Comments on Improving consumer access to mobile services at 3.6 to 3.8 GHz

by Federated Wireless, Inc

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Federated Wireless welcomes the opportunity to respond to Ofcom. Federated Wireless is an innovator in the field of spectrum management and sharing tools, such as spectrum sensing, cloud computing, dynamic spectrum database technologies, cognitive radio, and small cell technology. Most recently, Federated Wireless has led the development and standardization of spectrum sharing technologies at 3.6 GHz band in the US, permitting mobile services to dynamically share spectrum with a diverse set of incumbent services including fixed satellite services (FSS) earth stations, and grandfathered WiMAX systems.

We praise Ofcom, as well as Government authorities around the world, in their continued efforts to increase the amount of spectrum available for mobile services. We believe that spectrum sharing holds great potential to meet the rapidly growing demand for mobile services globally, protecting the ongoing operations of a diverse set of existing services, while enabling optimal use of the spectrum and delivering the greatest benefits to citizen and consumers

Federated Wireless looks forward to continued engagement with the Ofcom on matters related to spectrum sharing in the future and would be pleased to expand upon any of the points raised in this document.

Yours sincerely,

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Federated Wireless's position on Consultation questions

Question 1: Do you have any comments on the use of the 3.6 to 3.8 GHz band by existing services?

No comment.

Question 2: Do you agree with our identification of a trend towards the use of mobile in the 3.6 to 3.8 GHz band?

We agree that the 3.6-3.8 GHz band is trending towards use for mobile, and that more generally 3.4-3.8 GHz is trending towards 5G deployments in shared spectrum. Additionally, considering the broader 3400-3800 band, we note the following developments:

- Early 5G trials in Japan at 3600-4200 MHz
- Early 5G trials in China at 3400-3600 MHz
- Identification of the band 3400-3600 for initial 5G deployments in Europe by the Radio Spectrum Policy Group and the European Conference of Postal and Telecommunications Administrations
- The 3550-3700 MHz ("CBRS") band in the US, which is allocated for flexible use for both fixed and mobile operation on a shared basis with incumbent FSS, WISPs and US Department of Defense systems. Early CBRS deployments will be based on existing 4G (e.g., LTE) technologies, with an evolution toward 5G

Question 3: Do you agree with our high level proposal to make 116 MHz within the 3.6 to 3.8 GHz band available for mobile and 5G services, bearing in mind our statutory duties and the high level trends we have identified?

Allowing disparate uses – mobile, fixed, satellite – to compete in an open market for spectrum access will better ensure that spectrum is used optimally than limiting the spectrum to just fixed and FSS operation by virtue of increasing the number of potential uses. Similarly, a mobile only option (Option B in Section 9) would also tend to be suboptimal by denying some potential uses. Furthermore, a flexible regulatory and assignment structure that can adapt with changing use priorities will enable allocations to continue to put towards optimal use even as usage and service patterns evolve with time.

Question 4: Do you agree with our general approach regarding spectrum currently licensed to UK Broadband?

Spectrum is currently licensed to UK Broadband so that it shares the band "on a first-come-first-served basis with other existing users coordinated through Ofcom."[1] While first-come-first-served simplifies administration of spectrum rights, it generally leads to spectrum inefficiencies with incumbent technologies and uses blocking new entrants. When possible, adopting a dynamic market for spectrum access that is open to multiple technologies and uses will best

[1] See paragraph 1.4 of the Consultation

allow a spectrum band to continually evolve to its optimal utility given changing usage and service patterns.

Question 5: Do you agree with our assumptions, methodology, and conclusions with regards to potential coexistence between mobile and existing fixed links and satellite earth stations? Please refer to annex 5 for further details.

The assumptions and methodology with regards to potential coexistence appear correct. Our conclusion from this analysis is that efficient and effective spectrum sharing will be best achieved via a sharing regime whereby sharing is facilitated through analyses employing environment specific details, such as terrain, land use, and land clutter information. As noted in the Consultation – for instance, the 30 dB shielding that would be provided by the tree line between Chalfont Grove and London – incorporating such environmental information in coexistence analyses for spectrum sharing could yield much more accurate results.

Question 6: Do you have a view on any of the two options we identified?

While we wish to leave the question of whether Option A or Option B would strike a better socio-economic balance for the UK to others, we do strongly endorse the concept of the interference budget described in the consultation if Option A is adopted. In addition to creating a path to more intensive sharing, an interference budget would permit spectrum sharing regimes to exploit site-specific conditions in predicting propagation, which fixed exclusion or restriction zones would not permit. The interference budget approach also gives secondary users greater flexibility in their deployments, for instance, being able to tradeoff if one site close to an earth station is more valuable to their operations than ten sites farther away.

We also clarify that the interference budget does not have to be a single number and could represent a set of protection parameters that all have to be simultaneously met, such as an interference power spectral density to the receiver's passband and a total interference power level presented to the receiver.

Question 7: Do you have any quantitative evidence on the costs and benefits associated with the options? This include costs for existing users and/or consumers of existing services associated with potential changes, and benefits to UK consumers in gaining access to mobile services in this band.

No comment.

Question 8: Do you have any other suggestions that would allow widespread 5G availability using the 3.6 to 3.8 GHz band across the UK while allowing certainty for at least some existing users to continue to provide the benefits currently provided by use of the 3.6 to 3.8 GHz band?

We make the following suggestions to allow widespread 5G availability using the 3.6 to 3.8 GHz band across the UK while allowing certainty for at least some existing users.

- Permit commercial third parties to automate spectrum access decisions in near real-time.

- Add mechanisms whereby FSS Operators report which frequencies are in use.
- Require frequency flexibility in new entrant systems.
- Leverage sensor deployments to realize more aggressive interference budgets.
- Consider a three tier spectrum sharing model.

Permit commercial third parties to automate spectrum access decisions in near real-time

As noted throughout the consultation and the supporting coexistence analysis[2], leveraging more detailed knowledge of the propagation environment increases the amount of spectrum available for secondary access. However, constructing and maintaining high resolution terrain and clutter databases for propagation modeling requires significant initial and ongoing investment. A third party whose business success was premised on making as much spectrum available for secondary use while protecting incumbent systems would be naturally incentivized to make the investments to acquire and maintain high resolution data and to develop tools that enable more efficient spectrum sharing. The following would further aid in the deployment of this approach.

- Ensure multiple third parties are authorized to provide these services to further incentivize competition to improve models and data.
- Mandate mechanisms for secondary systems to regularly renew spectrum assignments with these third parties so that first-come-first-served can be replaced with a model that better supports the continuing evolution of assignments to the optimal spectrum use and accommodates protections of incumbents with flexible spectrum usage.
- Ensure the third parties regularly synchronize spectrum assignments so that interference budget calculations are correct and accurate.
- Require the third parties to provide mechanisms for auditing spectrum assignments accessible to Ofcom, mobile users, and incumbents to aid in ex-post enforcement and monitoring.

Add mechanisms whereby flexible FSS Operators report which frequencies are in use

As noted in the consultation[3], some FSS operators need to reserve a broad set of frequencies as their receiving channels change from time to time and often are based on decisions made by operators of transmitters on other continents. More spectrum is always available for secondary use if protection calculations are based on the actual spectrum use instead of potential spectrum use.

To address this, we suggest that FSS Operators with time-varying frequency use be mandated to communicate with a third party spectrum manager these changes in actual use and that the third party spectrum manager be responsible for making the corresponding changes in mobile service spectrum use. In this way, the FSS operators can continue their existing practices of changing frequencies from time to time while remaining free from interference and enabling greater spectrum access. In this scenario, the third party would remain responsible for ensuring

[2] *Geographic Sharing in C-band,* June 2015, https://www.ofcom.org.uk/__data/assets/pdf_file/0012/51303/c-band-sharing.pdf

[3] See paragraphs 4.26 and 9.14 of the Consultation.

that the spectrum assigned to the secondary systems still protect the passband, adjacent channel, receiver blocking, and any other relevant interference protection considerations needed to ensure existing FSS systems can continue to provide the benefits currently provided by use of the 3.6 to 3.8 GHz band as well as coordinating such changes with other third party spectrum managers.

Require frequency flexibility in new entrant systems

To achieve the spectrum sharing benefits realizable by introducing automated reporting of FSS frequency usage, a) the secondary radio systems need to be sufficiently frequency agile to capitalize on the opportunity and b) the business processes and auction processes need to accommodate flexible frequency usage. From a technical perspective, frequency agile LTE systems are being developed and currently field tested to accommodate efforts in the US and elsewhere in the world to build out a 3.4-3.8 GHz 5G spectrum sharing band and efforts elsewhere in the LTE community to enable LTE to access unlicensed spectrum (e.g., LTE-U and LTE-LAA). Operators comfortable with this new equipment will also adopt appropriate operational practices, but any auctions of secondary rights should also reflect this need for frequency agility by awarding rights to logical channels rather than physical channels. For instance, an auction winner operating a secondary system would be granted exclusive use to some portion of the 3.6 GHz band, say 10 or 20 MHz, but the specific frequencies would be subject to those that are non-interfering at that time and location. Under an auction regime that awards logical frequencies, it would be reasonable to provide auction winners additional certainties such as minimum block sizes and contiguity guarantees.

Leverage sensor deployments to realize more aggressive interference budgets

Spectrum sharing based on propagation predictions will always have some degree of error, whether due to terrain and clutter modeling imprecision, anomalous propagation conditions, or simple human error when system parameters are entered. To mitigate the effect of these errors, spectrum sharing regimes have to build in protection margins to account for the related uncertainties, which decreases spectrum sharing efficiencies, much as the consultation's analyses showed that added shielding or the presence of clutter can dramatically increase the amount of spectrum for secondary use.

Because of the unique conditions of UK spectrum use at 3.6 GHz, where only 19 earth stations are present in the country, other approaches that do not rely solely on modeling and predictions should be viable. Specifically, if Ofcom chooses to explore the possibility of enabling 3rd parties to manage automated spectrum access decisions at 3.6 GHz, then Ofcom should also explore if those 3rd parties believe deploying interference sensors at each of the 19 earth stations to measure instantaneous interference at (or more realistically very near to) each earth station. In this way, smaller protection margins could be adopted, allowing for greater secondary access. Similarly these sensors could serve as a mechanism to detect when anomalous propagation conditions are present, which could be the impetus to adjust secondary system spectrum assignments to protect earth station operation.

Consider a three tier spectrum sharing model

If all available secondary spectrum is auctioned off with exclusive-use rights and logical channels, then conceptually changing frequency use by earth stations (or fixed links) could be accommodated via repacking for any number of secondary licensees. But changing protections to accommodate sensed anomalous propagation conditions will lead to situations where repacking exclusive use systems are not feasible, thereby leading to the potential of interference amongst licensed secondary licensee systems or changes in coverage areas. This issue could be addressed by reserving some logical portion of the spectrum around incumbent systems for unlicensed or third tier use. Such a tier would presumably not have to win an auction to access the spectrum, but similarly, would not be guaranteed spectrum access nor have any interference protection guarantees so that when spectrum availability is withdrawn by the first tier from the second tier, second tier access expectations can continue to be met by decreasing the spectrum available for the third tier. Alternately, no third tier could be defined and the second tier operators could be required to operate under access uncertainty, but we expect this arrangement to significantly decrease auction revenues.

Question 9: Do you have any comments in relation to these proposals?

No further comment.