March 03, 2023

Shri Akhilesh Kumar Trivedi,
Advisor (Networks, Spectrum and Licensing),
Telecom Regulatory Authority of India,
Mahanagar Doorsanchar Bhawan,
Jawahar Lal Nehru Marg,
New Delhi – 110 002.

Subject: **Tata Communications Limited's response to TRAI Consultation Paper on "Telecommunication Infrastructure Sharing, Spectrum Sharing, and Spectrum Leasing"**

Dear Sir,

This is with reference to the TRAI Consultation Paper No.2/2023 dated 13-01-2023 on Telecommunication Infrastructure Sharing, Spectrum Sharing, and Spectrum Leasing.

In this regard, please find enclosed herewith Tata Communications Limited's response to the Consultation Paper as Annexure -I for your kind perusal.

We request you to kindly take on record our response and consider the same while finalizing the recommendations.

Thanking You,
Yours Sincerely,

For Tata Communications Limited,

Praveen Sharma
(Authorized Signatory)

Enclosure: As mentioned above

TATA COMMUNICATIONS

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Tata Communications Limited's Response to TRAI Consultation Paper on Telecommunication Infrastructure Sharing, Spectrum Sharing, and Spectrum Leasing

Preamble

At the outset, we welcome this TRAI Consultation Paper dealing with important issues on Telecommunication Infrastructure Sharing, Spectrum Sharing, and Spectrum Leasing considering the fact that with the increasing digitization, telecommunication infrastructure has become crucial for digital economy. Therefore, enabling sharing of active and passive infrastructure, spectrum sharing and leasing in an unrestricted manner for all licensed Telecom Service Providers (TSPs) is imperative to bring down the overall cost of network deployment and to attract more investments.

Active and Passive Infrastructure sharing be permitted across all Telecommunication Service Licenses/ Authorizations

Telecommunications is a capital-intensive business and all licensed telecom service providers require huge amount of CAPEX and OPEX investments for network operations and expansion to roll-out new services. Tata Communications recommends that both active and passive infrastructure sharing be permitted across licensed telecom Service Providers only on a bilateral basis with the option of sharing of few or all network elements among licensed TSPs for both wireless and wireline / fixed networks. This would ensure availability of a larger resource pool for sharing and bring greater cost efficiencies, enhanced service coverage and improved time to market for all digital services. This would also allow the licensed TSPs to make more investments on improving quality of service and help to reduce consumption of power, space and other resources, thus making the telecom infrastructure more efficient and environmentally sustainable.

To enable the same, there is a need for license amendment in all telecommunication services licenses and in various service authorizations under Unified telecom license to bring clarity and removing ambiguity and anomaly with respect to the provisions relating to both action and passive infrastructure sharing.

Infrastructure created under USO Fund should be mandatorily available for sharing among all Licensed Telecom Service Providers

Telecom infrastructure created by use of USO fund should be mandated to be shared among all licensed telecom service providers & capacity should be reserved for other service providers as well on first come first served basis. In this way USO funded infrastructure benefits can be extended to other service providers subscribers, thus a much larger beneficiary base. This also avoids duplicate asset creation in these areas that will result in appropriate optimization of USO funds, also the benefit would be wide reached and not restricted to the subscribers of the USP. Further, adequate provision should also be made to allocate funds from Universal Services Obligation Fund (USOF) for incentivizing Licensed Service Providers who are promoting connectivity to rural and remote areas especially with alternative and innovative technologies especially two million hotspots in rural area as envisaged in NDCP-2018.

Infrastructure sharing framework should ensure non-discriminatory, fair sharing of USO funded infrastructure among all licensed service providers in a time bound manner with no or minimum passive infrastructure rentals based on market trends.

Liberalization of Spectrum Sharing Guidelines to permit Spectrum Sharing among all Licensed Telecom Service Providers

Spectrum Sharing is considered by Industry as much needed solution for efficient and effective utilization of this limited and valuable natural resource. Spectrum sharing between service providers leads to enhanced spectral efficiency by combining/ pooling the spectrum holding of two or more service providers. It leads to more efficient use of the spectrum which is a limited natural resource. Given the growing demand for spectrum and the need to ensure most efficient and optimal use of spectrum, Tata Communications recommends that access spectrum sharing should be permitted among all the licensed telecom service providers. This will ensure better optimization of scarce resources (spectrum) and make use of it efficiently and effectively.

Spectrum Management is an important policy enabler for Digital India and to ensure larger participation for proliferation of broadband services across the country ISPs being a licensee under section (4) of the Indian Telegraph Act 1885, should be allowed to participate in spectrum sharing among all licensees for IMT / 5G Spectrum for efficient utilisation of this scarce natural resource. Globally also, spectrum sharing is generally treated as a part of active infrastructure sharing.

To enable the same, Spectrum sharing guidelines should be liberalized in line with NDCP- 2018 to permit spectrum sharing among all Licensed TSPs, thereby, providing full flexibility to the licensees for sharing their spectrum to get the optimal spectrum efficiency for this scarce resource.

Implementation of Authorized Shared Access (ASA) for all Licensed Telecom Service Providers

Authorized shared access (ASA) of spectrum, involves the concept of primary and secondary users, wherein a secondary user can use the same frequency spectrum when the primary user is not using it. Standard practices for ASA have been implemented globally to enable shared access spectrum to more operators can implement networks and roll out affordable services. In this regard one can refer to, USA based Automated Frequency Coordination (AFC), Spectrum Access System (SAS) and European Telecommunications Standards Institute based Licensed Shared Access (LSA). In India there is a lot of Spectrum for TV Broadcast, Satellite Space etc. that remain unutilized at most times owing to excess spectrum than current demand and likely to remain so for a long term especially with alternatives available. Sharing of such spectrums must be allowed to all licensed Service Providers under various licenses/ authorizations for various new applications.

Spectrum is assigned to non -TSP users generally govt and public sector agencies through administrative for their mission critical activities. For instance, recently a block of 5 MHz in 700 MHz spectrum band has been assigned to Indian Railways for captive use such as to track monitoring system, security etc. Such spectrum usages are critical to their operation, but many times usage are confined to limited geography / railway track. There is scope exist in India to assign such spectrum to secondary user which could be Non licensed entity having interest in setting up private captive 5G network.

Current spectrum allocation policy framework doesn't allow other users to use that spectrum for their services. However, this spectrum if coordinated efficiently, can be re-allocated multiple times to Captive Non-Public Network (CNPN) services for Enterprises and Industry verticals provided there is no interference or any security related issues to the primary user's network. As consultation paper itself mentions that such kind of policy frameworks are already exists in Europe and US Regions and have been operating quite effectively. We, Tata Communication endorse and request TRAI to adopt such best practices. This will help in not only meeting the growing requirements of additional spectrum and achieving optimal utilization but will also ensure proliferation of Industry 4.0 applications.

Tata Communications recommends exploring the AFC (Automated Frequency Coordination) implemented in USA by FCC apart from listed techniques mentioned in the consultation paper like Spectrum Access System (SAS) and European Telecommunications Standards Institute based Licensed Shared Access (LSA) for implementation of ASA in India to be equally applicable for all licensed telecom service providers. Such allocation should be done administratively.

Allow Spectrum Leasing among all Licensed Telecom Service Providers for ensuring optimal and efficient use of spectrum being a scare resource

There is a need to permit spectrum leasing among all licensed service providers as it would further expand the market by way of more Operators using the licensed spectrum which will strengthen the competition thereby benefitting both the Customer as well as Government. Spectrum leasing would make larger participation in the forthcoming spectrum auctions vis-a-vis from three Access Service Providers. Spectrum leasing would also ensure that the spectrum should not be underutilized or remain idle.

There should also be a provision for enabling spectrum leasing amongst all licensed entities including ISP, NLD, ILD etc. which is likely to create a secondary market for spectrum and proliferate efficient and better usage of a scarce natural resource. It should also facilitate spectrum sharing amongst all licensees irrespective of one of the licensee's holding spectrum in that band or licensee not holding any spectrum at all enabling full flexibility to the licensees for sharing their spectrum to get the optimal spectrum efficiency for this scarce resource.

Globally also spectrum leasing has been permitted as standard practice among TSPs, for example, countries like USA, Canada, Malaysia have already permitted leasing of access spectrum to other TSPs. Thus, under the Spectrum Sharing guidelines, leasing of spectrum should be permitted to enable efficient utilization of this scarce natural resource among all licensed telecom service providers.

Tata Communications' issue wise response is as follows:

A. Issues relating to Infrastructure sharing.

Q1. Should passive infrastructure sharing be permitted across all telecommunication service licenses/ authorizations? Kindly justify your response.

Tata Communications Response:

Telecommunications is a capital-intensive business. BEREC in its summary report[1] has mentioned that as long as sufficient infrastructure-based competition is maintained, infrastructure sharing allows cost savings and makes more extensive coverage viable. TRAI in its paper has also highlighted referring BEREC report that there is a cost savings from the passive infrastructure sharing in the tune of 16%-35% in both CAPEX and OPEX. As also rightly pointed out by TRAI to DoT in the paper that there is a need to streamline the provisions relating to passive / active infrastructure sharing across all telecom licenses and such provisions should be clear and unambiguous.

In our view, Passive Infrastructure sharing should be permitted across all telecommunication service licenses/ authorizations enabling licensed TSPs to share their passive infrastructure with other licensed TSPs having different licenses/ Service Authorizations under Unified License. It would help the industry to expand services faster and across much broader geographies in a cost-effective manner. It is an important measure to reduce costs and overall deployment / roll out time, especially over new technologies. It would help in making telecom services more affordable to end-customers.

Telecom service reach and affordability in India increased significantly after allowing such infrastructure sharing. India is among the many countries which are offering cheapest telecom service and Telecom service penetration is increasing on year on year. DoT issued amendments to the UASL, CMTS License and Unified License (UL) through which, TSPs were permitted to share passive as well as the active infrastructure limited to certain network elements. The Present Infrastructure Sharing Regime in India have different provisions in different licenses. For example, IP-I can share the passive infra only with the licensed access service providers or with the entity notified by govt. They are not allowed to share their infrastructure with UL-VNO licensees.

Building of passive infrastructure involves dark fiber-optic cable deployment & significant infrastructure creation which involves ROW permissions, digging of roads, civil works, etc. Sharing of passive infrastructure would lead to better utilization of assets which would also be better for the environment, more sustainable and help the society at large.

Therefore, passive infrastructure sharing should be permitted across all telecommunication service licenses/ authorizations.

Q2. Should other active infrastructure elements deployed by service providers under various licenses/ authorizations, which are not permitted to be shared at present, be permitted to be shared among licensees of telecommunication services?

Tata Communications Response:

As mentioned in response to Q1 above, telecommunication service providers require huge amount of CAPEX and OPEX investments for network expansion to roll-out new services. Tata Communications recommends that active infrastructure sharing be permitted across licensed Telecom Service Providers (TSPs) only. Active Infrastructure sharing should be allowed on a bilateral basis with the option of sharing of few or all network elements among licensed TSPs for both wireless and wireline / fixed networks. This would enable a larger resource pool sharing and hence greater cost efficiencies (both capital cost and operating cost), enhanced service coverage and improved time to market for all digital services. This would also allow the operators to make

1 https://www.berec.europa.eu/sites/default/files/files/document_register_store/2020/12/BoR%20(20)%20240_Summary_report_on_mobile%20infrastructure%20sharing%20workshop.pdf

more investments on improving quality of service. This would also help to reduce consumption of power, space and other resources, thus making the telecom infrastructure more efficient and environmentally sustainable.

Q3. If your response to the Q2 is in the negative, which active infrastructure elements should not be permitted to be shared? Further, which active infrastructure elements should be permitted to be shared with which licensees/ authorization holders? kindly provide details for each authorization with detailed justification.

Tata Communications Response:

In view of our response to Q2, we reiterate that the license provision should enable / permit active infrastructure sharing among licensed TSPs on a bilateral basis with the option of sharing all or some of the active infrastructure network elements depending upon their business model and network requirements.

Q4. In case it is decided to permit sharing of any additional active infrastructure elements among licensees,

a) **What precautionary conditions should be put in place to avoid disruption in telecommunication services due to any unforeseen situation? The response may be provided for each active infrastructure element.**
b) **Whether there is a need to have a provision for permission from/ intimation to the Licensor before commencement of such sharing? If yes, what provisions and timelines need to be prescribed for each active infrastructure element?**

Tata Communications Response:

a) Tata Communications recommends allowing sharing of active Infrastructure on a bilateral basis among license telecom service providers only. Telecom Service providers design their network to be able to provide quality service to end customers by deploying resilient telecom infrastructure. The option of sharing active infrastructure would help licensed telecom service providers to better design their networks, make them more resilient and cost effective. This would in turn also enhance competition in the telecom market, benefiting the end customers.
b) Government should setup a neutral governing body having representations from DoT, TRAI and Industry, that will introduce a framework for active infrastructure sharing and all license service providers should adhere to the recommended framework. The neutral governing body should also administer failure, if any, in the shared network elements. Hence, there is no need for permission from/ intimation to the Licensor prior to commencement of such sharing because sharing would be carried out between license service providers only based on mutual agreements.

Q5. Whether any other amendment is required to be made in the telecommunication services licenses/ authorizations with respect to the provisions relating to both active and passive infrastructure sharing to bring clarity and remove anomaly? If yes, clause-wise suggestions in the telecommunication services licenses/ authorizations may kindly be made with detailed justification.

Tata Communications Response:

Yes, there is a need for license amendment in all telecommunication services licenses and in various service authorizations under Unified telecom license to bring clarity and removing

ambiguity and anomaly with respect to the provisions relating to both action and passive infrastructure sharing.

The Unified License (UL) and Unified License for VNO (UL-VNO), contains two parts, viz. Part - I and Part - II. The Part - I (Chapter I to VII of UL and UL-VNO) contains terms and conditions which are applicable for all service authorizations under the License, whereas the Part - II (Chapter VIII to XVI of UL and Chapter VIII to XVII of UL-VNO) consists of chapters which contains terms and conditions specific to the respective service authorizations. Chapter V contains the conditions on sharing of infrastructure which are general conditions applicable to all licensees.

Sharing of passive infrastructure is permitted only between VNOs and not with the UL Access Service Providers other than Network Service Operators (NSOs) with whom VNO is parented. This need to be addressed.

It may also be noted that for all the network elements which are permitted to be installed by VNO in its network, UL-VNO Licensees shall be allowed to take requisite infrastructure from IP-1 registered entities, UL licensee's / standalone licensees other than its Parent NSOs. However, UL-VNO Licensee will be allowed to sell services only of its Parent NSOs. Further, UL-VNO licensee for Access Services shall also be allowed to have parenting with more than one NSOs (UL-VNO (Access Service) Licensee) in same LSA separately for Wireline Access Services and Wireless Access Services. Such licensing restrictions are required to be addressed. Such enablement will provide flexibility to UL-VNO (Access Service) licensee to rollout its access services more efficiently and in a time bound manner.

In line with our submission made in response to Q1, Q2 and Q3, Tata Communications proposed clause wise suggestions for license amendment related to passive and active infrastructure sharing are as follows:

- Proposed Passive Infrastructure Sharing clause for telecommunication services licenses / Service authorizations under Unified license:

  "*The Licensee may share Passive infrastructure elements including building, tower, dark fiber, duct space, Right of Way on a bilateral basis at a mutually agreed terms & conditions with all other telecom service providers to meet its business and network requirements*. *The Licensee may share its own active and passive infrastructure for providing other services authorized to it under any other telecom license issued by Licensor.*"

  It may also be noted that there is no requirement for any change in the existing provisions specified under the common conditions 4.2 (i) of UL license and same may be continued.

- Proposed Passive Infrastructure Sharing clause for Service authorizations under Unified license (VNO):

  "*The Licensee may share Passive infrastructure elements including building, tower, dark fiber, duct space, Right of Way on a bilateral basis at a mutually agreed terms & conditions with all other licensees including VNO licensees to meet its business and network requirements. The Licensee may share its own passive infrastructure for providing other services authorized to it under any other telecom license issued by Licensor.*"

  It may also be noted that there is no requirement for any change in the existing provisions specified under the common conditions 32.1 (i) of UL VNO license and same may be

continued for ensuring clarity among infrastructure sharing between the NSO(s) and VNO licensee.

- Proposed Active Infrastructure Sharing clause for telecommunication services licenses / Service authorizations under common conditions of the Unified license:

  "Sharing of Active infrastructure amongst all licensed Telecom Service Providers on a bilateral basis at a mutually agreed terms & conditions is permitted to meet their business and network requirements. Active infrastructure sharing will include all the network elements incl. Core network elements, antenna, feeder cable, Node B, Radio Access Network (RAN) and transmission system. Sharing of infrastructure related to Wi-Fi equipment such as Wi-Fi router, Access Point etc. is allowed. Sharing of backhaul is also permitted. The Licensee may share its own active and passive infrastructure for providing other services authorized to it under any other telecom license issued by Licensor. An authorized Gateway hub operated by the satellite provider itself is permitted to be shared with the satellite bandwidth seeker."

  It may also be noted that there is no requirement for any change in the existing provisions specified in clause 33.1 under common conditions under UL and clause 4.2 pertaining to Active infrastructure sharing under UL (Access Services) and same may be continued.

- Proposed Active Infrastructure Sharing clause under common conditions Unified license (VNO):

  "*The Licensee may share Active infrastructure elements of its NSO(s) at a mutually agreed terms & conditions to meet its business and network requirements. Active infrastructure sharing will include all the network elements incl. Core network elements, antenna, feeder cable, Node B, Radio Access Network (RAN) and transmission system. Sharing of infrastructure related to Wi-Fi equipment such as Wi-Fi router, Access Point etc. is allowed. Sharing of backhaul is also permitted. The Licensee may share its own active and passive infrastructure for providing other services authorized to it under any other telecom license issued by Licensor."*

  It may also be noted that there is no requirement for any change in the existing provisions specified in clause 32.1 under common conditions of UL-VNO and clause 4.2 pertaining to Active infrastructure sharing UL-VNO (Access Services) and same may be continued.

Q6. Should there be any obligation on telecom service providers to share infrastructure that has been funded, either partially or fully, by the Government through Universal Service Obligation (USO) Fund or otherwise, with other telecom service providers? Kindly justify your response.

Tata Communications Response:

The USO Fund was established with the fundamental objective of providing access to telecom services to people in remote and rural areas at affordable and reasonable prices. Presently, all licensees are paying 5% of their AGR towards USO levy under licensing obligation since introduction of revenue sharing regime for rural coverage. We are of the view that USO fee should not be construed as levy, rather it is contribution made by Licensees and existing amount available in USO fund is sufficient to connect the balance unconnected villages. Thus, USO levy is immediately to be brought down to 3% of ApGR, in accordance with TRAI recommendations dated 06-01-2015. It would be therefore in the fairness of things if the individual licensee's

contribution is reduced to at least 2 % from current 5% of the ApGR for which 7 years have already elapsed when TRAI recommended making this levy at 3% of ApGR with an ultimate objective of totally doing away with the levy in next 2-3 years. Alternatively, if this levy cannot be reduced then license fee contribution which is to the tune of 3% of ApGR should be reduced to 1 % of ApGR.

Telecom infrastructure created by use of USO fund should be mandated to be shared among licensed telecom service providers & capacity should be reserved for other service providers as well. In this way USO funded infrastructure benefits can be extended to other service providers subscribers, thus a much larger beneficiary base. This also avoids duplicate asset creation in these areas that will result in appropriate optimization of USO funds, also the benefit would be wide reached and not restricted to the subscribers of the USP.

Further, adequate provision should also be made to allocate funds from Universal Services Obligation Fund (USOF) for incentivizing Licensed Service Providers who are promoting connectivity to rural and remote areas especially with alternative and innovative technologies especially two million hotspots in rural area as envisaged in NDCP-2018.

Large Enterprises are expanding their businesses to remote geographies across the country and need quality telecommunications services to enable their digital transformation. Mandatory sharing of telecom infrastructure on a non-discriminatory basis would help telecom companies focus on designing new digital services to telecom customers, enhance competition and make services more affordable.

Q7. In case it is decided to impose some obligations on telecom service providers to share the infrastructure funded by Government with other telecom service providers, is there a need to provide a broad framework for sharing of such infrastructure? If yes, kindly suggest the key aspects of such framework with detailed justification.

Tata Communications Response:

As suggested in the response to Q6, the infrastructure created under USO Fund owned by the USP/TSP to whom project was assigned, to be made available to all licensees including VNO on first come first served basis.

Infrastructure sharing framework should be based on below points:

- Ensure non-discriminatory, fair sharing of USO funded infrastructure among all licensed service providers in a time bound manner.
- Building of infrastructure with max. capacity considering other service providers requirements & future roadmaps.
- No or minimum passive infrastructure rentals based on market trends.
- Infrastructure design like Tower/Mast/Power capacity and design to accommodate multiple licensed service providers.

Q8. Any other suggestion to facilitate infrastructure sharing may kindly be made with proper explanation and justification.

Tata Communications Response:

No additional comments.

B. Connectivity Issues Faced by the Subscribers in Remote and Far-flung Areas of the Country

Q9. What measures could be taken to encourage roaming arrangements among telecom service providers in remote and far-flung areas? What could be the associated regulatory concerns and what steps could be taken to address such concerns? Kindly provide details on each of the suggested measures with justification.

Tata Communications Response:

We have no comments from the perspective of Access Service Provider. However, Tata Communications being a M2M Service Provider would like to submit as follows:

- The foreign eUICC fitted devices will be roaming with Indian TSP's networks under mutually agreed international roaming arrangements entered between the foreign carrier (whose eUICC is fitted in the device) and the Indian TSP/TSPs with whom that foreign carrier has the roaming arrangement.
- Roaming of eUICC fitted devices in India should be left to the market forces and the roaming arrangement foreign carrier has with Indian TSPs and should not be restricted by a time limit for M2M services.
- Global models for M2M have evolved for unrestricted access across the borders due to the nature of services as use of device is not necessarily same as the country (or place) of manufacturing. If at all, TRAI recommends any timeline, then same should be three years as per earlier recommendations of TRAI.

Q10. What could be the other ways to ease out the hardship faced by the subscribers in remote and far-flung areas due to connectivity issues of the home network provider? Kindly provide detailed response with justification.

Tata Communications Response:

No Comments.

Issues relating to inter-band spectrum sharing among access service providers.

Q11. Whether inter-band access spectrum sharing among the access service providers should be permitted in the country?

Tata Communications Response:

Spectrum Sharing is considered by Industry as much needed solution for efficient and effective utilization of this limited and valuable natural resource. Spectrum sharing between service providers leads to enhanced spectral efficiency by combining/ pooling the spectrum holding of two or more service providers. It leads to more efficient use of the spectrum which is a limited natural resource. Given the growing demand for spectrum and the need to ensure most efficient and optimal use of spectrum, Tata Communications recommends that inter-band access spectrum sharing should be permitted among all the licensed service providers.

Spectrum sharing can provide additional network capacities in places where there is network congestion due to spectrum crunch and would further contribute to socio-economic development of the country. Inter-band spectrum sharing is also an important element for effective active infrastructure sharing among service providers. If two service providers pool their spectrum holdings, spectral efficiency increases non-linearly. Spectrum sharing makes use of carrier aggregation to achieve higher data rates. This will ensure better optimization of scarce resources (spectrum) and make use of it efficiently and effectively.

To enable the above proposition, the existing Spectrum sharing guidelines should be liberalised further in line with NDCP 2018 having full flexibility to the licensees for sharing their spectrum to get the optimal spectrum efficiency for this scarce resource.

Q12. In case it is decided to permit inter-band access spectrum sharing among access service providers, please provide detailed inputs to the following questions:

a) What measures should be put in place to avoid any potential adverse impact on competition and dynamics of spectrum auction? Kindly justify your response.
b) Considering that surrender of spectrum has been permitted in the country, what provisions need to be included in the guidelines for inter-band access spectrum sharing so that any possible misuse by the licensees could be avoided? Kindly justify your response.
c) What should be the broad framework for inter-band access spectrum sharing? Whether the procedure prescribed for intra-band access spectrum sharing could be made applicable to inter-band access spectrum sharing as well, or certain changes are required to be made?
d) What should be the associated charges, and terms & conditions for inter-band access spectrum sharing?

Tata Communications Response:

a) Internationally, spectrum sharing is generally treated as a part of active infrastructure sharing. As per the data available on ITU website, spectrum sharing is permitted in 109 countries. Inter-band will only be opted for by service providers only if there is genuine requirement. It would help the service providers to expand services to new geographies, improve cost efficiencies and further improve quality of service for end consumers. It would help in the socio-economic development of underserved regions by bringing on more competition. Spectrum sharing should be allowed on a bilateral basis between licensed service providers only. It would have a positive impact on the overall telecom sector by bringing in cost efficiencies and more choices, better quality of service to end customers.

b) The current policy to permit operators to surrender spectrum after a lock-in period of 10 years has been a thought through policy by the DOT that gives operators the flexibility to re-align plans and investments as per changing business dynamics. This was also done to ensure the most optimal utilization of a limited network resource. Allowing Inter-band spectrum sharing would help service providers to better plan their network and improve return on investments. Also as stated in response to previous questions, it would help improve utilization of available spectrum and maximize efficiency.

c) Framework for inter-band access spectrum sharing can be based similar to 'Guidelines for Sharing of Access Spectrum' issued on 11.10.2021 by DoT, GOI.

Tata communications recommends the following change but not limited to:

- Inter-band Spectrum sharing should be permitted between two telecom service providers without the mandate to have the spectrum in the same band.

d) Charges to be mutually decided between the operators.

Q13. Any other issues/ suggestions relevant to the spectrum sharing between access service providers, may be submitted with proper explanation and justification.

Tata Communications Response:

Spectrum assignment by DoT today is technology agnostic i.e., any spectrum in any frequency band can be used to deploy any technology. On similar lines, all forms of spectrum sharing should be permitted among all service providers under various licenses/ authorizations and not limited to access service provider, to allow level playing field and most efficient use of spectrum which is a limited natural resource. This would also help improve quality and reach of services to large base of customers.

Spectrum Management is an important policy enabler for Digital India. In this regard, following are the suggestions which we believe will not only enable larger participation for proliferation of broadband services across the country but also ensure availability of adequate spectrum for all the Licensees -

- ISPs being a licensee under section (4) of the Indian Telegraph Act 1885, should be allowed to participate in spectrum sharing among all licensees for IMT / 5G Spectrum.

- Under the spectrum sharing, leasing of spectrum should be permitted to enable spectrum holder licensee to lease out the access spectrum to other licensed Service Providers by for efficient utilisation of this scarce natural resource.

C. Issues relating to Authorized Shared Access (ASA) of Spectrum

Q14. Whether there is a need to explore putting in place a regime to implement Authorized Shared Access (ASA), wherein an access service provider as a secondary user could use the frequency spectrum assigned to a non-TSP primary user (government agencies and other entities) on a dynamic spectrum sharing basis? Kindly justify your response.

Tata Communications Response:

Authorized shared access (ASA) of spectrum, involves the concept of primary and secondary users, wherein a secondary user can use the same frequency spectrum when the primary user is not using it. Standard practices for ASA have been implemented globally to enable shared access spectrum to more operators can implement networks and roll out affordable services. In this regard one can refer to, USA based Automated Frequency Coordination (AFC), Spectrum Access System (SAS) and European Telecommunications Standards Institute based Licensed Shared Access (LSA).

It has been observed that growing data usage amongst consumers owing to increased digitalization and uptake of data hungry applications, and increasing proliferation of IoT based solutions, makes it necessary for all the concerned stakeholders to explore use of spectrum sharing using ASA in India. In India there is a lot of Spectrum for TV Broadcast, Satellite Space etc. that remain unutilized at most times owing to excess spectrum than current demand and likely to remain so for a long term especially with alternatives available. Sharing of such spectrums must be allowed to all licensed Service Providers under various licenses/ authorizations for various new applications.

Frequency spectrum are assigned to non -TSP users generally govt and public sector agencies through administrative for their mission critical activities. Recently a block of 5 MHz is assigned to Indian Railways for their track monitoring system. Such spectrum usages are critical to their operation, but many times usage are confined to limited geography. There is scope exist in India to assign such spectrum to secondary user which could be Non licensed entity having interest in

setting up private captive 5G network. We suggest to have Automated Frequency Coordination (AFC), Spectrum Access System (SAS) and European Telecommunications Standards Institute based Licensed Shared Access (LSA) for assignment and Monitoring purposes. Such allocation should be done administratively.

We also wish to submit that industries have always been backbone of the nation. New technologies such as Artificial Intelligence, Machine Learning, Computer vision, Metaverse, AR-VR etc. are going to play an important role in the growth and digital journey of the Enterprises. Since last few years there is significant development in these technologies and wherever deployed have shown great potential. To leverage the benefit of these technologies, communication media such as 5G which provides significant opportunities and will eventually become backbone of the digital transformation and is playing a major role in Industry 4.0 transformation for the Enterprises and industry verticals. Therefore, there is an urgent need of making additional spectrum available for industrial use cases so that these Enterprises and Industry verticals can enhance their operations with adoption of such new technologies.

Considering the fact that the spectrum is a national asset and very scarce resource. From many decades, many government entities, PSUs, and Defence services organizations have been allocated various spectrum bands for their captive communication use. These govt bodies may not be operating throughout the telecom circles in a ubiquitous nature such as public mobile network services providers. Their operations are geographically limited to captive areas only. Current spectrum allocation policy framework doesn't allow other users to use that spectrum for their services. However, this spectrum if coordinated efficiently, can be re-allocated multiple times to Captive Non-Public Network (CNPN) services for Enterprises and Industry verticals provided there is no interference or any security related issues to the primary user's network. As consultation paper itself mentions that such kind of policy frameworks are already exists in Europe and US Regions and have been operating quite effectively. We, Tata Communication endorse and request TRAI to adopt such best practices. This will help in not only meeting the growing requirements of additional spectrum and achieving optimal utilization but will also ensure proliferation of Industry 4.0 applications.

Q15. In case it is decided to implement ASA technique for secondary use of frequency spectrum assigned to non-TSP primary users, please provide your response to the following questions with detailed justification:

a) What are the potential spectrum bands in which ASA implementation can be considered?

Tata Communications Response:

Radio frequency spectrum is a scarce natural resource. Any amount of frequency spectrum, if not in use optimally and efficiently, it is an opportunity loss to allow the benefits of the spectrum to a wider category of users/end customers across all service providers under various licenses/ authorizations, thus also hinders socio-economic development of the country. Considering the growing capacity and thus spectrum, government must explore better methods to tap the full potential of the captive spectrum i.e., currently under limited use by institutions such as Defence, Space, Railways, and other public sector undertakings (PSUs)etc. This presents a win-win scenario for all, TSPs, Government and end consumers.

Below are the Potential spectrum bands that can be considered for ASA implementation -

- 470 - 585 MHz (TV White space)
- 14 - 14.5 GHz, 28.5 – 29.1 GHz, 29.5 – 31 GHz (Co-existence of FWA along with Ku/Ka band uplink transmission, P2P microwave links)
- We also endorse the TRAI recommended frequency bands 3700-3800MHz, 3800-4200MHz, 4800-4990MHz and 28.5-29.5GHz or any other IMT spectrums being used by the government & PSU organisations and to be make available for Enterprises and Industry verticals through direct allocation through an efficient process of shared spectrum mechanism. As mentioned in the response to Q.14, already such best practices are operational in USA & Europe regions. A comprehensive study should be done of these policy frameworks for developing such similar framework in India.

b) What measures should be taken to encourage and motivate the incumbent users for participation in the spectrum sharing through ASA technique?

Tata Communications Response:

- Primary user services should not be impacted due to secondary devices user activity. It can be ensured by implementing AFC (Automated Frequency Coordination-FCC in USA) like systems or similar systems adopted worldwide.
- The AFC systems will determine which frequencies are available for outdoor devices. Once per day each AFC system is required to access to FCC's database to obtain the most up-to-date information on licensed primary user links including their transmitter and receiver locations, frequencies, bandwidths, polarizations, transmitter EIRP, antenna height, and make and model of antenna and equipment etc. The AFC systems will use this information, along with the propagation models to determine on which frequencies and at what power levels secondary outdoor devices may operate.
- There is also needed to build the confidence in incumbent users that there is no way of any compromise in terms of interference, quality of services issues, security related issues or any kind of limitation for their networks due to shared spectrum mechanism.
- Further, in lieu of them participating in such measures, Government can plan to offer few subsidies to the incumbent users or allocate funds on the form of operational grants.

c) What should be the broad framework for implementation of ASA technique?

Tata Communications Response:

The broad framework for implementation of ASA technique can be based on

- Use of geographic locations databases for all users to coordinate spectrum assignments
- Significant improvements in the computation power to efficiently and rapidly run advanced propagation analysis and coordinate devices and users in near real-time
- More agile wireless equipment that can interact directly with a dynamic frequency coordination database
- Efficient power controlling mechanisms for secondary users to minimize noise levels

d) Is there a need for putting in place a mechanism for dispute handling including interference issues in case of ASA? If yes, what should be the framework?

Tata Communications Response:

- As mentioned in response to question no 15(b), interference handling is the key to make ASA successful, a coordinated and controlled mechanism is needed which keeps the repository of primary and secondary usage of spectrum.
- In case of any dispute between both the entities then ASA shall hold the final right to take the decision. In USA, under the CBRS spectrum policy framework, there are authorized SAS administrators appointed by FCC their local Telecom services regulator for providing shared spectrum access in North America.
- This model has been successfully running for many years and we propose that the same should be studied in detail for developing similar model in India for coordination & dispute handling including interference issues among primary & secondary users.

e) What methodology should be adopted for spectrum assignment to secondary users? What could be the spectrum charging mechanism for such assignment?

Tata Communications Response:

- As responded for Q.15 (d) above, like a CBRS spectrum policy framework in USA, DoT can create a policy framework for shared spectrum access in India and appoint WPC as an authorized Shared spectrum access system administrator. However, Shared spectrum access system administrator must ensure fair distribution of spectrum among the secondary users & at the same time safeguard the incumbent users.
- An online portal can be developed with all the relevant spectrum bank details and prior allocation database to provide feasibility for enterprises and Industry verticals to apply for their campus / location / factory plants with nominal administrative charges.
- Detailed guidelines can be prepared for coverage / transmit power limitations at the perimeter of the campus / location of the enterprise / industry vertical to ensure that the spectrum usage is confined the prescribed property and to avoid any kind of interference.
- Comprehensive governance & audit processes to be developed for regular operations of such secondary users and their private networks to ensure regulated usage of the allocated shared spectrum within the defined guidelines.
- In terms of charging of spectrum, we have attached a white paper as "**Annexure A**" prepared by us which proposes to consider auction determined price to arrive at the price of such spectrum for an enterprise / industry vertical with a price/MHz/Sqr Meter which can be easily derived from the auction determined market price conducted in the last for the respective spectrum bands in the respective telecom circles.
- The industry would benefit by having access to more spectrum, the society at large would benefit by having access to better services at affordable prices and the exchequer would benefit as service providers the revenue share from service providers would grow as they are able to capture and offer services to newer markets and customers.

f) Who should be entrusted the work of managing shared access of spectrum?

Tata Communications Response:

WPC as Authorized Shared spectrum access system administrator governed by DoT should be entrusted the work of managing shared access of spectrum.

Q16. Whether there is a need to permit the ASA technique-based dynamic spectrum sharing among access service providers? If yes,

a) What are the possible regulatory issues involved and what could be the possible solutions?

b) What measures should be put in place to avoid any adverse impact on competition and dynamics of spectrum auction?

Kindly justify your response.

Tata Communications Response:

Tata Communications recommends permitting ASA technique based dynamic spectrum sharing among service providers.

a) ASA technique based dynamic spectrum sharing should be allowed to licensed service providers only. A robust technology-based mechanism as suggested in response to questions above to put in place to ensure no interference amongst users of shared spectrum.

b) There will not be any adverse impact on competition and dynamics of spectrum auction as ASA technique is utilizing small chunk of spectrum band (from incumbent captive users) for limited time as per availability and priority of primary users.

Q17. In case it is decided to permit ASA technique-based dynamic spectrum sharing among access service providers in the country, please provide your response to the following questions with justification:

a) Whether there is a need for prescribing any framework for such shared use? If yes, what should be the framework?

Tata Communications Response:

Yes, there is a need for prescribing framework for adherence by all the stakeholders. ASA technique framework can be based on following but not limited to:

- Use of geographic locations databases for all users to coordinate spectrum assignments.
- Significant improvements in the computation power to efficiently and rapidly run advanced propagation analysis and coordinate devices & users in near real-time.
- More agile wireless equipment that can interact directly with a dynamic frequency coordination database.
- Efficient power controlling mechanisms for secondary users to minimize noise levels.

b) Whether access service providers should be required to obtain approval or intimate to DoT before entering into such arrangement?

Tata Communications Response:

It is suggested that there is no need for permission from/ intimation to the DoT prior to entering such arrangements by the service providers and incumbents. Service providers will have to coordinate with the Authorized Shared spectrum access system administrator.

c) Whether any fee (one time, or recurring), should be prescribed on the spectrum sharing party(ies)? If yes, what should be the fee and who should be liable to pay such fee?

Tata Communications Response:

It is suggested that a nominal fee may be charged from spectrum sharing party (ies) to meet administrative expenses.

d) What should be the treatment of spectrum shared through ASA technique for the purpose of computation of spectrum cap?

Tata Communications Response:

Spectrum capping should be computed considering the quantum of spectrum and number of service providers participating in the sharing of spectrum.

e) Whether there is a need for an independent entity for managing spectrum access? If yes, who should be entrusted this work? If not, how should the spectrum access be managed?

Tata Communications Response:

Yes, there is need for a neutral governing body under DoT, for managing spectrum access. As submitted in earlier responses, WPC may be entrusted with the responsibility of Authorized Shared spectrum access system administrator.

f) Is there a need for putting in place a mechanism for dispute handling including interference issues or should it be left to the access service providers? If yes, what should be the framework?

Tata Communications Response:

Authorized Shared spectrum access system administrator can be setup for dispute handling and interference issues among primary & secondary users. Further, please also refer our response provided under Q15 (d).

g) What other terms and conditions should be applicable for the sharing parties?

Tata Communications Response:

The sharing of spectrum to be permitted with licensed telecom service providers only.

Q18. Suggestions on any other spectrum sharing technique(s), which needs to be explored to be implemented in India, may kindly be made along with the relevant details and international practice. Details of likely regulatory issues with possible solutions, interference management, dispute handling etc. may also be provided.

Tata Communications Response:

Tata communications recommends exploring the AFC (Automated Frequency Coordination) implemented in USA by FCC apart from listed techniques mentioned in the consultation paper like SAS and LSA.

- The AFC systems will determine which frequencies are available for outdoor devices. Once per day each AFC system is required to access to FCC's database to obtain the most up-to-date information on licensed primary user links including their transmitter and receiver locations, frequencies, bandwidths, polarizations, transmitter EIRP, antenna height, and make and model of antenna and equipment etc. The AFC systems will use this information, along with the propagation models to determine on which frequencies and at what power levels secondary outdoor devices may operate.

- The rules specify the propagation model the AFC system must use for determining frequency availability and power levels, which depends on the distance between the outdoor devices and the licensed primary user base station.
    - For separation distances of 30 meters or less, the AFC system will use a free space pathloss model.
    - When the separation distance is greater than 30 meters, but less than 1 kilometer, the AFC system will use the WINNER II model. The WINNER II model is one of the most widely used and well-known channel models in the world and was developed from measurements conducted by the WINNER organization, as well as results from academic literature. When using the WINNER II model, the AFC system should use site-specific information, including building and terrain data, for determining the line-of-sight/non-line-of-sight path component where this information is available. For evaluating paths where this data is not available, the rules specify probabilistic combining of the line-of-sight and non-line-of-sight path into a single path-loss.
    - For distances greater than 1 kilometer, the AFC system will use the Irregular Terrain Model (ITM) combined with a clutter model for the local environment. When using the ITM, the rules specify that AFC systems are to use 1 arc-second digital elevation terrain data and, for locations where such data is not available, use the most granular digital elevation terrain data available. To account for the effects of clutter, such as from buildings and foliage, the AFC system should combine use of the ITM with statistical clutter model ITU-R P.2108 for urban and suburban environments and the ITU-R P.452-16 clutter model for rural environments.

- As per FCC, AFC system operators are required to serve for a five-year term which can be renewed by the Commission based on the operator's performance during the term.

- If an AFC system operator discontinues service or its term is not renewed, it must transfer its database along with the information necessary to access the database to another designated AFC system operator.

In this regard, please also find attached Shared spectrum allocation policy framework for two countries namely UK & USA wherein such policy framework has been successfully implemented and is operational form last few years as Annexure B and Annexure C respectively.

UK Shared Access Guidelines (attached as Annexure -B)

UK OFCOM
shared-access-licenc

US Shared Access Guidelines (attached as Annexure -C)

WINNF-TS-0112.pdf

Issues relating to Leasing of Spectrum

Q19. Where there is a need to permit spectrum leasing among access service providers? Kindly justify your response.

Tata Communications Response:

- Yes, there is a need to permit spectrum leasing among all licensed service providers. We are of the view that Spectrum leasing would further expand the market by way of more Operators using the licensed spectrum which will strengthen the competition thereby benefitting both the Customer as well as Government. Thus, allowing spectrum leasing would be a win-win for all stakeholders. Spectrum leasing would make larger participation in the forthcoming spectrum auctions vis-a-vis from three Access Service Providers.

- Radio frequency spectrum is a scarce natural resource. Any amount of frequency spectrum, if not in use optimally and efficiently, it is an opportunity loss to allow the benefits of the spectrum to a wider category of users/end customers across all service providers under various licenses/ authorizations, thus also hinders socio-economic development of the country.

- There should also be a provision for enabling spectrum leasing amongst all licensed entities including ISP, NLD, ILD etc. which is likely to create a secondary market for spectrum and proliferate efficient and better usage of a scarce natural resource. It should also facilitate spectrum sharing amongst all licensees irrespective of one of the licensee's holding spectrum in that band or licensee not holding any spectrum at all enabling full flexibility to the licensees for sharing their spectrum to get the optimal spectrum efficiency for this scarce resource.

- Spectrum leasing would also ensure that the spectrum should not be underutilized or remain idle, as observed in the recent spectrum auction of 2021, where only 37% (in term of quantity) was sold and rest of the spectrum remains unsold. Allowing leasing of spectrum by the winning bidder would provide the necessary impetus to various entities to participate in the auction process. This will not only support in creation of networks for different 5G use cases, but also support reduction in CAPEX expenditure related to Spectrum to the licensees who would acquire spectrum in auction thereby ultimately increasing revenue for exchequer. Therefore, we strongly recommend that spectrum leasing should be allowed as a mechanism for ensuring optimal utilization of the available spectrum.

- Globally, spectrum leasing has been permitted as standard practice among TSPs. For example, countries like USA, Canada, Malaysia have already permitted leasing of access spectrum to other TSPs.

- The National Digital Communications Policy (NDCP) 2018 also recognized spectrum as a key natural resource for public benefit to achieve India's socio-economic goals. For making

adequate spectrum available to be equipped for the new broadband era, one of the action plans under NDCP 2018 is to further liberalize the spectrum sharing, leasing and trading regime.

- Thus, under the Spectrum Sharing guidelines, leasing of spectrum should be permitted to enable efficient utilization of this scarce natural resource among all licensed telecom service providers.

Q20. In case it is decided to permit spectrum leasing among access service providers, please provide detailed response to the following questions:

a) Whether spectrum leasing should be permitted for short-term period only, or for both short-term as well as long-term?

Tata Communications Response:

Spectrum leasing should be permitted amongst all licensed telecom service providers both for short term and long term. It would promote efficient use of spectrum and may particularly be needed for short-term time-bound events that require significant amount of capacity for broadcast and user applications as well as of longer-term use to offer services to customers by service providers.

b) In case only short-term leasing is to be permitted, what should be the maximum duration for such spectrum leasing? Should there be any restrictions on renewal of such short-term lease?

Tata Communications Response:

Duration of the spectrum leasing can be proportional to the duration of the short events or purpose for which TSPs have leased the same. There should not be any restrictions on the renewal of such leases. A standard framework can be created which incorporates all the short-term, long-term spectrum leasing and the tenure of such arrangements.

c) In case it is decided to permit long term leasing, please provide your response to the following questions with justification:

i. What measures should be put in place to avoid any adverse impact on competition and dynamics of spectrum auction?

ii. Whether there should be a maximum duration for which spectrum leasing may be permitted?

Tata Communications Response:

Question wise response for permitting long term leasing is as follows:

i. As spectrum is scarce national resource, efficient and optimal usage across all service providers under various licenses/ authorizations for wider set of customer base. There will not be any adverse impact on competition and dynamics of spectrum auction by spectrum leasing arrangement between any licensor and licensee for long-term. In fact policy framework to allow telecom service providers to lease spectrum would help further enhance competition in the telecom industry.

ii. No conditions on maximum duration must be included in leasing of spectrum.

d) What should be the applicable roll-out obligations for the Lessee (the access service provider which takes spectrum through leasing arrangement from the Lessor)? Whether the spectrum leasing should have any effect on the roll-out obligations applicable for the Lessor (the access service provider which has leased out the spectrum)? Whether the provisions for roll-out obligation require to be different for short-term and long-term spectrum leasing?

Tata Communications Response:

There should not be any separate Mandatory Roll out obligations (MRO) for spectrum lessee, as because leasing shall be done only on specific demand by lessee business requirements. Mandatory roll-out obligations are prescribed by the government to ensure optimum use of spectrum and availability of service to larger set of customers. The sites rolled out by the lessee of the spectrum should count towards meeting the roll-out obligations of the lessor, if any. This would be another way to ensure that the objectives of mandatory roll-out obligations prescribed by Government for allocation of spectrum are being effectively met.

e) Should the spectrum leasing charges be levied on similar lines as applicable for spectrum trading? If no, what charges should be made applicable in case of spectrum leasing?

Tata Communications Response:

There should not be any additional charges levied for spectrum leasing as spectrum under leased would already be paid for by the lessor.

f) Should there be a lock-in period, after acquisition of spectrum, to become eligible for spectrum leasing as applicable in spectrum trading? If yes, what should be the lock-in period post which, spectrum holder would become eligible to lease it to another access service provider?

Tata Communications Response:

No lock-in period. There should not be any type of lock-in period for leasing of spectrum post-acquisition of the spectrum. By enforcing lock-in period rule, it may devoid and delay TSPs owning spectrum post auction to create a conducive environment for secondary market for spectrum.

g) Whether there is a need for an approval from, or intimation to DoT before the proposed leasing of spectrum? If yes, whether prior approval/ prior intimation requirement be different for long-term and short-term spectrum leasing? What should be the timelines for approval from, or intimation to DoT in each case?

Tata Communications Response:

It must not be mandatory to seek approval from DoT while leasing spectrum. However, intimation to DoT to be made for spectrum leasing agreement irrespective of whether it is short term or long-term leasing. Intimation to DoT should be made before completing the spectrum leasing agreement.

h) Whether the spectrum held by an access service provider on short-term, or long-term lease be included to calculate compliance to spectrum caps?

Tata Communications Response:

Yes, spectrum held by an Access Service provider on short-term, or long-term lease may be included to calculate compliance to spectrum caps.

i) Considering that surrender of spectrum has been permitted in the country, what provisions need to be created in the guidelines for leasing of spectrum between access service providers so that any possible misuse by the licensees could be avoided?

Tata Communications Response:

The guidelines may include the provision of surrendering spectrum before pre-determined tenure to avoid misuse of the provisions of spectrum leasing. Also, there should be mutual agreement between lessor and lessee before surrender of leased spectrum by the lessor.

j) What other terms and conditions need to be prescribed in respect of spectrum leasing between access service providers?

Tata Communications Response:

The sharing of spectrum to be permitted with licensed telecom service providers only.

Q21. Any other issues/ suggestions relevant to the spectrum leasing, may be submitted with proper explanation and justification.

Tata Communications Response:

No Comments

Annexure- A

Pricing Mechanism for Spectrum Allocation to the Captive Private Networks

We very much appreciate TRAI's well thought out recommendations dated 11-04-2022 and reconsidered recommendations dated 09-05-2022 for the option i.e., Enterprises to obtain the spectrum directly from DoT for establishing their own isolated Captive Wireless Private Network to paves the way for development of Industry 4.0 infrastructure in the country. India has vast presence of Industries across various sectors ranging from Manufacturing, Transportation, Mining, Land & Sea Ports, Automotive, Steel, Pharma, Education, where true potential of private networks can be exploited to drive "Make in India" initiative and eventually contributing to the national GDP. Thus, direct spectrum allocation and licensing of captive Industrial and enterprise 5G networks is in the overall national interest of all sectors of the economy.

It has been estimated that by 2030, the business value resulting from manufacturing 5G use cases running on improved connectivity especially with the use of ultrafast 5G technology could generate from $400 billion to $650 billion of GDP impact. That's because the enhanced bandwidth, higher speed, significantly lesser latency, improved security and device density that high-band 5G connectivity and private networks bring, can support manufacturing automation and numerous high-impact applications to achieve higher operational efficiencies. Apart from manufacturing, many other industries / sectors are also looking at 5G as the backbone for their equivalent of the Fourth Industrial Revolution.

It is also pertinent to mention that the enterprise connectivity would require utmost customer centric approach where network's reliability, speed, latency, efficiency, density each need to be defined by the Enterprises and can vary for each Enterprises depending on their operational requirement. For example, 5G network for a manufacturing plant with large assembly line would be completely different from the one being used by an educational institution for R&D. It would immensely be difficult for a Telecom service provider to customize its network for each Enterprises and fulfil the desired network with specific values of different connectivity parameters of such enterprises.

Several Regulators, particularly in developed countries around the world have realized the importance of captive private 5G communications by their industries and enterprises and have been proactively working towards making the necessary spectrum resources available directly for their captive needs, keeping in mind importance of these users in nation building and economic growth.

Internationally, there were 955 private mobile network customers by November 2022 in 72 countries, led by the US, China and Germany. Manufacturing, education and mining are the leading user sectors and 5G is used by 41 percent of the customers. Many Countries are already implementing rules and have started allocating spectrum directly for the vertical markets/private broadband/local area licensing. In fact, most industrial countries have already allocated mid band spectrum for deployment of private 5G Networks.

India too, could consider the popular mid-band and mmWave category as typical frequency spectrums for 5G private networks. TRAI has already recommended few such frequency bands for direct allocation to enterprises and industry verticals for captive non-public networks in India.

In the recently concluded spectrum auction, DoT (Department of Telecommunications) has already found the market determined price for both mid-band as well as mmWave spectrum bands. This is the price at which the spectrum was bought by Mobile network operators for their 5G network rollouts. The Unified Access Service licenses of these Mobile network operators permits them to cover any of the licensed service area (LSA) with the respective spectrum for public networks and provide services as stipulated in the licensing conditions. If we exclude the forest and unproductive lands in different LSAs, nearly 70 percent of the geographical area is a potential for any public mobile network operator for which the operator deploys his network coverage with respective spectrums.

We propose that the same market determined price identified in Spectrum auction 2022 may be applied to CNPN networks as well based on the coverage area of the CNPN network, that way the actual price to be paid by the CNPN Licensee can be determined. In this regard, below example may kindly be seen –

Example: Calculation of Spectrum price for Captive Private 5G network within 10 Sq. Km area network

LSA	Category	Auction Price in Rs. Crores per 10 MHz block in for 1 Years (mid Band)	Area (in Sq KM)	Usable area @ 70% of area	Price per 10 Sq. Km per 10 MHz Block -Mid Band (in Rs Lakhs) per year
Delhi	Metro	357	1,484	1038.8	343.7
Mumbai	Metro	313	603	422.1	741.5
Tamilnadu	A	125	1,30,058	91040.6	1.4
Haryana	B	53	44,212	30948.4	1.7
Kerala	B	104	38,863	27204.1	3.8

We believe, it is urgent and essential for the Government to reserve adequate spectrum for direct allocation basis proposed spectrum pricing under the CNPN licenses for deployment of Private 4G/5G (Non-public as well as Captive) networks to the Enterprises.

We therefore earnestly request TRAI to kindly consider above proposed spectrum allocation and pricing methodology while framing its recommendations to the Government to prepare a policy framework for allocation of dedicated spectrum for captive industrial and enterprise 4G/5G networks based on globally harmonized IMT technologies in standardized 3GPP frequency bands soon.

Ofcom
making communications work
for everyone

Shared Access Licence

Guidance document

Publication Date: 20 September 2022

Contents

Section

1. Overview

1.1 On 25 July 2019, Ofcom published a Statement, *Enabling wireless innovation through local licensing*, which sets out two new licence products we are introducing to make it easier for a wider range of users in the UK to access radio spectrum on a shared basis.[1]

1.2 These are:

a) **the Shared Access licence**, which gives access to four spectrum bands which support mobile technology; and

b) **the Local Access licence**, which provides a way for other users to access spectrum which has already been licensed to the UK's Mobile Network Operators (MNOs), in locations where an MNO is not using their spectrum.

1.3 This document is about the **Shared Access licence**, and is intended to outline everything that new users (who might not be familiar with obtaining licences from Ofcom or be aware of what spectrum options are available) need to know about the new Shared Access licence product. It includes information on how much the licence costs, how you can apply for a licence, and what terms and conditions you have to adhere to if you have a licence.

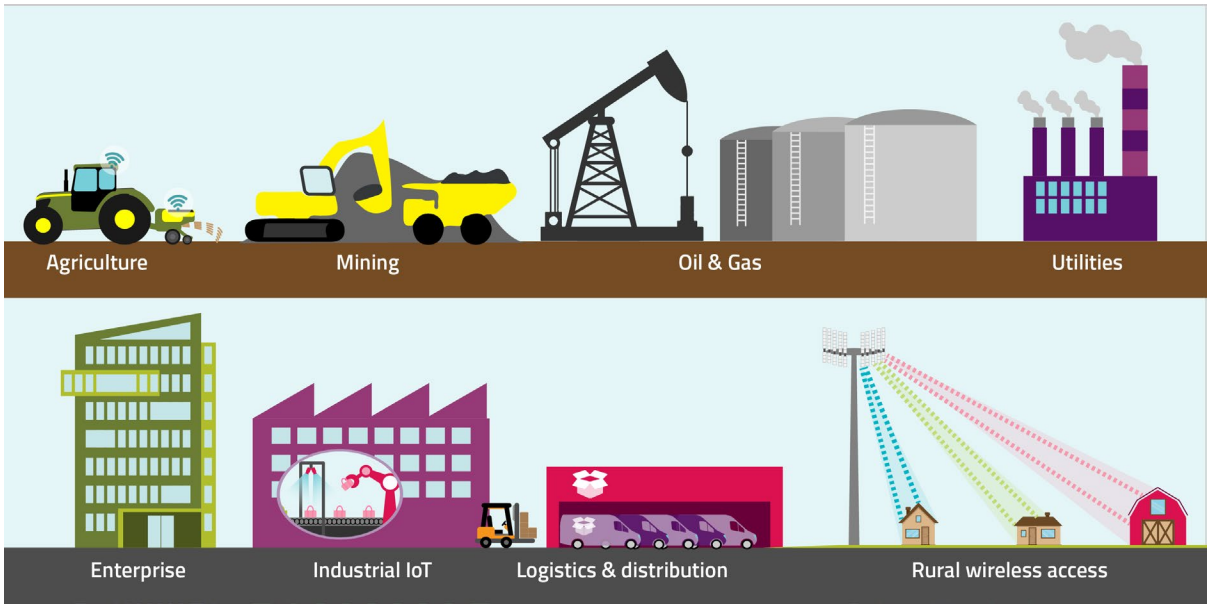
1.4 You can find the guidance document for the **Local Access licence** on the Ofcom website.[2]

1.5 The Shared Access licence may open up new options for users, such as small businesses and community groups which could support innovation and enable new uses. The licence could be useful for all sorts of different businesses and industries, such as those set out in the graphic below.

[1] Ofcom, *Enabling wireless innovation through local licences: Shared access to spectrum supporting mobile technology*, 25 July 2019, https://www.ofcom.org.uk/__data/assets/pdf_file/0033/157884/enabling-wireless-innovation-through-local-licensing.pdf

[2] Ofcom, *Local Access licence: Guidance document*, 25 July 2019, https://www.ofcom.org.uk/__data/assets/pdf_file/0037/157888/local-access-licence-guidance.pdf

Figure 1: Possible users of the new Shared Access licence product



1.6 You might find the Shared Access licence useful if you'd like to provide wireless connectivity to your business or site, in a way which is more secure than licence exempt technology like Wi-Fi, but more customisable than using a solution from an MNO.

Frequencies available using the Shared Access licence

1.7 There are four different spectrum bands available using the Shared Access licence under the Spectrum Sharing framework outlined in the Statement. We call these "the shared access bands", and they are:

a) **1781.7-1785 MHz paired with 1876.7-1880 MHz** (which we refer to as "the 1800 MHz shared spectrum"): This is part of the wider 1800 MHz mobile band (although this particular portion has not been licensed for national mobile services) and is supported by commercially-available mobile base stations and equipment, including most mobile handsets. There is a total of 2 x 3.3 MHz available in the band.

b) **2390-2400 MHz** (which we refer to as "the 2300 MHz shared spectrum"): This is part of the 2300 MHz mobile band and sits just above the 2350-2390 MHz band which is used for mobile in the UK. It is supported by commercially-available mobile base stations and equipment, and is included in some of the latest smartphones. There is 10 MHz available in this band.

c) **3.8-4.2 GHz**: This band sits just above the 3.6-3.8 GHz mobile band, and chipsets for this band which support 5G technology are currently available. There is 390 MHz of spectrum available in the band.

d) **24.25-26.5 GHz** (which we refer to as "the lower 26 GHz band"): This band is available for indoor low power licences only (see sections 2 and 3 for more details). This is part of one of the pioneer 5G bands in Europe and has 2.25 GHz of spectrum available in total.

1.8 In the future, we may look to make additional bands available under the same spectrum sharing framework as appropriate.

1.9 The type of application you want to provide will determine which band is most appropriate for you, as the characteristics and bandwidth available in each band differs.

1.10 For example, lower frequencies such as in the 1800 MHz or 2300 MHz shared spectrum have better propagation characteristics; this means that transmissions in these bands can "bend" around obstacles or penetrate through buildings much more easily than at higher frequencies. However, the smaller amount of bandwidth available in these two bands (2 x 3.3 MHz and 10 MHz respectively) means that you probably can't use these bands for applications that need to transmit large amounts of data. If you need larger bandwidth, the 1800 MHz shared spectrum could be coupled with licence exempt LTE in the 5150-5925 MHz band (3GPP Band 46) to provide additional channels to support higher capacity applications.

1.11 It is not permitted to use the 3.8-4.2 GHz band to provide national mobile broadband services; we're preparing to award national licences for spectrum in the 3.6-3.8 GHz band for that purpose.

2. Introduction to the Shared Access licence

The Shared Access licence is part of a new framework for enabling shared use of spectrum

2.1 Our spectrum sharing framework is intended to provide a simple method for users to access spectrum in a number of frequency bands.

2.2 One of the aims of this new framework is to make it easier for people and businesses to access spectrum which can be used to support a wide range of local wireless connectivity applications.

2.3 Our spectrum sharing framework enables access to a number of bands under a common process as outlined below:

a) **New users will apply to Ofcom** to get licences for the locations, bands and bandwidths that they need to provide their service.

b) **Ofcom will assess applications** to see if any interference would be caused to, or received from, other licensees in the band.

c) **Ofcom will grant individual licences** for the requested locations, bands and bandwidths on a first come, first served basis, provided that the application passes this coordination process.

d) **Users will pay licence fees to Ofcom**, which are due annually.

2.4 There may be some differences between conditions in the different bands. For example, each of the bands has different existing users and therefore our approach to assessing applications may look different from band to band because of different existing users and therefore different interference risk.

2.5 The Shared Access licence which we are making available under this new framework is currently available in four different bands:

a) the 1800 MHz shared spectrum;

b) the 2300 MHz shared spectrum;

c) 3.8-4.2 GHz; and

d) the lower 26 GHz band.

2.6 These bands all support widely-available conventional mobile technology, or are adjacent to other mobile bands where this is the case. This is good for users because lots of equipment is already available using these bands, which means this equipment is cheaper than using bespoke or proprietary technology.

2.7 In the future we expect to add more bands to this same framework as appropriate.

2.8 This guidance sets out the approach Ofcom generally expects to take when assessing and issuing Shared Access licences. However, we may consider exceptional applications on a

case-by-case basis and we retain the discretion to amend our approach, and to make exceptions or disapply the guidance if it is appropriate to do so in the particular circumstances. We will also keep this general guidance under review and may amend it from time to time as appropriate, as we gain experience of how these licences are used in practice.

There are two kinds of licence: low power and medium power

2.9 To provide a range of options for new users, we're offering two different versions of the Shared Access licence, which authorises uses in slightly different ways:

Low power licence

2.10 We think the low power licence product could be suitable for industrial and enterprise users looking to deploy their own private networks. This could be to support voice and text applications or other wireless data applications around their sites; it could also potentially be used for indoor mobile coverage extension schemes, for example through a neutral host model.

2.11 The low power licence will authorise users to deploy as many base stations as they require within **a circular area with a radius of 50 metres**, centred on a coordinate provided to us by the user when they apply for the licence. Users will have the flexibility to move their base stations around within the licensed area without requiring further coordination by Ofcom.

2.12 Users looking for the flexibility to place base stations anywhere within a larger area can apply for multiple low power licences, which could be contiguous or spaced out over a larger area. You can see some examples of this in Figure 4 and Figure 5 below.

2.13 There will be an indoor-only option available, as well as an indoor/outdoor option for users looking to deploy either partly or wholly outdoors.

2.14 Base stations covered by the low power Shared Access licence can connect to fixed, nomadic or mobile terminals.

2.15 "Fixed terminals" are those which are at a fixed location and do not move; we refer to these as "fixed/installed terminals" in our Statement. "Nomadic terminals" are terminals that can move around, but typically only transmit when stationary. "Mobile terminals" can transmit and receive while moving.

Medium power licence

2.16 We think that this licence could be suitable for users who need a longer transmission range from their base station, but don't expect to need to change the locations of base stations once they're deployed. This could suit providers of Fixed Wireless Access (FWA) services in rural areas, along with industrial or enterprise users with sites spread over a larger area, such as ports, agriculture or forestry. It could also be suited to providing mobile coverage

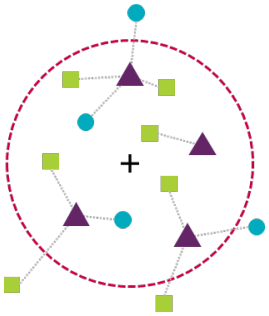
extension schemes in rural areas, as the 1800 MHz and 2300 MHz shared spectrum bands are in wider bands which already support mobile technology.

2.17 The medium power licence will authorise **a single base station**. The base station can connect to fixed, nomadic or mobile terminals.

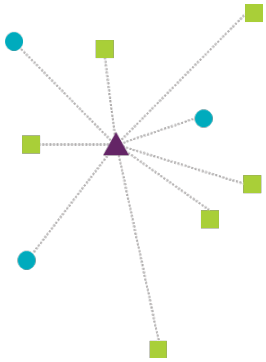
2.18 Medium power base stations are generally only permitted in rural areas, as their increased power and transmitting range mean that if they were deployed in urban areas, they could potentially prevent a large number of low power users from deploying.

2.19 Figure 2 below shows how the two types of licence differ, with the low power licence authorising an area where the base stations could operate, and the medium power licence authorising each base station individually.

Figure 2: Low power (left) and medium power (right) Shared Access licences



Licence authorises all base stations within 50 metres of a given location (max EIRP 24 dBm), and any connected terminals.



Licence authorises a base station at a given location (max EIRP 42 dBm) and any connected terminals.

Legend

- Base station
- Fixed/installed terminal
- Mobile/nomadic terminal

2.20 Airborne use is not permitted for both the low and medium power licences.

Where in the UK the Shared Access licence will be available

2.21 Although generally speaking, the Shared Access licence is available all around the UK, there are some exceptions to this:

a) The medium power licence is generally only available in rural areas. (We define what we mean by "rural areas", and discuss this restriction in more detail, in Section 3.)

b) The 2300 MHz shared spectrum is currently not available in Northern Ireland.

c) The 2300 MHz shared spectrum will initially only be available for indoor low power licences.[3]

d) In the 3.8-4.2 GHz band, we are not initially accepting applications within 5km of the following MOD sites:

[3] We will need to gather more evidence before making outdoor low power and medium power uses more generally available

i) GCHQ Bude, Cornwall

ii) RAF Menwith Hill, North Yorkshire

e) In the lower 26 GHz band, we are not initially accepting applications within 1km of Harwell Earth Exploration Satellite Service earth station, Oxfordshire.

f) There are some restrictions in the Crown Dependencies:

i) On the Isle of Man, neither the 1800 MHz or 2300 MHz shared spectrum bands are available. Use of the other bands may be possible but you might need to talk to the Isle of Man Communications Commission[4] as well as Ofcom.

ii) On the Channel Islands, the 1800 MHz shared spectrum is currently unavailable. Use of the other bands may be possible but you might need to talk to the Channel Islands Competition & Regulatory Authorities[5] as well as Ofcom.

2.22 Additionally, while these are not restrictions, users should also be aware of the following:

a) **1800 MHz shared spectrum:** It's possible that users of the 1800 MHz shared spectrum could experience periodic interference from MOD use of this band in some locations. This could happen near three specific sites: RAF Colerne in Wiltshire, RAF Oakhanger in Hampshire, and RAF Menwith Hill in North Yorkshire. We consider the risk of interference to be very low.

b) **2300 MHz shared spectrum (in band):** Users of this band should be aware that the band is shared by amateur radio users. These uses are mainly temporary and we expect the risk of interference to be very small. However, it is possible that Shared Access licence users in this band could experience interference from amateur radio users, as Ofcom does not coordinate these. If you do receive interference to your licensed equipment, you can report this to Ofcom – although it should be noted that Ofcom cannot guarantee spectrum will always be free of interference.[6]

c) **2300 MHz shared spectrum (adjacent band):** The 2400 MHz band, adjacent to the 2300 MHz shared spectrum, contains a number of different services. These include Wi-Fi, Zigbee (used, for example, in smart meters and home automation) and Assistive Listening Devices (ALDs), devices used in conjunction with hearing aids to help people with hearing impairments hear properly.

i) To avoid interference to Wi-Fi and Zigbee, it's probably best to make sure your Wi-Fi access point or smart meter is not located next to (i.e. within a few metres of) your 2300 MHz shared spectrum base station.

ii) Regarding ALDs, we'd advise prospective users of the 2300 MHz shared spectrum to consider very carefully if they intend to install a base station anywhere ALDs are likely to be used. In particular, we'd advise against using this band inside a school

[4] https://www.iomcc.im/
[5] https://www.cicra.gg/
[6] You can find more information on doing this on the Ofcom website: https://www.ofcom.org.uk/spectrum/interference-enforcement/troubleshooting-interference/reporting-interference

and recommend that you consider if any of the other shared access bands might suit your intended application instead. This is because younger school pupils who use hearing aids and ALDs are much less likely than adult users to understand why their devices are not working correctly, if these were receiving interference from mobile terminals or base stations in the 2300 MHz shared spectrum in the same location.

d) **3.8-4.2 GHz band:** We don't expect that this spectrum will be used as part of national mobile networks. Users looking to provide wide-area coverage should look for spectrum in other bands.

How to apply for a licence

2.23 To apply for a Shared Access licence, you'll need to fill in an application form. You'll be able to access the form on the Ofcom website[7].

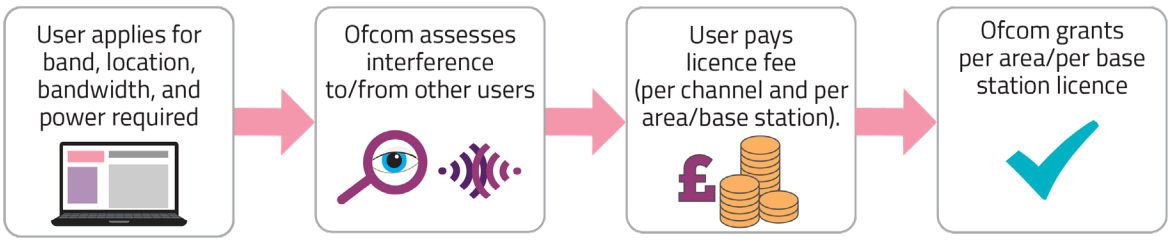
2.24 Once you've filled in the licence application form, email it to the Ofcom Licensing Team at spectrum.licensing@ofcom.org.uk.

2.25 Once you send in your completed application form, we'll carry out a technical assessment to make sure your new deployment wouldn't interfere with anyone else's equipment – and that their equipment won't interfere with your deployment. We'll notify you of the result of our assessment, and if your application is successful we'll assign you a frequency to transmit on.

2.26 If you're happy with the frequency we've assigned you, we'll then send an invoice and request payment. You have 30 days to pay for the invoice. Once you pay your licence fees, we'll then issue you with your licence.

2.27 This process is summarised briefly in the graphic below.

Figure 3: Shared Access licence application process



Dynamic Spectrum Access and how this might affect your licence

2.28 In the future, we would like to move towards a Dynamic Spectrum Access (DSA) approach if appropriate, where users' equipment would communicate directly with a central

[7] https://www.ofcom.org.uk/manage-your-licence/radiocommunication-licences/shared-access

database in order to access spectrum. This means that you will only be assigned frequencies when you request for one directly from the spectrum assignment database.

2.29 This would help to ensure that the shared spectrum is being used effectively and efficiently, and would mean that if a user no longer transmits in their assigned frequency in a particular place, this would automatically become available again for other users.

2.30 However, we are not yet in a position to implement a DSA approach in the shared access bands, so in the meantime we are embedding the DSA concept in the Shared Access licence to achieve the same outcome. There may be further changes to your licence in the future if we do implement a DSA approach.

2.31 You'll have to start transmitting within six months of being issued your licence, and continue to remain operational after this. If you need to switch your equipment off from time to time (e.g. for maintenance) this is fine; this condition is more about making sure that licensees who've stopped transmitting for good aren't blocking access to spectrum for new users.

2.32 Your Shared Access licence will also allow Ofcom to request that you change frequency from time to time; we may do this for spectrum planning purposes, or if we need to deal with interference.

2.33 If we need to do this, we will email you the frequency you need to change to, and the time by which you will need to have changed frequency by. This means that you should deploy equipment that can be tuned across an entire band (that is, for the 3.8-4.2 GHz band and 26 GHz band where this is relevant) to ensure continuity in access.

2.34 We are now starting work to assess whether it would be appropriate to transition towards DSA, supported by a fully automated authorisation database. This will include setting specifications for equipment to enable it to contact the future DSA database. We think setting these specifications is best done in collaboration with industry, particularly equipment vendors. This would allow us to best consider the costs and complexity of implementing this, both in relation to users' radio equipment and the spectrum assignment database.

2.35 If we decide to transition to DSA in the future, we will vary the Shared Access licences. When we do this, the new licence may include an additional requirement for equipment to be able to contact any future DSA database.

2.36 If we introduce DSA in the shared access bands, the first come, first served principle will remain. This means that existing installations would generally be able to continue their deployment as long as their equipment remains operational and, once an automated database is in place, they continue to request spectrum from the database and comply with any technical parameters, for example, in relation to maximum transmission power, etc.

3. The low power Shared Access licence

3.1 Rather than authorising one specific base station, the low power licence authorises any number of base stations located in a circular area with a radius of 50 metres, centred on a coordinate provided to Ofcom by the user.

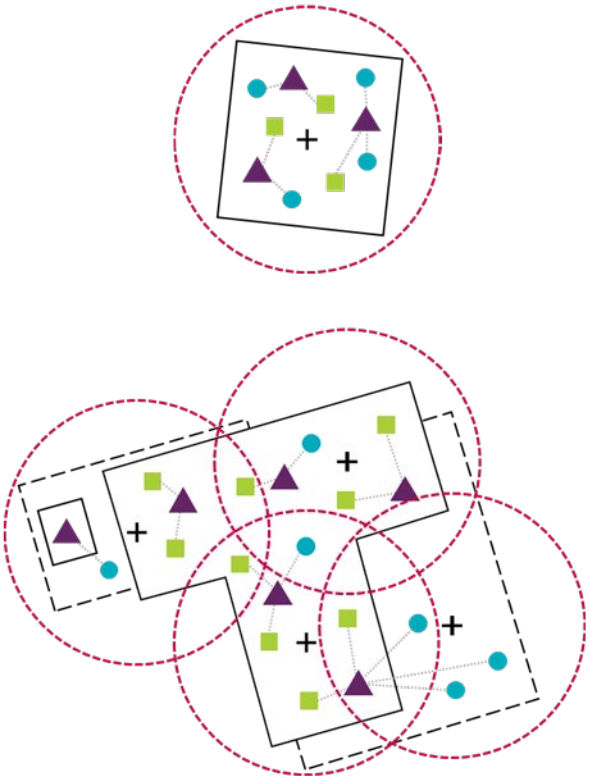
3.2 You can connect fixed, mobile or nomadic terminals to any base stations operating within the area covered by your licence, and these terminals will also be authorised by your licence.

3.3 Additionally, mobile and nomadic terminals connected to base stations using the 1800 and 2300 MHz shared spectrum will also be licence exempt.

3.4 Users are free to deploy as many base stations as they like in the licensed area, and can move base stations around within this area without needing to inform Ofcom of such changes.

3.5 If you want to deploy base stations in a larger area, you can apply for multiple areas as part of the same licence application. It could be that you need these areas to be next to each other and overlapping, as shown in Figure 4 below, or spaced out around a larger site, like in Figure 5 further down.

Figure 4: Examples of low power Shared Access licence use



Simple deployment with one registered low power licence area. Licensee has opted for an indoor-only licence as they do not anticipate needing to deploy base station equipment outdoors.

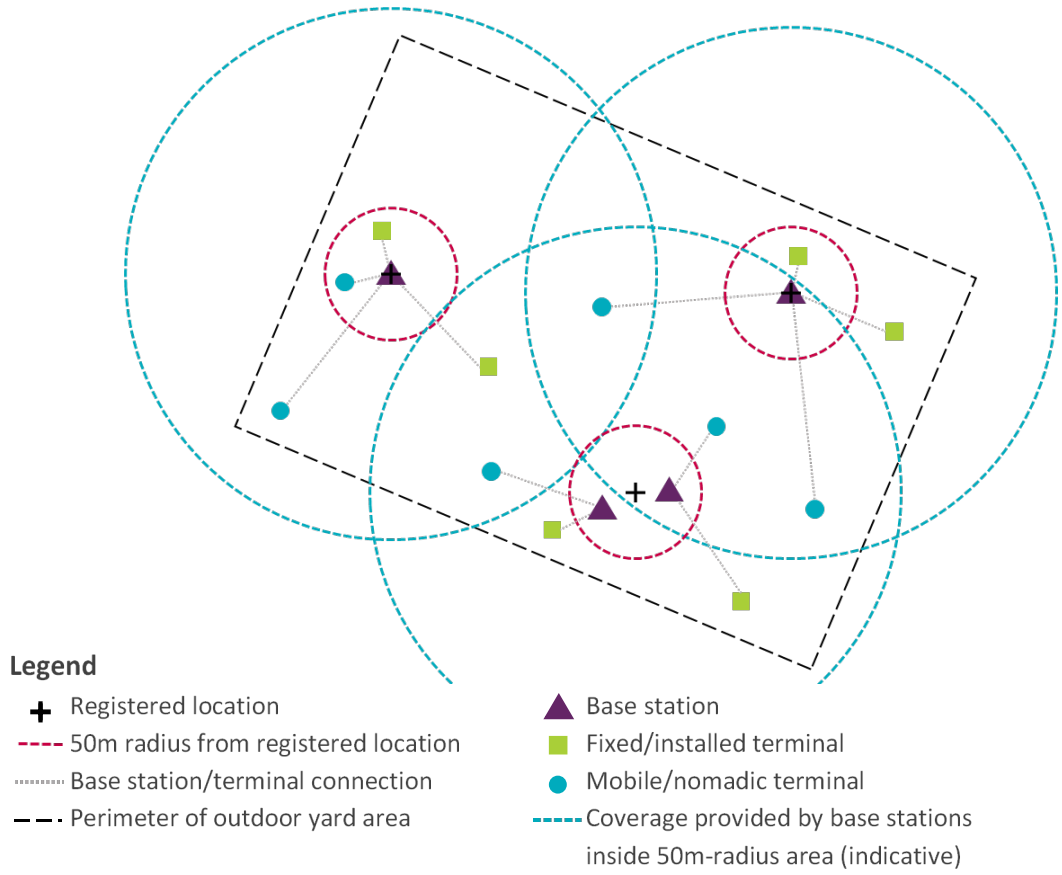
More complex deployment with four areas licensed in order to give the user the flexibility to move base stations anywhere on their premises, which is made up of one large T-shaped building, an outbuilding on the left of the image, and two outdoor yard areas on the left and right. Licensee intends to install base stations in the yards, so has chosen licences valid for both indoor and outdoor use.

Legend

- Registered location
- 50m radius from registered location
- Wall of building
- Perimeter of outdoor yard area
- Base station
- Fixed/installed terminal
- Mobile/nomadic terminal
- Base station/terminal connection

3.6 Remember that you can only deploy **base stations** within the licensed 50 metre-radius areas, but **terminals** just need to be connected to a base station in a licensed area. Terminals don't need to be situated inside a licensed area. In practice the coverage provided by base stations is likely to be more than the 50 metre-radius circle we license especially when deployed outdoor. It will therefore be possible to connect devices across a larger site area without needing to obtain low power licences to cover the entire area, unless you want to have the flexibility to move your base stations anywhere within your coverage area. You can see an example of how this might work in Figure 5 below.

Figure 5: Example of terminal stations outside the areas licensed by the Shared Access low power licence, but connected to licensed base stations within these areas



3.7 Users can apply for an indoor-only licence or one which allows both indoor and outdoor use. The exception to this rule is the 2300 MHz shared spectrum; initially we expect that the 2300 MHz band will only be available for indoor-only licences.

3.8 In this context, "indoors" means inside premises which have a ceiling or a roof; and except for any doors, windows or passageways, are wholly enclosed.

3.9 If you have an indoor-only licence, it is not permitted to deploy base stations or fixed terminals outdoors; if you do, you'll be breaking your licence conditions. If you are looking to provide both indoor and outdoor coverage, you should apply for an indoor and outdoor licence.

3.10 If you have base stations outdoors, these can be a maximum of 10 metres above ground level. For indoor base stations, these can be at any height within your building.

3.11 The price of the licence will stay the same regardless of whether or not you opt for an indoor-only licence. However, we would encourage users who do not expect to deploy any equipment outdoors to apply for an indoor-only licence, as this is more likely to pass coordination than an application for both indoor and outdoor use and is therefore more likely to be approved. Conversely, if you do expect to deploy any equipment outdoors, you should not apply for an indoor-only licence in order to pass coordination, as you will be

restricted to indoor use only and will be breaking your licence conditions if you deploy outdoors.

Technical conditions

3.12 The following table contains the technical conditions for the low power Shared Access licence. You should consult the licence for the full technical conditions.[8]

Table 1: Technical licence conditions for low power Shared Access licence

Condition	Parameters (by band)			
	1800 MHz shared spectrum	*2300 MHz shared spectrum*	*3.8-4.2 GHz*	*Lower 26 GHz band*
Permitted deployment	Indoor and outdoor Outdoor antennas limited to 10m height above ground	Initially likely to be widely available for indoor only Outdoor antennas limited to 10m height above ground	Indoor and outdoor Outdoor antennas limited to 10m height above ground	Indoor only
Authorised bandwidth	2 x 3.3 MHz	10 MHz	10, 20, 30, 40, 50, 60, 80 and 100 MHz	50, 100, 200 MHz
Maximum base station power	24 dBm / carrier (up to 3 MHz)[9] (EIRP)	24 dBm / carrier (up to 10 MHz) (EIRP)	24 dBm / carrier for carriers ≤ 20 MHz; or 18 dBm / 5 MHz for carriers > 20 MHz (EIRP)	23 dBm / 200 MHz (TRP)
Maximum terminal station (TRP for	23 dBm	25 dBm[10]	28 dBm[11]	23 dBm

[8] Ofcom, *Enabling wireless innovation through local licences: Annexes 6-10*, 25 July 2019, https://www.ofcom.org.uk/__data/assets/pdf_file/0036/157887/annexes-6-10-licences-and-interface-requirements.pdf

[9] This power will only be available over 3 MHz of the 3.3 MHz bandwidth as existing power density requirements restrict the power in the first 200 kHz and last 100 kHz of the bandwidth

[10] The authorisation will list this as 25 dBm **including** a 2 dB tolerance consistent with the European harmonisation.

[11] The authorisation will list this as 28 dBm **including** a 2 dB tolerance consistent with the European harmonisation.

Condition	Parameters (by band)			
	1800 MHz shared spectrum	*2300 MHz shared spectrum*	*3.8-4.2 GHz*	*Lower 26 GHz band*
mobile/nomadic; EIRP for fixed)				
Frame structure requirements	N/A	3:1 structure for all outdoor deployments	N/A (but see notes below)	N/A

3.13 The tables on the following pages outline the out of channel and in band/ out of band emissions limits for the four Shared Access bands. You need to ensure your equipment complies with these limits.

Table 2: 1800 MHz shared spectrum base station in band emission limits

Frequency offset from the lower frequency of the band edge	Maximum mean EIRP density
0 to 0.05 MHz	-33.6 + 153.3 x Δ_{FL}* dBm / kHz
0.05 to 0.1 MHz	-26 + 60 x (Δ_{FL}*- 0.05) dBm / kHz
0.1 to 0.2 MHz	-23 + 230 x (Δ_{FL}*- 0.1) dBm / kHz
0.2 to 3.2 MHz	24 dBm / carrier
3.2 to 3.3 MHz	-23 + 230 x (3.3 - Δ_{FL}*) dBm / kHz

** Note: Δ_{FL} in MHz is the offset from the lower edge of the permitted frequency band at 1876.7 MHz (it has values in the range 0 to +0.2 MHz and +3.2 to +3.3MHz)*

Table 3: 1800 MHz shared spectrum base station out of band emission limits

Frequency offset from the lower frequency of the band edge	Maximum mean EIRP density
-6.2 to -3.2 MHz	-55 dBm / kHz
-3.2 to 0 MHz	-45 + 10 x (Δ_{FL}*+ 0.2)/3 dBm / kHz
Frequency offset from the upper frequency of the band edge	**Maximum mean EIRP density**
0 to 0.05 MHz	-23 - 60 x Δ_{FH}* dBm / kHz
0.05 to 0.1 MHz	-26 - 153.3 x (Δ_{FH}* - 0.05) dBm / kHz
0.1 to 2.8 MHz	-45 - 10 x (Δ_{FH}* + 0.2)/3 dBm / kHz
2.8 to 5.8 MHz	-55 dBm dBm / kHz

** Note: Δ_{FL} in MHz is the offset from the lower edge of the permitted frequency band at 1876.7 MHz (it has values in the range -3.2 to 0 MHz)*

Δ_{FH} in MHz is the offset from the upper edge of the permitted frequency band at 1880 MHz (it has values in the range 0 to 2.8 MHz)

Table 4: 2300 MHz shared spectrum base station out of band emission limits

Frequency	Maximum mean EIRP density
2385 to 2390 MHz 2400 to 2403 MHz	(Pmax - 40) dBm / 5 MHz EIRP per antenna
2300 to 2385 MHz	(Pmax - 43) dBm / 5 MHz EIRP per antenna
Above 2403 MHz	-17 dBm / 5 MHz EIRP*

* The maximum mean power relates to the EIRP of a specific piece of Radio Equipment irrespective of the number of transmit antenna.
Pmax is the maximum mean carrier power for the base station in question.

Table 5: 3.8-4.2 GHz base station out of channel emission limits

Frequency offset	Maximum mean EIRP density
-5 to 0 MHz offset from lower channel edge 0 to 5 MHz offset from upper channel edge	(Pmax - 40) dBm / 5 MHz EIRP per antenna
-10 to -5 MHz offset from lower channel edge 5 to 10 MHz offset from upper channel edge	(Pmax - 43) dBm / 5 MHz EIRP per antenna
Out of block baseline power limit (BS) < -10 MHz offset from lower channel edge > 10 MHz offset from upper channel edge	(Pmax - 43) dBm / 5 MHz EIRP per antenna

Table 6: 3.8-4.2 GHz base station out of band emission limits

Frequency	Maximum mean EIRP density
3795 MHz-3800 MHz 4200 MHz-4205 MHz	(Pmax - 40) dBm / 5 MHz EIRP per antenna
3760 MHz-3795 MHz 4205 MHz-4240 MHz	(Pmax - 43) dBm / 5 MHz EIRP per antenna
Below 3760 MHz Above 4240 MHz	-2 dBm / 5 MHz EIRP per antenna

Table 7: 24.25-26.5 GHz base station and terminal station out of channel and out of band emission limits

Condition	Parameters
Maximum base station out of channel power (TRP)	*Up to 50MHz below or above channel edge:* 12dBm / 50MHz *Beyond 50MHz below or above channel edge:* <4dBm / 50MHz
Maximum base station power in the frequency range 23.6-24.0 GHz (TRP)	*Initial limit before 1 January 2024: -33 dBW / 200 MHz* *Final limit from 1 January 2024: -39 dBW / 200 MHz*
Maximum terminal station power in the frequency range 23.6-24.0 GHz (TRP)	*Initial limit before 1 January 2024: -29 dBW / 200 MHz* *Final limit from 1 January 2024: -35 dBW / 200 MHz*

Synchronisation

3.14 Synchronisation is not required in

a) the 1800 MHz shared spectrum;

b) the 2300 MHz shared spectrum for indoor deployment;

c) the 3.8-4.2 GHz; and

d) the lower 26 GHz band.

3.15 Synchronisation is required in the 2300 MHz shared spectrum for outdoor deployment. There may be some circumstances where it is required in the 3.8-4.2 GHz band and for indoor deployment in the 2300 MHz shared spectrum.

2300 MHz shared spectrum

3.16 If you have a licence for the 2300 MHz shared spectrum and you have deployments outdoors, you will need to make sure your transmissions are synchronised with those of the adjacent user in the 2350-2390 MHz band (this is Telefónica). You will need to use the frame structure in the diagram below and Coordinated Universal Time (UTC) as the common reference time. A new frame should start at the start of the UTC 1 second boundary.

Figure 6: Frame structure for 2300 MHz shared spectrum[12]

DL/UL ratio	Subframe number									
	0	1	2	3	4	5	6	7	8	9
3:1	D	S	U	D	D	D	S	U	D	D

3.17 This frame structure means:

- timeslots (or subframes) 0, 2 to 5 and 7 to 9 must be allocated to Downlink (D) or Uplink (U) transmissions as indicated or may be left with no transmissions;
- the licensee must ensure that the special subframe (S) in timeslots 1 and 6 has a structure that is compatible with TD-LTE special subframe configuration 6, also known as 9:3:2;
- all timeslots must be 1 millisecond in duration and the frame must start at a common reference time so that frames are aligned with Telefónica and transmissions synchronised; and
- TD-LTE frame configuration 2 (3:1) is compatible with this frame structure. Other technologies are permitted provided that the requirements are met.

3.18 If you have an indoor-only deployment this does not have to be synchronised – however, if other users (including Telefónica in the 2350-2390 MHz band as well as other users in the 2390-2400 MHz band) reports that they are receiving interference from an indoor base

[12] We refer to this as Frame Structure A in our Statement.

station, we may require this to be synchronised to the same frame structure so that all users can coexist without causing interference.

3.19 If Telefónica requests a variation of its licence to change the way it transmits, you will also need to have your licences varied and ensure that your transmissions still synchronise with Telefónica's. If this needs to happen, we will consult on this at the same time we consult on any proposed variation to Telefónica's licence, and licensees in the 2300 MHz shared spectrum will be notified so they can have their say.

3.8-4.2 GHz

3.20 We're not planning on imposing a synchronisation requirement in the 3.8-4.2 GHz band. However, we reserve the rights to mandate synchronisation at a later date if this turns out to be necessary to ensure spectrum is being used efficiently.

3.21 This means there's a small chance that if licensees in this band operating in very close proximity to each other happen to be using adjacent channels within the band, they may interfere with each other. In these situations, we'd encourage both parties to work together and reach a mutual agreement on how to avoid this. Measures to avoid interference might include users synchronising their transmissions.

3.22 If the licensees can't come to a mutual agreement to avoid interference within a reasonable time, say, within a few months, we may require the licensees to adopt a synchronisation regime which we consider to be appropriate in the circumstances. The factors that we may take into account when deciding an appropriate synchronisation regime may include which user deployed first in an area, and the size/extent of networks that have been deployed – though we may also consider other factors depending on the circumstances of each case.

3.23 There's also a chance that if you use spectrum at the lower end of the band, you could possibly experience interference from users in the adjacent 3.6-3.8 GHz band. If you do have a problem with this, you may want to consider adopting the synchronisation requirement which we have outlined for users of the 3.6-3.8 GHz band.[13] You could also consider other methods of protecting yourself from interference, such as screening your site from unwanted transmissions.

3.24 Since it's possible that you might have to synchronise with other users, or adopt a different synchronisation regime if we do in the future choose to impose one, we would recommend that you bear this in mind when procuring your radio equipment. If the equipment you buy isn't capable of synchronising with other users in these ways, you may have to replace it if we mandate synchronisation in the future.

[13] This is outlined in paragraphs 11.32-11.36 of the consultation on the award of the 700 MHz and 3.6-3.8 GHz spectrum (https://www.ofcom.org.uk/__data/assets/pdf_file/0019/130726/Award-of-the-700-MHz-and-3.6-3.8-GHz-spectrum-bands.pdf) and in conditions 12 and 13 of the draft 3.6-3.8 GHz licences (https://www.ofcom.org.uk/__data/assets/pdf_file/0014/130730/Annexes-19-26-licences-and-licence-procedures.pdf)

4. The medium power Shared Access licence

4.1 The medium power licence will authorise a single base station and any connected terminal stations. Additionally, mobile terminal stations in the 1800 MHz and 2300 MHz shared spectrum will be licence exempt.

4.2 The medium power licence is available for the 1800 MHz and the 3.8-4.2 GHz band, but it's not available for the lower 26 GHz band. It's also not currently available in the 2300 MHz shared spectrum. We will need to gather more evidence before making outdoor low power and medium power uses more generally available in the 2300 MHz shared spectrum.

4.3 We think that this licence could be suitable for users who need a longer transmission range from their base station, but don't expect to need to change the locations of base stations once they're deployed. This could suit providers of Fixed Wireless Access (FWA) services in rural areas, along with industrial or enterprise users with sites spread over a larger area, such as ports, agriculture or forestry. It could also be suited to providing mobile coverage extension schemes in rural areas, as the 1800 MHz and 2300 MHz shared spectrum bands are in wider bands which already support mobile technology.

4.4 Users will not be permitted to deploy wide area networks in the 3.8-4.2 GHz band; this includes national or regional mobile networks.

Availability in rural areas

4.5 In our Statement, outlining how we came to our decision on the approaches for these new licence products,[14] we explained that we think users of the low power Shared Access licence are more likely to want to deploy in urban areas. We expect that if we allowed medium power users to deploy in urban areas, with their higher power and increased range, this could risk low power users suffering from limited or no availability of spectrum.

4.6 For this reason, we will generally only consider applications for medium power in rural areas. We currently define "rural areas" as:

a) any location in England or Wales in an ONS 2011 Census Output Area which falls into categories D1, D2, E1, E2, F1 or F2 (i.e. "town and fringe", "villages" and "hamlets and isolated dwellings");[15]

b) any location in Scotland which falls into categories 3-8 based on the Scottish Government's 8-fold Urban Rural Classification;[16] and

[14] Ofcom, *Enabling wireless innovation through local licences: Shared access to spectrum supporting mobile technology*, 25 July 2019, https://www.ofcom.org.uk/__data/assets/pdf_file/0033/157884/enabling-wireless-innovation-through-local-licensing.pdf

[15] Office of National Statistics, "2011 Rural/Urban Classification", https://www.ons.gov.uk/methodology/geography/geographicalproducts/ruralurbanclassifications/2011ruralurbanclassification

[16] Scottish Government, "Scottish Government Urban Rural Classification", https://www.gov.scot/Topics/Statistics/About/Methodology/UrbanRuralClassification

c) any location in Northern Ireland which falls into bands E-H of the Northern Ireland Statistics and Research Agency's settlement classification bands.[17]

4.7 We're currently working on an interactive map for the Ofcom website, so that users can check to see if locations where they'd like to deploy are categorised as "rural" or "urban". We expect this tool to be ready to use by the time we open applications for Shared Access licences by end 2019.

Medium power operation in urban areas

4.8 Our general guidance on the availability of medium power licences being limited to rural areas means there could be some legitimate users who may not be able to deploy using this licence.

4.9 If you think you are one of these users, you can contact spectrum.licensing@ofcom.org.uk to discuss your application. We may consider exceptions to allow medium power licences in urban areas on a case-by-case basis.

4.10 In assessing whether to allow a medium power licence application in an urban area, there are several factors we'll be looking for – as the applicant, you'll have to provide us with some evidence supporting your case that we should allow your application.

4.11 Here are some of the key factors we're likely to consider (although this list is not exhaustive, and it could be that in your particular case some other factor not listed here is relevant):

a) What you want to do would not be technically possible using one or more low power licences; for example, you need the extra range made possible by the higher power limit in the medium power licence.

b) Emissions from your site, to the extent that these would be likely to reduce access to spectrum for other users, would not be higher using a medium power base station than they would using low power base stations. For example, this could be because in practice nobody else would be able to deploy anything near enough to your site to make any difference, because the land is owned or operated only by the one user. This could also be because your site is in some way shielded from the outside, for example if it is underground.

c) The boundaries between what's classed as a rural area and an urban area can be quite irregular. It could be that these boundaries place your site in an "urban" area even though surrounding locations with similar conditions on the ground have been classed as "rural".

[17] Northern Ireland Statistics and Research Agency, "Urban-Rural Classification", https://www.nisra.gov.uk/support/geography/urban-rural-classification

Using the licence at sea

4.12 Any location which falls outside one of the "rural areas" defined in paragraph 4.6 above, but which falls inside the limits of the UK's territorial seas, will also be treated as a rural area.

4.13 For any location further out to sea than this, you should consider a different licence product, such as a Spectrum Access Offshore licence. Any equipment installed on a ship may also have to be recorded on a separate Ship Radio licence. You can find more information about these on the Ofcom website.[18]

Technical conditions

4.14 The table below outlines the technical licence conditions for the medium power Shared Access licence. You should consult the licence for the full technical conditions.[19]

[18] https://www.ofcom.org.uk/manage-your-licence/radiocommunication-licences
[19] Ofcom, *Enabling wireless innovation through local licences: Annexes 6-10*, 25 July 2019, https://www.ofcom.org.uk/__data/assets/pdf_file/0036/157887/annexes-6-10-licences-and-interface-requirements.pdf

Table 8: Technical licence conditions for the medium power Shared Access licence

Condition	Parameters by band		
	1800 MHz shared spectrum	*2300 MHz shared spectrum*	*3.8-4.2 GHz*
Permitted deployment	Rural areas Outdoor antenna systems limited to 10m height above ground	Rural areas Outdoor antenna systems limited to 10m height above ground Initially limited availability	Rural areas
Authorised bandwidth	2 x 3.3 MHz	10 MHz	10, 20, 30, 40, 50, 60, 80 and 100 MHz
Maximum base station power (EIRP) per sector	42 dBm / carrier (up to 3 MHz)[20]	42 dBm / carrier (up to 10 MHz)	42 dBm / carrier for carriers ≤20 MHz; or 36 dBm/5 MHz for carriers > 20 MHz
Maximum terminal station (TRP for mobile/ nomadic or EIRP for fixed/ installed)	23 dBm	25 dBm[21]	28 dBm[22] TRP 35 dBm / 5 MHz EIRP
Frame structure requirements	Not applicable	3:1 structure for all deployments	Not applicable (but see notes below)

4.15 The following tables outline the out of channel and in band/ out of band emissions limits for the three bands available under the medium power Shared Access licence.

[20] This power will only be available over 3 MHz of the 3.3 MHz bandwidth as existing power density requirements restrict the power in the first 200 kHz and last 100 kHz of the bandwidth.
[21] The authorisation will list this as 25 dBm **including** a 2 dB tolerance consistent with the European harmonisation.
[22] The authorisation will list this as 28 dBm **including** a 2 dB tolerance consistent with the European harmonisation.

Table 9: 1800 MHz shared spectrum base station in band emission limits

Frequency offset from the lower frequency of the band edge	Maximum mean EIRP density
0 to 0.05 MHz	-33.6 + 153.3 x Δ_{FL}* dBm / kHz
0.05 to 0.1 MHz	-26 + 60 x (Δ_{FL}*- 0.05) dBm / kHz
0.1 to 0.2 MHz	-23 + 300 x (Δ_{FL}*- 0.1) dBm / kHz
0.2 to 3.2 MHz	42 dBm / carrier
3.2 to 3.3 MHz	-23 + 300 x (3.3 - Δ_{FL}*) dBm / kHz

** Note: Δ_{FL} in MHz is the offset from the lower edge of the permitted frequency band at 1876.7 MHz (it has values in the range 0 to +0.2 MHz and +3.2 to +3.3MHz)*

Table 10: 1800 MHz shared spectrum base station out of band emission limits

Frequency offset from the lower frequency of the band edge	Maximum mean EIRP density
-6.2 to -3.2 MHz	-55 dBm / kHz
-3.2 to 0 MHz	-45 + 10 x (Δ_{FL}*+ 0.2)/3 dBm / kHz
Frequency offset from the upper frequency of the band edge	**Maximum mean EIRP density**
0 to 0.05 MHz	-23 - 60 x Δ_{FH}* dBm / kHz
0.05 to 0.1 MHz	-26 - 153.3 x (Δ_{FH}* - 0.05) dBm / kHz
0.1 to 2.8 MHz	-45 - 10 x (Δ_{FH}* + 0.2)/3 dBm / kHz
2.8 to 5.8 MHz	-55 dBm dBm / kHz

** Note: Δ_{FL} in MHz is the offset from the lower edge of the permitted frequency band at 1876.7 MHz (it has values in the range -3.2 to 0 MHz)*

Δ_{FH} in MHz is the offset from the upper edge of the permitted frequency band at 1880 MHz (it has values in the range 0 to 2.8 MHz)

Table 21: 2300 MHz shared spectrum base station out of band emission limits

Frequency	Maximum mean EIRP density
2385 to 2390 MHz 2400 to 2403 MHz	(Pmax - 40) dBm / 5 MHz EIRP per antenna
2300 to 2385 MHz	(Pmax - 43) dBm / 5 MHz EIRP per antenna
Above 2403 MHz	(Pmax - 41) dBm / 5 MHz EIRP*

** The maximum mean power relates to the EIRP of a specific piece of Radio Equipment irrespective of the number of transmit antenna.*

Pmax is the maximum mean carrier power for the base station in question.

Table 32: 3.8-4.2 GHz base station out of channel emission limits

Frequency offset	Maximum mean EIRP density
-5 to 0 MHz offset from lower channel edge 0 to 5 MHz offset from upper channel edge	(Pmax - 40) dBm / 5 MHz EIRP per antenna
-10 to -5 MHz offset from lower channel edge 5 to 10 MHz offset from upper channel edge	(Pmax - 43) dBm / 5 MHz EIRP per antenna
Out of channel baseline power limit (BS) < -10 MHz offset from lower channel edge > 10 MHz offset from upper channel edge	(Pmax - 43) dBm / 5 MHz EIRP per antenna

Table 4: 3.8-4.2 GHz base station out of band emission limits

Frequency	Maximum mean EIRP density
3795 MHz-3800 MHz 4200 MHz-4205 MHz	(Pmax - 40) dBm / 5 MHz EIRP per antenna
3760 MHz-3795 MHz 4205 MHz-4240 MHz	(Pmax - 43) dBm / 5 MHz EIRP per antenna
Below 3760 MHz Above 4240 MHz	-2 dBm / 5 MHz EIRP per antenna

Synchronisation

4.16 Synchronisation is not required in

a) the 1800 MHz shared spectrum,

b) the 3.8 – 4.2 GHz and

c) the lower 26 GHz band.

4.17 Synchronisation is required in the 2300 MHz shared spectrum. There may be some circumstances where it is required in the 3.8-4.2 GHz band.

2300 MHz shared spectrum

4.18 If you have a licence for the 2300 MHz shared spectrum, you will need to make sure your transmissions are synchronised with those of the adjacent user in the 2350-2390 MHz band (this is Telefónica). You will need to use the frame structure in the diagram below and Coordinated Universal Time (UTC) as the common reference time. A new frame should start at the start of the UTC 1 second boundary.

Figure 7: Frame structure for 2300 MHz shared spectrum[23]

DL/UL ratio	Subframe number									
	0	1	2	3	4	5	6	7	8	9
3:1	D	S	U	D	D	D	S	U	D	D

4.19 This frame structure means:

- timeslots (or subframes) 0, 2 to 5 and 7 to 9 must be allocated to Downlink (D) or Uplink (U) transmissions as indicated or may be left with no transmissions;
- the licensee must ensure that the special subframe (S) in timeslots 1 and 6 has a structure that is compatible with TD-LTE special subframe configuration 6, also known as 9:3:2;
- all timeslots must be 1 millisecond in duration and the frame must start at a common reference time so that frames are aligned with Telefónica and transmissions synchronised; and
- TD-LTE frame configuration 2 (3:1) is compatible with this frame structure. Other technologies are permitted provided that the requirements are met.

4.20 If Telefónica requests a variation of its licence to change the way it transmits, you will also need to have your licences varied and ensure that your transmissions still synchronise with Telefónica's. If this needs to happen, we will consult on this at the same time we consult on any proposed variation to Telefónica's licence, and licensees in the 2300 MHz shared spectrum will be notified so they can have their say.

3.8-4.2 GHz

4.21 We're not planning on imposing a synchronisation requirement in the 3.8-4.2 GHz band. However, we reserve the rights to mandate synchronisation at a later date if this turns out to be necessary to ensure spectrum is being used efficiently.

4.22 This means there's a small chance that if licensees in this band operating near each other happen to be using adjacent channels within the band, they may interfere with each other, particularly if deploying antenna heights significantly above the surrounding clutter. In these situations, we'd encourage both parties to work together and reach a mutual agreement on how to avoid this. Measures to avoid interference might include users synchronising their transmissions.

[23] We refer to this as Frame Structure A in our Statement.

4.23 If the licensees can't come to a mutual agreement to avoid interference within a reasonable time, say, within a few months, we may require the licensees to adopt a synchronisation regime which we consider to be appropriate in the circumstances. The factors that we may take into account when deciding an appropriate synchronisation regime will probably include which user deployed first in an area, and the size/extent of networks that have been deployed – though we may also consider other factors depending on the circumstances of each case.

4.24 There's also a chance that if you use spectrum at the lower end of the band, you could possibly experience interference from users in the adjacent 3.6-3.8 GHz band. If you do have a problem with this, you may want to consider adopting the synchronisation requirement which we have outlined for users of the 3.6-3.8 GHz band. You could also consider other methods of protecting yourself from interference, such as screening your site from unwanted transmissions.

4.25 Since it's possible that you might have to synchronise with other users, or adopt a different synchronisation regime if we do in the future choose to impose one, we would recommend that you bear this in mind when procuring your radio equipment. If the equipment you buy isn't capable of synchronising with other users in these ways, you may have to replace it if we mandate synchronisation in the future.

5. Licence fees and non-technical licence conditions

Licence fees

5.1 We've set the fees for the Shared Access licence to be cost-based; this means the amount we charge has been calculated to make sure Ofcom recovers the costs of administering the licence.

5.2 Demand for these new licences is currently uncertain and we will keep fees under review as we gather more evidence on actual use. We expect to consult on proposals to change the fee if we believe there is evidence to do so.

5.3 The fees below are all applicable per licence – this means you'll pay for each low power area you have a licence for, and each medium power base station you have a licence for. The fees are payable annually.

1800 MHz and 2300 MHz shared spectrum, and 3.8-4.2 GHz band

5.4 For the lower three shared access bands, we are charging fees based on the bandwidth used – this only makes a big difference for the 3.8-4.2 GHz band, as the 1800 MHz and 2300 MHz shared spectrum only have one channel each. This means that licence fees for the lower three shared access bands look like this:

Table 54: Licence fees by bandwidth for the Shared Access licence

Channel size	Price per channel
2 x 3.3 MHz	£80
10 MHz	£80
20 MHz	£160
30 MHz	£240
40 MHz	£320
50 MHz	£400
60 MHz	£480
80 MHz	£640
100 MHz	£800

26 GHz band

5.5 For the 26 GHz band, the fee we are charging does not change based on the bandwidth the user applies for; this is because there is more spectrum available in this band compared to the lower three bands.

5.6 For the 26 GHz band a licence will cost **£320** regardless of how much bandwidth you use.

Non-technical licence conditions

5.7 Below is an overview of the main non-technical licence terms and conditions which are common to both the low power and medium power Shared Access licences.

5.8 It is your responsibility to ensure that you understand and can meet the licence obligations, and you should look at the example licences we have included in our Statement to see these and the other conditions in full.[24]

Licence duration and revocation

Duration

5.9 The Shared Access licence is indefinite; as long as you pay your licence fees each year and don't break any of the licence terms and conditions, you can keep it for as long as you like.

5.10 If, however, you would like a licence of less than one year, we can issue a short-term licence. This would mean you would not have to pay the full annual licence fee as we would charge you pro rata per month, based on how long you wanted the licence for. There is a minimum licence fee of £32 per licence if you do this, however, as we have to recover the cost to Ofcom of issuing and administering the licence.

Revocation, including for non-use

5.11 You should also be aware of the requirement in the licence to continue transmitting, which is in clause 6 of the Shared Access licence. This clause means that if you don't start transmitting within six months of getting your licence and remain operational after this, we can revoke your licence with one month's notice. We're including this condition so that new users aren't prevented from deploying their equipment by existing users who are no longer operational but have not surrendered their licences, or by users who acquired more spectrum than they needed in order to make it harder for other companies to compete.

5.12 We can also revoke your licence for spectrum management reasons. We normally only do this if we intend to change the way the band is used, and we currently do not have any plans to do this as we have only just introduced the new licensing regime. Should we consider repurposing the band for alternative use, we will give a reasonable notice period. This will be longer than one month and would not occur without us first conducting a

[24] Ofcom, *Enabling wireless innovation through local licences: Annexes 6-10*, 25 July 2019, https://www.ofcom.org.uk/__data/assets/pdf_file/0036/157887/annexes-6-10-licences-and-interface-requirements.pdf

formal consultation, of which current users would be notified. The timing of any such process would be informed by an assessment of the impact of our decision.

5.13 Finally, if you break the terms of your licence, or if you're causing interference to other users and don't cooperate with us to stop the interference, we can also revoke your licence because of this. Again, you would be given one month's notice for this.

Trading the licence to someone else

5.14 Users are allowed to transfer their rights to access spectrum (and their obligations to pay the associated fees, and stick to the licence conditions) to another party by trading them. This might be especially relevant if one company is acquired or bought out by another.

5.15 We allow two kinds of trade:[25]

a) **Outright total trades**, where all the rights and obligations of the licence are completely transferred to one user; or

b) **Concurrent total trades**, where all the rights and obligations of the licence are completely transferred to two or more users.

Keeping records and providing information to Ofcom

5.16 As part of Ofcom's duty to manage spectrum efficiently, our standard licence terms and conditions include a provision which says that licensees are required to provide information to us if we request it. The Shared Access licence includes this condition, and you'll therefore need to keep records of your deployments in case we ask you for them.

a) If you have a **low power licence**, you'll need to keep a record of the address, antenna type and antenna height above ground for all base stations.

b) If you're using **fixed terminals**, with either the low or medium power licence, you'll need to keep a record of the location (using the National Grid Reference system to 1m resolution), antenna type and antenna height above ground.

c) If you're using **mobile terminals in the 3.8-4.2 GHz band**, with either the low or medium power licence, you'll need to keep a record of the number of terminals, and the address of the site or building where the terminals will be operating. This is to make sure that mobile terminals are only used within the user's site, and are not used to form part of a regional or nationwide public mobile network, as the Shared Access licence is not intended for this.

5.17 Recording this information is important because if somebody has a problem with interference, it will help us narrow down the source if we need to investigate it. This information will also be needed if we move towards a DSA approach in the future (see Section 2) and all equipment will need to be recorded in order to access spectrum.

[25] You can find more information on trading in Ofcom's Trading Guidance Notes (https://www.ofcom.org.uk/__data/assets/pdf_file/0029/88337/Trading-guidance-notes.pdf)

5.18 Any commercially sensitive information which you give to us is subject to a number of different legal provisions which govern how we keep and use it. These provisions include the Wireless Telegraphy Act 2006, the Communications Act 2003, the Data Protection Act 2018, the Freedom of Information Act 2000 and the Environmental Information Regulations 2004.

Accessing, modifying and shutting down your equipment if something goes wrong

5.19 The Shared Access licence includes terms that allow Ofcom to instruct you to provide access to, modify or shut down your equipment – but we will only do this if there is a problem of some sort that we consider requires such action.

5.20 For example, we could need to do this are if an emergency meant that some sort of equipment for public safety needed to be deployed, and your equipment would interfere with this.

5.21 Another example might be if your equipment was causing interference to another user. We might request that you modify your equipment parameters and change the way it transmits so that both you and the other user can transmit without interference. For instance, if we were to require users to synchronise their transmissions (we talk about this at the ends of Section 2 and 3), this provision allows us to do that.

Changing frequency if we ask you to do so

5.22 In Section 2, we outlined that your Shared Access licence will also allow Ofcom to request that you change frequency from time to time. We may do this because we want to accommodate new users in the same area or on the same frequency, or if we need to deal with interference.

5.23 If we need to do this, we will email you the frequency you need to change to, and the time by which you will need to have changed frequency by. This means that you will have to deploy equipment that can be tuned across an entire band (that is, for the 3.8-4.2 GHz band and 26 GHz band where this is relevant).

6. Mobile Network Codes and telephone numbers

Introduction

6.1 For some mobile technologies to work, they may require the mobile network to be identified by a Mobile Network Code (MNC) and may require the use of telephone numbers.

6.2 It is Ofcom's duty to administer the UK's National Telephone Numbering Plan, including MNCs and telephone numbers. Allocations of numbers to communications providers for public network use is carried out via Ofcom's Number Management System (NMS).[26] Our policy is not to allocate an exclusive MNC or telephone numbers for use in private networks.

MNCs

6.3 For private networks needing to input an MNC, the International Telecommunications Union (ITU) has made available the Mobile Country Code (MCC) 999 for internal use within a private network.[27] Users are able to select any two- or three-digit code for their network. No interaction with ITU or Ofcom is required for using an MNC under this MCC for internal use within a private network. However, please note that as they are not subject to assignment, they are not unique.

6.4 Licensees wishing to deploy a public network and in need of an MNC should apply for allocation via NMS. Any questions may be directed to Ofcom's Numbering Team directly by emailing numbering@ofcom.org.uk.

Telephone numbers

6.5 Ofcom's NMS allows communications providers to apply for the allocation of numbers and to manage their existing resource. Communications providers are required to provide certain information when applying for numbers. Ofcom will only allocate numbers to communications providers and only for use in public networks.

6.6 For those companies wanting to provide telephony services using VoIP and/or WiFi, and for interconnection with other networks, various number ranges are available. We encourage providers to consider the number types available for allocation, including, for example, 056 Location Independent ECS numbers. We also allocate National Signalling Point Codes (NSPCs), if required. Further information is available on Ofcom's website.[28]

[26] https://ofcom.force.com/NMS_LoginPage
[27] Appendix III ITU-T E.212, https://www.itu.int/rec/dologin_pub.asp?lang=e&id=T-REC-E.212-201807-I!Amd1!PDF-E&type=items
[28] https://www.ofcom.org.uk/phones-telecoms-and-internet/information-for-industry/numbering

7. Contact details

Ofcom, Riverside House, 2a Southwark Bridge Road, London, SE1 9HA

Tel: 020 7981 3000

Fax: 020 7981 3333

Website: Ofcom | Spectrum

All enquiries to **Spectrum Licensing Team**

Email: spectrum.licensing@ofcom.org.uk

8. Document history

8.1 This is a live document, and we may change it from time to time to update it with new information. Any changes that have been made on the document history is outlined at the table below.

Version	Date	Changes
1.0	July 2019	First published
1.1	December 2019	Changes to reflect that licences are now available for application
1.2	July 2020	Clarification that airborne use is not permitted, users have up to 30 days to pay for invoice and users should deploy equipment that can tune across entire band to ensure continuity of access
1.3	July 2022	Changes to Section 7 Contact Details
1.4	September 2022	Update 26 GHz out of band transmission limits.

Requirements for Commercial Operation in the U.S. 3550-3700 MHz Citizens Broadband Radio Service Band

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Requirements for Commercial Operation in the U.S. 3550-3700 MHz Citizens Broadband Radio Service Band

1 Scope

This document specifies the requirements for commercial operations in the 3550-3700 MHz band in the United States. The requirements are based on Federal Communications Commission (FCC) rules adopted in the 2015 (FCC 15-47 [1]), 2016 (FCC 16-55 [7]), and 2018 (FCC 18-149 [20]) Orders in FCC dockets GN 12-354 and GN 17-258. The CBRS-specific rules themselves are codified in Part 96 of Title 47 the U.S. Code of Federal Regulations [2]. The FCC's Part 96 rules will hereafter be referred to as "the FCC Rules," "the Rules," or "Part 96," and reference to specific items in the rules will be given in the form of, for example, 96.15(a)(1) if from Part 96. If the reference is to a different rule part, the reference will be of the form 47 CFR 2.106, which refers to Title 47 of the Code of Federal Regulations, Part 2, section 106.

The document defines the requirements on the Spectrum Access System (SAS), Citizens Broadband Radio Service Device (CBSD), End User Device (EUD), Priority Access License (PAL), and General Authorized Access (GAA) to specify the necessary operation and standards interfaces to effect a properly functioning spectrum sharing environment in the 3550-3700 MHz band.

To assist the reader, we include below the SAS functional architecture with defined interfaces.

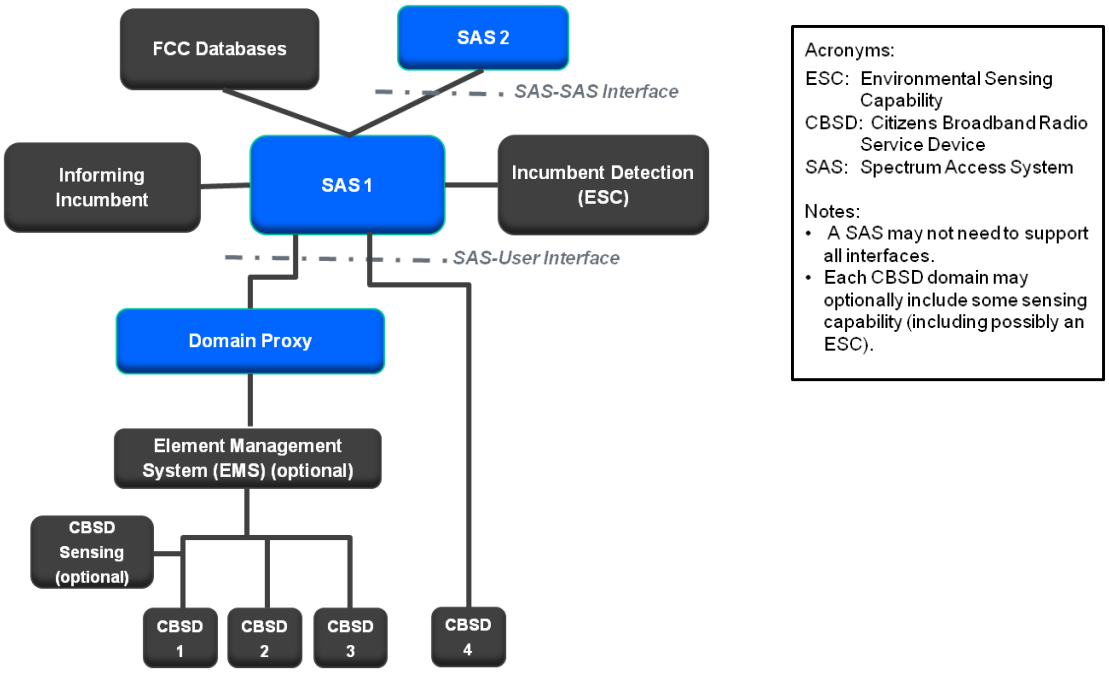

Figure 1: SAS Functional Architecture

2 Definitions and Abbreviations

The Wireless Innovation Forum Spectrum Sharing Committee (SSC) leverages the definitions provided by the FCC from their Title 47 Part 96 rules. These definitions and others are also available at reference [3].

2.1 Wireless Innovation Forum Definitions

This document uses these definitions:

AMSL: Above Mean Sea Level

BTS-CBDS[1]. A base transceiver station CBSD that serves one or more points, which may be EUDs or CPE-CBSDs.

CBRS-wide: Across the entire CBRS system including all CBRS entities (note: this is equivalent to system-wide).

CBSD-ID: The system-wide unique identifier for registered CBSDs.

CBSD Group Identifier (CGI): An identifier used to allow one or more registering CBSDs to identify as a group that the CBSD User for those CBSDs has established.

CBSD Registration: The process required to register a valid Citizens Broadband Radio Service Device (CBSD) with a SAS. This includes providing CBSD information, the User identity, the CBSD installation parameters (e.g., location parameters) and if applicable, the CBSD antenna parameters, and, in case of successful registration, the unique CBSD identifier.

CBSD User: The registered entity that has operational responsibility for the CBSD.

Certified Professional Installer Device Information (CPIDI): The body of information required to be entered by a CPI to register a valid CBSD with a SAS for installation and to allow for spectrum grant requests and transmission pursuant to Part 96 rules, industry standards, or SAS-specific requests.

Certified Professional Installer Registration Identifier (CPIR-ID): The unique identifier provided by the CPI Accrediting Body through the CPI Training Program to CPIs who are validly and currently certified and registered as CPIs.

Certified Professional Installer Training Program: A required training curriculum contained in a valid program, as defined by the CPI Accrediting body, for certification of a CPI. Such curriculum may have mandatory (such as Part 96 and rules based requirements) and optional components (such as industry best practices or manufacturer or SAS specific training).

[1] BTS-CBSD is used for disambiguation in context of CPE-CBSD operation. In other contexts when only EUDs connect to such a device, CBSD alone generally refers to the same function.

Cluster List: The set of CBSDs, identified by their CBSD-IDs, that define a PPA. The PAL Holder provides this Cluster List to the Managing SAS. These are the CBSDs that provide service and coverage within the claimed PPA.

Coexistence Group: A group of CBSDs that coordinate their own interference within the group according to a common interference management policy.

CPE-CBSD. A CBSD used as customer premise equipment. A CPE-CBSD is a client of a BTS-CBSD.

CPI: Certified Professional Installer: Any individual trained and currently validly certified from an accredited CPI Training Program based on the relevant Part 96 rules and associated technical best practices for the Citizens Broadband Radio Service (CBRS).

CPI Accreditation Standard: Standard defining how a CPI Training Program Administrator can be accredited to run a Certified Professional Installer (CPI) Training Program. The CPI Accreditation Standard includes a curriculum standard defining the requirements necessary for trainees to be certified as a Certified Professional Installer. The CPI Accreditation Standard includes a requirement for an objective certification test to be administered by a program administrator as part of the CPI Training Program. Passing this test is a prerequisite for an individual to be considered a Certified Professional Installer.

CPI Accrediting Body: Entity that accredits a CPI Training Program Administrator to offer a CPI Training Program based on the CPI Accreditation Standard. This entity must be independent from CPI Training Program Administrators.

CPI Training Program Administrator: Entity such as a network equipment operator, an equipment vendor, a SAS administrator or a 3rd party training organization that develops a Certified Professional Installer (CPI) Training Program, gains accreditation, administers the objective certification test and maintains certification records.

Domain Proxy: An entity engaging in communications with the SAS on behalf of multiple individual CBSDs or networks of CBSDs. The Domain Proxy can also provide a translational capability to interface legacy radio equipment in the 3650-3700 MHz band with a SAS to ensure compliance with Part 96 rules.

Dynamic Protection Area (DPA): A predefined protection area which is activated or deactivated to protect a federal incumbent radar. An activated DPA must be protected from aggregate CBSD interference. A deactivated DPA is not protected from CBSD interference.

HAAT: Height Above Average Terrain

Initial Certification: Initial Certification in this specification applies to Release 1; however, after Initial Certification, each SAS administrator could have an alternate method that, when approved by the FCC, would be allowed.

Installation: The act of physically installing a device and establishing CBSD physical installation parameters (e.g., location, indoor/outdoor status, antenna parameters as required by Part 96). Any

change in the CBSD physical installation parameters, FCC identification number, or unique manufacturer's serial number constitutes a new Installation.

Largest Allowable PPA Contour Method: The FCC-mandated contour calculation method that defines the largest allowable size of a PPA. This is based upon the Managing SAS calculated protection area of the CBSDs on the PPA's Cluster List, the CBSDs' largest allowable EIRPs, the CBSDs' antenna heights and antenna parameters, the RF propagation model, and a -96 dBm/10 MHz threshold.

Managing SAS: The SAS that administers a PAL and serves the CBSDs that form the Cluster List of a PPA registered to a PAL Holder that is authorized to use that PAL. This Managing SAS is the SAS which accepts, checks, and validates a PPA claim and which issues a PPA-ID for a valid PPA, and which shares the PPA-ID and the PPA vertex points with all SASs. Subsequently, the Managing SAS serves the CBSDs on the PPA Cluster List. The Managing SAS also serves CBSDs using GAA grants and their CBSD Users.

PAL-ID: The system-wide unique identifier for a PAL.

PAL Database: The system-wide accessible database that allows the look-up of a PAL boundary and PAL ownership based upon the PAL-ID.

PAL Holder: The registered entity who has legal rights to make PPA claims under the registered PAL.

PPA-ID: The system-wide unique identifier for a PPA.

PPA Database: The system-wide accessible database that allows the look-up of a PPA boundary and associated PAL information based upon the PPA-ID.

SAS Essential Data: SAS-Essential Data are defined as data shared between any two SASs which are required to fulfill all SAS functions required by 47 C.F.R Part 96.

SMLA: Secondary Market Leasing Agreement. The leasing terms by which PAL rights are conveyed from a PAL licensee to an eligible lessee.

UR-ID: User Registration ID. The system-wide unique identifier for Registered Users of the CBRS; these may be CBSD Users or PAL Holders.

2.2 Abbreviations

3GPP	3rd Generation Partnership Project
CBSD	Citizens Broadband radio Service Device
CGI	CBSD Group Identifier
DoD	U.S. Department of Defense
DPA	Dynamic Protection Area
ESC	Environmental Sensing Capability

EUD	End User Device
FCC	Federal Communications Commission
FFS	For Further Study
FSS	Fixed-Satellite Service
GAA	General Authorized Access
IAP	Iterative Allocation Process
IMG	Interference Margin Group
JSIR	Joint Spectrum Interference Resolution
NTIA	National Telecommunications and Information Administration
OpenSSRF	Open source Standard Spectrum Resource Format
UR-ID	User Registration ID
PA	Priority Access
PAL	Priority Access License
PPA	PAL Protection Area
SAS	Spectrum Access System
SMLA	Secondary Market Leasing Agreement
WBS	Wireless Broadband Service (FCC Rules Part 90, Subpart Z)

3 Requirement Organization

Requirements shall be uniquely identified by: R#-<CATEGORY>-<XX>-<Y>. Where

- R0-: Requirements directly from FCC Rules
  R1-: Requirements derived from FCC Rules

- R2-: Requirements imposed by WInnForum <CATEGORY>

Code	Category
SGN	SAS General
IPM	Incumbent Protection Management
IMZ	SAS Interference Management and Exclusion Zones
SAD	SAS Administration
SPU	SAS Requirements for PAL Users
SGU	SAS Requirements for GAA Users
ISC	Inter-SAS Communication
PAL	Priority Access Licensee and PAL Protection Requirements (Leasing, Transfer of Control, etc.)
DEV	CBSD and EUD Requirements
DPX	Domain Proxy

SRR	System Registration Requirements (includes CBSD User, CBSD & Certified Professional Installer Registration)
ESC	Environmental Sensing Capability
CPI	Certified Professional Installer

- <XX>: Unique number to identify the requirement

- <Y>: Optional and used to identify subordinate requirements, typically captured in an alphabetical list following the main requirement number <XX> (e.g., R0-IPM-01-a).

Requirements taken from the FCC Rules are included as "R0" and we attempted to use the FCC Rules without change. In some instances, the FCC uses "must" or "will" for rules, which we have included below as a requirement; however, we insert [shall] to indicate we consider this as a formal requirement.

The following terms are used within this document and should be interpreted as described in RFC-2119 [Ref-9]:

- SHALL is a mandatory requirement (negative is SHALL NOT)
- SHOULD is recommended requirement/best practice (negative is SHOULD NOT)
- MAY is an optional requirement, i.e. something that is allowed (negative is NEED NOT)

4 SAS Requirements

4.1 SAS General Requirements (SGN)

R0-SGN-01: DEPRECATED

R0-SGN-02: DEPRECATED (converted to R1-SGN requirement)

R0-SGN-03: The SAS assigns channels for PALs to use. [Ref-2, 96.11, 96.13, 96.25 & 96.59]

a. The SAS shall authorize 10 MHz channels in the 3550-3650 MHz frequency band to PAL Holders following a spectrum request. Note: 10 MHz channels shall be contiguous spectrum unless the PAL licensee agrees to subdivide the spectrum [Ref-1, para 74]
b. The SAS shall not assign more than seven PALs in any given License Area at any given time.
c. The SAS must [shall] assign multiple channels held by the same Priority Access Licensee to contiguous channels in the same License Area, to the extent feasible, and to the extent indicated by the PAL holder and consistent with the other requirements of the SAS.
d. The SAS may temporarily reassign individual PALs to non-contiguous channels to the extent necessary to protect Incumbent Users or if necessary to perform its required functions under subpart F of Part 96 [2].

e. Priority Access Licensees may request a particular channel or frequency range from the SAS but will not be guaranteed a particular assignment.

R0-SGN-04: GAA users may operate in the 3550-3700 MHz frequency band. [96.11(a)(1)]

PAL channels [in the 3550-3650 MHz frequency band] shall be made available for assignment by the SAS for General Authorized Access use only in areas consistent with 96.25 and 96.41(d). [96.11(a)(2)]

a. A CBSD will [shall] be considered to be in use for purposes of calculating a PAL Protection Area once it is registered and authorized for use on a Priority Access basis by a SAS consistent with 96.39, 96.53, and 96.57.
   i. Priority Access Licensees must [shall] inform the SAS if a previously activated CBSD is no longer in use.
   ii. Any CBSD that does not make contact with the SAS for seven days shall not be considered in use and will be excluded from the calculation of the PAL Protection Area until such time as contact with the SAS is re-established.

b. The default PPA protection contour will [shall] be determined by the SAS as a -96 dBm/10 MHz contour around each CBSD. The default protection contour will be calculated based on information included in the CBSD Registration and shall be determined and enforced consistently across all SASs.
   i. The default protection contour is the outer limit of the PAL Protection Area for any CBSD but a Priority Access Licensee may choose to self-report protection contours smaller than the default protection contour to the SAS.
   ii. If the PAL Protection Areas for multiple CBSDs operated by the same Priority Access Licensees overlap, the SAS shall combine the PAL Protection Areas for such CBSDs into a single protection area.

c. The PAL Protection Area may [shall] not extend beyond the boundaries of the Priority Access Licensee's Service Area.

R0-SGN-05: SAS interface security [Ref-2, 96.61 & 96.39]

a. An SAS must [shall] employ protocols and procedures to ensure that all communications and interactions between the SAS and CBSDs are accurate and secure and that unauthorized parties cannot access or alter the SAS or the information it sends to a CBSD.
b. Communications between CBSDs and an SAS, between an ESC and a SAS, between individual CBSDs, and between different SASs, must [shall] be secure to prevent corruption or unauthorized interception of data. An SAS must be protected from unauthorized data input or alteration of stored data.
c. An SAS must [shall] verify that the FCC identification number supplied by a CBSD is for a certified device and must not provide service to an uncertified device.

R0-SGN-06: The purposes and functionality of the SAS include [Ref-2, 96.53]:

a. To enact and enforce all policies and procedures developed by the SAS Administrator pursuant to section 96.63.
b. To determine and provide to CBSDs the permissible channels or frequencies at their location.
c. To determine and provide to CBSDs the maximum permissible transmission power level at their location.
d. To register and authenticate the identification information and location of CBSDs.
e. To retain information on, and enforce, Exclusion Zones and Protection Zones in accordance with sections 96.15 and 96.17.
f. To communicate with the ESC to obtain information about federal Incumbent User transmissions and instruct CBSDs to move to another frequency range or cease transmissions.
g. To ensure that CBSDs operate in geographic areas and within the maximum power levels required to protect federal Incumbent Users from harmful interference, consistent with the requirements of sections 96.15 and 96.21.
h. To ensure that CBSDs protect non-federal Incumbent Users from harmful interference, consistent with the requirements of section 96.17 and 96.21 [Reference R0-SGU-01:(b)].
i. To protect Priority Access Licensees from interference caused by other PAL Users and from General Authorized Access Users, including the calculation and enforcement of protection areas, consistent with section 96.25 [Reference R0-SGU-01:(b)].
j. To facilitate coordination between GAA users operating Category B CBSDs, consistent with section 96.35.
k. To resolve conflicting uses of the band while maintaining, as much as possible, a stable radio frequency environment.
l. To ensure secure and reliable transmission of information between the SAS and CBSDs.
m. To protect Grandfathered Wireless Broadband Licensees consistent with section 90.1307, 90.1338, and 96.21. [Ref-13]
n. To implement the terms of current and future international agreements as they relate to the Citizens Broadband Radio Service.
o. To receive reports of interference and requests for additional protection from Incumbent Access users and promptly address interference issues.

R0-SGN-07: The SAS shall maintain current information on registered CBSDs, the geographic locations and configuration of protected FSS locations as set forth in section 96.17, and the federal Incumbent User Exclusion Zones and Protection Zones. [Ref-2, 96.55]

a. For registered CBSDs, such information shall include all information required by section 96.39 and 96.45.

b. SAS Administrators must [shall] make all information necessary to effectively coordinate operations between and among CBSDs available to other SAS Administrators.
c. Upon request, SAS Administrators must [shall] make available to the general public aggregated spectrum usage data for any geographic area. Such information must include the total available spectrum and the maximum available contiguous spectrum in the requested area. SAS Administrators shall not disclose specific CBSD registration information to the general public except where such disclosure is authorized by the registrant.
d. For non-federal Incumbent Users, the SAS shall maintain a record of the location of protected earth stations as well as [all the] registration information required by section 96.17.

R0-SGN-08: The SAS shall maintain records not pertaining to federal Incumbent User transmissions for at least 60 months. [Ref-2, 96.55]

R0-SGN-09: The SAS shall only retain records of information or instructions received regarding federal Incumbent User transmissions from the ESC in accordance with information retention policies established as part of the ESC approval process. [Ref-2, 96.55]

R0-SGN-10: The SAS shall be technically capable of directly interfacing with any necessary FCC database containing information required for the proper operation of an SAS. [Ref-2, 96.55]

R0-SGN-11: The SAS shall process and retain acknowledgements by all entities registering CBSDs that they understand the risk of possible interference from federal Incumbent User radar operations in the band. [Ref-2, 96.55]

R0-SGN-12: SAS Registration, Authentication and Authorization of CBRS Devices [Ref-2, 96.57]
a. An SAS must [shall] register, authenticate, and authorize operations of CBSDs consistent with this rule part.
b. CBSDs composed of a network of base and fixed stations may employ a subsystem for aggregating and communicating all required information exchanges between the SAS and CBSDs. [Note: Related to Domain Proxy Requirements & R2-SRR-13 & 14].
c. An SAS must [shall] also verify that the FCC identifier (FCC ID) of any CBSD seeking access to its services is valid prior to authorizing it to begin providing service. A list of devices with valid FCC IDs and the FCC IDs of those devices is to be obtained from the Commission's Equipment Authorization System. [Note: Related to R0-SRR-01 & -02]
d. An SAS must [shall] not authorize operation of CBSDs within Protection Zones except as set forth in section 96.15.

e. An SAS must [shall] calculate and enforce PAL Protection Areas consistent with section 96.25 and such calculation and enforcement shall be consistent across all SASs.

R0-SGN-13: SAS Assignment of Frequencies [Ref-2, 96.13c, 96.59]

a. An SAS must [shall] determine the available and appropriate channels/frequencies for CBSDs at any given location using the information supplied by CBSDs, including location, the authorization status and operating parameters of other CBSDs in the surrounding area, information communicated by the ESC, other SASs, and such other information necessary to ensure effective operations of CBSDs consistent with this part. All such determinations and assignments shall be made in a non-discriminatory manner, consistent with this part.

   i. Upon request from the Commission or a CBSD, an SAS must [shall] confirm whether frequencies are available in a given geographic area.

   ii. Upon request from the Commission, an SAS must [shall] confirm that CBSDs in a given geographic area and frequency band have been shut down or moved to another available frequency range in response to information received from the ESC.

   iii. If an SAS provides a range of available frequencies or channels to a CBSD, it may require that CBSD to confirm which channel or range of frequencies it will utilize.

b. Consistent with the requirements of 96.25, an SAS shall assign geographically contiguous PALs held by the same Priority Access Licensee to the same channels in each geographic area, where feasible. The SAS shall also assign multiple channels held by the same Priority Access Licensee to contiguous frequencies within the same License Area, where feasible.

c. An SAS may temporarily assign PALs to different channels (within the frequency range authorized for Priority Access use) to protect Incumbent Access Users or if necessary to perform its required functions.

R0-SGN-14: We [the Commission] require[s] that the SAS and the ESC must [shall] not have any connectivity to any military or other sensitive federal database or system. Nor shall they store, retain, transmit, or disclose operational information on the movement or position of any federal systems. The SAS shall only retain records of information or instructions received from the ESC in accordance with information retention policies established as part of the ESC approval process. These policies will [shall] include appropriate safeguards for classified and other sensitive data and will be developed by the Commission in coordination with NTIA and DoD. [Ref-2, 96.63n & para 330]

R1-SGN-01: The SAS must [shall] not collect, track, or store information on End User Devices or their users without user consent. [Ref-1, para 333]

R1-SGN-02: The SAS shall set CBSD initial transmission authorization time and extend each reauthorization request according to Part 96.15(a)(4) and 96.15(b)(4). The signal sent by a SAS to deny reauthorization shall enable the SAS to direct CBSDs to cease transmission associated with that authorization as soon as technically possible.

R2-SGN-01: A SAS may request measurement reports from a CBSD, and the measurement report requested by a SAS shall be consistent with the CBSD measurement capabilities reported during the registration process.

R2-SGN-02: Any grants issued to a CBSD for which the CBSD has not made contact with the SAS for seven days shall be considered by the SAS to have been relinquished. (Related to R0-SGN-04).

R2-SGN-03: For Initial Certification, SAS shall use the NTIA ITS Irregular Terrain Model (ITM)[2] in point-to-point mode for propagation determination for use in FSS earth station, DPA protection, and ESC sensor protection. Consideration of propagation models, including hybrid or application-specific models, may advance beyond this initial model, subject to FCC approval. If the CBSD is indoors, add 15 dB to the computed loss to account for attenuation due to building loss.

Note: For practical implementation reasons, if the antenna height of a CBSD or a protected entity is lower than 1 meter above the ground level, the antenna height is taken to be 1 meter above the ground level in the ITM model for initial certification.

Note 2: The reference implementation is maintained in the WInnForum code repository.[3]

R2-SGN-04: Propagation Model Requirements for the use in PPA and GWPZ Calculation

a. For Initial Certification, SAS shall use the propagation models described in this Requirement (which is based on the NTIA Technical Report TR-15-517 3.5 GHz Exclusion Zone Analyses and Methodology[4]) for propagation loss determination for use in PAL Protection Area (PPA) (both -96 dBm/10 MHz coverage and -80 dBm/10 MHz PPA protection calculations), Grandfathered Wireless Protection Zone (GWPZ) calculations, and protection of all systems outside of 3550-3700 MHz.[5]
b. After Initial Certification, the SAS may use other propagation models, subject to approval by the FCC.

[2] NTIA – ITS Irregular Terrain Model (ITM) (Longley-Rice) (20MHz-20 GHz): http://www.its.bldrdoc.gov/resources/radio-propagation-software/itm/itm.aspx
[3] https://github.com/Wireless-Innovation-Forum/Spectrum-Access-System
[4] NTIA Technical Report TR-15-517 3.5 GHz Exclusion Zone Analysis and Methodology: http://www.its.bldrdoc.gov/publications/2805.aspx
[5] The reference implementation of all the required propagation models is maintained in the WinnForum code repository: https://github.com/Wireless-Innovation-Forum/Spectrum-Access-System

c. For PPA contour calculation, SAS shall use the region type, *r*, corresponding to the location of the CBSD. For PPA and GWPZ protection calculations, SAS shall determine the region type (urban, suburban, or rural) by a method that effectively averages the National Land Cover Database (NLCD) land category within the protection area (PPA or GWPZ). Each NLCD 1 arc second pixel shall be sampled within the protection area, and assigned a value for averaging as designated in the table below. The values for all pixels within the protection area are averaged together, and the resulting average determines the appropriate region to use in all propagation calculations involving the protection or extent of that region, as designated in the table below.

NLCD Land Cover Class	**Region *r***	**Value Assigned for Averaging**	**Use this Region Type if Protection-Area-Wide Average Value is in the Range:**
23 or 24	Urban	2	> 1 1/3
22	Suburban	1	[2/3, 1 1/3]
All others	Rural	0	< 2/3

d. Propagation loss shall be calculated based on the following table:

Distance *d* [*km*]	**Formulas**
$d \le 0.1$	Loss = $L_{fs}(f,d) = 20\log_{10}(R) + 20\log_{10} f_{\text{MHz}} - 27.56,$ where $R = \sqrt{(1000d)^2 + (h_{cbsd} - h_m)^2}$
$0.1 < d < 1.0$	Loss = $L_{fs}(f, 0.1) + [1 + \log_{10}(d)] \cdot \left[L_{EHB}(f, h_{cbsd}, h_m, r, d = 1\,km) - L_{fs}(f, 0.1)\right]$
$1.0 \le d \le 80.0$	$\text{Loss} = \begin{cases} L_{ITM} & if \;\; L_{ITM}^{MED} \ge L_{EH} \\ L_{EH} & \text{otherwise} \end{cases}$
$80.0 < d$	Loss = $L_{ITM}(f, h_{cbsd}, h_m, p(d)) + J$, where $J = \max\left[L_{EH}(f, h_{cbsd}, h_m, r, p(d_{80})) - L_{ITM}^{MED}(f, h_{cbsd}, h_m, p(d_{80})), 0\right]$
ANY	Loss = L_{ITM} if $h_b \ge 200\,\text{m}$ or $r =$ "Rural"

Note: The nomenclature used in the formulas:

- L_{ITM}: ITM point-to-point loss (in dB) using desired values of reliability and confidence factors.
- L_{ITM}^{MED} : Median ITM point-to-point loss (in dB) using reliability and confidence factors of 0.5.
- L_{EH}: The loss (in dB) computed using the extended Hata model as defined in TR 15-517, with all site-specific corrections (effective height, rolling hilly terrain, etc.) applied. Note, however, the effective height corrections are not applied on the receive side of the link.
- L_{EHB}: The loss (in dB) computed using the site general extended Hata model (i.e., without any site-specific correction factors applied).
- h_{cbsd} : The structure height of the CBSD antenna (i.e., the height above ground of the center line of the antenna), in meters. h_{cbsd} shall not be less than 20 m regardless of the actual structure height of the CBSD antenna.
- h_b : The effective height of the CBSD antenna, in meters, as defined here:

  For path lengths less than 3 km, h_b is the structure height of the CBSD antenna (i.e., $h_b = h_{cbsd}$).

  For path lengths greater than or equal to 3 km but less than or equal to 15 km, h_b is the structure height, h_{cbsd}, plus (d-3)/12 times the difference between the terrain elevation at the CBSD antenna and the average terrain elevation over a distance of 3 km to the location of the receiver.

  For path lengths greater than 15 km, h_b is the structure height, h_{cbsd}, plus the difference between the terrain elevation at the CBSD and the average terrain elevation over the range 3 – 15 km.

  h_b shall not be less than 20 m regardless of the calculated effective height of the CBSD antenna.
- h_m: The receiver height, in meters. SAS shall use the structure height as defined in TR 15-517. Effective height is not used for this side of the link. For PPA and GWPZ calculations, h_m shall be 1.5 m.
- r: Refers to “urban,” “suburban,” or “rural,” as derived from the NLCD land cover database and used by the extended Hata model.
- $p(d_{point})$: Terrain elevation profile from the transmitter to the d_{point} km point along the great circle path. When d_{point} is d, $p(d)$ is full terrain elevation profile from the transmitter to the receiver.
- f: Frequency of the signal. For all purposes, f shall be fixed at a value of 3625 MHz.

e. If the CBSD is indoors, add 15 dB to the computed loss to account for attenuation due to building loss.

R2-SGN-05: Terrain and land cover data

a. For Initial Certification, the SAS shall use terrain data[6] and land cover[7] classification data only. The terrain and land cover data shall have an intrinsic angular resolution of 1 arc second, i.e., intrinsic spatial resolution of approximately 30 meters for propagation calculations.
b. After Initial Certification, the SAS may use terrain and land cover data that advance beyond these requirements (e.g., including buildings, etc.) subject to FCC approval.

R2-SGN-06: For Initial Certification, the SAS shall assume that data for propagation calculations specified relative to the NAD83 and WGS84 datum[8] are equivalent, and perform no translation between these two reference systems.

R2-SGN-07: Given transmitter and receiver locations, for Initial Certification, the SAS propagation calculations shall employ Vincenty's Inverse Solution [Vincenty[9], sections 3 and 4] to compute the great circle distance and the azimuth from the transmitter to the receiver. The procedure uses Equation 13, the iterations over Equations 14-17, 18, 10 and 11, and subsequently Equations 3, 4, 6, 19 and 20 of Vincenty.

R2-SGN-08: For Initial Certification, the SAS shall choose a great circle path spacing that is as close to 30 m as possible without exceeding 30 m for R2-SGN-07 calculated distances up to 45 km for the propagation and path loss calculations. Beyond 45 km, SAS shall use 1500 equally spaced points along the great circle path for path loss calculations.

R2-SGN-09: Given the transmitter and receiver locations, great circle path distance and transmitter-receiver azimuth (R2-SGN-07), and desired spacing of points along the great circle path (R2-SGN-08), for Initial Certification, the SAS shall employ Vincenty's Forward Solution [Vincenty[10], section 3] to determine the latitude and longitude of the points along the great circle path from the transmitter to the receiver for propagation calculations. The procedure uses Equations 1-4, the iterations over Equations 5-7, and subsequently Equations 8-11 of Vincenty.

[6] https://nationalmap.gov/3dep_prodserv.html (1 arc second 3DEP Seamless DEM)
[7] 2011 NLCD data for CONUS and Alaska and 2001 NLCD data for Hawaii and Puerto Rico, available at http://www.mrlc.gov/data. This combination of data sets utilizes consistent resolution and land cover classifications.
[8] https://vdatum.noaa.gov/docs/datums.html
[9] Vincenty, T., Direct and Inverse Solutions of Geodesics on the Ellipsoid with application of nested equations, Survey Review, XXIII (misprinted as XXII) (176): 88-93.
[10] Ibid

R2-SGN-10: Given the equally spaced points with latitude and longitude calculated in R2-SGN-09, SAS shall use bilinear interpolation using the elevation at the four nearest locations in the 1 arc second 3DEP seamless DEM database to yield an estimate of the elevation at the latitude/longitude of each equally spaced point.

R2-SGN-11: DEPRECATED

R2-SGN-12: Aggregate Interference Calculations

a. For Initial Certification, the aggregate interference calculations done by the SAS shall employ a method that results in no smaller aggregate interference than that calculated by a Monte Carlo method using 1000 sampling iterations. Each iteration uses interference realizations from a specified set of interfering CBSDs, determined by drawing a random contribution from the Cumulative Distribution Function (CDF) of the interference caused by that CBSD.
b. For the ITM model, the CDF to be used for interference realizations shall be that given by fixing the confidence parameter at 0.5 and varying the reliability parameter. Note: this value can be calculated relative to a median value for a specific path by using the 'avar' method in the reference implementation.
c. For the eHata model, the CDF to be used for interference realizations shall be that given by the situation-dependent log-normal distribution using a standard deviation given by equations A-18(a,b,c) in [TR 15-517 ref].
d. For the model defined in R2-SGN-04, the CDF to be used shall be that for the ITM or eHata model as selected by the criteria for the specific path.
e. A given percentile estimate of the aggregate interference for all nearby interfering CBSDs shall then be computed by taking that specified percentile value of the resulting Monte Carlo probability distribution.
f. The description of an Area-Protection-Reference-Standard is as follows:

    i Define a fixed grid spanning candidate CBSD locations and to be used by all SASs. The grid has points separated by 2 arc seconds in north/south and east/west directions. The grid is aligned to integer latitude and longitude lines.

    ii Let a protection area be defined by a set of bounding contours. Protection points of a protection area are grid points of the fixed grid within the protection area. Protection to this area provided by a SAS aims to ensure that estimated aggregate interference exceeds that of [R2-SGN-12] at each protection point. The aggregate interference calculations shall be performed assuming the use of an isotropic antenna integrating over a 10 MHz bandwidth and using a specified elevation above ground level.

    iii Aconservative SAS estimate of aggregate interference from interfering CBSDs is expected to be less than or equal to a specified protection level for all protection points in the

protection area. Due to variability in approximation methods and artifacts of terrain, propagation, and statistical models, to fulfill the protection standard the SAS must show that it succeeds for the specified minimum fraction (per the corresponding requirements that refer to this requirement) of the protection points in the protection area.

R2-SGN-13: DEPRECATED

R1-SGN-03: The SAS shall coordinate the operation of all Citizens Broadband Radio Service Devices (CBSDs) in the frequency band 3550 – 3700 MHz. [Ref: 96.11]

R2-SGN-14: DEPRECATED

R2-SGN-15: SAS-SAS ESC Sensor Information sharing: If an ESC operator requests protection of an ESC sensor, a SAS shall share with other SASs the location, height, antenna pattern, and alternate protection level (if any) of the protected ESC sensor antenna(s). [Reference R2-ESC-07]

R2-SGN-16: Margin Allocation

a. If CBSDs are deployed in the neighborhood of protected entities as defined in Table 1 and require power limitations on them in order to meet aggregate protection thresholds, the SAS shall assign maximum power for CBSD transmissions so as to satisfy the following constraints:

   i No aggregate interference protection level of an affected incumbent, PPA, or ESC sensor shall be violated by any grant made by any SAS.

   ii The SAS shall ensure that grants to CBSDs located within the neighborhood of a corresponding protected entity (incumbent, PPA or ESC sensor, as described in Table 1), will be at or lower than the aggregate interference threshold for each protected entity.

Note: For protected entities that are defined to have an area of protection, the aggregate interference threshold is applied to each of the protection points within the area of protection according to R2-SGN-12. The distance indicated in Table 1 is to a particular location in the protected area. For protected entities that are defined by a single point, the distance indicated is to the protected antenna.

Table 1. Criteria for consideration of protection points for a given CBSD.

Protected Entity Type: Incumbent/PAL/ESC Sensor	Maximum distance for consideration from a CBSD to a given protection point	Type of CBSD/Grant for consideration

	within the neighborhood of a protected entity	
Grandfathered Wireless Protection Zone	40 km	GAA only
PAL Protection Area	40 km	GAA and PAL
ESC Sensor	40 km for Category A CBSDs; 80 km for Category B CBSDs	GAA and PAL [1]
In-band FSS site [as pass-band interferer – 96.17(a.2)]	150 km	GAA and PAL
In-band FSS site [as a blocker 96.17 (a.3)]	40 km	GAA and PAL
Out-of-band FSS site [as pass-band interferer – 96.17 (b.1)]	40 km	GAA and PAL
Out-of-band FSS site [as a blocker – 96.17 (b.2)]	40 km	GAA and PAL

[1] Channels that are considered as protection constraints for ESC protection need to take into consideration [R2-ESC-07].

iii Each protection constraint, <*p*,*ch*>, is associated with a protected frequency (*ch*) and a protection point (*p)* within the neighborhood of a protected entity according to Table 1. For each protection constraint <*p*, *ch*>, there is a number, $N_{p,ch}$, corresponding to the total number of CBSDs having or requesting a qualifying grant within the neighborhood of that protection point, *p*, associated with the frequency range, *ch*, that is required to be protected for the given protected entity.

b. The SAS shall make maximum power assignments to all CBSDs with qualifying grants as follows:

i Each SAS shall allocate an EIRP limit to a CBSD (unless otherwise limited by the CBSD's radio capabilities or requested EIRP) such that the mean of the interference contribution of the CBSD for every qualifying protected point for every protected entity is allowed by the SAS to be at least $(1/N_{p,ch})$ of the allowable interference protection level for the given CBSD's most constraining applicable protected point. Specifically, the EIRP limit shall be assigned by the SAS such that the interference contribution is no less than $\min_p(Q_{p,ch}/N_{p,ch})$, where $Q_{p,ch}$ is the total allowable interference

protection level for protected point *p* and frequency range *ch*, reduced by sum of all the modest remainders of interference margin that SAS Administrators agree to reserve.

ii When allowing CBSD grants to exceed these $1/N_{p,ch}$ limits, the SAS shall use an allocation procedure for all CBSDs it manages producing substantially similar results to the Iterative Allocation Process (IAP) defined below. Substantially similar is defined to mean that the resulting allocations are within a reasonable tolerance of results of the IAP, with that tolerance limit to be determined as part of the test and certification specifications.

iii SASs may collaborate to modify the IAP to provide for a modest remainder of interference margin to enable ease of operations during CBSD deployment, and to create a coordinated schedule for execution of the IAP. The limits on how large this modest remainder of interference margin may be for each SAS, how it will be consistently applied by all SASs, and how the associated testing and certification process will be defined by a SAS administrator's operational agreement. Any further revisions to, or use by the SAS of allocation methods different from, the IAP, including grouping of protection points to improve processing efficiently, are FFS and shall be made consistently by SASs and publicly disclosed.

iv Subject to agreements (beyond the scope of this specification) between the SAS Administrator and the CBSD Users comprising an Interference Margin Group (IMG), SASs may allow CBSD grants to exceed individual interference margin allowances when all of the following conditions are satisfied:

- Associated CBSD grants were assigned as a result of application of the IAP.
- The aggregate interference contribution from all of the CBSDs that share any given IMG shall be no greater than the total allowable interference assigned to the given IMG as a result of application of the IAP.

v SASs shall share sufficient information to determine the numbers and qualification criteria of CBSDs registered with all SASs so as to allow other SASs to perform the IAP consistently.

vi SASs shall share the grant requested information of CBSDs so as to allow other SASs to perform the IAP consistently.

vii SASs shall share sufficient information to identify the membership of IMGs so as to allow other SASs to perform the IAP consistently.

viii The IAP is applied for every CBSD and over every qualifying protection point *p* (according to Table 1) and for every applicable frequency range *ch*. $Q_{p,ch}$ for a co-channel requirement is normalized by the portion of the channel that overlaps the frequency range used by the corresponding protected entity.

The IAP is applied to all existing and pending grants.

The IAP consists of the following steps:

1. For each CBSD grant that remains unsatisfied:
   i $I_{cbsd,p,ch}$ is the estimated mean of the aggregate interference contribution from the fundamental emission of that CBSD grant request to the quota for each protection point *p* and frequency range *ch*, either based upon the EIRP level that the CBSD requested or reduced after adjustment in Step 4.
   ii For all such protection points *p* and the frequency ranges *ch* for the CBSD grant:
   - If $I_{cbsd,p,ch} < Q_{p,ch}/N_{p,ch}$ corresponding to the CBSD grant and for all relevant protection points *p* and frequency ranges *ch*, then the grant is satisfied.
2. Satisfied CBSD grants are removed from consideration in future steps, and the interference quota reduced by the sum of $I_{cbsd,p,ch}$ for all satisfied CBSD grants, and $Q_{p,ch}$ and $N_{p,ch}$ will be reduced appropriately for all relevant protection points *p*.
3. Repeat steps 1 and 2 until no more CBSD grants can be satisfied.
4. If any CBSD grants remain unsatisfied, then for each such CBSD grant, decrease the maximum EIRP level that it will be allocated by 1 dB each and repeat steps 1, 2 and 3 until all grants are satisfied.

Note: For Initial Certification, choices of specific frequency range assignment for use in testing of the IAP are left FFS.

R2-SGN-17: Use of the ITM Model:

a. The following inputs shall be used for path loss predictions when using the ITM implementation of the Longley-Rice propagation model:

i Polarization = 1 (vertical)
ii Dielectric constant = 25 (good ground)
iii Conductivity = 0.02 S/m (good ground)
iv Confidence = 0.5
v Mode of Variability (MDVAR) = 13 (broadcast point-to-point)

b. For path loss calculations that are not for the purpose of aggregate interference calculations, the reliability factor shall be set to 0.5. For aggregate interference calculations, the statistical methods of R2-SGN-12 shall be followed.
c. The surface refractivity value varies by location and shall be derived by the methods and associated data files in ITU-R Recommendation P.452[11]. The refractivity values shall be evaluated at the mid-point of the great circle path between transmitter and receiver.
d. The climate value varies by location and shall be derived by the methods and associated data files in ITU-R Recommendation P.617[12].

Note: Although polarization, dielectric constant, and conductivity vary by application and location, predicted losses with the ITM propagation model do not have a strong dependency on these values.

R1-SGN-04: Unless directed otherwise by the FCC, SASs shall authorize CBSD activity only within the boundary defined by international borders and the United States coastline (the mean low water line – see 47 CFR 96.3, definition of Coastline). The NOAA National Shoreline MLLW tidal datum is the reference for this coastline. The NOAA National Shoreline MHW tidal datum may be used where MLLW data is incomplete. For inland waterways or where both are unavailable, the SAS may use the NLCD Open Water classification as delineating areas outside the coastline.

R2-SGN-18: Unless directed otherwise by the FCC, SASs shall authorize no CBSD activity within the borders of quiet zones without the appropriate coordination as specified in 47 CFR 1.924.

a. With regard to the Table Mountain Radio Receiving Zone, the coordination distance is as follows (relative to 40.130660º N, 105.244596º W):

Table 2. Coordination Area around Table Mountain Quiet Zone

CBSD Category	Total CBSD Operating Bandwidth (BW)	Coordination Distance (km)
A	N/A	3.8

[11] Specifically, the data file N050.txt shall be used, in the manner prescribed in Section 2 of Attachment 1 of Annex 1 of ITU-R Recommendation P.452-16, available at https://www.itu.int/rec/R-REC-P.452-16-201507-I/en.
[12] Specifically, the data file TropoClim.txt shall be used, in the manner prescribed in Section 2 of Annex 1 of ITU-R Recommendation P.617-3, available at https://www.itu.int/rec/R-REC-P.617-3-201309-I/en.

B	BW ≤ 10 MHz	38
B	10 MHz < BW ≤ 20 MHz	54
B	20 MHz < BW ≤ 30 MHz	64
B	BW > 30 MHz	80

i If the CBSD is located within the coordination distance as defined in Table 2, the CBSD User may coordinate their operation with the Department of Commerce as specified in 47 CFR 1.924(b)(3), and present the terms of the coordination to the managing SAS. The managing SAS may accept the coordination, and if it does, it shall follow the terms of the coordination, subject to the obligations the SAS has to other protected entities.

ii For a CBSD located within the specified coordination distance, if no coordination is presented to the managing SAS, or the SAS does not accept the terms of the coordination, the managing SAS may authorize the requested assignment only if the total predicted signal strength from that CBSD across its entire bandwidth, using median ITM pathloss, is less than or equal -88.4 dBm, as received by an isotropic antenna located at the Table Mountain Radio Receiving Zone reference point at a height of 9 m above ground level.

R1-SGN-05: Unless directed otherwise by the FCC, SASs shall consider the United States border with Canada and Mexico to be defined by geographical information available at the URLs:

a. https://transition.fcc.gov/oet/info/maps/uscabdry/uscabdry.zip
b. http://www.ibwc.gov/GIS_Maps/downloads/us_mex_boundary.zip

R1-SGN-06: The SAS shall support registration of CBSDs prior to CBSD initial service transmission. [Ref-2, 96.39]

R2-SGN-19: According to Arrangement R (Ref.15) and (Ref.4), a “Sharing Zone” adjacent to United States border is defined as 8 km from United States border for any CBSD utilizing an antenna of which the entire main beam looks within the 160-degree sector oriented away from the closest point on the border, or 56 km from United States border for any CBSD utilizing an antenna of which any part of the main beam looks within the 200-degree sector toward the closest point on the border. Unless directed otherwise by the FCC, or informed of alternative international protection arrangements, and for the United States borders defined by R1-SGN-05, the SAS shall apply the following rules:

a. For all CBSDs within the Sharing Zone adjacent to Canadian border and operating in 3650-3700 MHz, the SAS shall allow spectrum grants only if

the Power Flux Density (PFD) at any point along the border does not exceed -110 dBW/m^2/MHz at a height 1.5 m above the ground, using median ITM path loss.

b. In addition, to fulfill Arrangement R along US-Canada border (Ref.15, sections 4.1 and 7.1), the SAS shall protect the single Canadian FSS site using the same criteria as used for FSS co-channel as specified in section 4.2 of this document. The Weir FSS earth station information in Quebec, Canada is:

i Channel Type = Receive (RX_RES)
ii Lower operational Frequency: 3616.36625 MHz
iii Higher operational Frequency: 3616.37875 MHz
iv Protected Frequency Range: 3615-3620 MHz
v Emission designator = 12K5G7DDT
vi Call Sign = CJ633
vii Type of Station = Fixed
viii Province = Quebec
ix Location (Lat, Long) = 45.94444444, -74.53277778
x Service = Satellite
xi Sub-Service = Earth Station, Shared Bands
xii Authorization Status = Granted
xiii Antenna height (Above Ground): 20 m
xiv Model number: AP-28 (D/L>100), 56.1_D22.69
xv Antenna Gain: 56.1 dBi
xvi Elevation 14.5 degrees
xvii Azimuth: 151.3 degrees relative to True North
xviii Polarization of emission: Dual

R2-SGN-20: CBSD Antenna Gain used in Aggregate Interference Calculations: For Initial Certification, SAS shall apply the following procedure to estimate the CBSD antenna gain in the direction toward a receiver in aggregate interference calculations.

If the antenna beamwidth and pattern are not available, the SAS shall assume that the maximum gain, as reported during registration, is directed towards the receiver. Otherwise, the following procedure shall be applied to compute the CBSD antenna gain:

1. The azimuth angle, AZ, relative to True North from the CBSD toward a receiver location shall be computed from the associated latitudes and longitudes using Vincenty's formula [Ref-10].
2. The CBSD antenna azimuth, α, shall be used to calculate the off-axis angle θ, i.e., the angle between the axis of the main beam of the CBSD and the line between the CBSD and receiver location, via

   $\theta=\alpha-AZ$ (degrees)
3. SAS shall then calculate the CBSD antenna gain in dBi using $G(\theta)+G$ where G is the CBSD peak antenna gain and $G(\theta)$ is either obtained

from the horizontal antenna pattern, if available, or calculated using the methodology in [Ref-11]:

$$\boldsymbol{G(\theta) = -min\left[12\left(\frac{\theta}{\theta_{3dB}}\right)^2, \quad A_H\right] \ (dBi)}$$

where A_H = 20 dB and θ_{3dB} is CBSD reported beamwidth of antenna in degrees.

After initial certification, the algorithm to calculate CBSD antenna gain may advance beyond this initial requirement to include the CBSD downtilt and the vertical antenna pattern, subject to FCC approval.

R2-SGN-21: FSS Earth Station Antenna Gain in direction of the CBSD:

a. For Initial Certification, SAS shall apply the following procedure to estimate the FSS antenna gain in the direction toward a CBSD in aggregate interference calculations

i The azimuth angle, AZ, relative to True North from the FSS earth station toward the CBSD shall be computed from the associated latitudes and longitudes using Vincenty's formula [Ref-10].

ii The elevation angle, ϕ_1, from the FSS earth station toward the CBSD is computed by the method which is equivalent to the hzns() subroutine [Ref-12].

iii AZ, ϕ_1 , the FSS earth station antenna elevation (ϕ_2), and FSS earth station antenna azimuth (α) are used to calculate the off-axis angle θ, i.e., the angle between the axis of the main beam of the FSS earth station and the line between the FSS earth station and the CBSD via:

$$\boldsymbol{\theta = \frac{180}{\pi}\cos^{-1}(\cos\phi_1 \cos\phi_2 \cos(\alpha - AZ) + \sin\phi_1 \sin\phi_2) \ (degrees)}$$

iv θ shall then be used with FSS earth station antenna patterns $G_{GSO}(\theta)$, defined in section 25.209(a)(1), and $G_{GSO\perp}(\theta)$, defined in section 25.209(a)(4). These patterns shall be combined using weights w1 and w2 according to the FSS earth station skew angle[13] to get the gain from an FSS earth station to a CBSD as

$$G(\theta) = w_1 G_{GSO}(\theta) + w_2 G_{GSO\perp}(\theta)$$

[13] The "skew angle" is the angular difference between the major axis of the antenna and the geostationary arc when the antenna is pointed at the serving satellite but located at a different longitudinal position than the satellite. Thus, at 0° skew angle, antenna performance is dictated solely by the azimuth gain pattern. As skew angle increases, the elevation gain pattern contributes to overall antenna performance and the combined pattern broadens to reflect this contribution

v If the FSS earth station registration data includes values for w_1 and w_2, SAS shall use these values. Otherwise SAS shall assume $w_1=0$ and $w_2=1$.

b. After Initial Certification, procedure to estimate the FSS antenna gain may advance beyond this initial requirement, subject to FCC approval.

R2-SGN-22: Interference Margin Allocation Calculation: For purposes of Interference Margin Allocation calculations (including the IAP), the following methods shall be employed for initial certification:

a. When ITM path loss is used, the mean interference contribution of a grant shall be computed as EIRP * <1/L>, where L is the ITM path loss on a linear scale, and <·> is the statistical mean computed using confidence = 0.5 and 99 reliability values uniformly spaced between reliability=0.01 and 0.99.

b. When extended Hata path loss is used, the mean interference contribution of a grant shall be computed as EIRP * <1/L> in the linear domain, or in the dB domain $EIRP_{dBm} - (L_{med,dB} - \sigma^2 / 2\xi)$ where $L_{med,dB}$, is the extended Hata median path loss in dB ($L_{med,dB}=L_{EH}$ or $L_{med,dB}=L_{EHB}$ as defined in R2-SGN-04), $\xi = 10 / ln10$, and σ is the land use category (urban or suburban) dependent log-normal distribution using a standard deviation given by equations A-18(a,b,c) in [TR 15-517 ref] and the land category is chosen using R2-SGN-04. For the avoidance of doubt, the value of σ shall be taken as σ = 8.4 dB for urban areas and 10.4dB for suburban areas.

R2-SGN-23: SAS DPA Protection

a. When a SAS receives notification from the ESC that a DPA needs protection on certain frequencies, the SAS shall activate that DPA on those frequencies
b. The SAS shall be capable of determining that an ESC failure has occurred.
c. If the SAS loses communications with the ESC or otherwise determines that the ESC has failed , the SAS shall activate all DPAs monitored by the failed ESC, over the entire frequency range for which the DPAs must be protected.
d. In the absence of an ESC, all DPAs are considered activated on all frequencies.
e. Specific coordinates for the DPAs will be available at [Ref-14].

R2-SGN-24: DPA Protection Procedure

a. In the case of co-channel frequency range protection for offshore or inland DPAs, for each protection point, *p*, under consideration within the given DPA and for any co-channel frequency range *ch*, designate the protection constraint $c = <p,ch>$ and define N_c to be the total number of CBSDs

having or requesting a co-channel grant that includes any portion of the frequency range *ch*, and that are within a neighborhood of protection point *p*.

For each protection constraint *c*, the SAS shall determine the N_c CBSDs that are considered to be within the neighborhood of protection constraint <*p*,*ch*> in a manner that is substantially similar[14] to the following procedure:

i. A Category A $CBSD_i$ shall be included in the neighborhood of protection constraint <*p*,*ch*> if and only if $CBSD_i$ is less than or equal to $R\_C\_DPA_A$ km from protection point *p* (the default value of $R\_C\_DPA_A$ is 150 km for all in-land and offshore DPAs)

ii. A Category B $CBSD_i$ shall be included in the neighborhood of protection constraint <*p*,*ch*> if and only if $CBSD_i$ is less than or equal to $R\_C\_DPA_B$ km from protection point *p*.

The values of $R\_C\_DPA_A$ and $R\_C\_DPA_B$ for co-channel in-land and offshore DPAs are captured in DPA KML files determined in [Ref-14].

Note: The Category B Neighborhood distances contained in [Ref-14] are provided by WInnForum and are not a requirement of the federal government.

b. In the case of out-of-band frequency range protection for inland DPAs, for each protection point, *p*, under consideration within the given DPA and for any protected out-of-band frequency range, *ch*, designate the protection constraint *c* = <*p*,*ch*> and define N_c to be the total number of CBSDs having or requesting any grant, and that are within a neighborhood of protection point *p*.

For each protection constraint *c*, the SAS shall determine the N_c CBSDs that are considered to be within the neighborhood of protection constraint <*p*,*ch*> in a manner that is substantially similar[15] to the following procedure:

i. A Category A $CBSD_i$ shall be included in the neighborhood of protection constraint <*p*,*ch*> if and only if $CBSD_i$ is less than or equal to $R\_O\_DPA_A$ km from protection point *p*.

[14] Substantially similar is defined to mean that this determination is within a reasonable tolerance of the results of the DPA Protection Procedure, with the tolerance limit to be determined as part of the test and certification specification.

[15] Substantially similar is defined to mean that this determination is within a reasonable tolerance of the results of the DPA Protection Procedure, with the tolerance limit to be determined as part of the test and certification specification.

ii A Category B $CBSD_i$ shall be included in the neighborhood of protection constraint <*p*,*ch*> if and only if $CBSD_i$ is less than or equal to $R\_O\_DPA_B$ km from protection point *p*.

The values of $R\_O\_DPA_A$ and $R\_O\_DPA_B$ for co-channel in-land and offshore DPAs are captured in DPA KML files determined in [Ref-14].

Note: The Neighborhood distances contained in [Ref-14] are provided by WInnForum and are not a requirement of the federal government.

c. For every protection constraint, *c* (i.e., for each of the protection constraints <*p*,*ch*> corresponding to every protection point *p* under consideration within a given protection area *DPA* and for every applicable frequency range *ch*), the SAS shall determine the associated DPA Move List M_c (see [R2-SGN-24 (d)]) using a method that generates results that are substantially similar to the following procedures:

i Form the ordered list $S_{c,sorted} = [CBSD_1, CBSD_2, \cdots CBSD_{Nc}]$, sorted according to increasing values of $(P_{CBSD,ch} + G_{CBSDi->c} - L_{CBSDi,c})$, where $P_{CBSD,ch}$ is the CBSD conducted power (in dBm) on frequency range *ch*, $G_{CBSDi->c}$ is the CBSD antenna gain in the direction of the protection point *p* (in dB*i*) [R2-SGN-20], and $L_{CBSDi,c}$ is the median path loss based on ITM model as defined in [R2-SGN-03] from $CBSD_i$ to the protection point *p* (in dB).

ii In case of out of band frequency range protection of inland DPAs,

- For CBSDs having multiple grants, the grant closest to "*ch"* is taken into account.
- The CBSD conducted power $P_{CBSD,ch}$, is replaced with one of the three values, -13 dBm/MHz, -25 dBm/MHz, or -40 dBm/MHz, depending on the distance of closest edge of the grant operational frequency range to *"ch",* as defined in R0-DEV-05(e)[16]
- If the out of band inland DPA is operating below 3550 MHz and is always activated, *ch* is assumed to be the frequency range 3540-3550 MHz.

iii DPA Move List analysis is performed using increments of half of beamwidth (beamwidth/2), where beamwidth is defined in the appropriate KML file in [Ref-14], over the azimuth range of the given DPA, where the azimuth range is defined in the appropriate KML file in [Ref-14].

[16] Note: e.g., if the upper edge of *ch* falls at or below 3530 MHz, the value of -40 dBm/MHz, and if *ch* falls at or below 3540 MHz but above 3530 MHz, the value of -25 dBm/MHz is assumed for all grants.

iv Find the largest n_c, $1<=n_c<=N_c$, such that $CDF_{c,a}(n_c)$ does not violate 95% threshold for all potential azimuths, *a*, where $CDF_{c,a}(n_c)$ is the CDF of sum of the interference from the fundamental emission (in case of co-channel DPA protection) or the out-of-band emission (in case of out-of-band inland DPA protection) of the first n_c elements of $S_{c,sorted}$ (i.e., $CBSD_1$, $CBSD_2$, …, $CBSD_{nc}$) given radar gain $G_{r,c->a}$ (per [R2-IPM-04]) for a federal incumbent radar *r*, hypothetically located at the protection point *p* associated with constraint *c*, in the direction of azimuth *a*.

v The associated DPA Move List, M_c, corresponding to protection constraints *c* is determined to be {$CBSD_{nc+1}$, $CBSD_{nc+2}$, …, $CBSD_{Nc}$}.

d. The SAS shall determine the DPA Move List for protection area *DPA* on frequency range *ch*, $M_{DPA,ch,}$ to be the union of M_c for all protection constraints *c*, where the associated *p* is within the protection area *DPA*.

e. Whenever any DPA, *DPA*, is activated on any given channel, *ch* (per channel definition as given in R2-SPU-01), a Managing SAS for any CBSDs under its management that are members of the DPA Move List $M_{DPA,ch}$ shall ensure that those CBSDs are not transmitting using any grant that has a frequency range that overlaps with the channel *ch* from a time starting no later than 300 seconds after the activation of the DPA until no earlier than the time when the DPA becomes deactivated.

f. For the case of out of band inland radar protection, if a CBSD's grant G is inside the DPA Move List, all CBSD's grants shall be included in the DPA Move List. SASs shall manage CBRS interference for all 3550-3650 MHz ESCs.

R1-SGN-07: CBSD Antenna Height Above Average Terrain (HAAT): The Height Above Average Terrain (HAAT) of a CBSD antenna is determined by taking 50 evenly spaced elevation points (with the elevations above or below mean sea level [AMSL]) along 8 evenly spaced radials from the transmitter site (starting at 0 degrees [True North]). The 50 evenly-spaced points are sampled in the segment between 3 to 16 km along each radial. The elevation points along each radial are averaged, then the 8 radial averages are averaged to provide the final average value. This value is subtracted from the CBSD antenna's height AMSL to determine the antenna's height above average terrain.

The terrain database used for HAAT calculations shall be the same database used for the SAS propagation calculations, and consistent with R2-SGN-05.

R2-SGN-25: SAS ESC Sensor Protection

a. SASs shall manage CBRS interference for all ESC sensors that require protection such that the aggregate mean interference at the reference ESC filter output of the protected sensor in 3550-3700 MHz does not exceed -

109 dBm/MHz. The reference ESC filter has 0.5 dB insertion loss in the passband.

b. For initial certification, the SAS shall treat Category B CBSDs operating within the frequency range 3650-3680 MHz, and Category A CBSDs operating within the frequency range 3650-3660 MHz, as co-channel to ESCs and apply the same protection described above, after assuming a straight line 1 dB per MHz ESC reference filter roll-off from 3650-3680 MHz.
c. SAS shall calculate the CBRS interference using the CBSD antenna gain defined in R2-SGN-20 and the ESC antenna gain using the antenna pattern specified in R2-ESC-07(a) or the effective antenna pattern specified in R2-ESC-07(b). The angle-off boresight between the ESC sensor antenna and the CBSD shall be determined using an azimuth angle relative to true north from the ESC sensor toward the CBSD computed from the associated latitudes and longitudes using Vincenty's formula [Ref-10]. ESC protection criteria may evolve as the U.S. Department of Defense defines new waveforms that require detection. [Ref R2-ESC-01].

R2-SGN-26: CBSD Digital Certificate Modification

If a CBSD's digital certificate is modified (e.g. it is exposed and a new valid certificate is generated for the CBSD by a valid root certificate), the CBSD is required to re-register at the SAS with its new certificate.

R2-SGN-27: Deprecated

R2-SGN-28: SAS Handling of CBSDs with Grants from multiple SASs simultaneously

a. If a SAS determines that a CBSD has been authorized to use spectrum by other SASs simultaneously, the SAS shall revoke all the privileges of that CBSD to use spectrum which are managed by that SAS and associated with that CBSD.
b. If a SAS determines that a CBSD already has an authorization to use spectrum from another SAS, the SAS shall reject all grant requests from that CBSD until it determines that the CBSD no longer has the authorization from another SAS.
c. If a managing SAS fails, CBSDs authorized to use spectrum with the failed SAS may attempt to switch to an alternate SAS as the new managing SAS. The alternate SAS shall confirm the original managing SAS has failed, prior to becoming the new managing SAS.

R2-SGN-29: FSS OOBE Purge List

a. For each FSS TT&C protection entity, the SAS shall determine the *Nc* CBSDs that are within the 40 km of the of the FSS TT&C location.
b. For every FSS TT&C OOBE protection point, SAS shall determine the associated Purge List.

c. The process of calculating purge list is done before interference margin allocation process (such as IAP).
d. Purge List will be only calculated for the first channel segment (*RefBW*), starting from the lowest frequency of the passband above or at 3700 MHz.
e. The *RefBW* size shall be 5 MHz.
f. SAS shall determine the associated Purge List using a method that generates results that are substantially similar to the following procedures:

i For CBSDs having multiple grants, the grant closest to *RefBW* is taken into account.

ii An ordered list, S_{FSS}, will be formed where S_{FSS} = [$CBSD_1$, $CBSD_2$, … $CBSD_{Nc}$], sorted according to increasing values of ($M_{CBSDi,ch}$ + G_{CBSDi} + $PLinv_i$ + G_{FSSi}), where:

- $M_{CBSDi,ch}$ is the CBSD conducted power (in dBm) on frequency segment ch, using the CBSD Tx mask according to [R0-DEV-05(e)],
- G_{CBSDi} is the CBSD antenna gain in the direction of the FSS protection point (in dBi) [R2-SGN-20],
- $PLinv_i$ = 10 log10 <1/PL_i>, is the ITM path loss from $CBSD_i$ to the FSS protection point, where PL_i is the ITM path loss in linear scale, as defined in R2-SGN-22,
- G_{FSSi} is the antenna gain (in dBi) of FSS receiver, as defined in [R2-SGN-20].

iii Find the largest n_c, $1 \leq n_c \leq N_c$, such that aggregation of elements from S_{FSS}, for i ranging from 1 to n_c, does not cross -129dBm+10*log10 (RefBW /1 MHz) + ILoss, where ILoss is the insertion loss of a reference RF filter in the FSS passband, set to 0.5 dB (as defined in [R0-IPM-01]).

iv The associated Purge list, P_{FSS}, corresponding to protection of FSS TT&C is determined to be {$CBSD_{nc+1}$, $CBSD_{nc+2}$, …, $CBSD_{Nc}$}.

v If a CBSD's grant is purged, all the CBSD's grants that have the same emission mask (-13 or -25 dBm/MHz) at *RefBW* as the purged grant shall be terminated. If the CBSD has grants with a lower emission mask at *RefBW*, the lower emission grant has to be added back to the sorted list, and the purge process is re-executed.

vi The CBSD(s) that are in the purge list, PFSS, will not be considered as part of calculation for IAP for any other protection entities.

R2-SGN-30: The SAS shall assign frequencies to a CBSD such that, for any given frequency assignment, the lower frequency and upper frequency are both

constrained to be 3550 + *n**5 MHz, where *n* is an integer in the range 0 to 30, inclusive; and the lower frequency is less than the upper frequency.

4.2 Incumbent Protection Management (IPM)

R0-IPM-01: Protection of Existing FSS earth stations in the 3600-3650 MHz Band, the 3650-3700 MHz Band, and the 3700-4200 MHz Band [Ref-2, 96.17]

a. FSS earth stations licensed to operate in the 3600-3650 MHz band listed at fcc.gov/cbrs-protected-fss-sites shall be protected from CBSD operation consistent with [the requirements below]. The protections shall only apply to registered FSS earth stations that are authorized to operate on a co-primary basis consistent with 47 CFR 2.106.

   i FSS earth stations in the 3650-3700 MHz band will be afforded protection consistent with these requirements only after the conditions set forth in 47 CFR 96.21(c) are satisfied.

   ii *Co-channel:* The aggregate passband RF power spectral density at the output of a reference RF filter and antenna at the location of an FSS earth station operating in the 3600 – 3700 MHz band, produced by emissions from all co-channel CBSDs (within 150 km) operating in the Citizens Band Radio Service shall not exceed a median RMS[17] value of -129 dBm/MHz. The reference antenna system requires SAS to calculate antenna gain using § 25.209(a)(1) and 25.209(a)(4), and a reference RF filter between the feed-horn and LNA/LNB, with 0.5 dB insertion loss in the passband.

   iii *Blocking:* The aggregate RF power at the output of a reference RF filter and antenna at the location of an FSS earth station operating in the 3600 – 3700 MHz band, produced by emissions from all CBSDs (within 40 km), shall not exceed a median RMS value of -60 dBm. The reference antenna system requires an SAS to calculate antenna gain using § 25.209(a)(1) and 25.209(a)(4), and a reference RF filter between the feed-horn and LNA/LNB, with a filter mask of 0.6 dB/MHz attenuation to 30.5 dB at 50 MHz offset below the lower edge of the FSS earth station's authorized passband, and 0.25 dB/MHz attenuation to 55.5 dB at an offset greater than or equal to 150 MHz below the lower edge of the FSS earth station's authorized passband.

b. Registered FSS earth stations in the 3700-4200 MHz band listed at: fcc.gov/cbrs-protected-fss-sites, shall be protected from CBSD operation in accordance [with this section]. Only licensed FSS earth stations used for satellite telemetry, tracking, and control (TT&C) operations will be protected under this section. Other licensed 3700-4200 MHz earth stations may be protected consistent with section 96.17(f)

[17] RMS means Root Mean Squared received signal power (as opposed to peak or peak envelope power). Median applies to the statistics of the signal including the effects of propagation and /or the aggregation of multiple emitters.

i *Out-of-Band Emissions into FSS:* The aggregate passband RF power spectral density at the output of a reference RF filter and antenna at the location of a TT&C FSS earth station operating in the 3700 – 4200 MHz band, produced by emissions from all CBSDs (within 40 km) operating in the Citizens Band Radio Service shall not exceed a median RMS value of -129 dBm/MHz. The reference antenna system requires SAS to calculate antenna gain using § 25.209(a)(1) and 25.209(a)(4), and a reference RF filter between the feed-horn and LNA/LNB, with 0.5 dB insertion loss in the passband.

ii *Blocking:* The aggregate RF power at the output of a reference RF filter and antenna at the location of a TT&C FSS earth station operating in the 3700 – 4200 MHz band, produced by emissions from all CBSDs (within 40 km), shall not exceed a median RMS value of -60 dBm. The reference antenna system requires SAS to calculate antenna gain using § 25.209(a)(1) and 25.209(a)(4), and a reference RF filter between the feed-horn and LNA/LNB, with a filter mask of 0.6 dB/MHz attenuation to 30.5 dB at 50 MHz offset below the lower edge of the FSS earth station's authorized passband, and 0.25 dB/MHz attenuation to 55.5 dB at an offset greater than or equal to150 MHz below the lower edge of the FSS earth station's authorized passband. [A graphical representation is shown in Figure 2]

c. These protection criteria will [shall] be enforced by the Spectrum Access System authorized consistent with section 96.53,[Ref-2] et seq. below.

d. FSS earth station licensees requesting protection under this Part must [shall] register with the Commission annually, no later than 30 days before the end of the preceding calendar year, or upon making changes to any of the operational parameters listed in this section. Registration information will [shall] be made available to all approved SASs.

i Annual registration for each earth station shall include, at a minimum: the earth station's geographic location (Using NAD83 coordinates); antenna gain; azimuth and elevation antenna gain pattern; antenna azimuth relative to true north; and antenna elevation angle; whether the earth station is used for satellite telemetry, tracking, and control (for earth stations in the 3700-4200 MHz band).

ii Such information must [shall] be made available to SAS Administrators and maintained consistent with section 96.55.

e. CBSDs may operate within areas that may cause interference to FSS earth stations, in excess of the levels described in R0-IPM-01 (a) & (b), provided that the licensee of the FSS earth station and the authorized user of the CBSD mutually agree on such operation and the terms of any such agreement are provided to an SAS Administrator that agrees to enforce

them. The terms of any such agreement shall be communicated promptly to all other SAS Administrators.

f. FSS earth station licensees in the 3600-3700 and 3700-4200 MHz bands may request additional protection from SAS Administrators to prevent harmful interference into their systems. SAS Administrators must establish a process to receive and address such requests, consistent with section 96.53(o) and 96.63 and shall make good faith efforts to address interference concerns, consistent with their other responsibilities under this Part. In addressing such requests, SASs shall assume that 3700-4200 MHz earth stations are utilizing filters with the characteristics described in sections 96.17(a)(3) or (b)(2) as appropriate for the 3600-3700 or 3700-4200 MHz band.

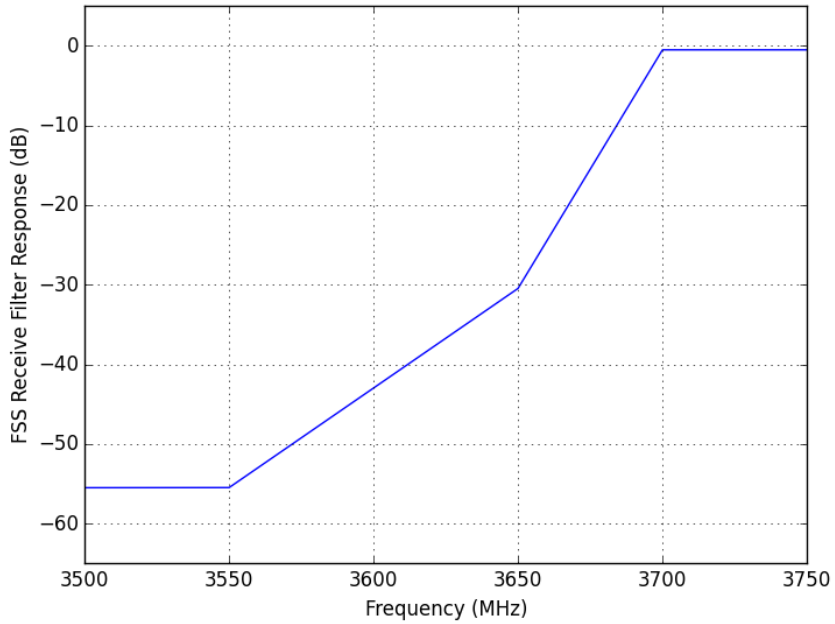

Figure 2: Filter curve plot for FSS Receive Filter Response vs. Frequency
Graphical representation of the filter described in R0-IPM-01(b)(ii) or 96.17(b)(2)

R0-IPM-02: Protection of Existing Operators in the 3650-3700 MHz Band [Ref-2 96.21, Ref-13]

a. Grandfathered Wireless Broadband Licensees shall be granted Incumbent User status consistent with sections 90.1307 and 90.1338. Notwithstanding this status, Grandfathered Wireless Broadband Licensees shall not cause harmful interference to federal Incumbent Users and grandfathered FSS earth stations consistent with the rules governing Citizens Broadband Radio Service operators in this part.

i. Incumbent User protections for a Grandfathered Wireless Broadband Licensee shall only apply within its Grandfathered Wireless Protection Zone.

ii. Incumbent User protections for a Grandfathered Wireless Broadband Licensee shall only apply to Grandfathered Wireless Protection Zones around base or fixed stations that are registered in ULS on or before April 17, 2015 and constructed, in service, and fully compliant with the rules in Part 90, subpart Z as of April 17, 2016. Grandfathered Wireless Protection Zones will [shall] be reduced in geographic area and/or applicable frequency range if portions of the protected network fail to meet the above criteria after April 17, 2016. Grandfathered Wireless Protection Zones will [shall] not be defined for subscriber units operated by Grandfathered Wireless Broadband Licensees, regardless of whether they have been registered in ULS.

iii. Grandfathered Wireless Protection Zones must [shall] be registered in the SAS for these protections to apply.

b. Grandfathered Wireless Broadband Licensees may operate within their Grandfathered Wireless Protection Zones and operational frequencies consistent with the technical rules in Part 90, subpart Z, consistent with the transition period set forth in sections 90.1307 and 90.1338.

c. Grandfathered Wireless Broadband Licensees and Citizens Broadband Radio Service users must [shall] protect authorized grandfathered FSS earth stations in the 3650-3700 MHz band, consistent with the existing protection criteria in part 90, subpart Z until the last Grandfathered Wireless Broadband Licensee's license expires within the protection area defined for a particular grandfathered FSS earth station. Thereafter, the protection criteria in section 96.17 applicable to FSS earth stations in the 3600-3700 MHz band shall apply.

R1-IPM-01: Protection of Federal Incumbent Users from CBSDs operating in the 3550-3650 band [Ref-2, 96.15]

a. CBSDs and End User Devices must [shall] not cause harmful interference to and must accept interference from federal Incumbent Users authorized to operate in the 3550-3700 MHz band and below 3550 MHz.[18]

b. The SAS shall only authorize the use of CBSDs consistent with information on federal frequency use obtained from an approved ESC, except as provided in this section.

c. For Category A CBSDs, Exclusion Zones shall be maintained along the Coastline, as shown at ntia.doc.gov/category/3550-3650-mhz. Exclusion Zones shall also be maintained around federal radiolocation sites as set forth at ntia.doc.gov/category/3550-3650-mhz. The Zones shall be updated if and when NTIA notifies the Commission in writing if the list of protected federal radiolocation sites is updated. Exclusion Zones shall be maintained and enforced until one or more ESCs are approved and used by

[18] The FCC rules do not explicitly state how far below 3550 MHz that federal Incumbent Users must be protected. However, primary federal allocations extend to 3100 MHz

at least one SAS, in accordance with section 96.67. Thereafter, Exclusion Zones shall be converted to Protection Zones.

i. Category A CBSDs may be authorized by an approved SAS in geographic areas outside of Exclusion Zones before an ESC is approved.

ii. Once an ESC is approved and used by at least one SAS, Category A CBSDs may only be authorized consistent with information on federal frequency use provided to the SAS by an approved ESC.

iii. Category B CBSDs may only be authorized consistent with information on the presence of a signal from a federal system provided to the SAS by an approved ESC. [Ref-2, 96.45b]

d. Within 300 seconds after the ESC communicates to the SAS that it has detected a signal from a federal system in a given area, or the SAS is otherwise notified of current federal incumbent use of the band, the SAS must [shall] either confirm suspension of the CBSD's operation or its relocation to another unoccupied frequency, if available. If the President of the United States (or another designated Federal Government entity) issues instructions to discontinue use of CBSDs pursuant to 47 U.S.C. § 606, SAS Administrators must instruct CBSDs to cease operations as soon as technically possible (but no more than 300 seconds).
e. The SAS shall adapt to changes in the Exclusion Zones or Protection Zones to protect current and future federal Incumbent Users.
f. The SAS shall adapt to temporary changes in Exclusion Zones and Protection Zones to protect temporary operations by federal Incumbent Users as may be modified by the FCC. Federal Incumbent Users will [shall] coordinate with the Commission prior to the beginning of any non-emergency operation requiring additional protection. Such modifications will [shall] be communicated to the SAS along with the expiration date and time of any modification.

R1-IPM-02: Protection of Federal Incumbent Users from CBSDs operating in the 3650-3700 band [Ref-2, 96.15 & Ref-7 para 64]

a. CBSDs and End User Devices must [shall] not cause harmful interference to and must accept interference from federal Incumbent Users.
b. Exclusion Zones shall be maintained for an 80 km radius around the federal radiolocation sites listed in 47 CFR 90.1331 [Ref-4] and 47 CFR 2.106 footnote US 109 [Ref-4]. These Exclusion Zones shall be maintained and enforced until one or more ESCs are approved and used by at least one SAS, in accordance with section 96.67. Thereafter, Exclusion Zones shall be converted to Protection Zones.
c. CBSDs may only be authorized within these Protection Zones consistent with information on the presence of a signal from a federal system provided to the SAS by an approved ESC, in accordance with section 96.67.

d. Within 300 seconds after the ESC communicates to the SAS that it has detected a signal from a federal system in a given area, or the SAS is otherwise notified of current federal incumbent use of the band, the SAS must [shall] either confirm suspension of the CBSD's operation or its relocation to another unoccupied frequency, if available. If the President of the United States (or another designated Federal Government entity) issues instructions to discontinue use of CBSDs pursuant to 47 U.S.C. § 606, SAS Administrators must instruct CBSDs to cease operations as soon as technically possible (but no more than 300 seconds).

R2-IPM-01: Impacts from CBSD and EUD transmissions shall be managed to achieve an aggregate interference level at 3550-3700 MHz for federal incumbent radars not to exceed an I/N of -6 dB at the incumbent radar system receiver if its position is known, or within the possible operating area of the radar system if its position is not known [NTIA Report 15-517 section 4.3]. In the absence of other information, a nominal noise figure of 3 dB for the incumbent radar receiver may be assumed.

Note: A nominal noise figure of 3 dB was used in the derivation of the R2-ESC-02.

R2-IPM-02: SASs shall manage CBSD transmissions for all co-channel CBSDs within 40 km of a particular point in a Grandfathered Wireless Protection Zone such that aggregate interference protection at that point is equal to or better than the Area Protection Reference Standard (R2-SGN-12) using:

a. a protection level of -80 dBm/10 MHz for a reference isotropic antenna 1.5 m in elevation,
b. a protection Monte Carlo percentile of 50% (median),
c. a protection point minimum fraction of 95%.

R2-IPM-03: SASs shall manage CBSD transmissions for all considered co-channel CBSDs (per R2-SGN-24(a)) to an activated co-channel offshore Dynamic Protection Area (DPA) such that aggregate interference protection level at the point within the DPA is equal to or better than the Area Protection Reference Standard (R2-SGN-12) using:

a. the protection level and reference antenna described in R2-IPM-04,
b. a protection Monte Carlo percentile of 95% with a minimum of 2000 trials, and
c. CBSD antenna gain modeled per R2-SGN-20

R2-IPM-04: For co-channel offshore DPAs, unless otherwise specified in the DPA database [Ref-14], the protection level applied at DPA protection points shall be -144 dBm/10 MHz, and the reference antenna shall be 50 m above sea level in elevation with a reference gain of 0 dBi relative to the protection level within the beamwidth, and a beamwidth of 3 degrees and side-lobe gain of -25 dBi outside the beamwidth, using 1.5 degree analysis increments beginning with the main beam boresight at true north.

For inland co-channel DPAs, unless otherwise specified in the DPA database [Ref-14], the protection level applied at DPA protection points shall be -144 dBm/10 MHz, and the reference antenna shall be 10 m above ground level in elevation with a reference gain of 0 dBi relative to the protection level within the beamwidth, and a beamwidth of 3 degrees and side-lobe gain of -25 dBi outside the beamwidth, using 1.5 degree analysis increments beginning with the main beam boresight at true north.

Unless otherwise noted by NTIA, SASs shall apply exclusion zones defined in [Ref-18] for Ground-Based 1 (GB1) and Ground-Based 3 (GB3) inland out-of-band radars (operating below 3500 MHz) as listed in [Ref-17, Appendix C] for all CBSDs.

R2-IPM-05: SASs shall manage CBSD transmissions within a neighborhood of a particular point in a co-channel or out-of-band inland DPA such that aggregate interference protection at that point is equal to or better than the Area Protection Reference Standard (R2-SGN-12) using:

a. protection level and reference antenna as described in R2-IPM-04,
b. a protection Monte Carlo percentile of 95% with a minimum of 2000 trials, and
c. CBSD antenna gain modeled per R2-SGN-20.

4.3 SAS Interference Management and Exclusion Zones (IMZ)

R0-IMZ-01: Citizens Broadband Radio Service operation in the 3550-3700 MHz band is [shall be] subject to current and future international agreements with Mexico and Canada. The terms of these agreements shall be implemented by the SAS. [Ref-2, 96.19]

4.4 SAS Administrators (SAD)

R0-SAD-01: SAS Administrators are [shall be] designated by the FCC to provide nationwide service.

Note: The Commission may, at its discretion, permit the functions of a SAS, such as a data repository, registration, and query services, to be divided among multiple entities; however, it [the FCC] shall designate one or more specific entities to be a SAS Administrator responsible for coordinating the overall functioning of a SAS and providing services to operators in the Citizens Broadband Radio Service. [Ref-2, 96.63]

R0-SAD-02: Each SAS Administrator designated by the Commission must [shall]: [Ref-2, 96.63]

a. Maintain a regularly updated database that contains the information described in section 96.55 [2].

b. Establish a process for acquiring and storing in the database necessary and appropriate information from the Commission's databases, including PAL assignments, and synchronizing the database with the current Commission databases at least once a day to include newly licensed facilities or any changes to licensed facilities.
c. Establish and follow protocols and procedures to ensure compliance with the rules set forth in this part, including the SAS functions set forth in section 96.53 [2], et seq.
d. Establish and follow protocols and procedures sufficient to ensure that all communications and interactions between the SAS, ESC, and CBSDs are accurate and secure and that unauthorized parties cannot access or alter the SAS or the information transmitted from the SAS to CBSDs.
e. Provide service for a five-year term. This term may be renewed at the Commission's discretion.
f. Respond in a timely manner to verify, correct or remove, as appropriate, data in the event that the Commission or a party brings a claim of inaccuracies in the SAS to its attention. This requirement applies only to information that the Commission requires to be stored in the SAS.
g. Securely transfer the information in the SAS, along with the IP addresses and URLs used to access the system, and a list of registered CBSDs, to another approved entity in the event it does not continue as the SAS Administrator at the end of its term. It may charge a reasonable price for such conveyance.
h. Cooperate to develop a standardized process for coordinating operations with other SASs, avoiding any conflicting assignments, maximizing shared use of available frequencies, ensuring continuity of service to all registered CBSDs, and providing the data collected pursuant to section 96.55 [2].
i. Coordinate with other SAS Administrators including, to the extent possible, sharing information, facilitating non-interfering use by CBSDs connected to other SASs, maximizing available General Authorized Access frequencies by assigning PALs to similar channels in the same geographic regions, and other functions necessary to ensure that available spectrum is used efficiently consistent with this part.
j. Provide a means to make non-federal non-proprietary information available to the public in a reasonably accessible fashion in conformity with these rules.
k. Ensure that the SAS shall be available at all times to immediately respond to requests from authorized Commission personnel for any and all information stored or retained by the SAS.
l. Establish and follow protocols to respond to instructions from the President of the United States, or another designated Federal government entity, issued pursuant to 47 U.S.C. 606.
m. Establish and follow protocols to comply with enforcement instructions from the Commission.

n. Ensure that the SAS operates without any connectivity to any military or other sensitive federal database or system, except as otherwise required
o. Ensure that the SAS does not store, retain, transmit, or disclose operational information on the movement or position of any federal system or any information that reveals other operational information of any federal system that is not required by this part to effectively operate the SAS.

R0-SAD-03: An SAS Administrator may charge Citizens Broadband Radio Service users a reasonable fee for provision of the services [Ref-2, 96.65]

R1-SAD-01: SAS Administrators to [shall] implement protocols to respond to directions from the President of the United States or another designated federal entity to manually discontinue operations of its associated CBSDs in a given area pursuant to 47 U.S.C. § 606. SAS Administrators must [shall] also implement protocols to manually discontinue operations of their associated CBSDs in response to enforcement actions taken by the Commission. [Ref-1, para 268]

R1-SAD-02: SAS Administrators must [shall] develop policies and procedures to ensure CBRS users accept and acknowledge that they may receive potentially harmful interference from federal radar systems as a condition of their authorization. [Ref-1, para 274]

R1-SAD-03: SAS Administrator Reporting

a. A SAS Administrator shall provide a capability for receiving reports of exceptional circumstances requiring the attention of the Administrator. A SAS Administrator shall provide a capability for receiving reports from various entities of exceptional circumstances requiring the attention of the Administrator from the following entities:
    i The Federal Government
    ii Operators of incumbent Fixed-Satellite Earth Stations
    iii Operators of incumbent Wireless Broadband Service stations operating in the 3650-3700 MHz band
    iv Operators of networks protected by Priority Access licenses
    v Operators of network equipment licensed by GAA rules
    vi Other SAS Administrators
    vii ESC Operators
b. Such reports shall support communication to the SAS Administrator of the following exceptional circumstances:
    i The report of erroneous data in the SAS database.
    ii The report of harmful interference experienced by an incumbent station or Priority Access licensee which is prohibited by Part 96 rules.

iii The report of an alternative interference protection relationship between an incumbent user and CBSDs operating under Part 96 (e.g. an FSS user, see 96.17(e)).

iv The report of an alternative interference protection relationship between a network operator protected by a Priority Access license and other CBSDs operating under Part 96 (see 96.41(d)(1)). Details FFS.

v The report by the FCC of an enforcement action, including any action taken regarding a particular CBSD or group of CBSDs or regarding a particular CBRS user or group of users.

vi Information on waivers the FCC has granted to provide an exception to Part 96 rules for CBSDs or other CBRS entities.

vii Information on waivers the FCC has granted to non-CBRS entities which impact CBRS operations.

viii The request by an FSS earth station licensee pursuant to 47 CFR 96.17(f) for additional SAS protection of a licensed site.

c. When in receipt of such a report of exceptional circumstances, a SAS Administrator shall provide the full details of such a report to all other SAS Administrators.

    i Reports originated by the Federal Government shall always be provided to other SAS Administrators without delay.

    ii Reports of alternative interference protection relationships between incumbents and CBSDs or between Priority Access and General Authorized Access users shall always be provided to other SAS Administrators without delay.

    iii Reports leading to corrections in the SAS database shall be communicated to other SAS Administrators without delay insofar as the correction will impact previously-communicated information the SAS Administrator has corrected as a result of the report.

    iv Reports of harmful interference may be communicated to other SAS Administrators in the process of responding to such a report.

d. The tools provided by a SAS Administrator for the reporting of harmful interference should provide sufficient information for the reporter of such harmful interference to follow standardized reporting procedures such as OpenSSRF formats and the JSIR process. Such tools shall also inform the user that reports may be acted upon by the FCC.

e. A SAS Administrator shall respond in a timely fashion corresponding to the nature of the report of exceptional circumstances, including those of harmful interference.

Note: FCC actions regarding an ad hoc exclusion zone or an emergency reclamation of spectrum are addressed in requirement R2-ISC-01.

[Ref-2, 96.17(f), 96.35(e), 96.41(d)(1), 96.41(e)(4), 96.63(f) and Ref-1 para. 37, 214, 399]

4.5 SAS Requirements for PAL Holders (SPU)

R0-SPU-01: Each PAL [shall] consist[s] of a single License Area. [Ref-2, 96.25]

R0-SPU-02: DEPRECATED

R0-SPU-03: Priority Access Licensees may aggregate up to four PAL channels in any License Area at any given time. The criteria to attribute partial ownership and other interests for the purpose of applying the aggregation limits are defined in 47 CFR 20.22 (b). [Ref-2, 96.31]

R2-SPU-01: The following channels are defined for PAL assignments in the 3550-3650 MHz band:

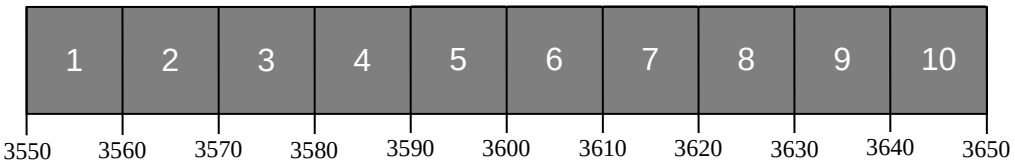

Figure 3: Channels defined for PAL assignments in the 3550-3650 MHz band

[Ref-1 paragraph 59]

Informative Note: Future studies will examine the relative utility of each channel for single-carrier and aggregate emissions, in the context of out-of-band emissions limits, fixed-satellite and Part 90 incumbent protections, and other considerations.

R2-SPU-02: PAL Registration ID (PAL-ID): Each PAL shall have a system-wide unique ID number assigned (the PAL-ID) per license area and per logical licensed frequency channel.

R2-SPU-03: PAL Database: SAS Administrators shall cooperate to define and maintain a database of registered PAL-IDs and associated information that is available to all SASs.

The PAL database shall contain at least the following information:

a. The PAL-ID
b. The PAL licensee identity from the auction results.

c. The User Registration ID (UR-ID) that corresponds to the above PAL licensee identity.
d. The PAL initiation date
e. The PAL termination date
f. The FCC License Area identifier (e.g., the license area identification used by the FCC in the license auction).
g. The FCC frequency channel identity (identification numbers) corresponding to a 10 MHz frequency channel; this identifier is independent of the actual frequency allocation.
h. The vertex points that define the PAL license area boundaries.
i. License validity status information on a PAL.
j. Any channel assignment information associated with this PAL

R2-SPU-04: PPA

a. A PAL Holder shall register a PAL Protection Area (PPA) with the Holder's selected SAS, which shall be the Managing SAS for the PAL holder.
b. The PAL Holder shall provide the following information to the Managing SAS:
    i Proof of ownership (or valid lease) of a valid PAL as indicated by the PAL-ID.
    ii A Cluster List of registered CBSDs whose protection area is within the PPA.
c. The Managing SAS shall further register the following information for the PPA:
    i The user identifier (User Registration ID (UR_ID)).
    ii The PAL-ID or PAL-IDs upon which the PPA is based.
    iii The list of vertex points that define the PPA boundary.
d. For each established PPA (and PPA-ID), the Managing SAS shall maintain and share the PPA boundary with any and all other SASs.
e. The Managing SAS shall assign a system-wide unique PPA-ID number for each established PPA.
f. The PAL Holder shall coordinate with the Managing SAS to ensure that the Cluster List results in a single geographically contiguous PPA.

R2-SPU-05: Each SAS shall exchange the information related to each PPA to all SAS Administrators. The exchanged PPA information shall include the following:

a. The PPA-ID
b. The associated PAL-ID(s)
c. The PPA initiation date
d. The PPA termination date
e. The vertex points that define the PPA boundaries

R2-SPU-06: PPA Conflict Resolution: A PPA that conflicts, overlaps or coincides with an existing PPA record associated with the same PAL shall cause the Managing SAS Administrator to reject the new or modified PPA.

For PPAs based upon leased PAL rights, it shall be the responsibility of the licensee to coordinate with the lessee(s) and for such PPA to be made with the advice and consent of both the owner and the lessee(s).

R2-SPU-07: PAL Owner Validation: The Managing SAS shall have the capability to validate the rights to a PAL when a PAL Holder claims a PPA. The Managing SAS shall have the capability to validate PAL leasing and that a lessee is a valid lessee as per FCC rules and requirements if the PPA is made under the auspices of a lease on behalf of a lessee.

a. The Managing SAS shall, via the use of the PAL-ID database, be able to verify:
   i The identity and validity of the PAL licensee.
   ii The identity and validity of any subsequent PAL Holder
   iii The identity, the lessee pre-registration information and valid eligibility of the PAL Lessee (if any).
   iv The geographic validity of the PPA within the appropriate parent PAL(s).
   v The identity and validity of the parent PAL(s) based upon the PAL-ID(s).
b. Any SAS shall be able to access such records from the PAL database.

R2-SPU-08: PPA Tied Back to PAL: The PPA-ID shall be tied back to the parent PAL-ID(s) such that if any parent PAL expires or is revoked then the derived PPA(s) shall also expire. If a 'child' PPA has more than one 'parent' PAL, then if any (one) parent PAL expires, then the whole PPA (the whole Cluster List that spans more than one PAL) shall also expire.

R2-SPU-09: PPA Cluster List Use: The Managing SAS shall be able to determine if a CBSD is entitled to the use of a PAL channel by determining if the CBSD is on the PPA's Cluster List.

R1-SPU-01: The Managing SAS shall allow the PPA Boundary to be defined by a contour (e.g. the vertex points of a polygon) supplied by the PAL Holder. For each PPA Boundary claimed by the claimant where the claimant provides the defining PPA vertex points, the Managing SAS shall verify that the claimed PPA Boundary is within the 'Largest Allowable PPA Protection' contour (See R1-SPU-02).

R1-SPU-02: The Managing SAS shall allow the PPA Boundary to be defined by a contour determined by the Managing SAS. The Managing SAS shall determine the size and shape of the Largest Allowable PPA Protection contour as per the FCC

mandate. The SAS shall use: 1) the locations of the CBSDs on the Cluster List, 2) the CBSDs' maximum allowable EIRPs, 3) the appropriate RF propagation model, 4) the CBSDs' antenna height, 5) antenna gain and, if available, antenna radiation patterns, 6) the -96 dBm/10 MHz receiver criteria assuming a 0 dBi measurement antenna at a height of 1.5 meters above the ground level to perform an RF model of the Largest Allowable Protection contour.

R1-SPU-03: DEPRECATED <moved to R2-SPU-10>

R1-SPU-04: PAL Steady State Channel Assignment: A SAS shall assign the "steady-state" channels designated per R2-SPU-10 to all CBSDs included in the user's PPA Cluster List as defined by the PPA and the governing PAL held by that licensee.

R1-SPU-05: Temporary PAL Channel Reassignment: According to 96.25(b)(1)(i) and 96.25(b)(2)(i), and to the extent necessary to protect Incumbent Users or if necessary to perform its required functions under Part 96 subpart F, SAS may temporarily reassign individual PALs (and their associated PPAs and CBSDs) held by the same licensee to channels different than the "steady-state" channels assigned per R2-SPU-10.

R2-SPU-10: PAL Channel Assignment Planning: At the conclusion of the auction and prior to PAL use commencing, and at the times requested by the Commission, SAS Administrators shall cooperate to apply appropriate protocols to allocate and to assign "steady-state" frequencies to PAL Licensees to meet FCC requirements 96.11 (a)(3), 96.13, 96.31, 96.25(b)(1)(i), and 96.25(b)(2)(i), as well as meeting incumbent protection requirements. The SAS Administrators may consider additional constraints and objectives provided by PAL Licensees. The proposed allocation methodology shall be presented to the PAL Licensees for review and comment.

4.5.1 SAS Requirements for Temporary PAL Channel Reassignment (per R1-SPU-05)

Note: this section was added to this document after SAS Initial Certification.

R1-SPU-06: SAS Administrators shall cooperate to apply appropriate protocols for identifying temporary PAL channel reassignments to avoid conflicts among SASs.

R1-SPU-07: When individual PALs have to be reassigned by SAS, they shall have higher priority over GAA users in the lower 100 MHz of the band.

R2-SPU-11: The SAS shall temporarily reassign impacted PAL channels to unoccupied channels where possible in the lower 100 MHz, such that:

a. Impact to PAL contiguity shall be minimized, and

b. Impact to PAL users shall be minimized, and

c. Impact to GAA users shall be minimized.

R2-SPU-12: PPA Enforcement on Temporary PAL Channel Reassignment: If and when a managing SAS indicates that a PAL has been reassigned to a temporary PAL channel, all SASs shall protect the PAL (and its associated PPAs and CBSDs) in the temporary PAL channel.

4.6 SAS Requirements for GAA Users (SGU)

R0-SGU-01: General Authorized Access Users shall be permitted to use frequencies assigned to PALs when such frequencies are not in use, as determined by the SAS, consistent with R0-SGN-04:. Frequencies that are available for General Authorized Access Use shall be made available on a shared basis. [Ref-2, 96.35]

a. General Authorized Access Users shall have no expectation of interference protection from other General Authorized Access Users operating in accordance with this part.
b. General Authorized Access Users must [shall] not cause harmful interference to and must accept interference from Priority Access Licensees and Incumbent Users in accordance with this part. [Reference R0-SGN-06:(h) and R0-SGN-06:(i)]
c. General Authorized Access Users operating Category B CBSDs must [shall] make every effort to cooperate in the selection and use of available frequencies provided by an SAS to minimize the potential for interference and make the most effective use of the authorized facilities. Such users shall coordinate with an SAS before seeking station authorization, and make every effort to ensure that their CBSDs operate at a location, and with technical parameters, that will minimize the potential to cause and receive interference among CBSDs.
d. Operators of CBSDs suffering from or causing harmful interference are [shall be] expected to cooperate and resolve interference problems through technological solutions or by other mutually satisfactory arrangements.

R0-SGU-02: DEPRECATED

R0-SGU-03: CBSDs used for General Authorized Access must [shall] register with the SAS and comply with its instructions. [Ref-2, 96.33]

R1-SGU-01: SASs shall facilitate GAA coexistence among all GAA CBSDs, including those registered as Category A and Category B. [Ref-1 para 321, Ref-7 para 197, 96.53(k), 96.59(a)]

R2-SGU-01: Coexistence Groups

a. The SAS shall provide a way for a CBSD to identify itself to the SAS as belonging to one or more Coexistence Group(s), and to voluntarily designate that the Coexistence Group(s) and/or other applicable coexistence-related information is to be shared with other CBSDs and CBSD Users.
b. SASs shall share this coexistence-related information (including any designated Coexistence Group(s)) with other SASs, subject to all Operational Security restrictions [Ref-8] and in compliance with information sharing agreements the SAS has with other SAS administrators for disclosure of such information.

R2-SGU-02: Subject to all Operational Security restrictions [Ref-8], terms of service agreements the SAS has with CBSD operators, and in compliance with information sharing agreements with other SAS administrators related to the disclosure of such information, the SAS shall provide to a CBSD any coexistence information that is voluntarily provided for sharing with CBSDs by other potentially interfering GAA CBSDs. This information is provided in order to support CBSD to CBSD coordination in the selection of available GAA frequencies, and in order to minimize the potential for interference with other users of the band. This information includes, but is not limited to:

a. Coexistence Group(s), if any, associated with the CBSDs for the purposes of facilitating cooperation with other GAA CBSDs that could potentially interfere with the GAA CBSD; and
b. Information related to radio operating parameters for each potentially available GAA channel at the CBSD's location, such as the estimated maximum EIRP.

R2-SGU-03: SAS Administrators may provide information for CBSD operators to perform coordination, including location, radio technology, and radio operating parameter selection before or after they seek authorization [96.35(e)], subject to all Operational Security restrictions [Ref-8], terms of service agreements the SAS has with CBSD operators, and in compliance with information sharing agreements with other SAS administrators related to the disclosure of such information. Coexistence information can include (but is not limited to) CBSD registration data that could be helpful in enabling location and technical parameter selection during network planning.

Requirements on the SAS administrators and/or CBSD operators for the determination of potential interference, for the resolution of conflicting uses of the band, and for the coordination of coexistence operations with other SAS administrators are FFS.

4.7 Inter-SAS Communication (ISC)

R1-ISC-01: Moved to R2-ISC-06

R1-ISC-02: Moved to R2-ISC-07

R1-ISC-03: Moved to R2-ISC-08

R2-ISC-01: When a SAS Administrator receives instructions from the President of the United States or another designated Federal government entity issued pursuant to 47 U.S.C. 606, or instructions from the FCC pursuant to FCC enforcement actions, that SAS Administrator shall, without delay, inform all other designated SAS Administrators of those instructions.

[Ref-2, 96.63(l & m) & Para 268; Title 47 USC 606]

R2-ISC-02: When a SAS Administrator receives communication that the Commission has temporarily extended or modified an Exclusion Zone or Protection Zone to protect temporary operations by federal incumbent users, that SAS Administrator shall, without delay, inform all other designated SAS Administrators of such communication. This information shall include the nature of the extension or modification as well as any accompanying expiration date and time specified by the Commission. [Ref-2, 96.15(a)(6)]

R2-ISC-03: Sharing of ESC incumbent detection information between SASs:

a. Sharing of ESC incumbent detection information between SASs is as defined in [Ref-8].
b. SASs shall exchange on a timely basis all CBSD data required for each SAS to correctly participate in aggregate federal incumbent radar protection relying on an ESC without reference to the behavior of any other SAS.
c. In addition, SAS administrators shall perform any necessary pre-arrangement of protection behavior needed to ensure the protection of federal incumbent radar activity.

R2-ISC-04: SAS Essential Data: The following Data records shall be classified as SAS-Essential Data:

a. ESC sensor location, height, antenna characteristics, and protection level records
b. CBSD physical installation parameters (e.g., location, indoor/outdoor status, antenna parameters as required by Part 96)
c. CBSDs are identified by a system-wide unique designator assigned by the Managing SAS
d. CBSD coexistence parameters (e.g. interference coordination group memberships, air interface standards)[19]

[19] Coexistence information is associated with the CBSD and setup at registration

e. Information on all active CBSD grants: CBSD grant information (frequency ranges), power, grant type, grant expiration time, requested authorization status (Priority Access or General Authorized Access)
f. PAL Protection Area (PPA) records (note: PPA Records = PPA Database defined in R2-SPU-05)
g. SAS-SAS Coordination Event records (note: SAS Coordination Records are defined as the records from: R1-SAD-03 items p, q, r, s; R2-ISC-01 and R2-ISC-02)

R2-ISC-05: Exchanging SAS Essential Data between SASs: Incremental SAS-Essential Data should be exchanged in near-real-time. Exchange of SAS-Essential Data between any SASs shall use mechanisms which reliably enable the SASs to perform their functions.

If requested by a peer SAS, exchange mechanisms of SAS-Essential Data should provide for an expected reliable latency of incremental SAS-Essential Data provided to the requesting SAS in less than 10 seconds.

R2-ISC-06: Disclosure of CBSD Registration Data: SAS administrators shall not publicly disclose CBSD registration data shared with them by other SASs.

R2-ISC-07: SAS Essential Data: SAS-Essential Data are defined as data shared between any two SASs which are required to fulfill all SAS functions required by 47 C.F.R Part 96.

a. SAS-Essential Data should be subject to governing peering agreements among SAS Administrators, supported by the WINNF to provide privacy and data protection certainty to the users of SAS (such as CBSD Users, etc.).
b. SAS-Essential Data shall be exchanged symmetrically between all pairs of SASs.
c. SAS-Essential Data shall be exchanged on demand by SASs. SASs shall also share such data proactively.
d. Use of SAS-Essential Data by a SAS Administrator is limited to satisfying obligations under 47 C.F.R Part 96. SAS administrator should enter into agreements to document this requirement, as well as the requirement to maintain all such data confidentiality, except Public Registration Data.

R2-ISC-08: SAS Public Data Set: The following Data records shall be classified as Public Data:

a. SAS Administrator FCC registration records, including identity, contact information, SAS certification date and term, and mode of operation (Phase I, without ESCs deployed, or Phase II, with ESCs deployed)
b. Public Registration Data
c. PAL Area and Service Area records (47 C.F.R 96.3), resulting from FCC auctions
d. Federal Incumbent Exclusion Zone records

e. Non-Federal Incumbent records

R2-ISC-09: Any SAS receiving information from a peer SAS through the SAS-SAS interface shall not be held responsible for the validity of information received from the peer SAS.

5 Priority Access Licensee Requirements (PAL)

R0-PAL-01: Priority access assignments of authorization, transfers of control, and leasing arrangements [Ref-2, 96.32]

a. Priority Access Licensees may transfer or assign their licenses and enter into de facto leasing arrangements in accordance with 47 CFR 1.
b. Priority Access Licensees may partition or disaggregate their licenses and partially assign or transfer their licenses pursuant to §1.950 and may enter into de facto transfer leasing arrangements for a portion of their licensed spectrum pursuant to part 1 of this chapter.
c. Priority Access Licensees may enter into spectrum manager leasing arrangements with approved entities as prescribed in 47 CFR1.9046. Priority Access Licensees may only enter into leasing arrangements for areas that are within their Service Area and outside of their PAL Protection Areas.

R0-PAL-02: A SAS Administrator may accept and support leasing notifications, in which case that SAS Administrator shall: [Ref-2, 96.66]

a. Verify that the lessee is on the certification list, as established in 47 CFR 1.9046.
b. Establish a process for acquiring and storing the lease notification information and synchronizing this information, including information about the expiration, extension, or termination of leasing arrangements, with the Commission databases at least once a day;
c. Verify that the lease will not result in the lessee holding more than the 40 megahertz of Priority Access spectrum in a given License Area;
d. Verify that the area to be leased is within the Priority Access Licenses's Service Area and outside of the Priority Access Licensee's PAL Protection Area;
e. Provide confirmation to licensee and lessee whether the notification has been received and verified;
f. During the period of the lease and within the geographic area of a lease, SASs shall treat any CBSD operated by the lessee the same as [a] similarly situated CBSD[s] operated by the lessor for frequency assignment and interference mitigation purposes.

R2-PAL-01: SASs shall manage CBSD transmissions for all co-channel CBSDs within 40 km of a particular point in a PAL Protection Area such that aggregate interference protection at that point within the defining contours of that area is

equal to or better than the Area Protection Reference Standard (R2-SGN-12) using:

a. a protection level of -80 dBm/10 MHz (and e.g. -83 dBm/5 MHz for a 5 MHz partially overlapping emission) for a reference isotropic antenna 1.5 m in elevation,
b. a protection Monte Carlo percentile of 50% (median),
c. a protection point minimum fraction of 95%.

R2-PAL-02: PAL Protection Contour Methodology: PAL Protection Contour shall be determined by a SAS in a manner that yields substantially similar results as generated by the following methodology:

a. For a particular CBSD in a PPA cluster list, SAS shall define 360 radials where each radial corresponds to the line extending out to 40 km from the CBSD location with heading defined relative to due north by angles, $\theta = 0, 1, \ldots, 359$ degrees.
b. SAS shall estimate the received power of the signal from the CBSD in accordance with R2-SGN-04 and R2-SGN-20 at regularly spaced points along each radial where the regular spacing "M" of the points shall be 200 meters for Initial Certification.
c. SAS shall determine N(i) for all radials ($0 \leq i \leq 359$), which is the number of points along the i-th radial with median signal strength greater than or equal to -96 dBm/10 MHz.
d. SAS shall generate a first contour, C(θ), which is comprised of 360 vertex points where the i-th vertex point is the point at distance M x N(i) along the i-th radial.
e. The PAL Coverage Contour S(θ) shall be generated by smoothing C(θ) using a Hamming filter of size 15.
f. SAS shall compute contours, S(θ), for each CBSD in the PPA cluster list. Subsequently, SAS shall determine the union of the coverage contours for all CBSDs within the PPA cluster list. This union is denoted the "PAL Coverage Contour"

R2-PAL-03: DEPRECATED

R2-PAL-04: PAL CBSD coverage boundaries

a. A set of boundaries around the PAL CBSD coverage union determined in R2-PAL-02 shall then be determined by SAS using a polygon union function operating on the individual boundaries[20]. Any interior holes with area less than 0.5 km^2 shall be removed.
b. SAS shall determine and share with other SASs the polygon representing the outer extent of the boundary as well as the polygon representing any hole.
c. In some circumstances, this method will produce a single boundary. In such cases, this boundary shall be used as the PPA boundary.

[20] Example implementation: Python Shapely library "cascaded_union" function.

d. Multiple PPAs may be produced in scenarios where the per-CBSD individual boundaries do not overlap.

R2-PAL-05: The PPA created by a SAS shall be close to the PPA created by the reference methodology described in R2-PAL-02 and R2-PAL-04 such that the area of the difference shall be no more than 10% of the area of the PPA created by the reference methodology.

6 CBSD and EUD Requirements (DEV)

R0-DEV-01: The Citizens Broadband Radio Service is [shall be] authorized in the 3550-3700 MHz frequency band. General Authorized Access Users may operate in the 3550-3700 MHz frequency band. Priority Access License Holders may operate in the 3550-3650 MHz frequency band. Grandfathered Wireless Broadband Licensees may continue to use the 3650-3700 MHz band in accordance Ref-2. [Ref-2, 96.11]

R0-DEV-02: All CBSDs must [shall] be able to determine their geographic coordinates (referenced to the North American Datum of 1983 (NAD83)) to an accuracy of ±50 meters horizontal and ±3 meters of elevation. Such geographic coordinates shall be reported to an SAS at the time of first activation from a power-off condition. [Ref-2, 96.39]

a. For professionally installed CBSDs, geographic coordinates to the same accuracy specified above may be determined and reported to the SAS as part of the installation and registration process. Geographic coordinates must [shall] be determined and reported each time the CBSD is moved to a new location.
b. Non-professionally installed CBSD must [shall] check its location and report to the SAS any location changes exceeding 50 meters horizontal and ±3 meters elevation from its last reported location within 60 seconds of such location change.

R0-DEV-03: A CBSD must [shall] register with and be authorized by an SAS prior to its initial service transmission. The CBSD must [shall] provide the SAS upon its registration with its geographic location, antenna height above ground level (in meters), CBSD class (Category A/Category B), requested authorization status[21] (Priority Access or General Authorized Access), FCC identification number, call sign, user contact information, air interface technology, unique manufacturer's serial number, sensing capabilities (if supported), and additional information (see below) [Ref-2, 96.39].

a. CBSD Category-A devices must [shall] also indicate if they are operating indoors or outdoors. [Ref-2, 96.43b]

[21] Note: Part 96 Registration/Authorization process includes portions of the WINN Forum Registration and Spectrum Grant process.

b. CBSD Category-B devices must [shall] also provide: antenna gain, beamwidth, azimuth, downtilt angle, and antenna height above ground level. [Ref-2, 96.45d]
c. If any of the registration information changes, the CBSD shall update the SAS within 60 seconds of such change, except as otherwise set forth in section 96.39 [Ref-2].
d. All information provided by the CBSD to the SAS must [shall] be true, complete, correct, and made in good faith. [Ref-2, 96.39]

R0-DEV-04: CBSD technical operation [Ref-2, 96.39]

a. All CBSDs must [shall] be capable of two-way operation on any authorized frequency assigned by an SAS. Equipment deployed by Grandfathered Wireless Broadband Licensees during their license term will be exempt from this requirement
b. A CBSD must [shall] operate at or below the maximum power level authorized by an SAS, consistent with its FCC equipment authorization, and within geographic areas permitted by an SAS on the channels or frequencies authorized by an SAS.
c. A CBSD must [shall] receive and comply with any incoming commands from its associated SAS about any changes to power limits and frequency assignments. A CBSD must [shall] cease transmission, move to another frequency range, or change its power level within 60 seconds as instructed by an SAS.
d. A CBSD must [shall] report to an SAS regarding received signal strength in its occupied frequencies and adjacent frequencies, received packet error rates or other common standard metrics of interference for itself and associated End User Devices as directed by an SAS [Note: See R2-SGN-01].
e. If directed by the SAS, a CBSD that receives a range of available frequencies or channels from an SAS must [shall] promptly report to the SAS which of the available channels or frequencies it will utilize.
f. CBSDs shall incorporate security measures sufficient to ensure that they are capable of communicating only with SASs operated by approved SAS Administrators, and that communications between CBSDs and SASs, between individual CBSDs, and between CBSDs and End User Devices are secure to prevent corruption or unauthorized interception of data.
g. For purposes of obtaining operational limits and frequency availabilities and their updates, CBSDs shall only contact SASs operated by SAS Administrators approved by the Commission in accordance with subpart F [of Ref. 2].
h. All communications between CBSDs and SASs must [shall] be transmitted using secure methods that protect the systems from corruption or unauthorized modification of the data.
i. Communications between a CBSD and its associated End User Devices for purposes of obtaining operational power, location, and frequency

assignments shall employ secure methods that protect the system from corruption or unauthorized modification of the data.

j. All CBSDs and End User Devices must [shall] contain security features sufficient to protect against modification of software and firmware by unauthorized parties. Applications for certification of CBSDs and End User Devices must [shall] include an operational description of the technologies and measures that are incorporated in the device to comply with the security requirements of this section. In addition, applications for certification of CBSDs and End User Devices must [shall] identify at least one of the SAS databases operated by an approved SAS Administrator that the device will access for channel/frequency availability and affirm that the device will conform to the communications security methods used by such databases.

k. Airborne operations by CBSDs and End User Devices are [shall be] prohibited.

R0-DEV-05: CBSD and End User Devices General Radio Requirements [Ref-2, 96.41]

a. Digital Modulation: Systems operating in the Citizens Broadband Radio Service must [shall] use digital modulation techniques.

b. Power Limits: Unless otherwise specified in this subsection, the maximum EIRP and maximum Power Spectral Density (PSD) of any CBSD and End User Device must [shall] comply with the limits shown in the table below:

Device	Maximum EIRP (dBm/10 megahertz)	Maximum PSD (dBm/MHz)
End User Device	23	n/a
Category A CBSD	30	20
Category B CBSD*	47	37

* Category B CBSDs will only be authorized for use after an ESC is approved and commercially deployed consistent with [Ref-2, 96.15 and 96.67].[22]

c. Power Management: CBSDs and End User Devices shall limit their operating power to the minimum necessary for successful operations.

   i. CBSDs must [shall] support transmit power control capability and the capability to limit their maximum EIRP and the maximum EIRP of associated End User Devices in response to instructions from an SAS.

   ii. End User Devices shall include transmit power control capability and the capability to limit their maximum EIRP in response to instructions from their associated CBSDs.

d. Received Signal Strength Limits:

[22] This rule is the subject of a conditional waiver granted by the FCC's Wireless Telecommunications Bureau and the Office of Engineering and Technology. See "Promoting Investment in the 3550-3700 MHz Band", DA 18-538, docket GN 17-258, released May 22nd, 2018, available at https://docs.fcc.gov/public/attachments/DA-18-538A1.pdf

i. For both Priority Access and GAA users, CBSD transmissions must [shall] be managed such that the aggregate received signal strength, for all locations within the PAL Protection Area of any co-channel PAL, shall not exceed an average (RMS) power level of -80 dBm in any direction when integrated over a 10 megahertz reference bandwidth, with the measurement antenna placed at a height of 1.5 meters above ground level, unless the affected PAL licensees agree to an alternative limit and communicate that to the SAS.

ii. These limits shall not apply for co-channel operations at the boundary between geographically adjacent PALs held by the same Priority Access Licensee.

e. 3.5 GHz Emissions and Interference Limits:

i. General protection levels. Except as otherwise specified below, for channel and frequency assignments made by the SAS to CBSDs, the conducted power of any CBSD emission outside the fundamental emission bandwidth as specified below (whether the emission is inside or outside of the authorized band) shall not exceed -13 dBm/MHz within 0-10 megahertz above the upper SAS-assigned channel edge and within 0-10 megahertz below the lower SAS-assigned channel edge. At all frequencies greater than 10 megahertz above the upper SAS assigned channel edge and less than 10 MHz below the lower SAS assigned channel edge[23], the conducted power of any CBSD emission shall not exceed -25 dBm/MHz. The upper and lower SAS assigned channel edges are the upper and lower limits of any channel assigned to a CBSD by an SAS, or in the case of multiple contiguous channels, the upper and lower limits of the combined contiguous channels.

ii. Additional protection levels. Notwithstanding paragraph (e)(i) of this section, the conducted power of any emissions below 3540 MHz or above 3710 MHz shall not exceed -25 dBm/MHz, and the conducted power of emissions below 3530 MHz or above 3720 MHz shall not exceed -40 dBm/MHz.

iii. Measurement procedure:

Compliance with this provision is [shall be] based on the use of measurement instrumentation employing a resolution bandwidth of 1 megahertz or greater. However, in the 1megahertz bands immediately outside and adjacent to the licensee's authorized frequency channel, a resolution bandwidth of no less than one percent of the fundamental emission bandwidth may be employed. A narrower resolution bandwidth is permitted in all cases to

[23] The text is intended to be read as: At all frequencies greater than 10 megahertz above the upper SAS assigned channel edge and [at frequencies] less than 10 MHz below the lower SAS assigned channel edge, the conducted power of any emission shall not exceed -25 dBm/MHz. [i.e., At all frequencies greater than 10 MHz outside the assigned channel edge, the conducted power of any emission shall not exceed -25 dBm/MHz]

improve measurement accuracy provided the measured power is integrated over the full reference bandwidth (i.e., 1 MHz or 1 percent of emission bandwidth, as specified). The fundamental emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

When measuring unwanted emissions to demonstrate compliance with the limits, the CBSD and End User Device nominal carrier frequency/channel shall be adjusted as close to the licensee's authorized frequency block edges, both upper and lower, as the design permits.

Compliance with emission limits shall be demonstrated using either average (RMS)-detected or peak-detected power measurement techniques.

iv. When an emission outside of the authorized bandwidth causes harmful interference, the Commission may, at its discretion, require greater attenuation than specified in this section.

f. Reception Limits: Priority Access Licensees must [shall] accept adjacent channel and in-band blocking interference (emissions from other authorized Priority Access or GAA CBSDs transmitting between 3550 and 3700 MHz) up to a power spectral density level not to exceed -40 dBm in any direction with greater than 99% probability when integrated over a 10 megahertz reference bandwidth, with the measurement antenna placed at a height of 1.5 meters above ground level, unless the affected Priority Access Licensees agree to an alternative limit and communicates that to the SAS.

Note to paragraph (f): Citizens Broadband Radio Service users should be aware that there are Federal Government radar systems in the band and adjacent bands that could adversely affect their operations.

g. Power Measurement: The peak-to-average power ratio (PAPR) of any CBSD transmitter output power must not exceed 13 dB. PAPR measurements should be made using either an instrument with complementary cumulative distribution function (CCDF) capabilities or another Commission approved procedure. The measurement must be performed using a signal corresponding to the highest PAPR expected during periods of continuous transmission.

R0-DEV-06: Category A CBSDs shall not be deployed or operated outdoors with antennas exceeding 6 meters height above average terrain. CBSDs deployed or operated outdoors with antennas exceeding 6 meters height above average terrain will be classified as, and subject to, the operational requirements of Category B CBSDs. [Ref-2, 96.43a]

R0-DEV-07: Any CBSD operated at higher power than specified for Category A CBSDs in section 96.41 [R0-DEV-05:] will be classified as, and subject to, the operational requirements of a Category B CBSD. [Ref-2 96.43c]

R0-DEV-08: Category B CBSDs must [shall] be professionally installed. [Ref-2, 96.45a]

R0-DEV-09: Category B CBSDs are [shall be] limited to outdoor operations. [Ref-2, 96.45c]

R0-DEV-10: Each transmitter used for operation under this part and each transmitter marketed as set forth in section 2.803 [Ref-4, Chapter I, Subchapter A, Part 2] must [shall] be of a type which has been certificated for use under this part.

Any manufacturer of radio transmitting equipment to be used in these services must [shall] request equipment authorization following the procedures set forth in Subpart J [Ref-4, Chapter I, Subchapter A, Part 2]. [Ref-2, 96.49]

Communication between individual CBSDs must [shall] be secure to prevent corruption or unauthorized interception of data. [Ref-2, 96.61]

R1-DEV-01: A CBSD shall support at least one measurement metric that can be reported to the SAS and the CBSD shall indicate the supported measurement reporting capability in the CBSD registration process [Ref-2, 96.39(d)].

R2-DEV-01: For a CBSD supporting received power reporting before authorization for transmission, it shall, as directed by a SAS, over the entire CBRS band measure the radio frequency energy received over a set of frequency ranges during a measurement interval and report the results to a SAS for each of the multiple frequency ranges in terms of effective received power for each frequency range. The measurement bandwidth for each individual measurement shall not exceed 10 MHz

R2-DEV-02: A set of CBSDs may provide, where necessary due to physical limitations of the CBSD antennas and where appropriate for the type of measurement, common signal level measurement(s) for a group of coherent radiators, each of which is registered as a unique CBSD. A coherent radiator group identifier shall be indicated by each CBSD in the group during registration of the CBSDs.

Informational note: Such a signal level measurement, e.g. received power, is applicable to e.g., Distributed Antenna Systems (DASs), where muting of all but one CBSD to perform individual measurements is not feasible.

R1-DEV-02: When a CBSD Grant expires, the CBSD shall cease transmissions on the channel within 60 seconds, in accordance with 96.39(c)(2).

R0-DEV-11: End User Device Radios must [shall] also comply with CBSD General Radio Requirements stated above in R0-DEV-05. [Ref-2, 96.41].

R0-DEV-12: End User Devices may [shall] not be used as intermediate service links or provide service over frequencies listed in section 96.11 to other End User Devices or CBSDs. [Ref-2, 96.3]

R0-DEV-13: End User Devices may operate only if they can positively receive and decode an authorization signal transmitted by a CBSD, including the frequencies and power limits for their operation. An End User Device must [shall] discontinue operations, change frequencies, or change its operational power level within 10 seconds of receiving instructions from its associated CBSD.

Any device operated at higher power than specified for End User Devices in section 96.41 [R0-DEV-05:] will [shall] be classified as, and subject to, the operational requirements of a CBSD. [Ref-2, 96.47]

R1-DEV-03: If SAS informs the CBSD that it is subject to enforcement action, the CBSD shall cease all transmissions, consider all grants void, and consider itself deregistered.

R2-DEV-03: A CBSD shall not be authorized to use spectrum by multiple SASs simultaneously.

R1-DEV-04: CPE-CBSD Operation [19]

a. Operation of a CPE-CBSD at a power level above EUD levels for the purpose of authorization shall only be used when an out-of-band connection is unavailable and the device needs to operate at signal levels higher than the 23 dBm permitted by rules for End-User Devices.

b. CPE-CBSD operation prior to receipt of authorization from the SAS should be at the lowest power level necessary for communications with the BTS-CBSD, when power levels higher than +23 dBm/10 MHz EIRP are required.

c. Prior to authorization, transmissions at higher EIRP than +23 dBm/10 MHz shall be used only for communicating to the SAS for registration and authorization of the device.

d. The channel on which the CPE-CBSD responds to the BTS-CBSD shall be the one used by, or indicated in, the BTS-CBSD transmission.

e. The rate and extent of transmissions that are part of the Over-the-Air Grant-less handshake above +23 dBm/10MHz EIRP prior to receipt of a Grant is limited in duration and duty cycle to the minimum time necessary to get a grant from the SAS; this time should not exceed 1 second within any 10-second period, 10 seconds within any 300-second period, or 20 seconds within any 3600-second period.

f. The CPE-CBSD shall request a grant with the same frequency-range parameters as, or a subset of, the frequency range parameters used by the BTS-CBSD to which the CPE-CBSD connects.

g. In the event the CPE-CBSD needs to reconnect to a SAS or renew its connection for registration and (re)authorization purposes, the device can use the same or a shortened protocol to reestablish connection. The maximum number of unsuccessful attempts to complete a registration by a CPE-CBSD should also be limited and specified by the manufacturer, after which the device must wait a period of time before recommencing transmissions above +23 dBm/10 MHz EIRP.

7 Domain Proxy Requirements (DPX)

The following requirements related to the Domain Proxy

R1-DPX-01: Domain Proxy to CBSD operational requirements: A Domain Proxy must [shall] ensure that all of the CBSD requirements of 96.39 [Ref-2] are met by CBSDs for which the Domain Proxy is communicating to the SAS.

R1-DPX-02: Domain Proxy to SAS interface security [Ref-2, 96.61]

a. A Domain Proxy must [shall] employ protocols and procedures to ensure that all communications and interactions between the Domain Proxy and SAS are accurate and secure and that unauthorized parties cannot access the Domain Proxy via this communication path or alter the information exchanged between the Domain Proxy and the SAS.
b. Communications between a Domain Proxy and a SAS must [shall] be secure to prevent corruption or unauthorized modification of data
c. A Domain Proxy must [shall] incorporate security measures sufficient to ensure that it is capable of communicating only with SASs operated by approved SAS Administrators.

R1-DPX-03: Domain Proxy to CBSD communications security [Ref-2 96.3, 96.61, 96.39(f), R0-SGN-05:]

a. A Domain Proxy must [shall] employ protocols and procedures to ensure that all communications and interactions between the Domain Proxy and CBSDs are accurate and secure and that unauthorized parties cannot access the Domain Proxy via this communication path or alter the information exchanged between the Domain Proxy and the CBSD.
b. Communications between a Domain Proxy and a CBSD must [shall] be secure to prevent corruption or unauthorized modification of data.

R2-DPX-01: Domain Proxy to CBSD communications security implementation: The protocols and procedures to fulfill and enforce Domain Proxy to CBSD security requirements are out of the scope of this document and are not specified.

R2-DPX-02: Domain Proxy+CBSD Certification and Operation: Some models of CBSDs may only meet CBRS certification requirements as part of a collective entity with a Domain Proxy function and any other network elements necessary for CBRS certification. Such models of CBSDs shall only be operated in

conjunction with the Domain Proxy and other necessary elements with which they were collectively certified. Domain Proxies shall only provide for SAS communications with the models of CBSDs with which they were collectively certified.

Note: the definition of "model of CBSD" is to be determined by Working Group 4 in coordination with the FCC.

8 System Registration Requirements (SRR)

R2-SRR-01: User Registration Information: The User Registration and associated database requires the CBRS User (either a CBSD user or a PAL holder) to provide the following information:

a. User legal identity (corporate or individual),
b. User mailing address (contact address), User's physical address (may or may not correspond to the mailing address),
c. User's legal address (may or may not correspond to the mailing address),
d. User's email contact address,
e. User's phone number (contact)

R2-SRR-02: During the User Registration process, the SAS Administrator shall provide to the user in a secure manner the following:

a. A system wide unique User Registration Identity (UR-ID) to identify the User,
b. A method to authenticate the User when accessing the User account (e.g, password)

R2-SRR-03: During the User Registration process and subsequent account maintenance, the SAS shall record and maintain the following information associated with that Registered User:

a. User Registration date,
b. User Registration expiration or term,
c. User Registration state (valid, expired, pending enforcement, revoked),
d. Registering Agent (FCC, SAS, or other agent),
e. Optional Registration Fee Paid (true or false indication).
f. A list of the CBSDs (CBSD-IDs) registered by the user.
   Note: These CBSDs may be managed within nested lists that correspond to groupings by area, by Domain Proxy, by network, or other useful groupings.
g. A list of PALs owned by that registered user.
h. A list of PPAs registered to that user.
i. A list of PPAs leased by a licensee to lessees.
   Note: these leased PPAs may be managed within nested lists that correspond to useful groupings by area, by tenant, by network, or other useful groupings.

j. A list of CGIs (CBSD Group Identifiers) that the user has created to form groups of CBSDs (exact requirements FFS.)

Note: These requirements assume that reports of claimed PPAs are adequate for SMLA reporting to the FCC. We are awaiting clarification from the FCC on this question. If further SMLA reporting is required by the FCC, WINNF will add requirements to define the SMLAs, the SMLA lists associated with the registered user's account, vertex points that define the area for the SMLA within the PAL, the initiation and termination dates for the lease terms for the SMLA, and the terms of the SMLA.

R1-SRR-01: During User Registration, the User shall provide and the SAS shall record:
a. Acknowledgment of part 96 license rules, [Ref-2, 96.55(e) & para 274]
b. Acknowledgement of federal operations risk [Ref-2, 96.55(e) & para 274]

R2-SRR-04: User Validation: The User credentials (whether an individual or business) shall be validated by the SAS to ensure the user is who they represent, and whether the user has valid contact information & address.

R2-SRR-05: Maintenance of account: The Registered User, using a password or other security feature, shall be able to:
a. Update contact information
b. Update the list of fielded CBSDs by registering or deregistering CBSDs associated with a user account,
c. Update information lists associated with that user account, including the following:
    i Addition, deletion or administration of groupings of CBSDs (administer CGIs).
    ii Update the list of PPAs by means of the associated unique PPA-ID (administer PPAs).
    iii Addition, deletion or administration of groupings of registered PPAs.
    iv For each and every PPA, the PAL Holder shall be able to update the list of CBSDs on that PPA's Cluster List. (Note: adding or deleting a CBSD from the PPA's Cluster List alters the PPA and creates a new PPA and a new PPA-ID.)
    v For each and every PPA, the PAL Holder shall be able to update the list of vertex points (boundary definitions) for that PPA. This shall require SAS approval consistent with the PPA Largest Allowable Claim Contour.
    vi For each and every PPA, the PAL Holder may be able to query the SAS for the SAS calculated Largest Allowable Claim Contour.

vii For each and every PPA, the PAL Holder may be able to query the SAS for the existing registered vertex points defining the PPA boundary.

viii For each and every leased PPA, the PAL Holder shall be able to update the list of lessee claimed PPAs. (These are PPAs on behalf of others where PAL rights have been leased to others.)

ix The PAL Holder may be able to add, delete or administer groupings of Leased PPAs.

x For each and every leased PPA, the PAL Holder shall be able to update the list of CBSDs on that lessee's PPA's Cluster List. (Note that adding or deleting a CBSD from the PPA's Cluster List alters the PPA and creates a new PPA and a new PPA-ID.)

xi For each and every leased PPA, the PAL Holder shall be able to update the list of lessee's vertex points that define the boundary for that PPA.

xii For each and every leased PPA, the PAL Holder shall be able to update the initiation and termination dates for that leased PPA.

xiii For each and every leased PPA, the PAL Holder shall be able to query the SAS for the existing SAS registered initiation and termination dates for that leased PPA.

Note: These requirements assume that reports of claimed PPAs are adequate for SMLA reporting to the FCC. We are awaiting clarification from the FCC on this question. If further SMLA reporting is required by the FCC, WINNF will add requirements to maintain the SMLAs within the Registered user's account, including: the SMLA lists associated with the registered user's account, vertex points that define the area for the SMLA within the PAL, the initiation and termination dates for the lease terms for the SMLA, and the terms of the SMLA.

R2-SRR-06: Association of a CBSD with the CBSD User: The SAS Administrator and the CBSD User shall exchange information that establishes a secure mechanism to identify the CBSD User identity and to establish the relationship between the CBSD and its user. The user information association shall be established per individual CBSD in such a way that CBSD users may revoke the CBSD's identity within the CBRS.

R2-SRR-07: CBSD-ID: The CBSD Registration process shall establish a CBRS-wide unique CBSD-ID.

R2-SRR-08: The CBSD-ID shall have a one-to-one correspondence with the combination FCC ID + CBSD S/N and may be identical to that combination and may include a suffix.

R2-SRR-09: DEPRECATED

R0-SRR-01: Category A CBSD Parameter Set: Prior to the SAS enabling spectrum use by the CBSD, the following Category A CBSD information shall be provided to the SAS. The information shall be uploaded either via the CBSD communicating with the SAS or entered by a Certified Professional Installer via a mechanism provided by the SAS administrator.

a. <DEPRECATED>
b. CBSD Serial number [required by Ref-2 96.39(c)],
c. FCC Identification number [required by Ref-2 96.39(c)],
d. Call Sign [required by Ref-2 96.39(c)],
e. Secure information to associate CBSD with the User,
Informative Note: this will link a valid User with the CBSD [required by Ref-2 96.39(c)]
f. CBSD Air Interface Technology [required by Ref-2 96.39(c)]
g. CBSD Sensing capability [required by Ref-2 96.39(c)],[24]
h. CBSD installation location (Indoor or Outdoor, required for Category A CBSDs) [Ref-2 96.43(b)],
i. Location information: latitude, longitude, and antenna height above ground level (in meters) [Ref-2 96.39(c) & Ref-1 para 219],
j. Certified Professional Installer Registration ID (if information provided to the CBSD was manually entered by a Certified Professional Installer)
k. Optional vendor specific information fields. The SAS shall allow CBSDs to provide optional vendor specific information which can be used by the SAS. Examples include: CBSD Vendor, CBSD model number, CBSD HW version number, CBSD SW and/or FW version number, hardware characteristics, etc.

R0-SRR-02: Category B CBSD Parameter Set: Prior to the SAS enabling spectrum use by the CBSD, the following Category B CBSD information shall be provided to the SAS. The information shall be uploaded either via the CBSD communicating with the SAS or entered by a Certified Professional Installer via a mechanism provided by the SAS administrator.

a. <DEPRECATED>
b. CBSD Serial number [required by Ref-2 96.39(c)],
c. FCC Identification number [required by Ref-2 96.39(c)],
d. Call Sign [required by Ref-2 96.39(c)],
e. Secure information to associate CBSD with the User,
Informative Note: this will link a valid User with the CBSD [required by 96.39(c)]
f. CBSD Air Interface Technology [required by Ref-2 96.39(c)].
g. CBSD Sensing capability [required by Ref-2 96.39(c)],[25]
h. Location information: latitude, longitude, and antenna height above ground level (in meters) [Ref-2, 96.39(c) & Ref-1 para 219],

[24] To be defined by the Sensing & Measurement Task Group
[25] To be defined by the Sensing & Measurement Task Group

i. Certified Professional Installer Registration ID (if information provided to the CBSD was manually entered by a Certified Professional Installer)
j. Antenna gain [Ref-2 96.45(d)],
k. Antenna beamwidth [Ref-2 96.45(d)],
l. Antenna azimuth pointing direction [Ref-2 96.45(d)],
m. Antenna downtilt angle [Ref-2 96.45(d)],
n. Optional vendor specific information fields. The SAS shall allow CBSDs to provide optional vendor specific information which can be used by the SAS. Examples include: CBSD Vendor, CBSD model number, CBSD HW version number, CBSD SW and/or FW version number, hardware characteristics, etc.

R1-SRR-02: During the CBSD Registration process, the SAS shall provide the following information to the registering CBSD:

a. A system wide unique CBSD-ID to identify the CBSD,
b. An indication if the Registration was successful or what additional information is needed to complete the registration process.

This information is required to register the CBSD and to establish a CBSD-ID. This CBSD-ID shall be linked to a specific user through the associated UR-ID, but each user may register multiple CBSDs. A CBSD-ID corresponds to a single CBSD that can request a spectrum assignment from a SAS.

For a managed network with a Domain Proxy, the Domain Proxy may register on behalf of one or more CBSDs under its control. Each CBSD shall require its own CBSD-ID for its own parameters and location.

R2-SRR-10: A SAS shall be able to provide the following information on CBSD registration status to the CBSD User, Professional Installer of the CBSD, other SASs or the FCC:

a. Whether the CBSD registration is revoked, pending or completed
b. Whether the CBSD has been taken out of service (decommissioned)
c. Whether the CBSD has any enforcement actions initiated against it or determined to be in effect

R2-SRR-11: Category A CBSDs unable to automatically determine their location to within the requirements set forth by the FCC Rules shall be installed by a Certified Professional Installer. [Ref-2, 96.39 & Ref-1 para 221]

R2-SRR-12: CBSD Group Identifier (CGI): While registering a CBSD, a CBSD Group identifier may be specified along with other required device information. If present, this identifier designates a CBSD as a member of a particular group (or network) of CBSDs.

Note: It is anticipated that a system-wide naming convention will be established such that CBSD Group Identifiers can be easily selected by entities (such as Users or Domain Proxies). Support for multiple group identifiers is left for further study.

R2-SRR-13: CBSD Group Assignment Indicator: A Group Assignment Indicator may be provided to the SAS with the CBSD Group Identifier and other required device information, where this value shall indicate whether all CBSDs in the group prefer or require a common radio frequency assignment and reassignment when frequency reassignment is necessary.

R2-SRR-14: Domain Proxy Relationship with SAS: The SAS shall ensure that manager information and the credentials for the Domain Proxy are known to, and verified by, the SAS administrator prior to providing service to any CBSD that is subordinate to that Domain Proxy.

R2-SRR-15: Professional Installer information provided to the CBSD: If a professional installer accesses the CBSD to provide additional information for Category A or Category B CBSDs, the professional installer shall provide to the CBSD their associated Certified Professional Installer Registration ID.

R2-SRR-16: DEPRECATED

R2-SRR-17: DEPRECATED

R2-SRR-18: During the Certified Professional Installer Registration process, the SAS accessible centralized database (note: database to be managed by the CPI Accreditation Body. Database details are FFS) shall record and maintain the following information for the Certified Professional Installer:

a. A system wide unique Certified Professional Installer Identity,
b. A method to authenticate the Installer when accessing the Certified Professional Installer account

R2-SRR-19: Domain Proxy Manager Information: The following Domain Proxy manager information shall be known to the SAS administrator:

a. Manager legal identity (corporate or individual)
b. Manager contact (responsible individual in the case where legal identity is a corporate entity)
c. Manager contact mailing address
d. Manager contact email address
e. Manager phone number

R2-SRR-20: DEPRECATED

R2-SRR-21: SAS Spectrum Information: The Managing SAS shall have some mechanism and protocol to inform the CBSD about which frequency range(s) are available.

R2-SRR-22: SAS Spectrum Availability Response: When providing frequency range(s) availability to a CBSD, the Managing SAS shall indicate whether an available frequency range is designated for use by that CBSD as PAL or GAA. CBSDs with PAL rights shall be provided with frequency range availability information for both available PAL frequency ranges and available GAA frequency ranges.

R2-SRR-23: Channel Grant: The Managing SAS shall allow a CBSD within a PPA to request use of GAA channel(s), a PAL channel(s), or both GAA and PAL channels together. When providing a grant to a CBSD, the Managing SAS shall indicate whether the grant is designated for use by that CBSD as PAL or GAA.

R2-SRR-24: CBSD registration update: When CBSD registration information changes, the CBSD shall send a registration update to the SAS with the updated information. The SAS may allow the CBSD registration information to be updated without the CBSD being deregistered or losing spectrum grants.

R2-SRR-25: A shared database shall be created and maintained with a list of supported CBSD Air Interface Technologies.

R2-SRR-26: Category A CBSD antenna gain: In addition to the requirements of R0-SRR-01, the maximum antenna gain of a Category A CBSD shall be provided to the SAS prior to the SAS enabling spectrum use by the CBSD. The information shall be uploaded either via the CBSD communicating with the SAS or entered by a Certified Professional Installer via a mechanism provided by the SAS administrator. Also, the following optional information may be provided to the SAS:

a. Antenna beamwidth
b. Antenna azimuth pointing direction
c. Antenna downtilt angle

R2-SRR-27: For CBSDs registered as Category A, any change in one or more of the following parameters constitutes a new Installation: R0-SRR-01 items b, c, h, i, and R2-SRR-26 maximum antenna gain and items a, b, c.

R2-SRR-28: For CBSDs registered as Category B, any change in one or more of the following parameters constitutes a new Installation: R0-SRR-02 items b, c, h, j, k, l, m.

R2-SRR-29: A Certified Professional Installer (CPI) shall be engaged by the CBSD User, as per R2-CPI-05, to verify the Installation parameters associated with each new Installation, as per R2-SRR-27~~xx~~ and R2-SRR-28~~yy~~, requiring professional Installation.

9 Environmental Sensing Capability Requirements (ESC)

R0-ESC-01: The following are ESC Requirements as identified in [Ref-2, 96.67]

a. An ESC may only operate after receiving approval by the Commission.
b. An ESC must [shall] be managed and maintained by a non-governmental entity.
c. An ESC must [shall] accurately detect the presence of a signal from a federal system in the 3550-3700 MHz band and adjacent frequencies using approved methodologies that ensure that any CBSDs operating pursuant to ESC will [shall] not cause harmful interference to federal Incumbent Users.
d. An ESC must [shall] communicate information about the presence of a signal from a federal Incumbent User system to one or more approved SASs.
e. An ESC must [shall] maintain security of detected and communicated signal information.
f. An ESC must [shall] comply with all Commission rules and guidelines governing the construction, operation, and approval of ESCs.
g. An ESC shall be available at all times to immediately respond to requests from authorized Commission personnel for any information collected or communicated by the ESC.
h. An ESC must [shall] operate without any connectivity to any military or other sensitive federal database or system and does not store, retain, transmit, or disclose operational information on the movement or position of any federal system or any information that reveals other operational information of any federal system that is not required by this part to effectively operate the ESC.

R1-ESC-01: The rules governing the ESC are technologically neutral and ESC developers may utilize different sensing techniques that yield the desired result. These sensors shall be deployed in the vicinity of the Exclusion Zones described in section III(G) [Ref-1] to ensure that all federal radar use in and adjacent to the CBRS Band is accurately detected and reported to a SAS. [Ref-1, para 383]

R2-ESC-01: An ESC shall be capable of detecting those radar waveforms described in [NTIA Technical Memorandum 18-527] that are identified as required for ESC certification by the FCC.

R2-ESC-02: An ESC shall be capable of detecting in-band incumbent radars down to the peak sensitivity level established in [NTIA Technical Memorandum 18-527]. The ESC shall be capable of performing the detection in the presence of broadband Gaussian noise as described in [Technical Memorandum 18-527].

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R2-ESC-03: ESC Performance Monitoring: An ESC operator shall implement one or more methods to monitor ESC performance and detect ESC faults (including intrusion). Such methods shall be justified in the ESC certification process.

R2-ESC-04: DEPRECATED [per R2-ESC-10]

R2-ESC-05: Inland ESC: Operation of inland in-band ground-based incumbent radars may be detected by an ESC in the same manner as it detects shipborne radar operation in coastal areas.

R2-ESC-06: Detection of out-of-band radars: Future periodic reviews with the U.S. Government may establish metrics to detect out-of-band radars operating in the NTIA-defined federal radiolocation sites.

R2-ESC-07: ESC Sensor Protection:

a. An ESC Operator shall request interference protection for all of its ESC sensors. An ESC Operator shall provide to its affiliated SAS(s) the location and height of the protected sensor antenna, as well as the sensor system's antenna gain in all horizontal directions, specified at 1 degree increments referenced to true north. [Reference R2-SGN-08 and R2-SGN-09].
b. The ESC Operator may provide an equivalent antenna pattern in R2-SGN-07(a) that includes the effects of clutter and/or intentional shielding in the immediate area of the ESC sensor antenna.
c. ESC Operators shall not deploy ESC sensor antennas that unreasonably restrict operation within the CBRS band.

R2-ESC-08: Figures of Merit: For a signal exceeding the threshold of detection as established in [NTIA Technical Memorandum 18-527], an ESC shall be capable of detecting, and informing the SAS of, in-band incumbent radar activity within 60 seconds with 99% probability. These time scales and performance characteristics may be adjusted as a consequence of future periodic ESC review. [Ref NTIA Technical Memorandum 18-526.]

R2-ESC-09: ESC Data Retention:

a. ESC detection records shall not be retained within the ESC system for a time past the cessation of incumbent activity longer than the detection time figure of merit plus any additional randomized deactivation period determined by the ESC. The time period may be subject to periodic review and adjustment.
b. ESC operators may propose keeping statistical records for the purposes of behavior analysis and reporting during the approval process, but any such record keeping will be subject to DoD review and may be declined.

R2-ESC-10: Dynamic Protection Area Monitoring by ESCs

a. For any DPA whose geographic area is fully monitored by the ESC, the ESC shall notify the SAS of the presence and absence (as defined in [NTIA Technical Memorandum 18-527]) of a signal from a federal system in that DPA pursuant to [R2-ESC-12]. The geographic area of a DPA is fully monitored by the ESC if the ESC can fulfill [R2-ESC-02] for a signal from a federal system anywhere in the DPA.

b. For any DPA whose geographic area is not fully monitored by the ESC, that ESC shall notify the SAS that the DPA requires protection for the entire frequency range for which that DPA must be protected.
c. For any DPA whose geographic area is fully monitored by the ESC but for which a portion of the frequency range over which the DPA must be protected is not monitored, the ESC shall notify the SAS that the DPA requires protection for the portions of the required frequency range not monitored by the ESC.

R1-ESC-02: DEPRECATED

R2-ESC-11: ESC Periodic Review: ESC requirements are subject to periodic review and modification by FCC, NTIA, and/or the Department of Defense.

R2-ESC-12: Federal Incumbent Detection Event:

a. Notice from the ESC to the SAS resulting from a detection of federal incumbent activity in the band shall be made expeditiously subsequent to the detection of that activity by the ESC. Information relevant to federal activity passed from an ESC to a SAS in an incumbent detection event record shall be limited to the following information:

    i The DPA or DPAs in which activity has been detected.

    ii A frequency range which defines the extent of federal incumbent activity to be protected. This range shall be limited according to any constraints described by [Ref-8]

    iii An activation time for this protection (which may be the current time).

    iv A deactivation time for this protection (optional)

    v A retention time for this record within the SAS, which shall be obeyed by the SAS following notification by the ESC that the incumbent detection event has expired. This retention time shall be limited to the constraints described by [Ref-8]

    vi The ESC shall not notify the SAS of the deactivation of a DPA until after at least two hours past the absence of detected federal incumbent radar activity. This requirement could be modified in the future by FCC/NTIA/DoD.

b. Upon cessation of the incumbent detection event, the information passed from an ESC to a SAS relevant to the federal activity shall be limited to the amount necessary to identify which incumbent detection event record is no longer active.
c. Other information as needed for SAS and ESC operational concerns may also be passed by the ESC to the SAS as necessary and as in conformance with [Ref. 8].

R1-ESC-03: DEPRECATED

R2-ESC-13: An ESC sensor is identified by a system-wide unique designator assigned by its ESC operator, starting with the company name of the ESC operator.

10 Certified Professional Installer Requirements (CPI)

R1-CPI-01: SAS Administrators shall cooperate with the multi-stakeholder community to define a common CPI Accreditation Standard to be applied to Certified Professional Installer Training Programs. This CPI Accreditation Standard shall be used by a designated CPI Accrediting Body to accredit and regularly evaluate accreditation status of Certified Professional Installer Training Programs.

R2-CPI-01: The Certified Professional Installer Accreditation Standard shall require that CPI Training Programs use a curriculum including the following elements:

a. An explanation of the importance of the CPI role in the CBRS ecosystem.
b. An explanation of the structure of the CBRS band, including the support of incumbent, PAL, and GAA users. (Three-tier architecture)
c. An explanation of CBSD devices including examples of such devices. This explanation shall include the definitions of Category A and B devices and examples of such.
d. An explanation of the impacts of such devices on other users of the band, including incumbent users and Grandfathered Wireless Broadband Licensees.
e. An explanation of high-level responsibilities of the SAS to protect incumbent and PAL users of the band from harmful interference and to facilitate coordination among GAA users and resolve conflicting uses of the band. This explanation shall include the SAS ecosystem functional architecture and explain the roles of the architectural elements.
f. An explanation of the radio characteristics of harmful interference.
g. An enumeration of the CBSD registration parameters which Part 96 defines, including an explanation of each CBSD registration parameter including examples of how the parameter can be measured by the Professional Installer. Consistent use of parameter names, types, and units shall be employed by all CPI Training Programs.
h. An explanation of the interaction of a CBSD with the SAS including but not limited to registration, grants, heartbeats, transmission, suspension, revocation, reassignment and deregistration.
i. A minimum number of worked examples, both indoors and outdoors, providing case studies of gathering a full set of CBSD registration data for a particular CBSD or set of CBSDs.
j. An explanation of the responsibility of the CPI to seek out methods for gathering CBSD registration data for unfamiliar equipment, and the responsibility to do so before providing such data to the SAS.

k. An explanation of the processes whereby collected information may be provided to the SAS by a CPI.
l. An explanation of the relationship of the Part 96 registration data to any other industry-defined data (as defined in [this: 0112] document) which may be required to be collected and provided to the SAS as part of the installation process for particular CBSD equipment.
m. An explanation that the CPI is fully responsible for CBSD registration data reported to the SAS, even when working with other people or systems which may assist in gathering such data.
n. An explanation of the processes whereby a CPI can interface with the SAS to correct inaccurate data discovered in the course of operations.
o. An explanation of the processes whereby a CPI can retrieve data from the SAS about the CBSDs for which they have provided registration parameters.
p. An explanation of the division of responsibility between the CBSD User and the CPI in the installation process and ongoing operation.
q. An explanation of the ongoing responsibilities of a CPI to maintain registration with the CPI Training Program to receive notice of any updates to Part 96 regulations or CPI Training Program requirements, as well as periodic renewal of certification status.
r. An explanation that CPI data will be subject to accuracy checks by other parties and systems; and the obligation to provide correct data.
s. An explanation of the corrective actions the CPI Training Program will be entitled to take pursuant to inaccuracies in data provided to the SAS by a CPI.
t. An explanation of any actions available to the Federal Government pursuant to negligence or willful misuse of the powers of a CPI.

Accredited CPI Training Programs may include additional information not subject to the CPI Accreditation Standard, but such information, if included, shall not be contradictory to the required curriculum.

R2-CPI-02: CPI Accreditation Standard Overview

a. The CPI Accreditation Standard shall establish consistent and objective criteria for successful completion of such a CPI Training Program.
b. The CPI Accreditation Standard shall require that candidate CPI Training Programs administer objective testing of individual CPIs to prove their understanding of the current material.

R2-CPI-03: Certified Professional Installer Registration Information: The Certified Professional Installer Registration process requires the CPI Training Program Administrator to collect the following information from a Certified Professional Installer and provide it to the CPI Accrediting Body, which stores it and makes it available to a SAS Administrator upon request:

a. Legal identity (name),
b. Mailing address,

c. Legal address,
d. Email contact,
e. Phone contact,
f. Accredited certification number from a CPI Training Program (CPIR-ID),
g. License initiation date, expiration date,
h. CPI Training Program successfully completed

R2-CPI-04: Professional Installer information provided to the SAS: When a professional installer provides additional information on Category A or Category B CBSDs via a mechanism provided by the SAS administrator, the professional installer shall provide:

a. The CBSD serial number and FCC ID (to uniquely identify the CBSD),
b. The associated Certified Professional Installer Registration ID (CPIR-ID)

R2-CPI-05: CPI Registration Data Accountability

a. The SAS shall hold CPIs accountable for the CBSD registration data those individuals provide to the SAS. Note: the CPIR ID is a mechanism for tracking the association of a CPI with provided CBSD registration data.
b. If a CBSD User alters the deployment of a CBSD such that new registration data is required (as per Part 96.39), it is the responsibility of the CBSD User to engage a CPI (if required) to provide updated CBSD registration data to the SAS.

R2-CPI-06: CPI Accreditation Standard Training Program

a. The CPI Accreditation Standard shall require CPI Training Programs to document processes for any instructor selection, training, and continuing education they do. The Standard shall impose record keeping requirements on CPI Training Programs to track the participation of instructors and CPIs in the CPI Training program.
b. The Standard shall establish consistent continuing education requirements to be satisfied by CPI Training Programs and disciplinary actions available to CPI Training Programs should CPIs be found to be providing inaccurate data to the SAS. Note: such continuing education requirements are expected to reflect rules, requirements, and technology changes.
c. The standard shall ensure that candidate CPI Training Program administrators receive acknowledgement and legal consent by CPIs to abide by the disciplinary structure developed as part of the CPI Accreditation Standard. Such a structure may include retraining, suspension and revocation of CPI certification status.
d. The Standard shall require CPI Training Program administrators to be contractually bound by an obligation to carry out the disciplinary actions set forth in the CPI Accreditation Standard, including an acknowledgement and consent to the consequences of failure to carry out such duties, which shall include the suspension or revocation of accreditation status as a Certified Professional Installer Training Program Administrator.

e. The Standard shall require CPI Training Program administrators to agree to transfer the pertinent information in their records (e.g., ongoing training status, responsibility to contact a CPI for certification renewal) to another accredited CPI Training Program administrator in the event it ceases operation. It may charge a reasonable fee for such conveyance.

R2-CPI-07: CPI re-accreditation of CPI Training Programs

a. The CPI Accreditation Standard shall establish periodic re-accreditation requirements to be agreed to by CPI Training Programs.
b. The registry of CPI Training Programs maintained by the CPI Accrediting Body shall contain at least the following information:
    i Name of CPI Training Program Administrator
    ii Accreditation status
    iii Accreditation dates
    iv Accreditation review history
    v Legal identity of responsible party or parties
    vi Contact information for responsible party
c. The CPI Accreditation Standard shall require CPI Training Program Administrators to maintain contact information such that any updates promulgated in the CPI Accreditation Standard itself or in its program requirements can be communicated to the CPI Training Programs and adopted in a timely fashion.

R2-CPI-08: CPI Interface to enter CBSD Registration Parameters

a. SAS administrators shall provide a means whereby their SASs will accept CBSD registration parameters from CPIs.
b. This means shall include an interface containing standardized terminology used in the CPI Accreditation Standard for the identification of CBSD registration parameters common to Part 96 operations. Any additional parameters which users of this interface may be permitted to provide to the SAS shall not conflict with Part 96 CBSD registration parameters.
c. The SAS shall validate that only individuals who are CPIs in good standing have the capability to use such interfaces to provide CBSD registration parameters to the SAS.
d. If a CBSD or network management system supervising one or more CBSDs provides an interface to a CPI to facilitate the collection and/or provision of CBSD registration parameters, that interface should use standardized terminology used in the CPI Accreditation Standard for the identification of CBSD registration parameters common to Part 96 operations. (Note: legacy devices are exempted from this requirement.)

11 References

[1] Federal Communications Commission, “Amendment of the Commission’s Rules with Regard to Commercial Operations in the 3550-3650 MHz Band,” GN Docket 12-354, FCC 15-47, Report and Order and Second Notice of Proposed Rulemaking, Released April 21, 2015, available at https://apps.fcc.gov/edocs_public/attachmatch/FCC-15-47A1_Rcd.pdf

[2] Title 47, Code of Federal Regulations, Part 96 (2015), available at: http://www.ecfr.gov/cgi-bin/text-idx?node=pt47.5.96&rgn=div5.

[3] Wireless Innovation Forum, Spectrum Sharing Committee, "Definitions Related to Commercial Operations in the U.S. 3550-3700 MHz Citizens Broadband Radio Service Band" available at: http://www.wirelessinnovation.org/fcc-definitions

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Appendix A: Informative Annex

Deprecated

Appendix B: Revision History

Document History		
V1.0.0	May 2016	Forum approval
V2.0.0	February 2017	V2 requirements includes the following major enhancements: • FCC Order on Reconsideration and Second Report & Order (FCC 16-55) • Measurement Reporting • Domain Proxy Functionality • SAS Initial Propagation Model • PAL support • SAS information sharing • Certified Professional Installer
V 1.1.0	13 July 2017	Document Number update to reflect change in configuration management policy
V1.2.0	13 July 2017	Forum Approval of recent technical revisions
V1.3.0	27 Sep 2017	Forum Approval of recent technical revisions
V1.4.0	15 January 2018	Forum Approval of recent technical revisions
V1.4.1	16 January 2018	Updated publication date from Jan 2017 to Jan 2018 on the cover
V1.5.0	3 May 2018	WINNF-18-I-00039 PPA contour and CBSD interference r3 WINNF-18-I-00058-EHata-Mean-Corr.docx WINNF-18-I-00062 - International Border Protection Update.docx
V1.6.0	30 October 2018	WINNF-18-I-00078 - Define Minimum Height for ITM WINNF-18-I-00079 - ESC sensor identification r2.docx WINNF-18-I-00091- SAS-SAS Exchange Rules Rev1 WINNF-18-I-00092 - Inland Radars Out of Band Protection Rev1 WINNF-18-I-000107 CR to change mean ITM to median ITM WINNF-18-I-00119- Canadian FSS Characteristics Rev4 WINNF-18-I-00120- DPA Neighborhood WINNF-18-I-00128 - Including insertion loss - r2 WINNF-18-I-00105 Rev3 – Table Mountain Quiet Zone Protection R2-SGN-18 Google Edits v3
V1.7.0	6 May 2019	WINNF-19- I-00025 - Editorial Fix in R2-SGN-16 WINNF-19-I-00038 - CR for TS-0112 Installation definition

		Editorial Ballot comments that added clarity to requirements R2-SRR-27 and R2-SRR-28 and to Revision History
V1.8.0	25 June 2019	WINNF-16-I-00219.2.1 CBSD-CBSD requirements
V1.9.0	4 December 2019	Brought up to date with FCC Part 96
V1.9.1	11 March 2020	Approve technical clarification WINNF-19-I-00162
V1.1.0	TBA	WINNF-22-I-00050 on Temporary PAL Channel Reassignment