



CBRS Operational and Functional Requirements (Release 2)

Document WINNF-TS-1001

Version V1.1.0

2 April 2020



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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 discovery/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 may 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.

Note that the capability exchange protocol may be extended to proprietary features implemented by SASs and/or CBSDs through the same interface.

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.

The requirements in Section 6 propose solutions to address inter-release operability as noted above and the Annexes are requirements for optional Release 2 features (unless otherwise stated). The adoption of certain Release 2 optional features may impact the certification status of SAS and/or CBSD.

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

Any previously undefined terms and abbreviations first used in the current version of this document are defined below. 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 Release 1.
- 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.

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 change of Release 2 optional features with all other Release 2 SASs.

REL2-R3-SGN-06: SAS Use of Release 2 Features for IAP, DPA Move List or FSS Purge List

- 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 IAP, DPA Move List, or FSS Purge List calculation associated with that Protected Entity or DPA.
- b. The SAS shall apply the optional Release 2 feature for IAP and DPA move list only if it has been certified that the use of the optional feature will not negatively impact the protection of higher tier users.

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 IAP, DPA Move List, or FSS Purge List calculation associated with that 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 (suspend or terminate radio transmission, channel assignment, power assignment, power reduction, and channel switch) from a Release 1 SAS.

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 change 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, WINNF-TS-0112 available at:
<https://cbcs.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

Annex 1. Single Frequency Group (Optional)

Annex 1.1 Feature Description

A Single Frequency Group (“SFG”) is a set of CBSDs that require a common radio frequency assignment and reassignment when frequency reassignment is necessary.

Annex 1.2 Types of group and rationale for the requirement

Three types of SFG are recognized, Principal-Subordinate, Interdependent, and Separable.

Annex 1.2.1 Principal-Subordinate Single Frequency Groups

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 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.

Note 1: BTS CBSDs and their Subordinate CPE-CBSDs in the same Principal-Subordinate SFG are allocated the same spectrum by the SAS and are reassigned to the same spectrum in concert when reassignment is warranted. Subordinate CBSDs incapable of being reassigned to suitable spectrum will cease operation until they are capable of being assigned a Grant that coincides with the BTS-CBSD in control of their communication link.

Note 2: 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.

Note 3: A Principal-Subordinate Group is created by the Principal and later joined, and exited, by Subordinates.

Annex 1.2.2 Interdependent Single Frequency Groups

Interdependent SFGs are sets of CBSDs that are required by their hardware to operate on a single frequency, and whose members are not individually addressed by the SAS, e.g. some Distributed Antenna System (DAS) deployments.

Note: These devices must be reassigned together when frequency reassignment is necessary. If it is not possible for the SAS to move the entire group to a new frequency due, for example, to the requirement of Incumbent or PAL protection, the entire group could have to stop operating.

Annex 1.2.3 Separable Single Frequency Groups

Separable SFGs are sets 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, e.g. an active DAS deployment.

Note: The CBSDs in a Separable SFG will always be assigned to operate on a common frequency. If it is not possible for the SAS to move the entire group to a new frequency, e.g. due to incumbent or PAL protection, the SAS may reassign some members of the group to a new frequency while requiring others to cease transmitting or reduce power, if such transmit power control is supported. The ability of the CBSD to control transmit power may be provided in the device parameters recorded during registration.

Annex 1.3 SAS General Requirements (SGN)

REL2-R3-SGN-130 SFG frequency assignment SHALL be processed by the SAS.

Annex 1.4 System Registration Requirements (SRR)

REL2-R3-SRR-140 Membership of a Single Frequency Group

- a. An individual CBSD may be a member of one of three types of SFGs.
 - Principal-Subordinate SFG
 - Interdependent SFG
 - Separable SFG
- b. SFG membership shall be persistent after a frequency reassignment.
- c. A CBSD shall retain its group assignment whether or not it receives a Grant when a frequency reassignment is required, unless it requests the change.
- d. All members of an SFG shall be managed by the same SAS.

REL2-R3-SRR-141 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.

REL2-R3-SRR-142 Interdependent Single Frequency Group.

- a. 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.
- b. 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.

REL2-R3-SRR-143 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 2. 2D Antenna Patterns (Optional)

Annex 2.1 Feature Description

This section specifies requirements on how CBSD two-dimensional antenna patterns should be specified and used in the SAS to calculate CBSD antenna gain in a certain direction.

Annex 2.2 SAS General Requirements (SGN)

REL2-R3-SGN-220: CBSD Antenna Gain in Aggregate Interference Calculation Using 2D Antenna Patterns. If a 2D antenna pattern of a CBSD described in REL2-R3-DEV-230 is available to the SAS, the SAS shall follow the following procedure to calculate the CBSD antenna gain toward the receiver of a protected entity:

- a. To ensure proper protection of protected entities, SAS admins may work with CBSD users to mutually agree on a lower bound to the antenna gain of the 2D antenna patterns described in [REL2-R3-DEV-230].
- 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-230, 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 $\theta = \alpha - az$ (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.

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

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

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

- iv. 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-230, the SAS shall calculate the horizontal antenna pattern as follows:

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

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

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

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

With $G_H(\cdot)$ and $G_V(\cdot)$ calculated above, the SAS shall follow step 4.a to 4.c to calculate the CBSD antenna gain toward an azimuth angle, α , and an elevation angle, β .

- e. 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-230, the CBSD antenna gain toward the receiver shall be generated using the following equation.

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

where $G_{2D}(\theta_1, \varphi_1)$, $G_{2D}(\theta_1, \varphi_2)$, $G_{2D}(\theta_2, \varphi_1)$, and $G_{2D}(\theta_2, \varphi_2)$ are values in $G_{2D}(\cdot, \cdot)$. 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-221: SAS may use 2D antenna patterns for GAA coexistence purposes in Release 2.

Note: Use of 2D antenna pattern for other purposes is for further study.

REL2-R3-SGN-222: 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-220(e);
- b. otherwise, if both the horizontal and the vertical antenna patterns are available, method specified in REL2-R3-SGN-220(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-220(d)(iv);
- d. otherwise, if the horizontal antenna pattern is available and the vertical antenna pattern is not available, method specified in REL2-R3-SGN-220(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].

Annex 2.3 **CBSD and EUD Requirements (DEV)**

REL2-R3-DEV-230: Utilizing 2D Antenna Patterns for Interference Calculations. To allow SAS utilizing 2D antenna patterns for interference calculation, CBSDs or CBSD registrants shall provide necessary CBSD registration information in one of the following two ways:

- a. A CBSD or a CBSD registrant may provide a specific antenna model used by the CBSD during CBSD registration, which allows SAS to find one of the following antenna information from 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 antenna orientation, static beamforming, and electrical downtilt.
- b. A CBSD or a CBSD registrant may provide the peak antenna gain and the 3 dB beamwidths of the horizontal and vertical antenna patterns during CBSD registration.

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.