

## **Federated Wireless Inc.**

### **Response to DCMS Statement of Strategic Priorities for telecommunications, the management of radio spectrum and postal services**

Federated Wireless Inc. (Federated Wireless) hereby submits comments in response to the Department for Digital, Culture, Media & Sport (DCMS) consultation entitled, "Statement of Strategic Priorities for telecommunications, the management of radio spectrum and postal services," in which DCMS promotes the use of flexible, shared spectrum models. Federated Wireless commends DCMS for its recognition of the importance of shared spectrum technology and licensing models and their ability to enable new entrants and the development of new business models and innovative applications.

We appreciate the opportunity to share our experience in implementing dynamic spectrum sharing in the 3.5 GHz band in the United States and offer our perspectives on how this same technology can be readily deployed to meet the United Kingdom's strategic priorities, including: a) improving broadband coverage in rural communities as well as in dense urban environments, such in-buildings as well as large public venues; b) enabling deployment of private 4G/5G networks by industrial and critical infrastructure enterprises; and c) supporting introduction of fixed wireless access.

#### **I. Background on Federated Wireless and Dynamic Spectrum Sharing in the CBRS Band**

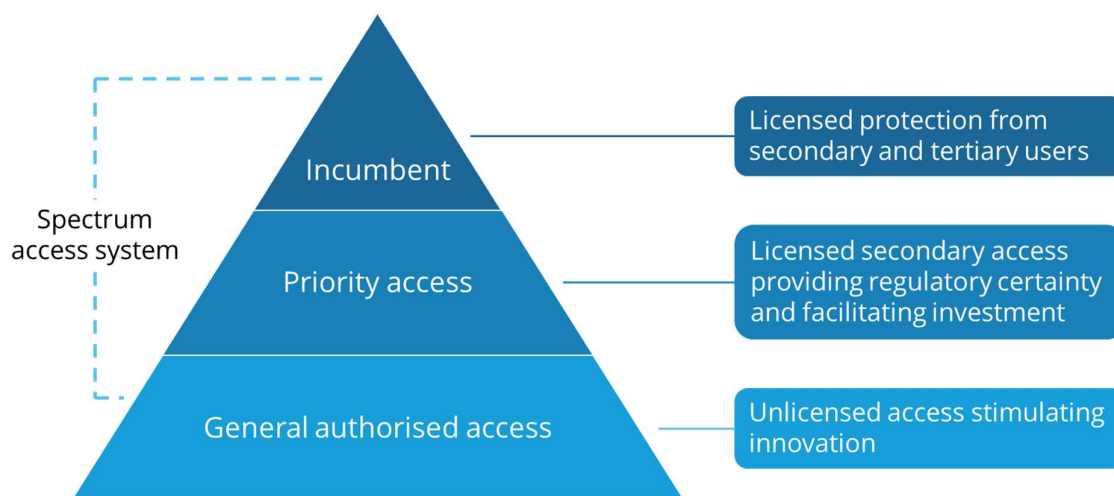
Federated Wireless is a U.S.-based wireless technology company (70% owned by U.K. investors) that is assisting the U.S. Government and industry to launch new wireless broadband services in 3550-3700 MHz, known as the Citizens Broadband Radio Service (CBRS) band, by managing dynamic sharing of these frequencies between incumbent military and commercial uses as well as between different tiers of commercial uses on both a licensed and unlicensed basis.

The U.S. Federal Communications Commission (FCC) has established rules to allow use of the CBRS band by commercial broadband service providers, while protecting the incumbent shipborne and land-based U.S. Department of Defense radars, commercial Fixed-satellite Service (FSS) receive earth stations, and commercial terrestrial fixed point-to-multipoint systems (see Figure 1 below). Federated Wireless is one of the entities authorized by the FCC to deploy and administer a Spectrum Access System (SAS) to enable dynamic spectrum sharing of the CBRS band.<sup>1</sup> This standards-based SAS is implemented as a Software as a Service (SaaS) in the cloud for efficiency, scalability, reliability, and ease of deployment.

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<sup>1</sup> In addition to Federated Wireless, the FCC has conditionally approved the following additional SAS administrators: Amdocs, Inc., Comsearch, Google, Inc., Key Bridge, and Sony Electronics, Inc. All conditionally approved SAS Administrators were required to submit their systems for compliance testing before final approval. This compliance testing process is in the final stages leading to commercial launch of services.

**Figure 1 – CBRS Tiered Sharing**



The priority of spectrum access and protection of higher tier users in the 3.5 GHz band is governed by the SAS, which maintains a database of all commercial CBRS devices (both base stations and outdoor access points) and works with environmental sensors, known as the Environmental Sensing Capability (ESC), to mitigate possible interference to the incumbent users. The functions of the Federated Wireless SAS+ESC are to:

- Register and authenticate the identity, location and technical characteristics of CBRS devices;
- Determine the available frequencies at a given geographic location and assign them to CBRS devices;
- Determine the maximum permissible radiated transmission power level at a given location and communicate that information to the CBRS devices.
- Enforce protection zones, including any future changes to such zones, to ensure compatibility between CBRS users and incumbent federal operations.

While the FCC’s rules for CBRS are specific to the United States and its incumbent users, the Federated Wireless SAS is readily adaptable to new frequency bands and technologies. Once protection criteria for incumbent users are established and a database of these incumbent users is updated with the most current information, it is straightforward to adapt the dynamic shared access system developed for CBRS to operate in other frequency bands, such as those Ofcom has identified in its recent consultation, “Enabling Opportunities for Innovation.”

In addition to enabling sharing between incumbent government users and commercial users, the adoption of a dynamic shared access system can facilitate access for 4G and/or 5G services in bands already occupied by other commercial users, including licensed mobile incumbents, in an automated and light-touch manner and can further facilitate sharing by lower tier users on a lightly-licensed or unlicensed basis. The regulatory certainty afforded to licensed use of the spectrum is critical to attract investment and develop a robust ecosystem, while lightly-licensed/unlicensed access can promote innovation and new business models.

The FCC noted the myriad benefits of this multi-tiered dynamic sharing approach when it established the CBRS rules and framework:

“This regulatory adaptability should make the 3.5 GHz Band hospitable to a wide variety of users, deployment models, and business cases, including some solutions to market needs not adequately served by our conventional licensed or unlicensed rules. Carriers can avail themselves of “success-based” license acquisition, deploying small cells on a GAA [unlicensed opportunistic] basis where they need additional capacity and paying for the surety of license protection only in targeted locations where they find a demonstrable need for more interference protection. Real estate owners can deploy neutral host systems in high-traffic venues, allowing for cost-effective network sharing among multiple wireless providers and their customers. Manufacturers, utilities, and other large industries can construct private wireless broadband networks to automate processes that require some measure of interference protection and yet are not appropriately outsourced to a commercial cellular network. Smart grid, rural broadband, small cell backhaul, and other point-to-multipoint networks can potentially access three times more bandwidth than was available under our previous 3650-3700 MHz band rules. All of these applications could share common wireless technologies, providing economies of scale and facilitating intensive use of the spectrum.”<sup>2</sup>

As Ofcom considers its options for the 1.8, 2.3, and 3.8-4.2 GHz bands, as well as the previously awarded mobile bands, we believe dynamic spectrum access technology, such as the Federated Wireless dynamic shared spectrum access system, can be a powerful spectrum management tool to harness additional spectrum on both a licensed and opportunistic basis in the immediate future. Furthermore, given the widespread availability of equipment in the 3.6 GHz band today, spectrum for opportunistic access should first be considered in the 3.6-3.8 GHz band where there is enough spectrum to license multiple operators on an exclusive basis and still provide ample spectrum for opportunistic or unlicensed access. We believe that the implementation of dynamic shared spectrum technology, together with tiered licensed and opportunistic access, will assist both DCMS and Ofcom to achieve their objectives of maximizing the efficient use of spectrum, enabling innovative industrial applications, improving wireless broadband coverage, and promoting competition in the provision of wireless broadband services.

## **II. Federated Wireless’ Perspectives on Ofcom’s Shared Spectrum Proposal**

As we mentioned in our recent comments on Ofcom’s consultation, “Enabling Opportunities for Innovation,” Federated Wireless welcomes proposals to enable shared access to bands supporting mobile technology. We believe that a shared spectrum approach, in particular one involving dynamic shared technology combined with multiple tiers of commercial access, will achieve the goals that Ofcom has identified, namely to: a) promote deployment of private networks that can facilitate industrial IoT applications; b) improve rural broadband connectivity through neutral host solutions; and c) address the challenges of urban and rural not-spots.

We note that Ofcom set out two different licensing approaches in its consultation - one for bands previously awarded to mobile operators and another for three bands where there is limited incumbent usage. Ofcom suggests that the first would be an application process leading to a three-year entitlement and that the second would be a form of hyper-local licensing. Federated Wireless suggests that the same approach should be used for both scenarios and that this approach be based on dynamic sharing using automated database access. We believe an automated database approach will be quicker to implement, less bureaucratic, more likely to lead to a vibrant innovative eco-

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<sup>2</sup> Amendment of the Commission’s Rules with Regard to Commercial Operations in the 3550-3650 MHz Band, GN Docket No. 12-354, FCC 15-47, Report and Order and Second Further Notice of Proposed Rulemaking (*CBRS R&O*), ¶ 6, (2015).

system, much more efficient in the use of spectrum, and future-proof. Such an approach can build on Ofcom's prior experiences with TV White Spaces and Federated Wireless' own experience with enabling dynamic shared spectrum access in mobile bands.

We have identified some aspects of Ofcom's proposal to which we recommend an alternate approach. After summarizing each of our recommendations, we will address each in greater detail below.

- 1) Shared spectrum access should be implemented on an automated, dynamic basis given that the technology is available today, is easily adapted for new bands and/or incumbent protection criteria, will maximize the use of available spectrum more quickly and broadly than a static approach, and will avoid significant administrative burdens on Ofcom, incumbents and new licensees alike.
- 2) The use of dynamic shared technology, combined with multiple tiers of commercial access, should be implemented in the 1.8, 2.3 and 3.8-4.2 GHz bands at the outset to maximize opportunistic access for the largest number of diverse users and to encourage investment and the development of a robust ecosystem.
- 3) Ofcom's focus should be to develop protection criteria for incumbents as well as a set of minimum requirements for dynamic shared spectrum access systems that can be easily enforced, is consistent across shared access system administrators, and is future-proof (meaning the shared access system can adapt if changes to protection criteria are needed and/or if incumbents look to expand or otherwise change their usage). Ofcom already has experience of these tasks from its work on TV Whites Spaces.
- 4) Dynamic spectrum sharing should be implemented in bands where standardized mobile equipment is available today, such as 3.6-3.8 GHz, and in bands where sufficient spectrum is available for multiple users to gain access on both a licensed and opportunistic basis, which incentivize investment and drive development of low-cost equipment.
- 5) In addition to the upper 10 MHz of the 2.3 GHz band, opportunistic access can be introduced in the lower portion of the 2.3 GHz band by implementing a dynamic sharing access system with MoD's use as the highest tier.

### III. Federated Wireless' Detailed Recommendations

- 1) ***Shared spectrum access should be implemented on an automated, dynamic basis given that the technology is available today, is easily adapted for new bands and/or incumbent protection criteria, will maximize the use of available spectrum more quickly and broadly than via a static approach, and will avoid significant administrative burdens on Ofcom, incumbents and new licensees alike.***

Federated Wireless agrees with DCMS and Ofcom in their assessment that a dynamic shared access approach would provide users with more flexibility and would enable more efficient use of available frequencies than the manual, static approach proposed in the consultation. We disagree, however, with Ofcom's determination that an automated dynamic shared access solution would take too long to develop and test. Dynamic shared access technology is already available from multiple vendors and has been thoroughly tested through a rigorous process involving multiple government agencies,

incumbent users, industry associations and technology providers. It will be neither difficult nor time-consuming to adapt available solutions to the bands that Ofcom has identified, while meeting current demand for additional spectrum access.

Automated and dynamic spectrum sharing technology is available today, is frequency band agnostic, and can readily provide a spectrum management tool that offers advantages to stakeholders over traditional approaches. These advantages include:

- Speed to market and agility of deployment;
- Seamless protection of incumbent users;
- Increased spectrum efficiency through opportunistic spectrum access on a geographic or time dependent basis; and
- Support for innovative business plans and the creation of a robust and sizeable ecosystem of suppliers and vendors;
- Flexibility to adjust protection criteria (whether more conservative or more liberal) as needed;
- Ability to adjust for future growth of both incumbent and new services.

Dynamic spectrum sharing technology's strength lies in its ability to adapt quickly to any set of rules in any band. Creating and assigning protection through "priority tiers" can be fully customized, as can the rules pertaining to prioritization, size, location, duration of spectrum grants, and more (e.g., a priority tier can also be exclusive licenses). The parameters can be changed if subsequent circumstances warrant, such as the need and/or opportunity to change protection criteria, and typically such changes require little more than changes to software code and importantly with no impact to infrastructure or devices already deployed. Conceptually, so long as the spectrum access sharing system knows the rules for the band, it can assign spectrum and provide protection when and where needed. The sharing system can dynamically adjust spectrum allocations, power limits, and other operational parameters to ensure protection to incumbents and afford spectrum access for new entrants, while also providing regulatory and technological flexibility that allows use cases to develop over time.

Given its experience, Federated Wireless estimates it would take 3-6 months of engineering work to adapt the SAS developed for the CBRS band to the United Kingdom once Ofcom has completed the process of establishing protection criteria for incumbent and/or higher tier users. Such adaptation would include incorporating terrain databases, synchronizing with Ofcom's databases, eliminating unneeded features, etc.

We are concerned that the proposed manual, static approach would impose significant administrative burdens on Ofcom and could include processing potentially hundreds, if not thousands, of license applications and negotiating an equally large number of access agreements with incumbents. In addition to the administrative burdens that would be imposed on Ofcom, mobile license incumbents would also be required to respond to myriad access requests, resulting in significant costs to operators.

An automated shared access system, on the other hand, could determine available frequencies for multiple prospective users within the same area within a matter of hours, while simultaneously protecting incumbent operations. Such an automated system could also be refreshed on a regular basis, making new frequency assignments available days or even hours after a particular user is no longer occupying the spectrum or when a new user comes online, making far more efficient use of available spectrum than would a static approach.

Furthermore, only an automated shared access system can scale effectively with the pent-up demand for spectrum access. In the United States, such demand can be seen in the number of CBRS devices that are planned for Initial Commercial Deployment (ICD) once FCC certification of SAS software is completed (anticipated in Q2'18). In its ICD application, Federated Wireless' partners have requested authority to deploy 17,000 devices on a shared basis in the CBRS band in the first 12 months.<sup>3</sup> It would be an extraordinary burden on Ofcom and on the mobile industry as a whole to manage manually a volume of applications similar to this for access to spectrum.

**2) *The use of dynamic shared technology combined with multiple tiers of commercial access should be implemented in the 1.8, 2.3 and 3.8-4.2 GHz bands at the outset to maximize opportunistic access for the largest number of diverse users and to encourage investment and the development of a robust ecosystem.***

Without adequate bandwidth for current and future standards-based technology and the confidence that sufficient bandwidth will be available on an opportunistic basis to support their business needs, it will be difficult to convince new entrants to invest.

The Ofcom proposal for first-come, first-served, local area licensing is unlikely to fully realize the Government's policy goals of introducing new users or new uses in these bands. Ofcom should instead adopt a tiered shared approach that includes both licensed and opportunistic access, including a use-it or share-it provision for the licensed access tier. Such an approach has undeniable benefits to broaden access to and use of spectrum:

- A tiered, multi-access approach assures that spectrum is always in use. An indefinite license term that grants exclusive use and does not include an obligation to either use the spectrum or make it available for others will not assure the spectrum is fully utilized. Furthermore, there is no mechanism in place to prevent the accumulation of local area licenses into large regional or near nationwide licenses in these bands.
- A first-come, first-served approach triggers an unfavorable race to file applications. The opportunity cost to forego applying for a license at the outset is far greater than the cost of carrying the license. Therefore, users are far more likely to license and warehouse spectrum until they can find a purpose to use it. This trigger is exacerbated by the ability of the licensee to conduct spectrum trading, which would incentivize speculators to file applications and wait to sell without ever putting the spectrum to use. The United Kingdom's goal should be to ensure that spectrum is used for its best and highest purpose by those who value it most, not just by whoever is able to submit an application the fastest. With a hybrid licensed/opportunistic access approach, on the other hand, users can "right size" their spectrum access based on the relative abundance or scarcity of spectrum. Transitioning from the shared, opportunistic access tier to the licensed access tier can occur on a frictionless basis.
- Spectrum users compete for spectrum access based on market conditions. The Ofcom proposal to recover mere administrative costs for licensing via fees is not market based. It places the same value on spectrum access without regard to underlying market conditions (e.g., a license in central London carries the same cost as one in rural Scotland, despite the fact that the value of that license to the user is much different).

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<sup>3</sup> <https://ecfsapi.fcc.gov/file/10910536424136/Federated%20Wireless%20ICD%20Proposal%20-%20OREDACTED.pdf>

Together, licensed and opportunistic shared access assure the largest possible ecosystem for equipment and devices, resulting in more choice and lower cost for network operators and end users. Manufacturers will build devices to satisfy both the needs of licensed and shared access users. Ofcom's proposal does not include a band-wide interoperability mandate for equipment or devices. As such, a market where equipment is purpose-built for specific customers and their exclusively licensed bands will continue. Limiting the potential size of the equipment and device ecosystem will similarly limit the potential for new and innovative uses of these bands, and it increases the likelihood that these bands will be licensed only by those with sufficient size and capital to drive ecosystem development (e.g., the incumbent MNOs).

**3) *Ofcom's focus should be to develop protection criteria for incumbents as well as a set of minimum requirements for private-sector developed dynamic shared spectrum access systems that can be easily enforced, is consistent across shared access system administrators, and is future-proof.***

Ofcom can most expediently implement dynamic shared spectrum access by: a) enabling competition in the development and operation of dynamic shared access systems; and b) setting protection criteria for existing authorized users and determining a set of requirements for shared access systems that will enable administrators to develop protocols, procedures, and systems to enforce Ofcom's rules.

*a) Competitive private sector development of shared access solutions*

The most expedient way to enable spectrum sharing in the various bands Ofcom has identified is to allow the private sector to develop solutions on a competitive basis. Authorizing more than one spectrum sharing access administrator can introduce significant competitive pressure, which will in turn foster innovation and service enhancements that accrue to the benefit of both users and consumers. Competition amongst shared spectrum access administrators will aid in ensuring that various use cases – whether consumer, enterprise, or Internet-of-Things applications—are all served and that a dynamic, innovative ecosystem can evolve unimpeded.

Through the CBRS rulemaking process, the FCC realized that its efforts would be better spent determining the baseline technical rules that will be necessary to protect incumbent users, rather than adopting proscriptive rules for shared access systems. The FCC allowed industry to develop standards-based approaches to ensure that the SASs operate and communicate with each other in a way that ensures compliance with the FCC's protection criteria, including standards governing interfaces between the SAS and CBRS devices, interfaces between SASs, communications security, professional installation of CBRS devices, and other aspects of CBRS operations. Federated Wireless recommends that the United Kingdom follow a similar process that allows industry to adapt existing solutions for the U.K. market on a competitive basis, which will facilitate the rapid development and deployment of multiple fully functional dynamic shared spectrum access systems. Ofcom can verify and approve the shared access systems using processes such as those adopted for TV White Spaces and we would be happy to advise based on our experience of the U.S. approval process

*b) Protection criteria for existing authorized users and requirements for shared access systems*

In addition to developing incumbent protection criteria, shared access systems should synchronize with Ofcom databases to obtain current data regarding incumbent licensees' locations and operational characteristics, including power levels, antenna height, among others. Shared access

systems would then use such information to conduct the analyses necessary to implement and enforce relevant incumbent protection criteria.

Having access to the most current data on incumbent operations will be critical for shared access system administrators to conduct interference calculations to coordinate new users and simultaneously protect incumbent users. This information can be maintained in a publicly accessible database or, depending on the sensitivity of the incumbent use, could be maintained in a confidential database. In cases where the incumbent use is dynamic, a scheduling portal and/or a sensing capability could provide shared access administrators with the data necessary to conduct interference calculations. This type of reporting requirement is not new. A notification approach by the mobile operators is already in use for in the 800 MHz band to allow them to mitigate interference from their operations to TV reception.

It will also be important for shared spectrum access system administrators to have access to the information about new users, including accurate location and technical information that be used to conduct the computations needed to identify what spectrum is available for new users to operate in accordance with the incumbent protection criteria. The provision of this location and technical information, such as antenna height, orientation, and power level, is fundamental to enable spectrum access system administrators to perform intended incumbent protection functions. Without knowledge of a new user's location and operational parameters, shared access system administrators would be unable to demonstrate that they are effectively enforcing incumbent protections, nor would they be able to assess and implement any needed modifications to their interference calculations in the event of unexpected interference to an incumbent licensee.

Another important aspect of this automation is interference resolution. The manual process proposed by Ofcom will be inefficient in identifying and resolving interference claims. Ofcom proposes to coordinate interference both with existing authorized users as well as newly licensed users, thereby increasing the complexity of interference identification and resolution according to the total number of issued licenses. In central London, where potentially thousands of low power licenses may be issued, there will be no feasible way to identify and resolve interference through manual processes. The burden of manual processes will be on Ofcom as well as the licensees given the need for resources to identify, report, and remediate interference events. Ultimately this will be a barrier to investment in the bands.<sup>4</sup>

Furthermore, in order to ensure ongoing compliance with incumbent protection criteria, it will be imperative for new users to send a periodic query back to a shared access system to receive updated frequency availability information. The combination of regular synchronization between a shared access system and databases with respect to incumbent licensee operations in addition to a mechanism under which new users regularly query a shared access system to obtain frequency availability creates a "closed loop" ecosystem. A closed loop system ensures that the shared access system has an accurate picture of the local RF environment to facilitate spectrum access for new users and ensure incumbent protection. This periodic querying mechanism would also provide additional flexibility for incumbents to grow their operations, as the regular updates between databases, shared access systems, and new users would ensure appropriate protection for newly deployed incumbent systems.

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<sup>4</sup> Site-based licensing is already in use in a number of bands in the United States. For example, trunked radio systems and fixed microwave links are authorized on site-based licensing. Over time the burden related to coordinating frequency assignments and resolving interference in these bands has become so great that the FCC has approved third parties to serve as band managers.



Should it be determined that revised protection criteria for incumbents is warranted, whether more or less stringent than what is initially adopted, a dynamic shared access system that is in periodic contact with both databases and new users will be capable of updating its interference calculations in real-time and providing up-to-date frequency availability to new users.

- 4) *Dynamic spectrum sharing should be implemented in bands where standardized mobile equipment is available today, such as 3.6-3.8 GHz, and in bands where sufficient spectrum is available for multiple users to gain access on both a licensed and opportunistic basis, which incentivize investment and drive development of low-cost equipment.***

Federated Wireless, like DCMS, recommends a focus on the 3.6-3.8 GHz band, which has significant support from the mobile community. On the other hand, the 3.8-4.2 GHz band, which Ofcom has proposed to make available on a shared basis, currently has less support from industry, making the timing of widespread availability of handsets for this band unclear. There is a risk that, like TV White Spaces, a lack of handsets could lead to a lack of network deployment, and a robust ecosystem will fail to evolve in this band. As such, spectrum for opportunistic access should first be considered in the 3.6-3.8 GHz band where there is enough spectrum to license multiple operators on an exclusive basis and still provide ample spectrum for opportunistic or unlicensed access.

Similarly, while the 1.8 GHz and 2.3 GHz bands are both global mobile broadband bands, the amount of spectrum proposed for shared access in each band (2x3.3 MHz and 10 MHz respectively) will be insufficient for most new opportunistic users to invest in equipment and networks. While there are a few IoT applications that could use such narrow channels, most broadband use cases will require at least 10, if not 20 MHz. And, if only one new user is authorized per geographic area, as Ofcom has proposed, it will discourage entities that need access in multiple locations from investing without assurances that they can deploy across their all of their target areas.

Instead, we believe a 20 MHz channel, at a minimum, should be made available on an opportunistic basis to support emerging 5G technologies. Furthermore, multiple 20 MHz channels should be available in each geographic area to opportunistic users to ensure access to spectrum to support their use cases. Without both sufficient bandwidth for current and future standards-based technology and the confidence that sufficient bandwidth will be available on an opportunistic basis to support their business needs, it will be difficult to convince new entrants to invest.

With regard to the previously awarded mobile bands, Federated Wireless supports Ofcom's proposal to enable new entrants to access spectrum that has been undeployed by current licensees. Numerous vendors offer equipment supporting these bands, enabling new entrants to take advantage of existing ecosystems and identify opportunities to offer services in under and un-served areas.

However, rather than compelling incumbent mobile operators to identify areas where they do not have plans to deploy networks for the next three years, Federated Wireless recommends an approach similar to what the FCC established for the CBRS Priority Access License (PAL) tier where lower tier users are allowed to access higher tier spectrum if the high tier licensee is not using it.

By way of background, the FCC intends to auction up to seven, 10 MHz PALs per county across the United States sometime in the coming 12-15 months. Opportunistic access users, known as the General Authorized Access (GAA) tier, will have access to the remaining 80 MHz of CBRS spectrum whenever incumbent protection does not otherwise restrict spectrum access. GAA users are also allowed to access licensed PAL spectrum in areas where the PAL licensee has not deployed equipment, making the PAL licenses subject to a use-it or share-it condition.

Instead of requiring PAL users to predict with any amount of certainty where they will not deploy and spectrum available could be available to other users for a set time period, the FCC defined PAL protection criteria that SAS administrators, including Federated Wireless, will enforce on a real-time basis. To protect PAL CBRS devices, a SAS must not authorize other CBRS devices on the same channel in geographic areas and at maximum power levels that will cause aggregate interference in excess of -80 dBm/10 MHz channel within a PAL Protection Area. This aggregate co-channel interference level was defined utilizing common inputs and assumptions – including the propagation model and any clutter or terrain assumptions – during the SAS approval process. This approach is consistent with the methods that will be used to model and measure the aggregate interference to protect incumbent FSS earth stations and incumbent Federal radar systems. Said another way, the SAS will authorize GAA use of PAL spectrum so long as the -80 dBm/10 MHz channel protection level is met. If a PAL licensee registers a new CBRS device in its licensed PAL Protection Area that would conflict with the previously authorized lower-tier user, the SAS will inform the GAA user that it may no longer have access to that spectrum and that it must request a new authorization.

This use-it or share-it approach provides higher tier users with enough certainty that the spectrum they have purchased via auction is available to them when and where they need it without having to make business decisions three years in advance. It also provides opportunistic access for lower tier users who may only need the spectrum on a temporary basis to support a particular event, while also enabling them to request access to a different higher-tier channel if the one they were using becomes unavailable. We believe this automated, dynamic shared approach will be far more palatable to incumbent mobile network operators, while still providing sufficient opportunities for new users to access underutilized spectrum resources.

***5) In addition to the upper 10 MHz of the 2.3 GHz band, opportunistic access can be introduced in the lower portion of the 2.3 GHz band by implementing a dynamic sharing access system with MoD's use as the highest tier.***

Federated Wireless believes that a dynamic spectrum access system could manage and protect MoD's ongoing use and maximize spectrum access for new entrants in this band. Rather than licensing a single user per geographic area and limiting new entrants to particular uses cases (such as indoor only), a dynamic spectrum access system could calculate the amount of aggregate interference that multiple new entrants in an area might cause to MoD and limit or adjust spectrum access accordingly.

Similarly, we believe the lower portion of the 2.3 GHz band could also be shared between MoD and new opportunistic users through implementation of a dynamic spectrum access system. Having access to an additional 40 MHz in the 2.3 GHz band would make opportunistic access of the upper 10 MHz much more appealing. Even if the lower portion of the band took longer to implement, having knowledge that additional spectrum will be available should encourage initial investments in 2390-2400 MHz.

#### **IV. Conclusion**

Federated Wireless appreciates the opportunity to share its perspectives on dynamic shared spectrum technology and its ability to meet the challenges identified by DCMS, namely to promote deployment of private networks that support a variety of industrial IoT applications, improve broadband coverage in rural communities as well as in dense urban environments, and support the introduction of fixed wireless access.

In conclusion, Federated Wireless recommends the implementation of a dynamic shared approach that enables both licensed and opportunistic access to spectrum, which will be critical to address the policy objectives that DCMS has identified. Dynamic sharing technology is available today that can be readily adapted to meet the unique challenges of the U.K. market. A combination of both licensed and opportunistic access to sufficient spectrum will be necessary to drive the development of a large ecosystem and the widespread deployment of 5G technologies and services.