NOKIA CONTRIBUTION

To the Discussion Paper on

Planning of the 3700 MHz-4200 MHz

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# 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](https://www.nokia.com/networks/portfolio/small-cells/) and [AirScale BTS](https://www.nokia.com/networks/solutions/airscale-radio-access/" \t "_blank) provide in-building and outdoor coverage, while our [Microwave Anyhaul](https://www.nokia.com/networks/portfolio/microwave-anyhaul/), [Cloud native RAN](https://www.nokia.com/networks/solutions/airscale-cloud-ran/), antennas, and [5G cloud-native core](https://www.nokia.com/networks/solutions/airgile-cloud-native-core-network/) are part of approximately half of our agreements to date. Beyond our mobile networks portfolio, Nokia has excellent [FP4 network processor-based IP routers](https://www.nokia.com/networks/technologies/fp4/) and [PSE- 3 chipset powered optical networking](https://www.nokia.com/networks/technologies/photonic-service-engine/) - our customers can use the [Nokia Network Services Platform](https://www.nokia.com/networks/products/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.

As of June 2019, Nokia confirms its 5G leadership position with 42 commercial 5G deals in place with operators around the world, 22 with named customers such as T-Mobile, Telia Company and Softbank. Including these agreements, Nokia's 5G deals, trials and demos total over 100 5G customer engagements to date.

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 revolutionising 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 View

Nokia welcomes the opportunity to comment the discussion paper related to 3700 MHz- 4200 MHz. Nokia supports progressing consideration of the 3700 MHz- 4200 MHz band from the *initial investigation* to the *preliminary replanning* stage of the planning process.

**3700 – 3800 MHz**

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.

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 Australia is maximised and in doing so, maximising the competitiveness of the Commonwealth of Australia as we enter a new communications era.

We therefore recommend allocating 3700-3800 MHz for 5G and we support **spectrum scenario C.**

Nokia recommends to ACMA to adopt a consistent spectrum emission management framework across the entire 3.4-3.8GHz band, including modernisation of existing arrangements for 3.4GHz Spectrum License Band and 3.5GHz Band, aligned on 3GPP outputs. While representing a significant shift from current arrangements, this approach will align the entire band and benefit existing and new licensees by enabling the uninhibited deployment of 5G services and the use of mMIMO technology without performance compromise. This approach will put Australia under a framework consistent with other regions of the world and aligned with the outputs of 3GPP, positioning Australia to leverage the global 5G ecosystem to the greatest possible degree.

*Australian Communications and Media Authority emission limits*

Current status of spectrum emission limits for base station devices operated under spectrum license in the 3.4GHz band and 3.5GHz is that unless an agreement between the spectrum license holder and all the affected licensees of frequency-adjacent and area-adjacent spectrum licensees exist, the requirements need to be met.

Non-spurious emission limits, i.e. in-band emissions aka operating band unwanted emissions are shown in Table 2.1.

Table 2.1 ACMA non-spurious emission limits for base stations, 3.4 GHz and 3.5GHz spectrum

|  |  |  |
| --- | --- | --- |
| **Frequency offset range (foffset)** | **Radiated maximum true mean power (dBm EIRP)** | **Specified Bandwidth** |
| 0 kHz < foffset < 5 MHz | 10 - (7/5) x foffset (MHz) | 100 kHz |
| 5 MHz < foffset < 10 MHz | 3 | 100 kHz |
| foffset > 10 MHz | 2 | 1 MHz |

Frequency offset range is defined as offset from the edge of license holder’s spectrum allocation.

For user end devices and other devices which are exempt from the registration requirement the non-spurious emission limits are shown in Table 2.2.

Table 2.2 ACMA non-spurious emission for user end devices, 3.4 GHz and 3.5GHz spectrum

|  |  |  |
| --- | --- | --- |
| **Frequency offset range (foffset)** | **Radiated maximum true mean power (dBm EIRP)** | **Specified Bandwidth** |
| 0 kHz < foffset < 1 MHz | -15 | 30 kHz |
| 1 MHz < foffset < 20 MHz | -13 | 1 MHz |
| foffset > 20 MHz | -25 | 1 MHz |

Spurious emission limits are shown in Table 2.3.

Table 2.3 ACMA spurious emission limits

|  |  |  |
| --- | --- | --- |
| **Frequency offset range (foffset)** | **Radiated maximum true mean power (dBm EIRP)** | **Specified Bandwidth** |
| 9 kHz < f < 150 kHz | -36 | 1 kHz |
| 150 kHz < f < 30 MHz | -36 | 10 kHz |
| 30 MHz < f < 1 GHz | -36 | 100 kHz |
| 1 GHz < f < 12.75 GHz | -30 | 1 MHz |

*Approach in 3GPP – guideline for reliable operation throughout the world*

Considerable work is ongoing within 3GPP to formulate approaches for establishing requirements for massive multiple-input multiple output (mMIMO) systems which are essential to the realisation of 5G performance possibilities. The 3GPP work includes defining optimal emission requirements and measurement methodologies (such as 3GPP specification TS 38.104, TS 38.141-2, TS 37.105 and TS 37.145-2). These specifications include requirements in both conducted and radiated domain and are meant to facilitate efficient use of spectrum with mMIMO system, including reliable coexistence between adjacent spectrum licensees. Typically, the 3GPP requirements regarding operating band emissions, and unwanted emissions on adjacent channels guarantee sufficient isolation between the networks using the frequency band.

In the context of mMIMO systems, it is especially important to recognise that a separate framework has been developed for mMIMO systems for which requirements differ from traditional fixed antenna base stations. In 3GPP these requirements are called Active Antenna System (AAS) requirements.

For AAS emission requirements are relaxed up to 8 times, equalling 9 dB, compared to traditional fixed antenna base stations. The value comes from the maximum number of layers/streams specified in 3GPP Rel-12. In case of an over-the-air (OTA) AAS BS, where no conducted measurement interface is available, the scaling factor is fixed at 8, together with a requirement that at least 8 digital transmission chains exist in the product.

Furthermore, 3GPP has recognised that network interference correlates in relation to total radiated power (TRP) rather than effective isotropic radiated power (EIRP), since beamforming systems effectively time-average the emission impact in spatial domain. Therefore, conformance to the emission limits can be demonstrated by either power-sum over all antenna connectors meeting the limit or power at each antenna connector being 10\*log10(n) below the emission limit, where n is the number of antenna connectors. Similar framework exists for radiated domain also.

For user end devices, 3GPP 5G NR specifications consider the wider signal bandwidths. Moreover, without updating the current ACMA requirements. support for over 20 MHz wide transmissions would require extensive additional standardisation and development work compromising the performance of 5G systems.

As a conclusion, the 3GPP specification framework for mMIMO systems enables utilising the high directivity of antenna array without increasing network interference. Additionally, user end device requirements have been updated to support transmission on wider bandwidths.

*Proposed updates to ACMA emission limits*

Current ACMA emission regulation framework under 3.4GHz Spectrum License and 3.5GHz Apparatus License would significantly disadvantage mMIMO in comparison to the 3GPP framework. In particular, it is likely to increase the power backoff required, impacting product size and cost and reduce potential performance to likely uneconomic levels.

Nokia recommends that ACMA modernise its emissions management framework across 3.4-3.8GHz to align with requirements in 3GPP technical specifications, maximising product commonality to improve economies of scale, helping drive rapid uptake of 5G. This modernisation approach would pave the way for 5G deployment and the use of mMIMO across the wider 3.4-3.8GHz band, including within the existing licenses covering 3.4-3.575GHz, 3.575-3.7GHz as a single update as the new segment of 3.7-3.8 GHz is made available for the deployment of point to multipoint wireless broadband applications.

For reference, 3GPP requirements for mMIMO/AAS are shown in Table 3.1 and Table 3.2. Additionally, spectrum emission mask for user end devices has been shown in Table 3.3. It should be noted that in 3GPP frequency offset range is defined as offset immediately from the channel bandwidth edge, not from the spectrum license edge.

Table 3.1 3GPP operating band unwanted emission limits for single-RAT E-UTRA, category B option 1 [2]

|  |  |  |
| --- | --- | --- |
| **Frequency offset range (foffset)** | **Radiated maximum true mean power (dBm TRP)** | **Measurement Bandwidth** |
| 0 kHz < foffset < 5 MHz | +2 dBm - (7/5) x (foffset -0.05) dB | 100 kHz |
| 5 MHz < foffset < 10 MHz | -5 | 100 kHz |
| foffset > 10 MHz | -6 | 1 MHz |

Table 3.2 3GPP AAS spurious emission limits for E-UTRA [2]

|  |  |  |
| --- | --- | --- |
| **Frequency offset range (foffset)** | **Radiated maximum true mean power (dBm TRP)** | **Measurement Bandwidth** |
| 9 kHz < f < 150 kHz | -27 | 1 kHz |
| 150 kHz < f < 30 MHz | -27 | 10 kHz |
| 30 MHz < f < 1 GHz | -27 | 100 kHz |
| 1 GHz < f < 12.75 GHz or 5th harmonic of the upper frequency ed of the DL operating band in GHz | -21 | 1 MHz |

Table 3.3 3GPP User Equipment Spectrum Emission Mask for 5G new radio [3]

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **ΔfOOB**  **(MHz)** | **5**  **MHz** | **10**  **MHz** | **15**  **MHz** | **20**  **MHz** | **25**  **MHz** | **40**  **MHz** | **50**  **MHz** | **60**  **MHz** | **80**  **MHz** | **100**  **MHz** | **Measurement bandwidth** |
| ± 0-1 | -15 | -18 | -20 | -21 | -22 | -24 | -24 | -24 | -24 | -24 | 30 kHz |
| ± 1-5 | -10 | -10 | -10 | -10 | -10 | -10 | -10 | -10 | -10 | -10 | 1 MHz |
| ± 5-6 | -13 | -13 | -13 | -13 | -13 | -13 | -13 | -13 | -13 | -13 |
| ± 6-10 | -25 |
| ± 10-15 |  | -25 |
| ± 15-20 |  |  | -25 |
| ± 20-25 |  |  |  | -25 |
| ± 25-30 |  |  |  |  | -25 |
| ± 30-40 |  |  |  |  |  |
| ± 40-45 |  |  |  |  |  | -25 |
| ± 45-55 |  |  |  |  |  |  |
| ± 55-60 |  |  |  |  |  |  | -25 |
| ± 60-65 |  |  |  |  |  |  |  | -25 |
| ± 65-80 |  |  |  |  |  |  |  |  |
| ± 80-85 |  |  |  |  |  |  |  |  | -25 |
| ± 85-100 |  |  |  |  |  |  |  |  |  |
| ± 100-105 |  |  |  |  |  |  |  |  |  | -25 |

**3800 – 4200 MHz**

Nokia recommends to ACMA to further investigate the potential future use of 3800-4200 MHz for private wireless networks. In line with our position on 3700 MHz-3800 MHz, the proposed **scenario C** opens this opportunity. 5G New Radio (NR) Band **n77** has been defined for 3.3-4.2 GHz covering the proposed range of 3.8-4.2 GHz. With demand also from other regions such as USA and Japan, Nokia expect a quickly evolving ecosystem for Band n77.

Nokia see large economical value in the possibilities for enterprises to invest into private wireless networks using 3GPP technologies on their premises. Additional investment into private networks by private enterprises can significantly speed up the overall 5G take-up.

Production and automation industry have gathered with Communication Service Providers (CSPs) and the vendor community in 5G-ACIA to express requirements for industrial use of 3GPP technologies. Networks need to be tailored to industry needs in terms of performance, availability and reliability, privacy and security, and meeting their operational requirements. Specifically, stringent performance requirements in terms of guaranteed bandwidth and low latency at very high availability levels e.g. in wireless production control make access to licensed spectrum necessary.[[1]](#footnote-1) Thus, Nokia support individually licensed spectrum on a per location base for local private enterprise use. Access to licensed spectrum for private enterprises shall not preclude any usage scenarios in terms of how such private networks are implemented. Within the German national IT summit process, industry and administration have created a paper on such usage models including standalone private, industrial networks, shared local access networks to private networks implemented as 5G networks slices.[[2]](#footnote-2) A sharing framework could be based on the USA Citizens Broadband Radio Service (CBRS) framework developed in USA, as mentioned by ACMA, that could be adapted for the 3.8-4.2 GHz band. As one of the drivers of this sharing framework in USA, Nokia would be happy to further discuss the CBRS framework with ACMA. On July 25th, 2019 UK OFCOM also put forward a local licensing framework for the 3.8-4.2GHz band that could be explored.

Therefore, we encourage ACMA to further assess and promote identification of spectrum for Private Wireless networks. This approach will benefit of a combined evolution of the band ecosystem between the extended use of it for CSPs in some areas in the Asia Pacific region and North America and the shared use with localised licensing system for private networks approach in Europe. As such, ACMA can attain the goal for efficient management of the spectrum resources while opening a harmonised frequency band n77 with a robust 5G ecosystem to the industries.

1. 5G-ACIA white paper on 5G for Connected Industries and Automation https://www.5g-acia.org/index.php?id=5125 [↑](#footnote-ref-1)
2. 5G Focus Group on 5G Usage Scenarios for Industrial Communication https://plattform-digitale-netze.de/publikationen/ [↑](#footnote-ref-2)