



**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)**

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Extensions to Spectrum Access System (SAS) - Citizens Broadband Radio Service Device (CBSD) Interface Technical Specification (Release 2)

1 Introduction

This document is the technical specification of the extended signaling protocol and procedures for the SAS-CBSD Interface. As a prerequisite or foundation, any readers should use this specification together with WINNF-TS-0016 [n.1].

2 Scope

The scope of this document is to specify the extensions to the SAS-CBSD Interface in accordance with WINNF-TS-0016 [n.1] and requirements specified in WINNF-TS-0112 [n.2] and WINNF-TS-1001 [n.3].

The key words "required", "shall", "shall not", "should", "should not", "recommended", "may", and "optional" in this document are to be interpreted as described in RFC-2119 [n.4]. In addition, the key word "conditional" shall be interpreted to mean that the definition is an absolute requirement of this specification only if the stated condition is met.

3 References

3.1 Normative references

The following referenced documents are necessary for the application of the present document.

- [n.1] WINNF-TS-0016-V1.2.4, "Signaling Protocols and Procedures for Citizens Broadband Radio Service (CBRS): Spectrum Access System (SAS) - Citizens Broadband Radio Service Device (CBSD) Interface Technical Specification", Wireless Innovation Forum
- [n.2] WINNF-TS-0112, "Requirements for Commercial Operation in the U.S. 3550-3700 MHz Citizens Broadband Radio Service Band", Wireless Innovation Forum
- [n.3] WINNF-TS-1001, "CBRS Operational and Functional Requirements (Release 2)", Wireless Innovation Forum
- [n.4] [RFC-2119](#), "Key words for use in RFCs to Indicate Requirement Levels", March 1997.
- [n.5] WINNF-SSC-0011, "Spectrum Sharing Committee Policy and Procedure SSC Abbreviations and Definitions", Wireless Innovation Forum
- [n.6] WINNF-SSC-0012, "WInnForum Registry of Third-Party Proprietary Features", Wireless Innovation Forum
- [n.7] Electronic Code of Federal Regulations, Title 47, Chapter I, Subchapter D, Part 96 Citizens Broadband Radio Service, <https://www.ecfr.gov/cgi-bin/text-idx?node=pt47.5.96>
- [n.8] [RFC-7542](#), "The Network Access Identifier", DeKok, May 2015
- [n.9] Electronic Code of Federal Regulations, Title 47, Chapter I, Subchapter A, Part 2, Subpart J, §2.926 FCC identifier, https://www.ecfr.gov/cgi-bin/text-idx?node=se47.1.2_1926

- [n.10] Electronic Code of Federal Regulations, Title 47, Chapter I, Subchapter A, Part 2, Subpart D, §2.302 Call signs, https://www.ecfr.gov/cgi-bin/text-idx?node=se47.1.2_1302
- [n.11] WINNF-SSC-0002, “Signaling Protocols and Procedures for Citizens Broadband Radio Service (CBRS): WinnForum Recognized CBRS Air Interfaces and Measurements”, Wireless Innovation Forum
- [n.12] WINNF-SSC-0010, “WinnForum Recognized CBRS Grouping Parameters Document”, Wireless Innovation Forum
- [n.13] NGA.STND.0036_1.0.0_WGS84 (Version 1.0.0 - July 8, 2014): Department of Defense (DoD) World Geodetic System (WGS) 1984
- [n.14] [RFC-7515](#), “JSON Web Signature (JWS)”, Jones, Bradley and Sakimura, May 2015
- [n.15] [RFC-4648](#), “The Base16, Base32, and Base64 Data Encodings”, Josefsson, October 2006
- [n.16] [RFC-3339](#), "Date and Time on the Internet: Timestamps", Klyne, Newman, July 2002
- [n.17] [RFC-7159](#), “The JavaScript Object Notation (JSON) Data Interchange Format”, December 2017
- [n.18] [RFC-3986](#), “Uniform Resource Identifier (URI): Generic Syntax”, Berners-Lee, Fielding, Masinter, January 2005
- [n.19] [RFC-1035](#), “Domain Names - Implementation and Specification”, Mockapetris, November 1987
- [n.20] [RFC-2818](#), “HTTP Over TLS”, Rescorla, May 2000
- [n.21] [RFC-2616](#), “Hypertext Transfer Protocol -- HTTP/1.1”, Fielding, Gettys, Mogul, Frystyk, Masinter, Leach and Berners-Lee, June 1999
- [n.22] [RFC-7231](#), “Hypertext Transfer Protocol (HTTP/1.1): Semantics and Content”, Fielding, Reschke, June 2014

4 Definitions and abbreviations

4.1 Abbreviations

For the purposes of the present document, the abbreviations and definitions given in [n.5] and the following apply.

FID Feature ID

4.2 Definitions

For the purposes of the present document, the abbreviations and definitions given in [n.5] and the following apply.

Authorized State: The state of a Grant where it is currently approved by the SAS and that the radio transmission using the Grant is allowed to occur.

Common Feature Capability List: A Feature Capability List that consists of names of functional features supported by both a CBSD and the managing SAS.

Feature Capability List: A list of Feature IDs, defined in this document or WINNF-SSC-0012 [n.6], which a SAS or a CBSD supports for its operation.

Feature ID: A string identifying the name of a Release 2 feature.

Feature-REG-Conditional: This parameter is defined as a REG-Conditional and is specifically associated to one of the Release 2 features.

Granted State: The state of a Grant where it is currently approved by the SAS but radio transmission using the Grant is not permitted.

Registered State: The state of a CBSD where it is currently registered with a SAS.

Unregistered State: The state of a CBSD where it is not currently registered with a SAS.

5 Architecture of SAS-CBSD Interfaces

5.1 Baseline Architecture

There is no change concerning the architecture from WINNF-TS-0016 [n.1].

6 Features for Release 1 Procedure Enhancements

6.1 General

Section 6 defines the procedure enhancements for the SAS-CBSD Interface. Minimum requirements to claim compliance with WinForum Release 2 SAS-CBSD Protocol specified in this document are the following:

- To support Feature Capability Exchange as specified in section 6.2;
- To support “RELEASE 2 ENHANCEMENT” parameters marked as “*Mandatory*”;
- To support “RELEASE 2” parameters marked as “*Mandatory*”; and
- To support “RELEASE 2” response codes marked as “*Mandatory*”.

NOTE: Labels “RELEASE 2 ENHANCEMENT” and “RELEASE 2” are defined in section 8.1.1 of this document.

6.2 Feature Capability Exchange

6.2.1 General

This section defines Feature Capability Exchange which ensures backward and forward compatibility between different releases of SAS and CBSD. Section 6.2.2 gives backward and forward compatibility principles of inter-release operation. Section 6.2.3 defines details of Feature Capability Exchange and the required procedure. Feature Capability Exchange shall facilitate the exchange of both WinForum defined Feature IDs and proprietary Feature IDs. WinForum defined Feature IDs (starting with “WF_”) are specified in this document starting with section 6.3. Proprietary Feature IDs are included in WINNF-SSC-0012 [n.6].

6.2.2 Backward and Forward Compatibility Principles of Inter-Release Operation

6.2.2.1 Exchange of Feature Capability List

To allow predictable operation between SASs and CBSDs supporting different releases of SAS-CBSD protocols, the SAS-CBSD protocol in this specification is designed to be backward and forward compatible. To ensure backward compatibility, any SAS and CBSD beyond Release 1 shall exchange

Feature Capability List over the SAS-CBSD interface upon registration and upon change in the supported features. The recipient shall ignore unrecognized feature names received in the Feature Capability List. If a CBSD does not share its Feature Capability List with a SAS, the SAS shall treat the CBSD as a Release 1 CBSD and shall not send its Feature Capability List to the CBSD. Likewise, if a SAS does not share its Feature Capability List with a CBSD, the CBSD shall treat the SAS as a Release 1 SAS.

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

6.2.2.2 Inclusion of Feature-Specific Parameters

Feature specific parameters are always Conditional, Optional, or Feature-REG-Conditional and identified with the corresponding feature name. The message recipient shall ignore a parameter if the parameter name is unrecognized or the recipient did not indicate support for the feature associated with the parameter.

6.2.3 Details of Feature Capability List and Data Exchange

6.2.3.1 Exchange of Feature Capability List in the CBSD Registration Procedure

After exchanging Feature Capability List during CBSD Registration procedure, a Common Feature Capability List shall be established. The Common Feature Capability List will be used for Feature Data Exchange Procedure as specified in section 6.2.3.2.

6.2.3.2 Feature Data Exchange Procedure

Feature Data Exchange Procedure is a procedure for CBSDs in *Registered* State to exchange supported FIDs and associated feature-specific data with the managing SAS. The managing SAS can request CBSD re-registration if e.g. the CBSD supported feature list is updated.

Figure 1 shows message flow diagram of Feature Data Exchange Procedure.

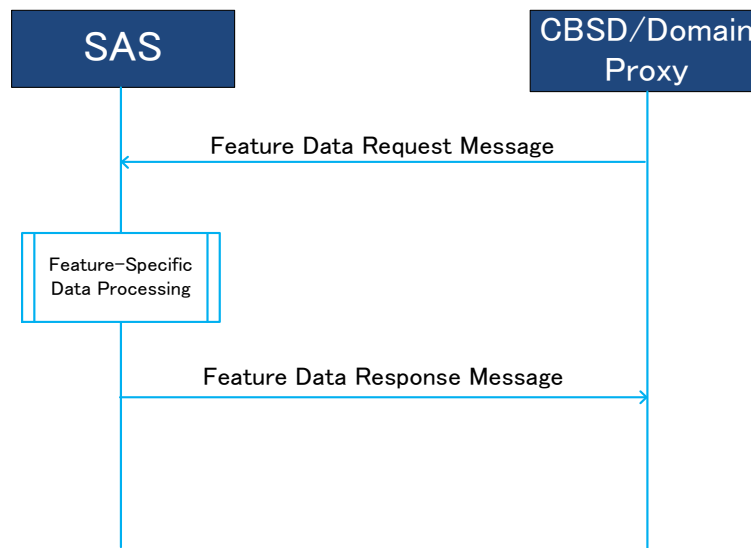


Figure 1: Message flow diagram of Feature Data Exchange Procedure

This procedure consists of three steps:

- Feature Data Request Message from CBSD/DP to SAS
- Feature-specific data processing at SAS
- Feature Data Response Message from SAS to CBSD/DP

6.2.3.2.1 Feature Data Request Message

This procedure may be initiated for CBSD in *Registered* State at any time. The managing SAS may indicate the CBSD to initiate the Feature Data Exchange Procedure through responses of CBSD Spectrum Inquiry Procedure, CBSD Grant Procedure, CBSD Heartbeat Procedure and CBSD Grant Relinquishment Procedure. If CBSD receives this configuration request from the managing SAS, the Feature Data Exchange Procedure shall be initiated by CBSD/DP.

Feature Data Request Message contains feature-specific data of CBSD corresponding to the features in the Common Feature Capability List.

6.2.3.2.2 Feature-Specific Data Processing

After receiving Feature Data Request Message from the CBSD/DP, the SAS identifies and generates its feature-specific data corresponding to the feature-specific data of the CBSD.

6.2.3.2.3 Feature Data Response Message

After the feature-specific data processing, the SAS shall generate and send a Feature Data Response Message to the requesting CBSD/DP. If the feature-specific data processing is completed successfully, the feature-specific data of the SAS is included in the Feature Data Response Message.

Regardless of the result, the response carries an indication of the result of the feature-specific data processing. The applicable response codes are as follows:

- 0 (SUCCESS)

- 101 (BLACKLISTED)
- 102 (MISSING_PARAM)
- 103 (INVALID_VALUE)
- 105 (DEREGISTER)
- 106 (NOT_PROCESSED)
- A range of 600 – 699 is reserved for Feature Data Exchange Procedure.

6.3 Enhanced CBSD Group Handling (FID: WF_ENHANCED_GROUP_HANDLING)

6.3.1 General

This feature supports the exchange of information between CBSD/DP and SAS by using Grouping Information objects. The registered list of group types and their information is documented in WINNF-SSC-0010 [n.12].

This feature does not specify support of any of the particular types/values of grouping information listed in [n.12]; it only supports the capability to exchange the *GroupParam* and *GroupConfig* objects.

6.3.2 Release 2 Feature Dependencies and Interworking

There is no dependency on other features.

6.3.3 Description

There are two types of Grouping Information objects defined in WINNF-SSC-0010 [n.12]:

- *GroupParam*: used to communicate grouping information from the CBSD/DP to SAS;
- *GroupConfig*: used to communicate grouping configuration from SAS to CBSD/DP.

The Enhanced CBSD Group Handling feature can be used only when both the SAS and the CBSD/DP indicate support for this feature in the Feature Capability Exchange. In this case, a CBSD/DP can initiate a Group information exchange, for the Group types it supports, by including the *GroupParam* objects. In case the SAS also supports the included Group types received from CBSD, it may respond with a *GroupConfig* object in the corresponding response message [n.12].

If a SAS is a Release 2 SAS and it supports the Enhanced CBSD Group Handling feature but it does not support some of the Groups in the *groupingParam* parameter of a request message sent by a CBSD/DP, the SAS shall indicate unsupported Groups by using the *groupingConfig* parameter in the corresponding response message as specified in the WINNF-SSC-0010 [n.12].

7 Extensions to Message Encoding and Transport

7.1 SAS URLs of Different Releases

A SAS administrator may choose to use the same or different URLs for transporting messages defined in different releases of SAS-CBSD protocols. A SAS administrator shall ensure that all operational URLs are able to properly receive and respond to request messages from CBSDs supporting different releases of SAS-CBSD protocols pursuant to the backward and forward compatibility principles described in section 6.2.2.

7.2 SAS Method Names

Mapping of SAS-CBSD messages, the corresponding JSON array names and corresponding SAS method names shall be defined as per the following table.

Table 2: Mapping of SAS-CBSD Messages to JSON Array Names

sas_method_name	Release	SAS-CBSD Message Name	JSON Array Name
registration	Rel.1	Registration Request Message	<i>registrationRequest</i>
		Registration Response Message	<i>registrationResponse</i>
featureData	Rel.2	Feature Data Request Message	<i>featureDataRequest</i>
		Feature Data Response Message	<i>featureDataResponse</i>
spectrumInquiry	Rel.1	Spectrum Inquiry Request Message	<i>spectrumInquiryRequest</i>
		Spectrum Inquiry Response Message	<i>spectrumInquiryResponse</i>
grant	Rel.1	Grant Request Message	<i>grantRequest</i>
		Grant Response Message	<i>grantResponse</i>
heartbeat	Rel.1	Heartbeat Request Message	<i>heartbeatRequest</i>
		Heartbeat Response Message	<i>heartbeatResponse</i>
relinquishment	Rel.1	Relinquishment Request Message	<i>relinquishmentRequest</i>
		Relinquishment Response Message	<i>relinquishmentResponse</i>
Deregistration	Rel.1	Deregistration Request Message	<i>deregistrationRequest</i>
		Deregistration Response Message	<i>deregistrationResponse</i>

SAS method name shall be used in the SAS URL for the SAS-CBSD Interface as defined in WINNF-TS-0016 [n.1].

8 Baseline Parameters of SAS-CBSD Messages and Extensions

8.1 General

Section 8 defines baseline parameters of SAS-CBSD messages and the extensions specified in section 6.

8.1.1 Label for Extension Parameters and Response Codes

Parameters concerning the extensions specified in section 6 shall be described with the following column format:

Table 3: Column Format for Extension Parameters

Parameter
NAME: [Name of extension parameter] DATA TYPE: [One of JSON Data Types specified in section 8.1.2] EXTENSION TYPE: [“RELEASE 2 ENHANCEMENT” or “RELEASE 2”] FEATURE ID: [Feature ID(s) or <i>Mandatory</i>]

The label “**EXTENSION TYPE**” describes which types of extensions are made. The followings are the definitions of acceptable values for this label:

- “RELEASE 2 ENHANCEMENT”: Parameters and response codes which were defined originally in Release 1 [n.1] and which have the definitions extended or modified only for the purpose of Release 2 operation. Extended or modified definitions are captured in the Parameter Information column of the table.
- “RELEASE 2”: Parameters and response codes which do not exist in Release 1 [n.1] and which are defined for the purpose of Release 2 operation.

The label “**FEATURE ID**” describes in which specific features this parameter is used. The acceptable values are WinForum defined FIDs or “*Mandatory*”, where “*Mandatory*” means that the parameter does not depend on any specific feature and shall be supported for Release 2 operation.

These labels and their values are also used for the definitions of extension or modified response codes in Table 46.

Any parameter and response code which does not have labels “FEATURE ID” and “EXTENSION TYPE” is specified in WINNF-TS-0016 [n.1] and its description is reproduced in sections starting from section 8.2 for information only.

8.1.2 JSON Data Type

A parameter value can be one of the primitive JSON data types, i.e., string, number, boolean, array, or object. If a parameter is an object, a name for the object is given and a separate table describes parameters in the object. If an object is defined in other document, definition of the object is left to such document and the citation is put following to the name of the object.

8.1.3 Parameter Inclusion Criteria

Each parameter is indicated as “Required”, “Optional” or “Conditional”. The definitions of these indicators are as follows:

- “**Required**”: The parameter shall always be included in the message.
- “**Optional**”: The parameter may be included in the message.
- “**Conditional**”: The parameter shall be included in the message if and only if the specified conditions are satisfied.

The tables of parameters in this section have a column marked R/O/C that indicates whether the particular parameter is required, optional, or conditional.

8.1.4 REG-Conditional Registration Parameters

REG-Conditional Registration Parameter is a parameter that is required by the SAS to complete the CBSD registration process but may be omitted in the *RegistrationRequest* object. If not included in the *RegistrationRequest* object, the parameter, to the extent that it is needed by the SAS to satisfy the 47 CFR Part 96 [n.7], shall be provided to the SAS by other means outside the protocol specified in this document, e.g., it may be provided by a CPI as required by 47 CFR Part 96 [n.7] for Category B CBSDs or CBSDs without automatic location determination, or for operational reasons. Other means based on CBSD device characteristics that are beyond the scope of this specification, are not precluded from use.

Such parameters are labeled as “REG-Conditional” in a column marked R/O/C.

8.2 Registration Request Message

Table 4: Registration Request Message

Parameter	R/O/C	Parameter Information
NAME: <i>registrationRequest</i> DATA TYPE: array of object: <i>RegistrationRequest</i>	Required	Array of <i>RegistrationRequest</i> data objects. Each <i>RegistrationRequest</i> data object represents a registration request of a CBSD.

8.2.1 RegistrationRequest object

Table 5: RegistrationRequest Object Definition

Parameter	R/O/C	Parameter Information
NAME: <i>userId</i> DATA TYPE: string	Required	The User Registration Identifier (UR-ID) per [n.2] R2-SRR-02 conformant per section 2.2 of [n.8].
NAME: <i>fccId</i> DATA TYPE: string	Required	The FCC certification identifier of the CBSD. The value is a string of up to 19 characters as described in [n.9].
NAME: <i>cbSDSerialNumber</i> DATA TYPE: string	Required	A serial number assigned to the CBSD by the CBSD device manufacturer having a maximum length of 64 octets. This serial number shall be unique for every CBSD instance sharing the same value of the <i>fccId</i> . Each CBSD has a single CBSD Antenna and has a single <i>cbSDSerialNumber</i> . NOTE: See definition of CBSD Antenna in [n.5].
NAME: <i>callSign</i> DATA TYPE: string	Optional	A device identifier provided by the FCC per [n.10]. NOTE: This parameter is FFS.

Parameter	R/O/C	Parameter Information
NAME: <i>cbsdCategory</i> DATA TYPE: string	REG- Conditional	Device Category of the CBSD. Allowed values are “A” or “B” as defined in Part 96 [n.7].
NAME: <i>cbsdInfo</i> DATA TYPE: object: <i>CbsdInfo</i>	Optional	Information about this CBSD model.
NAME: <i>airInterface</i> DATA TYPE: object: <i>AirInterface</i>	REG- Conditional	A data object that includes information on the air interface technology of the CBSD.
NAME: <i>installationParam</i> DATA TYPE: object: <i>InstallationParam</i>	REG- Conditional	A data object that includes information on CBSD installation.
NAME: <i>measCapability</i> DATA TYPE: array of string	REG- Conditional	The array of string lists measurement reporting capabilities of the CBSD. The permitted enumerations are specified in [n.11].
NAME: <i>groupingParam</i> DATA TYPE: array of object: <i>GroupParam</i> EXTENSION TYPE: RELEASE 2 ENHANCEMENT FEATURE ID: WF_ENHANCED_GROUP_HANDLING	Optional	An array of data objects that includes information on CBSD grouping. For Release 2 operation, see <i>GroupParam</i> object details in WINNF-SSC-0010 [n.12]. For Release 1 operation, see <i>GroupParam</i> object definition and permitted enumerations in WINNF-TS-0016 [n.1].
NAME: <i>cpiSignatureData</i> DATA TYPE: object: <i>CpiSignatureData</i>	Optional	The CPI is vouching for the parameters included in this object. In addition, the digital signature for these parameters is included.
NAME: <i>cbsdFeatureCapabilityList</i> DATA TYPE: array of string EXTENSION TYPE: RELEASE 2 FEATURE ID: <i>Mandatory</i>	Required	This parameter represents CBSD’s Feature Capability List containing zero or more FIDs. FIDs shall be conformant with those described in the headings of sections specifying features in section 6 of this document or WINNF-SSC-0012 [n.6]. This parameter shall be included if the CBSD supports any Release 2 functionality. If it is not included, the CBSD is treated as a Release 1 CBSD according to section 6.2.2 of this document.

NOTE: JSON format of *cbsdFeatureCapabilityList* parameter is according to the following:

“cbsdFeatureCapabilityList”: [] (for zero FID) OR

"cbsdFeatureCapabilityList": ["FID_1"] OR

"cbsdFeatureCapabilityList": ["FID_1", "FID_2", "FID_3"]

8.2.2 *AirInterface* object

Table 6: *AirInterface* Object Definition

Parameter	R/O/C	Parameter Information
NAME: <i>radioTechnology</i> DATA TYPE: string	REG-Conditional	This parameter specifies the radio access technology that the CBSD uses for operation in the CBRS band. The permitted values are specified in [n.11].

8.2.3 *InstallationParam* object

Table 7: *InstallationParam* Object Definition

Parameter	R/O/C	Parameter Information
NAME: <i>latitude</i> DATA TYPE: number	REG-Conditional	Latitude of the CBSD Antenna location in degrees relative to the WGS 84 datum [n.13]. The allowed range is from -90.000000 to +90.000000 and the values are specified using 6 digits to the right of the decimal point. Positive values represent latitudes north of the equator; negative values south of the equator. NOTE: Use of WGS84 will also satisfy the NAD83 positioning requirements for CBSDs with the accuracy specified by 47 CFR Part 96 [n.7]. For reporting the CBSD location to the FCC, the SAS is responsible for converting coordinates from the WGS84 datum to the NAD83 datum.

Parameter	R/O/C	Parameter Information
NAME: <i>longitude</i> DATA TYPE: number	REG-Conditional	Longitude of the CBSD Antenna location in degrees relative to the WGS84 datum [n.13]. The allowed range is from -180.000000 to +180.000000 and the values are specified using 6 digits to the right of the decimal point. Positive values represent longitudes east of the prime meridian; negative values west of the prime meridian. NOTE: Use of WGS84 will also satisfy the NAD83 positioning requirements for CBSDs with the accuracy specified by 47 CFR Part 96 [n.7]. For reporting the CBSD location to the FCC, the SAS is responsible for converting coordinates from the WGS84 datum to the NAD83 datum.
NAME: <i>height</i> DATA TYPE: number	REG-Conditional	The CBSD Antenna height in meters. When the value of <i>heightType</i> parameter value is “AGL”, the antenna height should be given relative to ground level. When the <i>heightType</i> parameter value is “AMSL”, it is given with respect to WGS84 datum. For reporting the CBSD location to the FCC, the SAS is responsible for converting coordinates from the WGS84 datum to the NAD83 datum.
NAME: <i>heightType</i> DATA TYPE: string	REG-Conditional	The value should be “AGL” or “AMSL”. AGL height is measured relative to the ground level. AMSL height is measured relative to the mean sea level.
NAME: <i>horizontalAccuracy</i> DATA TYPE: number	Optional	A positive number in meters to indicate accuracy of the CBSD antenna horizontal location. This optional parameter should only be present if its value is less than the FCC requirement of 50 meters.
NAME: <i>verticalAccuracy</i> DATA TYPE: number	Optional	A positive number in meters to indicate accuracy of the CBSD antenna vertical location. This optional parameter should only be present if its value is less than the FCC requirement of 3 meters.

Parameter	R/O/C	Parameter Information
NAME: <i>indoorDeployment</i> DATA TYPE: boolean	REG-Conditional	Whether the CBSD antenna is deployed indoor or not. <ul style="list-style-type: none"> ▪ true: indoor. ▪ false: outdoor.
NAME: <i>antennaAzimuth</i> DATA TYPE: number	REG-Conditional	Boresight direction of the horizontal plane of the antenna in degrees with respect to true north. The value of this parameter is an integer with a value between 0 and 359 inclusive. A value of 0 degrees means true north; a value of 90 degrees means east. This parameter is Optional for Category A CBSDs and REG-Conditional for Category B CBSDs.
NAME: <i>antennaDowntilt</i> DATA TYPE: number	REG-Conditional	Antenna down tilt in degrees and is an integer with a value between -90 and +90 inclusive; a negative value means the antenna is tilted up (above horizontal). This parameter is Optional for Category A CBSDs and REG-Conditional for Category B CBSDs.
NAME: <i>antennaGain</i> DATA TYPE: number EXTENSION TYPE: RELEASE 2 ENHANCEMENT FEATURE ID: <i>Mandatory</i>	REG-Conditional	Peak antenna gain in dBi. This parameter is an integer with a value between -127 and +128 (dBi) inclusive. In Release 2, this parameter can also be a floating-point value.
NAME: <i>eirpCapability</i> DATA TYPE: number EXTENSION TYPE: RELEASE 2 ENHANCEMENT FEATURE ID: <i>Mandatory</i>	Optional	This parameter is the maximum CBSD EIRP in units of dBm/10MHz and is an integer with a value between -127 and +47 (dBm/10MHz) inclusive. If not included, SAS interprets it as maximum allowable EIRP in units of dBm/10MHz for CBSD category. In Release 2, this parameter can also be a floating-point value.
NAME: <i>antennaBeamwidth</i> DATA TYPE: number	REG-Conditional	3-dB antenna beamwidth of the antenna in the horizontal-plane in degrees. This parameter is an unsigned integer between 0 and 360 (degrees) inclusive. It is Optional for Category A CBSDs and REG-Conditional for Category B CBSDs. NOTE: A value of 360 (degrees) means the antenna has an omnidirectional radiation pattern in the horizontal plane.

Parameter	R/O/C	Parameter Information
NAME: <i>antennaModel</i> DATA TYPE: string	Optional	This parameter contains the antenna model. If an external antenna is used, the antenna model is optionally provided. The string has a maximum length of 128 octets.

8.2.4 CbsdInfo object

Table 8: CbsdInfo Object Definition

Parameter	R/O/C	Parameter Information
NAME: <i>vendor</i> DATA TYPE: string	Optional	The name of the CBSD vendor. The maximum length of this string is 64 octets.
NAME: <i>model</i> DATA TYPE: string	Optional	The name of the CBSD model. The maximum length of this string is 64 octets.
NAME: <i>softwareVersion</i> DATA TYPE: string	Optional	Software version of this CBSD. The maximum length of this string is 64 octets.
NAME: <i>hardwareVersion</i> DATA TYPE: string	Optional	Hardware version of this CBSD. The maximum length of this string is 64 octets.
NAME: <i>firmwareVersion</i> DATA TYPE: string	Optional	Firmware version of this CBSD. The maximum length of this string is 64 octets.

NOTE: The *CbsdInfo* object can be extended with other vendor information in additional key-value pairs.

8.2.5 *CpiSignatureData* object

Table 9: *CpiSignatureData* Object Definition

Parameter	R/O/C	Parameter Information
NAME: <i>protectedHeader</i> DATA TYPE: string	Required	The value of this parameter is the BASE64-encoded JOSE protected header. This is a JSON object equivalent to the JWT RS256 method or the ES256 method described in RFC 7515 [n.14]. BASE64 encoding is per RFC 4648 [n.15]. Valid values are equivalent to the JSON: <pre>{ "typ": "JWT", "alg": "RS256" } or { "typ": "JWT", "alg": "ES256" }</pre>
NAME: <i>encodedCpiSignedData</i> DATA TYPE: string	Required	The value of this parameter is the encoded JOSE payload data to be signed by the CPI's private key. This parameter is calculated by taking the BASE64 encoding of a <i>CpiSignedData</i> object according to the procedures as specified in RFC 7515 [n.14].
NAME: <i>digitalSignature</i> DATA TYPE: string	Required	The value of this parameter is the CPI digital signature applied to the <i>encodedCpiSignedData</i> field. This signature is calculated by taking the BASE64URL encoding of the digital signature, prepared according to the procedures in Section 3 of RFC 7515 [n.14], using the algorithm as declared in the <i>protectedHeader</i> field.

NOTE 1: The JOSE JSON Web Signature per RFC 7515 [n.14] is used to ensure data integrity and CPI non-repudiation of the signed parameters.

NOTE 2: The JOSE compact serialization is formed by concatenating the *protectedHeader*, *encodedCpiSignedData* and *digitalSignature* parameters with dot "." characters as described in section 3 of RFC 7515 [n.14].

8.2.6 *CpiSignedData* object

Table 10: *CpiSignedData* Object Definition

Parameter Name	R/O/C	Parameter Information
NAME: <i>fccId</i> DATA TYPE: string	Required	The value of this parameter is the FCC ID of the CBSD. Shall be equal to the <i>fccId</i> parameter value in the enclosing registration request.
NAME: <i>cbsdSerialNumber</i> DATA TYPE: string	Required	The value of this parameter is the CBSD serial number. Shall be equal to the <i>cbsdSerialNumber</i> of the enclosing registration request.
NAME: <i>installationParam</i> DATA TYPE: object: <i>InstallationParam</i>	Required	The value of this parameter is the <i>InstallationParam</i> object containing the parameters being certified by the CPI, and only those.
NAME: <i>professionalInstallerData</i> DATA TYPE: object: <i>ProfessionalInstallerData</i>	Required	The value of this parameter is the data identifying the CPI vouching for the installation parameters included in the <i>installationParam</i> value contained in this object.

8.2.7 *ProfessionalInstallerData* object

Table 11: *ProfessionalInstallerData* Object Definition

Parameter	R/O/C	Parameter Information
NAME: <i>cpiId</i> DATA TYPE: string	Required	The value of this parameter is the ID of the CPI providing information to the SAS. This string has a maximum length of 256 octets.
NAME: <i>cpiName</i> DATA TYPE: string	Required	This parameter contains the human-readable name of the CPI providing information to the SAS. This string has a maximum length of 256 octets.
NAME: <i>installCertificationTime</i> DATA TYPE: string	Required	The value of this parameter is the UTC date and time at which the CPI identified in this object certified the CBSD's installed parameters. It is expressed using the format, YYYY-MM-DDThh:mm:ssZ, as defined by [n.16].

8.2.8 *GroupParam* object

Table 12: *GroupParam* Object Definition

Parameter	R/O/C	Parameter Information
NAME: <i>groupType</i> DATA TYPE: string	Required	Identifies the type of group that the CBSD belongs to. Acceptable values of this parameter are defined in WINNF-SSC-0010 [n.12].
NAME: <i>groupId</i> DATA TYPE: string	Required	Identifies a particular group of the specified type of group (<i>groupType</i>). Acceptable values of this parameter are defined in WINNF-SSC-0010 [n.12].
NAME: <i>groupInfo</i> DATA TYPE: object: <i>GroupInfo</i> EXTENSION TYPE: RELEASE 2 FEATURE ID: WF_ENHANCED_GROUP_HANDLING	Optional	This JSON object is specified by the organization, entity or individual that specifies the <i>groupId</i> . See details of <i>GroupInfo</i> object definition in WINNF-SSC-0010 [n.12].

8.3 Registration Response Message

Table 13: Registration Response Message

Parameter	R/O/C	Parameter Information
NAME: <i>registrationResponse</i> DATA TYPE: array of object: <i>RegistrationResponse</i>	Required	This parameter is an array of <i>RegistrationResponse</i> data objects. Each <i>RegistrationResponse</i> data object represents a registration response to a registration request from a CBSD.

8.3.1 *RegistrationResponse* object

Table 14: *RegistrationResponse* Object Definition

Parameter	R/O/C	Parameter Information
NAME: <i>cbsdId</i> DATA TYPE: string	Conditional	This is a CBRS-wide unique identifier for this CBSD. This parameter shall be included if and only if the <i>responseCode</i> indicates SUCCESS. The CBSD shall set its CBSD identity to the value received in this parameter. The string has a maximum length of 256 octets.

Parameter	R/O/C	Parameter Information
NAME: <i>measReportConfig</i> DATA TYPE: array of string	Optional	<p>The SAS uses this parameter to configure CBSD measurement reporting.</p> <p>The measurement report requested by SAS shall be consistent with the CBSD measurement capabilities reported during the registration request.</p> <p>The CBSD shall report the measurement listed in this array.</p> <p>The permitted enumerations are specified in [n.11].</p>
NAME: <i>groupingConfig</i> DATA TYPE: array of object: <i>GroupConfig</i> EXTENSION TYPE: RELEASE 2 FEATURE ID: WF_ENHANCED_GROUP_HANDLING	Optional	<p>An array of data objects that includes information concerning group configuration.</p>
NAME: <i>sasFeatureCapabilityList</i> DATA TYPE: array of string EXTENSION TYPE: RELEASE 2 FEATURE ID: <i>Mandatory</i>	Conditional	<p>This parameter represents SAS's Feature Capability List containing zero or more FIDs.</p> <p>FIDs shall be conformant with those described in the headings of sections specifying features in section 6 of this document or WINNF-SSC-0012 [n.6].</p> <p>This parameter shall be included if:</p> <ul style="list-style-type: none"> ▪ Response Code is SUCCESS; and ▪ the corresponding <i>RegistrationRequest</i> object included the <i>cbSDFeatureCapabilityList</i> parameter; and ▪ the SAS supports any Release 2 functionality. <p>If this parameter is not included when the response code indicates SUCCESS, the SAS is treated as a Release 1 SAS according to section 6.2.2 of this document.</p> <p>If response code is not SUCCESS, then SAS may optionally include this parameter.</p>
NAME: <i>response</i> DATA TYPE: object: <i>Response</i>	Required	<p>This parameter includes information on whether the corresponding CBSD request is approved or disapproved for a reason. See details in section 8.16.</p>

NOTE: JSON format of *sasFeatureCapabilityList* is similar to the above example JSON format of *cbbsdFeatureCapabilityList*.

8.3.2 Response Object

Table 15: Response Object Definition

Parameter	R/O/C	Parameter Information
NAME: <i>responseCode</i> DATA TYPE: number	Required	An integer to indicate the type of result. The value 0 means the corresponding CBSD request is successful. This shall be one of the values defined in Table 46.
NAME: <i>responseMessage</i> DATA TYPE: string	Optional	A short description of the result.
NAME: <i>responseData</i> DATA TYPE: Dependent on <i>responseCode</i> – see Table 47.	Optional	Additional data can be included to help the CBSD resolve failures.

8.3.3 GroupConfig object

Table 16: GroupConfig Object Definition

Parameter	R/O/C	Parameter Information
NAME: <i>groupType</i> DATA TYPE: string EXTENSION TYPE: RELEASE 2 FEATURE ID: WF_ENHANCED_GROUP_HANDLING	Required	Identifies the type of group that the CBSD belongs to. Acceptable values of this parameter are defined in WINNF-SSC-0010 [n.12].
NAME: <i>groupId</i> DATA TYPE: string EXTENSION TYPE: RELEASE 2 FEATURE ID: WF_ENHANCED_GROUP_HANDLING	Required	Identifies a particular group of the specified type of group (<i>groupType</i>). Acceptable values of this parameter are defined in WINNF-SSC-0010 [n.12].
NAME: <i>supportedBySas</i> DATA TYPE: boolean EXTENSION TYPE: RELEASE 2 FEATURE ID: WF_ENHANCED_GROUP_HANDLING	Conditional	This parameter indicates whether <i>groupType</i> and/or <i>groupId</i> is supported by the SAS. It shall be included if the corresponding request message includes the <i>groupingParam</i> parameter and the indicated <i>groupType</i> and/or <i>groupId</i> are not supported by the SAS. The default value is true. true: supported, false: not supported

Parameter	R/O/C	Parameter Information
NAME: <i>groupConfigInfo</i> DATA TYPE: object: <i>GroupConfigInfo</i> EXTENSION TYPE: RELEASE 2 FEATURE ID: WF_ENHANCED_GROUP_HANDLING	Optional	This JSON object is specified by the organization, entity or individual that specifies the <i>groupId</i> . See details of <i>GroupConfigInfo</i> object definition in WINNF-SSC-0010 [n.12].

8.4 Feature Data Request Message

Table 17: Feature Data Request Message

Parameter	R/O/C	Parameter Information
NAME: <i>featureDataRequest</i> DATA TYPE: array of object: <i>FeatureDataRequest</i> EXTENSION TYPE: RELEASE 2 FEATURE ID: <i>Mandatory</i>	Required	This parameter is an array of <i>FeatureDataRequest</i> data objects. Each <i>FeatureDataRequest</i> data object represents a feature data request from a CBSD.

8.4.1 FeatureDataRequest object

Table 18: FeatureDataRequest Object Definition

Parameter	R/O/C	Parameter Information
NAME: <i>cbidId</i> DATA TYPE: string EXTENSION TYPE: RELEASE 2 FEATURE ID: <i>Mandatory</i>	Required	The CBSD shall set this parameter to the value of its CBSD identity.
NAME: <i>cbidFeatureInfo</i> DATA TYPE: array of object: <i>FeatureInfo</i> EXTENSION TYPE: RELEASE 2 FEATURE ID: <i>Mandatory</i>	Required	This parameter contains one or more datasets containing feature-specific data supported by this CBSD. Each element of this array contains the data related to a feature in the Common Feature Capability Lists.

8.4.2 FeatureInfo object

Table 19: FeatureInfo Object Definition

Parameter	R/O/C	Parameter Information
NAME: <i>featureId</i> DATA TYPE: string EXTENSION TYPE: RELEASE 2 FEATURE ID: <i>Mandatory</i>	Required	This parameter contains the feature identifier. The string value shall be conformant with FIDs specified in this document or WINNF-SSC-0012 [n.5].

Parameter	R/O/C	Parameter Information
NAME: <i>sasFeatureData</i> DATA TYPE: object: <i>FeatureData</i> EXTENSION TYPE: RELEASE 2 FEATURE ID: <i>Mandatory</i>	Optional	This parameter contains the data/parameters associated with the feature. This parameter shall not be included if this <i>FeatureInfo</i> object is used in the <i>FeatureDataRequest</i> object.
NAME: <i>cbsdFeatureData</i> DATA TYPE: object: <i>FeatureData</i> EXTENSION TYPE: RELEASE 2 FEATURE ID: <i>Mandatory</i>	Optional	This parameter contains the data/parameters associated with the feature. This parameter shall not be included if this <i>FeatureInfo</i> object is used in the <i>FeatureDataResponse</i> object.

8.4.3 *FeatureData* object

Table 20: *FeatureData* Object Definition

Parameter	R/O/C	Parameter Information
Definition of this object is left to features to be defined in future revisions of this document.		

8.5 Feature Data Response Message

Table 21: Feature Data Response Message

Parameter	R/O/C	Parameter Information
NAME: <i>featureDataResponse</i> DATA TYPE: array of object: <i>FeatureDataResponse</i> EXTENSION TYPE: RELEASE 2 FEATURE ID: <i>Mandatory</i>	Required	This parameter is an array of <i>FeatureDataResponse</i> data objects. Each <i>FeatureDataResponse</i> data object represents a response to the corresponding feature data request from a CBSD.

8.5.1 *FeatureDataResponse* object

Table 22: *FeatureDataResponse* Object Definition

Parameter	R/O/C	Parameter Information
NAME: <i>cbSDId</i> DATA TYPE: string EXTENSION TYPE: RELEASE 2 FEATURE ID: <i>Mandatory</i>	Conditional	This parameter represents the CBSD identity of the requesting CBSD. This parameter shall be included if and only if the <i>cbSDId</i> parameter in the <i>FeatureDataRequest</i> object is valid. If included, the SAS shall set this parameter to the value of the <i>cbSDId</i> parameter in the corresponding <i>FeatureDataRequest</i> object.
NAME: <i>sasFeatureInfo</i> DATA TYPE: array of object: <i>FeatureInfo</i> EXTENSION TYPE: RELEASE 2 FEATURE ID: <i>Mandatory</i>	Conditional	An array of <i>FeatureInfo</i> objects, each object containing data for a feature in the Common Feature Capability List. This parameter shall be included if and only if the <i>responseCode</i> parameter indicates SUCCESS.
NAME: <i>response</i> DATA TYPE: object: <i>Response</i> EXTENSION TYPE: RELEASE 2 FEATURE ID: <i>Mandatory</i>	Required	This parameter includes information on the outcome of the Feature Data Exchange Procedure.

8.6 Spectrum Inquiry Request Message

Table 23: Spectrum Inquiry Request Message

Parameter	R/O/C	Parameter Information
NAME: <i>spectrumInquiryRequest</i> DATA TYPE: array of object: <i>SpectrumInquiryRequest</i>	Required	Array of <i>SpectrumInquiryRequest</i> objects. Each <i>SpectrumInquiryRequest</i> object represents a spectrum inquiry request of a CBSD.

8.6.1 *SpectrumInquiryRequest* object

Table 24: *SpectrumInquiryRequest* Object Definition

Parameter	R/O/C	Parameter Information
NAME: <i>cbSDId</i> DATA TYPE: string	Required	The CBSD shall set this parameter to the value of the <i>cbSDId</i> parameter obtained in the <i>RegistrationResponse</i> object.

Parameter	R/O/C	Parameter Information
NAME: <i>inquiredSpectrum</i> DATA TYPE: array of object: <i>FrequencyRange</i>	Required	This field describes the spectrum for which the CBSD seeks information on spectrum availability.
NAME: <i>measReport</i> DATA TYPE: object: <i>MeasReport</i>	Conditional	The CBSD uses this parameter to report measurements to the SAS. The format of the <i>MeasReport</i> object is provided in WINNF-SSC-0002 [n.11]. Refer to section 8 of WINNF-TS-0016 [n.1] and WINNF-SSC-0002 [n.11] for inclusion rules.
NAME: <i>groupingParam</i> DATA TYPE: array of object: <i>GroupParam</i> EXTENSION TYPE: RELEASE 2 FEATURE ID: WF_ENHANCED_GROUP_HANDLING	Optional	An array of data objects that includes information on CBSD grouping.

8.6.2 *FrequencyRange* object

Table 25: *FrequencyRange* Object Definition

Parameter	R/O/C	Parameter Information
NAME: <i>lowFrequency</i> DATA TYPE: number	Required	The lowest frequency of the frequency range in Hz.
NAME: <i>highFrequency</i> DATA TYPE: number	Required	The highest frequency of the frequency range in Hz.

8.7 Spectrum Inquiry Response Message

Table 26: Spectrum Inquiry Response Message

Parameter	R/O/C	Parameter Information
NAME: <i>spectrumInquiryResponse</i> DATA TYPE: array of object: <i>SpectrumInquiryResponse</i>	Required	Array of <i>SpectrumInquiryResponse</i> objects. Each <i>SpectrumInquiryResponse</i> object represents a spectrum inquiry response to a spectrum inquiry request of a CBSD.

8.7.1 *SpectrumInquiryResponse* object

Table 27: *SpectrumInquiryResponse* Object Definition

Parameter	R/O/C	Parameter Information
NAME: <i>cbsdId</i> DATA TYPE: string	Conditional	This parameter is included if and only if the <i>cbsdId</i> parameter in the <i>SpectrumInquiryRequest</i> object contains a valid CBSD identity. If included, the SAS shall set this parameter to the value of the <i>cbsdId</i> parameter in the corresponding <i>SpectrumInquiryRequest</i> object.
NAME: <i>availableChannel</i> DATA TYPE: array of object: <i>AvailableChannel</i>	Conditional	This parameter is an array of zero or more <i>AvailableChannel</i> objects, which describes a channel that is available for the CBSD. Included: If and only if the Spectrum Inquiry is successful.
NAME: <i>groupingConfig</i> DATA TYPE: array of object: <i>GroupConfig</i> EXTENSION TYPE: RELEASE 2 FEATURE ID: WF_ENHANCED_GROUP_HANDLING	Optional	An array of data objects that includes information concerning group configuration.
NAME: <i>featureDataExchangeConfig</i> DATA TYPE: boolean EXTENSION TYPE: RELEASE 2 FEATURE ID: <i>Mandatory</i>	Optional	If set to true, the SAS notifies CBSD to initiate Feature Data Exchange Procedure.
NAME: <i>response</i> DATA TYPE: object: <i>Response</i>	Required	This parameter includes information on whether the corresponding CBSD request is approved or disapproved for a reason.

8.7.2 *AvailableChannel* object

Table 28: *AvailableChannel* Object Definition

Parameter	R/O/C	Parameter Information
NAME: <i>frequencyRange</i> DATA TYPE: object: <i>FrequencyRange</i>	Required	This parameter is the frequency range of the available channel.
NAME: <i>channelType</i> DATA TYPE: string	Required	<ul style="list-style-type: none"> ▪ “PAL”: the frequency range is a PAL channel. ▪ “GAA”: the frequency range is for GAA use.

Parameter	R/O/C	Parameter Information
NAME: <i>ruleApplied</i> DATA TYPE: string	Required	The regulatory rule used to generate this response, e.g., "FCC_PART_96".
NAME: <i>maxEirp</i> DATA TYPE: number	Optional	Maximum EIRP likely to be permitted for a Grant on this <i>frequencyRange</i> , given the CBSD registration parameters, including location, antenna orientation and antenna pattern. The maximum EIRP is in the units of dBm/MHz and is an integer or a floating-point value between -137 and +37 (dBm/MHz) inclusive.

8.8 Grant Request Message

A *GrantRequest* object contains operating parameters that the CBSD plans to operate with. Operation parameters include a continuous segment of spectrum and the maximum EIRP.

Table 29: Grant Request Message

Parameter	R/O/C	Parameter Information
NAME: <i>grantRequest</i> DATA TYPE: array of object: <i>GrantRequest</i>	Required	Array of <i>GrantRequest</i> objects. Each <i>GrantRequest</i> object represents a Grant request of a CBSD.

8.8.1 *GrantRequest* object

Table 30: *GrantRequest* Object Definition

Parameter	R/O/C	Parameter Information
NAME: <i>cbsdId</i> DATA TYPE: string	Required	The CBSD shall set this parameter to the value of the <i>cbsdId</i> parameter obtained in the <i>RegistrationResponse</i> object.
NAME: <i>operationParam</i> DATA TYPE: object: <i>OperationParam</i>	Required	This data object includes operation parameters of the requested Grant.
NAME: <i>measReport</i> DATA TYPE: object: <i>MeasReport</i>	Conditional	The CBSD uses this parameter to report measurements to the SAS. The format of the <i>MeasReport</i> object is provided in WINNF-SSC-0002 [n.11]. Refer to section 8 of WINNF-TS-0016 [n.1] and WINNF-SSC-0002 [n.11] for inclusion rules.

Parameter	R/O/C	Parameter Information
NAME: <i>groupingParam</i> DATA TYPE: array of object: <i>GroupParam</i> EXTENSION TYPE: RELEASE 2 FEATURE ID: WF_ENHANCED_GROUP_HANDLING	Optional	An array of data objects that includes information on CBSD grouping.

8.8.2 *OperationParam* object

Table 31: *OperationParam* Object Definition

Parameter	R/O/C	Parameter Information
NAME: <i>maxEirp</i> DATA TYPE: number	Required	Maximum EIRP permitted by the Grant. The maximum EIRP is in the units of dBm/MHz and is an integer or a floating-point value between -137 and +37 (dBm/MHz) inclusive. The value of <i>maxEirp</i> represents the average (RMS) EIRP that would be measured per the procedure defined in §96.41(e)(3) [n.7]..
NAME: <i>operationFrequencyRange</i> DATA TYPE: object: <i>FrequencyRange</i>	Required	This parameter is frequency range of a contiguous segment.

8.9 Grant Response Message

Table 32: Grant Response Message

Parameter	R/O/C	Parameter Information
NAME: <i>grantResponse</i> DATA TYPE: array of object: <i>GrantResponse</i>	Required	Array of <i>GrantResponse</i> objects. Each <i>GrantResponse</i> object represents a Grant response to a Grant request of a CBSD.

8.9.1 *GrantResponse* object

Table 33: *GrantResponse* Object Definition

Parameter	R/O/C	Parameter Information
NAME: <i>cbsdId</i> DATA TYPE: string	Conditional	<p>This parameter is included if and only if the <i>cbsdId</i> parameter in the <i>GrantRequest</i> object contains a valid CBSD identity.</p> <p>If included, the SAS shall set this parameter to the value of the <i>cbsdId</i> parameter in the corresponding <i>GrantRequest</i> object.</p>
NAME: <i>grantId</i> DATA TYPE: string	Conditional	<p>An ID provided by the SAS for this Grant.</p> <p>Included: If and only if the Grant request is approved by the SAS.</p> <p>The CBSD shall set the Grant identity for this Grant to the value received in this parameter.</p>
NAME: <i>grantExpireTime</i> DATA TYPE: string	Conditional	<p>The <i>grantExpireTime</i> indicates the time when the Grant associated with the <i>grantId</i> in this Heartbeat Response expires.</p> <p>This parameter is UTC time expressed in the format, YYYY-MM-DDThh:mm:ssZ as defined by [n.16].</p> <p>This parameter shall be included if the <i>responseCode</i> parameter indicates SUCCESS or SUSPENDED_GRANT and the <i>grantRenew</i> parameter was included and set to True in the corresponding <i>HeartbeatRequest</i> object.</p> <p>This parameter may be included at other times by SAS choice.</p>
NAME: <i>heartbeatInterval</i> DATA TYPE: number	Conditional	<p>This parameter is a positive integer and indicates the maximum time interval in units of seconds between two consecutive heartbeat requests.</p> <p>This parameter is included when the SAS wants to change the heartbeat interval.</p>

Parameter	R/O/C	Parameter Information
NAME: <i>measReportConfig</i> DATA TYPE: array of string	Optional	The SAS uses this parameter to configure CBSD measurement reporting. The measurement report requested by the SAS shall be consistent with the CBSD measurement capabilities reported during the registration request. The CBSD shall report the measurements listed in this array. The permitted enumerations are specified in [n.11].
NAME: <i>operationParam</i> DATA TYPE: object: <i>OperationParam</i>	Optional	If the Grant request is disapproved, using this object the SAS can optionally provide a new set of operation parameters to the CBSD for use in a new Grant request.
NAME: <i>channelType</i> DATA TYPE: string	Conditional	This parameter is included if and only if the <i>responseCode</i> parameter indicates SUCCESS, i.e., the Grant request was successful. <ul style="list-style-type: none"> ▪ “PAL”: the frequency range has been granted as a PAL channel. ▪ “GAA”: the frequency range has been granted for GAA use.
NAME: <i>groupingConfig</i> DATA TYPE: array of object: <i>GroupConfig</i> EXTENSION TYPE: RELEASE 2 FEATURE ID: WF_ENHANCED_GROUP_HANDLING	Optional	An array of data objects that includes information concerning group configuration.
NAME: <i>featureDataExchangeConfig</i> DATA TYPE: boolean EXTENSION TYPE: RELEASE 2 FEATURE ID: <i>Mandatory</i>	Optional	If set to true, the SAS notifies CBSD to initiate Feature Data Exchange Procedure.
NAME: <i>response</i> DATA TYPE: object: <i>Response</i>	Required	This parameter includes information on whether the corresponding CBSD request is approved or disapproved for a reason.

8.10 Heartbeat Request Message

Table 34: Heartbeat Request Message

Parameter	R/O/C	Parameter Information
NAME: <i>heartbeatRequest</i> DATA TYPE: array of object: <i>HeartbeatRequest</i>	Required	Array of <i>HeartbeatRequest</i> objects. Each <i>HeartbeatRequest</i> object represents a heartbeat request of a CBSD.

8.10.1 *HeartbeatRequest* object

Table 35: *HeartbeatRequest* Object Definition

Parameter	R/O/C	Parameter Information
NAME: <i>cbsdId</i> DATA TYPE: string	Required	The CBSD shall set this parameter to the value of the <i>cbsdId</i> parameter obtained in the <i>RegistrationResponse</i> object.
NAME: <i>grantId</i> DATA TYPE: string	Required	The CBSD shall set this parameter to the value of the Grant identity of this Grant.
NAME: <i>grantRenew</i> DATA TYPE: boolean	Optional	If set to True, the CBSD asks for renewal of the current Grant. SAS shall include a <i>grantExpireTime</i> parameter in the following <i>HeartbeatResponse</i> object.
NAME: <i>operationState</i> DATA TYPE: string	Required	This parameter contains the CBSD operation state (“AUTHORIZED” or “GRANTED”).
NAME: <i>measReport</i> DATA TYPE: object: <i>MeasReport</i>	Conditional	The CBSD uses this parameter to report measurements to the SAS. The format of the <i>MeasReport</i> object is provided in WINNF-SSC-0002 [n.11]. Refer to section 8 of WINNF-TS-0016 [n.1] and WINNF-SSC-0002 [n.11] for inclusion rules.
NAME: <i>groupingParam</i> DATA TYPE: array of object: <i>GroupParam</i> EXTENSION TYPE: RELEASE 2 FEATURE ID: WF_ENHANCED_GROUP_HANDLING	Optional	An array of data objects that includes information on CBSD grouping.

8.11 Heartbeat Response Message

Table 36: Heartbeat Response Message

Parameter	R/O/C	Parameter Information
NAME: <i>heartbeatResponse</i> DATA TYPE: array of object: <i>HeartbeatResponse</i>	Required	Array of <i>HeartbeatResponse</i> objects. Each <i>HeartbeatResponse</i> object represents a heartbeat response of a CBSD.

8.11.1 *HeartbeatResponse* object

Table 37: *HeartbeatResponse* Object Definition

Parameter	R/O/C	Parameter Information
NAME: <i>cbsId</i> DATA TYPE: string	Conditional	<p>This parameter is included if and only if the <i>cbsId</i> parameter in the <i>HeartbeatRequest</i> object contains a valid CBSD identity.</p> <p>If included, the SAS shall set this parameter to the value of the <i>cbsId</i> parameter in the corresponding <i>HeartbeatRequest</i> object.</p>
NAME: <i>grantId</i> DATA TYPE: string	Conditional	<p>This parameter is included if and only if the <i>grantId</i> parameter in the <i>HeartbeatRequest</i> object contains a valid Grant identity.</p> <p>If included, the SAS shall set this parameter to the value of the <i>grantId</i> parameter in the corresponding <i>HeartbeatRequest</i> object.</p>
NAME: <i>transmitExpireTime</i> DATA TYPE: string	Required	<p>The CBSD shall cease radio transmission using the SAS authorized radio resource within 60 seconds after the value of the <i>transmitExpireTime</i> parameter expires, in accordance with §96.39(c)(2) [n.7].</p> <p>The <i>transmitExpireTime</i> is UTC time expressed in the format, YYYY-MM-DDThh:mm:ssZ as defined by [n.16].</p> <p>The <i>transmitExpireTime</i> value shall be no later than the value of the <i>grantExpireTime</i> parameter.</p>
NAME: <i>grantExpireTime</i> DATA TYPE: string	Conditional	<p>Required if the <i>responseCode</i> parameter indicates SUCCESS or SUSPENDED_GRANT and the <i>grantRenew</i> parameter was included and set to True in the corresponding <i>HeartbeatRequest</i> object. This parameter may be included at other times by SAS choice.</p>
NAME: <i>heartbeatInterval</i> DATA TYPE: number	Optional	<p>This parameter is a positive integer and indicates the maximum time interval in units of seconds between two consecutive heartbeat requests.</p> <p>This parameter is included when the SAS wants to change the heartbeat interval.</p>

Parameter	R/O/C	Parameter Information
NAME: <i>operationParam</i> DATA TYPE: object: <i>OperationParam</i>	Optional	If heartbeat request is disapproved or the SAS intends to change the CBSD operation parameters, the SAS can provide a new set of operation parameters to the CBSD using this object.
NAME: <i>measReportConfig</i> DATA TYPE: array of string	Optional	<p>The SAS uses this parameter to configure CBSD measurement reporting.</p> <p>The measurement report requested by the SAS shall be consistent with the CBSD measurement capabilities reported during the registration request.</p> <p>The CBSD shall report the measurement listed in this array.</p> <p>The permitted enumerations are specified in WINNF-SSC-0002 [n.11].</p>
NAME: <i>groupingConfig</i> DATA TYPE: array of object: <i>GroupConfig</i> EXTENSION TYPE: RELEASE 2 FEATURE ID: WF_ENHANCED_GROUP_HANDLING	Optional	An array of data objects that includes information concerning group configuration.
NAME: <i>featureDataExchangeConfig</i> DATA TYPE: boolean EXTENSION TYPE: RELEASE 2 FEATURE ID: <i>Mandatory</i>	Optional	If set to true, the SAS notifies CBSD to initiate Feature Data Exchange Procedure.
NAME: <i>response</i> DATA TYPE: object: <i>Response</i>	Required	This parameter includes information on whether the corresponding CBSD request is approved or disapproved for a reason.

8.12 Relinquishment Request Message

Table 38: Relinquishment Request Message

Parameter	R/O/C	Parameter Information
NAME: <i>relinquishmentRequest</i> DATA TYPE: array of object: <i>RelinquishmentRequest</i>	Required	Array of <i>RelinquishmentRequest</i> objects. Each <i>RelinquishmentRequest</i> object Represents a request of a CBSD.

8.12.1 *RelinquishmentRequest* object

Table 39: *RelinquishmentRequest* Object Definition

Parameter	R/O/C	Parameter Information
NAME: <i>cbsdId</i> DATA TYPE: string	Required	The CBSD shall set this parameter to the value of its CBSD identity.
NAME: <i>grantId</i> DATA TYPE: string	Required	The CBSD shall set this parameter to the value of the Grant identity of the Grant.

8.13 **Relinquishment Response Message**

Table 40: Relinquishment Response Message

Parameter	R/O/C	Parameter Information
NAME: <i>relinquishmentResponse</i> DATA TYPE: array of object: <i>RelinquishmentResponse</i>	Required	Array of <i>RelinquishmentResponse</i> objects. Each <i>RelinquishmentResponse</i> object represents a response to a request of a CBSD to relinquish a Grant.

8.13.1 *RelinquishmentResponse* object

Table 41: *RelinquishmentResponse* Object Definition

Parameter	R/O/C	Parameter Information
NAME: <i>cbsdId</i> DATA TYPE: string	Conditional	This parameter is included if and only if the <i>cbsdId</i> parameter in the <i>RelinquishmentRequest</i> object contains a valid CBSD identity. If included, the SAS shall set this parameter to the value of the <i>cbsdId</i> parameter in the corresponding <i>RelinquishmentRequest</i> object.
NAME: <i>grantId</i> DATA TYPE: string	Conditional	This parameter is included if and only if the <i>grantId</i> parameter in the <i>RelinquishmentRequest</i> object contains a valid Grant Identity. If included, the SAS shall set this parameter to the value of the <i>grantId</i> parameter in the corresponding <i>RelinquishmentRequest</i> object.
NAME: <i>featureDataExchangeConfig</i> DATA TYPE: boolean EXTENSION TYPE: RELEASE 2 FEATURE ID: <i>Mandatory</i>	Optional	If set to true, the SAS notifies CBSD to initiate Feature Data Exchange Procedure.

Parameter	R/O/C	Parameter Information
NAME: <i>response</i> DATA TYPE: object: <i>Response</i>	Required	This parameter includes information on whether the corresponding CBSD request is approved or disapproved for a reason.

8.14 Deregistration Request Message

Table 42: Deregistration Request Message

Parameter	R/O/C	Parameter Information
NAME: <i>deregistrationRequest</i> DATA TYPE: array of object: <i>DeregistrationRequest</i>	Required	Array of <i>DeregistrationRequest</i> data objects. Each <i>DeregistrationRequest</i> data object represents a deregistration request of a CBSD.

8.14.1 *DeregistrationRequest* object

Table 43: *DeregistrationRequest* Object Definition

Parameter	R/O/C	Parameter Information
NAME: <i>cbid</i> DATA TYPE: string	Required	The CBSD shall set this parameter to the value of its CBSD identity.

8.15 Deregistration Response Message

Table 44: Deregistration Response Message

Parameter	R/O/C	Parameter Information
NAME: <i>deregistrationResponse</i> DATA TYPE: array of object: <i>DeregistrationResponse</i>	Required	Array of <i>DeregistrationResponse</i> data objects. Each <i>DeregistrationResponse</i> object represents a response to a deregistration request of a CBSD.

8.15.1 *DeregistrationResponse* object

Table 45: *DeregistrationResponse* Object Definition

Parameter	R/O/C	Parameter Information
NAME: <i>cbstdId</i> DATA TYPE: string	Conditional	This parameter is included if and only if the <i>cbstdId</i> parameter in the <i>DeregistrationRequest</i> object contains a valid CBSD identity. If included, the SAS shall set this parameter to the value of the <i>cbstdId</i> parameter in the corresponding <i>DeregistrationRequest</i> object.
NAME: <i>response</i> DATA TYPE: object: <i>Response</i>	Required	This parameter includes information on whether the corresponding CBSD request is approved or disapproved for a reason.

8.16 Response Codes and Data

In the *Response* object of a SAS-CBSD response message, the SAS shall include a *responseCode* parameter to inform the CBSD of the status of the corresponding request. The response codes are grouped into the following categories and defined in the Table 46. The name associated with each *responseCode* parameter is not included in the *Response* object, but can be attached to a *responseCode* parameter by the CBSD or other network entity for logging or human-involved troubleshooting.

CBSD shall support any “RELEASE 2 ENHANCEMENT” and “RELEASE 2” response code whose value of **FEATURE ID** is “Mandatory”. For “RELEASE 2 ENHANCEMENT” and “RELEASE 2” response codes which are associated with a specific feature, CBSD shall support it if the CBSD supports that feature.

0: success

100 – 199: general errors related to the SAS-CBSD Protocol

200 – 299: error events related to the CBSD Registration Procedure

300 – 399: error events related to the CBSD Spectrum Inquiry Procedure

400 – 499: error events related to the CBSD Grant Procedure

500 – 599: error events related to the CBSD Heartbeat Procedure

600 – 699: error events related to the Feature Data Exchange Procedure

NOTE: No response codes for the Feature Data Exchange Procedure are defined in this version of the document.

Table 46: Response Code Definitions

Response Codes	Description
VALUE: 0 NAME: SUCCESS	This response code was defined in WINNF-TS-0016 [n.1]. CBSD request is approved by SAS
VALUE: 100 NAME: VERSION	This response code was defined in WINNF-TS-0016 [n.1]. SAS protocol version used by CBSD is not supported by SAS
VALUE: 101 NAME: BLACKLISTED	This response code was defined in WINNF-TS-0016 [n.1]. CBSD is blacklisted. This <i>responseCode</i> is returned if the CBSD is under a SAS or FCC enforcement action and is barred from CBRS operation. In general, the CBSD should not try to re-register until actions external to this specification are taken. NOTE: Blacklisting behavior by the SAS and CBSD is FFS.
VALUE: 102 NAME: MISSING_PARAM EXTENSION TYPE: RELEASE 2 ENHANCEMENT FEATURE ID: <i>Mandatory</i>	This response code was defined in WINNF-TS-0016 [n.1]. Required parameters missing. In Release 2, this response code is not applicable to missing case of the <i>cbdsFeatureCapabilityList</i> parameter defined in <i>RegistrationRequest</i> object.
VALUE: 103 NAME: INVALID_VALUE	This response code was defined in WINNF-TS-0016 [n.1]. One or more parameters have invalid value
VALUE: 104 NAME: CERT_ERROR	This response code was defined in WINNF-TS-0016 [n.1]. There is an error in the certificate used to make the request (e.g. the credential is of the wrong role). NOTE: Most certificate errors, such as expired or syntactically invalid certificates, will cause errors at the TLS connection.

Response Codes	Description
<p>VALUE: 105 NAME: DEREGISTER</p>	<p>This response code was defined in WINNF-TS-0016 [n.1]. A CBSD receiving this <i>responseCode</i> is automatically deregistered by the SAS. The CBSD shall cease all transmissions, terminate all Grants, and consider itself <i>Unregistered</i>. The SAS may include this <i>responseCode</i> parameter in any message. The <i>responseMessage</i> parameter may contain a string describing the reason for deregistration. See NOTE 1 below.</p>
<p>VALUE: 106 NAME: NOT_PROCESSED EXTENSION TYPE: RELEASE 2 FEATURE ID: <i>Mandatory</i></p>	<p>This response code is defined for Release 2 operation. The SAS cannot provide a proper response to the CBSD request temporarily. The CBSD can resend the same request message or send a different request message after receiving this <i>responseCode</i>. The <i>responseData</i> parameter may carry suggested wait time for the CBSD to resend the request message.</p>
<p>VALUE: 200 NAME: REG_PENDING</p>	<p>This response code was defined in WINNF-TS-0016 [n.1]. Incomplete registration information. The registration process is pending. One or more REG-Conditional parameters have not yet been supplied to the SAS. The CBSD is likely to accomplish a successful registration when the missing registration information is made available to the SAS.</p>
<p>VALUE: 201 NAME: GROUP_ERROR EXTENSION TYPE: RELEASE 2 ENHANCEMENT FEATURE ID: WF_ENHANCED_GROUP_HANDLING</p>	<p>This response code was defined in WINNF-TS-0016 [n.1]. An error has been identified in the grouping parameters of the CBSD. In Release 2, it is also used by feature “Enhanced CBSD Group Handling”. This response code can be used for indicating errors in <i>GroupParam</i> or <i>GroupConfig</i> object.</p>
<p>VALUE: 300 NAME: UNSUPPORTED_SPECTRUM</p>	<p>This response code was defined in WINNF-TS-0016 [n.1]. The frequency range indicated in the spectrum inquiry request or grant request is at least partially outside of the CBRS band.</p>

Response Codes	Description
<p>VALUE: 400 NAME: INTERFERENCE</p>	<p>This response code was defined in WINNF-TS-0016 [n.1]. Requested operation parameters cause too much interference. This <i>responseCode</i> value indicates that the Grant request is unlikely to be successful if retried by the CBSD.</p>
<p>VALUE: 401 NAME: GRANT_CONFLICT</p>	<p>This response code was defined in WINNF-TS-0016 [n.1]. Conflict with an existing Grant of the same CBSD. The CBSD should be able to remediate this using the data returned in the <i>responseData</i> structure, by synchronizing its Grant state with the SAS and relinquishing any out-of-sync Grants.</p>
<p>VALUE: 500 NAME: TERMINATED_GRANT</p>	<p>This response code was defined in WINNF-TS-0016 [n.1]. The Grant is terminated. This condition occurs if, for example, incumbent status has changed permanently causing the current Grant to terminate. The CBSD shall terminate radio operation by turning off its radio transmission associated with this Grant within 60 seconds after the value of the <i>transmitExpireTime</i> parameter expires, in accordance with §96.39(c)(2) [n.7]. The Grant is considered terminated by the SAS, but the CBSD may relinquish the Grant. If the <i>operationParam</i> parameter is included in the <i>HeartbeatResponse</i> object, the CBSD should consider it as a recommendation by the SAS to obtain a new Grant using the included operational parameter values, and may request a new Grant using those operational parameters.</p>

Response Codes	Description
VALUE: 501 NAME: SUSPENDED_GRANT	<p>This response code was defined in WINNF-TS-0016 [n.1].</p> <p>The Grant is suspended. This condition occurs if incumbent status has changed temporarily.</p> <p>The CBSD shall terminate radio operation by turning off its radio transmission associated with this Grant within 60 seconds after the value of the <i>transmitExpireTime</i> parameter expires, in accordance with §96.39(c)(2) [n.7]. In such a case the CBSD may continue to send <i>HeartbeatRequest</i> objects and waiting until the Grant is re-enabled, or may relinquish the Grant and request another.</p> <p>If the <i>operationParam</i> parameter is included in the <i>HeartbeatResponse</i> object, the CBSD should consider it as a recommendation by the SAS to obtain a new Grant using the included operational parameter values, and may request a new Grant using those parameters.</p>
VALUE: 502 NAME: UNSYNC_OP_PARAM	<p>This response code was defined in WINNF-TS-0016 [n.1].</p> <p>The Grant state is out of sync between the CBSD and the SAS. The CBSD shall turn off the radio transmission associated with this Grant within 60 seconds from receiving this <i>responseCode</i> value, in accordance with §96.39(c)(2) [n.7], and shall relinquish this Grant.</p>

NOTE 1 (Informative): This is an assistive *responseCode* parameter value to reset the CBSD out of a situation where it is out of sync with the SAS and there is no easier solution than to reset the registration. Examples are: The CBSD has been deregistered by the owner or deregistration is required by authorities, and presumably the CBSD needs to refresh its local configuration management.

In the *Response* object, the SAS can optionally include supplemental data (e.g., using the *responseData* parameter) to help the CBSD with further investigation of the error. The following table describes supplemental data to be included with some *responseCode* values.

Table 47: *responseData* Definitions

<i>responseCode</i> Value	Name	<i>responseData</i> Data Type	Description of error data
0	SUCCESS	<i>Not present</i>	
100	VERSION	array of string	Protocol versions supported by the SAS administrator
101	BLACKLISTED	<i>Not present</i>	
102	MISSING_PARAM	array of string	A list of missing parameters

<i>responseCode</i> Value	Name	<i>responseData</i> Data Type	Description of error data
103	INVALID_VALUE	array of string	A list of parameters names with invalid values
104	CERT_ERROR	<i>Not present</i>	
105	DEREGISTER	<i>Not present</i>	
106	NOT_PROCESSED	array of string	The first element of the array contains a number in the string format. The number is the suggested wait time in seconds before the CBSD may resend the request message after receiving this <i>responseCode</i> .
200	REG_PENDING	array of string	A list of missing registration parameters
201	GROUP_ERROR	<i>Not present</i>	
300	UNSUPPORTED_SPECTRUM	<i>Not present</i>	
400	INTERFERENCE	<i>Not present</i>	
401	GRANT_CONFLICT	array of string	The Grant ID of an existing Grant that causes the conflict.
500	TERMINATED_GRANT	<i>Not present</i>	
501	SUSPENDED_GRANT	<i>Not present</i>	
502	UNSYNC_OP_PARAM	<i>Not present</i>	

