

## NOKIA CONTRIBUTION

Spectrum sharing

Overview and new approaches

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## 1 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 FP4 network processor-based IP routers and PSE- 3 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.

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 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

## 2 Nokia View

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 ACMA'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.

As indicated in the paper by ACMA, 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<sup>1</sup>.

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. We are also on the Boards of the WInnForum and [CBRS Alliance](#).

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<sup>1</sup> <https://www.fcc.gov/wireless/bureau-divisions/mobility-division/35-ghz-band/35-ghz-band-overview>

On the broader topic of spectrum for vertical industries, the 3GPP has analysed use cases and defined a set of functional requirements<sup>2</sup> and system parameters related to communication services for each use case in each domain. Several of the developed service performance requirements<sup>3</sup> 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 km<sup>2</sup>. 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<sup>4</sup> major challenges of 5G, highlighting spectrum and operator models. In order to meet extremely demanding latency 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.

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<sup>2</sup> 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)

*Issue 1: Given current momentum in international markets and opportunities for other sharing models offered by 5G technologies, is it timely to develop a more detailed consideration of spectrum sharing opportunities in Australia?*

As ACMA rightfully underlines in its paper, spectrum sharing is not a new concept and several types of coexistence are already in place in different radio frequency bands and between different services.

Several dynamic sharing techniques have been under investigation in recent years and Nokia has been highly involved in the research, trial and development of several of them. In particular, given the increasing spectrum scarcity and the difficulties to clear IMT-identified frequency bands from existing users, efforts have been made to accommodate IMT technologies to co-exist with the incumbents. As such, two main technological and regulatory frames were developed: Licensed Shared Access (LSA) in Europe and APAC, and Citizen Broadband Radio Service (CBRS) in the USA.

While LSA was developed with the idea of sharing spectrum between incumbents and mobile operators, the CBRS considers a more complex approach of sharing spectrum resources between incumbents and other two types of users, on licensed and unlicensed conditions.

Leaving aside the complexities of one or the other, both concepts emerged in the last ten years and the development of the technical, operational and regulatory frameworks for each took around five to seven years. Under these circumstances Nokia considers that Australia's timing to consider and evaluate the spectrum sharing now is the right one. However, involvement of all interested stakeholders from start is of paramount importance for the paradigm shift in spectrum management to happen.

Nokia supports the initiative of ACMA and is happy to further provide support based on our expertise.

*Issue 2: Are there recent developments in sharing techniques that industry and the ACMA should be aware of?*

ACMA correctly identified and described the sharing techniques that are under consideration at global level.

We also want to draw attention on two recent developments:

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<sup>3</sup> 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).

<sup>4</sup> 5G Alliance for Connected Industries and Automation (5G-ACIA): White Paper, 5G for Connected Industries and Automation, (2018).

- On July 25, 2019, UK's OFCOM decided<sup>5</sup> to open up airwaves to enable innovation and support new services in several bands / part of bands in 1800 MHz, 2.3 GHz, and 3.8-4.2 GHz and 26 GHz. These bands are opened for localised sharing under a two-tier framework with incumbents and/or between access seekers.
- On September 16, 2019, the U.S. Federal Communications Commission (FCC) issued a Public Notice authorizing five Spectrum Access System ("SAS") Administrators to commence Initial Commercial Deployments ("ICDs") in the CBRS band. This is the culmination of several years of regulatory and industry development to enable deployment in a band shared with military systems and represents an important commercial opportunity in mid-band spectrum. The SAS Administrators are now authorized for specific commercial deployments described in advance to the FCC for ICD. The ICD phase is expected to be completed in early 2020. After the ICD phase is complete, SAS Administrators will be fully authorized nationally for the band and will have blanket authorization to add new customers and deployments without needing project-by-project approval. In addition to the ICD Public Notice, earlier this month, FCC Chairman announced that the FCC will auction Priority Access Licenses ("PALs") for this band on June 25, 2020 in seven, 10 MHz blocks. The remainder of the band will be operated on a General Authorized Access ("GAA") basis, not requiring a license, but still managed by a SAS. The FCC also issued a draft Public Notice seeking comment on PAL auction procedures. This sets up a likely timeline for such procedures being finalized by Q1 2020 to enable the June 2020 PAL auction.

In addition, several administrations are looking for suitable spectrum for 5G industrial applications or localised use in medium and high frequency bands. Considering the difficulties to clear spectrum from PMSE, satellite, or military users, regulators in Japan, Canada, France, Norway, Sweden, announced their intention to open certain bands for shared usage between new (industrial) users and existing ones. Such an approach can be used in bands like 2.3 GHz, TDD 2.6 GHz, 3.8-4.2 GHz, as well as in 26 GHz. Germany has made available local area spectrum in the 3.7-3.8 GHz band for Industry 4.0 use cases<sup>6</sup>.

Finally, a different sharing option is emerging for high frequency bands as the 26 GHz band in Italy where each of the five operators that acquired 200 MHz each in the band are considering a new approach of pooling and sharing this spectrum together in a 'club licensing' model.

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<sup>5</sup> <https://www.ofcom.org.uk/about-ofcom/latest/media/media-releases/2019/airwaves-opened-up-to-support-wireless-revolution>

<sup>6</sup> <https://www.techradar.com/au/news/germany-makes-private-5g-spectrum-available-for-industry>

*Issue 3: What are the (potentially new) use cases that might benefit from secondary or tertiary access to spectrum and who benefits?*

Nokia see large economic value for enterprises to access spectrum on secondary or tertiary basis. This is an opportunity for industries to invest into private wireless networks using 3GPP technologies on their (localised) premises. We see such additional investment into private networks by enterprises as significant to speeding up the overall 5G take-up in specific locations.

In Australia we have already seen the deployment of private LTE networks to cover mines in the Pilbara, enabling safer remote and autonomous operation of equipment. There are deployments for agricultural use cases and water management. There are many more Industry 4.0 uses cases which are localised to small areas (factories, ports, warehouses, airports, etc) which would benefit greatly to having access to spectrum.

Development of such local enterprise operations (private networks using shared spectrum) can be considered in several industries, e.g. in agriculture, forestry, mining, utility, logistic hubs, remote industrial areas or smart city applications like driverless trams, health applications, etc. Alternatively, more ‘traditional’ users can be the providers of local broadband networks and solutions, as well as the existing mobile operators that seek access to additional spectrum for capacity augmentation, network densification (indoor / outdoor), 5G, or carrier aggregation.

However, the key for the successful adoption of such solutions for private local usage by secondary access seekers is - as for the mobile network operators - the access to global ecosystems for chipsets, devices and network infrastructure, based on global / regional standards (3GPP, Wireless Innovation Forum), i.e. access to harmonised bands.

*Issue 4: What are the potential challenges/impediments to the introduction of DSA in Australia—technical, industry capability, licensing and regulatory frameworks?*

While spectrum sharing is a preoccupation of the administrations for optimal and efficient use of scarce resources, challenges may come from different sources. As mentioned previously, concepts like LSA and CBRS took long periods of time to get articulated from technical, operational and regulatory perspective.

Choosing the right spectrum sharing strategy depends on the spectrum bands under consideration, the addressable secondary market and the complexity of the sharing scheme and conditions. ACMA already identified many of these aspects. Nokia’s experience shows that it is necessary to get all interested stakeholders involved from early stage in the process for an open and constructive dialog.

While experience in Europe shows that the mobile community had little / no interest in the LSA, in USA, the early engagement of the mobile community in the CBRS discussion made it an important topic for operators like AT&T who got highly involved

in the development of the concept. Close collaboration of the industry and the administration is also of high relevance to define the regulatory framework and technical requirements and licensing conditions. And last, but not least, the access to a global / regional ecosystem, large enough to allow for economies of scale for the chipsets and the network and end-user equipment at affordable prices.

*Issue 5: Facilitating spectrum access (e.g. monitoring, control, reporting, assignment) logically necessitates involvement from both government and industry. Are there any early thoughts on what an appropriate industry / government balance might look like? How might the ACMA facilitate shared spectrum access? How might the ACMA address this?*

Choosing the right spectrum sharing strategy is a challenge as there is the need to balance the rights of the license holders with the ever-increasing demand for spectrum to enable industrial use cases. As part of the consultation the ACMA should engage the various stake holders, including AMTA, CommsAlliance, IOTAA, AiGroup, etc.

*Issue 6: What is the relevance of DSA examples such as the US Citizens Broadband Radio Service (CBRS) arrangements to the Australian spectrum environment? Are there other or lower cost alternatives to help inform access control and assignment systems of incumbent usage in a timely manner?*

The CBRS solution emerged from the need of the US operators to access spectrum in the 3.5 GHz occupied by incumbent military radars and satellite services. While CBRS addresses for now the coexistence with the naval radar, the technical and regulatory approach can be translated for other bands as well. It is to note that thanks to the CBRS approach the level of usability of the 3550-3700 MHz bandwidth increased sensibly, the exclusion zones reducing by 70%.

ACMA already identified several alternative options for spectrum sharing, with different level of complexity but likely with less detailed and dynamically accurate information on the actual usage of the spectrum by the incumbent. To better assess the right approach and sharing model, ACMA should identify the potential users of the shared spectrum and their spectrum requirements. The appropriate solution should come from the collaborative discussions with the stakeholders.

Nokia, as provider of technology, is well placed to offer solution with different levels of complexity, from LSA to CBRS. In the US context Nokia is progressing its approval as Spectrum Access System (SAS) administrator.



*Issue 7: Under a multi-tier DSA approach:*

*Tier 1 (highest priority or incumbent) users would be expected to share spectrum with lower tier users when not being utilised. Are there any specific licensing and / or regulatory arrangements that might incentivise the tier 1 users to release unutilized spectrum for lower-tier access?*

*Tier 2 and 3 users need to vacate spectrum (regardless of their service type or communication urgency) for tier 1 users to operate seamlessly. Do we see potential services/service types in Australia who would fit the criteria of second or third tier users? What are the incentives to adopt a conditional (lower priority) spectrum than an unconditional (full access) spectrum?*

The main benefit for tier 1/incumbents is that they can continue operations and do not need to vacate the bands. CBRS is a good example where the US Department of Defense and FSS users preferred to keep their primary rights to the band instead of having to vacate the band. The same principle is valid in the case of LSA, where coexistence of different services is possible in a given band as a permanent option or while waiting for the incumbents to liberate the band.

Benefits for tier 2 & tier 3: quicker access to the band at a lower / no cost compared to more traditional licenses. Vacating the 3.5 GHz CBRS band in the US would have taken more than 10 years and cost billions to relocate radars and FSS to different spectrum bands. This amount of money can be spent in infrastructure instead of spectrum, which then brings broadband to the society and benefits people. If operators have to spend billions on spectrum, then spending in infrastructure may be delayed.

Availability of spectrum in Tier 2 / 3 also enables new entrants, verticals, etc with better control over interference.

Unlicensed spectrum is an alternative option for enterprise, with its limitations, as unlicensed provides less assurance for quality of service compared to shared spectrum. To the contrary of unlicensed spectrum, shared spectrum access is typically controlled by a Spectrum Access System which manages coexistence among tiers as well as users within a given tier. In the unlicensed spectrum, transmission can be done as soon as the product is certified while in shared spectrum, one needs permission from a SAS to transmit and the parameters are controlled by the SAS to manage coexistence.

For a dynamic spectrum sharing model to be adopted, it must protect the rights of T2, T3 users without impact to the legacy systems. It must also create a reasonable straightforward opportunity for an entity that wishes to access a shared spectrum to do so in a manner that is neither overly complex nor costly to implement. The practical implementation of dynamic spectrum sharing models is likely to require different national implementations because the regulatory approaches and the incumbent spectrum uses are different in various countries. As such, the approach considered in the US is subject to potential implementation and modification in another country, i.e. Australia, to reflect the local context and environment. The WInnForum set up the Regulatory Advisory Committee to discuss the sharing requirements in other countries and see if/how CBRS framework could be adapted to satisfy the needs of a specific country. We currently have representatives from France, UK, Germany, Singapore, Canada, Mexico and USA on this committee and would like to extend the invitation to representatives from ACMA to join to discuss the requirements for Australia.

There are a number of Tier 2 & Tier 3 use cases which are localised geographically and / or temporally. Examples would include underground mining<sup>7</sup>, logistics hubs and factories, and major events<sup>8</sup>.

The frequencies which might be considered for a CBRS approach in Australia could include the 3.7-4.2 GHz band, as Nokia indicated in its' submission to the replanning discussion paper for that band (specifically the 3.8-4.2 GHz range).

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<sup>7</sup> <https://www.rocktechnology.sandvik/en/news-and-media/news-archive/2019/01/sandvik-and-nokia-collaborate-to-deliver-industrial-iiot-to-mining-industry-over-lte-and-5g-networks/>

<sup>8</sup> <https://www.fiercewireless.com/tech/nokia-alphabet-qualcomm-take-cbrs-to-race-track>