Nokia response to RSM Draft Five Year Spectrum Outlook 2022-2026

About Nokia

We create the technology to connect the world. We develop and deliver the industry's only end-to-end portfolio of network equipment, software, services and licensing that is available globally. Our customers include communications service providers whose combined networks support 6.1 billion subscriptions, as well as enterprises in the private and public sector that use our network portfolio to increase productivity and enrich lives.

With an end-to-end portfolio that is unique in the industry, Nokia can work in partnership with operators to deliver "real 5G". Nokia's in house 5G mmWave Small Cells and AirScale BTS provide in-building and outdoor coverage, while our Microwave Anyhaul, Cloud native RAN, antennas, and 5G cloud-native core are part of approximately half of our agreements to date. Beyond our mobile networks portfolio, Nokia has excellent FP5 network processor-based IP routers and PSE-4 chipset powered optical networking - our customers can use the Nokia Network Services Platform to make this into full-5G-strength software defined connectivity 'smart network fabric' secured by Nokia Security Orchestration, Analytics and Response (Nokia SOAR) to ensure resilient 5G.

Nokia is a global leader in 5G standardization and technology innovation with a strategy specifically designed to support the New Zealand market.

Nokia is also a supplier to various enterprises which have deployed private wireless networks. Globally Nokia has been selected by more than 214 operators to supply 5G networks.

Through our research teams, including the world-renowned Nokia Bell Labs, we are leading the world to adopt end-to-end 5G networks that are faster, more secure and capable of revolutionizing lives, economies and societies. Nokia adheres to the highest ethical business standards as we create technology with social purpose, quality and integrity.

For more information: https://www.nokia.com/networks/5g/

Disclaimer: This response is based on Nokia's current understanding of the market dynamics and various standards bodies; these dynamics are changing and hence our views may update with these changes

Nokia Position

Nokia welcomes the opportunity to respond to New Zealand RSM, draft "Five-Year spectrum outlook 2022-2027". As a leading player in the global communications sector, and contributor to the New-Zealand market over many decades, Nokia is well placed to provide insight on market and technology trends, including industry structure and regulatory practice.

RSM's Draft "Five-Year spectrum outlook 2022-2027" is a clear signal that all stakeholders should work together to meet the expected demand for spectrum for mobile broadband (public or private) and ensuring the speedy development of 5G. RSM has identified several spectrum bands to address future needs to make 5G a reality for New Zealand. Nokia welcomes the effort of RSM on the regional and international discussions and its clear and transparent process in the planning of spectrum.

450 MHz

The 450MHz and 410MHz bands could also be considered for private broadband networks in New Zealand (initially LTE) e.g. for public safety and the utilities, as this usage is occurring in other countries and so an equipment ecosystem is developing. Additionally, the 380-400MHz historically used for TETRA and Tetrapol public safety networks is another candidate band for private LTE broadband networks.

In Germany, 450connect GmbH is currently building and will operate the fail-safe platform for the digitalisation of critical infrastructures in Germany. The Cologne-based company is thus creating a decisive prerequisite for the decarbonisation and resilience of our national economy. For this purpose 450connect recently received the exclusive assignment of the 450MHz spectrum until 2040. 450connect is backed by more than 70 utilities, including Alliander, E.ON, a consortium of regional energy companies and the Versorger-Allianz 450, which includes numerous public utilities, energy and water suppliers with the participation of the EnBW-subsidiary Netze BW

With 450connect's new nationwide, highly-available and secure LTE450 radio network, operators of critical infrastructures will receive the platform they need to digitalize their infrastructure, implement the energy transition to decarbonization, and further secure the energy supply[1].

We encourage RSM to further investigate the potential use of this bands.

[1] https://www.nokia.com/about-us/news/releases/2022/02/14/nokia-chosen-by-450connect-to-supply-network-technology-for-lte450-critical-infrastructure-network-in-germany/

600 MHz

Availability of additional UHF spectrum (in the 470-694/698 MHz range) can bring great benefits to achieve improved capacity coverage and performance in sparsely populated areas and some suburban areas as well as in hard-to-reach locations (e.g., deep indoors). Beside enhanced mobile broadband services, it is necessary to address a growing range of applications[2] requiring good propagation characteristics in an economically efficient manner.

The 600 MHz band is rising in importance in countries in the Americas and in some countries in Asia-Pacific for IoT use in remote areas and for indoor penetration in urban areas. In the United States, following the Voluntary Incentive Auction of the 600 MHz band, T-Mobile and Nokia completed the world's first 5G data transmission over "low-band" 600MHz radio spectrum back in November 2018. T-Mobile is looking for a broad and potentially fast rollout of 5G services across the United States on this band.

The quantum of spectrum in 700MHz is limited hence 600MHz is critical to complement low band 5G requirements. We have existing band plan based on 3GPP, the n71 (2x35; 617-698MHz) band that benefits of a steady and growing ecosystem, and there are two more candidate bands being studied in 3GPP based on AWG request as part of efforts to expand the available spectrum in this band to 2x40 MHz (612-703 Option B1, 617-703 Option B2). RSM should actively monitor the discussion at AWG and 3GPP in order to efficiently allocate this spectrum.

3.3-3.4 GHz, 3.4-3.8 GHz and 3.8-4.2 GHz bands

Global 5G harmonization is happening now, and the 3.3-3.8 GHz spectrum range is at the epicenter of this, being the spectrum for near-term deployment of robust 5G services. Spectrum harmonisation helps to achieve economies of scale, enables global roaming and reduces equipment design complexity. 3GPP has developed two bands supporting the 3.5GHz ecosystem: band n78 covering 3.3-3.8GHz and band n77 covering 3.3-4.2GHz. Altogether they represent the frequency bands with the strongest ecosystem available already for 5G.
Goal should be for 3.3-3.8 GHz spectrum to be widely deployed and available to all. For this reason, Nokia recommends enabling a licensing framework that supports sustained investment and widespread network deployment to ensure the utility of 3.3-3.8GHz spectrum in New Zealand is maximised.

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[2] A study of spectrum needs of C-V2X network-based (V2N) communications (cellular vehicle to everything) indicated that additional service-agnostic sub-1 GHz spectrum would provide connectivity for advanced automotive V2N services in rural environments with affordable deployment costs. The study concludes that: "... c) At least 50 MHz of additional service-agnostic low-band (< 1 GHz) spectrum would be required for mobile operators to provide advanced automotive V2N services in rural environments with affordable deployment costs. d) At least 500 MHz of additional service-agnostic mid-band (1 to 7 GHz) spectrum would be required for mobile operators to provide high capacity city wide advanced automotive V2N services." See: https://5gaa.org/news/the-new-c-v2x-roadmap-for-automotive-connectivity/ .

The 3300-4200 MHz band offers the unique opportunity for largest amount of spectrum below 6 GHz. The amount of contiguous spectrum that can be made available in the 3300-4200 MHz range offers an interesting opportunity for the exploitation of the innovative capabilities of the latest IMT technologies, with particular reference to the 5G New Radio air interface which will deliver increased capacity and connectivity. Nokia supports the availability of largest contiguous frequency range within the 3300-4200 MHz.

The ability of mobile operators to fulfil the market demand for 5G services cost effectively will largely depend on the availability of wide and contiguous frequency blocks. The Global Suppliers Association (GSA where Nokia is member) has suggested that the largest possible contiguous frequency blocks be made available for IMT within the 3300–4200 MHz range at the national level. This is because the assignment of contiguous blocks to mobile operators will lead to significant benefits in terms of spectrum efficiency, signalling overhead, physical layer flexibility, latency performance, base station radio unit implementation and UE implementation.

At least 100 MHz contiguous blocks in the 3300–4200 MHz range are being made available per operator in several leading countries by the 2021/22 timeframe. This target should be achieved in all markets. Spectrum availability should grow further over time considering the steadily increasing market adoption of a growing number of use cases with more and more requirements (higher throughput and lower latency in the first place). GSA believes that additional mid-band spectrum may therefore be required for MNOs in leading markets by 2023–2025; the 3300–4200 MHz range may represent a valuable opportunity in this respect. We note in some regions of the world administrations pave the way in this direction in order to secure access to up to 200 MHz (contiguous spectrum) per operator in the upcoming future. Examples include Japan, Korea, the Saudi Arabia and United Arab Emirates that already have opened or include in their plans opening the upper 400 MHz of the band n77 for mobile services for both national public and local networks.

6GHz

Nokia undertakes the initiative from RSM to consult on the potential future use of the 5925-6425 MHz band for license-exempt use by RLAN technologies, while deferring the decision on the upper 6425-7125 MHz for a later phase, in line with the ITU WRC-23 calendar. We encourage RSM to support studies under the WRC-23 Agenda Item 1.2 with regards to IMT identification of 6425-7125 MHz portion of the 6 GHz band. We see this as an important consideration by RSM.

As any decision to release spectrum for license-exempt use is an irreversible decision that makes it next to impossible to reclaim any portion of a license-exempt band, given the profusion of licensed-exempt uses and devices, Nokia is of the view that a balanced approach of the 6 GHz band should allow the expansion of the ICT sector in New Zealand and serve the country's information-communication needs well into the future by providing additional spectrum for both licensed and license-exempt operations in the mid-term.

On *the 5925-6425 MHz band*, noting that this range is outside of the WRC-23 process, indeed one option is to open it to RLAN (low power, unlicensed use) for indoor use, as evaluated by RSM. However, it is essential to provide a level playing field framework to both 3GPP (5G NR-U) and IEEE (Wi-Fi) technologies.

The release of 500 MHz in the 5925-6425 MHz band for RLAN operations in New Zealand could provide extra-capacity to cover the needs of license-exempt technologies by doubling the spectrum available for such operations in the 5 GHz range could use up to roughly 1100 megahertz of license-exempt spectrum in the 2.4 GHz, 5 GHz and 5925-6425 MHz bands for RLAN technologies (e.g. NR-U, Wi-Fi 6/6E and other) and allow the use of wide RLAN channels (of up to 160 MHz per channel) over both 5 GHz and lower 6 GHz bands.

We would like to highlight that while licence-exempt provides an easy access to spectrum resources, it can – at most – provide "best effort" services, assuming a good quality infrastructure (e.g., FWA) is in place. A license-exempt spectrum regime cannot address any of the QoS dependent use cases[3].

Nokia recommends:

- A technology neutral approach with rules that allow for coexistence with incumbents;
- Technical conditions equally allowing for both 3GPP and IEEE deployments;
- Adoption of technical rules that are harmonised to a greater extent with other markets (like the CEPT or the USA) to ensure the development of a harmonised ecosystem.

The 3GPP has defined the 6 GHz unlicensed frequency band (band n96) that is included in the Rel16 specifications for countries following the US FCC's regulation only. As such, the development of the ecosystem for the 5G new radio unlicensed (NR-U) is undergoing.

EU is currently developing harmonized standards (ETSI BRAN EN 303 687[4]) for unlicensed operation in the frequency range 5945-6425 MHz, meaning that both WiFi and NR-U can deploy in the same shared spectrum on equal terms. Equal access opportunities for NR-U in this shared spectrum will allow telecom operators to utilise it as a supplement to their spectrum holdings using the same NR (5G) platform and leading as such to more synergies and economies of scale with NR. Further, NR-U can be utilized for industrial communication/automation applications. In all cases the NR-U deployments can be under the control of a NR gNB allowing operators more control over the network.

We also note that Wi-Fi is only a radio access technology and not a broadband network technology and its benefits are circumscribed by the E2E capacity and penetration of the fixed-line

[3] 3GPP justification in NR-U work item *RP-192926* and 3GPP technical reports *TR 38.889* (NR-U) and *TR 36.889* (LAA)
[4] In line with ECC decision (20)01 on the harmonized use of the frequency band 5945-6425 MHz for Wireless Access Systems including Radio Local Area Networks (WAS/RLAN).

infrastructure – in particular, the availability of a combination of high capacity E2E fibre connectivity and high data rate subscriptions/data plan.

Taking into account the above, we encourage RSM to further consider limiting the unlicensed RLAN operation only to the 5925-6425 MHz band and support studies for IMT identification of the 6425-7125 MHz as per AI 1.2 of WRC-23.

While we take note of RSM proposal to implement similar decision as OFCOM, we would like to draw attention that approaches in other regions consider different power levels for indoor and outdoor operations.

In Europe, the ECC decision (20)01 provides the power limits and limitations for two categories of devices that can be used indoor-only (low power indoor LPI), and indoor and outdoor (very low power VLP) respectively. In some cases, specific conditions of operation are attached. Those limits and the conditions attached were defined based on coexistence studies conducted in the ECC Report 302/ ECC Report 316.

On the other hand, FCC defined another category of devices with higher power (referred to as "standard-power". The LPI devices in FCC's rules also operate at higher power compared to CEPT's regulations for LPI devices.

If New Zealand wants to consider adopting rules that allow higher standard-power operations in the 5925-6425 MHz range, Nokia recommends RSM to evaluate the use of a database solution that can improve coordination between services, minimizing the required separation and risk for interference, reducing restriction zones, and optimizing thus the use of the spectrum. Solutions like Automated Frequency Coordination (AFC), for example, as the FCC is implementing in the USA in the 6 GHz band can have as benefit the use of the band with higher (standard) power by the unlicensed users. The use of higher power under the control of an AFC shall assure the protection of the incumbents in the 5925-6425 MHz frequency band while allowing, for instance, for more efficient deployments using NR-U.

We note that in Europe, for the frequency band 5925-6425 MHz, the CEPT conducted detailed sharing and compatibility studies between Wireless Access Systems including Radio Local Area Networks (WAS/RLAN) and the existing FS/ FSS services, based on the specific regional FS allocations and assumptions (see ECC Report 302and ECC Report 316).

Similar studies have been conducted in the USA and conclusions are available in the FCC's rules (see FCC's Order).

Views on the 6425-7125 MHz band:

Nokia would like to further comment on the upper part of the 6 GHz (6425-7125 MHz) band in the context of the ITU process of the WRC-23 under Agenda item 1.2, aiming at identifying this portion of spectrum for terrestrial component of IMT:

- 7025-7125 MHz (globally);
- 6425-7025 MHz (Region 1).

Studies are on-going both in 3GPP for the potential use of the 6 GHz range for LTE and 5G new radio NR, and in ITU-R for a potential IMT identification at WRC-23 with the least restrictive conditions for the band usage (e.g., highest possible output power targeting macro cell usage). 3GPP has started a new study on IMT parameters for 6.425-7.025GHz, 7.025-7.125GHz and 10.0-10.5GHz in response to the LS from ITU-R.

Nokia believes in the potential of the 6425-7125 MHz band to become an IMT band, providing a good compromise for coverage and capacity for citywide high-speed capacity. With the identification of the upper 6 GHz band for IMT and licensed operation, significant economic benefits and boost of the 5G NR development for additional use cases such as industrial use case is expected to arise. We therefore appeal to RSM to take into consideration the international context and to support the ITU-R studies for this range and defer the decision on the upper 6GHz band for a later stage, in accordance with future WRC-23 decisions.

Moreover, we note a momentum within the mobile industry to set 6 GHz as priority for future IMT spectrum. There is a global support from leading industry players – mobile operators and vendors – in 3GPP; work is ongoing to specify the band in RAN4 for NR licensed use. This gives a clear indication that the 5G NR ecosystem for this band will develop and benefit from global economies of scale and interested countries such as Russia[5] and China[6] plan tests of 6 GHz band for licensed use in 2021.To conclude, Nokia supports a balance approach in the 6 GHz frequency range between the licence-exempt and licensed use of the band. Allocating the range 5925-6425 MHz for license-exempt use on a technology neutral bases considering synergies and economies of scale and securing the 6425-7125 MHz for licensed use will allow satisfying all demands in the short and long term from both RLAN and IMT technologies.

4.5 GHz/4.8 GHz (n79)

The 4400-5000 MHz band can serve as one of the complementary bands to the already available mid-bands and we are observing an interest from countries in Asia to further investigate the potential use of this band. The 4.5GHz has been allocated in Japan in April 2019 and China is also

[5] *https://iz.ru/1082264/anna-ustinova-aleksei-ramm/chastotnaia-nedostatochnost-dlia-5g-predlozhili-novyi-diapazon-6ggtc*

[6] IMT-2020 Promotion Group of China, 6 GHz IMT Opportunity for Society Webinar, Dec 15th, 2020; *https://na.eventscloud.com/file_uploads/b08325f6e2bf9dcdf55f79395aab555b_6GHzWebinarPresentation.pdf*

considering this band for future deployment. Taiwan's government has announced plans to release 100 MHz of spectrum in the 4.8–4.9 GHz band for public and private organisations to test 5G applications.

it is important to note that in all cases 4.8–4.99 GHz spectrum has been allocated primarily as a back-up or supplementary band to 3.5 GHz, or for specific localised use cases. In Hong Kong and Japan, the main use case is localised private network deployments, with additional use in Hong Kong to provide eMBB coverage in specific locations where there is an issue with satellite interference. The migration can be challenging, therefore we encourage RSM to start a study on potential use for 5G for additional capacity or for specific localised used cases.

40 GHz (37–43.5 GHz)

The 37-43.5 GHz band presents an excellent opportunity for global harmonisation and implementation (also by use of a tuning range). The 37-40 GHz band (39GHz) has already been decided in the United States and Nokia considers that this band will be used for early deployment. In Europe, the 40.5-43.5 GHz frequencies are not extensively used by incumbents and therefore, could provide large additional 5G capacity in subsequent upgrade steps to 5G networks as more and more services will be put onto 5G networks.

Sharing

Nokia welcomes the opportunity to comment on the discussion paper related to new approaches to spectrum sharing and contribute its views based on our expertise in sharing technologies. Spectrum scarcity and the growing demand for wireless connectivity make spectrum sharing a regulatory priority, in both sub-6 GHz bands where spectrum re-farming is unsustainable, and in the mmWave ranges where sharing is more appropriate given the propagation characteristics of the radio frequencies. Equally, spectrum sharing is also seen as a key enabler of 5G & Industry 4.0 use cases and is high on the regulatory agenda.

Nokia supports RSM's effort in evaluating the future spectrum management techniques that can increase the effectiveness and efficiency in spectrum usage by assessing the potential for new services / usages to flourish while ensuring that co-existence with adjacent services is possible.

Some initiatives are underway in different regions and some countries have already tested sharing schemes in Europe and North America, investigating the potential use of various sharing / collaboration techniques on several frequency bands in all spectrum ranges. Of special relevance is the possibility to have access to additional frequency bands for mobile broadband services through sharing with incumbent services underutilizing these resources.

While clearing spectrum for mobile remains the preferred option for the public network providers, in some cases such solutions are not feasible and therefore co-existence is the most efficient option. Over time several solutions have been investigated, with two methods getting traction at international level and being standardised: Licensed Shared Access (LSA) and Citizen Broadband Radio Service (CBRS) covering 3.55-3.7GHz range. While the first one was not embraced by the European mobile industry, the latter is highly supported by the US stakeholders and subject to licensing[7].

Nokia has been consistently working on spectrum sharing methods for the last ten years, contributing to the technical and regulatory developments of several dynamic sharing technologies. Nokia is one of the companies at the origin of and has extensive experience with Licensed Shared Access (LSA), being equally engaged in ETSI RRS in the further evolution to eLSA (evolved LSA). – Nokia has played an instrumental role in the FCC technical regulatory and policy proceedings as well standards work in WInnForum, CBRS Alliance and 3GPP to lay the foundation for successful commercial deployments in the CBRS band.

Connected industries

On the broader topic of spectrum for vertical industries, the 3GPP has analysed use cases and defined a set of functional requirements[8] and system parameters related to communication services for each use case in each domain. Several of the developed service performance requirements[9] have an impact on preferred spectrum management approach. High communication service availability can be reached through exclusive access to dedicated spectrum assignments and through protection from harmful interference.

Access to wide bandwidths is needed. The required service areas are typically geographically limited, covering one or several, local or regional areas, ranging from indoor coverage, up to few km². This means that frequency ranges below 4 GHz with sufficient transmit powers are preferred if outdoor coverage is required. Depending on the application, traffic may range from symmetric up to very asymmetric, in either direction requiring uplink/downlink ratio (UL/DL) flexibility from the technology, the deployment and the band regulation. Use of time division duplex (TDD) technology can provide the required duplex flexibility, though adjacent networks may need to be synchronized, which would limit the applicability.

The 5G Alliance for Connected Industries and Automation (5G-ACIA) addresses[10] major challenges of 5G, highlighting spectrum and operator models. In order to meet extremely demanding latency

[7] https://www.fcc.gov/wireless/bureau-divisions/mobility-division/35-ghz-band/35-ghz-band-overview

[8] 3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Study on Communication for Automation in Vertical Domains (Release 16), 3GPP TR 22.804, V16.1.0 (2018)

[9] 3GPP: TS 22.261, v16.6.0 - Technical Specification Group Services and System Aspects; Service requirements for the 5G system; Stage 1 (Release 16). (2018).

[10] 5G Alliance for Connected Industries and Automation (5G-ACIA): White Paper, 5G for Connected Industries and Automation, (2018).

and reliability requirements, licensed spectrum and protection from harmful interference are highly preferred.

Investment cycles of vertical industries differ from cycles of the telecom industry: cycles for media and entertainment are typically shorter, ranging between 2-3 years, for automotive industry 7-8 years, energy, manufacturing and mechanical industries 25 years, and for oil & gas from 10 to 25 years. Partly due to this difference, vertical industries may prefer to deploy their own networks. Furthermore, the timing for investing in wireless communications depends solely on their own business plans. Vertical industries require the assurance that for their networks there will be a continuity of service, without unjustified price increases, spectrum re-farming or technology upgrades over their planned life span.

On the other hand, deploying and operating a wireless network for IIoT is not their core business, but an enabler for optimizing operations and productivity, enhancing security and safety, and improving planning and decision making. This means that the cost of spectrum should be affordable, suitable authorization process would be application based, and that the applications should be allowed to be submitted any time, based on the business need. It also means, that the license duration should be comparable to the investment cycle, and that overall regulatory certainty is needed for years to come.