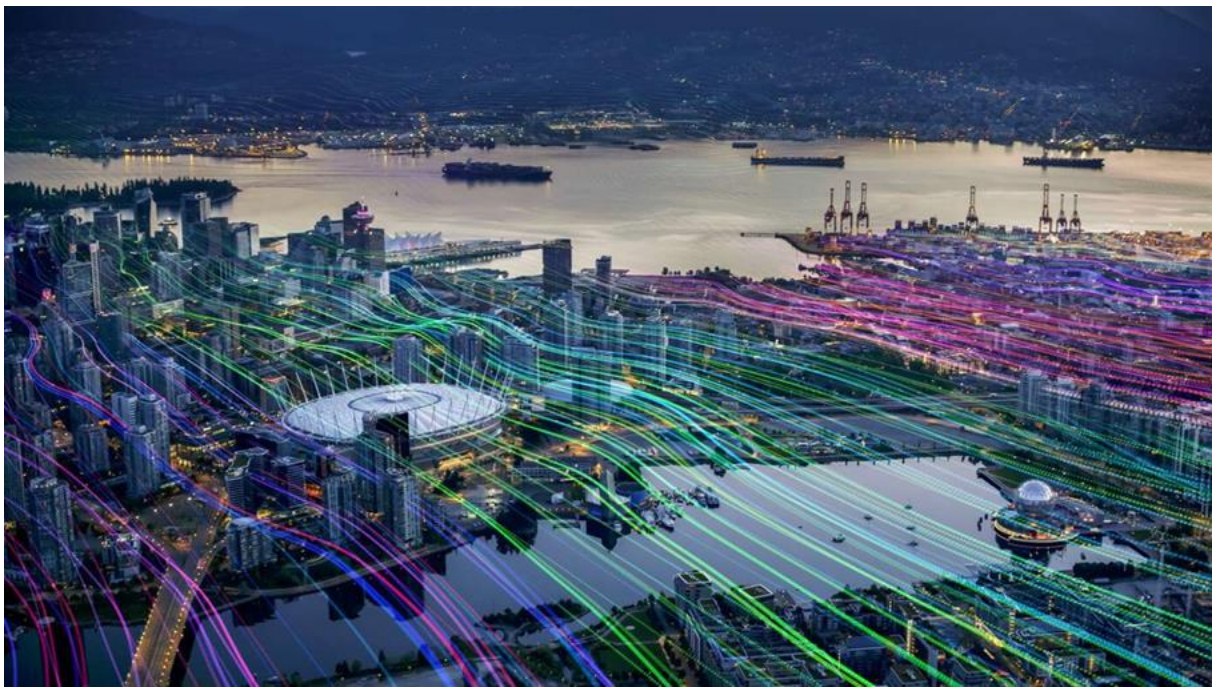
Ofcom Consultation – 6 GHz hybrid sharing licensed mobile and Wi-Fi



About Ericsson.
Ericsson is one of the leading providers of Information and Communication Technology (ICT) to service providers. We enable the full value of connectivity by creating game-changing technology and services that are easy to use, adopt, and scale, making our customers successful in a fully connected world. Our comprehensive portfolio ranges across Networks, Digital Services, Managed Services and Emerging Business; powered by 5G and IoT platforms.

Ericsson welcomes the opportunity to respond to Ofcom's consultation on Hybrid sharing: enabling both licensed mobile and Wi-Fi users to access the upper 6 GHz band. Response is due on 15 September 2023.

Summary

Digital societies and industries need future-proof communications infrastructure. 5G is a key pillar for digital transformation, providing reliable, secure, high capacity, low latency, and wide-area connectivity to consumers and industries.
Midband frequencies are essential in the rollout of 5G with the 3.5 GHz band being deployed as the launchpad for 5G networks worldwide. Midbands are tailor made for 5G with high capacity and desirable propagation characteristics providing cost effective network coverage both indoor and outdoor.
Traffic growth trends indicate that additional midband spectrum will be required beyond 2025. This will address increased urban connectivity demand as well as FWA deployments in urban and rural locations. GSMA estimates that an average of 2 GHz of spectrum is needed in the 2025-2030 timeframe[1].
By the end of 2028, Ericsson forecast 4.6 billion 5G subscriptions globally, making it the dominant mobile access technology, accounting for more than 50% of all mobile subscriptions. The most recent Ericsson mobility report[2] showed that in Q2 2023, 5G subscriptions grew by 175 million, lifting the total to close to 1.3 billion. Mobile network data traffic grew 33% between Q2 2022 and Q2 2023, reaching 134 EB per month.
The upper 6 GHz band is a crucial capacity resource for the future development of mobile networks reaching similar performance to 3.5 GHz spectrum.

Summary of points for consideration: -

- The upper 6 GHz band is the only opportunity in the midband range in which 5G mobile networks can continue to grow.

- Licence-exempt (e.g., Wi-Fi, NR-U) and licensed mobile services are different, for instance Wi-Fi networks are often closed and access needs to be granted. It cannot be assumed that "non-licensed" upper 6 GHz deployments will be made available to offload congested licensed mobile networks or supplement indoor locations where there is limited coverage.

- An outdoor Macro site with midband spectrum will serve both outdoor and indoor users due to the radio propagation properties and the implementation of MIMO technologies. Additionally, small cells can be added indoors. It is thus expected that the upper 6 GHz, if licensed, will serve outdoor and indoor users in an integrated fashion, as opposed to relying on a patchwork of disaggregated and largely unrelated solutions.

- There is a high potential for interference from unlicensed indoor signals overwhelming licensed mobile outdoors signals as well as in the reverse situation. Interference will remain even with proposed solutions while significantly reducing the performance of both licence-exempt (e.g., Wi-Fi, NR-U) and licensed mobile. (see ECC PT1 (23)216)[3].

- The proposal to implement a hybrid shared model will impact the commercial deployment of midband for licensed mobile deployments, it removes a large complement of the addressable market for Mobile Network Operators (MNOs), i.e., indoor users.

- Licensed Spectrum for Mobile networks is fundamental to build a robust foundation for industry and consumers, examples include smart cities, industry 4.0, and connected transport. Midband 5G NR is a fundamental pillar for the digitalisation of a wide range of verticals across the UK. Licence-exempt deployments can address indoor use cases that are based on best efforts connectivity.

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[1] GSMA The Importance of 6 GHz for 5G's Future – Jan 2023

[2] Ericsson mobility report Q2 2023

[3] ECC PT1 (23) 216 – Vodafone Ericsson 6 GHz spectrum sharing

- Studies carried out by CEPT conclude that sharing with both FS and FSS UL is possible which is contrary to information shared in the Ofcom consultation.

- The implementation of sensing capabilities for hybrid sharing between Wi-Fi and licensed mobile will add cost to the network deployments, are likely to be unreliable and will require modification to standards.

- One of Ofcom's proposals is the "international harmonization of hybrid sharing" with the interest of creating an ecosystem both for RLAN and licensed mobile (IMT). Ericsson believe that a more aligned Ofcom position to this principle would be to support licensed mobile allocation to ensure the IMT ecosystem in time. Allocation of the spectrum to licensed mobile identification would help the ecosystem growth during which time Ofcom can still decide to use the band for licensed mobile, hybrid sharing or licence-exempt in the future. Without a licensed mobile identification, there is a risk that the development of the ecosystem will take longer time.

- A more tenable hybrid sharing approach would be for licensed mobile allocations in the upper 6 GHz band to deploy licensed-assisted operation in indoor environments by deploying 5G NR with LBT in the lower-6 GHz band. The proximity of the two bands offers the commercial industry a tremendous opportunity to innovate in indoor environments.

- MNOs are expected to deploy more intensively mmWave in the upcoming years, however, this will not address wide-area capacity needs for 5G growth in the UK.

- The range 7-24 GHz is expected to be explored for 6G to increase capacity of mobile networks. To achieve coverage, as wide as possible, spectrum must be considered in the closest proximity to mid-bands, the 7–15 GHz centimetric range. There are propagation differences within this range, the closer to the midband (below 7 GHz), the larger the reuse of the existing grid and thus reduction of the number of new sites, costs, and power consumption. Whereas spectrum above 15 GHz, if made available cannot replace the crucial spectrum below 15 GHz, it may complement the capacity needs for 6G geographical areas (e.g.,, where user density is high) [4]. No spectrum is being considered within CEPT at this point below 10 GHz.

Consultation Questions

Question 1:
Hybrid sharing could mean that the upper 6 GHz band will be used for mobile outdoors, and Wi-Fi indoors. What are your views on the priorities for each of these two services, assuming that suitable coexistence mechanisms will be developed?

The proposed hybrid sharing does not fit the business purpose for MNOs as a large complement of indoor users could be significantly reduced. This could impact the commercial deployment of 5G midband for MNOs, as it removes a large complement of the addressable market (i.e., small cells indoors either for consumers, industries, and enterprises).
Wi-Fi networks are often closed, and access needs to be granted. It cannot be assumed that "non-licensed" upper 6 GHz will be made available to offload congested licensed mobile networks at indoor locations where there is limited coverage and/or network congestion.
Connectivity provided by licence-exempt and licensed mobile have differing motivations that lead to the different morphologies that drive deployment. Ofcom provide one example in the statement, "Wi-Fi connections are made by tapping into a network that already has an established connection. This means you need to be located near a router to get an internet connection. Mobile data, on the other hand, is accessed through the nearest licensed mobile site. It will provide access wherever you are." This includes when you are out of range of

[4] 6G spectrum - future mobile life - Ericsson

Wi-Fi. Licensed mobile service covers some significant proportion of the population while Wi-Fi access is restricted both from a reach perspective and access. Unlicensed spectrum use is driven by a grassroots business model involving the exercise of choice by users and private network owners. Licensed spectrum use is driven by the imperative for MNOs to secure a return on capitalisation of spectrum licenses procured by auction. Deployment is motivated by the existence of users and the traffic they generate, albeit with the objective that the MNO manages a minimal number of points of physical presence in the service area to exercise thrift.
There is a high potential for interference from unlicensed indoor signals overwhelming licensed mobile outdoors signals as well as in the reverse situation. Interference will remain even with proposed solutions while significantly reducing the performance of both licence-exempt and licensed mobile (see ECC PT1 (23)216). If hybrid sharing is decided, it should prioritise the use of mobile both indoors and outdoors without the risk of interference, allowing licence-exempt services to use the band if and when mobile is not there.

Question 2:
Hybrid sharing could mean that the upper 6 GHz band will be used for mobile in some locations, and Wi-Fi in others. We would like feedback on the priorities for each of these two services, assuming that suitable coexistence mechanisms will be developed.

a) From the point of view of mobile, is the upper 6 GHz band most useful to provide outdoor coverage, or indoor coverage? Is it most useful in urban areas, or in those base stations that are currently carrying more traffic or some other split?
b) Similarly, what are the priorities from the point of view of Wi-Fi deployments?

5G is a key pillar of the digital transformation providing reliable, secure, high capacity, low latency, and wide-area connectivity to consumers and industries. A hybrid licensed mobile and licence-exempt (e.g., Wi-Fi, NR-U) approach assumes that MNOs will have other midbands to support growth in the network which is not feasible in the UK.
The upper 6 GHz band is a crucial capacity resource for the future development of public mobile networks and allows similar performance to 3.5 GHz spectrum. It will provide cost effective network coverage both indoor and outdoor as a complement to the 3.5 GHz network deployments. It is the only remaining midband spectrum in which mobile can grow and this will be required to avoid network congestion and a limited capacity.
Midband spectrum can serve both indoor and outdoor users from the mobile macro network. Additionally, indoors can also be served by small cells. MNOs require the possibility to deploy indoor and outdoor.
The 6 GHz band is envisioned to be used in the same site grid as 3.5 GHz and thus not only cover outdoors but also indoor locations. This is possible because of the developments in advanced antenna systems that enable MIMO and beamforming solutions to trade off capacity and coverage, while also reducing the interference faced by users.
Licensed mobile deployments in the upper 6 GHz would span many different geographies and MNOs would desire the flexibility to implement functionality in urban and suburban areas for the most part, even extending into busy villages and along major motorways.
While it is indeed true that 3GPP is enabling features like Wi-Fi calling, mixing network access across domains removes certain types of traffic away from the control of the MNO, thereby degrading their ability to offer both a suitable quality of service to their subscribers and potentially resulting in breakout of information services away from transit through their network assets. This could affect a variety of operational and regulatory compliance factors, such as security and provenance of information transfer.
In most situations, it is the user who determines when Wi-Fi should be used for communication, the exception being those rare cases where an MNO may direct the user to a trusted licence-exempt network domain.

Question 3:
What are your views on reusing a modified AFC or SAS-type approach to enable hybrid sharing? What additional work do you think would be required?

It is recognised that the SAS, as used within CBRS, is still considered experimental and has evolved into a scheme that tries to achieve several objectives, some of which are not met. It is also a matter of perspective as to

whether CBRS/SAS can be decreed a resounding success for spectrum utility, both in the manner of carrying traffic in aggregate as well as in the density of deployments on a nationwide basis. A large number of problems identified with CBRS are due to the use of the SAS and the complexities imposed by it on the ecosystem.
The use of the SAS and the subsequent imposition of a small-cell topology in network results in low power limits to deployed nodes. The lower power in CBRS in deference of a small cell topology creates barriers towards the extent to which the band is populated. There are further complications such as the competitive approach to multiple SAS providers and the improbability of significant change to the WinnForum specifications caused by the adherence to a burdensome aggregate interference calculation. The interference calculation impedes spectrum allocation by delaying spectrum grants across a 24-hour period while peer SAS entities reconcile spectrum allocation information.
CBRS operation tries to benefit the SAS operator by way of high transaction volume; that volume is itself rather unfortunate from the perspective of the network provider.[5] The high transaction volume benefits a market-based approach to competing SAS providers. However, the rigidity of inter-SAS communication protocols overly complicates any innovation in the band, making improvements to the SAS very unlikely, if not impossible. If Ofcom were to insist on a hybrid sharing approach, using the SAS would be inadvisable. An attempt to instead improve the SAS would cause fragmentation of an already complicated ecosystem and cause confusion among solution providers.
The AFC offers a better template than the SAS to share spectrum with licensed incumbents but would require RLAN to always see where licensed mobile is deployed (indoor or outdoor). Ericsson has a poor opinion of the value of mixing RLAN technologies (Wi-Fi or any other licence-exempt radio access technology) and mobile systems across indoor and outdoor users in a hybrid approach, respectively. Databases could be utilised to arbitrate between a sparse use of spectrum by incumbents (e.g., fixed services) and RLAN.
Geographical sharing is also mentioned in the consultation. We would like to note that additional capacity for both mobile and RLAN is required where people live and work (e.g., across the city). As example, while additional RLAN spectrum in the lower 6 GHz may help in a very crowded building given that the fixed network is not the bottleneck, this will not add any benefit where people live more scattered. In the case of mobile, the spectrum will add capacity to existing networks across busy areas while the spectrum can still be used in less crowded areas, e.g., for FWA to improve the internet connection to homes and enterprises.

Question 4:
How could existing access protocols and sensing mechanisms be leveraged (i.e., those in Wi-Fi or 5G NR-U) to enable hybrid sharing?

A recent Ericsson/Vodafone study ECC PT1 (23)216 has been carried out on the co-existence between MFCN systems with outdoor base stations and WAS/RLAN systems with access points placed indoors. The results indicate the interference issues that can be expected with such deployments:

- Interference to MFCN downlink both indoors and outdoors
- Interference to WAS/RLAN from both MFCN BS and UE
- Interference to MFCN uplink

Modifications to sensing and channel access: EDT (Energy Detection Threshold) is currently technology neutral in the ETSI standard. The study concluded that even a significant decrease of the EDT, thus improving the detection capability of the WAS/RLAN system, will not prevent interference to the mobile systems while decreasing the RLAN area considerably. In particular, the study outlines a potential reduction of the EDT of the WAS/RLAN AP slightly increases the area where the Mobile service is not interfered. Enlarging the interference-free distance to 100m already requires a threshold of −82 dBm, resulting in a reduction of the potential

[5] On the other hand, TV White Space databases failed partly due to a non-existent transaction volume that had insignificant benefit to the database operator. There are many additional reasons for this including poor commercial interest from device manufacturers and a sub-standard specification that was incapable of moving with the times. The TVWS database offered limited opportunity for a database provider to seek rent for providing the interface. In general, economists do not look kindly on rent-seeking as an economic good.

operational area of WAS/RLAN. However, importantly even this reduction by about 10dB does not solve the significant interference to the mobile signal level at cell edge locations, both for indoor and outdoor locations Tighter power limits on mobile have also been considered in the study. This is not a viable solution for mobile as it significantly reduces the coverage area. Nevertheless, even with this solution, there is still interference to RLAN indoor locations.

Question 5:
What mechanisms could potentially enable device-to-device connections?

This question seems to address an objective that is unrelated to hybrid sharing. 5G supports D2D under certain scenarios such as CV2X and for public safety use.
In general, wide area networks can use device-to-device connections under control of the network, so that interference can still be coordinated within the cell. The purpose of enabling such communication is service-oriented and is determined by the overall advantage to the entire network. In short range networks such as those served in indoor licence-exempt scenarios, device-to-device communications are possible under the same terms as all such devices contending with one another using LBT. Such mechanisms are a market convenience, as opposed to serving much more than an opportunity for communication between individual users. Excessive traffic loading among such devices as a routine mode of operation would result in uncertainty and lower reliability in communications, affecting quality of experience for users.

Question 6:
If hybrid sharing is eventually adopted, and requires mobile to operate at medium power, in what way would mobile networks use the upper 6 GHz band?

Ericsson believes that medium power shared access is not a viable approach to enable licensed mobile wide area coverage and midband capacity offload. The midband spectrum 3.8 – 4.2 GHz is already allocated to shared access. The technical conditions restrict the deployment of active antenna systems (AAS).
High power 6 GHz is necessary to complement 3.5 GHz and add midband capacity, medium power would not achieve this goal.

Question 7:
How would you suggest that the mechanisms presented here can be used, enhanced, or combined to enable hybrid sharing or are there any other mechanisms that would be suitable that we have not addressed?

Hybrid sharing models should ensure the availability of this band for licensed usage both indoors and outdoors, without risk of interference, to be able to deliver licensed mobile quality to end users supporting the MNOs business case to drive 5G investment. Sharing models need to consider the implications on the ability for MNOs to offer a consistent service to consumers and business.

Question 8:
Assuming the future of the band includes indoor use for Wi-Fi and outdoors use for mobile:
a) how could this be achieved without creating or suffering interference?
b) Could there be a combination of technical adjustments such as power limits and other mechanisms (including databases or sensing mechanisms)?

Assuming that this would be the solution implemented by UK, achieving sharing would impose a very large burden on both services. We reiterate that a large number of network users for outdoor networks are located indoors. The decision to deploy infrastructure indoors is directed by coverage and capacity needs. An MNO would seek flexibility and complete freedom in the choice to extend coverage to indoor locations based on the quality of experience of high bandwidth users in that locale. Allowing an unrelated operator to deploy a RLAN in indoor

locations in the midst of outdoor deployments under licence-exempt or licensed-by-rule terms would isolate the licensed mobile network from access to subscribers. Interference from RLAN nodes deployed near outer walls and windows could well pose interference risks to outdoor networks and would lower capacity and disincentivize investment in licenses and infrastructure.
Indoor RLAN deployment that is allowed on a non-interfering basis, with licensed mobile deployed outdoors, can improve exercise of well-defined rights for licensees of licensed mobile spectrum. The basis of sharing spectrum may employ databases with pertinent authorisation of spectrum use. However, such a regime would require complex interference management techniques that would effectively deny RLAN coverage over large urban geographies and impose certification requirements on the RLAN industry that are effectively unenforceable. It will also put Ofcom in the role of creating or adopting an engineering role that will constrain the ecosystem by means of limiting market outcomes and imposing complex certification requirements on RLANs.
Our experience is that MNO networks do not benefit from power limits that are lower than used by the majority of their spectrum assets. Indeed, the flexibility to develop products with medium and low power is one that is exercised in addition to the strong basis provided by high power base stations, and not instead of those. The mobile telecommunications industry is organised around a highly efficient business model that motivates network densification under well-understood circumstances: real-estate costs, rights of access, transport or fronthaul bandwidth, and user loading of infrastructure. Products developed benefit from economies that span the global marketplace and must be deployable across over 200 nations in roughly similar configurations.
Licensed mobile networks are an integral part of the national infrastructure that offer direct benefits in identifying users, offering secure connectivity, and mobility across network domains. Licensed mobile is designed to support emergency services and offers legal intercept of communications for law enforcement, an obligation that is rarely met by RLANs by virtue of purpose. RLANs are a bridge to the Internet that rely on disaggregation of local capacity by parochial interests; there is no implied necessity to offer a resilient network platform that is supportive of universal mobility. Licensed mobile and RLAN each have their place in the ecosystem; we believe that hybrid sharing of spectrum here is not advisable.

Question 9:
We are interested in input about the importance of the upper 6 GHz band for its incumbent users, and on the potential impact of hybrid sharing of the band.

a) What evidence do you have on whether incumbents are likely to coexist with hybrid sharing of the band with mobile and Wi-Fi? Are there unique advantages of the upper 6 GHz band for these uses?
b) What are your views on the initial analysis we have conducted around hybrid sharing and coexistence with incumbents?
c) For any incumbent uses that you view as unlikely to be able to coexist, what alternatives are there? What are the barriers that might prevent those alternatives?

It should be noted that studies carried out within CEPT concluded that co-channel co-existence between licensed mobile (IMT) and FS is possible with site-by-site coordination across borders as well as if IMT and FS are deployed in the same or in adjacent geographical areas within a country. In addition, co-existence with FSS UL is possible and we note inputs ECC CPG on EIRP mask to protect FSS UL, e.g., CPG (23)046 by France and UK and CPG (23)050 from FIN.
Ericsson would like to note the on-going work in ECC CEPT SE45[6] to study possible technical conditions under which Wireless Access Systems including Radio Local Area Networks (WAS/RLAN), could operate and coexist with existing services in the 6425-7125 MHz band. The work includes revising the parameters and methodologies that were adopted during the work on the lower part of the band (i.e., ECC Report 302[7]), mainly

[6] SE 45 - WAS/RLANs in the frequency band 5925 – 7125 MHz

[7] ECC Report 302 - Sharing and compatibility studies related to Wireless Access Systems including Radio Local Area Networks (WAS/RLAN) in the frequency band 5925-6425 MHz

to ensure proper protection of incumbents after concerns raised by some administrations on the protection of FS, and to adapt the RLAN/WAS parameters to the envisioned usage in the upper part of the band 6425-7125 MHz. Thus, we disagree that Wi-Fi imposes less risk of interference to incumbent services than licensed mobile.

Question 10:
Do you have any other thoughts that you would like to share about hybrid sharing in the upper 6 GHz band, or about hybrid sharing more generally and its potential for applications in other bands?

We applaud the thought leadership exhibited by Ofcom in proposing novel solutions to the use of spectrum. This is the same innovation that will be key to identify future spectrum for 6G.
However, spectrum sharing, even if appearing good in principle, must account for a holistic recognition of the respective natures of the industry for licensed mobile and RLAN equipment. The realistic choice for allocating spectrum for mobile must start with policy that allows wide area, full power deployments that can be deployed using existing infrastructure and not as a sparsely deployed underlay within existing networks.
The sum total of spectrum accessible by Wi-Fi by any single network is far greater than accessible by a single outdoor network. At the same time, the level of investment into outdoor networks, including the commitment by MNOs towards investing in spectrum, and subsequently on infrastructure, is a testament to the importance of outdoor public networks as opposed to RLANs and should be a factor when deciding whether a hybrid approach is prudent.
While Ericsson does not support the proposed hybrid sharing between RLAN and IMT, we support and believe that sharing between IMT and incumbents is possible, as concluded by CEPT in preparation towards WRC-23.

Question 11:
Do you have any other comments to make on these proposals or on the future use of the upper 6 GHz band?

To support the growth of today's 5G networks the UK mobile industry will need access to additional mid-band spectrum. As a result, near-term action is needed. Ofcom has an essential role to play in developing a well-defined pipeline that can help ensure industry and government spectrum users can plan equipment development.
Ericsson prefers that the upper 6 GHz band be dedicated to wide area mobile use with adequately high power and be allocated under individual national or regional licenses. It is unclear how the hybrid plan would provide sufficient access for mobile use while sharing with Wi-Fi.
Ericsson would like to clarify that we don't see licensed mobile and Wi-Fi sharing the band due to their fundamental differences and likely interference to each other. We also do not see that a spectrum management database will address the needs of the mobile community and consumers. Where sharing is needed, the governing principle should be simple, predefined sharing that enables commercial operators the greatest potential for wide-area, full-power, wide-channelization operations.
5G is designed to fulfil QoS requirements for a much broader range of use cases than Wi-Fi. 5G supports massive MTC, eMBB, critical IoT, public safety, TSN and public interest statutory requirements.