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Independent Communications Authority of South Africa (ICASA)
via email to: rmakgotlho@icasa.org.za

March 4, 2022

RE: Long-Term Spectrum Outlook for South Africa

Please find herewith attached Qualcomm's comments on the *Long-Term Spectrum Outlook for South Africa*.

Please feel free to contact me should you have any questions.

Kind regards,

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1 Introduction

Qualcomm Inc. (Qualcomm) welcomes the opportunity to provide input to the Independent Communications Authority of South Africa (ICASA) regarding the *Long-Term Spectrum Outlook for South Africa* (the Outlook).

Qualcomm is a world leader in 3G, 4G, 5G, Wi-Fi, and next-generation wireless. For more than 30 years, Qualcomm's ideas and inventions have driven the evolution of digital communications, linking people everywhere more closely to information, entertainment, and each other. Qualcomm Technologies, Inc., a wholly owned subsidiary of Qualcomm Incorporated, is the world's largest fabless semiconductor producer and the largest provider of wireless chipset and software technology, which powers many wireless devices commercially available today. Our technologies are powering the convergence of mobile communications and consumer electronics making wireless devices and services more personal, affordable, and accessible to people everywhere. We are redefining the experience of wireless mobility by applying our unmatched legacy of wireless innovation to enable new generations of increasingly powerful cell phones, smartphones, computers and consumer electronics, and Internet of Things (IoT) devices.

Today, we license nearly our entire patent portfolio to more than 300 manufacturers worldwide – from new market entrants to large multinational companies. Qualcomm's business model has created a pro-competitive, pro-innovation value chain of global scale whose ultimate beneficiaries are consumers.

When considering 5G, Qualcomm urges continued identification of unutilized and underutilized frequencies in low, mid, and high bands in order that spectrum is put to its highest-value use. Qualcomm's vision is for 5G to enable new services and devices, connect new industries, and empower new user experiences. We are developing a unified 5G system addressing both licensed and unlicensed spectrum and frequency bands both below 6 GHz and on higher millimeter wave (mmWave) bands.

5G will be driven by heterogeneous services with vastly different requirements – from very low energy sensors, wearables, and new form factors, to new mission-critical applications with high reliability and low latency (e.g., smart city and critical infrastructure, medical and emergency response, sensing and remote control), to very high data rate backhaul and access transmissions across wide bandwidths for ultra-high capacity broadband. 5G will be a new platform with the scalability and adaptability to cost-efficiently support new wireless applications, services, and deployment models for 2019-2030 and beyond.

The mobile industry continues to prepare for an increase in mobile data traffic growth due to: greater numbers of more capable smartphones; larger file downloads and streaming driven by increasing demand for video content; increasing number of connected devices including those related to the Internet of Things (IoT); and the deployment of 5G networks. While increasing the efficiency of existing assets, employing more resources in the form of small cells and spectrum, and adopting radically different ways of acquiring, deploying, operating, and managing these resources are all important, additional spectrum will continue to be essential to supporting increasing numbers of connected devices, mobile broadband (MBB) growth, and the advent of 5G services.

Qualcomm applauds ICASA's efforts towards the development of a long-term spectrum plan that seeks to ensure efficient spectrum use and to set out a forward-looking plan to enable access to adequate spectrum for the continued development of wireless services over the next 20 years. We believe that involving stakeholders in the considerations for spectrum planning enables ICASA to obtain useful information from spectrum users and other stakeholders. These actions will maximize the overall public benefit derived from a scarce national

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resource such as spectrum, which is crucial to bringing high-quality connectivity and expanded coverage to users nationwide.

2 Responses to consultation questions

1. **Please comment on whether the above captures the relevant regulatory and policy aspects of long term spectrum planning.**

Qualcomm applauds ICASA for considering a range of relevant policy and spectrum guidance to set out the foundation for long-term spectrum planning. Collectively, the provisions of the Electronic Communications Act, the National Development Plan and SIP 15, the South Africa Connect broadband policy, and guidance from the Communications Regulators' Association of South Africa (CRASA) and the African Telecommunications Union (ATU) capture a wide range of relevant aspects of long-term spectrum planning.

2. **Are there services, in addition to broadband, that ought to be considered as important for economic growth? If so, please explain what these services might be and what the trade-offs are between using spectrum for broadband and alternative services. Please provide any evidence from other countries that may be relevant.**

No comment.

3. **Please comment on the above assessment of the status quo on broadband penetration in South Africa, and what role spectrum may play in addressing the gaps identified.**

No comment.

4. **What future changes, if any, should ICASA examine with regard to the existing licensing regime to better plan for innovative new technologies and applications and allow for benefits that new technology can offer, such as improved spectrum efficiency?**

Implementation of approaches including private networks, spectrum sharing, and spectrum trading would enable greater flexibility in South Africa's spectrum licensing regime and, consequently, the ability of spectrum users to innovate in their service offerings. Flexibility in spectrum use, the ability for MNOs to acquire different spectrum amounts, and the ability for verticals and/or other sub-national operators to gain access to spectrum (and/or for new business models to emerge) are key elements that regulators around the world are considering when awarding spectrum for 5G.

<u>Private networks</u>

Some regulators have issued shared licenses to support local/private 5G networks, managing interference through geographic separation or other mitigation techniques. The limited coverage needed for private networks makes it well-suited for a shared-use format in mmWave bands, for instance, where interference can largely be managed through geographic separation.

The deployment of private mobile networks for verticals has emerged as an important market. The demand for private LTE, and increasingly 5G, networks has been driven by the spiraling data requirements of modern business and government entities. Organizations of all types are combining connected systems with big data

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and analytics to transform operations, increase automation and efficiency, and deliver new services to their users.

Numerous countries are implementing or considering licensing regimes that allow for local or private wireless networks. These include:

Australia: Area-wide apparatus licenses (AWLs) are aggregable licenses permitting technology-neutral use of spectrum, initially in the 26 GHz and 28 GHz bands, over by a large number of devices in a small geographic area and defined spectrum range provided such use is in line with applicable technical parameters.[1] In March 2022, Australia opened a consultation on the use of the AWL model in the C band.[2]

Belgium: The regulator issued a consultation proposing to allow the use of spectrum in the 3800-4200 MHz range by private local networks within specific technical parameters. The proposal also suggested the creation of dedicated numbering ranges for such private networks.[3]

Chile: The Telecommunications Undersecretary consulted on a proposed award of spectrum, including the 26 GHz band, to be used for industrial 5G applications, such as mining, fishing, agriculture, and transport. The 10-year authorizations would not permit interconnection with public telecommunications networks.[4] The auction process was held in 2021, although the 26 GHz assignments have not yet been awarded.

Germany: The Federal Network Agency (BNetzA) allows companies to apply for authorizations to use spectrum in the 3.7-3.8 GHz band for local applications. These frequencies can be used for industrial automation, Industry 4.0, and agriculture and forestry. BNetzA established the relevant fees in October 2019 and began accepting applications in November 2019.[5]

Hong Kong: In December 2018, the Communications Authority (CA) and Secretary for Commerce and Economic Development set out their decision on the allocation of the 26 GHz and 28 GHz bands for mobile services and plans for assignment of the spectrum, including 400 MHz set aside for small scale localized wireless services in specified locations ("localized wireless services").[6] The spectrum set aside is to be assigned on a geographically shared basis for use in locations such as university campuses, airports, and technology parks. In July 2019, the CA announced the creation of the Localized Wireless Broadband Services (LWBS) license and began accepting applications for shared spectrum

[1] ACMA, "Area-wide apparatus licensing in the 26 and 28 GHz bands," https://www.acma.gov.au/area-wide-apparatus-licensing-26-and-28-ghz-bands.
[2] ACMA, "Allocation of AWLs in the 3.4–4.0 GHz band in remote Australia," March 1, 2022, https://www.acma.gov.au/consultations/2022-02/allocation-awls-34-40-ghz-band-remote-australia.
[3] BIPT, December 2019, "Consultation at the request of the Minister of Telecommunications regarding a draft bill and three draft Royal Decrees regarding mobile networks," https://www.ibpt.be/en/operators/radio/rights-of-use/consultation-at-the-request-of-the-minister-of-telecommunications-regarding-a-draft-bill-and-three-draft-royal-decrees-regarding-mobile-networks.
[4] SUBTEL, October 2019, "Servicios Limitados de Telecomunicaciones a través de 5G," https://www.subtel.gob.cl/participacion-ciudadana/consultas-ciudadanas/.
[5] BNetzA, "5G spectrum fees for local usages," October 31, 2019, https://www.bundesnetzagentur.de/SharedDocs/Pressemitteilungen/EN/2019/20191031_LokalesBreitband.html.
[6] Communications Authority and Secretary for Commerce and Economic Development, "Allocation of the 26 GHz and 28 GHz Bands to Mobile Service and the Associated Arrangements for Spectrum Assignment and Spectrum Utilisation Fee," December 13, 2018, https://www.coms-auth.hk/filemanager/statement/en/upload/480/joint_statement_st_052018.pdf.

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assignments.[7] In December 2020, a CA committee proposed a new private LWBS license, intended to be a more restricted form of the LWBS license for private industry applications and offered at a lower fee price.[8]

Singapore: In April 2020, the Infocomm Media Development Authority (IMDA) awarded two licenses to operators to deploy 5G networks in the 3.5 GHz, 26 GHz, and 28 GHz bands.[9] Additionally, IMDA made an additional 800 MHz of mmWave spectrum available to operators that did not obtain the combined 3.5 GHz and mmWave licenses to deliver localized 5G services.

United Kingdom: In July 2019, Ofcom published a statement in which it set out the framework for authorizing spectrum usage on a local/private basis in several bands.[10] The statement sets out the regime for local and shared access across three categories of spectrum bands, including the lower 26 GHz band.

Qualcomm believes that local and private 5G networks for use by industry verticals will play an increasingly important role in 5G deployments and strongly encourages ICASA to enable access to mmWave spectrum for such deployments.

Spectrum sharing

New technologies will increase demand for scarce spectrum. While IMT spectrum is often assigned through individual licensing, regulators are also making spectrum available through spectrum sharing approaches. Shared access arrangements usually allow a limited number of licensed users to access the spectrum, under certain conditions. It is often used when spectrum cannot be released everywhere or within a certain timeframe, or if spectrum use must be coordinated to mitigate interference.

Qualcomm is pioneering spectrum sharing technologies with various efforts including LTE Unlicensed (LTE-U), Licensed-Assisted Access (LAA), LTE Wi-Fi Link Aggregation (LWA), MulteFire, and Licensed Shared Access, among others. 5G is built to natively support and advance these technologies as spectrum sharing becomes increasingly important to meeting tomorrow's connectivity needs for faster data rates and increased network capacity. Qualcomm encourages ICASA to advance its 5G spectrum policy taking into account these developments.

Spectrum trading

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[7] Communications Authority, "Communications Authority Creates New Localised Wireless Broadband Service Licence," July 5, 2019, https://www.coms-auth.hk/en/media_focus/press_releases/index_id_1952.html; Communications Authority, "Applications Open for Assignment of Shared Spectrum in 26 GHz and 28 GHz Bands," (July 15, 2019), https://www.ofca.gov.hk/en/media_focus/press_releases/index_id_1953.html.

[8] Communications Authority, "Proposed Creation of a New Licence for the Provision of Private Localised Wireless Broadband System," (December 16, 2020), https://www.ofca.gov.hk/filemanager/ofca/en/content_757/traac4_2020.pdf.

[9] IMDA, "Singapore Forges Ahead with Nationwide 5G Rollout," (April 29, 2020), https://www.imda.gov.sg/news-and-events/Media-Room/Media-Releases/2020/Singapore-Forges-Ahead-with-Nationwide-5G-Rollout; IMDA, "Singapore on Track to Develop Vibrant 5G Ecosystem, Underpinned By A World-Class, Secure and Resilient 5G Infrastructure," (June 24, 2020), https://www.imda.gov.sg/news-and-events/Media-Room/Media-Releases/2020/Singapore-on-track-to-develop-vibrant-5G-ecosystem-underpinned-by-a-world-class-secure-and-resilient-5G-infrastructure.

[10] Ofcom, "Enabling wireless innovation through local licensing" (July 25, 2019), https://www.ofcom.org.uk/__data/assets/pdf_file/0033/157884/enabling-wireless-innovation-through-local-licensing.pdf.

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Qualcomm encourages ICASA to implement spectrum trading to increase efficient spectrum use and enable scarce spectrum resources to be employed for their highest-value use. Assignments are an integral piece of any country's licensing framework, as they provide the certainty necessary for operators to invest and deploy networks. Allowing spectrum trading in the license terms introduces flexibility and can help balance spectrum demand with supply by allowing operators to sell unused spectrum to another party that will use it more effectively. This is especially important when considering longer license durations, which are often particularly valued by operators.

5. What future emerging technologies are to be taken into consideration and which technologies will have a significant impact? When are these technologies expected to become available?

Qualcomm believes that 5G is by far the most impactful technology for which ICASA should plan spectrum usage. 5G will bring about a paradigm shift in the use of wireless technology across the economy. Key 5G use cases in South Africa and globally may include high-speed home/office broadband, virtual meetings/virtual reality/augmented reality, broadcast-like services, broadband to special events, and connected vehicles, driving innovation and efficiency gains across the transportation, education, and healthcare sectors and beyond. It is also important to keep in mind that as 5G technology becomes more widely deployed it is likely to enable innovations and use cases that are not currently envisioned. Routine engagement with stakeholders will enable ICASA to ensure that its spectrum use plans and priorities are informed by current and emerging use cases, as appropriate.

Similarly, cognitive and software-defined radio technologies have significant potential to allow even more efficient spectrum usage. By leveraging software and instantaneous adjustments to allow opportunistic spectrum usage while protecting licensed services, technology will allow further maximization of spectrum usage, delivering improved services to users. The combination of more flexible spectrum licensing and usage approaches with continued improvements in software-defined radio would allow ICASA to ensure efficient spectrum usage nationwide.

5G technologies are already in use around the world, including initial deployments in South Africa. While some of the earliest deployments have leveraged existing assignments in bands below 6 GHz, operators are increasingly deploying 5G-enabled services in the 26 GHz and 28 GHz bands that enable enhanced mobile broadband (eMBB) as well as in the range between 1 GHz and 6 GHz, notably the C band, balancing increased coverage and expanded capacity. 5G deployments leveraging mmWave spectrum in the 26 GHz and 28 GHz bands are already underway in markets around the world, complementing low-band and mid-band deployments that enable the full complement of 5G services. We encourage ICASA to make mmWave spectrum – as well as low-band and mid-band spectrum – available for use by 5G providers at the earliest possible stage to support 5G deployment and begin realizing its potential quantitative and qualitative impacts, especially in industrial settings.

The continuing deployment of 5G networks in mid-band and mmWave spectrum is rapidly making available exciting new 5G-enabled services. In a recent example, in the United States, Verizon has leveraged its mmWave and now mid-band spectrum to offer enhanced capabilities at the 2021 and 2022 Super Bowl events. At the 2021 Super Bowl, attendees were able to wirelessly access seven different HD video streams, plus augmented reality features and more, and the 2022 Super Bowl built on this foundation by offering further content and connectivity options to event attendees.

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6. **What and how will technology developments and/or usage trends aid in relieving traffic pressures? When are these technologies expected to become available?**

No comment.

7. **Are there any IoT applications that will have a large impact on the existing licence-exempt bands? If so, what bands will see the most impact from these applications?**

No comment

8. **Please provide your views regarding the standardization of the naming of applications in the NRFP in accordance with CEPT ECC decision 1(03) approved 15 November 2001 and its subsequent revisions.**

Qualcomm supports ICASA's intent to standardize the naming of applications in line with the convention employed in Europe. As noted in the Outlook, the use of a defined structure, particularly one that is harmonized with the structure used in Europe, will improve efficiencies, simplify type approvals, and contribute to the harmonization of spectrum usage.

9. **What are your forecasts for data traffic and radio frequency spectrum needed over the next 5, 10 and 20 years for each of the EFIS application layers?**

No comment.

10. **How much spectrum is allocated to each of the EFIS application layers, and what is the economic value of spectrum used in each of the above EFIS application layers? What are the opportunity costs for current spectrum allocations for EFIS these application layers (what is the value to alternative users of these allocations)?**

No comment.

11. **How should demand for commercial mobile services and IMT in the next few years be determined? What traffic model should be used in South Africa for traffic demand expectations? What are your comments on the spectrum requirements set out on Table 2Error! Reference source not found.? What are your views on using the Recommendation ITU-R M.1768-1 methodology to forecast IMT spectrum demand in South Africa? Please complete the input parameters in the attached spreadsheet for the market study information needed to apply the Recommendation ITU-R M.1768-1.**

No comment.

12. **Provide your support or reasons for objections on the bands being considered internationally for 5G commercial mobile allocations.**

Qualcomm strongly supports the allocation of spectrum across low-, mid-, and high bands at the earliest possible dates to enable and support 5G deployment. The 700 MHz, 2.6 GHz, 3.5 GHz, and 26 GHz bands are key bands for meeting South Africa's 5G deployment and commercialization needs. We believe that the identification of this first group of bands provides a solid foundation upon which to promote the rapid deployment of 5G technology, which is essential for South Africa to fully realize its socioeconomic benefits.

As noted above, we also encourage ICASA to consider additional bands being discussed internationally to enable more robust 5G deployments. In particular, the 3.8-4.2 GHz band has already been made available or

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considered in markets around the world and is enabled by growing device ecosystems. As South Africa and the region more broadly fully embraces 5G technology, this range could be particularly important to expanding connectivity, capacity, and coverage.

Looking further ahead, Qualcomm expects continued demand for spectrum to enable 5G use cases and technologies. There are potential use cases for additional 5G bands, including the L band, 4.8 GHz band, 40 GHz band, 47.2-48.2 GHz band, and 66-71 GHz band. Qualcomm supports the continued exploration of the appropriate opportunities to make them available for use by 5G networks.

13. Are the spectrum allocations comprehensive enough for spectrum demand projections for commercial mobile services in South Africa for the next 10 to 20 years?

Qualcomm agrees with the statement in the Outlook that approximately double the spectrum currently planned for wireless broadband should be considered in South Africa. This should be ICASA's minimum target for spectrum availability for mobile services. In addition, ICASA should enable operators to obtain large, contiguous blocks of spectrum whenever possible to maximize the efficiency of 5G service delivery.

As mentioned, Recommendation ITU-R M.2083-0 on IMT-2020 Vision provides the expected requirements for 5G networks. Mobile broadband systems should achieve a data transmission capacity of 10 Gbps for hotspot with limited coverage, which is better provided by bands above 24 GHz. In the case of broad coverage networks in urban and suburban areas, for which bands below 6 GHz are best suited, 5G is expected to offer a user experience at speeds of 100 Mbps.

In mid-range bands, particularly in the 3.5 GHz band, Qualcomm supports both the assignment of 100 MHz TDD contiguous channels and the inclusion of conditions intended to ensure timely service deployment. The provision of large amounts of contiguous spectrum is ideal for the efficient deployment of mobile services, notably 5G. The use of an assignment approach that allows operators to acquire contiguous lots is preferred because contiguous spectrum will allow easier implementation of higher-order carrier aggregation in an optimized manner.

In the mid and high bands, 5G can leverage bandwidths in multiples of 100 MHz to deliver high-capacity mobile broadband. In mid-range bands, blocks of spectrum of up to 100 MHz per operator are ideal. eMBB offering data rates measured in multiple gigabits will require large, contiguous bandwidths of hundreds of megahertz. Approaches that enable operators to obtain exclusive, licensed spectrum in large, contiguous blocks will provide the greatest benefit for users.

The 3GPP standards for the 26 GHz band, for example, indicate that the spectrum blocks should be of 50 MHz, 100 MHz, 200 MHz, or 400 MHz sizes, which can be combined if needed.[11] The capacity provided per user will be highly dependent on the amount of spectrum available per operator. It is essential to mobilize mmWave technologies for smartphones to deliver even better mobile broadband experiences in dense urban areas and a clear differentiation to today's Gigabit LTE, with each operator accessing bandwidths of 400 MHz to 800 MHz to enable extreme throughput, lower latency, and significantly more network capacity.

[11] 3GPP TS 38.101-2, "User Equipment (UE) radio transmission and reception; Part 2: Range 2 Standalone", V15.3.0, October 2018, Table 5.3.5-1, https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=3284.

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Qualcomm simulations in real-world conditions demonstrated the benefits of the increased capacity afforded by 800 MHz of mmWave spectrum.[12] Key findings of one simulation included:

- burst download speeds exceeding 3 Gbps and download latencies as low as a few milliseconds;
- browsing download speeds increasing from 71 Mbps for the median 4G user to 1.4 Gbps for the median 5G user in mmWave coverage, a gain of approximately 20x;
- approximately 23x faster responsiveness, with median browsing download latency reduced from 115ms to 4.9ms;
- file download speeds of more than 186 Mbps for 90 percent of 5G users, compared to 10 Mbps for LTE, a gain of over 18x; and
- median streaming video quality increasing from 2K/30 FPS/8-bit color for LTE users to 8K/120 FPS/10-bit color and beyond for 5G users.

In lower bands, where there can be challenges in assigning 100 MHz or more to individual operators in specific bands, Qualcomm encourages the CA to maximize opportunities for licensees to obtain contiguous blocks of spectrum, which better enable the capacity benefits of 5G.

Taken together, the spectrum needed to maximize the benefits of 5G technology will require significantly larger assignments than are currently available, spread across multiple bands, necessitating the allocation and assignment of significantly more spectrum for IMT use.

14. Is there a demand for more flexible frequency licensing and frequency assignment/allotments processes on a regional basis required to complement the national frequency licensing and frequency assignments/allotments in the next 10 to 20 years?

Yes. Please see our response to Question 4.

15. Are there any other frequency bands that should be considered for release in the next 10 to 20 years for commercial mobile that are not discussed? Provide motivations for your proposal.

Yes. Please see our response to Question 12.

16. Which vertical markets will require the most secured licensed spectrum to overcome their current interference and congestion issues?

No comment.

17. Assuming that South Africa follows the ITU's recommendations to assign up to 1,940MHz of spectrum for IMT-2000 and IMT-advanced services, and that South Africa follows trends in Europe for potentially another 2,000 MHz of spectrum for IMT-2020, what bands would need to be freed up?

Please see our response to Question 12.

18. What are your views on reallocating [the bands in Table 3] for IMT over the next years?

[12] Qualcomm, "Predicting real-world performance of 5G NR mobile networks and devices," (March 7, 2018), https://www.qualcomm.com/news/onq/2018/03/07/predicting-real-world-5g-performance.

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Qualcomm believes that these bands, all of which have been the subject of international discussions related to IMT, have valuable potential to enable and expand the availability of wireless services over the coming years. As noted in our response to Question 12, ranges including the 3.5 GHz band and the 26 GHz band are particularly important for the initial wave of 5G deployments.

C band

Qualcomm strongly supports the use of the C band (3.3-3.8 GHz) and its extension (3.8-4.2 GHz) for mobile services. The C band is a key band for 5G deployment, with increasing interest and support from different stakeholders. Harmonization of the 3.4-3.8 GHz band, or portions thereof, for mobile is increasing globally. Europe has taken decisions to pioneer the use of the 3.4-3.8 GHz band for 5G; China and various other Asian countries have designated the 3.4-3.6 GHz band; Korea (Rep.), Australia, Hong Kong. Some countries in the Americas are targeting the 3.4-3.7 GHz for 5G; Canada recently awarded licenses in the 3.45-3.65 GHz range; and the United States has authorized use of the 3.55-3.7 GHz band, among others.

Based on these developments, Qualcomm believes the C band will be widely used for mobile broadband and that many of the initial 5G deployments will occur in this band, which will also later drive the use of its extension in the 3.8-4.2 GHz range.

There have been extensive studies of IMT deployment in the C band and the potential for coexistence with other services, including the FSS. ITU studies of compatibility between IMT and FSS can be found in Report ITU-R S.2368.[13] Further, when considering cross-border issues, the ITU Radio Regulations set limits for the use of IMT in the 3.4-3.7 GHz band that should be employed unless the relevant administrations come to a different agreement. The appropriate ITU footnotes are 5.430A, 5.431B, 5.432A, 5.432B, 5.433A, and 5.434.[14]

Considering the existing support from manufacturers and mobile operators, as well as international trends and existing harmonization, the full C band, including 3.8 GHz to 4.2 GHz, should be prioritized for release in South Africa. In considering this and other mid-range bands, it is also important to attempt to maximize the amount of spectrum released to allow each prospective licensee the potential to obtain large blocks of contiguous spectrum, ideally 100 MHz per operator.

Qualcomm studies have investigated the effect of signals from 5G NR base stations on the operating point of the LNA/LNBs of FSS earth-station receivers in the 3.5 GHz band. The impact of a guard band of 100 MHz, 41 MHz, and 20 MHz between the 5G NR transmission and the FSS receiver was evaluated for the three different 5G NR base station classes: wide area (macro cell), mid-range (micro cell) and indoor (pico cell). The analytical model used in our study to calculate the minimum pathloss between the 5G NR base stations and FSS earth stations is based on the free space pathloss model contained in Recommendation ITU-R P.452, FSS protection criteria specified in Recommendations ITU-R S.1432 and Report ITU-R M.2109, and 5G NR base-station spurious emission masks specified in 3GPP TS38.104.16.

[13] Report ITU-R S.2368-0, "Sharing studies between International Mobile Telecommunication-Advanced systems and geostationary satellite networks in the fixed-satellite service in the 3 400-4 200 MHz and 4 500-4 800 MHz frequency bands in the WRC study cycle leading to WRC-15,"(June 2015), https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-S.2368-2015-PDF-E.pdf.

[14] GSMA, "Considerations for the 3.5 GHz IMT range: getting ready for use," (May 2017), https://www.gsma.com/spectrum/wp-content/uploads/2017/06/Considerations-for-the-3.5-GHz-IMT-range-v2.pdf.

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The results of the study show that to prevent 5G NR macro cell deployments from saturating studied FSS earth stations with LNA gain of 50-60 dB a separation distance of 1.02 to 3.20 km is required regardless of the size of the guard-band because the FSS LNA operates over the entire 3.4-4.2 GHz frequency range. Limiting the FSS operating range and creating a 41 MHz guard band by fitting a filter with 5-15 dB attenuation enables the separation distance to be reduced to less than 1km. For micro-cells and indoor cells, the study shows that no additional filtering of the FSS operating range is required for the satisfactory operation of 5G NR with FSS earth station reception.

The use of private networks in this frequency range can also enable important use cases for 5G technology, such as capacity-intensive applications for industrial environments. Qualcomm's technology is already supporting these use cases through private networks under frameworks like those approved in Germany.

According to Global Suppliers Association (GSA), the largest ecosystems of announced 5G devices are in 3GPP bands n78 (3300-3800 MHz), n41 (2496-2690 MHz), n79 (4400-5000 MHz), and n77 (3300-4200 MHz), in that order respectively.

26 GHz

Qualcomm believes that the 26 GHz (24.25-27.5 GHz) band also offers a tremendous opportunity for the deployment of 5G services as it will enable 5G connectivity with multi-gigabit data rates, dense spatial re-use, and flexible configuration of spectrum, which enables both access and backhaul services to be provided. As stated in previous sections, Qualcomm believes that the availability of new spectrum in the low (700 MHz), mid (3.5 GHz), and high (26 GHz) bands is key to unlocking the full potential associated with 5G.

Qualcomm expects initial use cases to focus on 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)[15] 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 vehicles, and health care will all benefit from 5G deployments in mmWave.

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, however, will not be uniform across the network, it will rather be concentrated in specific hotspots (cafes, venues, public squares, city centers, etc.) and aligned with the strategic deployment of high-capacity small cells covering the hotspot area.

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

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The 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. The latter case could be the most challenging one, as it would entail covering an area of 1 2 km^2. However, depending on traffic patterns, it could be even enough to cover only the main public squares and roads within the city center, as those would be the locations where most traffic is consumed.

19. Provide your support or reasons for objections on the bands being considered internationally for 5G commercial mobile, fixed, satellite, or licence-exempt allocations.

Please see our responses to Questions 12 and 18.

In addition, Qualcomm notes that global demand for connectivity continues to grow, especially driven by the rapid rise in the number of users working, learning, and consuming entertainment from home. The most widespread versions of Wi-Fi were not designed for the sudden and massive surges in uplink data demand that are common today, such as during video calls. Qualcomm continues to support policies and regulations that enable and promote Wi-Fi in the 6 GHz band. The availability of a new allocation of wide and contiguous mid-band spectrum at 5 925-6 425 MHz is critical to meet demands for license-exempt wireless access systems (WAS)/radio local access network (RLAN) technologies, including Wi-Fi 6E and 5G NR-U. Wi-Fi 6 is designed to enable massive new wireless capacity for the next generation of high-bandwidth wireless connectivity, including multi-gigabit per second speeds with superb stability and consistent experiences. By supporting numerous 160 MHz channels, advanced modulation techniques, and the opportunity to extend highly differentiated end-to-end Wi-Fi 6 feature implementations, we are well-positioned to deliver powerful, reliable, and immersive Wi-Fi 6E experiences for the next generation, supporting parallel evolution in the transition to 5G.

Expanding the spectrum available for Wi-Fi will enable increased capacity for local-area networks that deliver an increasing percentage of traffic to users' mobile devices. Cisco estimates that 59% of mobile data traffic will be offloaded to Wi-Fi by 2022, as compared to 54% of such traffic in 2017.[16] This increase offsets a projected increase in mobile data usage that would result in increased traffic on wide-area mobile networks. However, the 2.4 GHz and 5 GHz bands used globally for Wi-Fi have become increasingly congested due to their popularity and ease of use. Unencumbered 6 GHz spectrum occupied only by efficient Wi-Fi 6E traffic designed to deliver significant reductions in latency will add capacity and increase responsiveness for latency-sensitive applications.

Enabling the use of Wi-Fi 6 devices in the 6 GHz band will allow users across South Africa to enjoy high-speed connectivity on a higher number of connected devices. This is particularly important to note in the context of COVID-19, which has further increased our reliance on information and communication technologies (ICTs), especially as many continue to work, attend school, seek medical care, and conduct countless other activities via the Internet.

Qualcomm believes that access to the 5 925-6 425 MHz band will enable WAS/RLAN technologies to continue delivering positive experiences for the most bandwidth-intensive applications. Indeed, the 5 925-6 425 MHz band represents new greenfield spectrum that will allow for innovation in high-performance WAS/RLAN.

[16] Cisco. Mobile Wi-Fi Traffic Profiles. 2019. https://www.cisco.com/c/dam/assets/sol/sp/vni/forecast_highlights_mobile/pdf/Global_Mobile_Wi-Fi_Traffic_Profiles.pdf.

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Opening the 5 925-6 425 MHz for license-exempt use will benefit consumers and businesses very rapidly. In this frequency band, Wi-Fi 6E and 5G NR-U devices will be able to leverage wider channels, lower latency, and additional capacity to deliver greater network performance and support more users at once, even in very dense and congested environments. Such capabilities will support ultra-high-speed connections in settings including homes, businesses, schools, universities, and libraries.

While the upper portion of the band (6 425-7 125 MHz) also holds significant potential for use by Wi-Fi and other license-exempt technologies, we fully recognize that decisions regarding the use of this band are under consideration in WRC-23 agenda item 1.2. Work is currently underway within ITU-R to consider the potential identification of the 6 425-7 025 MHz range for IMT in Region 1, and the 7 025-7 125 MHz range globally. As such, it will be beneficial for South Africa to develop plans that consider regional harmonization efforts, by engaging in the deliberations and the decisions of WRC-23.

Qualcomm has also been actively participating in the development of next-generation 802.11 Wi-Fi in unlicensed spectrum technologies that enable extremely high throughput services and applications among multiple distinct users in the same location. Qualcomm and others in the wireless industry are targeting greenfield unlicensed and shared spectrum to support the development of advanced spectrum sharing paradigms used by IEEE 802.11be (extremely high throughput, or EHT) that deliver significant benefits in terms of increased spectral efficiency, superior throughput, and much-improved Quality of Service (QoS).

20. Provide your support or reasons for objections on the bands being considered internationally for fixed applications. Please provide a list of such bands for potential fixed use.

Given the potential for the deployment of 5G for both fixed and mobile uses, please see our response to Question 12.

21. Are the spectrum allocations comprehensive enough for spectrum demand projections for fixed services in South Africa for the next 10 to 20 years?

Given the potential for the deployment of 5G for both fixed and mobile uses, please see our response to Question 13.

22. Is there a demand for more flexible frequency licensing and frequency assignment/allotments processes for fixed services on a regional basis required to complement the national frequency licensing and frequency assignments/allotments in the next 10 to 20 years?

Given the potential for the deployment of 5G for both fixed and mobile uses, please see our response to Question 14.

23. Are there any other frequency bands that should be considered for release in the next 10 to 20 years for fixed services that are not discussed? Provide motivations for your proposal.

Given the potential for the deployment of 5G for both fixed and mobile uses, please see our response to Question 15.

24. Will the demand for commercial mobile, licence-exempt, satellite, or fixed wireless services/applications impact the demand for backhaul spectrum? If so, how and which of these

No comment.

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25. Are there adequate spectrum allocations for video backhaul for broadcast and security services in South Africa? What is the realistic demand for these services in the next 10 to 20 years?

No comment.

26. How much will transmission technology improve the volume of traffic in the next 10 to 20 years?

No comment.

27. What and how will technology developments and/or usage trends aid in relieving traffic pressures and addressing spectrum demand for backhaul services? When are these technologies expected to become available?

No comment.

28. How much bandwidth for backhaul will be saved due to the deployment of fibre networks in South Africa for the next 5, 10 to 20 years?

No comment.

29. What will impact on the demand for these services/applications in the coming 10-20 years? What is the realistic demand for these services in the next 10 to 20 years? Are there adequate spectrum allocations for Aeronautical services in South Africa?

No comment.

30. What will impact on the demand for these services/applications in the coming 10-20 years? What is the realistic demand for these services in the next 10 to 20 years? Are there adequate spectrum allocations for Broadcasting services in South Africa?

No comment.

31. How much spectrum should be maintained for terrestrial broadcasting in the band 470MHz to 694MHz in the next 10 to 20 years?

Recognizing the importance of this range for terrestrial broadcasting, Qualcomm also notes that the 470-694 MHz range will also be a key sub-1 GHz band, with propagation characteristics that make it ideal for wide-area coverage and superior in-building penetration. These characteristics make this range particularly well-suited to delivering wireless broadband connectivity over long distances in less-populated areas. They are also relevant to provide coverage for low-power, low-duty cycle, long-range performance devices as part of the IoT.

The 500 MHz and 600 MHz bands were identified for mobile broadband during the International Telecommunication Union (ITU) 2015 World Radiocommunication Conference (WRC-15) in various countries in the Americas and Asia. These bands are being freed up due to gains in spectrum efficiency derived from the digitalization of television, thereby allowing for part of the band to be used for mobile broadband. Under WRC-23 agenda item 1.5, the ITU-R is currently conducting studies to review the spectrum use and spectrum needs of existing services in the frequency band 470-960 MHz in Region 1, considering possible regulatory actions for the range 470-694 MHz. As these studies progress, the needs of different services, including mobile broadband and broadcasting, will be assessed in conjunction with regulatory actions to support the development of this band in the region.

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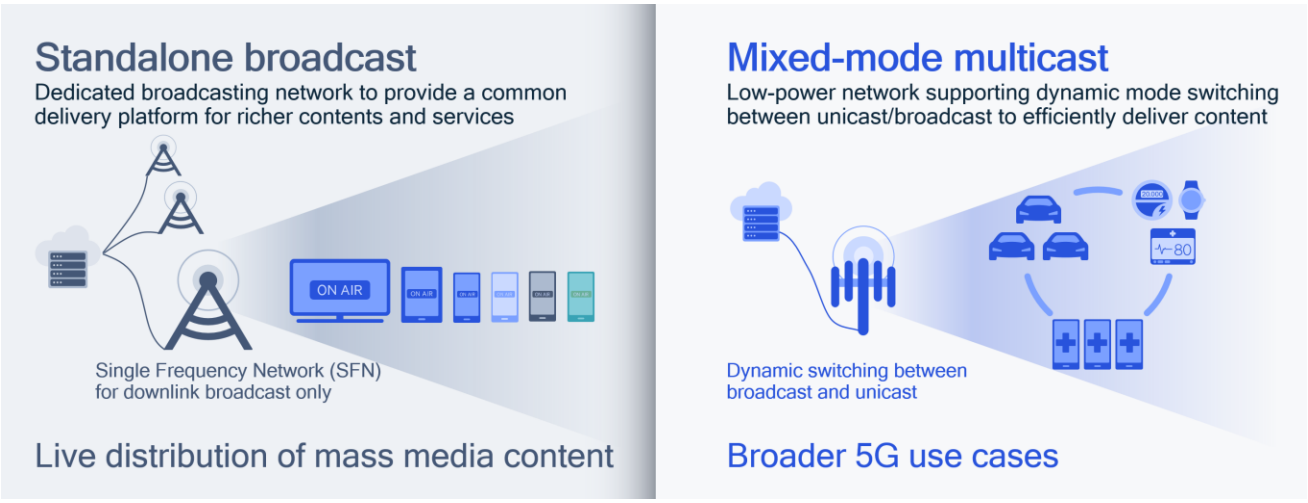
Qualcomm sees the future of broadcasting technologies evolving in two distinct paths. The first is a terrestrial broadcast that enables a dedicated broadcasting network leveraging cellular technology to provide a common delivery platform for different content and services. The second is a mixed-mode broadcast that allows for dynamic mode switching between unicast and broadcast to more efficiently deliver identical content. We envisioned 5G as a unified platform that can connect diverse devices, services, and deployments. 5G broadcast in Release 16 is defined to do this by supporting two distinct modes: 5G standalone broadcast and mixed-mode multicast.



In recent years, the support for 5G broadcast across the broader mobile and broadcast ecosystem has grown significantly. More than 25 3GPP members have cosigned the Release 16 Work Item, which was subsequently completed in 2020. The 5G Multimedia Action Group (5G MAG), a cross-industry organization established in 2019, has more than 40 active members across the media sector promoting the commercial adoption of 5G broadcast. In addition, numerous 5G broadcast trials have been conducted, and new trials are being planned worldwide which are rapidly setting the stage for virtually seamless rich media content delivery to our 5G devices.

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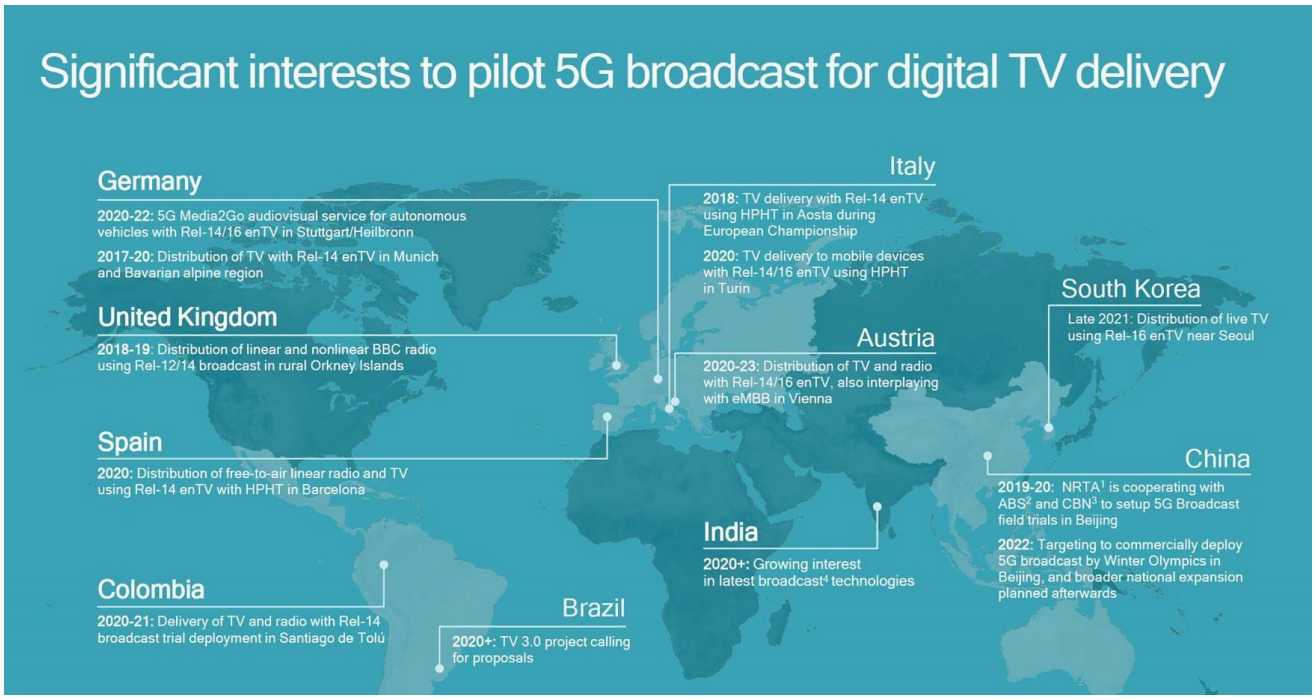

32. What will impact on the demand for these services/applications in the coming 10-20 years? What is the realistic demand for these services in the next 10 to 20 years? Are there adequate spectrum allocations for Defence services in South Africa?

No comment.

33. What will impact on the demand for these services/applications in the coming 10-20 years? What is the realistic demand for these services in the next 10 to 20 years? Are there adequate spectrum allocations for Maritime services in South Africa?

No comment.

34. What will impact on the demand for these services/applications in the coming 10-20 years? What is the realistic demand for these services in the next 10 to 20 years? Are there adequate spectrum allocations for Meteorological services in South Africa?

No comment.

35. What will impact on the demand for these services/applications in the coming 10-20 years? What is the realistic demand for these services in the next 10 to 20 years? Are there adequate spectrum allocations for PMSE services in South Africa?

No comment.

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36. **What will impact on the demand for these services/applications in the coming 10-20 years? What is the realistic demand for these services in the next 10 to 20 years? Are there adequate spectrum allocations for PPDR services in South Africa?**

No comment.

37. **Can mobile broadband currently be used for PPDR purposes? If not, will this be possible in the future with better quality of service and lower prices?**

No comment

38. **Are there any reasons to consider further spectrum from broadcasting in the band 470MHz to 694MHz to public protection and disaster relief (PPDR) services in the next 10 to 20 years?**

No comment.

39. **What will impact on the demand for these services/applications in the coming 10-20 years? What is the realistic demand for these services in the next 10 to 20 years? Are there adequate spectrum allocations for Satellite services in South Africa?**

No comment.

40. **Which applications and allocations will require the most frequency spectrum demand in the following frequency bands?**
    - **C-band**
    - **Ku-band**
    - **Ka-band**

No comment.

41. **What and how will technology developments and/or usage trends aid in relieving traffic pressures and addressing spectrum demand for satellite services? When are these technologies expected to become available?**

No comment.

42. **What will impact on the demand for these services/applications in the coming 10-20 years? What is the realistic demand for these services in the next 10 to 20 years? Are there adequate spectrum allocations for Astronomy services in South Africa?**

No comment.

43. **What will impact on the demand for these services/applications in the coming 10-20 years? What is the realistic demand for these services in the next 10 to 20 years? Are there adequate spectrum allocations for Short-range services in South Africa?**

No comment.

44. **Which vertical markets will require most secured licensed spectrum to overcome their current interference and congestion issues?**

No comment.

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45. How much will spectrum management and orderly frequency planning improve the interference situations in certain frequency bands?

A robust spectrum management framework, coupled with appropriate monitoring and enforcement, is central to improving or avoiding interference within and between bands. As such, ICASA and its fellow national regulatory authorities play a key role in ensuring that spectrum can be put to its most valuable uses as defined by a combination of factors including national priorities, market conditions, and technological development.

Qualcomm encourages ICASA to continue to develop a transparent spectrum management plan and to employ orderly processes that are in line with regionally and globally harmonized approaches. An orderly frequency planning process increases regulatory certainty, thereby increasing the likelihood of future investment in long-term projects, such as wireless network deployments.

46. Please provide input on future spectrum requirements for the different service allocations as well as the urgency for such additional frequency allocations for such a service.

Maybe

47. Which Service allocations require RFSAP's and for which frequency bands. Also specify the urgency for the creation of such RFSAP's.

No comment.

48. Please provide your organisations strategy and suggestions on how the Authority can ensure that spectrum outlook and demand studies can contribute to stimulation of the South African economy.

No comment.

49. The spectrum outlook described above in Section 4, and in particular the substantial additional requirements for IMT and fixed-wireless spectrum, suggest that a number of additional bands will need to be assigned for the purposes of internet access, and incumbent users will need to be migrated out of the bands mentioned in the list on Table 3 and on any bands your organisation suggests on Table 4. What are the costs of migrating these users so that radio frequency spectrum is allocated to its highest value use?

No comment.

50. What would the costs of freeing up spectrum for commercial fixed and mobile use be (considering the bands mentioned above on Table 3 and Table 4)? What would the economic benefits of doing so be, in respect of increase consumer surplus, and increased producer surplus?

According to a study by IHS Economics and IHS Technology, by 2035 a broad range of industries—from retail to education, transportation to entertainment, and everything in between—could produce up to USD 12 trillion worth of goods and services enabled by 5G.[17]

In addition, as noted by IHS Markit, the use cases enabled by 5G technology will drive value generation through cost savings and efficiencies, new sources of revenue, more "intelligent" products, and better customer

[17] IHS Economics and IHS Technology, "The 5G economy: How 5G technology will contribute to the global economy" (January 2017), https://www.qualcomm.com/documents/ihs-5g-economic-impact-study.

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experiences.[18] One key forecast presented in a November 2020 publication is that 5G's net contribution to global GDP through 2035 (in net present value terms) will amount to approximately USD 2.3 trillion in constant 2016 US dollars—roughly the same as France's current GDP. Over the same period, IHS Markit forecasts that global real GDP will grow at an average annual rate of 2.7%, of which 5G will contribute almost 0.2%. While these figures look at the global impact of 5G, Qualcomm expects to see a positive impact on GDP growth in South Africa as well as countries around the world.

In addition, 5G studies and forecasts indicate that 5G use cases will be reflected across multiple sectors or verticals, demonstrating the wide range of potential impacts of 5G technology and services across economies globally.[19] A 2018 study published by GSMA and Telecommunications Management Group (TMG) considered the economic impact of deploying mmWave spectrum for 5G and found that 5G is expected to generate USD 2.2 trillion in GDP by 2034, with mmWave spectrum responsible for USD 565 billion, or approximately a quarter of that total.[20] Further, it considered the impact of mmWave spectrum on various regions, including the Middle East and North Africa as well as Sub-Saharan Africa. The study's findings indicated that mmWave spectrum used for 5G services would enable USD 15.4 billion of GDP growth in the Middle East and North Africa region, and USD 5.2 billion in Sub-Saharan Africa, or 1.1% GDP growth in the former and 0.7% GDP growth in the latter.

51. Assuming that South Africa follows the ITU's recommendations to assign up to 1,940MHz of spectrum for IMT-2000 and IMT-advanced services, and that South Africa follows trends in Europe for potentially another 2,000 MHz of spectrum for IMT-2020, what would the costs of freeing up the various spectrum bands be? In this regard, please refer to Table 3 and Table 4, as explained above.

No comment.

52. Due to the scarcity of high demand spectrum and the consequential fact that Spectrum Sharing in certain bands are non-negotiable, how shall you describe the best sharing conditions for the South African scenario?

No comment.

53. Due to the convergence of technologies and the changes in regulatory licensing environment do you believe that certain service allocations categories will or need to change?

No comment.

54. What existing licence-exempt frequency bands will see the most evolution in the next five years?

Please see our response to Question 19.

55. How much spectrum, and in which bands, should be made available for licence-exempt purposes (such as Wi-Fi) over the 5, 10 and 20 years? What would the costs of freeing up these bands for IMT be? What would the economic benefits of doing so be, in respect of increase consumer surplus, and

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[18] IHS Markit, The 5G Economy in a Post-COVID-19 Era, November 2020.

[19] See, for example, SNS Research (2017), "The 5G Wireless Ecosystem: 2017 – 2030: Technologies, Applications, Verticals, Strategies & Forecasts," http://www.snstelecom.com/5g and 5G Americas (2017), "5G Services & Use Cases," http://www.5gamericas.org/files/9615/1217/2471/5G_Service_and_Use_Cases__FINAL.pdf.

[20] GSMA/TMG, "Study on Socio-Economic Benefits of 5G Services Provided in mmWave Bands," (December 2018), https://www.gsma.com/spectrum/wp-content/uploads/2019/06/mmWave-5G-benefits.pdf.

increased producer surplus? Which vertical markets will require most secured licensed spectrum to overcome their current interference and congestion issues?

No comment.

56. **How much spectrum, and in which bands, should be made available for dynamic spectrum access over the next 5, 10 and 20 years? What would the costs of freeing up these bands for IMT be? What would the economic benefits of doing so be, in respect of increase consumer surplus, and increased producer surplus?**

No comment.

57. **What existing licence-exempt frequency bands will see the most evolution in the next five years?**

Please see our response to Question 19.

58. **Are there any IoT applications that will have a large impact on the existing licence-exempt bands? If so, what bands will see the most impact from these applications?**

No comment.

59. **Will the trend for offering carrier-grade or managed Wi-Fi services continue to increase over the next five years? If so, will this impact congestion in Wi-Fi bands and which bands would be most affected?**

No comment.

60. **Are there specific frequency bands that will be in higher demand over the next 10 to 20 years and do you expect higher demands for spectrum in these frequency bands in South Africa? Are there any other frequency bands that should be considered for release in the next 10 to 20 years for commercial mobile, fixed, satellite, or licence-exempt that are not discussed above? Provide motivations for your proposal.**

No comment.

3 Conclusion

Qualcomm welcomes the opportunity to convey our views to ICASA regarding the *Long-Term Spectrum Outlook for South Africa*. We strongly support ICASA's efforts to enable the efficient and effective use of radiofrequency spectrum, as well as new technologies and applications enabled by 5G networks.

Should you have any questions or comments on this submission, please do not hesitate to contact me at +27 82 616 3604 or emigwall@qualcomm.com.