



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

**Document WINNF-TS-1001**

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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.

Note: Every SAS and CBSD must go through FCC certification based on Release 1. Release 2 features and capabilities are in addition to, not instead of, Release 1.

## 2 Background and Principles of Release 2 Operation

It is expected that a mix of Release 1 and Release 2 SASs and CBSDs will 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.

Adoption of Release 2 is not mandatory. Any SAS or CBSD that supports Release 2 must function like a Release 1 SAS or CBSD when communicating with a Release 1 SAS or CBSD.

At a minimum, a SAS or CBSD supporting Release 2 must implement the Feature Capability Exchange defined in Section 6. Adoption of any other Release 2 feature is optional, and the Feature Capability Exchange supports selective implementation of Release 2 optional features. If a SAS or CBSD does not successfully perform a Feature Capability Exchange with another SAS or CBSD, it must revert to Release 1 behavior when communicating with that SAS or CBSD (See Table 1).

**Table 1: SAS/CBSD Operation Mode**

		CBSD Capability	
		Rel. 1	Rel. 2
SAS Capability	Rel. 1	Rel. 1	Rel. 1
	Rel. 2	Rel. 1	Rel. 2

Using the Feature Capability Exchange, SASs and CBSDs can inquire about optional Release 2 features from another SAS or CBSD) or inform other Release 2 SASs and CBSDs 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 that support Release 2 (referred to as Release 2 CBSD/DP or Release 2 CBSD, or Release 2 SAS). A Release 2 SAS communicates with a Release 2 CBSD/DP using SAS-CBSD/DP protocol defined by WG3 [2]. A Release 2 SAS communicates with a peer Release 2 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. A Release 2 SAS shall manage any CBSD/DP that does not exchange feature capabilities with it as a Release 1 CBSD/DP in accordance with WINNF-TS-0016 [6] and WINNF-TS-0112 [1]
- b. A Release 2 SAS shall function with any SAS that does not exchange feature capabilities with it as if it were a Release 1 SAS in accordance with WINNF-TS-0096 [12] and WINNF-TS-0112[1]

REL2-R2-SGN-31: Any Release 2 SAS shall support communication with any Release 1 CBSD/DP in accordance with WINNF-TS-0016 [6].

REL2-R2-SGN-32: Any Release 2 SAS shall support communication with any Release 1 SAS in accordance with WINNF-TS-0096 [12].

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 only at CBSD Registration.
  - i. Any Release 2 SAS shall exchange its support of Release 2 optional features with its Release 2 managed CBSD/DPs only at CBSD Registration.
  - ii. Deprecated
- b. Any Release 2 SAS may exchange its support of proprietary features with its managed CBSD/DPs by using feature capability exchange only at CBSD Registration.

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

REL2-R3-SGN-04: Deprecated

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]) are managed by more than one SAS, then a Release 2 SAS may use a Release 2 optional feature to protect the Protected Entity if all SASs managing those CBSDs utilize the same Release 2 optional feature for performing calculation for the protection of the Protected Entity.

REL2-R3-SGN-08: If the collection of CBSDs located inside the neighborhood of a GWPZ, a PPA, an FSS or an ESC sensor (see R2-SGN-16 as specified in [1]) are managed by more than one SAS and not all SASs managing those CBSDs utilize the same Release 2 optional feature for protecting those Protected Entities, the following procedure shall be followed by a Release 2 SAS using a Release 2 optional feature to protect those Protected Entities:

1. The Release 2 SAS shall form an IMG in accordance with R2-SGN-16-b-iv [1] for all its CBSDs in the neighborhood of a GWPZ, a PPA, an FSS or an ESC sensor.
2. The Release 2 SAS shall calculate the interference budget of the IMG for the Protected Entity as the aggregate interference of all CBSDs in the IMG using only the Release 1 SAS functions.
3. The Release 2 SAS shall subsequently manage the Grants of CBSDs in the IMG such that the aggregate interference to the Protected Entity using the Release 2 optional feature does not exceed the interference budget of the IMG.

### 6.3 CBSD and EUD Requirements (DEV)

REL2-R3-DEV-01: A Release 2 CBSD/DP that does not receive a feature capability exchange from its Managing SAS shall communicate with the SAS as a Release 1 CBSD/DP in accordance with WINNF-TS-0016 [6].

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 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 only at CBSD Registration with its Release 2 managing SAS.

- a. Deprecated
- b. Any Release 2 CBSD/DP shall exchange only at CBSD Registration its support of Release 2 optional features it intends to use with its Release 2 managing SAS.

REL2-R3-DEV-03: Deprecated

## 7 References

- [1] Requirements for Commercial Operation in the U.S. 3550 – 3700 MHz Citizens Broadband Radio Service Band, WINNF-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](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] WinForum 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] WinForum CBRS Protection Margin Policy, WINNF-SSC-0007
- [11] <https://apps.fcc.gov/oetcf/kdb/forms/FTSSearchResultPage.cfm?switch=P&id=20673>

- [12] Signaling Protocols and Procedures for Citizens Broadband Radio Service (CBRS): Spectrum Access System (SAS) – SAS Interface Technical Specification (Release 1), WINNF-TS-0096.
  
- [13] WINNF-SSC-0002, “Signaling Protocols and Procedures for Citizens Broadband Radio Service (CBRS): WinForum Recognized CBRS Air Interfaces and Measurements”, Wireless Innovation Forum

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

### **Annex 1.1      Feature Description**

This feature enhances the existing Group handling function to support additional grouping information exchange between Release 2 CBSD/DPs and Release 2 SASs.

This feature does not specify any 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.

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

The Enhanced CBSD Group Handling feature does not affect protection of Protected Entities, so does not impact Part 96 regulatory compliance. CBSDs using this feature will not receive any special treatment by SASs in calculation of protection of Protected Entities.

Any special treatment or Group-specific management policy including whether they may impact Part 96 regulatory compliance will be defined in the Annex associated with a specific Group type.

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

REL2-R3-SGN-12100:      Group Applicability

- a. A SAS may 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 operational 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 1.2.3 System Registration Requirements (SRR)**

REL2-R3-SRR-12300: Release 2 CBSD utilizing Enhanced CBSD Group Handling shall declare it to its managing SAS using the Feature Capability Exchange defined in this document.

REL2-R3-SRR-12301: Release 2 SAS utilizing Enhanced CBSD Group Handling shall declare it to its Release 2 managed CBSD using the Feature Capability Exchange defined in this document.

### **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. The Principal-Subordinate SFG declaration and association is made 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.

Definitions:

**Principal CBSD:** A Principal CBSD is a member of a Principal-Subordinate Single Frequency Group which needs to be authorized in order for other members of the group (Subordinate CBSDs) to be authorized.

Note: The typical instantiation of a Principal CBSD is a BTS-CBSD.

**Subordinate CBSD:** A Subordinate CBSD is a member of a Principal-Subordinate Single Frequency Group whose Grant from the Managing SAS, if any, refers to a frequency range of its corresponding Principal CBSD.

Note: The typical instantiation of a Subordinate CBSD is a CPE-CBSD.

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

A Principal Subordinate SFG does not affect protection of Protected Entities and so does not impact Part 96 regulatory compliance. 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 DEPRECATED

## Annex 2.2.2 SAS General Requirements (SGN)

REL2-R3-SGN-22200 Frequency Assignment

- a. For each Subordinate CBSD within the Principal-Subordinate SFG, the SAS shall identify an available Grant frequency range which is within the frequency range of a Grant recommended and available for the Principal CBSD(s). Note: The identified frequency range can be null.
- b. The SAS shall support the capability to communicate this frequency range to the Subordinate CBSD(s).

REL2-R3-SGN-22201 Frequency Reassignment

- a. The SAS should maximize the number of Subordinate CBSDs moved to the same frequency range as the Principal CBSD's new frequency range if all members of the group cannot be moved to the same frequency range.
- b. The SAS may allow more than one CBSD to be a Principal if they are required to operate on the same frequency range.
- c. If the SAS needs to terminate the existing Grant(s) for the Principal CBSD(s) and suggest new Grant(s) to the Principal CBSD(s) due to SASs calculation results of protection of Protected Entities, the SAS should identify to the Subordinate CBSDs (to the extent possible and preferably before the termination of their existing Grant) a new Grant frequency range that is within the frequency range(s) of new Grant(s) suggested to the Principal CBSD(s).
- d. If the SAS cannot identify to the Subordinate CBSDs a new Grant frequency range in accordance with REL2-R3-SGN-22200-c above, the SAS shall terminate the existing Grant of those Subordinate CBSDs

## 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 a Principal CBSD.
- 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**

An 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. The Interdependent SFG declaration and association is made 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 affect protection of Protected Entities and so does not impact Part 96 regulatory compliance. 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**

A 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. The Separable SFG declaration and association is made 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 affect protection of Protected Entities so does not impact Part 96 regulations. 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 for sharing CBSD enhanced antenna pattern information with a SAS and calculation of directional antenna gain by the SAS based on that information.

#### Annex 5.1.1 Definitions

*Front to Back Ratio (FBR)*. A value (in dB) provided by the antenna or equipment manufacturer that generally describes the ratio of power radiated in the boresight direction to the power radiated in the opposite 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.

- The SAS shall be capable of using the following methods for calculation of the CBSD antenna gain in a direction towards a target receiver:

- Method A: Use of one two-dimensional antenna pattern (denoted as  $G_{2D}(\theta, \varphi)$ ) recorded in a CBSD Antenna Pattern Database as relative to Peak Antenna Gain

Note: There is no presumption that any antenna implementations are provided with the full two-dimensional pattern data used in Method A, but it is provided here for the sake of completion.

- Method B1: Use of two one-dimensional antenna patterns (denoted as  $G_H(\theta)$  and  $G_V(\varphi)$ , respectively) recorded in a CBSD Antenna Pattern Database;
- Method B2: Reserved for future use



- Method C: Use of two one-dimensional antenna patterns (denoted as  $G_H(\theta)$  and  $G_V(\varphi)$ , respectively) derived from the CBSD Registration parameters (Antenna Azimuth, Horizontal 3dB beamwidth, Vertical 3dB beamwidth, Peak Antenna Gain, Mechanical Downtilt, and Front-to-Back Ratio);
- Method D: Use of two one-dimensional antenna patterns (denoted as  $G_H(\theta)$  and  $G_V(\varphi)$ , respectively), where the horizontal antenna pattern (denoted as  $G_H(\theta)$ ) is recorded in the CBSD Antenna Pattern Database, and the vertical antenna pattern is derived from the CBSD Registration parameters (Vertical 3dB beamwidth, Peak Antenna Gain, Mechanical Downtilt, and Front-to-Back Ratio)
- Method E: Use of the horizontal antenna pattern (denoted as  $G_H(\theta)$ ) recorded in the CBSD Antenna Pattern Database. No vertical antenna pattern information is used.
- Method F: Use of the horizontal antenna pattern (denoted as  $G_H(\theta)$ ) derived from the CBSD Registration parameters (i.e., Release 1 method specified in R2-SGN-20 [1]).

NOTE: Method F-based Antenna Gain calculation is not specified in this Annex as it is identical to Release 1 method specified in R2-SGN-20 [1].

- b. The SAS shall select and use one of the above methods in order of priority based on the availability of the enhanced antenna pattern information of the CBSD listed in Table 2.
  - i. For Category A CBSDs, if antenna azimuth or horizontal 3dB beamwidth are not provided or are invalid, the SAS shall assume omni-directional horizontal pattern and consider it when selecting the method in REL2-R3-SGN-52100-b.
  - ii. If FBR is not provided or is invalid, the SAS shall assume 20 dB FBR as default and consider it when selecting the method in REL2-R3-SGN-52100-b.

**Table 2: Necessity of enhanced antenna pattern information in each method**

Enhanced Antenna Pattern Information	Antenna Model for 2D pattern	Antenna Model for 1D pattern(s)	Peak Antenna Gain	Antenna Azimuth	Mechanical Downtilt	Horizontal 3dB beamwidth	Vertical 3dB beamwidth	Front-to-Back Ratio (FBR)
Method A	Y		Y	Y	Y			
Method B1		Y (horizontal and vertical)	Y	Y	Y (small value)			

Method C			Y	Y	Y (small value)	Y	Y	Y
Method D		Y (horizontal only)	Y	Y	Y (small value)		Y	Y
Method E		Y (horizontal only)	Y	Y				
Method F			Y	Y		Y		

REL2-R3-SGN-52101: Deprecated (divided into multiple requirements)

REL2-R3-SGN-52102: For Intra-GAA operations in Release 2, SAS may use the CBSD antenna gain calculated by using the methods in REL2-R3-SGN-52100.

NOTE: This means that “a target receiver” in REL2-R3-SGN-52100 cannot be a receiver of Protected Entities.

REL2-R3-SGN-52103: Calculation of the direction from the CBSD towards a target receiver:

- a. In all the methods specified in REL2-R3-SGN-52100, the SAS shall compute the azimuth angle,  $\alpha$ , relative to true north from the CBSD toward a target receiver location from the associated latitudes and longitudes using Vincenty’s formula [4].
- b. In Method A, Method B1, Method C and Method D specified in REL2-R3-SGN-52100, the SAS shall compute the elevation angle,  $\beta$ , from the CBSD toward a target receiver by the method which is equivalent to the `hzns()` subroutine [5].
- c. The SAS shall calculate the azimuth and elevation angles ( $\theta_R$  and  $\varphi_R$ ) of the line between the CBSD main beam and the receiver location relative to the CBSD antenna boresight direction by using the following equations:

$$\theta_R = \alpha - az$$

$$\varphi_R = \beta + \cos(\theta_R) \cdot \tau$$

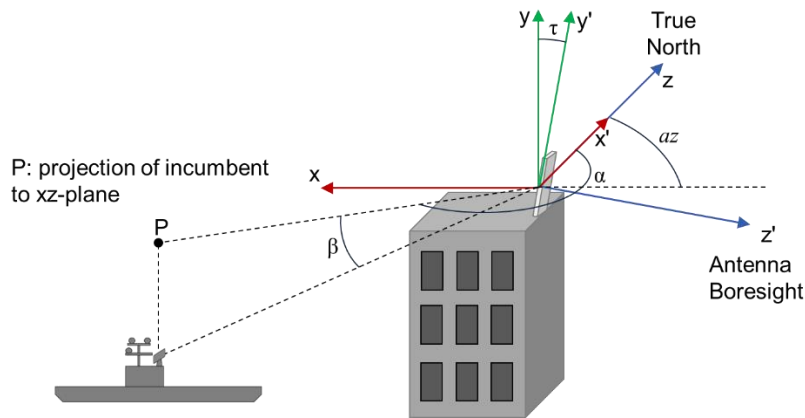
where:

$az$ : the CBSD antenna main beam pointing azimuth

$\tau$ : mechanical downtilt

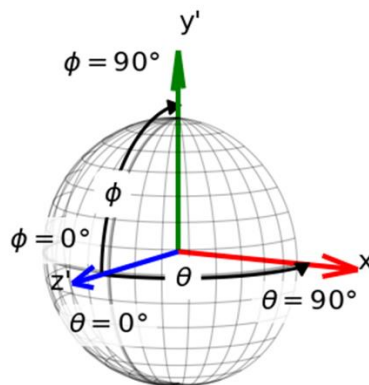
Figure 1 represents the orientation of the CBSD relative to the global coordinate system. The azimuth angle  $az$ , in the global  $xz$ -plane, describes the orientation of the CBSD antenna boresight ( $z'$  axis) and is positive clockwise from True North. The mechanical downtilt  $\tau$  describes the elevation angle of the antenna boresight direction, which is positive below horizon. Additionally, Figure 1 shows the orientation of a victim receiver (which could be an incumbent) in the global coordinate system described by the azimuth angle  $\alpha$  to the projection of the incumbent into the  $xz$ -plane. The azimuth angle  $\alpha$  is positive clockwise from True North. The elevation angle  $\beta$  towards the incumbent is positive above horizon (towards the sky) and negative below horizon (towards the

ground). Above calculations are only valid for small elevation angles  $\beta$  (0 to +/- 15 degrees).



**Figure 1: Global coordinate system illustration.** The orientation of the CBSD is described by the azimuth angle  $\alpha z$  relative to True North and the down tilt angle  $\tau$ . The position of the victim receiver is given by the azimuth angle  $\alpha$ , and the elevation angle  $\beta$ .

The local antenna coordinate system defined by the azimuth angle  $\theta_R$  and elevation angle  $\varphi_R$  is show in Figure 2. The pole of the coordinate system is aligned with the  $y'$  axis, and the antenna boresight direction is aligned with the  $z'$  axis.



**Figure 2: Local antenna coordinate system illustrating the local azimuth angle  $\theta$ , and local elevation angle  $\varphi$ .** The antenna boresight is aligned with the  $z'$  axis.

REL2-R3-SGN-52104: Method A based Antenna Gain Calculation:

The SAS shall determine the CBSD antenna gain  $G_{\text{CBSD}}(\alpha, \beta)$  using the following equation:

$$G_{CBSD}(\alpha, \beta) = \begin{cases} G_{2D}(\alpha, \beta), & \text{if } \theta \in \alpha \text{ and } \varphi \in \beta \\ \frac{[\theta_{m'+1} - \alpha \quad \alpha - \theta_{m'}] \begin{bmatrix} G_{2D}(\theta_{m'}, \varphi_{n'}) & G_{2D}(\theta_{m'}, \varphi_{n'+1}) \\ G_{2D}(\theta_{m'+1}, \varphi_{n'}) & G_{2D}(\theta_{m'+1}, \varphi_{n'+1}) \end{bmatrix} \begin{bmatrix} \varphi_{n'+1} - \beta \\ \beta - \varphi_{n'} \end{bmatrix}}{(\theta_{m'+1} - \theta_{m'}) (\varphi_{n'+1} - \varphi_{n'})}, & \text{otherwise} \end{cases}$$

Where:

- $\theta = [-180, \theta_1, \theta_2, \dots, \theta_m, \dots, 180]$  including 0 degree
- $\varphi = [-90, \varphi_1, \varphi_2, \dots, \varphi_n, \dots, 90]$  including 0 degree
- $\theta_{m'}, \theta_{m'+1}$ : two azimuth angles closest to  $\alpha$ , ( $\theta_{m'} < \alpha < \theta_{m'+1}$ )
- $\varphi_{n'}, \varphi_{n'+1}$ : two elevations angles closest to  $\beta$ , ( $\varphi_{n'} < \beta < \varphi_{n'+1}$ )

REL2-R3-SGN-52105: Method B1 based Antenna Gain Calculation:

- a. The SAS shall define  $G'_H(\theta_R)$ ,  $G'_V(\varphi_R)$  and  $G'_V(180 - \varphi_R)$  as follows:

$$G'_H(\theta_R) = \begin{cases} G_H(\theta_R), & \text{if } \theta \in \theta_R \\ \frac{1}{\theta_{m'+1} - \theta_{m'}} [\theta_{m'+1} - \theta_R \quad \theta_R - \theta_{m'}] \begin{bmatrix} G_H(\theta_{m'}) \\ G_H(\theta_{m'+1}) \end{bmatrix}, & \text{otherwise} \end{cases}$$

$$G'_V(\varphi_R) = \begin{cases} G_V(\varphi_R), & \text{if } \varphi \in \varphi_R \\ \frac{1}{\varphi_{n'+1} - \varphi_{n'}} [\varphi_{n'+1} - \varphi_R \quad \varphi_R - \varphi_{n'}] \begin{bmatrix} G_V(\varphi_{n'}) \\ G_V(\varphi_{n'+1}) \end{bmatrix}, & \text{otherwise} \end{cases}$$

$$G'_V(180 - \varphi_R) = \begin{cases} G_V(180 - \varphi_R), & \text{if } \varphi \in 180 - \varphi_R \\ \frac{1}{\varphi_{k'+1} - \varphi_{k'}} [\varphi_{k'+1} - (180 - \varphi_R) \quad (180 - \varphi_R) - \varphi_{k'}] \begin{bmatrix} G_V(\varphi_{k'}) \\ G_V(\varphi_{k'+1}) \end{bmatrix}, & \text{otherwise} \end{cases}$$

Where:

- $\theta = [-180, \theta_1, \theta_2, \dots, \theta_m, \dots, 180]$  including 0 degree
- $\varphi = [-90, \varphi_1, \varphi_2, \dots, \varphi_n, \dots, 90]$  including 0 degree
- $\theta_{m'}, \theta_{m'+1}$ : two azimuth angles closest to  $\theta_R$ , ( $\theta_{m'} < \theta_R < \theta_{m'+1}$ )
- $\varphi_{n'}, \varphi_{n'+1}$ : two elevations angles closest to  $\varphi_R$ , ( $\varphi_{n'} < \varphi_R < \varphi_{n'+1}$ )
- $\varphi_{k'}, \varphi_{k'+1}$ : two elevations angles closest to  $180 - \varphi_R$ , ( $\varphi_{k'} < 180 - \varphi_R < \varphi_{k'+1}$ )

- b. The SAS shall calculate the CBSD antenna gain  $G_{CBSD}(\alpha, \beta)$  by using the following equation:

$$G_{CBSD}(\alpha, \beta) = G_0 + G'_H(\theta_R) + \left[ \left( 1 - \frac{|\theta_R|}{180} \right) \cdot (G'_V(\varphi_R) - G_H(0)) + \frac{|\theta_R|}{180} \cdot (G'_V(180 - \varphi_R) - G_H(180)) \right] \text{ (dBi)}$$

where:

$G_0$ : Peak antenna gain (dBi)

$\theta_R = f(\alpha)$  for a given az as specified in REL2-R3-SGN-52103

$\varphi_R = f(\beta, \theta_R)$  as specified in REL2-R3-SGN-52103

The range of mechanical downtilt in this Method shall be limited to 0 to +/- 15 degrees.

NOTE: Antenna gain calculation with large mechanical downtilt is for further study (FFS).

REL2-R3-SGN-52106: Method C based Antenna Gain Calculation:

- a. The SAS shall derive the horizontal antenna pattern  $G_H(\theta)$  and the vertical antenna pattern  $G_V(\varphi)$  from the following equations:

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

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

where:

$\theta_{3dB}$ : Horizontal 3 dB beamwidth

$\varphi_{3dB}$ : Vertical 3 dB beamwidth

FBR: front-to-back ratio (FBR) in dB.

- b. The SAS shall calculate the CBSD antenna gain  $G_{CBSD}(\alpha, \beta)$  by using the derived patterns  $G_H(\theta)$  and  $G_V(\varphi)$  based on Method B1 specified in REL2-R3-SGN-52105.

The range of mechanical downtilt in this Method shall be limited to 0 to +/- 15 degrees.

NOTE: Antenna gain calculation with large mechanical downtilt is for further study (FFS).

REL2-R3-SGN-52107: Method D based Antenna Gain Calculation:

- a. The SAS shall derive the vertical antenna pattern  $G_V(\varphi)$  based on the Method C specified in REL2-R3-SGN-52106 (a)

- b. The SAS shall calculate the CBSD antenna gain  $G_{\text{CBSD}}(\alpha, \beta)$  by using the provided antenna pattern  $G_H(\theta)$  and derived vertical antenna pattern  $G_V(\varphi)$  based on Method B1 specified in REL2-R3-SGN-52105.

The range of mechanical downtilt in this Method shall be limited to 0 to +/- 15 degrees.

NOTE: Antenna gain calculation with large mechanical downtilt is for further study (FFS).

REL2-R3-SGN-52108: Method E based Antenna Gain Calculation:

The SAS shall calculate the CBSD antenna gain  $G_{\text{CBSD}}(\alpha, \beta)$  by using the horizontal antenna pattern  $G_H(\theta)$  and 0 dB vertical antenna discrimination in all directions based on Method B1 specified in REL2-R3-SGN-52105.

## **Annex 5.2.2 CBSD and EUD Requirements (DEV)**

REL2-R3-DEV-52200: Category A CBSD Parameter Set for Registration of Enhanced Antenna Pattern Information:

In addition to the parameter sets required or optional for Category A CBSD Registration as described in R0-SRR-01 [1], Category A CBSDs shall have a capability to provide one or multiple parameters from the following enhanced antenna pattern information during CBSD Registration:

- a. Antenna gain along with
  - i The 3 dB beamwidth of the horizontal antenna pattern antenna beamwidth
  - ii Antenna azimuth pointing direction
- b. The mechanical downtilt of the CBSD antenna
- c. The 3 dB beamwidths of the vertical antenna pattern.
- d. The front-to-back ratio (FBR)
- e. A specific antenna model or identifier which identifies one of the following antenna information recorded in the CBSD Antenna Pattern Database
  - i One two-dimensional antenna pattern including factors of static beamforming, and electrical downtilt
  - ii Horizontal antenna pattern including factors of static beamforming and electrical downtilt;
  - iii Combination of horizontal and vertical antenna patterns including factors of static beamforming and electrical downtilt.

REL2-R3-DEV-52201: Deprecated

REL-R3-DEV-52202: Deprecated

REL2-R3-DEV-52203: Deprecated (merged with REL2-R3-DEV-52200)

REL2-R3-DEV-52204: Category B CBSD Parameter Set for Registration of Enhanced Antenna Pattern Information:

In addition to the parameter sets required or optional for Category B CBSD Registration as described in R0-SRR-02 [1], Category B CBSDs shall have a capability to provide one or multiple parameters from the following enhanced antenna pattern information during CBSD Registration:

- a. The 3 dB beamwidths of the vertical antenna pattern.
- b. The front-to-back ratio (FBR)
- c. A specific antenna model or identifier which identifies one of the following antenna information recorded in the CBSD Antenna Pattern Database
  - i One two-dimensional antenna pattern including factors of static beamforming, and electrical downtilt
  - ii Horizontal antenna pattern including factors of static beamforming and electrical downtilt;
  - iii Combination of horizontal and vertical antenna patterns including factors of static beamforming and electrical downtilt.

REL2-R3-DEV-52205: The parameters listed in REL2-R3-DEV-52200 and REL2-R3-DEV-52204 may be provided to the SAS via single-step registration or multi-step registration.

### **Annex 5.2.3 Certified Professional Installer Requirements (CPI)**

REL2-R3-CPI-52300: Registration of the Enhanced Antenna Pattern Information:

For the registration of the CBSDs supporting Enhanced Antenna Pattern feature, the CPI should choose the Enhanced Antenna Pattern Information of the CBSD listed in REL2-R3-DEV-52200- based on the antenna calculation method in REL2-R3-SGN-52100 the CBSD User desires the SAS to apply.

### **Annex 5.2.4 SAS Administrator Requirements (SAD)**

REL2-R3-SAD-52400: Mutual Agreement with CBSD Users:

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]

REL2-R3-SAD-52401: CBSD Antenna Pattern Database:

- a. SAS Administrators shall cooperate to define a CBSD Antenna Pattern Database that is available to all SASs.
- b. A record of the CBSD Antenna Pattern Database shall be designed to contain at least the following information:
  - Antenna pattern ID

- One of the following antenna pattern information:
  - Horizontal antenna pattern including factors of static beamforming and electrical downtilt;
  - Combination of horizontal and vertical antenna patterns including factors of static beamforming and electrical downtilt; or
  - Two-dimensional antenna pattern including factors of static beamforming and electrical downtilt



## **Annex 5.2.5 System Registration Requirements (SRR)**

REL2-R3-SRR-52500: Release 2 CBSD utilizing Enhanced Antenna Patterns shall declare it to its managing SAS using the Feature Capability Exchange defined in this document.

REL2-R3-SRR-52501: Release 2 SAS utilizing Enhanced Antenna Patterns shall declare it to its Release 2 managed CBSD using the Feature Capability Exchange defined in this document.

## **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, REL2-R3-SGN-07, and REL2-R3-SGN-08, instead of CBSD antenna gain calculated based on Release 1 method specified in R2-SGN-20 [1], a SAS may use the CBSD antenna gain calculated based on Method A, Method B1, Method C, Method D and Method E specified in REL2-R3-SGN-52100 for the purpose of protecting Protected Entities.

NOTE: Method F is outside the scope of this requirement because it is identical to Release 1 method specified in R2-SGN-20 [1].

## **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 6.2.3 System Registration Requirements (SRR)**

REL2-R3-SRR-62300: Release 2 CBSD utilizing CPE-CBSD Indicator shall declare it to its managing SAS using the Feature Capability Exchange defined in this document.

REL2-R3-SRR-62301: Release 2 SAS utilizing CPE-CBSD Indicator shall declare it to its Release 2 managed CBSD using the Feature Capability Exchange defined in this document.

### **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.

REL2-R3-SRR-72103: A CBSD shall declare its association to a unique Passive DAS Group during Registration using the WinForum Release 2 Feature “Enhanced CBSD Group Handling”.

REL2-R3-SRR-72104: A CBSD that belongs to a Passive DAS Group may also belong to other Group(s) defined by WinForum specifications.

#### **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: Deprecated

### **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 a grant relinquishment procedure. The feature requires operation by both the SAS and CBSD. SAS use of this feature has regulatory impacts, however CBSD/DP use of this feature does 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 the CPAS process, a 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 a 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 a new Grant with the reduced max EIRP without needing the 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: DEPRECATED

REL2-R3-DEV-82101: Upon receiving the approval of the new Grant request in which the requested frequency range is exactly the same as the frequency range of an existing Grant, the CBSD shall consider the existing Grant terminated.

NOTE: The CBSD does not have to relinquish the existing Grant prior to sending such new Grant request. See R3-REL2-SGN-83100 for more information.

#### **Annex 8.2.2 System Registration Requirements (SRR)**

REL2-R3-SRR-82200: Release 2 CBSD utilizing Grant Update feature shall declare it to its Managing SAS using the Feature Capability Exchange defined in this document.

REL2-R3-SRR-82201: Release 2 SAS utilizing Grant Update feature shall declare it to its Release 2 managed CBSD using the Feature Capability Exchange defined in this document.

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

Due to the impact on Release 1 WinForum 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: Maximum Transmission Power Update

- a. The Managing SAS shall have the capability to approve the request of a new Grant in which the requested frequency range is exactly the same as an existing Grant of the CBSD in order to allow the CBSD to use the updated maximum transmission power in the same frequency range as the existing Grant without requiring the CBSD to relinquish the existing Grant.
- b. Upon approval of the new Grant request in accordance with REL2-R3-SGN-83100-a, the Managing SAS shall terminate the existing Grant.

REL2-R3-SGN-83101: Grant Type Update: The Managing SAS shall have the capability to update the CBSD's Grant type (GAA versus PAL) of an existing Grant without terminating the existing Grant and inform the CBSD of the updated Grant type for the existing Grant.

REL2-R3-SGN-83102: DEPRECATED

## **Annex 9      Extension to PPA Information**

### **Annex 9.1      Feature Description**

This feature extends PPA Information to include new parameters and enables SASs to exchange that information as part of PPA Information in the Full Activity Dump (FAD). New parameters include the followings:

- the FRN (FCC Registration Number) of the PAL Holder associated with a PPA

Use cases of this feature include handling multiple PPA protection, when PPAs are owned by the same licensee/operator but managed by different SAS Administrators and deployed in the proximity of each other such that some or all of the CBSDs in one PPA are in the protection neighborhood of the other PPA.

### **Annex 9.2      Use of Operations Not Impacting Part 96 Regulatory Compliance**

This feature does not alter the Release 1 process by which PPA information included in the Full Activity Dump (FAD) is exchanged, so it does not impact Part 96 regulatory compliance.

This feature has no impact on CBSD/DPs.

#### **Annex 9.2.1    SAS General Requirements (SGN)**

REL2-R3-SGN-92100:      SAS shall exchange the FRN of the PAL holder generating a PPA with other SAS Administrators.

### **Annex 9.3      Use of Operations that Could Impact Part 96 Regulatory Compliance**

Not applicable, as this feature does not impact Part 96 regulatory compliance

## **Annex 10 Global Navigation Satellite System (GNSS) Measurements to Estimate Building Entry Loss (BEL) (Optional)**

### **Annex 10.1 Feature Description**

This feature enables the Release 2 SASs to use GNSS measurements-based BEL in propagation loss calculation instead of the BEL value of 15 dB employed for Release 1. The feature requires operation by both the SAS and CBSD.

### **Annex 10.2 Use for operations not impacting Part 96 Regulatory Compliance**

Not applicable for this version of the document.

### **Annex 10.3 Use for that could impact Part 96 Regulatory Compliance**

#### **Annex 10.3.1 SAS General Requirements (SGN)**

REL2-R3-SGN-103100: CBSD-measured BEL loss value in aggregate interference calculation:

If the BEL of a CBSD described in WINNF-SSC-0002 section 7.2.1 [n.13] is available to the SAS, the SAS shall use the following procedure to calculate the CBSD BEL toward the receiver of a protected entity.

This applies to :

R2-SGN-04 Propagation model requirements for the use in PPA and GWPZ Calculation

R2-SGN-03 (restricted to CBSD to FSS interference only)

- a. 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 [n.4].
- b. The elevation angle, El, from the CBSD toward a receiver is computed by the method which is equivalent to the hzns() subroutine [n.12]
- c. The CBSD antenna azimuth, Az, shall be used to calculate the angle of the line between the CBSD and the receiver location relative to the CBSD.
- d. The CBSD shall capture the GPS signal power per satellite and either calculate a loss value or send the correlation data to a server to provide the calculation. The loss data per Azimuth and Elevation angle "pixel" is the measurement reported. The calculating entity should use the lowest loss data from adjacent pixels to provide the loss measurement. The measurement can be directly routed to the SAS or routed to the CBSD which in turn will route it to the SAS. In the event a pixel is empty, that is not filled in by data, the minimum loss of the adjacent pixels can be used. In the further event that these pixels have not yet been filled in with data a default value of 15 dB shall be used. The CBSD



will continue to collect data in an attempt to fill in all empty pixels. This data will be relayed to the SAS as it becomes available.

- e. For protected entities in the LOS direction for CBSD to protected entity > 1 street separation the BEL is calculated as
  - i. BEL is the min[loss(EI 5 to 10 deg.) AND (Az +/- 10 deg.) from the direct angle to the protected entity] dB
  - ii. The BEL measured at GPS L1 (1575.42 MHz) shall be optionally converted to 3.5 GHz by adding values in table 1 below taken from TR-1007 figures 13 and 14

Table 1 GPS L1 conversion factors

GPS L1 C/A code Loss measurement	BEL used
<4 dB	Add 0 dB to the GPS value
>+4 dB and <30 dB	Add 4 dB to the GPS value
>=30 dB	Add 17 dB to the GPS value

- iii. The BEL measured at GPS L5 (1176.45 MHz) shall be optionally converted to 3.5 GHz by adding values in the table below taken from TR-1007 figures 17 and 18 .

Table 2 GPS L5 conversion factors

GPS L5 Loss measurement	BEL used
<4 dB	Add 0 dB to the GPS value
>+4 dB and <30 dB	Add 3.5 dB to the GPS value
>=30 dB	Add 20 dB to the GPS value

- iv. The total path loss for a single BEL consideration for a distance  $d$  is
    - i.  $PL(d) = BEL + PL_{model}(d)$  dB
  - v. The total path loss for a double BEL consideration for a distance  $d$  is
    - i.  $PL(d) = BEL_1 + BEL_2 + PL_{model}(d)$  dB
- f. For protected entities in the LOS direction for CBSD to protected entity <= 1 street separation the BEL is calculated as
- i. BEL is the minimum[loss(EI 5 to 60, AND Az +/- 10 deg) from the direct angle to the protected entity] dB
  - ii. The BEL measured at GPS L1 (1575.42 MHz) shall be optionally converted to 3.5 GHz by adding values from table 1 .
  - iii. The BEL measured at GPS L5 (1176.45 MHz) shall be optionally converted to 3.5 GHz by adding values from table 2.
  - iv. The total path loss for a single BEL consideration is
    - i.  $PL(d) = BEL + PL_{model}(d)$  dB
  - v. The total path loss for a double BEL consideration is
    - i.  $PL(d) = BEL_1 + BEL_2 + PL_{model}(d)$  dB

REL2-R3-SGN-103101: In order to support this feature, the SAS shall have the capability to receive the measurement reports associated with the CBSD measurement capability “INDOOR\_LOSS\_USING\_GNSS” specified in WINNF-SSC-0002 [n.13].

### **Annex 10.3.2 CBSD and EUD Requirements (DEV)**

REL2-R3-DEV-103200: In order to support this feature, the CBSD shall have the measurement capability “INDOOR\_LOSS\_USING\_GNSS” specified in WINNF-SSC-0002 [n.13].

REL2-R3-DEV-103201: The CBSD shall not send the unsolicited measurement reports associated with the measurement capability “INDOOR\_LOSS\_USING\_GNSS” to the SAS not supporting this feature.

### **Annex 10.3.3 System Registration Requirements (SRR)**

REL2-R3-SRR-103300: Release 2 CBSD utilizing GNSS Measurements to Estimate BEL feature shall declare it to its managing SAS using the Feature Capability Exchange defined in this document.

REL2-R3-SRR-103301: Release 2 SAS utilizing GNSS Measurements to Estimate BEL feature shall declare it to its Release 2 managed CBSD using the Feature Capability Exchange defined in this document.

## **Annex 11      Antenna Pattern Negotiation (Optional)**

### **Annex 11.1      Feature Description**

This feature enables the SAS to calculate an Antenna Pattern EIRP Envelope as defined in section 11.1.1 that will allow CBSDs employing Active Antenna System (AAS) to reduce the EIRP in the direction towards Protected Entities while maintaining higher EIRP in the directions where Protected Entities are not impacted. For example, the CBSD and SAS can negotiate an antenna pattern that will be used by the CBSD until a new pattern is requested by the SAS due to changes related to activation of new Protected Entities (e.g., PPAs) or the increase in the number of deployed CBSDs that will result in the need to reduce EIRP values in certain directions.

In this Annex, "CBSD" refers to the CBSD employing AAS.

#### **Annex 11.1.1      Definitions**

*Antenna Pattern EIRP Envelope.* The permissible EIRP in different directions at the CBSD location to ensure, at minimum, protection of Protected Entities

### **Annex 11.2 Use for operations not impacting Part 96 Regulatory Compliance**

Not applicable for this version of the document.

### **Annex 11.3 Use for operations that could impact Part 96 Regulatory Compliance**

#### **Annex 11.3.1      System Registration Requirements (SRR)**

REL2-R3-SRR-113100: Release 2 CBSD utilizing Antenna Pattern Negotiation feature for Active Antenna System (AAS) shall declare it to its managing SAS using the Feature Capability Exchange defined in this document.

REL2-R3-SRR-113101: Release 2 SAS utilizing Antenna Pattern Negotiation feature for Active Antenna System (AAS) shall declare it to its Release 2 managed CBSD using the Feature Capability Exchange defined in this document.

#### **Annex 11.3.2      SAS General Requirements (SGN)**

REL2-R3-SGN-113200: A SAS supporting the Antenna Pattern Negotiation feature shall have the following capabilities:

- a. To calculate an Antenna Pattern EIRP Envelope for the CBSD that will ensure proper higher-tier users protection while maximizing EIRP in the directions where Protected Entities are not impacted.
- b. To communicate the Antenna Pattern EIRP Envelope to the CBSD and request the CBSD to confirm that it will not exceed the envelope by providing the enhanced antenna pattern array used by the CBSD
- c. To check that the enhanced antenna pattern array reported by the CBSD fits within the Antenna Pattern EIRP Envelope required to protect Protected Entities
  - i. NOTE: This check can be done by using the CBSD EIRP capability applied to the antenna pattern to be able to compare it with the Antenna Pattern EIRP Envelope
- d. To use methods as specified in Annex 5 to compute CBSD Antenna Gain towards Protected Entities using the antenna pattern declared by the CBSD
  - i. NOTE: The Enhanced Antenna Pattern used in these methods can be in the antenna pattern database or provided through other means

REL2-R3-SGN-113201: A SAS supporting the Antenna Pattern Negotiation feature shall exchange the negotiated antenna pattern arrays for the CBSDs with other SASes supporting the Antenna Pattern Negotiation Feature.

### **Annex 11.3.3 CBSD and EUD Requirements (DEV)**

REL2-R3-DEV-113300: A CBSD that supports the Antenna Pattern Negotiation feature

Shall have the following capabilities:

- a. To receive an Antenna Pattern EIRP Envelope from Managing SAS
- b. To compute an enhanced antenna pattern array that will fit within the Antenna Pattern EIRP Envelope received from Managing SAS
- c. To inform the Managing SAS of the calculated enhanced antenna pattern array
- d. To ensure that its transmission will not exceed the EIRP values corresponding to the declared enhanced antenna pattern array



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CBRS Release 2 Requirements  
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## 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 for the following list of parameters:

- 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
V1.4.0	20 December 2021	Technical revision to update various features and add Extension to PPA Information
V1.5.0	6 June 2023	Technical Revision to add GNSS BEL, Antenna Negotiation and SAS Assisted Beamforming  WINNF-21-I-00197 CR – Clarification of EAP feature  WINNF-22-I-00039 Clarification of Use Conditions for Indoor Loss Measurement and GNSS-based BEL  WINNF-23-I-00011 CR for Feature Capability Exchange Requirements  WINNF-23-I-00012_CR_TS-1001_SRR  CR – TS-1001 – Definition of Front to Back Ratio