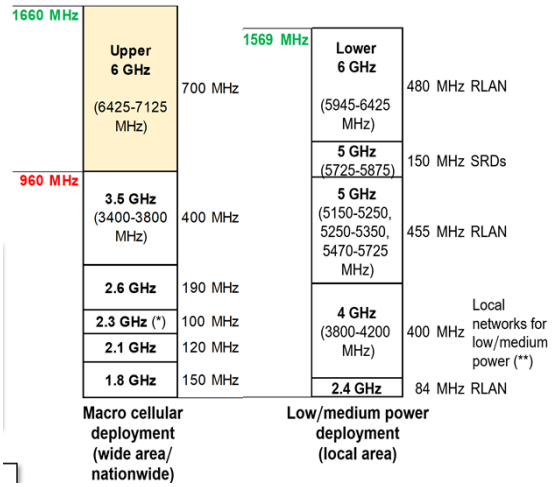

Fig. 3b. Recommended balanced approach between mid-bands spectrum allocated for macro cellular (wide) and low/medium (local) deployments with Upper 6GHz identified for IMT.

With reference to the potential link to IMT-2030 mentioned by the RSPG, the need for the upper 6 GHz band has been justified in the study from the GSMA [3] on the basis of fulfilling the IMT-2020 minimum performance requirements. Considering that the European regulatory framework is based on the principle of technology neutrality, the upper 6 GHz band, like any other harmonized MFCN band, would be available for both 5G Advanced and later on 6G / IMT-2030. The upper 6 GHz band will therefore also play a role in fulfilling the IMT-2030 minimum performance requirements which will be discussed in ITU starting from 2024.

GSMA Intelligence has conducted cost-benefit analysis [6] aiming at assisting policy makers in their decisions on different authorization models for the upper 6 GHz band. The report draws the following conclusions in house dwelling or apartment settings:

a) In general, allocating the full 6 GHz band for licensed mobile use will drive the greatest economic benefit;
b) Allocating the lower 6 GHz band for license-exempt use and the upper 6 GHz band for licensed mobile use could drive the greatest economic benefit only under certain conditions in some countries (e.g. where there is high fiber/cable broadband adoption and very high FBB speeds of 10 Gbit/s to all fiber/cable users);
c) Allocating the full 6 GHz band for license-exempt use will not be the most beneficial option in any of the considered analyses.

5. Role of high bands in cellular communication

According to GSMA Intelligence report [9], role of mm-Wave is important as supportive to low- and mid-band network deployments in providing additional capacity in areas with very high traffic density demands. Although number of successful deployments in mm-Wave are limited to selected FWA scenarios and enterprise network deployment for the time being, GSMA Intelligence estimates that on average 5GHz of mm-Wave spectrum per market will be needed by 2030 [9].

6. Role of WiFi in future communication and corresponding spectrum needs

Mobile networks are complemented by radio local area networks (WAS/RLANs) and we expect this trend to continue going forward with the evolutions of 5G NR mobile networks and Wi-Fi WAS/RLANs, respectively. Frequencies in mid-bands and high-bands are important for both 5G NR and Wi-Fi technologies, with mid-bands being essential for wider-area mobile use cases, whereas high-bands are more optimal where very high capacities over smaller areas are needed, such as for indoor or outdoor hotspots.

It is important to account for the fact that co-channel operation of IMT networks (5G NR) and WAS/RLAN (Wi-Fi or NR-U) in the same geographic area would result in harmful mutual interference, to the extent that they would not be able to perform at the levels for which they were designed: 5G NR's protocols for scheduled access to spectrum – specified for managed QoS in a controlled interference environment – would be severely disrupted, while Wi-Fi's/NR-U's protocols for opportunistic access to spectrum – specified for managing unscheduled interference from other similar equipment – would fail to function. Given that 5G NR and Wi-Fi must operate in different frequencies, and the criticality of mid-bands for wider-area mobile communications, the question arises as to how much additional mid-bands spectrum should be allocated for use by 5G NR and Wi-Fi, respectively.

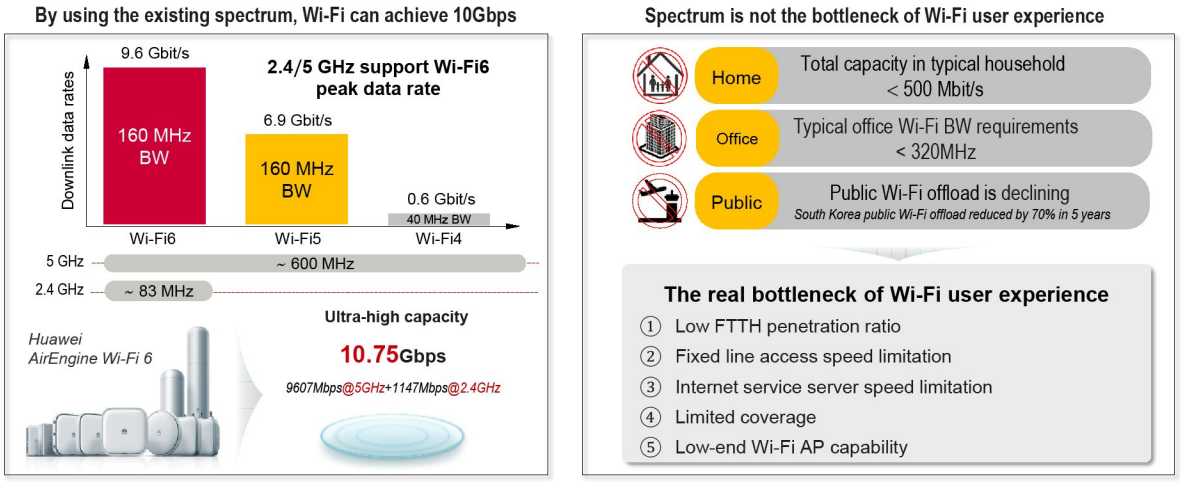

Fig. 4. Spectrum is not the bottleneck for Wi-Fi in three typical scenarios.

The maximum theoretical downlink data rate that can be delivered by Wi-Fi with a 160 MHz wide channel at 5 GHz or lower 6 GHz is about 9.6 Gbit/s. We note that commercially available Wi-Fi access points can already use the combination of a 40 MHz channel in the 2.4 GHz band and a 160 MHz channel in the 5 GHz band to achieve a data rate of 10.75 Gbit/s, see Fig. 4. As such, and in light of FBB speeds expected to be available to households over the next decade, the assignment of additional mid-bands spectrum for use by Wi-Fi does not appear to be necessary.

Simulations [7] of a three-story building with ten apartments per floor, and four rooms per apartment, have shown that, when using a 160 MHz channel in the 5 GHz or lower 6 GHz bands, each Wi-Fi 6/6E access point can deliver a downlink throughput in the order of 500 to 1000 Mbit/s depending on the number of available spatial streams and on the number of antennas available at the access points and stations. Wi-Fi performance today is quite limited by legacy capabilities: performance enhancing features provided by Wi-Fi 7 will significantly improve the capability of Wi-Fi within their existing mid-bands spectrum. We expect that more advanced access points will become available in the future supporting throughputs that will be in the order of 2 Gbit/s in a 160 MHz channel in such dense urban environments.

Furthermore, high-bands spectrum is also available (or is being considered) on a licence-exempt basis in many countries, particularly within the 60 GHz band (57-71 GHz). A combination of the existing spectrum for license-exempt use in mid-bands as well as high bands, will relief the pressure to access additional mid-bands frequencies by Wi-Fi as they are more optimal for high-capacity wider-area mobile communications. Based on market demand, the possibility to allocate additional high bands spectrum (e.g. in the 7 to 24 GHz range) for WAS/RLAN should be considered carefully. Mobile operators are already deploying at high-bands today (e.g. 26/28 GHz) to address very high capacity needs in dense areas. These deployments allow capacity demand to be “offloaded” from mid-bands.

5G NR offers excellent managed quality of service for industrial and enterprise use cases which have more challenging latency and reliability requirements, while Wi-Fi can play a complementary role in addressing

use cases with less stringent requirements on a best effort basis. Simulations [8] of a factory environment have shown that 5G NR can deliver three times greater spectral efficiency than Wi-Fi 6 in meeting the more challenging latency requirements of industrial applications, even when assuming an optimised Wi-Fi6 scheduler, all in a controlled environment and without external sources of interference. Importantly, the deployment of wireless networks in mission-critical industrial and enterprise applications – for example, to control production processes – requires substantial investments, and such investments can be more readily justified where there is certainty of access to the spectrum resource. This can only be guaranteed in wireless networks which operate in licensed spectrum.

7. Evolution of fixed links (radiolines)

With reference to [10]

References:

[1] “The Socio-Economic Benefits of Mid-Band 5G Services” (Feb. 2022), GSMA Report

[2] “Minimum requirements related to technical performance for IMT-2020 radio interface(s)” (Nov. 2017), ITU-R M.2410 Report

[3] “Vision 2030 - Insights for Mid-band Spectrum Needs” (Jul. 2021), GSMA Report

[4] “Estimating the mid-band spectrum needs in the 2025-2030 time frame; Global Outlook; A report by Coleago Consulting Ltd” (Jul.2021), GSMA Report

[5] “Revised WID: Introduction of 6 GHz NR licensed bands” (Mar. 2022), 3GPP Work Item

[6] “The socioeconomic benefits of the 6 GHz band; Considering licensed and unlicensed options” (Jan. 2022), GSMA Intelligence Report

[7] “A quantification of unlicensed spectrum needs” (2016), Qualcomm

[8] “5G and Wi-Fi6 radio: options for operational technology - White paper” (2021), Nokia

[9] “Vision 2030: mmWave Spectrum Needs. Estimating High-Band Spectrum Needs in the 2025-2030 Time Frame” (Jun. 2022), GSMA Intelligence Report

[10] “Multi-company CEPT Bried on WRC-23 Agenda Item 1.2” (ECC PT1(21)227r1)