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Consultation publique de l'Office fédéral de la communication

concernant

la mise au concours et l'attribution de nouvelles fréquences de téléphonie mobile en Suisse.

Réponse de Qualcomm

Juillet 2017

Qualcomm thanks OFCOM for the opportunity to share its opinion on the award of new spectrum for mobile telephony in Switzerland.

Qualcomm recommends OFCOM to:

- Make the 700, 1400 and 3400-3800 MHz available as soon as possible and no later than Q4 2018,
- Consider making the 26GHz band available during the same procedure,
- Adopt award procedure designed to maximise the investment in networks and respond to the requirements of so called vertical actors,
- Review the exposure limits set by ORNI, considering the work and recommendation of ICNIRP.

Such approach could enable the quick availability of a 5G infrastructure in Switzerland, which would have a significant impact on the competitiveness of the country.

Qualcomm remain available, should OFCOM have any further question on this response.

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Question n° 1. Comment évaluez-vous l'évolution (notamment dans le temps) de la technologie de téléphonie mobile (LTE-Evolution, 5G, etc.)?

The innovation in the mobile ecosystem is maintaining a sustained pace. LTE-Evolution targeting vertical services (NB-IOT and LTE MTC for M2M/IOT, C-V2X for Intelligent Transport Systems) are either available or will be available in the coming month. 5G standardization is expected to complete mid-2018 and first 5G products are also expected in 2018 (see question 19 below). 5G is expected to address a growing number of use scenarios around 2020.

Question 2. Comment évaluez-vous l'impact de cette évolution sur les applications, les services, les terminaux, la convergence entre le réseau fixe et la radiocommunication mobile (FMC), etc.?

Mobile networks are no longer just the infrastructure for personal communication but will become a critical infrastructure for the overall economy, as more and more sectors and activities become connected. The quality of the mobile networks will have a direct impact on the economic activity in a country.

Mobile networks will have huge requirements and backhauling and will naturally lead to convergence between fixed and mobile networks.

Question 4. Comment jugez-vous les répercussions des actuelles valeurs limites de l'ORNI sur l'extension des réseaux de téléphonie mobile et l'utilisation des nouvelles fréquences disponibles?

The emission limits currently defined by the ORNI are set much lower than the recommendation from the ICNIRP. The GSMA published a document highlighting that such limits already led to deployment restrictions on 4G networks. Deployment of additional bands will obviously be even more problematic if such limits are maintained, as current site will not be able to radiate more power. This could put severe restrictions on the deployment of 5G networks.

ICNIRP is also working on the revision of its recommendation.

Qualcomm recommends OFCOM to get involved in the work of ICNIRP and to align and harmonise as much as possible the values set by ORNI with the recommendations from ICNIRP.

Question 5. Quelle devrait être la durée de validité des concessions? (motiver votre réponse s.v.p.)

Spectrum auctions and spectrum licences limited in time invariably lead to cycles where investment is stalled, due to uncertainty in the spectrum ownership situation, as well as extraction of funds from the market, which takes away from investment in the infrastructure.

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Furthermore, spectrum auction favours the player capable of extracting the most value from the market, not necessarily the player capable of growing the market the most, which can potentially lead to adverse effects for the consumers.

Qualcomm recommends OFCOM to review the award procedure thoroughly to favour investment and rapid innovation. Unlimited licences with Administrative Incentive Price related to investment and other goals from the government provide certainty to mobile operators, while also enabling the state and Ofcom to influence the players on a more regular and effective basis (each year).

Question 6. Quelles conditions (par bande de fréquences) devraient figurer dans les concessions (p. ex. conditions de desserte, caméras sans fil, radiodiffusion terrestre)? Ou convient-il de ne prévoir aucune condition?

The 700 and 1400 MHz band can provide significant societal benefits due to their beneficial propagation characteristics. It is therefore appropriate to ensure the award of the band is linked to requirements beneficial to the citizen of Switzerland.

The 3400-3800 MHz band is expected to play a key role in the early availability of 5G. It is therefore crucial to ensure that network in this band are deployed in a timely manner, although with perhaps more restricted coverage ambitions.

More critically, 5G is expected to support the rise of so called vertical market. It is important to ensure that the requirements of sectors such as ITS, Industry 4.0, mobile health, PMSE, PPDR are considered in the award procedure. As such, it is important to consult these vertical sectors about their requirement from networks, to include the appropriate requirements in the spectrum licences.

For example, BNetzA in its recent decision on the award of the 3400-3800 MHz band proposed to include an obligation for the licensees to facilitate business models as varied as possible, and spectrum access as wide as possible, to vertical actors. This is one way to ensure that vertical actors do benefit from deployment in these bands.

Question 7. Des ressources en fréquences devraient-elles être réservées à des réseaux régionaux? Si oui, combien, dans quelle bande de fréquences et pour quel type d'application?

Regional spectrum awards have not been successful across Europe for Electronic Communication Networks.

As mentioned in the previous section, the solution selected by Germany consist on additional requirements put on the spectrum licensee to collaborate with any entity requiring access to the

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spectrum/service. Such arrangement could be described as 'use it or lease it'. Such approach seems more promising than a simple restriction of the award on a national or regional basis, which does not really respond to the level of granularity required by each service. Since every vertical is different, a one size fit all will not respond to all requirements, whereas enhanced flexibility in spectrum access may prove useful.

Question 8. Estimez-vous que la date prévue pour la procédure d'adjudication – en principe fin 2018 – est appropriée?

With standardisation expected to be completed by mid-2018 and first product expected shortly after, the proposed award date, seems to be appropriate. The award should definitely not take place later, in order for Switzerland to have a chance to see commercial scale deployment by 2020. Ideally, the award could be brought forward by a few months to enable Switzerland to join the first wave of 5G deployments.

Question 9. Voyez-vous les fréquences dans les différentes bandes comme des substituts potentiels et/ou des compléments?

The spectrum in the different frequency bands awarded are very complementary for the deployment of 5G. Therefore, Qualcomm considers it critical to award these bands at the same time to enable MNOs to implement overall 5G spectrum strategy covering both low and high bands.

Qualcomm recommends OFCOM to consider making the 26 GHz band available during the same award procedure as the 700, 1400 and 3400-3800 MHz. The 26 GHz band is one of the 5G pioneer bands in Europe and is expected to be highly complementary to the bands proposed for inclusion in the award.

Question 10. Quel type de procédure d'attribution des fréquences faut-il privilégier (adjudication au plus offrant, attribution selon certains critères, attribution directe)? Toutes les bandes de fréquences devraient-elles être attribuées selon la même procédure?

As mentioned in our response to question 5, the most important aspect is to select an award procedure that maximises the expected amount of investment in the band and aligns the licence conditions with the interest of vertical players.

Question 11. La largeur de bande de fréquences maximale à acquérir par participant à l'adjudication devrait-elle être limitée? Si oui, pourquoi et à combien?

Qualcomm considers spectrum caps mostly as a tool to regulate competition in the mobile broadband market. As 5G will be mostly crucial for vertical services, Qualcomm questions the role that spectrum caps would play in the availability of 5G connectivity services for verticals. The vertical requirements

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should drive the design of the award procedure more than the regulation of the mobile broadband market.

700 MHz

Question 12. Comment évaluez-vous l'attractivité de cette bande de fréquences? (motiver votre réponse s.v.p.)

The 700 MHz band is extremely attractive due to its combination of favourable propagation conditions and the large existing mobile ecosystem in this band.

Just like other mobile bands below 1GHz (900 MHz and 800 MHz), the 700 MHz propagation characteristics are extremely favourable both in terms of outdoor propagation and indoor penetration. Furthermore, being very close to the 900 and 800 MHz bands, the same site will most likely be reused by MNOs, further reducing the cost of network deployment. The maximum bandwidth is similar to what is achievable in 800/900 (2x10MHz), but the 800/900 are already used for existing networks and technologies (GSM, UMTS, LTE), whereas the 700 as a new band will enable fast deployment of new technologies.

Furthermore, the 700 MHz band already benefit from a very developed ecosystem, due to the near worldwide harmonization of the band.

The 700 MHz band would typically be extremely attractive to a new entrant, but also in general to any MNO needing a coverage layer supporting high mobility.

The recent French spectrum award in the band has demonstrated the attractiveness of the band.

Question 13. Comment évaluez-vous l'attractivité des blocs SDL dans cette bande de fréquences? Ces blocs devraient-ils aussi être attribués? (motiver votre réponse s.v.p.)

The SDL blocs at 700 MHz may be beneficial for additional DL performance, but would require specific terminals, due to specific filtering requirements. Such ecosystem is not widely developed yet.

On the other hand, the 733-736/788-791 MHz (2x3 MHz) is part of 3GPP Band 28, i.e. benefits from a very large ecosystem. The band would be ideal for the deployment of networks optimized for IOT applications. Other EU countries such as Slovenia are consulting on the allocation of the band for networks targeting M2M applications. Qualcomm recommends OFCOM to award the 2x3 MHz at the same time as the 700 MHz, for MNOs to be in a position to be ambitious in the M2M/IOT area.

Question 14. Quels aspects faut-il prendre en considération lors de l'adjudication de cette bande de fréquences?

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The band is best suited for the deployment of 3 networks of 2x10 MHz each. Narrower channel bandwidth would significantly limit the performance and capacity delivered, while networks with wider bandwidth may restrict the sensitivity of the devices, which is counterproductive in a band which major attraction is its propagation characteristics. Qualcomm recommends OFCOM to select an award procedure enabling as potential outcome the deployment of 3 networks of 2x10 MHz.

Question 15. Comment évaluez-vous votre intérêt à acquérir des fréquences dans cette bande? A votre avis, existe-t-il un besoin minimal au-dessous duquel l'utilisation serait inefficace? Si oui, quel est ce volume de fréquences?

Qualcomm is not interested in acquiring spectrum in the band.

As stated above, the band is best suited for the deployment of 3 networks of 2x10 MHz each.

1400 MHz

Question 16. Comment évaluez-vous l'attractivité de cette bande de fréquences? Ces blocs devraient-ils aussi être attribués? (motiver votre réponse s.v.p.)

The 1427-1517 MHz is extremely attractive for MNOs.

Since carrier aggregation between low bands (700, 800, 900 MHz) is very difficult, the only way to augment the performance of MNOs' coverage layers is to pair one such low bands with bands above 1 GHz. In that context, the 1427-1517 MHz has many advantages as it combines support for large bandwidth (20MHz) with very wide coverage: through SDL, the MNO can raise the radiated power in 1427-1517 to compensate for the difference in propagation with its anchor carrier in bands below 1GHz.

In other words, an MNO can reuse its 800/900 MHz sites and augment them with 1427-1517, to more than triple the DL speeds of its coverage layer. This will be especially critical as 5G will be deployed in 3400-3800 mostly in dense area, to avoid a significant drop of quality when the user moves from the city centre to suburban and rural areas.

Even just 40 MHz of 1452-1492 MHz can have a significant impact for at least 2 MNOs in augmenting the performance of their coverage layer. For example, an MNO may decide to use the L-band to provide 5G service differentiation with LTE (30 MHz DL instead of 10 MHz DL) over the whole network footprint, instead of having the 5G experience limited to pockets of deployment in large cities.

Question 17. Quels aspects faut-il prendre en considération lors de l'adjudication de cette bande de fréquences?

The band 1452-1492 MHz is best suited for the deployment of 2 networks of 20 MHz each. 20 MHz is the optimal channel BW for LTE and enables a cost-effective network upgrade. Narrower channel bandwidth

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would provide less benefits for the same cost, larger channel bandwidth cannot easily be leveraged by the current LTE technology. Qualcomm recommends OFCOM to select an award procedure enabling as potential outcome the deployment of 2 networks of 20 MHz.

Qualcomm recommends OFCOM to award the 1452-1492 MHz at the same time as the 700 MHz band, which would enable MNO to adopt joint strategies for the 2 bands.

Question 18. Comment évaluez-vous votre intérêt à acquérir des fréquences dans cette bande? A votre avis, existe-t-il un besoin minimal au-dessous duquel l'utilisation serait inefficace? Si oui, quel est ce volume de fréquences?

Qualcomm is not interested in acquiring spectrum in the band.

As stated above, the band 1452-1492 is best suited for the deployment of 2 networks of 20 MHz each.

3400-3800 MHz

Question 19. Comment évaluez-vous l'attractivité de cette bande de fréquences? Ces blocs devraient-ils aussi être attribués? (motiver votre réponse s.v.p.)

Availability of spectrum is a key requirement to enable development, testing and early deployment of 5G before 2020 and we do believe that the 3400-3800 MHz will be the primary band in the spectrum between 1 GHz and 6 GHz for the introduction of 5G in Europe before 2020. The proximity of this band to existing bands used for mobile, the potential reuse of existing infrastructure in areas where dense networks are deployed, bandwidths considerably wider (in the order of 100 of MHz) than those of today that can assist to address 5G use cases in the short/medium term providing a combination of capacity and coverage making the 3400 – 3800 MHz range very attractive for 5G.

This band has been identified and recommended by the Radio Spectrum Policy Group and in the EC Action Plan as the primary band for 5G in Europe:

- In its 'Opinion on spectrum related aspects for next-generation wireless systems (5G)', the RSPG "…considers the 3400-3800 MHz band to be the primary band suitable for the introduction of 5G use in Europe even before 2020, noting that this band is already harmonized for mobile networks, and consists of up to 400 MHz of continuous spectrum enabling wide channel bandwidth. This band has the possibility to put Europe at the forefront of the 5G deployment."

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- In its Action Plan, the European Commission states: "….the 3.5 GHz band seems to offer high potential to become a strategic band for 5G launch in Europe."
- RSCOM mandate to CEPT In June 2016 ECC established a new Work Item and invited ECC PT1 to assess the suitability of the harmonized technical conditions of ECC Decision (11)06 to 5G.
- In December 2016, the EC RSCOM (Radio Spectrum Committee) issued a mandate to CEPT to develop harmonized technical conditions for spectrum use in support of the introduction of next-generation (5G) terrestrial wireless systems in the Union and in particular to review by June 2018 the harmonized technical conditions applicable to the 3.4-3.8 GHz ('3.6 GHz') frequency band, as a 5G pioneer band, with view to their suitability for 5G terrestrial wireless systems and amend these, if necessary - ECC CEPT PT1 activities are currently addressing BEM requirements, frequency arrangements and sharing with incumbent services when assessing suitability of ECC DEC (11)06.

In Europe, the UK, Germany, Italy and France have recently signalled in their public consultation their willingness to auction this spectrum for 5G. In Spain, the regulator has provided information on their re-farming activity regarding the 3.6 – 3.8 GHz band (planned completion end of 2017) and their intention to tender it for MFCN according to market and operators' needs for 5G. In Ireland, ComReg has just completed the award of spectrum rights of use for the 3.4 – 3.8 GHz frequency band. Belgium, Austria, Finland have signalled their intention to auction the band for 5G in 2018. In Sweden, the regulator has announced its plans to make available the band for 5G trials as early as in 2017. The C-band (3.3 – 4.2 GHz) is also being considered for early trials and introduction of 5G services in a number of countries/regions in the world including China, Japan and Korea.

3GPP standardization activities and acceleration

At its March plenary meeting, 3GPP agreed to a work plan proposal (RP-170741) for the first 3GPP 5G New Radio (NR) specification that will be part of Release 15 – the global 5G standard. As part of this work plan, Qualcomm and other mobile industry leaders committed to accelerate the 5G NR schedule by introducing an intermediate milestone for an early completion of a variant called Non-Standalone

(NSA) 5G NR. This intermediate milestone will enable 3GPP-based large-scale trials and deployments as early as 2019.

The previous project plan for 5G NR (as part of 3GPP Release 15) was allowing standard-compliant 5G NR deployment around 2020. With the agreed-to proposal, there will be an earlier intermediate milestone to complete technical specifications related to a configuration called Non-Standalone 5G NR in such a way to enable large-scale trials and deployments starting in 2019.

- Non-Standalone (NSA) 5G NR will utilize the existing LTE radio and core network as an anchor for mobility management and coverage while adding a new 5G carrier. This is the configuration that will be the target of early 2019 deployments (in 3GPP terminology, this is NSA 5G NR deployment scenario Option 3).
- Standalone (SA) 5G NR implies full user and control plane capability for 5G NR, utilizing the new 5G core network architecture also being done in 3GPP.

With the recently agreed upon proposal, it is defined a framework to ensure commonality between these two variants, as well as making forward compatibility a key design principle for the standardization of the first release of 5G NR. This will enable in-band introduction of new capabilities and features in subsequent releases of the standard, such as the addition of new signals to support new industries or use cases to achieve the 5G vision to connect everything to everything. An overview of the 3GPP 5G NR Release 15 work plan and schedule can be seen below; the complete details can be found in RP-170741.

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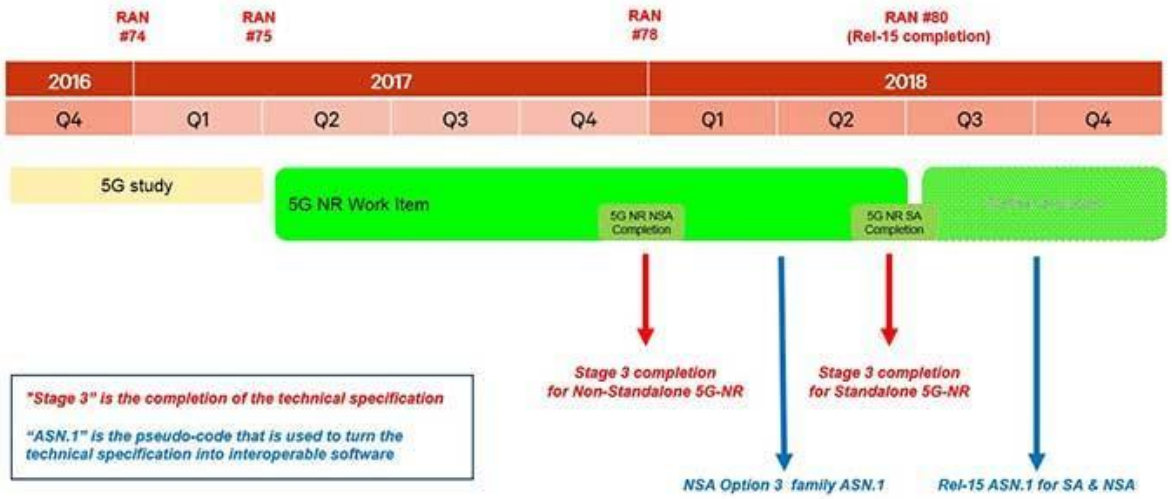

Figure 1: 3GPP work plan for 5G NR Release 15

5G NR deployments in 2019 will require more than just R&D test beds and a 3GPP specification. For example, it will require over-the-air trials and interoperability testing, compliant with the 3GPP 5G NR specification, to test and simulate 5G NR technologies in real-world scenarios across a broad set of use cases and deployment scenarios. In addition, an accelerated timeline for 5G NR deployments would be incomplete without supporting devices. This is why Qualcomm recently announced the expansion of our Qualcomm Snapdragon X50 5G modem family to include new multi-mode 2G/3G/4G/5G modems that will support the global 5G NR standard – both sub-6 GHz and multi-band mmWave – and Gigabit LTE on a single chip.

Work has also started in 3GPP for the specification of the 5G-NR ([1])([2]) bands which will address the larger 3300-4200 MHz range ([3]). The standardization of the new 5G-NR bands is expected to reach

1 RP-170847, 'New WID on New Radio Access Technology', March 2017.
2 TR38.802 V14.0.0, 3GPP 'Technical Report: Study on New Radio Access Technology, Physical Layer Aspects' (Release 14), March 2017.
3 3.3-4.2 GHz, 4.4-4.99 GHz, 24.25-29.5 GHz, 31.8-33.4 GHz, 37-40 GHz, 1.427-1.518 GHz, Band 3, Band 7, Band 8, Band 20, Band 28, Band 41, Band 66, Band 1 (Ref.: 3GPP RP-170855).

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completion by June 2018, within the 3GPP release 15. The following options are being discussed in 3GPP ([4]):

- Specify two different bands with the indication that 'a UE supporting Band X shall also support Band Y and vice versa' (Band X: 3300-3800 MHz; Band Y: 3600-4200 MHz)
- Specify 3300-4200 GHz as a single band
- Specify both of the above options, i.e. definition of 3 new bands

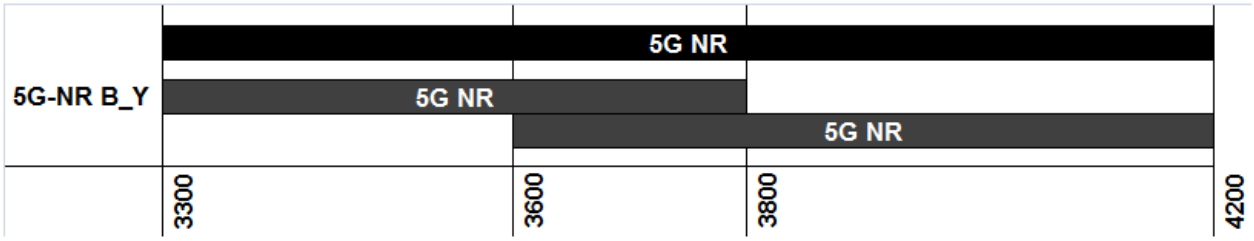

Figure 2: 3GPP channel arrangements for 5G-NR.

In summary, Qualcomm believe that OFCOM should auction the whole 390 MHz in the range 3410 – 3800 MHz as soon as possible and not later than 2019 in conformity with the revised ECC DEC 11(06) as soon as this is made available (target completion date is June 2018).

Such a roadmap with a clear firm timeline is indispensable to give proper guidance to industry, to encourage and attract early deployment of 5G systems in the country and to create a less uncertain environment encouraging national and foreign investments.

20. Dans la bande des 3400-3600 MHz, privilégiez-vous l'utilisation TDD ou FDD?

In the 3400-3600 MHz band in Europe, the CEPT preferred band plan is TDD. There is a larger and growing eco-system around TDD for the 3.5GHz band. TDD use in the context of 5G is certainly interesting for Qualcomm and we would expect that TDD will be mainstream. It is worth highlighting the capability in TDD of supporting UL/DL traffic asymmetry, and the possibility in some cases to provide an

4 R4-1704410

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increased efficiency for massive MIMO technology, due to exploiting channel reciprocity. To fully exploit the advantages from TDD, Qualcomm recommends adopting common synchronization between operators, to avoid inter-operator interference.

21. Quels aspects faut-il prendre en considération lors de l'adjudication de cette bande de fréquences?

Qualcomm would like to highlight the importance to ensure that operator could have access to wide contiguous spectrum assignments in the order of 100MHz per operator to reap the full benefits of this frequency range for 5G.

By design, 5G NR (New Radio) 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. Ongoing standardization for the 5G NR new air interface in 3GPP is considering bandwidth in the order of 100MHz.

5G-NR specification will provide a full set of new features that will allow leveraging large bandwidths in a differentiating way compared to latest releases of LTE Advanced Pro, thus providing better average performances or better capacities at equivalent bandwidth and proportionally amplified by the use of large channel bandwidth.

- Enhanced active multi-element antenna systems leveraging latest High Order MIMO, with beamforming capabilities on both DL and UL will be delivered by design when using mmW frequencies for 5G-NR and will also be available to 3.4-3.8 GHz 5G-NR. These new generation of 2-dimensional antenna arrays allow better control of interference through directional transmissions to users and minimisation of transmitted power and additional capacity enhancements.
- In particular, the 5G NR slot structure is being designed to have a more flexible TDD integrated sub-frame design with the efficient embedding of uplink reference signal transmissions to enable massive multiuser MIMO based on channel reciprocity (i.e. the ability to estimate the channel without

relaying large amounts of channel estimation side information). Compared to LTE MIMO, these 5G NR shorter latency wideband sounding signals enable robustness to channel variability.

- Qualcomm is currently working on new simulations to highlight the benefits of using these new active antennas solutions together with wideband channels and 5G-NR.
- As an example, massive MIMO at 3.6GHz allows re-use of existing macro sites at same transmit power to obtain a significant throughput gain at cell edge. Simulations have been carried out using the following characteristics:

    - macro cell deployment with inter-site distance of 1.7 km,
    - 46dBm transmit power at base stations,
    - 10 users per cell and
    - 24 column antenna array per cell and 4 antennas per UE at 4 GHz using an 80 MHz channel.

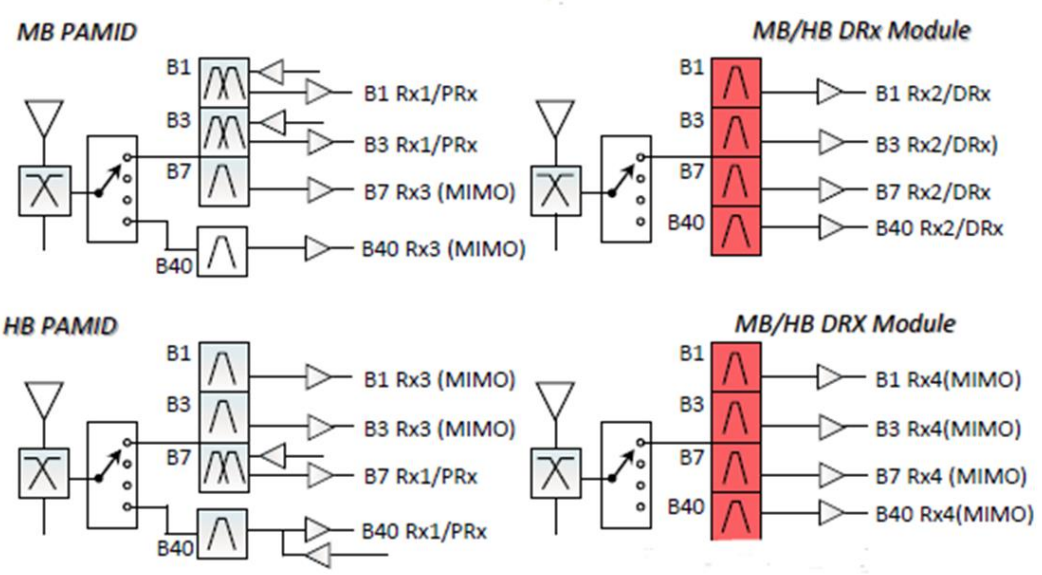
This provides 3.9x to 4.1x gains for cell edge and median users, respectively, compared to 2 x 4 MIMO using the same 80 MHz bandwidth at 4 GHz and delivers an average cell throughput of 808 Mbps.

- The massive MIMO designs enable MU-MIMO (Multi-User MIMO) to be able to simultaneously serve multiple users in the same spectrum and cell at the same time based on the increased level of directional transmission to separate users. Applied to large bandwidths, the absolute gains become significantly attractive to cope with new usages related to eMBB.

- It is therefore important to highlight that key element for successful deployment of massive MIMO and active antennas is the availability of large contiguous bandwidths. Considering channel reciprocity, the highest gains are expected in TDD deployments which allow the 5G NR system to leverage channel information without the need for large amounts of channel state information transfer between terminals and cell sites. The enhanced spatial directivity

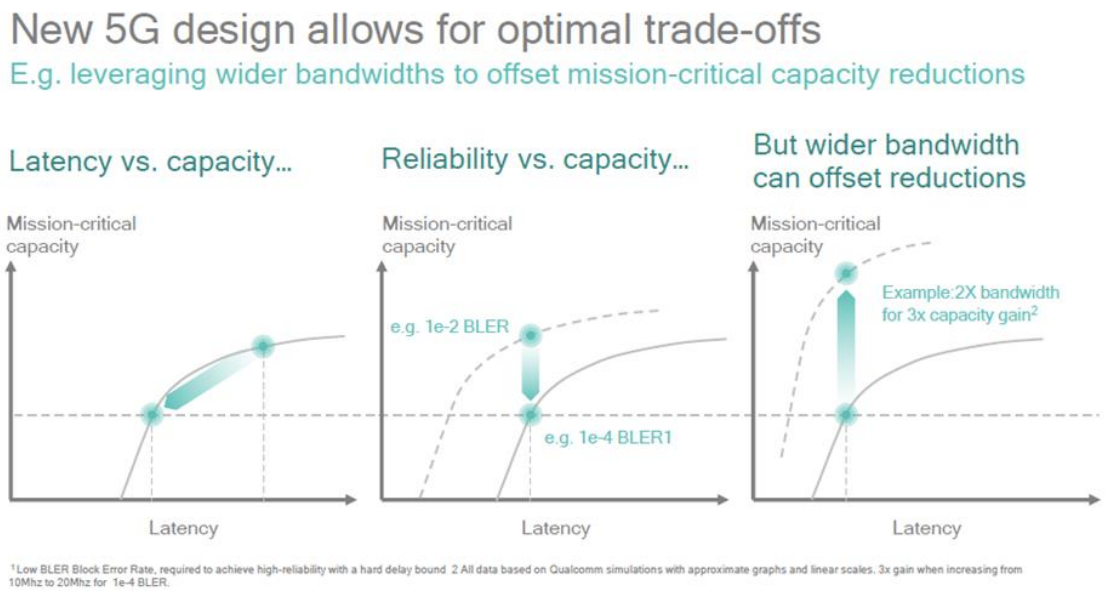
from Massive Multiuser MIMO at the 3.4-3.8 GHz band causes less interference to other users and cells which translates into a capacity gain as well as energy consumption savings on the network side since the signal is effectively steered to each of the desired users vs being transmitted in a broader spatial area.

- 5G-NR on large bandwidths will reduce terminal front end complexity and power consumption compared to LTE using multiple 5 to 20 MHz carrier aggregations to exploit a similar large bandwidth.
    - By being able to work on wideband carriers and by using flexibility in sub-carrier spacing, 5G-NR enables efficient RF front end and baseband processing to have improved power consumption per Mbps and per MHz.



Example : Mid-Band (MB) / High-band (HB) RF front-end with 4x4 MIMO for B1-B3-B7-B40

- 5G-NR on large bandwidths allow to improve access to ultra-reliable services by offsetting mission critical capacity needs and access to new generation of services by bringing native forward compatibility for straight forward launches with limited impact on legacy services.



LTE can use Carrier Aggregation to aggregate multiple 20MHz channels, but as described above, as the number of channels to be aggregated increases, LTE will become less inefficient than an 5G NR system designed to inherently leverage wideband TDD deployments and massive MIMO

By delivering improved link budget, better spectrum efficiency in higher bands such as 3.4-3.8 GHz, 5G-NR will improve peak and average data rates experienced in similar channel bandwidths.

The following table provides theoretical 5G data rate per channel BW.

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RF channel Bandwidth (MHz)	Peak data rates[5]	Average data rates[6]	5th percentile data rates[7]
40	1.2 Gb/s	0.312 Gb/s	9 Mb/s
100	3 Gb/s	0.78 Gb/s	22.5 Mb/s
200	6 Gb/s	1.56 Gb/s	45 Mb/s
400	12 Gb/s	3.12 Gb/s	90 Mb/s

5G-NR will also bring the ability to "multiplex" new forward compatible services with limited impact on eMBB capacity needs and the ability to deliver simultaneous wireless backhauling and fronthauling capabilities to gNBs (5G-NR base station). Wide bandwidths channel will significantly facilitate the use of these capabilities and therefore contribute to the acceleration of new services introduction.

To sum-up, it can be said that 5G NR is being designed to inherently incorporate advanced wireless techniques across a wide range of requirements that take full benefit of wideband channels to deliver improved spectral efficiency, better capacities and user experiences Wide contiguous spectrum assignments to operators in the order of 100 MHz or more will allow operators to reap the full benefits of the 3400-3800 MHz frequency range for 5G.

22. Comment évaluez-vous votre intérêt à acquérir des fréquences dans cette bande? A votre avis, existe-t-il un besoin minimal au-dessous duquel l'utilisation serait inefficace? Si oui, quel est ce volume de fréquences?

As already highlighted in our response to Q.21, Qualcomm would like to highlight the importance to ensure that each operator, willing to deploy 5G in the country, should have access to wide contiguous spectrum assignments in the order of 100MHz per operator to reap the full benefits of this frequency range for 5G.

[5] *Peak spectral efficiency (SE) of NR: 30 bit/s/Hz in DL (from draft New Report IMT-2020.TECH PERF REQ in ITU-R WP 5D). Peak data rate in IMT-2020.TECH PERF REQ is 20 Gbit/s in DL (roughly equivalent to a total of 667 MHz with the considered SE).*
[6] *Average SE of NR: 7.8 bit/s/Hz in DL for Dense Urban scenario (3 x SE of IMT-Advanced, also considered in IMT-2020.TECH PERF REQ)*
[7] *5th percentile SE of NR: 0.225 bit/s/Hz in DL for Dense Urban scenario (3 x SE of IMT-Advanced, also considered in IMT-2020.TECH PERF REQ). User experience data rate in IMT-2020.TECH PERF REQ is 100 Mbit/s in DL (roughly equivalent to a total of 444 MHz with the considered SE). Studies in ITU-R are still ongoing regarding these numbers also in the context of the spectrum needs of IMT-2020 above 24 GHz.*