Public consultation on the forthcoming public tender for the award of 700 MHz, 1500 MHz, 2100 MHz, 2300 MHz, 3600 MHz and 26 GHz bands for the provision of public communications services to end users.

Qualcomm Response

Qualcomm would like to thank the Agency for Communication Networks and Services of the Republic of Slovenia (Agencija za komunikacijska omrežja in storitve Republike Slovenije, AKOS) for the opportunity to provide our comments on the information memorandum setting out the draft terms and conditions of the tender with a public auction for the allocation of 700 MHz, 1500 MHz, 2100 MHz, 2300 MHz, 3600 MHz and 26 GHz bands for the provision of public communications services to end users. Qualcomm believes that making spectrum available by early 2021 in 700 MHz, 3.6 GHz and 26 GHz bands will be key for the deployment of 5G in the Republic of Slovenia.

a) 700 MHz (703 - 733 MHz / 758 - 788 MHz)

Qualcomm encourages the Agency to make available the 700 MHz FDD frequency band as this would lead to substantial benefits. The importance of the 700 MHz band is not only due to its large coverage benefits, but also to the role it is expected to play for 5G in Europe, as highlighted by RSPG that has identified this band as a 5G pioneer band in Europe. Late availability of the 700 MHz may have negative consequences on Republic of Slovenia's ambitions in 5G.

b) L-band

The L-band (1427-1517 MHz) can provide significant societal benefits due to its beneficial propagation characteristics. Qualcomm believes that this band will be an important resource to meet enhanced mobile broadband (eMBB) demand by increasing capacity and enhancing the user experience. The L-band (1427-1517 MHz) is another ideal candidate 5G band and might be extremely attractive for MNOs.

Qualcomm supports AKOS in licensing the whole spectrum in the 1427-1517 MHz band on a national scale.

c) 2.1 GHz (1920 - 1980 MHz/ 2110 - 2170 MHz)

Qualcomm welcomes AKOS's decision on the provision of 2 GHz spectrum allocations before license expiration in order to create planning and investment security for interested parties as well as a stable regulatory framework. The approach would make it possible to provide larger frequency blocks for the effective use of 5G technologies.

d) 2.3 GHz

Qualcomm supports AKOS in licensing the whole spectrum in the 2.3 GHz band.

e) 3.4 - 3.8 GHz

Qualcomm welcomes AKOS' decision to tackle band fragmentation and supports its decision to release 380 MHz of spectrum in the 3420 - 3800 MHz band. It is important to ensure that each operator could have access to wide national contiguous spectrum assignments in the order of at least 80 MHz but ideally 100 MHz to reap the full benefits of this frequency range for 5G. By design, 5G NR will optimally support wideband operation, allowing operators to fully take advantage of larger allocations of contiguous spectrum to increase peak rates and user experience, with manageable terminal complexity and minimal power consumption. The 3.6 GHz frequency range offers an optimal balance between coverage and capacity, which will support a broad range of 5G applications, including: Augmented Reality/Virtual Reality (AR/VR), Ultra High Definition (UHD) video, smart home, smart manufacturing, health care and drones. The 3.6 GHz band will also provide both mobile connectivity and Fixed Wireless Access (FWA) for domestic and business applications. Qualcomm supports AKOS in licensing the spectrum in the 3420 – 3800 MHz band on a national scale.

f) 26 GHz

Qualcomm supports that the 26 GHz band offer a tremendous opportunity for the deployment of 5G services in the Republic of Slovenia and supports its release. Indeed, the availability of new spectrum in both sub-6 GHz spectrum and the 26 GHz band is key to unlocking the full potential associated with 5G.

Qualcomm recommends AKOS to take all the possible actions to make available to the market this band as soon as in 1H 2021. Qualcomm agrees to the AKOS proposal to make available 1 GHz of spectrum for the provision of ultra-high-speed services. This gives room for innovative use of this band, including applications such as Mobile Virtual/Augmented Reality and Ultra High Definition Video, 5G fixed wireless access (FWA) services and smart home, smart manufacturing, autonomous and connected vehicle, health care which will all benefit from 5G deployments.

i) mmWave band availability and market demand

Qualcomm would like to inform the Agency that 5G NR equipment supporting the 26.5 – 29.5 GHz band (3GPP TDD band n257) is already widely available and commercial deployments of 5G end-to-end system at mmWave has already started or is about to start in several countries in the world including the US, Korea, Japan[1], Russia, Italy and many others.

In Europe, as of today three countries have made 26 GHz spectrum available (Italy, UK and Finland) with Germany, Greece and the UK working on making available the band from Q4 2020.

The US, China, the Special Administrative Territory of Hong Kong, Japan, and South Korea have taken the lead in releasing mmWave bands that play an essential role in defining the 5G experience:

- In the U.S., 5G services have been launched in the 600 MHz band (T-Mobile) and in the mmWave holdings of Verizon and AT&T (both hold large amounts of bandwidth in the 39 GHz band, while Verizon also does in the 28 GHz, and AT&T in the 24 GHz band).
- Japan awarded 3.5 GHz and 28 GHz spectrum to four operators in 2019. The three incumbent Japanese operators–NTT DoCoMo, KDDI, and Softbank–launched commercial 5G services almost simultaneously in late March 2020. The new fourth Japanese operator, Rakuten, is expected to launch 5G services later this year
- South Korea auctioned off 3.5 GHz and 28 GHz frequencies in mid-2018. The three Korean operators have been offering 5G services since late 2018.

According to GSA (Global Supplier mobile Association), the 24.25 – 29.5 GHz range covering the overlapping bands n257 (26500–29500 MHz), n258 (24250–27500 MHz) and n261 (27500–28350 MHz) has been the most-used 5G mmWave spectrum range to date above 6 GHz with:

- 381 operators in 123 countries had announced they were investing in 5G by the end of March 2020
- 70 commercial 5G networks have officially been launched worldwide
- 78 vendors had announced 208 5G devices. Almost all devices support 3.5 GHz, one third of them support millimeter-wave (mmWave) bands, and a quarter already include both, at the end of January 2020,

Please see the picture below from taken from GSA spectrum report[2].

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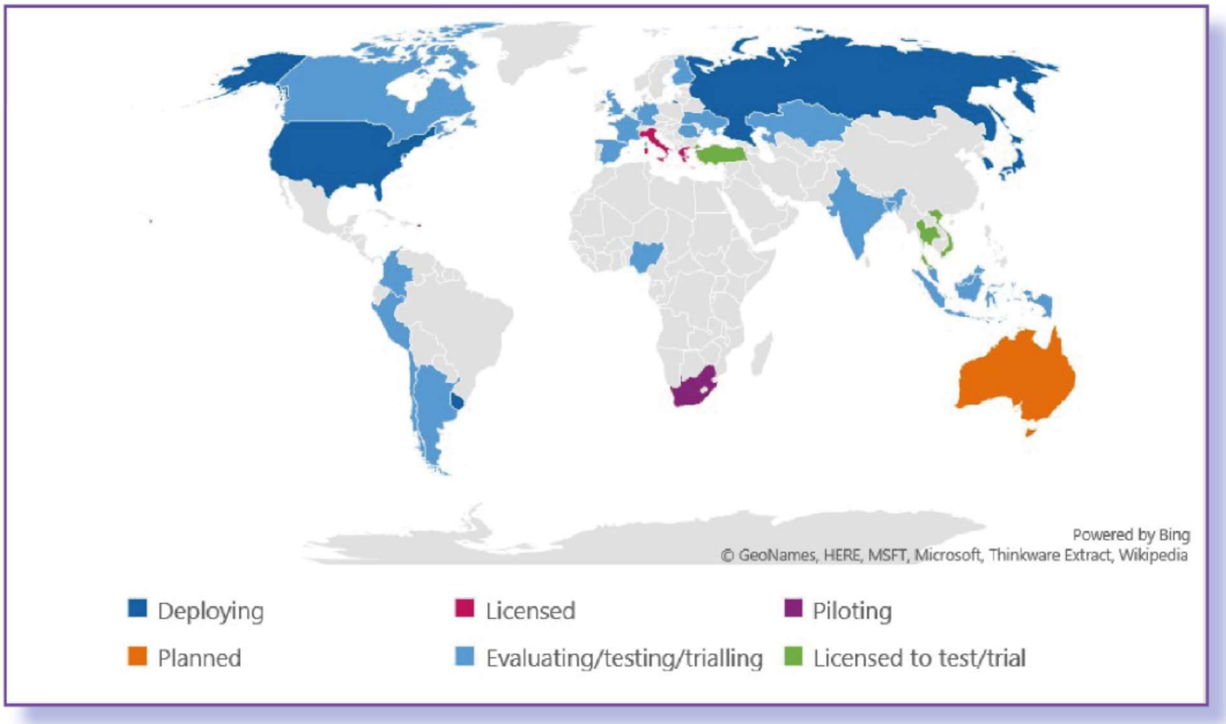
1 https://www.nttdocomo.co.jp/english/corporate/ir/binary/pdf/library/presentation/200318/new_product_presentation_200318_e.pdf

2 Spectrum above 6 GHz:Global Licensing & Usage Overview - A special report based on GSA's continuous LTE and 5G research programme

Figure 1: Use of 5G spectrum between 24.25 GHz and 29.5 GHz, countries plotted by status of most advanced operator activities



When it comes to devices supporting mmWave spectrum, GSA has published the following picture in its February 2020 report about eco-system availability: over 33% of the 5G announced devices support mmWave spectrum.

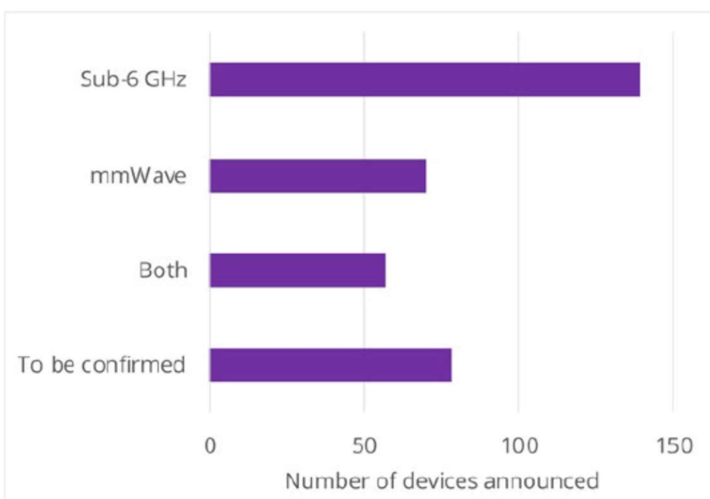


Figure 3: Announced devices with known spectrum support, by broad category (data not available for all devices)

Furthermore, Qualcomm Technologies, Inc. announced in February 2020 the Snapdragon X60 5G Modem-RF System, its third generation 5G modem-to-antenna solution (the Snapdragon X60).

The Snapdragon X60 is the last generation 5G modem-RF system from Qualcomm, succeeding the Snapdragon X55 5G Modem. In 2019, Qualcomm introduced 5G CPE reference design with support for both mmWave and sub-6 GHz spectrum bands and based on the second generation of the Snapdragon X55 5G modem and the Qualcomm RF Front End (RFFE) components and modules, making this a true "modem to antenna" solution. The reference design is built to help manufacturers address multiple operator's needs as they look to improve network performance, increase range, provide an unsurpassed user experience, and expand fixed broadband coverage by taking advantage of 5G infrastructure.

Snapdragon X60 features the world's first 5-nanometer 5G baseband and is the world's first 5G Modem-RF System to support spectrum aggregation across all key 5G bands and combinations, including mmWave and sub-6 using frequency division duplex (FDD) and time division duplex (TDD), providing ultimate operator flexibility to uplift 5G performance utilizing fragmented spectrum assets.

This 5G modem-to-antenna solution is designed to enhance the performance and capacity for operators worldwide while increasing average 5G speeds in mobile devices. The Snapdragon X60 also features the new Qualcomm® QTM535 mmWave antenna module, engineered for superior mmWave performance. QTM535, the company's third generation 5G mmWave module for mobile, features a more compact design than the previous generation which allows for thinner, sleeker smartphones.

Building on the success of the industry-leading Snapdragon X50 and X55 5G Modem-RF Systems, the Snapdragon X60 is the world's first to support mmWave-sub6 aggregation allowing operators to maximize their spectrum resources to combine capacity and coverage. Additionally, the Snapdragon X60 contains the world's first 5G FDD-TDD sub-6 carrier aggregation solution, in addition to supporting 5G FDD-FDD and TDD-TDD carrier aggregation, along with dynamic spectrum sharing (DSS), allowing operators a wide range of deployment options – including the ability to repurpose LTE spectrum for 5G – to effectively deliver higher average network speeds and accelerate 5G expansion. This 5G modem-to-antenna solution can deliver up to 7.5 gigabits per second (Gbps) download speeds and 3 Gbps upload speeds, and the aggregation of sub-6 GHz spectrum in standalone mode allows the doubling of peak data rates in 5G standalone mode compared to solutions with no carrier aggregation support. VoNR support in Snapdragon X60 will be an important step in the global mobile industry's transition from non-standalone to stand-alone mode, as it will allow mobile operators to provide high-quality voice services on 5G NR.

Qualcomm Technologies is scheduled to ship samples of Snapdragon X60 and QTM535 in the first quarter of 2020, with commercial premium smartphones using the new Modem-RF System expected in early 2021. **Qualcomm mmWave antenna modules support 3GPP bands n.260, n261 and n.257 (26.5 – 29.5 GHz) and n.258 (24.25 – 27.5 GHz).**

ii) mmWave band usage scenarios

Qualcomm expects initial use cases to focus on enhanced Mobile BroadBand (eMBB) and Ultra Reliable Low Latency Communications (URLLC) usage scenarios for indoor hotspots in enterprises and factories and outdoor mobile broadband in dense urban and urban areas as well as Fixed wireless access (FWA)[3] in suburban and rural macro scenarios. Applications such as Mobile Virtual/Augmented Reality and Ultra High Definition Video, 5G fixed wireless access services and smart home, smart manufacturing, autonomous vehicle, Health care will all benefit from 5G deployments.

The multi-gigabit data rates possible with mmWave technology and the wide bandwidths available in 26 GHz will likely enable new use cases benefiting from high instantaneous data rates. On one hand, end users, who could be individual consumers and machines), will be able to download large amounts of data very quickly e.g., a movie before boarding a flight, fiber like services on always on laptops, or a high definition map update to a vehicle. On the other hand, the network will be able to serve a lot of more highly demanding end points as the high instantaneous peak rates combined with Massive MIMO (M-MIMO) will dramatically increase network capacity and hence facilitate traffic offload to the existing 4G networks.

Capacity will be an important metric for 5G, as the amount of traffic will be burgeoning in the coming years with the more widespread adoption of competitive data plans comprising unlimited use of popular apps, video streaming or even full unlimited data usage. The capacity increase will focus on specific hotspots (cafes, venues, public squares, city centers, etc.) and aligned with the strategic deployment of high-capacity small cells covering the hotspot area.

mmWave technology brings the benefits of Massive MIMO down to a small-cell scale, hence maximizing small cell capacity and hotspot coverage. Deployments will encompass venues (e.g., stadiums) and locations within city centers. Depending on traffic patterns, it would cover the main public squares and roads within the city center, as those would be the locations where most traffic is consumed.

One area of focus for 5G NR mmWave mobile deployments will be high-traffic urban areas in large global cities. To help assess this deployment challenge for 5G NR mmWave, Qualcomm conducted an extensive set of 5G NR mmWave network coverage simulation studies in numerous global cities. The results of the simulation studies conducted across ten global cities, show that significant outdoor downlink coverage is possible when co-siting 5G NR mmWave with existing 4G LTE macro and small cell sites. The positive results show that mobile deployments in urban-areas based on existing LTE cell cities is feasible, especially when considering the tight-interworking of 5G NR with 4G LTE.

Although mmWave outdoor-to-indoor coverage for mobile is not feasible, the outdoor mmWave coverage will significantly free up resources in the spectrum bands below 6 GHz for outdoor-to-indoor capacity, utilizing either 4G LTE or 5G NR technology. In addition, outdoor mmWave coverage can be complemented with targeted indoor mmWave deployments.

Simulation results for several usage scenarios are presented hereafter.

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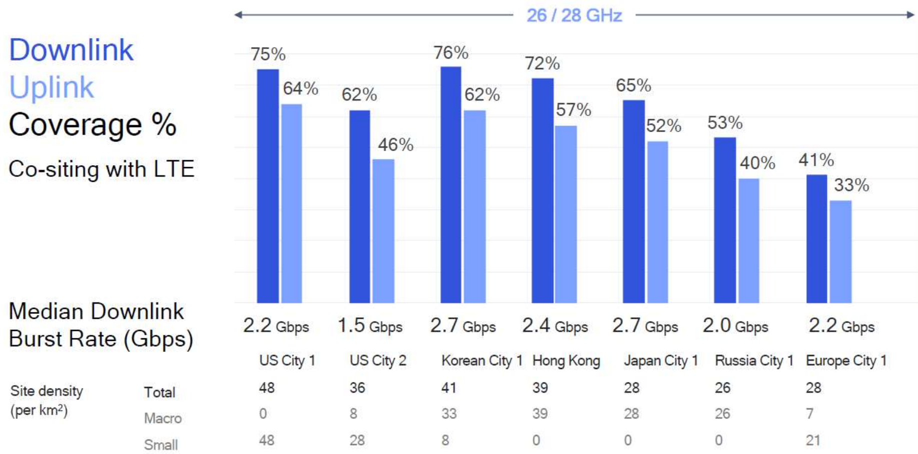
[3] A feasible use case for mmWave that provides expedited and low-cost deployment to replace fiber.

Outdoor Coverage Simulation Study using mmWave Smartphone for Mobility Application

Results of outdoor simulation studies performed at dense urban traffic hotspots across major global cities are reported in the picture below. The studies are based on co-siting mmWave transmission points with current LTE site locations of major tier-1 MNOs, used accurate high-resolution 3D geo-maps, and also factored in additional hand, body and shadowing losses



From the above, it is evident that a significant percentage of outdoor areas could very well be covered by 5G NR mmWave mobility services using smartphone and offer unprecedented experience to the end users.

Following is a more detailed snapshot of a Qualcomm case study performed in 10 sq-km cluster of San Francisco by reusing actual LTE deployment of a major tier-1 service provider. The observations remain the same that just by reusing existing deployment, nearly 70% of the outdoor area could be covered with a user-experience that far-exceeds what existing technologies can offer.

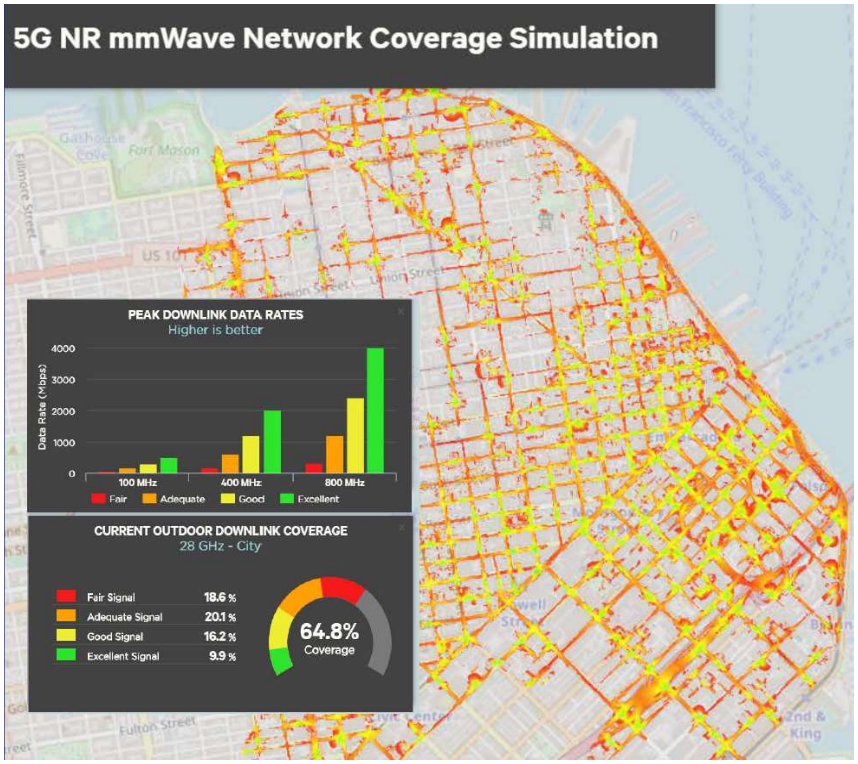
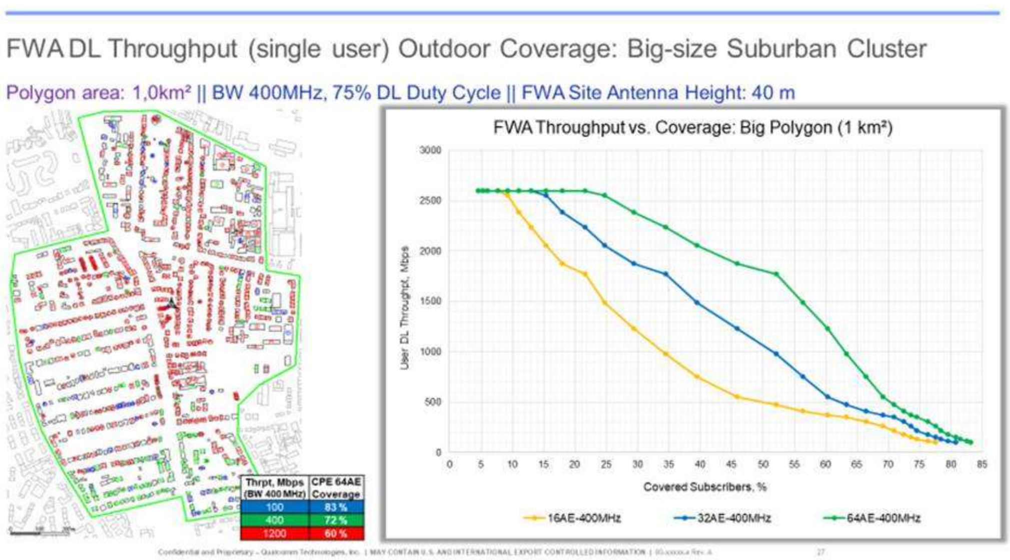


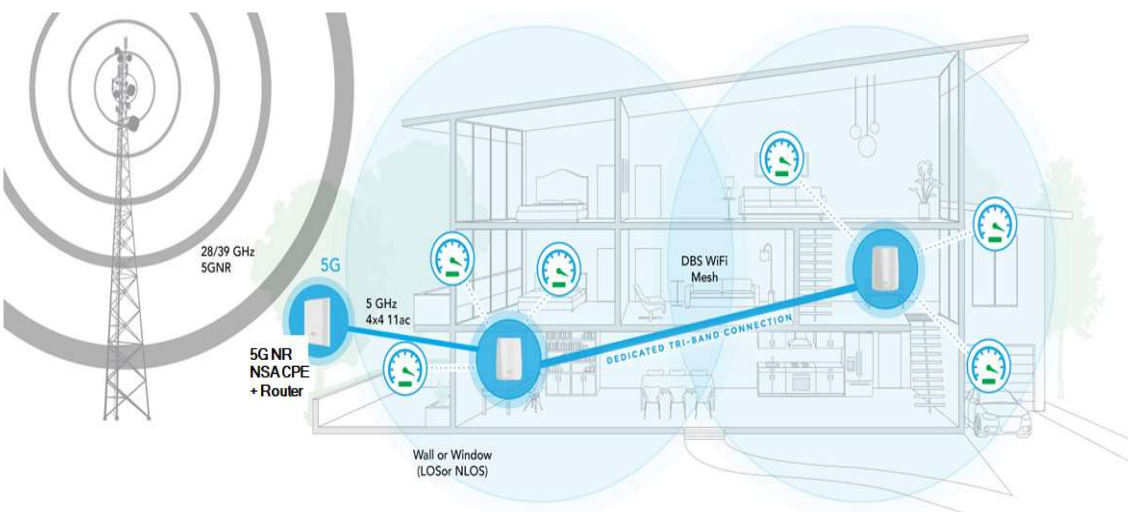
Figure 1: 5G NR mmWave outdoor coverage simulation

Fixed Wireless Access (FWA) Coverage Simulation Study

Qualcomm has carried out several coverage simulations studies of 5G NR mmWave Fixed Wireless Access (FWA) deployments at 26.5 – 27.5 GHz. Cluster location used was Hamburg vicinity area with a size of 12.8 km², mostly suburban environment and a high office building was used as the FWA macro-site. Results show a very good FWA coverage for suburban/rural clusters (DL Cell edge throughput = 120 Mbps for carrier bandwidth 400 MHz) obtained for a macro-cluster with cell radius 800m (2 km² = 16% of the full cluster area) which included 850 houses. In general, coverage depends on morphologies, environment type and a number of other factors. Possible solutions for further increasing the coverage include using repeaters, mesh network approach, more sites, gNB antenna height. By modelling FWA throughput in a big size suburban cluster (1 km^2 area, 400 MHz Bandwidth, 40 m FWA site antenna height, 64 antenna element CPE), results have been also very good with single user throughput reaching 1.2 Gbps for 60% of the area, 400 Mbps in 72% of the area and 100 Mbps in 83% of the area as depicted in the graph below:



In respect of FWA applications, one question that often comes up is how to transfer traffic from outdoor CPEs to serve broadband applications. To facilitate this, Qualcomm has already come up with innovative solutions that already started hitting the markets as commercial product, some examples of which are captured below.



Taking 5G NR mmWave indoors

With more than 80% of mobile data traffic originating or terminating indoors, one enormous opportunity for mobile operators and service providers is to bring mmWave services to indoor locations. Today, we are already seeing deployments of 5G mmWave for fixed wireless access. On this front, we have analyzed potential deployment scenarios in various dense urban cities, and one example is how a dense metropolitan city with an existing outdoor LTE network can re-use sites deploying 5G NR mmWave. By using rooftop CPEs, our simulation showed that co-siting 5G NR mmWave with LTE small cells can deliver service speeds of 1.6 Gbps downlink and 150 Mbps uplink to 80% of the buildings in the city.

The fact that mmWave may not propagate well from the outside to inside is beneficial for deploying mmWave indoors as well, since the same mmWave spectrum can be reused indoors with limited coordination with the outdoor deployment. This benefit opens up new possibilities for mobile operators to offer private indoor mmWave networks, in addition to expanding mmWave indoors as part of their public networks.

Complementing existing indoor Wi-Fi services, 5G NR mmWave can elevate user experiences to new heights by bringing multi-Gigabit speed, ultra-low latency, and virtually unlimited capacity to a wide range of devices such as smartphones, tablets, XR (extended reality) headsets, and always-connected laptops. Qualcomm has been working with indoor venue owners and operators to understand how 5G NR mmWave will perform in a wide range of indoor environments.

Figure 2:Taking 5G NR mmWave to a wide range of indoor locations

For indoor enterprises

One exciting opportunity for 5G NR mmWave is indoor enterprises. Today, most offices have Wi-Fi connectivity for computers and other enterprise devices. With 5G NR mmWave private networks, enterprises can realize the vision of “mobile office of the future”, bringing enhanced performance, convenience, security, and user experiences not possible with today’s connectivity solutions.

Figure 3: Opening doors to new and enhanced enterprise user experiences.

To understand how 5G NR mmWave performs in enterprise settings, we have studied a few different office layouts and performed comprehensive system-level simulations. As an example, we looked at one office floor at our San Diego headquarters and simulated coverage and performance with 5G NR mmWave small cells placed at the same locations as existing Wi-Fi access points. The rationale behind co-siting is that both power supply and wired backhaul connectivity are already available at these locations, and it is the most efficient way to start any 5G NR mmWave deployments. With 1-to-1 co-siting, we were able to achieve ~98% downlink coverage and ~99% uplink coverage. The median throughput achieved with this setup is 5 Gbps. Note that the red outline shown in the figure below are areas not covered by the co-sited mmWave small cells, as they are surrounded by concrete walls (e.g., balcony, stairwell). Such areas could typically be covered with macro sites, or if needed, additional small cells can be deployed to provide a more comprehensive coverage.

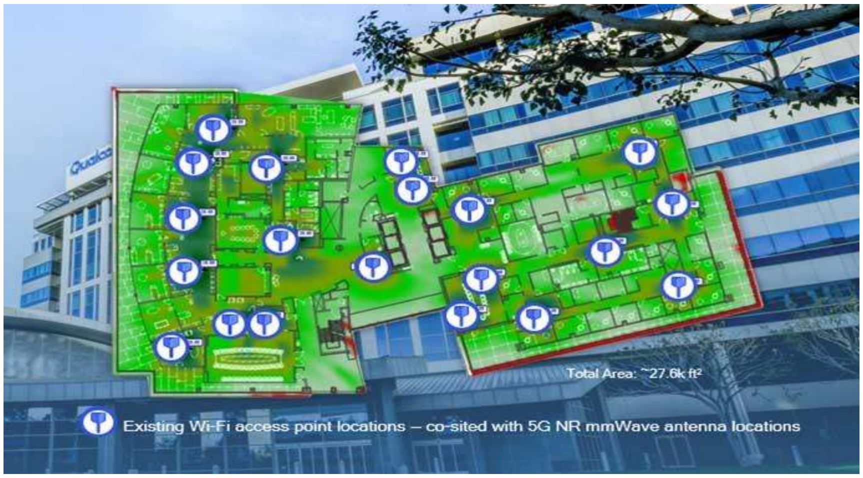


Figure 4:Co-siting 5G NR mmWave for higher-density indoor enterprise.

For dense venues

Large venues, such as convention centers, concert halls, and stadiums, are often plagued with wireless connectivity issues. As the venues are packed with large number of visitors during events, many users will be accessing the wireless network at the same time. The key challenge is for the wireless network to have enough capacity to sustain reasonable performance. While LTE and Wi-Fi network densification helps, they are still limited by the amount of available bandwidth. With 5G NR mmWave, venue networks can now have access to 100's of MHz of mmWave bandwidth that can satisfy the growing data demand.

Figure 5: Bringing enhanced venue experiences with 5G NR mmWave.

We have simulated 5G NR mmWave coverage and performance for a wide range of venues. One such simulation happened at an NFL stadium with 100 000 seats.

The results were very encouraging. We were able to achieve a significant coverage and more uniform user experience. The median downlink throughput achieved is more than 700 Mbps using 400 MHz DL bandwidth and the cell edge throughput achieved is more than 100 Mbps.

Figure 6: Simulating 5G NR mmWave (28 GHz) at NFL stadium.

For transportation hubs

Lastly, we also looked at various transportation hubs, such as airports and train stations. For an airport concourse that is about 160 thousand square feet in size, comprehensive coverage and a median throughput of ~4.2 Gbps could be achieved using just ten co-sited 5G NR mmWave small cells.

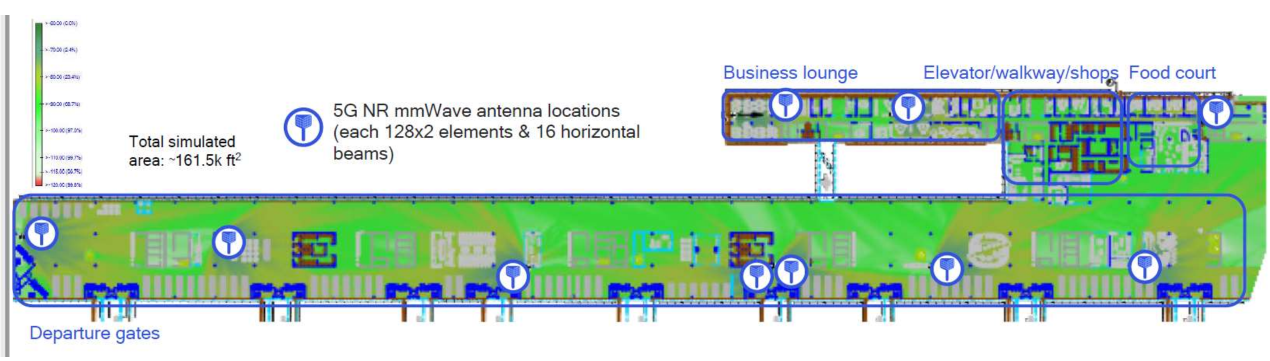


Figure 7: Delivering 100% 5G NR mmWave coverage and multi-Gbps speeds with at an airport concourse.

iii) Bandwidth availability for different use cases

5G is a new technology and a new market which requires global scale to gain market lift off during the launch phase. Mobile operators play a key role in order to help generate a competitive equipment market. Thus, mobile operators' role in the commercial deployments in the mmWave spectrum is critical. When considering vertical industries needs in the mmWave spectrum, it is important to highlight that network virtualization in 5G will provide the opportunity for networks to cater for diverse vertical market needs, with different performance requirements, via network slicing. Hence, different types of deployment can be catered for via the same network, without needing to assign specific spectrum for each different use.

Qualcomm believes that it is important to ensure that each network could use at least 400 MHz but ideally 800 MHz of spectrum with a national footprint in the 26 GHz range.

Flexibility in spectrum use, ability for MNOs to acquire different spectrum amounts, and ability for verticals and/or other sub-national operators to gain access to spectrum (and/or for new business models to emerge) could be aided if 5G licenses allow for spectrum leasing to occur. Thus, in order to help establish the 5G market in the first take off phase it is recommended that operators have access to the 26.5 – 27.5 GHz with a footprint as wide as possible and possibly national. At the same time, it would be important to preserve the ability for verticals and/or other sub-national operators to gain access to spectrum in particular in those areas/those cases where Mobile operators do not plan or are not in a position to roll out services. Local indoor and outdoor licenses could help in such cases.

An interesting authorization model worth investigating further is the one adopted by the Italian regulator AGCOM in its 26.5 – 27.5 GHz auction rules whereby 5 lots of 200 MHz each for the 26.5 – 27.5 GHz with a cap at 400 MHz have been offered. In particular, for the 26 GHz band, the regulator has adopted an innovative sharing model based on club use whereby winners could use up to 1 GHz of spectrum in a dynamic way when the other operators in the club do not use spectrum in any given location.

g) Synchronization

When it comes to most appropriate synchronization framework for 5G mmWave TDD bands, the situation is expected to be different from what adopted in sub 6 GHz frequency range.

It is widely recognized that mmWave propagation is affected by much higher losses compared to sub 6 GHz frequencies. Such high losses represent a challenge in terms of BS and UE design since sophisticated beam forming techniques are required, but at the same time provide an opportunity in terms of new deployment scenarios, allowing higher level of reuse. In fact, beamforming at both the transmitter and receiver side will dramatically limit the amount of interference that a given transmission will cause on nearby users and base stations. Furthermore, mmWave frequencies enjoy a very good indoor/outdoor isolation thanks to the high penetration losses. This implies that outdoor and indoor networks might operate independently.

In general, compared to typical sub 6 GHz deployment in which synchronization or semi-synchronization is preferable across TDD networks, for mmWave frequency ranges asynchronous deployment might be implemented in most scenarios through adequate network planning. In the most challenging scenarios, semi-synchronization might help to mitigate the higher level of cross interference due to the DL/UL misalignment across adjacent networks. As a consequence, in addition to synchronization and semi-synchronization we are supporting of enabling asynchronous deployments for 5G mmWave TDD bands.

Regarding the UL/DL ratio and other parameters related to the synchronization and semi-synchronization framework, they should be defined in concert with the frequencies license-holders in order to meet their specific deployments needs. That said, as we think it will be quite realistic for mmWave networks to operate also in a largely unsynchronized and independent fashion, it should be up to each operator to choose the most suitable configuration. Even within the network of a single operator, we envision different mmWave clusters to use different TDD configurations, and possibly adapt such configuration dynamically, depending on the time-variant DL/UL load ratio. This will be of pivotal importance to exploit the increase in UL capacity and peak. Throughput provided by mmWave, which are particularly relevant in key mmWave use cases like venues (stadiums, concert halls etc.). In those locations in fact, cellular networks are today under heavy stress due to the amount of UL traffic generated by users uploading photos and videos to social networks during key events.

h) Network Sharing

Achieving the European Union’s 2025 Gigabit connectivity objectives with secure very high capacity infrastructures, such as 5G, requires boosting investments into networks capable of offering Gigabit speeds, available to all households, rural or urban, as well as enterprises and the main European transport corridors. In this context, Qualcomm believes that infrastructure sharing, and co-investment are instrumental for the deployment of very high capacity networks.

In the 5G era, Qualcomm see business users having a lot of opportunities to access to the 5G connectivity. As in the case of building owners, the municipalities or the government can become the third-party provider of infrastructure under a public-private partnership. Taking an example of autonomous driving, it would be burdensome for owners of road infrastructure (e.g., lamp posts, traffic lights and lane control) to provide hubs for multiple operators to connect to. Rather, it would be simpler and more cost-effective for operators to share the infrastructure in deployment and operations processes.

Thus, Qualcomm supports the essentiality of network sharing agreements between mobile operators, business users, public sector or neutral hosts as a part of the solution to address the considerable investment challenges.

In addition, as previously pointed out, the next generation of mobile networks will require major capital investment to deliver on multi-gigabit mobile broadband, support for billions of internet of things devices and ultra-reliable low latency communications. Network sharing will intensify in the 5G era, particularly given the level of investment required for network densification.

In rural areas, 5G network deployment is challenging due to higher infrastructure costs and lower population densities. However, 5G offers opportunities for rural areas and could help bridge digital divides. So, network sharing agreements will prevail and will permit the operators to handle traffic by densifying existing networks with macro sites.

The cost and complexity of delivering fixed broadband has continually challenged the roll-out of high-speed data services. Fixed Wireless Access (FWA) enables network operators to deliver ultra-high-speed broadband to suburban and rural areas, supporting home and business applications where fiber is prohibitively expensive to lay and maintain. With the evolution to 5G, here at Qualcomm, we consider that Fixed Wireless Access (FWA) offers a path to deployments on a massive scale and better services for customers.

By contrast, in many highly populated urban areas, operators are confronted with the high cost of network densification relying on small cells and with such a scarcity of available sites, or limited space or other essential inputs such that they cannot separately deploy their parallel networks in order to supply demand. So, Infrastructure sharing is definitely and objectively necessary thus at Qualcomm; we are convinced that Infrastructure sharing will be extended also to urban areas.

To conclude, in the context of 5G, the need for connectivity is global and must be provided in all territories regardless of its density. 5G Deployment will require significant investment from mobile operators and other relevant stakeholders. For this reason, at Qualcomm, we believe that network sharing will prevail, with a strong focus on rural areas, and we believe also that the need to deploy sufficiently dense 5G networks will require sharing in urban areas as well.