



# **CBRS Operational and Functional Requirements (Release 2)**

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# CBRS Operational and Functional Requirements (Release 2)

## 1 Introduction and Scope

The document defines Release 2 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.

## 2 Background and Principles of Release 2 Operation

It is expected that a mix of Release 1 and post Release 1 (Release 2, Release 3, etc., herein called Release 2) participants coexist in the CBRS ecosystem for the foreseeable future. Note that FCC changes to Part 96 are, and will continue to be, included in Release 1.

No entity is mandated to support anything beyond Release 1, therefore supporting Release 2 is not mandatory for any entity. All entities claiming support for Release 2 are responsible for working with Release 1 entities in a mixed Release environment. Namely, any Release 2 entity must support backward compatibility to Release 1 entities using SAS-CBSD and SAS-SAS protocols, and any feature requiring coordination among SASs.

To address backward compatibility with Release 1, the only mandatory feature for any Release 2 entity (SAS or CBSD) is to support a mandatory protocol update to allow feature capability exchange for any Release 2 feature over SAS-CBSD/DP and SAS-SAS interfaces. All other Release 2 features are optional. The capability exchange protocol update will support selective implementation of Release 2 optional features.

Using the capability exchange protocol, SASs and CBSDs can inquire about implemented Release 2 optional features from other entities (SAS from CBSD, CBSD from SAS, and SAS from SAS) or inform other entities about implementation of such features.

As part of backward compatibility with Release 1, careful consideration must be given to features impacting any coordination among SASs including features requiring substantial similarity in performing incumbent protection or other activities.

Section 6 defines the requirements to address inter-release operability as noted above and the Annexes define optional Release 2 features (unless otherwise stated) and requirements for their use.

The adoption of certain Release 2 optional features could impact the certification status of SAS and/or CBSD if they are used in certain operations. Therefore, care has been taken in the Annexes to separate those requirements that do not impact Part 96 regulatory compliance, and those that could impact Part 96 regulatory compliance. Conformance with features used for operations that do not impact regulatory compliance can be asserted following the WinForum's CBRS Release 2 Self Testing Policy [n.7]. Use of features for operations that could impact Part 96 regulatory

compliance is subject to certification and approval by the FCC. CBSDs incorporating Release 2 features designated as not impacting regulatory compliance will not receive any special treatment by the SAS in calculating protection of Protected Entities.

### 3 Keywords or Requirements Language

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

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

When applicable, “shall” and “shall not” identify requirements that are mandatory for compliance with Release 2 features with no deviations from this standard. “Should” and “should not” indicate that a particular action is preferred but not necessarily required, or that (in the negative form) a certain possibility or course of action is discouraged but not prohibited. “May” and “need not” indicate a course of action permissible within the limits of the standard. “Can” and “cannot” are used for statements of possibility and capability, whether material, physical, or causal.

### 4 Requirement Organization

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

Where

- REL-: Applies to the WinForum document Release Number
- R0-: Requirements directly from FCC Rules
- R1-: Requirements derived from FCC Rules
- R2-: Requirements imposed by WinForum to meet FCC Rules
- R3-: Requirements imposed by WinForum to meet industry needs.
- <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., REL2-R0-IPM-01-a).

## 5 Definitions and Abbreviations

*Protected Entity.* An entity that receives interference protection from CBSDs. Such entities include federal incumbents, fixed-satellite service (FSS) earth stations, grandfathered wireless protection zones (GWPZ), PAL protection areas (PPA), environmental sensing capability (ESC) sensors, quiet zones, and certain international border areas. Some of these entities may be operating at frequencies outside of 3550 to 3700 MHz.

Any other previously undefined terms and abbreviations first used in the current version of this document are defined above. All previously defined terms and abbreviations are available at <https://cbrs.wirelessinnovation.org/acronyms>. **Feature-specific definitions are also captured in their associated annex and are included in this reference.**



## 6 Feature Capability Exchange (Mandatory for Release 2)

### 6.1 Feature Description

The following requirements apply to all CBSD/DPs or SASs claiming the support of Release 2 (referred to as Release 2 CBSD/DP or Release 2 CBSD, or Release 2 SAS). A SAS communicates with a CBSD/DP using SAS-CBSD/DP protocol defined by WG3 [2]. A SAS communicates with a peer SAS using the SAS-SAS protocol defined by WG3 [3].

### 6.2 SAS Requirements

#### 6.2.1 SAS General Requirements (SGN)

REL2-R3-SGN-01: Identification of Release 1 Entities

- a. Any CBSD/DP that does not exchange feature capabilities with its managing SAS shall be treated by the managing SAS as a Release 1 CBSD/DP as defined in WINNF-TS-0016 [6].
- b. Any SAS that does not exchange feature capabilities with another SAS shall be treated by that SAS as Release 1.

REL2-R2-SGN-31: Any Release 2 SAS shall be able to communicate with any Release 1 CBSD/DP.

REL2-R2-SGN-32: Any Release 2 SAS shall be able to communicate with any Release 1 SAS.

REL2-R3-SGN-02: Release 2 SAS to CBSD Feature Capability Exchange

- a. Any Release 2 SAS shall support feature capability exchange with its Release 2 managed CBSD/DPs.
  - i. Any Release 2 SAS shall exchange its support of Release 2 optional features with its Release 2 managed CBSD/DPs.
  - ii. Any Release 2 SAS may trigger a feature capability exchange of Release 2 optional features from its Release 2 managed CBSD/DPs.
- b. Any Release 2 SAS may exchange its support of proprietary features with its managed CBSD/DPs by using feature capability exchange.

REL2-R3-SGN-03: Any Release 2 SAS shall exchange feature capability with all other Release 2 SASs.

REL2-R3-SGN-04: Feature Capability Updates

- a. Any Release 2 SAS shall support the feature capability exchange of any update of Release 2 optional features with its Release 2 managed CBSD/DPs.
  - i. Any Release 2 SAS shall exchange any update of Release 2 optional features with its Release 2 managed CBSD/DPs.
  - ii. Any Release 2 SAS may trigger a feature capability exchange with its Release 2 managed CBSD/DPs about any update of Release 2 optional features.

REL2-R3-SGN-05: Any Release 2 SAS shall support the feature capability exchange of any update of Release 2 optional features with all other Release 2 SASs.

REL2-R3-SGN-06: SAS Use of Release 2 Features for Protection of Protected Entities

- a. If all CBSDs located inside the neighborhood of a Protected Entity (see R2-SGN-16 as specified in [1]) or a DPA are managed by the same Release 2 SAS, then the managing Release 2 SAS may use a Release 2 optional feature if it is capable of utilizing the feature, for the purpose of performing protection of that Protected Entity or DPA.
- b. The SAS shall apply the optional Release 2 feature for protection of Protected Entities only if it has been certified that the use of the optional feature will not negatively impact the protection of Protected Entities.

Note: How to apply Release 2 features to each protection methodology is feature specific and will be defined in the context of each feature

REL2-R3-SGN-07: If the collection of CBSDs located inside the Neighborhood of a Protected Entity (see R2-SGN-16 as specified in [1]) and/or DPAs are managed by more than one SAS, then the Release 2 SASs may use a Release 2 optional feature only if all SASs managing those CBSDs are capable of utilizing the feature for the purpose of performing calculation for the protection of Protected Entity or DPA (as relevant).

### 6.3 CBSD and EUD Requirements (DEV)

REL2-R3-DEV-01: Any SAS that does not exchange feature capabilities with its managed CBSD/DP shall be treated by the CBSD/DP as Release 1.

REL2-R2-DEV-04: Any Release 2 CBSD/DP shall support and be able to communicate with any Release 1 SAS.

REL2-R2-DEV-05: Any Release 2 CBSD/DP shall follow instructions from its Managing SAS (suspend or terminate radio transmission, channel assignment, power assignment, power reduction, and channel switch) regardless of the SAS being Release 1 or Release 2.

REL2-R3-DEV-02: Release 2 CBSD to SAS Feature Capability Exchange. Any Release 2 CBSD/DP shall support feature capability exchange with its Release 2 managing SAS.

- a. Any Release 2 CBSD/DP shall support initiating a feature capability exchange with its Release 2 managing SAS at any time.
- b. Any Release 2 CBSD/DP shall exchange its support of Release 2 optional features it intends to use with its Release 2 managing SAS.

REL2-R3-DEV-03: Any Release 2 CBSD/DP shall support the feature capability exchange of any update of Release 2 optional features with its Release 2 Managing SAS.

## 7 References

- [1] Requirements for Commercial Operation in the U.S. 3550 – 3700 MHz Citizens Broadband Radio Service Band, WINN-TS-0112 available at:  
<https://cbrs.wirelessinnovation.org/release-1-standards-specifications>
- [2] Signaling Protocols and Procedures for Citizens Broadband Radio Service (CBRS): Extensions to Spectrum Access System (SAS) - Citizens Broadband Radio Service Device (CBSD) Interface Technical Specification (Release 2), WINNF-TS-3002.
- [3] Signaling Protocols and Procedures for Citizens Broadband Radio Service (CBRS): Extensions to Spectrum Access System (SAS) - SAS Interface Technical Specification (Release 2), WINNF-TS-3003
- [4] T. Vincenty, “Direct And Inverse Solutions Of Geodesics On The Ellipsoid With Application Of Nested Equations”, Survey Review, Volume 23, Issue 176 (01 April 1975), pp. 88-93.
- [5] <https://www.its.bldrdoc.gov/media/50674/itm.pdf> section 47
- [6] Signaling Protocols and Procedures for Citizens Broadband Radio Service (CBRS): Spectrum Access System (SAS) - Citizens Broadband Radio Service Device (CBSD) Interface Technical Specification (Release 1), WINNF-TS-0016.
- [7] CBRS Release 2 Self Testing Policy, WINNF-TS-4005
- [8] WinnForum Recognized Grouping Information, WINNF-SSC-0010
- [9] Test and Certification for Citizens Broadband Radio Service (CBRS); Conformance and Performance Test Technical Specification; SAS as Unit Under Test (UUT), WINNF-TS-0061
- [10] WinnForum CBRS Protection Margin Policy, WINNF-SSC-0007
- [11] <https://apps.fcc.gov/oetcf/kdb/forms/FTSSearchResultPage.cfm?switch=P&id=20673>

## **Annex 1. Enhanced CBSD Group Handling (Optional)**

### **Annex 1.1 Feature Description**

This feature enhances the exchange of grouping information between CBSD/DP and SAS. In addition, this feature allows providing grouping configuration information from SAS to CBSD/DP.

This feature does not specify support of any of the particular Group types and it only supports the capability to exchange the grouping information and grouping configuration information. Also, this feature does not specify any special treatment of CBSDs nor Group-specific management policy. Any special treatment or Group-specific management policy including whether they may impact Part 96 regulatory compliance will be defined in Annex associated with a specific Group type.

### **Annex 1.2 Use for Operations not Impacting Part 96 Regulatory Compliance**

Enhanced CBSD Group Handling does not impact Protected Entities. CBSDs using this feature will not receive any special treatment by SASs in calculation of protection of Protected Entities. Treatment of a specific group passed between SAS and CBSD using this feature is detailed in the definition of that group.

#### **Annex 1.2.1 SAS General Requirements (SGN)**

REL2-R3-SGN-12100: Group Applicability

- a. A SAS may choose to support any Group type specified in this specification or WINNF-SSC-0010 [8]
- b. A SAS may handle Coexistence Group (defined in WINNF-TS-0112 [1]) during the Release 2 operation using this feature.

REL2-R3-SGN-12101: Grouping Information

- a. Upon reception of grouping information from a CBSD/DP, a SAS shall notify the CBSD/DP of whether it operationally supports the reported Group type(s) and Group ID(s).
- b. A SAS may notify the CBSD/DP of its operationally support of Group type(s) and Group ID(s) at any time.
- c. A SAS may exchange the grouping information of the registered CBSDs with its peer SASs.
- d. A SAS shall consider the CBSD as disassociated with a Group previously reported to the SAS if the latest reported grouping information received from the CBSD or the DP managing the CBSD does not include the information associated with the Group.

REL2-R3-SGN-12102: Grouping Configuration Information

- a. A SAS may notify the CBSD/DP of the grouping configuration information for the mutually supported Group type(s) and Group ID(s) at any time.
- b. A SAS may exchange the grouping configuration information of the registered CBSDs with its peer SASs.

### **Annex 1.2.2 CBSD and EUD Requirements (DEV)**

REL2-R3-DEV-12200: Group Applicability

- a. A CBSD may choose to support any Group type specified in this specification or in WINNF-SSC-0010 [8].
- b. A CBSD may be associated with a Coexistence Group (defined in WINNF-TS-0112 [1]) during the Release 2 operation using this feature.

REL2-R3-DEV-12201: Grouping Information

- a. A CBSD associated with one or more Groups or a DP managing such CBSDs may provide the grouping information to the managing SAS outside the CBSD Registration procedure.
- b. In providing the grouping information, a CBSD associated with one or more Groups or a DP managing such CBSDs shall provide the latest information of the associated Groups.

### **Annex 1.3 Use for Operations That Could Impact Part 96 Regulatory Compliance**

Not applicable for this version of this document.

## **Annex 2. Principal-Subordinate Single Frequency Group (SFG) (Optional)**

### **Annex 2.1 Feature Description**

Principal-Subordinate SFGs accommodate connections between a group of CBSDs, typically composed of one or more principal BTS-CBSDs and one or more subordinate CPE-CBSDs under control of those BTS-CBSDs and occupying the same frequency assignment. Each CPE-CBSD is under control of one BTS-CBSD. Multiple principals qualify for membership in a single Principal-Subordinate SFG only if they are incapable of operating in different frequency assignments. Principal-Subordinate SFG declaration and association is done using WinForum Release 2 Feature “Enhanced CBSD Group Handling” defined in Annex 1..

Note: Membership in a Principal-Subordinate Group can suggest association of a CPE-CBSD with a specific BTS-CBSD, but it is not definitively implied as a condition of membership. The definition of a device as a CPE-CBSD is a separate registration parameter defined in Annex 6.

### **Annex 2.2 Use for operations not impacting Part 96 Regulatory Compliance**

Principal Subordinate SFG does not impact protection of Protected Entities. CBSDs associated with this type of Group will not receive any special treatment by SASs in calculation of protection of Protected Entities.

#### **Annex 2.2.1 System Registration Requirements (SRR)**

##### **REL2-R3-SRR-22100 Principal-Subordinate SFG Membership**

- a. A CBSD shall declare its association to a Principal-Subordinate SFG using the WinForum Release 2 Feature “Enhanced CBSD Group Handling”.
- b. A CBSD that belongs to a Principal-Subordinate SFG may also belong to other Group(s) defined in this specification or WINNF-SSC-0010 [8].
- c. The SAS shall ensure the Principal-Subordinate SFG membership is persistent after a frequency reassignment.
- d. A CBSD shall retain its Principal-Subordinate SFG membership whether or not it receives a Grant when a frequency reassignment is required, unless it requests the change.
- e. All members of a Principal-Subordinate SFG shall be managed by the same SAS.

##### **REL2-R3-SRR-22101 Principal-Subordinate Single Frequency Group**

- a. If not all members of the group can be moved to the same frequency, the SAS should maximize the number of Subordinate CBSDs reassigned to the same frequency as the Principal CBSD.
- b. The SAS may allow more than one CBSD to be a Principal if they are required to operate on the same frequency.

## **Annex 2.2.2 SAS General Requirements (SGN)**

### REL2-R3-SGN-22200 Frequency Assignment

- a. The SAS shall assign the same spectrum to all CBSDs within a Principal-Subordinate SFG.
- b. The SAS shall reassign the same spectrum within a Principal-Subordinate SFG in concert when reassignment is warranted.
- c. The SAS shall terminate the grant for Subordinate CBSDs incapable of being reassigned to suitable spectrum.

### REL2-R3-SGN-22201 Principal-Subordinate Single Frequency Group

- a. If not all members of the group can be moved to the same frequency, the SAS should maximize the number of Subordinate CBSDs reassigned to the same frequency as the Principal CBSD.
- b. The SAS may allow more than one CBSD to be a Principal if they are required to operate on the same frequency.

## **Annex 2.2.3 CBSD and EUD Requirements (DEV)**

### REL2-R3-DEV-22300 Principal-Subordinate SFG Membership

- a. A Principal-Subordinate SFG shall be created by BTS-CBSDs.
- b. Subordinate CBSDs may exit the associated Principal-Subordinate SFG.

## **Annex 2.3 Use for Operations That Could Impact Part 96 Regulatory Compliance**

Not applicable for this version of this document

### **Annex 3. Interdependent Single Frequency Group (Optional)**

#### **Annex 3.1 Feature Description**

Interdependent SFG is a set of CBSDs that are required by their hardware to operate on a single frequency, and whose members are not individually addressed by the SAS. Interdependent SFG declaration and association is done using WinForum Release 2 Feature “Enhanced CBSD Group Handling” defined in Annex 1.

#### **Annex 3.2 Use for operations not impacting Part 96 Regulatory Compliance**

Interdependent SFG does not impact protection of Protected Entities. CBSDs associated with this type of Group will not receive any special treatment by SASs in calculation of protection of Protected Entities.

##### **Annex 3.2.1 System Registration Requirements (SRR)**

REL2-R3-SRR-32100 Interdependent SFG Membership

- a. A CBSD shall declare its association to an Interdependent SFG using the WinForum Release 2 Feature “Enhanced CBSD Group Handling”.
- b. A CBSD which belongs to an Interdependent SFG may also belong to other Group(s) defined by WinForum specifications or in WINNF-SSC-0010 [8].
- c. The SAS shall ensure Interdependent SFG membership is persistent after a frequency reassignment.
- d. A CBSD shall retain its Interdependent group assignment whether or not it receives a Grant when a frequency reassignment is required, unless it requests the change.
- e. All members of an Interdependent SFG shall be managed by the same SAS.

##### **Annex 3.2.2 SAS General Requirements (SGN)**

REL2-R3-SGN-32200 Frequency Assignment

- a. The SAS shall assign the CBSDs in an Independent SFG to operate on a common frequency and at a common power level when possible.
- b. If the SAS is unable to find a frequency assignment that all members can operate on, the SAS shall not provide a new Grant to members of the group.
- c. If reducing the power level of all members equally allows the whole group to operate on the same frequency assignment, the SAS may provide a new Grant to all members at that reduced power level.
- d. The SAS shall reassign the same spectrum within an Interdependent SFG in concert when reassignment is needed.

#### **Annex 3.3 Use for Operations That Could Impact Part 96 Regulatory Compliance**

Not applicable for this version of this document



## **Annex 4. Separable Single Frequency Group (Optional)**

### **Annex 4.1 Feature Description**

Separable SFG is a set of CBSDs that are restricted to operate on a single frequency assignment and are designed to allow deactivation and/or control of conducted power into the antenna from each member CBSD. Separable SFG declaration and association is done using WinForum Release 2 Feature “Enhanced CBSD Group Handling” defined in Annex 1.

### **Annex 4.2 Use for operations not impacting Part 96 Regulatory Compliance**

Separable SFG does not impact protection of Protected Entities. CBSDs associated with this type of Group will not receive any special treatment by SASs in calculation of protection of Protected Entities.

#### **Annex 4.2.1 System Registration Requirements (SRR)**

REL2-R3-SRR-42100 Separable SFG Membership

- a. A CBSD shall declare its association to a Separable SFG using the WinForum Release 2 Feature “Enhanced CBSD Group Handling”.
- b. A CBSD which belongs to a Separable SFG may also belong to other Group(s) defined by WinForum specifications or in WINNF-SSC-0010 [8].
- c. The SAS shall ensure that Separable SFG membership is persistent after a frequency reassignment.
- d. A CBSD shall retain its Separable group assignment whether or not it receives a Grant when a frequency reassignment is required, unless it requests the change.
- e. All members of an Separable SFG shall be managed by the same SAS.

REL2-R3-SRR-42101 Separable Single Frequency Group.

- a. If the SAS is unable to find a frequency assignment that all members can operate on, the SAS may deny grants to individual members of the group.
- b. If reducing the power level of some individual members allows the whole group to operate on a common frequency assignment, the SAS may reduce the power level of those individual members.

#### **Annex 4.2.2 SAS General Requirements (SGN)**

REL2-R3-SGN-42200 Frequency Assignment

- a. The SAS shall assign the CBSDs in a Separable SFG to operate on a common frequency when possible.
- b. If it is not possible for the SAS to assign the entire group to a frequency, e.g., due to protection of Protected Entities, the SAS may assign some members of the group to a different frequency while requiring others to cease transmitting or reduce power.

## **Annex 4.3 Use for Operations That Could Impact Part 96 Regulatory Compliance**

Not applicable for this version of this document

## **Annex 5. Enhanced Antenna Patterns (Optional)**

### **Annex 5.1 Feature Description**

This section specifies requirements on CBSD enhanced antenna patterns and how to calculate CBSD antenna gain in a certain direction.

### **Annex 5.2 Use for operations not impacting Part 96 Regulatory Compliance**

Operations not impacting Part 96 Regulatory Compliance include:

- Intra-GAA operation

CBSDs using this feature will not receive any special treatment by SASs in calculation of protection of Protected Entities.

#### **Annex 5.2.1 SAS General Requirements (SGN)**

REL2-R3-SGN-52100: SAS selection of CBSD antenna gain calculation methods. Depending on the antenna pattern information available, the SAS shall calculate the CBSD antenna gain in a direction using one of the following methods in order of priority:

- a. if the two-dimensional antenna pattern is available, method specified in REL2-R3-SGN-52101(f);
- b. otherwise, if both the horizontal and the vertical antenna patterns are available, method specified in REL2-R3-SGN-52101(d)(iii) using the horizontal and the vertical antenna patterns;
- c. otherwise, if both the horizontal beamwidth and the vertical beamwidth are available, method specified in REL2-R3-SGN-52101(e);
- d. otherwise, if the horizontal antenna pattern is available and the vertical antenna pattern is not available, method specified in REL2-R3-SGN-52101(d)(iii) using the horizontal antenna pattern and 0 dB vertical antenna discrimination in all directions;
- e. otherwise, method specified in R2-SGN-20 [1].

REL2-R3-SGN-52101: CBSD Antenna Gain in Aggregate Interference Calculation Using Enhanced Antenna Patterns. If an enhanced antenna pattern of a CBSD is available to the SAS as described in REL2-R3-DEV-52200, the SAS shall use the following procedure to calculate the CBSD antenna gain toward the Protected Entity receiver:

- a. SAS Administrators may work with CBSD Users to mutually agree on a lower bound to the antenna gain of the enhanced antenna patterns described in [REL2-R3-DEV-52200].

- b. The azimuth angle,  $\alpha$ , relative to True North from the CBSD toward a receiver location shall be computed from the associated latitudes and longitudes using Vincenty's formula [4].
- c. The elevation angle,  $\beta$ , from the CBSD toward a receiver is computed by the method which is equivalent to the `hzns()` subroutine [5].
- d. If the horizontal pattern,  $G_H(\cdot)$ , and the vertical pattern,  $G_V(\cdot)$ , are provided as specified in REL2-R3-DEV-52200, the SAS shall calculate the antenna gain with the following procedure assuming a small CBSD mechanical antenna downtilt (e.g., 0 to +/- 15 degrees). Antenna gain calculation with large mechanical downtilt is for further study (FFS).
  - i. The CBSD antenna azimuth,  $a_z$ , shall be used to calculate the angle of the line between the CBSD and the receiver location relative to the CBSD antenna boresight direction, via  $\theta = \alpha - a_z$  (degrees).
  - ii. The CBSD antenna mechanical downtilt,  $\tau$ , shall be used to calculate the elevation angle of the line between the CBSD and the receiver location relative to the CBSD antenna boresight direction via  $\varphi = \beta + \cos(\theta) \cdot \tau$ .
  - iii. Assuming both  $G_H(\cdot)$  and  $G_V(\cdot)$  are represented in dB relative to the peak antenna gain,  $G_0$  dBi, the CBSD antenna gain toward the receiver shall be generated using the following equation.

$$G_{\text{CBSD}}(\alpha, \beta) = G_0 + w_h * G_H(\theta) + w_v * G_V(\varphi) \text{ (dBi)}$$

where  $w_h$  and  $w_v$  are weighting factors for the horizontal and vertical gains respectively.  $w_h$  and  $w_v$  are both 1 unless specified otherwise by the antenna manufacture.

If the values of  $G_H(\theta)$  or  $G_V(\varphi)$  are not available from  $G_H(\cdot)$  and  $G_V(\cdot)$ , linear interpolation using two closest angles to  $\theta$  or  $\varphi$  from  $G_H(\cdot)$  and  $G_V(\cdot)$  shall be used to obtain  $G_H(\theta)$  and  $G_V(\varphi)$ . For example, if  $\theta_1$  and  $\theta_2$  are the two angles closest to  $\theta$  such that  $G_H(\theta_1)$  and  $G_H(\theta_2)$  are available from  $G_H(\cdot)$ ,  $G_H(\theta)$  can be equal to  $G_H(\theta_1) * (\theta_2 - \theta) / (\theta_2 - \theta_1) + G_H(\theta_2) * (\theta - \theta_1) / (\theta_2 - \theta_1)$ .

- e. If the peak antenna gain and the 3 dB beamwidths of the horizontal and vertical antenna patterns are provided as specified in REL2-R2-DEV-52200, the SAS shall calculate the horizontal antenna pattern as follows:

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

where  $A_H = 20$  dB and  $\theta_{3dB}$  is the beamwidth of the horizontal antenna pattern in degrees.  $\theta$  is a floating-point number between 0 and 360 and  $\theta=0$  corresponds to the antenna boresight direction. Similarly, the SAS shall calculate the vertical antenna pattern as follows:

$$G_V(\varphi) = -\min \left[ 12 \left( \frac{\varphi}{\varphi_{3dB}} \right)^2, A_V \right] \text{ (dBi)}$$

where  $A_V = 20$  dB and  $\varphi_{3dB}$  is the beamwidth of the vertical antenna pattern in degrees.  $\varphi$  is a floating point number between -90 and 90 and  $\varphi=0$  corresponds to the antenna boresight direction.

With  $G_H(\cdot)$  and  $G_V(\cdot)$  calculated above, the SAS shall follow step d.i to d.iii to calculate the CBSD antenna gain toward an azimuth angle,  $\alpha$ , and an elevation angle,  $\beta$ .

- f. If one two-dimensional antenna pattern, denoted by  $G_{2D}(\theta, \phi)$  where  $\theta$  is the azimuth angle and  $\phi$  is the elevation angle, is provided as specified in REL2-R3-DEV-52200, the CBSD antenna gain toward the receiver shall be generated using the following equation.

$$G_{CBSD}(\alpha, \beta) = \frac{1}{(\theta_2 - \theta_1)(\varphi_2 - \varphi_1)} [\theta_2 - \alpha \quad \alpha - \theta_1] \begin{bmatrix} G_{2D}(\theta_1, \varphi_1) & G_{2D}(\theta_1, \varphi_2) \\ G_{2D}(\theta_2, \varphi_1) & G_{2D}(\theta_2, \varphi_2) \end{bmatrix} \begin{bmatrix} \varphi_2 - \beta \\ \beta - \varphi_1 \end{bmatrix}$$

where  $G_{2D}(\theta_1, \varphi_1)$ ,  $G_{2D}(\theta_1, \varphi_2)$ ,  $G_{2D}(\theta_2, \varphi_1)$ , and  $G_{2D}(\theta_2, \varphi_2)$  are values in  $G_{2D}(\cdot, \cdot)$ .  $\theta_1$  and  $\theta_2$  are two azimuth angles closest to  $\alpha$ .  $\varphi_1$  and  $\varphi_2$  are two elevations angles closest to  $\beta$ .

REL2-R3-SGN-52102: SAS may use Enhanced Antenna Patterns for Intra-GAA operations in Release 2.

## Annex 5.2.2 CBSD and EUD Requirements (DEV)

REL2-R3-DEV-52200: Utilizing Enhanced Antenna Patterns for Interference Calculations.

To allow SAS utilizing Enhanced Antenna Patterns for interference calculation, CBSDs or CBSD registrants shall provide the azimuth, the vertical mechanical downtilt, the peak antenna gain, the 3dB horizontal beamwidth, and one of the following information during CBSD Registration:

- a. A specific antenna model used by the CBSD during CBSD Registration, which identifies one of the following antenna information recorded in an antenna pattern database:
  - i. Two one-dimensional antenna patterns including factors of static beamforming and electrical downtilt.
  - ii. One two-dimensional antenna pattern including factors of static beamforming, and electrical downtilt.
- b. The 3 dB beamwidths of the vertical antenna pattern.

REL2-R3-DEV-52201: Deprecated

REL2-R3-DEV-52202: Deprecated

REL2-R3-DEV-52203: Category A CBSD supporting Enhanced Antenna Pattern shall provide horizontal beamwidth during CBSD Registration.

## **Annex 5.3 Use for Operations that could impact Part 96 Regulatory Compliance**

Operations that could impact Part 96 Regulatory Compliance include:

- Protection of Protected Entities

### **Annex 5.3.1 SAS General Requirements (SGN)**

REL2-R3-SGN-53100: Subject to REL2-R3-SGN-06 and REL2-R3-SGN-07, a SAS may use the methods in REL2-R3-SGN-52100 and REL2-R3-SGN-52102 to calculate CBSD antenna gains in aggregate interference calculation for the purpose of protecting Protected Entities.

## **Annex 6. CPE-CBSD Indicator (Optional)**

### **Annex 6.1 Feature Description**

This feature enables a CPE-CBSD to indicate to the SAS that it is a CPE-CBSD.

### **Annex 6.2 Use for Operations not Impacting Part 96 Regulatory Compliance**

CPE-CBSD Indicator does not impact protection of Protected Entities. CBSDs using this indicator will not receive any special treatment by SASs in calculation of protection of Protected Entities.

#### **Annex 6.2.1 SAS General Requirements (SGN)**

REL2-R3-SGN-62100: A SAS shall treat a CBSD as CPE-CBSD if it receives the CPE-CBSD indication.

#### **Annex 6.2.2 CBSD and EUD Requirements (DEV)**

REL2-R3-DEV-62200: A CBSD may support this feature only if it meets R1-DEV-04 (CPE-CBSD Operation) specified in WINNF-TS-0112 [1].

### **Annex 6.3 Use for Operations That Could Impact Part 96 Regulatory Compliance**

Not applicable for this version of this document



## **Annex 7. Passive DAS (Optional)**

### **Annex 7.1 Description**

Passive DAS is a network of spatially separated Transmission Points (TPs) powered by the same single physical Radio Unit (RU), in which there are only passive elements (feeders, splitters, diplexers, etc.) between the RU and each of the TPs. Each TP associated to a Passive DAS is a CBSD. All the CBSDs associated with Passive DAS require the same spectrum (radio frequency range) assignment and have several restrictions on the allowed power. The Radio Unit (RU) is transmitting RF only when all the CBSDs (TPs) associated with the Passive DAS are authorized to transmit by the SAS. Passive DAS declaration and association uses WinForum Release 2 Feature “Enhanced CBSD Group Handling”.

### **Annex 7.2 Use for operations not impacting Part 96 Regulatory Compliance**

Passive DAS does not impact protection of Protected Entities. CBSDs associated with this type of Group will not receive any special treatment by SASs in calculation of protection of Protected Entities.

#### **Annex 7.2.1 System Registration Requirements (SRR)**

REL2-R3-SRR-72100: Deprecated

REL2-R3-SRR-72101: All the CBSDs associated to Passive DAS shall be registered by CPI regardless of their CBSD Category

REL2-R3-SRR-72102: All the CBSDs associated to Passive DAS shall report their EIRP Capability (dBm/10MHz) as part of registration by a CPI.

#### **Annex 7.2.2 SAS General Requirements (SGN)**

REL2-R3-SGN-72200: Spectrum Assignment

- a) SAS shall assign the same frequency range to all CBSDs (TPs) within the same Passive DAS group.
- b) If SAS is unable to assign a frequency range, due to protection of Protected Entities, that all TP(s) within the same Passive DAS group can operate on, SAS shall not assign any frequency range for any TP.
- c) Subject to above requirements and when reassignment is needed for at least one TP, SAS shall reassign in concert the same frequency range to all TPs within the same Passive DAS group.

#### **Annex 7.2.3 CBSD and EUD Requirements (DEV)**

REL2-R3-DEV-72300: Deprecated

REL2-R3-DEV-72301: Deprecated

REL2-R3-DEV-72302: All CBSDs (All TPs) in the same Passive DAS Group association shall be managed by the same SAS.

REL2-R3-DEV-72303: CBSD Registering to the SAS as belonging to a Passive DAS Group association shall meet with the requirements for Passive DAS defined by the FCC in KDB 935210 D02 Signal Boosters Certification [n.11]

REL2-R3-DEV-72304: A CBSD shall declare its association to a unique Passive DAS Group during Registration using the WinForum Release 2 Feature “Enhanced CBSD Group Handling”. A CBSD which belongs to a Passive DAS Group may also belong to other Group(s) defined by WinForum specifications without any restriction.

### **Annex 7.3 Use for Operations That Could Impact Part 96 Regulatory Compliance**

Not applicable for this version of this document

## **Annex 8. Grant Update (Optional)**

### **Annex 8.1 Feature Description**

This feature enables SASs to replace a CBSD's existing grant with a new grant with the same frequency range without having a grant relinquishment procedure. The feature requires enhancements in both the SAS and CBSD. SAS use of this feature is regulatory impacting, however CBSD/DP use of this feature is not.

There are several use cases where this Grant Update feature could be beneficial. An example of those use cases is max EIRP reduction after CPAS [10]. As a result of IAP during CPAS process, SAS could need to reduce the max EIRP of some of their CBSD's grants slightly. Without this feature, each CBSD needs to replace its existing Grant by obtaining new Grant with reduced max EIRP after relinquishment of the existing Grant, leading to CBSD's service disruption. By using this feature, such CBSDs can obtain new Grant with the reduced max EIRP without having Grant Relinquishment procedure. Another example is when the CBSDs with existing grants associated with the operator's PAL license, are added to a PPA. By using this feature, a GAA Grant can be replaced by a PAL Grant without relinquishing the GAA Grant.

### **Annex 8.2 Use of Operations Not Impacting Part 96 Regulatory Compliance**

#### **Annex 8.2.1 CBSD and EUD Requirements (DEV)**

REL2-R3-DEV-82100: A CBSD or DP shall be able to request updating the maximum transmission power of a grant from the SAS, without the need to request the grant relinquishment.

### **Annex 8.3 Use of Operations Impacting Part 96 Regulatory Compliance**

Due to the impact on Release 1 WinnF testing [9], this feature is considered impacting Part 96 Regulatory Compliance for SAS operations.

#### **Annex 8.3.1 SAS General Requirements (SGN)**

REL2-R3-SGN-83100: When requested by a CBSD/DP, the serving SAS shall be able to modify the maximum transmission power for the existing frequency range of a grant, without the need to relinquish the grant.

REL2-R3-SGN-83101: A SAS shall be able to update the CBSD's grant type (GAA versus PAL), without the need to relinquish the grant.

REL2-R3-SGN-83102: A SAS shall be able to inform the CBSD about the grant type (GAA versus PAL) and/or update of maximum transmission power, without the need to relinquish the grant.

## **Informative Appendix: Registration Update**

Some of the characteristics of a registered CBSD may change during operation. The intention is that changing the parameters that do not affect any protection of Protected Entities do not necessarily trigger re-registration of the CBSD. Except FCC identification number, unique manufacturer's serial number, CBSD category, and the physical installation parameters, other registration parameters can be updated without the need for CBSD re-registration. Such registration update might involve interaction with a CPI.

SASs and DP/CBSDs can update some of the registration parameters without the need to re-register with the SAS. This capability is achieved by using proprietary mechanisms designed by SAS Administrators. The methodology employed is left to SAS Administrators. The methodology could be based on either the WinForum Release 1 or Release 2 frameworks.

## Appendix A: Revision History

<b>Document History</b>		
V1.0.0	22 January 2020	Initial release
V1.1.0	2 April 2020	Technical revision on use of 2D antenna patterns.
V1.2.0	19 November 2020	Restructured document Technical revision adding passive DAS as a feature
V1.3.0	21 June 2021	Technical revision to add Grant Optimization – Grant Update feature; Updates to the passive DAS requirements; Addition of Informative annex for Registration update