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November 16, 2022

National Communications Authority (Nkom)
PO Box 93, 4791 Lillesand
Norway
firmapost@nkom.no

Re: DSA Comments to the public consultation on "Choice of path for frequency management towards 2030"

Dear Sir/Madam,

The Dynamic Spectrum Alliance (DSA)[1] respectfully submits these comments in response to the National Communications Authority (Nkom) public consultation on "Choice of path for frequency management towards 2030" (the Consultation), which seeks input on its efforts to ensure spectrum is used efficiently and effectively to maximize gains for users as well as for the Norwegian economy as a whole.

The DSA welcomes Nkom's interest in this important topic and fully supports its plans to explore innovative and increasingly efficient techniques for sharing spectrum. DSA believes that providing new spectrum access options through use of new spectrum management tools will benefit competition, create conditions for innovation, and spur more rapid deployments of new wireless broadband networks and services.

The DSA encourages Nkom to consider spectrum sharing approaches that allow multiple technologies, services, and deployment types to share and maximize efficient use of frequencies. In addition to considering lower power or localized use cases to enable sharing, we recommend that Nkom leverage dynamic shared access systems to maximize operational flexibility for new services as well as maximizing spectrum efficiency.

Several DSA members currently operate automated dynamic spectrum management systems on a commercial basis in the TV White Space (TVWS), 3.5 GHz, and 6 GHz bands and have significant insight into their operational capabilities and benefits as they enable the introduction of new services, including broadband mobile and fixed networks, local and private use cases, and applications. The success of these automated spectrum management systems has been notable - both in terms of their ability to increase

[1] The DSA is a global, cross-industry, not for profit organization advocating for laws, regulations, and economic best practices that will lead to more efficient utilization of spectrum, fostering innovation and affordable connectivity for all. Our membership spans multinationals, small-and medium-sized enterprises, as well as academic, research and other organizations from around the world all working to create innovative solutions that will benefit consumers and businesses alike by making spectrum abundant through dynamic spectrum sharing. A full list of DSA members is available on the DSA's website at www.dynamicspectrumalliance.org/members

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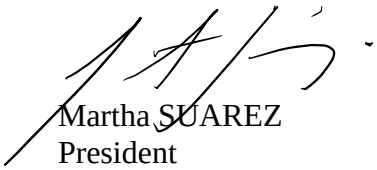
spectrum efficiency by enabling new services while successfully protecting incumbents as well as their ability to increase spectrum access options for a wide range of innovative, competitive services.

We are available to discuss these comments and provide any additional information as Nkom considers options for implementing such systems in Norway.

Respectfully submitted,



Martha SUAREZ
President
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DSA COMMENTS

I. Introduction to the DSA and Automated Spectrum Management Systems

Today we have the technical ability to automate frequency coordination and thereby lower transaction costs, use spectrum more efficiently, speed time-to-market for new services, protect incumbents from interference with greater certainty, and generally expand the supply of wireless connectivity that is fast becoming, like electricity, a critical input for most other industries and economic activity.

To maximize the efficient use of spectrum and provide a variety of access options, the DSA recommends Nkom implement automated shared access systems as well as innovative licensing frameworks. In the whitepaper entitled "Automated Frequency Coordination - An established tool for modern spectrum management,"[2] the DSA makes the case that the use of databases to coordinate spectrum assignments has evolved significantly since its first introduction, but at its heart, it is nothing new. The basic steps are the same as in a manual coordination process or where a regulator assesses the opportunities for local licensing on a case-by-case basis. However, what is new includes:

1) Surging consumer demand for wireless connectivity and hence the need to intensively share underutilized frequency bands;
2) Significant improvements in the computation power to efficiently and rapidly run advanced propagation analysis and coordinate devices and users in near real-time; and
3) More agile wireless equipment that can interact directly with dynamic frequency coordination databases.

Automated spectrum management systems, such as those developed for the TVWS, the 3.5 GHz Citizens Broadband Radio Service (CBRS), and 6 GHz bands are, at their core, very similar. Technical and service rules for operations in each band are converted into algorithms, which are used together with information provided as part of a database query, a list of available channels and the maximum power available on each available channel for that location is provided directly back to a device seeking to access the band.

The DSA anticipates that regulatory authorities worldwide will need to rely increasingly on automated spectrum management systems to handle surging demand for wireless connectivity by sharing underutilized frequency bands. Significant improvements in computation power are enabling more efficient and rapid advanced propagation analysis capability, which in turn enables coordination of devices and users in near real-time. In addition, more agile wireless equipment is

[2] Available at http://dynamicspectrumalliance.org/wp-content/uploads/2019/03/DSA_DB-Report_Final_03122019.pdf

being developed that can interact directly with dynamic frequency coordination databases, increasing opportunities for even greater efficiency and scale.

The following sections will describe three such automated spectrum management systems that have been developed in the United States and can be adapted to meet the objectives identified by Nkom for Norway's citizens and overall economy.

A) Automated Spectrum Sharing in the U.S. 3.5 GHz CBRS Band

One example of a successful implementation of an automated shared access system and novel licensing framework is the 3.5 GHz CBRS band in the United States. Authorized by the Federal Communications Commission (FCC) in January 2020, CBRS has been a shining example of the myriad benefits of automated spectrum sharing.

Under the CBRS regulatory framework, the spectrum access system (SAS) coordinates CBRS frequency use (3550-3700 MHz) and manages coexistence among the three tiers of access:

1) Incumbent (e.g., navy radar and commercial fixed satellite services);
2) Priority access licensed (PAL); and
3) General authorized access (GAA).

The environmental sensing capability (ESC) network detects incumbent naval radar use of the band and alerts the SAS to move new terrestrial commercial operations to non-interfering channels. The SAS also interfaces with the FCC's Universal Licensing System (ULS) to obtain information about fixed satellite service (FSS) incumbents and grandfathered fixed wireless systems. Using this information, the SAS is able to calculate aggregate interference from new commercial users to incumbents and enforce protection of these systems. In the nearly three years of commercial operational experience, no incumbents have reported interference from new CBRS users, demonstrating the effectiveness of SAS management of the band.

Commercial users in the CBRS band have multiple options for accessing this 150 MHz of spectrum:

- Acquisition of a PAL in the FCC's 2020 CBRS auction where use-or-share rights for county-based licenses were offered;
- Use of the GAA tier, which does not require an individual license to operate, but does require use of certified equipment and connectivity to a SAS to receive a spectrum grant for operations with a particular transmit power and antenna orientation at a specific location and height; or
- Leased rights from a PAL license holder.

Based on the type of device (fixed or personal/ portable) and its coordinates, information about the transmitter's location and operating parameters and the technical rules adopted to protect incumbents and/or adjacent users from harmful interference, the SAS calculation engine determines the list of available channels at the PAL and/or GAA device location and its maximum permissible radiated power.

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As described above, the SAS not only coordinates protection of incumbent users from new commercial operations, but also manages the assignment of frequencies to PAL and GAA users, protection of PAL operations, and co-existence among GAA users to maximize spectrum efficiency and provide deterministic access for all users. The automated SAS process provides near real-time management of the CBRS band, speeding time-to-market while minimizing uncertainty and administrative burdens.

Through this automation of shared spectrum, a whole host of new services have emerged. In addition to densification of the nationwide public mobile networks, and use of these frequencies by rural wireless Internet service providers (WISPs), a wide variety of private networks are also using the CBRS band. From business to leisure, hundreds of smart office, airport and stadium private networks have been deployed using CBRS as the result of having access to spectrum without the need for an individual license. In fact, today there are over 280,000 CBRS cell sites deployed across the United States with the vast majority using the GAA tier.

Examples of such private wireless network deployments using the CBRS GAA tier include:

Energy management:
https://www.fiercewireless.com/private-wireless/schneider-electric-adds-private-wireless-smart-factories

Retail:
https://www.druidsoftware.com/2019/11/15/cbrs-ongo-at-american-dream-entertainment-retail-complex-nj-usa/

Military logistics:
https://www.fiercewireless.com/private-wireless/federated-demo-dod-highlights-benefits-shared-spectrum

Municipal government:
https://www.fiercewireless.com/private-wireless/motorola-and-harris-county-build-private-lte-network

https://www.fiercewireless.com/private-wireless/cox-launches-cbrs-pilot-city-las-vegas

Transportation:
https://www.fiercewireless.com/wireless/boingo-deploys-trial-cbrs-network-at-dallas-love-field-airport

Education:
https://www.csrwire.com/press_releases/747561-private-wireless-helps-schools-close-digital-divide

https://www.fiercewireless.com/private-wireless/fort-worth-isd-builds-sustainable-cbrs-network

https://www.fiercewireless.com/private-wireless/samsung-amdocs-deploy-private-cbrs-network-howard-university

Entertainment:
https://inbuildingtech.com/venues/connectivity-wireless-jma-stadium-cbrs/

Hospitality:
https://www.thefastmode.com/technology-solutions/24585-airspan-networks-deploys-5g-cbrs-private-network-for-hospitality-industry

Manufacturing warehouse/supply chain:
https://www.fiercewireless.com/private-wireless/calchip-connect-emerges-key-player-private-wireless

https://www.fiercewireless.com/private-wireless/mxd-adds-second-private-wireless-network

Agriculture:
https://www.fiercewireless.com/private-wireless/three-day-deployment-makes-tractors-autonomous

https://enterpriseiotinsights.com/20220607/smart-farm/how-robot-tractors-and-a-private-network-came-together-at-a-smart-vineyard

B. Automated Frequency Coordination of Licence-Exempt Standard Power Operations in the 6 GHz Band

Another notable example of the application of automated spectrum sharing is in the 6 GHz Band, where regulators worldwide are enabling licence-exempt WLAN/RLAN use on a shared basis with incumbent services. While some countries have permitted licence-exempt operations in only the lower 500 MHz of the band, countries in all three ITU Regions have permitted license-exempt use across the entire 6 GHz band (5925-7125 MHz).

In general, three different categories of license-exempt devices have been authorized. These are:

(1) Very Low Power (VLP) devices that can operate both outdoors and indoors across the entire 6 GHz band, and

(2) Low Power Indoor (LPI) devices that can operate across the entire 6 GHz band, both of which can do not require automated frequency sharing, and

(3) Standard Power (SP) devices that can operate both outdoors and indoors under the coordination of an automated database management system, known as the

Automated Frequency Coordinator (AFC). Depending on the incumbent services licensed within a given country, SP devices may only be able to operate in portions of the 6 GHz band.

Countries worldwide are actively deploying LPI and VLP devices on a licence-exempt, shared basis in the 6 GHz band, leveraging wider channel availability (up to 160 MHz with Wi-Fi 6E) to increase spectrum efficiency while maintaining the ability to share spectrum with incumbents and other licence-exempt deployments. In the future, Wi-Fi 7 will be able to accommodate 320 MHz channels, which will further improve latency, throughput, reliability, and quality of service.

For SP and outdoor operations, AFC systems have been designed to provide channel availability information to licence-exempt devices, while ensuring that incumbent systems, including fixed point-to-point microwave links, are protected from interference. When an authorized and authenticated device queries an AFC for spectrum availability, the AFC assesses which incumbent receivers have the potential to receive excess energy from the licence-exempt device based on its location and potential transmit power. The AFC calculates the maximum transmit power for that device's location on each 6 GHz channel and provides a list of options for the device to select. The device must check in with the AFC daily to determine if any changes to incumbent use of the band have occurred that would alter the channel and transmit power options available to it.

Building on the experience and lessons learned from the use of SAS in the CBRS band, several DSA members have developed AFC systems for the 6 GHz Band and have applied to become AFC system operators in the United States. Just recently, the FCC granted conditional approval to these AFC system applicants. After the upcoming lab and public testing phases of the certification process, we expect the FCC will allow standard power licence-exempt devices to begin using the 6 GHz band in early 2023. DSA anticipates that many of these same AFC system developers will also seek to operate in countries, such as Canada, Brazil, Korea, and Saudi Arabia, that are in the process of finalizing their regulations for licence-exempt access to the 6 GHz Band, including use of an AFC to manage standard power devices.

C. TV White Spaces

A third example of an automated spectrum management system in operation in the United States and other countries is in the broadcast television White Spaces where automated spectrum management systems facilitate licence-exempt access to vacant TV band channels. Rules governing database-coordinated access to TVWS were finalized first in 2008 by the FCC but have been adopted by a growing list of countries since then. TVWS database systems ingest incumbent licensing data, including geolocation and operating parameters, and calculate vacant channel availability, as well as allowed power levels, providing a list of available frequencies and permissible transmit powers to White Space devices. In the United States this incumbent protection data includes "reservations" of scheduled activity provided via an online portal by licensed wireless microphones, which typically operate intermittently (for example, at major public events). In this sense, the TVWS system manages three-tiers of sharing, where

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licensed Program Making & Special Events (PMSE) users (microphones) have priority access in relation to licence-exempt devices.

II. DSA Comments on Nkom's Consultation

In the Consultation, Nkom identifies several types of wireless services, including mobile, point-to-multipoint, and licence-exempt (free use), where it seeks input on how to ensure spectrum is used efficiently and effectively to maximize gains for users as well as for the economy as a whole. The DSA looks forward to working with Nkom on planning for these bands and exploring how commercially available automated sharing technology can be leveraged to maximize opportunities for additional spectrum access. In the following sections, the DSA will provide its views on how Nkom can:

A. Foster the development of 5G/6G for new mobile and fixed broadband services;
B. Implement shared use of the 3800-4200 MHz band for private local area networks;
C. Maximize the use of the full 6 GHz band for the latest generation of licence-exempt technologies.

A. Foster the development of 5G/6G

In the Consultation Nkom indicates that it is monitoring technological developments that might aid it to identify new spectrum or conditions of spectrum sharing that will foster the development of 5G/6G mobile and fixed networks and services.

When considering these different licensing approaches to foster the development of new mobile broadband networks and services, DSA encourages Nkom to consider a tiered framework that will provide multiple spectrum access options for different types of operators and users. A three-tier or two-tier framework could be adopted depending on the frequency band and its incumbent situation. In bands where incumbents are operating, those operations could continue in the top tier on a protected basis, while new entrants in one or more lower tiers may operate so long as they protect the top tier. A three-tiered approach could be adopted as follows:

- Tier 1 – Incumbent users. Users operating in the band that have the highest priority in accessing spectrum. Their access must be guaranteed at all times during their operation so their radio equipment does not need to be aware of other operations sharing the band.
- Tier 2 – Licensed new users. New entrant users that require a degree of certainty in accessing spectrum. In order to ensure that the band can be shared with this tier of new users, it is fundamental that the operation of incumbent services is well understood (for example, they operate only in certain areas) and is predictable (for example, they operate at certain times or there is a way to know when spectrum needs to be vacated). If such information is not accurate enough or it is not available, then access to the band for Tier 2 users might be greatly reduced or not possible at all.

- Tier 3 – Opportunistic users. New entrant users that can access spectrum on a licence-exempt or licensed by rule basis. These users may not need access to spectrum over a larger geographic area and/or are operating indoors or on a campus or may be operating in more remote areas where spectrum usage will not be as competitive. In many cases, such networks are deployed in very remote areas where spectrum is largely unused and the risk of interference to higher tier users is negligible. There might be other cases where there is sufficient spectrum available and the envisioned applications allow QoS flexibility, for example because the band would mainly be used to provide additional capacity to networks using other anchor frequencies. In such cases, it is conceivable to have a third tier of users with minimal regulatory barriers and no need for interference protection from other Tier 3 users.

In theory, a tiered spectrum sharing model can be applied to any band. In addition, it is also possible to combine a tiered licensing approach with streamlined secondary market rights. For example, the new license conditions might include the right for the license holder to lease the spectrum to other users – whether on a geographic basis (partitioning) or by sub-dividing the spectrum (disaggregating). Such a secondary market can drive innovation, allow new technology to be deployed by leased spectrum users, and support various sectors, such as enterprise networks and industrial uses.

The DSA also recommends that regulators consider implementing a "use-it-or-share-it" policy for bands that are licensed to mobile network operators. Conceptually, use-it-or-share-it rules authorize opportunistic access to licensed spectrum that is locally unused or underutilized. Until the spectrum is actually put to use in a local area, it should be available for non-interfering use by networks and devices. Licensees lose no rights whatsoever. By way of example, as described above, the FCC authorized opportunistic access by GAA users to unused PAL spectrum in the 3.5 GHz CBRS band. Opportunistic use of unused PAL spectrum is controlled by the SAS, which requires that GAA users must periodically check with the database to renew permission to continue operating. This is one of the key reasons for the success of CBRS.

A general use-it-or-share-it authorization has a number of affirmative benefits. First, opportunistic access reduces spectrum warehousing in areas where the economics are least attractive for large service providers. It might increase access for operators that are interested in deploying, but who lack needed spectrum access in that local area. Second, opportunistic access further encourages secondary market transactions by facilitating price discovery on both the supply and demand side. For licensees, it will both identify users interested in a potential lease or partition and provide information on the potential value (i.e., how much is my spectrum worth?). For users, opportunistic use is an opportunity to test the local market and to determine the value of a more secure, longer-term lease or partition agreement (i.e., how much am I willing to pay for spectrum?). Third, opportunistic access will lower barriers to entry for innovative new use cases by parties that at least initially either cannot afford or do not believe they need to pay for exclusive use and interference protection. The option to deploy, at least initially, without committing to the cost of a long-term lease or license could be particularly useful for small providers and industries.

For these reasons, the DSA recommends that Nkom consider a tiered licensing approach, together with a use-it-or-share-it policy, which will help meet future mobile data traffic demands, benefit competition, create conditions for innovation, and spur more rapid deployment of 5G/6G wireless networks and services.

B. Implement shared use of the 3800-4200 MHz band for private local area networks

The DSA strongly supports plans to use the 3800-4200 MHz band for medium/low power local area licensing for wireless broadband services, including private 4G/5G networks. We encourage the use of an automated spectrum management system to protect incumbent services in the band, maximize efficiency, and offer multiple access options to new users.

Local licenses in the 3800-4200 MHz band could be for both indoor and outdoor use cases. Although the appropriate EIRP limits for these devices must be determined nationally, ideally such limits are adopted in a manner that will foster global harmonization.

Protection of incumbent fixed satellite services and efficient use of this band can both be achieved through the development and application of an automated cloud-based spectrum management system. Much has been learned over the years from the development of TV White Spaces Databases, the CBRS SAS, and the 6 GHz AFC system, that can be applied to local licensing in this band in Norway and throughout Europe. As mentioned above, use of the CBRS band for a wide range of private networks has grown dramatically since its commercialization nearly three years ago. One of the key reasons for this rapid growth is the ability for private network users to access spectrum on a near real-time basis for the duration and location of their choosing through use of an automated spectrum management system. Applying cloud-computing capabilities to spectrum management will also enable more predictable quality of service, better congestion avoidance, and improved coordination.

C. Maximize the use of the full 6 GHz band for the latest generation of licence-exempt technologies

The DSA respectfully suggests that Nkom consider: (1) dedicating the upper portion of the 6 GHz band (6425-7125 MHz) for license-exempt use, taking advantage of the full potential of this band; and (2) authorizing the three categories of license-exempt devices: VLP, LPI, and SP devices under the management of an AFC System.

Authorizing the entire 6 GHz band for licence-exempt use will allow Norwegian residents and enterprises to benefit from all the Wi-Fi 6E devices commercially available today, and importantly, also allow them to benefit from Wi-Fi 7 products expected to be widely available in 2024. Without sufficient licence-exempt spectrum, there will be less interest in making these products available for the Norwegian market for early adopters. Importantly, making the 6425-7125 MHz band available for licence-exempt device to share with incumbent users will continue to allow fixed service, fixed satellite service, and other incumbents thrive in the band.

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Even in the face of a lack of demonstrated demand for additional 5G (IMT) spectrum, were the 6425-7125 MHz band to be identified for IMT at WRC-23 and licensed domestically for mobile operations, Nkom would have to relocate fixed service links and other incumbent operations to other frequency bands. The clearing and relocation process would take years to complete and create economic disruption to the affected incumbents. The best guess today is that the 6425-7125 MHz band could be cleared and made available for mobile networks operators through auction around 2030. Realistically, the spectrum would not be put into widespread use until almost 10 years from now.

Alternatively, if Nkom supports licence-exempt access across the entire 6 GHz band, the economic and societal benefits to Norway can begin accruing as soon as ECC SE45 completes its work in 2024 and the homologation procedures are put in place, as there are currently many commercially Wi-Fi 6E products available today in North America and Asia. The DSA also encourages Norway to support a new work item in WG FM to study the regulatory aspects of making 6425-7125 MHz band available for licence-exempt use. To avoid unnecessary delay, this work item should start as soon as possible and run in parallel to the work item in SE45.

Over 90 percent of European data usage takes place indoors, and 92 percent of that indoor traffic is carried by Wi-Fi. Where broadband capacity is provided to the network termination point of a residential or office building through fiber, coax cable, or fixed wireless, Wi-Fi is by far the most energy and spectrally efficient technology to bring that capacity from outside the building to the multitude of devices operating within the building. The DSA has recently published a whitepaper that shows that allowing Wi-Fi in the upper 6 GHz band will improve the quality of service of about 90% of internet access in Europe, amounting to a more efficient use of spectrum than mobile networks.[3]

It is the collective experience of DSA's members that consumers judge the quality of their broadband service not on the broadband speed delivered to their residence, but rather on the data rates their device(s) achieve within their residence, the quality of the user experience, and the affordability of the service. Clearly, fiber solutions can provide enormous data rates. However, if there is a bottleneck between the network termination point at the edge of the residence and the user device(s), residents will not be able to receive the full benefits of their investment in the fiber service. The availability of Wi-Fi access points and Wi-Fi enabled user devices operating across the entire 6 GHz band will ensure that multiple Wi-Fi devices operating at broadband speeds can operate concurrently, without creating a bottleneck.

In general, a relatively low-power, licence-exempt technology such as Wi-Fi allows for permissionless innovation and rapid experimentation in many different industry verticals and consumer devices. If an insufficient amount of spectrum is available to be shared, Wi-Fi network performance will suffer, particularly with high-bandwidth use cases in high-density deployments such as educational facilities (universities), large public venues, and hospitals but also HD/UHD video streaming and virtual reality in dense residential areas. Norway can ensure that Wi-Fi can thrive in high-bandwidth / high-density use cases by ensuring that the entire 6 GHz band is made available for licence-exempt use.

[3] How do Europeans connect to the internet?, 2022. Available at: http://dynamicspectrumalliance.org/ressources

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III. Conclusion

The DSA appreciates the opportunity to provide input on Nkom's Consultation. We believe that the use of spectrum sharing and automated sharing technology can help Nkom to reach its goals of ensuring spectrum is used efficiently and effectively, maximizing gains for users as well as for the Norwegian economy, and facilitating spectrum access by a variety of entities and use cases, including 5G/6G mobile networks as well as private wireless networks.