Marktconsultatie 26 GHz band met het oog op toekomstige uitgifte voor nieuwe generatie draadloze netwerken

Qualcomm Response

Qualcomm would like to thank the Ministry of Economic Affairs and Climate (*Ministerie van Economische Zaken en Klimaat*) in the Netherlands for the opportunity to provide comments on its enquiries concerning the 26 GHz band (24.25 – 27.5 GHz).

Qualcomm do believe that the 26 GHz band offer a tremendous opportunity for the deployment of 5G services in the Netherlands and support the progressive release of the band starting with the 26.5 – 27.5 GHz range where a global eco-system of equipment, chipsets and devices has already been developed and is widely available. Indeed, Qualcomm believes that availability of new spectrum in both sub-6 GHz spectrum and the upper 1 GHz in the 26 GHz band is key to unlocking the full potential associated with 5G. Qualcomm recommend the Ministry to take all the possible actions to make available to the market at least the 26.5 – 27.5 GHz band in 2020.

Qualcomm appreciates also the challenges of 5G co-existing with existing Point to Point and Point to Multipoint Links in the lower 24.25-26.5 GHz spectrum. Given their significant number in the Netherlands, in this portion of the band this is a challenging issue. Ideally the fixed links should be moved over time while 5G zones could be identified and made available earlier also in this part of the 26 GHz band.

1. Marktvraag en timing uitgifte [Market demand and timing issue]

a. Wat zijn de use cases voor Nederland? [What are the use cases for the Netherlands?]

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) 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.

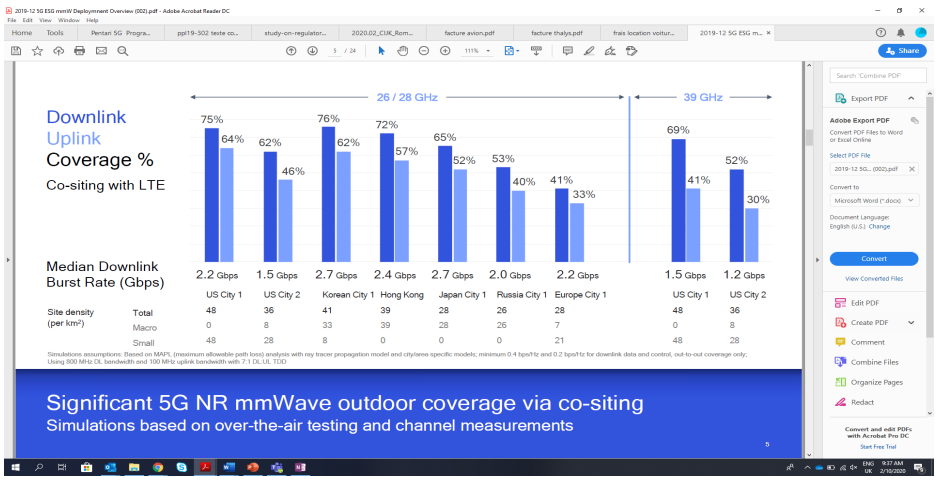
Capacity will be an important metric for 5G, as the amount of traffic will be burgeoning in the coming years with the more widespread adoption of competitive data plans comprising unlimited use of popular apps, video streaming or even full unlimited data usage. The capacity increase will focus on specific 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.

Qualcomm has performed several tests and simulations based on over the air testing and channel measurements on 5G NR mmWave deployments at both in outdoor and at indoor locations. Results reveal a significant 5G NR mmWave outdoor coverage via co-siting.

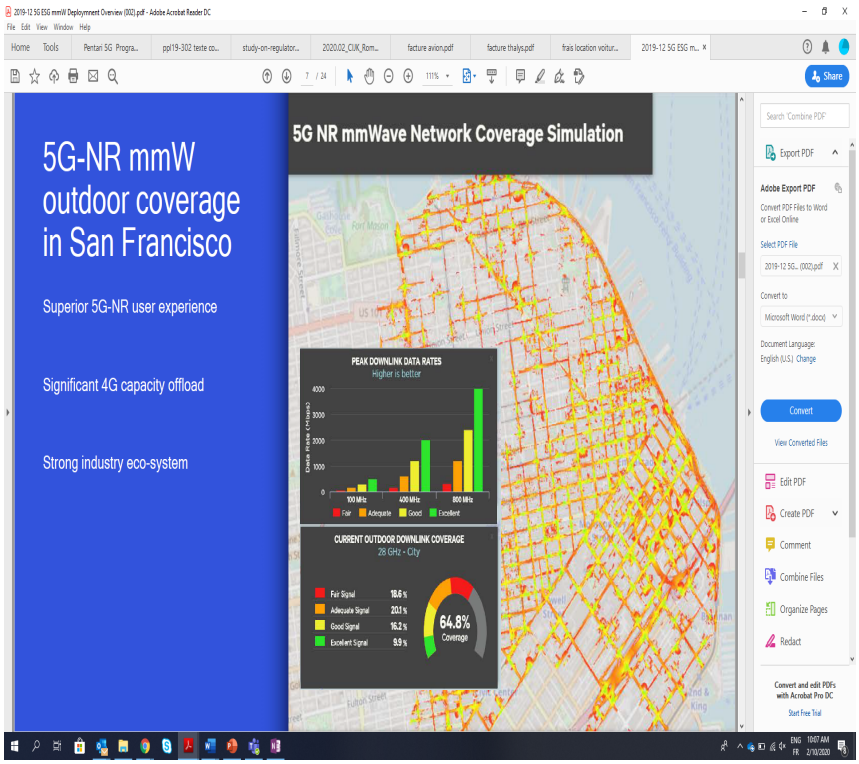
Outdoor Coverage Simulation Study using mmW Smartphone for Mobility Application

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 mmW 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



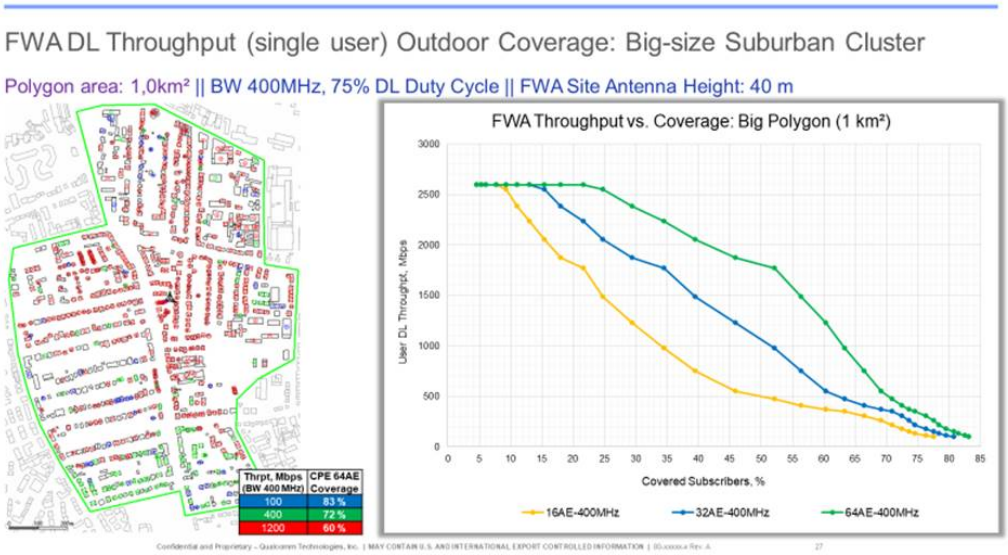
From the above, it is evident that a significant percentage of outdoor areas could very well be covered by 5G NR mmW mobility services using smartphone and offer unprecedented experience to the end users.

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.

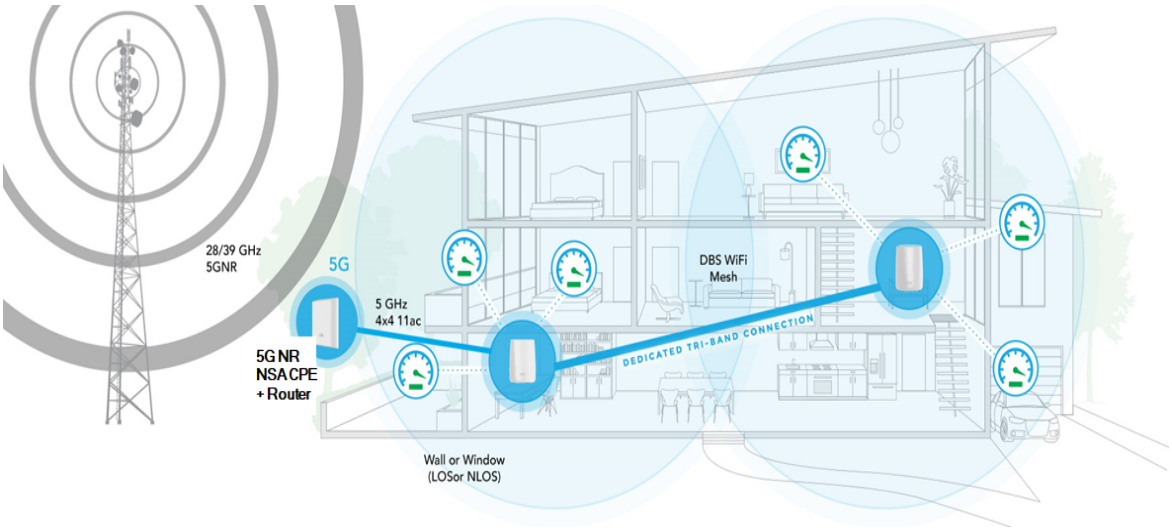


Fixed Wireless Access (FWA) Coverage Simulation Study

Qualcomm has carried out several coverage simulation 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 km2 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.

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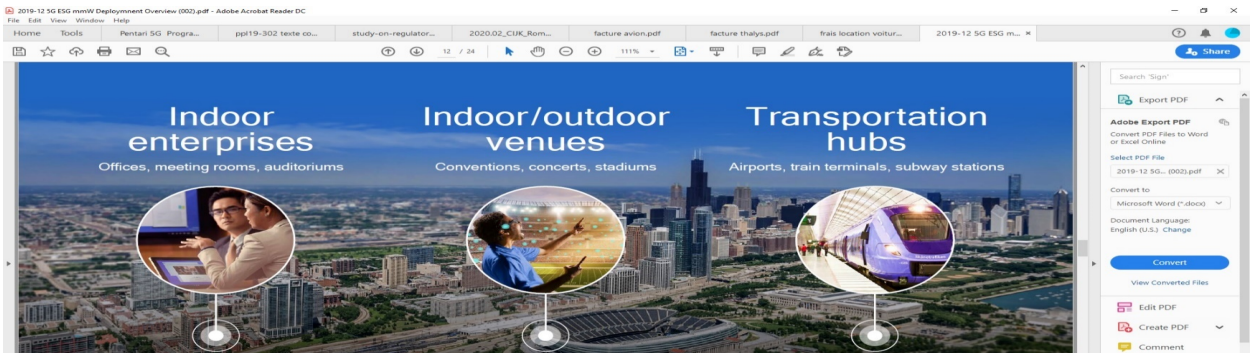
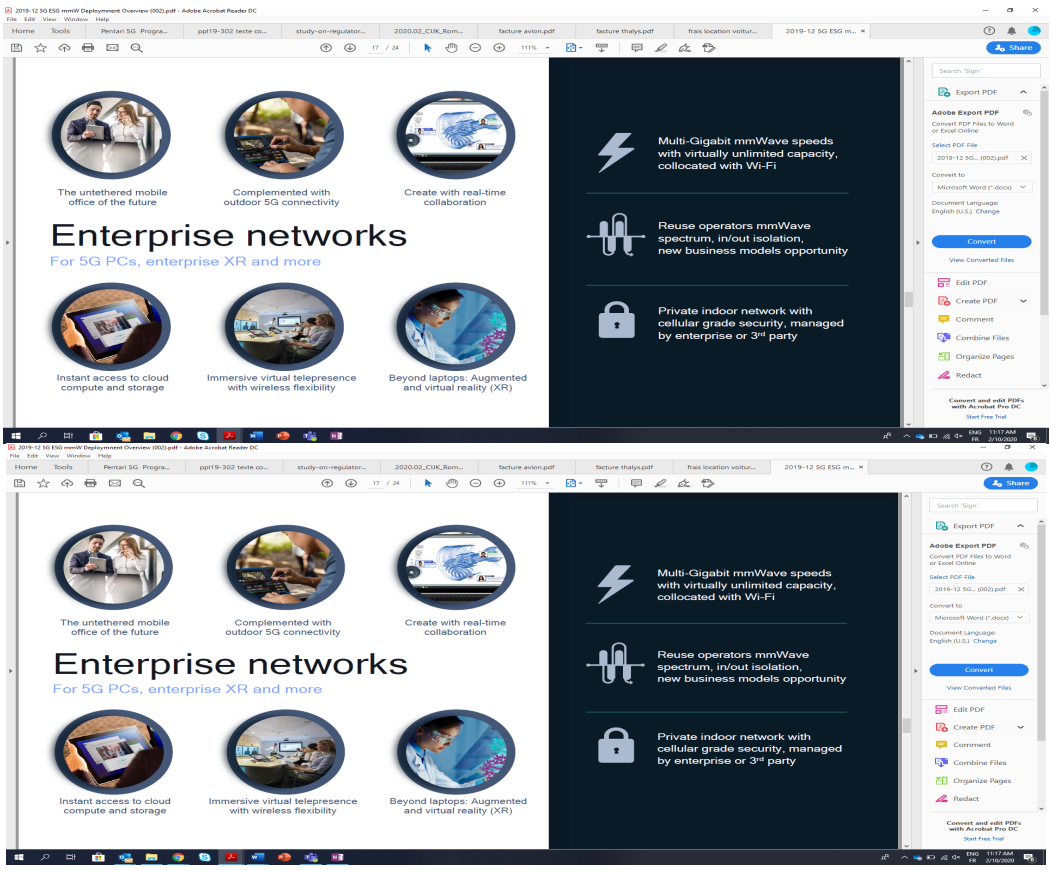


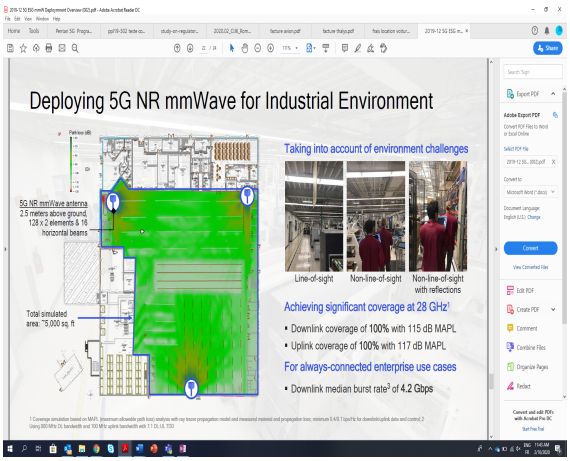
For indoor enterprises

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.



Opening doors to new and enhanced enterprise user experiences.

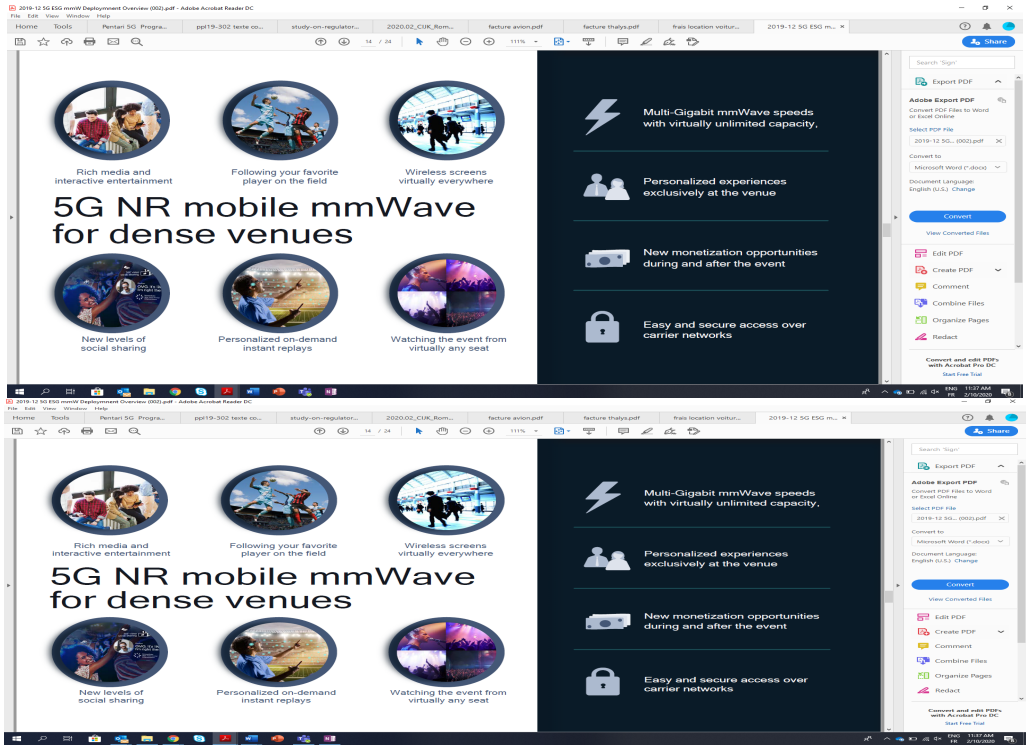
To understand how 5G NR mmWave performs in enterprise settings, we have studied a few different office layouts and performed comprehensive system-level simulations. As an example, we looked at an Industrial environment and simulated coverage and performance with 5G NR mmWave. The rationale behind co-siting 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 ~100% downlink coverage and ~100% uplink coverage. The median throughput achieved with this setup is 4.2 Gbps.



Co-siting 5G NR mmWave (28 GHz) in Industrial Environment for significant coverage and performance.

For dense venues

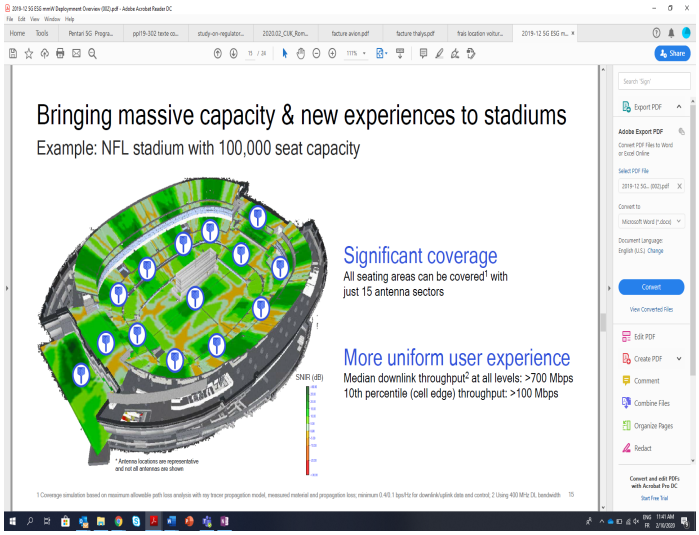
Large venues, such as convention centers, concert halls, and stadiums, are often plagued with wireless connectivity issues. As the venues are packed with large number of visitors during events, many users will be accessing the wireless network at the same time. The key challenge is for the wireless network 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.



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.



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.

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

b. Op welke termijn moet wat u betreft de 26 GHz-band uitgeven worden? Hoeveel frequentieruimte moet er dan beschikbaar worden gemaakt en waarom? Welk deel van de band moet beschikbaar komen en waarom? [In what period should you, as far as you are concerned, see the 26 GHz band? How much frequency space must then be made available and why? Which part of the band should become available and why?]

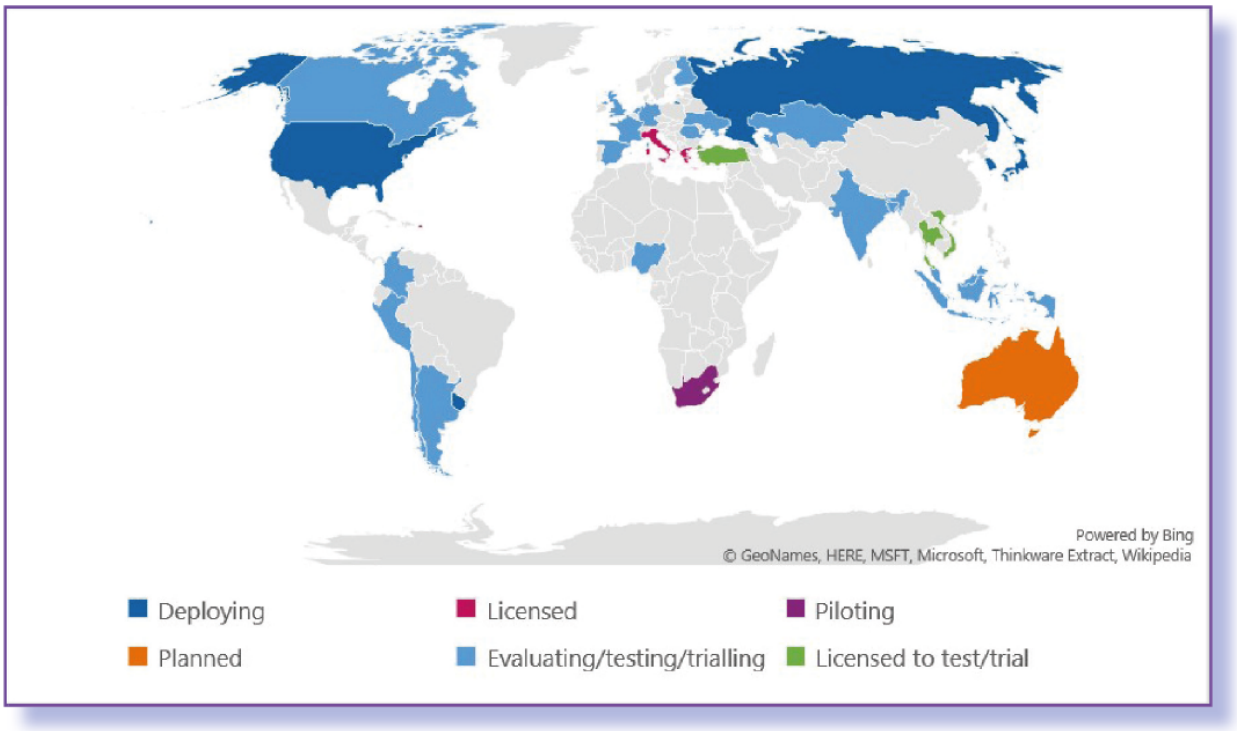
Qualcomm recommend the Ministry to take all the possible actions to make available to the market at least the 26.5 – 27.5 GHz band in 2020. 5G NR equipment supporting the 26.5 – 29.5 GHz band (3GPP TDD band n257) is already widely available and commercial deployments of 5G end-to-end system at mmWave has already started or is about to start in several countries in the world including the US, Korea, Japan, Russia, Italy and many others.

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:

- 113 operators in 39 countries that are investing in 5G (in the form of trials, licences, deployments or operational networks) across this spectrum range
- 66 operators licensed to deploy 5G in this range
- 12 operators understood to be actively deploying 5G networks using this spectrum.

Please see the picture below from taken from GSA spectrum report.

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.

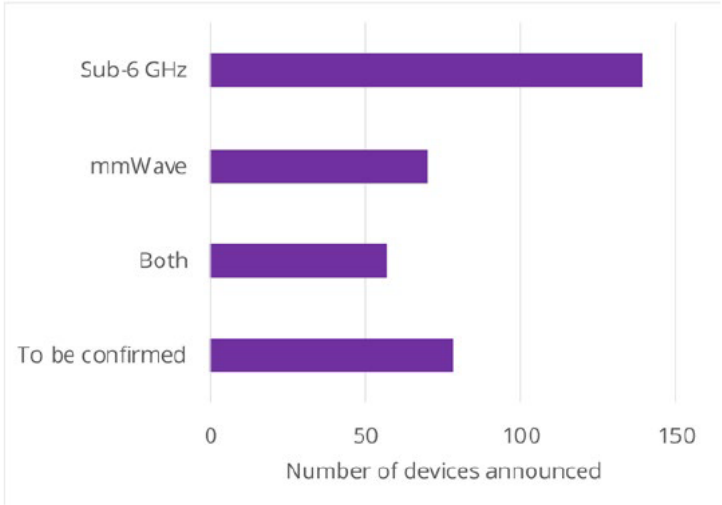


Figure 3: Announced devices with known spectrum support, by broad category (data not available for all devices)

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). 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).

c. Indien u uitgifte nu te vroeg vindt, over hoeveel tijd zou het ministerie van EZK de markt opnieuw hierover moeten consulteren? [If you issue now is too early, how much time would the Ministry of EZK market again to consult about this?]

No Comment

2. Vergunning [Licenses]

a. Should frequency authorizations be regional or national?

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.

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.

More information on the Italian mmWave auction outcome and authorizations is provided below.

The Italian Club Use model

Italy has been the first country to auction 5G mmWave spectrum in 26.5 – 27.5 GHz in September 2018. The auction resulted in five winners, each being assigned 200 MHz worth of spectrum. National individual licenses were issued, and additional provisions were introduced to promote efficient use of spectrum, competition and innovation with a clear focus on light touch regulations with market-driven dynamics. Such innovative regulatory framework has been termed "Club Use". In particular:

- The use of the frequencies in a shared manner is foreseen among licensees (i.e., the members of the "Club"), with priority access for each licensee to its own block.
- Licensees can share spectrum on a geographical basis: a licensee can obtain access to the entire 26.5-27.5 GHz band in locations where the spectrum is not used by other licensees.
- Licensees can stipulate reasonable and non-discriminatory commercial agreements combining spectrum sharing and infrastructure sharing policies. For example, MNO-A can engage with MNO-B

to have access to MNO-B's spectrum at a certain location. If MNO-A and MNO-B agree on fair and reasonable commercial terms, MNO-A can build a network in that location, pooling spectrum from its own assets and MNO-B's assets (e.g. 200 MHz + 200 MHz). Within the commercial agreement, MNO-A can trade the use of MNO-B's spectrum with the allowance for MNO-B to use its infrastructure. MNO-B will not have access to MNO-A spectrum, but it will have priority access to its own spectrum. Also, in this way that location will be served by a single network.

- Licensees could make agreements with a trusted Third Party ("Neutral Host") to manage concurrent installations and delegate to a third party the construction of the physical infrastructures of the radio network (without transferring the right of use of the frequencies). Commercial agreements (in the form of Service Level Agreements – SLAs – between licensees and the Neutral Host) will regulate how licensees share spectrum while operating on the common infrastructure.

Furthermore, AGCOM has put in place additional provisions to define how a licensee can lease spectrum to the so-called "vertical" players (i.e., entities that do not provide public electronic communications services). The Italian Ministry of Economic Development (MiSE), AGCOM and the mmWave spectrum licensees are working on the practical implementation of the regulatory framework based on Club Use.

3. Vergunningsvoorschriften [Licensing arrangements]

a. Verkaveling en fragmentatie [Subdivision and fragmentation]?

Qualcomm recommends Netherlands' Ministry of Economic Affairs and Climate to license the band in a way that could enable the deployment of 5G mmWave networks over large contiguous spectrum of at least 400 MHz.

b. Synchronisatie [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.