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 WInnForum'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 WInnForum document Release Number
- R0-: Requirements directly from FCC Rules
  R1-: Requirements derived from FCC Rules

  R2-: Requirements imposed by WInnForum to meet FCC Rules
  R3-: Requirements imposed by WInnForum 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

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 WInnForum 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 WInnForum 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-SRR-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 WInnForum 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 WInnForum 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 WInnForum 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 WInnForum 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 WInnForum 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 WInnForum 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, α, 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, β, 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, *az*, 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 θ= α - *az* (degrees).

   ii. The CBSD antenna mechanical downtilt, τ, 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.

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

where w_h and w_v are weighting factors for the hornizontal 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 θ or φ from $G_H(\cdot)$ and $G_V(\cdot)$ shall be used to obtain $G_H(\theta)$ and $G_V(\varphi)$. For example, if θ_1 and θ_2 are the two angles closest to θ 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:

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

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

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

where A_V = 20 dB and φ_{3dB} is the beamwidth of the vertical antenna pattern in degrees. φ is a floating point number between -90 and 90 and φ=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, α, and an elevation angle, β.

f. If one two-dimensional antenna pattern, denoted by $G_{2D}(\theta, \phi)$ where θ is the azimuth angle and ϕ 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.

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

where $G_{2D}(\theta_1, \varphi_1)$, $G_{2D}(\theta_1, \varphi_2)$, $G_{2D}(\theta_2, \varphi_1)$, and $G_{2D}(\theta_2, \varphi_1)$ are values in $G_{2D}(\cdot, \cdot)$. θ_1 and θ_2 are two azimuth angles closest to α. φ_1 and φ_2 are two elevations angles closest to β.

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 azimuth, vertical downtilt and one of the following information during CBSD Registration:
a. AA 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, antenna orientation, and electrical downtilt.
b. The peak antenna gain and the 3 dB beamwidths of the horizontal and vertical antenna patterns.

REL2-R3-DEV-52201: Category A CBSD supporting Enhanced Antenna Pattern shall provide antenna downtilt during CBSD Registration

REL2-R3-DEV-52202: Category A CBSD supporting Enhanced Antenna Pattern shall provide antenna azimuth during CBSD Registration

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 radio frequency assignment and have several restrictions on the allowed power. Passive DAS declaration and association uses WInnForum 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:   A CBSD shall declare its association to a unique Passive DAS chain using the WInnForum 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 WInnForum specifications without any restriction.

Note: A CBSD should declare its association to a unique Passive DAS chain during Registration.

REL2-R3-SRR-72101:   All the CBSDs associated to Passive DAS shall be Registered by CPI regardless of their Category (CAT A/B)

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

Annex 7.2.2   SAS General Requirements (SGN)

REL2-R3-SGN-72200: If the SAS is not able to Grant the same frequency(s) to ALL the CBSDs (ALL the TPs) in the same Passive DAS chain association, then the SAS shall not Grant any of the CBSDs (any of the TPs) in the same Passive DAS chain association.

Annex 7.2.3   CBSD and EUD Requirements (DEV)

REL2-R3-DEV-72300: If one of the CBSDs (one of the TPs) belonging to a Passive DAS chain association is NOT AUTHORIZED to transmit, then all the other CBSDs (all other TPs) in the same Passive DAS chain association shall stop their radio transmission within 60 seconds.

(The Radio Unit feeding the Passive DAS chain stops transmitting within 60 seconds, which causes all the TPs in the Passive DAS chain association to stop transmitting).

REL2-R3-DEV-72301: The output power of the Radio Unit feeding a Passive DAS chain shall be set so all the CBSDs (all the TPs) in the same Passive DAS chain association will transmit with an EIRP equal or below to their Granted EIRP from the SAS.

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

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

Not applicable for this version of this document

Appendix A: Revision History

Document History		
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