Interim SAS to CBSD Protocol Technical Report-A

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Preface

This document describes various high-level concepts and principles relating to SAS and CBSD operation. This Technical Report (TR) document is the first in an envisioned series of Technical Reports, the sum of which may be combined to embody a complete Technical Report for a SAS-to-CBSD interface. It is to be noted that this TR reflects the discussions in WINN Forum Spectrum Sharing Committee (SSC) Work Group 3 (WG3) as of the date mentioned on the cover page and is not the final version of the TR. As work progresses, the TR will be updated accordingly to reflect any updates in WG3.

A complete list of partial Technical Report documents, including this document, will be provided in the final SAS-to-CBSD Technical Specification.

SAS to CBSD Protocol Technical Report

1 Introduction

2 Scope

This document is a Technical Report on the signaling protocol for the SAS-CBSD interface describing various high-level concepts and principles relating to SAS and CBSD operation

3 References

3.1 Informative references

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] "In the Matter of Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band", GN Docket No. 12-354, Further Notice of Proposed Rulemaking (FNPRM), FCC 14-19, Released: April 23, 2014

[i.2] "Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650MHz Band", GN Docket No. 12-354, Report and Order and Second Further Notice of Proposed Rulemaking, released April 21, 2015, FCC 15-47.

[i.3] "SAS Notional Architecture", WINN Forum Spectrum Sharing Committee, 25 Aug 2015, WINNF-15-P-0047-V0.6.0
[i.4] "CBRS Operational Security", Working Document WINNF-15-S-0071, Version V0.3.0, 28 August 2015

4 Definitions and abbreviations

Citizens Broadband Radio Service Device (CBSD): Fixed Stations, or networks of such stations, that operate on a Priority Access or General Authorized Access basis in the Citizens Broadband Radio Service consistent with this rule part. For CBSDs which comprise multiple nodes or networks of nodes, CBSD requirements apply to each node even if network management and communication with the SAS is accomplished via a single network interface. End User Devices are not considered CBSDs. [i.2]

Spectrum Access System (SAS): A system that authorizes and manages use of spectrum for the Citizens Broadband Radio Service in accordance with subpart F in [i.2].

5 Architecture Model and Concepts

This section describes the Architecture Reference Model, operational concepts and high level functions.

5.1 Architecture Reference Model [i.3]

This section describes a notional SAS architecture as agreed in WINN Forum SSC as a common baseline that can be used by all 4 working groups in the SSC.
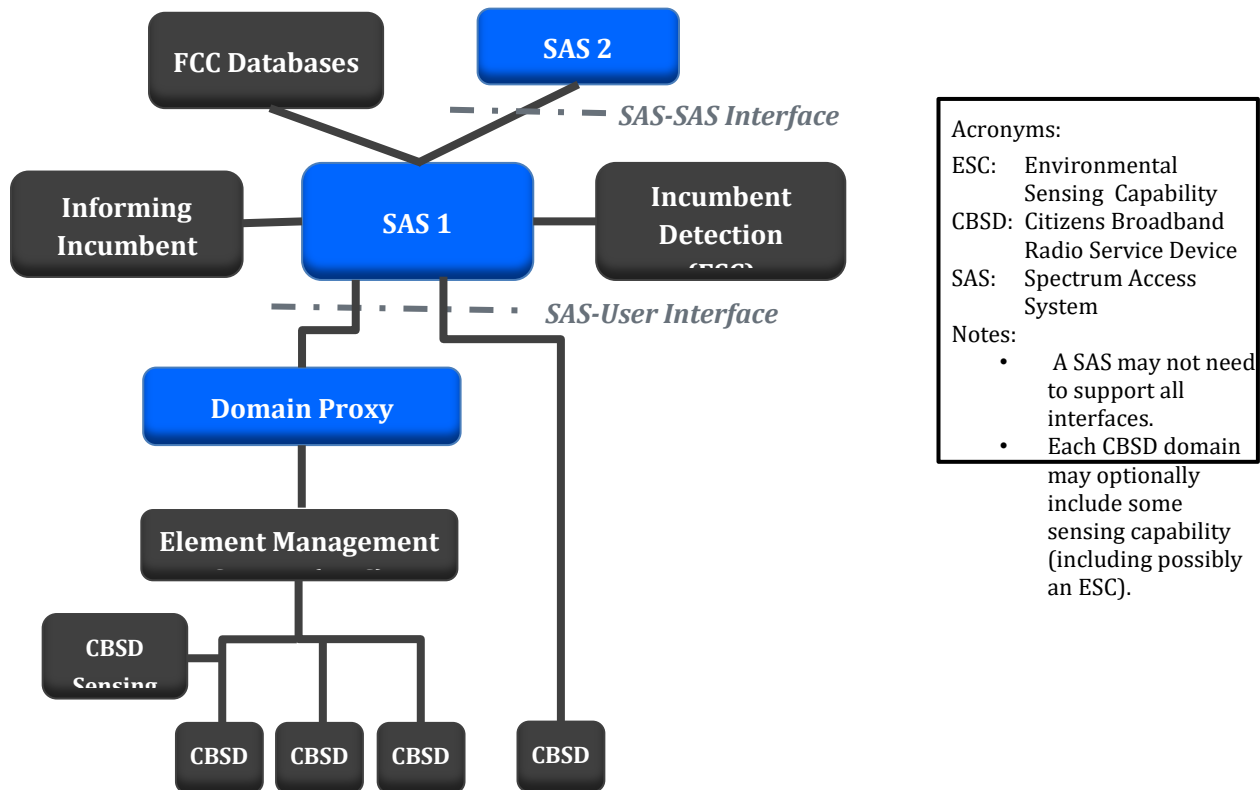
5.1.1 SAS [i.2][i.3]

This section describes the functions a SAS needs to support from a SAS-to-CBSD and CBSD-to-SAS perspective.

A SAS function is to:

- Determine the available frequencies at a given geographic location and assign them to CBSDs;
- Determine the maximum permissible transmission power level for CBSDs at a given location and communicate that information to the CBSDs;
- Register and authenticate the identification information and location of CBSDs;

- Enforce Exclusion and Protection Zones, including any future changes to such Zones, to ensure compatibility between Citizens Broadband Radio Service users and incumbent federal operations;
- Communicate with the ESC and ensure that CBSDs operate in a manner that does not interfere with federal users;
- Ensure that CBSDs protect non-federal incumbent users consistent with the rules;
- Protect Priority Access Licensees from impermissible interference from other Citizens Broadband Radio Service users;
- Facilitate coordination between GAA users to promote a stable spectral environment;
- Ensure secure and reliable transmission of information between the SAS, ESC, and CBSDs;
- Provide an approved ESC with any sensing information reported by CBSDs if available;
- Protect Grandfathered Wireless Broadband Licensees until the end of the grandfather period;
- Facilitate coordination and information exchange between SASs.

5.1.2   Domain Proxy [i.3]

In some cases a Domain Proxy may exist which serves as a managing intermediary for a number of separate CBSDs such that the SAS communicates directly with the Domain Proxy rather than with each individual CBSD. This section describes the functions that CBSD needs to support from CBSD-to-proxy and SAS-to-proxy perspectives.

A Domain Proxy's function is to:
- Accept a set of one or more available channels and select channels for use by specific CBSDs, or alternatively pass the available channels to the carrier EMS for CBSD channel selection
- EMS may optionally be co-located with the domain proxy
- Back report selected channels to SAS optionally received via EMS
- Receives confirmation of channel assignment from SAS
- Performs bidirectional bulk CBSD registration and directive processing, optionally through carrier EMS if present.
- Perform bidirectional information processing and routing.
- E.g. interference reporting, etc.

5.1.3   CBSD[i.2]

This section describes the functions that CBSD needs to support from CBSD-to-SAS and SAS-to-CBSD perspective.

- *Registration with SAS*: A CBSD must register with and be authorized by an SAS prior to its initial service transmission. The CBSD must provide the SAS upon its registration with its geographic location, antenna height above ground level (in meters), CBSD class (Category A/Category B), requested authorization status (Priority Access or General Authorized Access), FCC identification number, call sign, user contact information, air interface

technology, unique manufacturer's serial number, sensing capabilities (if supported), and additional information on its deployment profile required by sections 96.43 and 96.45. If any of this information changes, the CBSD shall update the SAS within 60 seconds of such change, except as otherwise set forth in this section. All information provided by the CBSD to the SAS must be true, complete, correct, and made in good faith.

(1) A CBSD must operate at or below the maximum power level authorized by an SAS, consistent with its FCC equipment authorization, and within geographic areas permitted by an SAS on the channels or frequencies authorized by an SAS.

(2) A CBSD must receive and comply with any incoming commands from its associated SAS about any changes to power limits and frequency assignments. A CBSD must cease transmission, move to another frequency range, or change its power level within 60 seconds as instructed by an SAS.

- *Signal Level Reporting*: A CBSD must report to an SAS regarding received signal strength in its occupied frequencies and adjacent frequencies, received packet error rates or other common standard metrics of interference for itself and associated End User Devices as directed by an SAS.
- If directed by the SAS, a CBSD that receives a range of available frequencies or channels from an SAS must promptly report to the SAS which of the available channels or frequencies it will utilize.
- *Security*: CBSDs shall incorporate security measures sufficient to ensure that they are capable of communicating only with SASs operated by approved SAS Administrators, and that communications between CBSDs and SASs, between individual CBSDs, and between CBSDs and End User Devices are secure to prevent corruption or unauthorized interception of data.

6 SAS Procedures

Goal of Section 6 is to provide a high level view of the procedures which are then further detailed in Sections 7 to 9. It is to be noted that the procedures described as well as the steps described in each procedure are still work in progress and that this section will be updated as needed in the future. In particular, it is recognized that in order to meet the entire set of requirements of the FCC 3.6 GHz Report & Order [i.2], WINN SSC WG1 is working on a requirements framework for the Registration process that includes end-to-end registration sequence for Users, CBSDs, and PAL credentials. This section of the document will be updated based on the WG1 output.

6.1 Pre-requisite Procedures

Before commencement of SAS and CBSD communications, several procedures need to be in place and performed. Details of these procedures are not within the scope of this document. Purposes and high-level functions of these procedures are described below.

1. CBRS User Registration. A CBRS user is a legal identity that owns or is responsible for one or multiple CBSDs. Before a CBSD can start automated machine-to-machine

communication with SAS for CBSD Registration, the CBRS user must register with the SAS and the FCC and create a CBRS User ID. The CBRS User ID is used for subsequent SAS-CBSD communication. During the user registration process, the user shall provide basic information like legal identity (individual or corporate), address, mailing address, email contact, phone contact, etc. As a part of the registration process, CBRS Users also need to acknowledge that they understand and accept the risk of interference from federal radar systems (CFR 96.55(e)) and file such a form as acknowledgment. The user registration establishes a unique user ID number and PIN (or similar security feature to allow SAS authentication of the user identity) that is used for subsequent steps when the CBSD is registered.

2. PAL rights management and PAL ID registration. A mechanism needs to be in place and carried out for SAS to properly allocate PAL channels to requesting CBSDs that deserve such privileges. The mechanism should allow SAS to acquire information based upon FCC auction results for the 3.5 GHz band and also the secondary market for PAL licenses. Each PAL will need to have a PAL ID number and security credentials that allows the SAS to authenticate the claim to a PAL license. This PAL ID credential is presented by the CBSD in that area to the serving SAS in order to request a PAL reserved channel.

3. Device Type parameters may have been pre-entered by the device vendor into a CBSD database . For a specific make, model and version, the data associated with that radio type may be stored in a database rather than this data being provided by the user or stored directly within the devices' memory. This may include parameters such as the out-of-band/spurious emission mask, the Adjacent Channel Leakage Ratio (ACLR), the maximum conducted power, etc. This avoids corruptions, errors and having to repeat this data many times for the same device type.

4. Installation parameters may be entered offline, perhaps by a web based entry system with security features that only allows certified and authenticated professional installers to enter such information. The information specific to the CBSD installation would include information that may not be known by the CBSD itself nor by the device manufacturer or vendor. This might include the CBSDlocation if GPS methods cannot meet the elevation accuracy, or if indoor mounting precludes the use of GPS derived information. This would include the antenna parameters (antenna height, antenna gain, antenna pattern, and antenna pointing information for Category B CBSDs).

5. Communication security. A security framework should be followed so that SAS and CBSD or Domain Proxy can verify the identification of each other and trust the information exchanged through SAS-CBSD interface.

6.2   SAS Discovery

This procedure discusses how a CBSD discovers a SAS. A Domain Proxy can also discover a SAS on behalf of all CBSDs that it serves. The key steps in this procedure are:

1. CBSD discovery involves the methods which a CBSD uses to find a SAS entity which the CBSD can use for spectrum requests.

2. Both static and dynamic methods should/may be supported. Static methods imply the SAS connection information is provisioned into the CBSD.

3. The CBSD then uses this provisioned information to initiate CBSD Registration. Dynamic provisioning may leverage existing protocols like Domain Name System (DNS)/ Dynamic Host Control Protocol (DHCP) to determine the SAS connection information.

6.3   CBSD Registration

This procedure discusses how a CBSD registers with a SAS. There are discussions in WINN Forum SSC Work Group 1 (WG1) on whether or not the SAS can register with more than one SAS. Once this is resolved in WG1, we will update this section accordingly.

The CBRS User must have already registered with the system and the SAS to establish a User Identity that is used during the CBSD Registration procedure. See section 5.1 for other preconditions that may apply prior to device registration.

Another precondition is that SAS discovery has happened.

CBSD registration includes these steps:

1. The CBSD performs authentication with the SAS and provides its device identity and user identity information. Refer to WG2 for more details on authentication.

2. If the user and the CBSD is successfully authenticated, the CBSD registers with the SAS and provides its CBSD parameters to the SAS including device type, device name, location information, and other device specific information.

3. If CBSD registration succeeds, the SAS informs the CBSD that it has successfully completed registration. The Procedure ends when the device is ready to initiate the spectrum request.

6.4   CBSD Spectrum Request

This procedure covers the request by a CBSD for spectrum access managed by a SAS. It is to be noted that the steps described in this procedure are not the final ones and that further study of the spectrum request procedure is needed. This section will be updated once WG3 comes to a

conclusion on the steps. Precondition of this procedure is that CBSD Registration completed successfully.

The key steps in this procedure are:

1. The CBSD initiates a spectrum inquiry request to the SAS and provides its PAL ID if applicable.
2. The SAS provides CBSD information on available channels in a spectrum inquiry response. It is to be noted this step could have Operational Security implications that are being studied in WINN SSC WG2 [i.4] to preserve incumbent operational security as required by the FCC for operation in the CBRS band. This section will be updated based on the output from WG2.

3. The CBSD sends a grant request, including selected channel(s), to the SAS.

4. The SAS may then perform more detailed channel interference assessments to determine if the selected channel is acceptable. If so, the request is granted, and the SAS response contains the granted frequency, bandwidth and duration the grant is valid. The CBSD periodically queries the SAS to validate if the grant is still valid or if a spectrum reassignment is required.

5. If connectivity to the SAS is lost, the CBSD must assume any existing grant is invalid because the SAS would not have the capability to revoke it, and the CBSD must cease transmitting.

6.5   CBSD Spectrum Relinquish

This procedure covers the case when CBSD requests SAS to relinquish spectrum because the CBSD no longer has need for the spectrum. Precondition is that CBSD has been granted spectrum access.

The key steps in this procedure are:

1. If the CBSD no longer needs access to the spectrum prior to the expiration of the duration of the grant from the SAS, the CBSD issues a Relinquish Request message to the SAS.

2. If the duration of access granted by the SAS has expired, in this case also, the CBSD issues a Relinquish Request message to the SAS. The CBSD may send another SAS Spectrum Request to the SAS if the CBSD still requires access to the assigned spectrum as specified in 6.4.

6.6   SAS Spectrum Reassignment/Revocation

This procedure covers the need for a SAS to either revoke or reassign another part of the spectrum to a CBSD as a result of a higher priority user requiring access to the assigned spectrum. Precondition is that CBSD was granted spectrum access.

The key steps in this procedure are:

1. A higher priority user requires access to the same spectrum previously granted to the user.

2. The SAS notifies the CBSD that a higher priority user requires access to the spectrum assigned. (Note this notification may occur as part of the periodic query described in the Spectrum Request procedure). As part of this notification, the SAS may include a new spectrum assignment for the CBSD to use, if requested by CBSD during the query procedure and if one is available.

3. The CBSD ceases access to the spectrum allowing the higher priority user access. If the CBSD is provided a new frequency assignment, it moves to that assignment and starts using that spectrum. If the CBSD is not provided a new frequency assignment (i.e. revocation), the CBSD may request a new spectrum assignment if it requires.

7 CBSD States and State Transitions

This section defines the states used on the interface, the state machine and state transitions supported by the state machine. There are multiple operation states of a CBSD, i.e., Registered, Granted, Transmission.

A CBSD is in the "Registered" state if it goes through the registration process so that SAS knows basic information of the CBSD, like serial number, FCC ID, location, etc. A grant request from a CBSD includes operating parameters like requested frequency range, peak transmission power, etc. Based on the CBSD's request, SAS can approve or disapprove the grant request based on information in the SAS database and the results of accumulated interference calculation for protection of incumbent and/or PAL users.

If approved, the CBSD moves to the Granted state. Once in the Granted state, a CBSD/domain proxy shall send periodic heartbeat requests to maintain continuing communication with SAS and act according to instructions in the heartbeat responses from SAS.

A CBSD moves to the Transmission state if a heartbeat response from SAS confirms the approval of the use of granted operational parameters. Only CBSD in the Transmission state are allowed to transmit with the granted operating parameters. The heartbeat design allows SAS control over CBSD emission based on the variation of spectrum usage and interference environment. For example, if incumbent activities are detected, SAS would send a heartbeat response to affected CBSDs and suspend the transmission, in which case the operation state of those CBSDs move from Transmission back to Granted.

Figure 1 shows the CBSD operation state diagram. SAS discovery procedure happens in Phase 0 in the diagram. SAS registration procedure corresponds to the first half of Phase 1 where CBSD sends registration request (R1) and SAS replies with registration response (R2). SAS spectrum request procedure consists of Grant Request/Response (G1/G2) and Heartbeat Request/Response (H1/H2). Through this procedure a CBSD gets approval from SAS to use certain operating

parameters for transmission. Relinquish Request/Response messages (L1/L2) allow CBSD to initiate SAS Spectrum Relinquish procedure once a spectrum grant is not needed or expires. SAS Spectrum Reassignment/Revocation procedure starts from SAS notifying CBSD to stop use of the current grant (H2). CBSD then relinquishes the existing grant (L1) and requests a new grant (G1) with new operating parameters.

In Figure 1, R1, G1, H1, L1, and D1 are request messages sent from CBSD/domain proxy to SAS. R2, G2, H2, L2 and D2 are response messages sent from SAS to CBSD/domain proxy. Boxes with solid borders in Phase 1 and 2 are CBSD operation states. These messages are explained in the next section in more details.

For a group of CBSDs managed by a domain proxy, the domain proxy instead of individual CBSD is the point of contact for SAS. The domain proxy should create SAS request messages for all CBSDs under its management and parses responses messages from SAS and controls individual CBSDs accordingly. Messages received and sent by a domain proxy are aggregation of multiple messages described in Section 8.

Three additional CBSD states are also needed for SAS operation and CBSD management. Figure 2 in the Appendix captures how the state transition works with these additional states.

Registration Pending state: Registration information may be provided to SAS in stages. A CBSD is in the Registration Pending state if SAS only gets partial registration information of a CBSD and the registration process is not completed.

Revoked state: A CBSD known to SAS is in the Revoked state if it is not allowed to be served in any fashion. Possible reasons to put a CBSD in the Revoked state include violation of FCC rules in 3.5GHz band or incorrect implementation of SAS-CBSD protocols.

Decommissioned state: A CBSD previously known to SAS is in the Decommissioned state if the device is no longer operational and served by a SAS. SAS retains last registration information of CBSDs in this state.
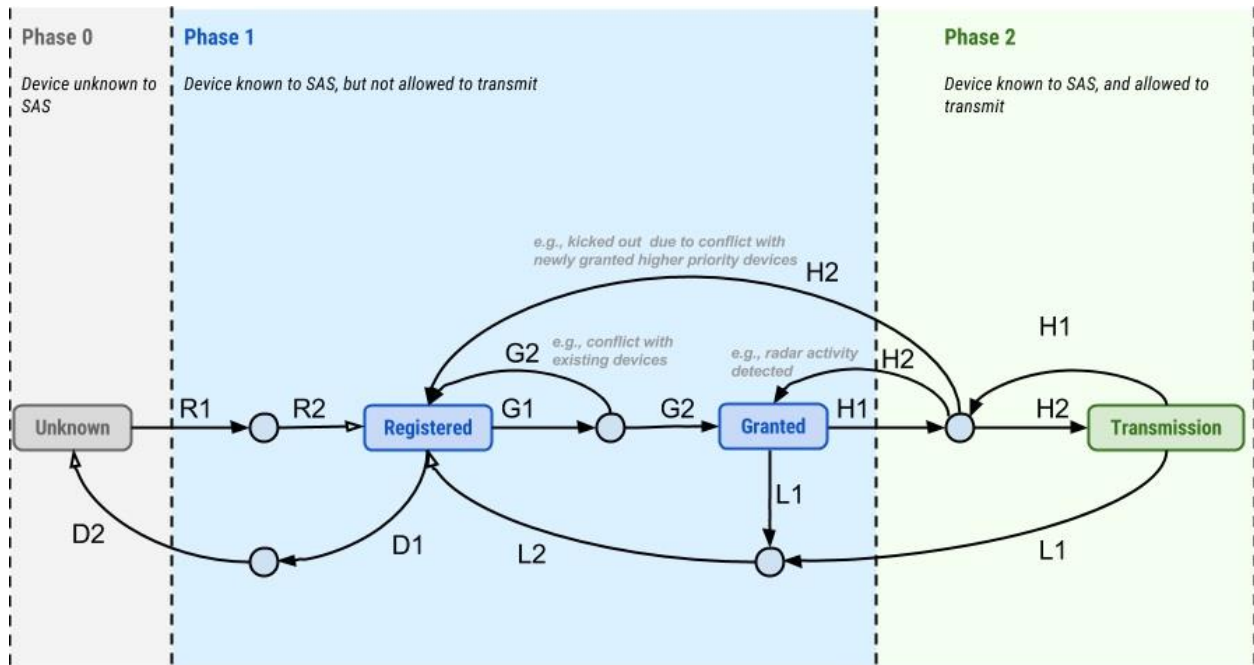
Figure 1: Operation state diagram of a CBSD

8 SAS-CBSD Interface Messages

8.1 Operational State Messages

This section specifies messages required for executing the functions required on the interface as outlined in Figure 1. Each message represents a request or a response for a single CBSD. Multiple messages can be aggregated together if a domain proxy is the point of contact for SAS. It is to be noted that this section could be updated at a later time based on progress in WG3. Some of the fields mentioned in the messages are also for further study.

R1: Registration Request. For a CBSD to transmit in SAS controlled spectrum, it needs to registered in SAS first. To be ready for registration, basic information on the CBSD needs to be available and sent to SAS as a part of the registration request message. Key information includes, but is not limited to:

Field	Field Description
FCC identification number	Required by CFR 96.39(c). This is a unique ID for a FCC certified device model.
Installation Parameter: Latitude, longitude, and height of the CBSD antenna	Required by CFR 96.39(c). Height of the CBSD antenna is the above ground level (AGL) of the CBSD antenna.
CBSD category	Required by CFR 96.39(c). Category A or Category B
Call sign	Required by CFR 96.39(c).

User contact information	Required by CFR 96.39(c). User contact information can be inferred from a registered User ID to which the CBSD Registration is tied.
Air interface technology	Required by CFR 96.39(c). E.g. LTE, WiMAX, WiFi. Whether more detailed information like release number and optional features should be provided is for further discussion.
Unique manufacturer's serial number	Required by CFR 96.39(c). Hardware and firmware version numbers may also be provided.
Max number of simultaneous grants	The maximum number of simultaneous grants for the CBSD
Sensing capability	Required by CFR 96.39(c). There can be different types of sensing capabilities supported by CBSD.
Installation Parameter: Indoor or outdoor	Required by CFR 96.43(b). For Category A devices, this field indicates whether the device is installed indoor or outdoor. For Category B devices must be installed outdoor so this field should be set to outdoor.
Installation Parameter: Antenna azimuth	Required by CFR 96.45(d) for Category B devices. Antenna azimuth and downtilt angles.
Installation Parameter: Antenna downtilt	Required by CFR 96.45(d) for Category B devices.
Installation Parameter: Antenna gain	Required by CFR 96.45(d) for Category B devices. Antenna gain and beamwidth
Installation Parameter: Antenna beamwidth	Required by CFR 96.45(d) for Category B devices.
Installation Parameter: Antenna model number	This information allows SAS to retrieve further antenna information out of channel and perform SAS functions more efficiently.

Some additional RF characteristics of the CBSD are also required by SAS for interference calculation, e.g., antenna pattern, out-of-band/spurious emission mask, ACLR. Such information may be pre-populated in SAS from a manufacturer or vendor device parameter database when a device owner or a device manufacturer registers a specific device type with SAS.

R2: Registration Response. SAS can approve or disapprove a Registration Request. If disapproved, an error message should be provided in the registration response. A nominal expected registration response time will be specified later and upper bounded. Key information includes, but is not limited to:

Field	Field Description
CBSD ID	CBSD ID is a unique identifier for the device
Success	Indicate if the request is approved or disapproved
Error message	If registration fails, SAS includes an error message

G1: CBSD Grant Request. In a grant request message, a CBSD needs to declare a protection level and pick a set of operating parameters that it intends to operate with. If a CBSD wants to change the operating parameters of an approved grant, the CBSD needs to terminate the old grant first and request a new grant. Key operation parameters include:

Field	Field Description
CBSD ID	CBSD ID is a unique identifier for the device
Protection level	PAL or GAA. Instead of having it in the registration, providing protection level in grant request allows more flexible operation of CBSD. For PAL use, a PAL ID and authentication credential must be presented for access.
Operation parameter: Peak transmit power	Maximum Tx power to be used by the CBSD
Operation parameter: Low frequency of the grant	
Operation parameter: High frequency of the grant	

G2: SAS Grant Response. SAS can approve or disapprove a Grant Request. SAS should include the following information in the grant response.

Field	Field Description
CBSD ID	CBSD ID is a unique identifier for the device
Grant ID	Identification associated with a specific grant of a CBSD
Success	Indicate if the request is approved or disapproved
Grant time	The time stamp that the grant is approved
Lifetime of the grant	Length of the grant duration. CBSD should relinquish the grant before it expires
CBSD polling interval	Time interval that a CBSD should poll SAS (heartbeat duration).
Measurement report configuration	Configuration for CBSD to perform various measurements (interference, incumbent, etc) and report to SAS
Operation parameters	If grant request is disapproved, SAS can optionally provide a new set of operation parameters for the CBSD
Error Message	If grant request is disapproved, SAS includes an error message

H1: Heartbeat Request. The purpose of heartbeat is for SAS to get status update from CBSDs periodically. If SAS doesn't get heartbeat from CBSDs for a certain period, it will assume the CBSD is not operating with the grant. It also serves the purpose for SAS to instruct CBSDs what to do next. The heartbeat rate is set by SAS in Grant Response. A Heartbeat Request should include:

Field	Field Description
CBSD ID	CBSD ID is a unique identifier for the device
Grant ID	Identification associated with a specific grant of a CBSD
Operation state	CBSD operation state: Granted or Transmission
Operation parameters	CBSD operation parameters for the grant

H2: Heartbeat Response. The Heartbeat Response allows SAS to confirm a grant, suspend a grant, or deny a grant. A grant can be suspended if a higher-tier device like navy radar is in the neighborhood temporarily. A grant can be denied if a high-tier device moves into the neighborhood to stay. SAS can also change the heartbeat interval through Heartbeat Response. A Heartbeat Response should include the following information.

Field	Field Description
CBSD ID	CBSD ID is a unique identifier for the device
Grant ID	Identification associated with a specific grant of a CBSD
Success	Indicate if the request for transmission is approved or disapproved
Grant suspension	True/false. If true, the CBSD should be in the Granted state
Grant termination	True/false. If true, the CBSD should relinquish the grant and move to the Registered state
Operation parameters	If grant request is suspended or terminated, SAS can optionally provide a new set of operating parameters for the CBSD
CBSD polling interval	SAS can change the heartbeat interval as needed
Measurement report configuration	Configuration for the CBSD to perform various measurements (interference, incumbent, etc) and report to SAS
Error Message	SAS includes an error message in the response as needed

L1: Relinquish Request. A CBSD should send a Relinquish Request to SAS if a grant is not used by the CBSD anymore. A CBSD should include CBSD ID and operation state in the Relinquish Request

Field	Field Description
CBSD ID	CBSD ID is a unique identifier for the device
Grant ID	Identification associated with a specific grant of a CBSD
Operation state	The operation state should be either Granted or Transmission

L2: Relinquish Response. The Relinquish Response from SAS confirms the termination of a grant.

Field	Field Description
CBSD ID	CBSD ID is a unique identifier for the device
Grant ID	Identification associated with a specific grant of a CBSD
Success	Indicate if the request is approved or disapproved
Error message	SAS includes an error message in the response as needed

D1: Deregister Request. Deregistration Request from CBSD de-lists a CBSD with SAS. This must be done if the CBSD is moved from its registered position by further than the FCC allowable distance or other registration information is changed, or the CBSD is decommissioned. CBSD ID should be included in the Deregister Request.

Field	Field Description
CBSD ID	CBSD ID is a unique identifier for the device

D2: Deregister Response. SAS confirms deregistration of the CBSD.

Field	Field Description
CBSD ID	CBSD ID is a unique identifier for the device
Success	Indicate if the request is approved or disapproved
Error message	SAS includes an error message in the response as needed

8.2   Management Messages

This section specifies messages that do not directly change CBSD operation states but are important for SAS operations.

Spectrum Inquiry Request. For registered CBSDs, a spectrum inquiry request is sent to SAS to inquire the available channels near the location of the CBSD. With SAS providing available channel information, the CBSD can decide operation parameters for a grant request. It is to be noted that there could be Operational security implications that are being studied in WINN SSC WG2 [i.4] to preserve incumbent operational security as required by the FCC for operation in the CBRS band. This section will be updated based on the output from WG2. A Spectrum Inquiry Response should include the following information.

Field	Field Description
CBSD ID	CBSD ID is a unique identifier for the device
Protection level	PAL or GAA. For PAL use, a PAL ID and authentication credential must be presented for access.
Frequency range	Range(s) of frequency to inquire

Spectrum Inquiry Response. SAS should provide CBSD location dependent, regulation dependent, available channel information including

Field	Field Description
CBSD ID	CBSD ID is a unique identifier for the device
Available channels: Frequency range	Frequency range of the channel
Available channels: Applicable regulation	E.g., US FCC Part 96
Available channels: Channel type	E.g., PAL-assigned, PAL-unassigned, GAA

Measurement Report. Based on measurement report configuration in Grant Response or Heartbeat Response, CBSD should send measurement reports to SAS. Such information can help SAS tune or update its propagation models and coordinate the spectrum usage more effectively. The measurement report could include

- Incumbent measurement (if CBSD has ESC capability)
- Received interference power
- Received signal strength
- Others

Note: A measurement report definition requires further requirements from WG1 and is expected to be completed in a subsequent Technical Report. Measurement Report is included here as a placeholder and for consistency.

Measurement Report Acknowledgement. SAS acknowledges receipt of the measurement report.

Note: A measurement report acknowledgement is dependent upon the measurement report and also is expected be completed in a subsequent Technical Report.

9 Appendix- Additional Procedures

This section presents some additional procedures that could be performed on the SAS to CBSD interface.
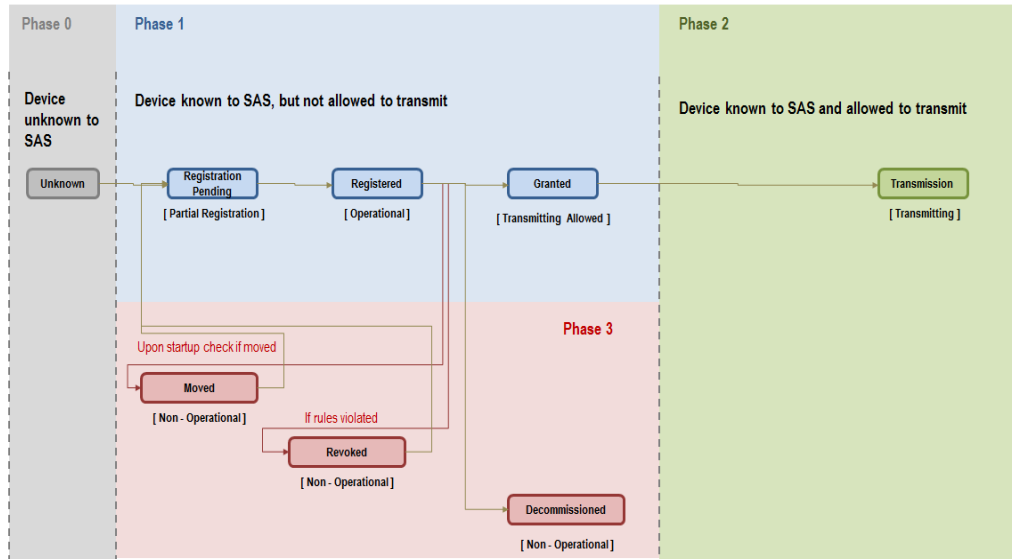

Figure 2: Additional SAS-CBSD Procedures

Multi-stage CBSD registration: Registration information may be provided to the SAS in stages. The CBSD can use the Registration Request Message to provide the SAS partial registration information. The SAS replies to the request message with an error code indicating incomplete registration information and registration pending. This may allow for later data from a registered installer (antenna installation information, location information), or from a device vendor's database (device parameters, version number update identifiers) to complete all the required registration information. The SAS shall retain the partial registration information of CBSD and identity to allow such later inputs and updates that correspond to that identified CBSD.   After receiving registration pending response from SAS, CBSD should, as instructed by SAS, periodically send further Registration Requests to SAS until receiving registration success response (registration complete acknowledgement) from SAS.

CBSD movement: Locations of CBSDs must be reported to SAS if either the CBSDs are moved to new locations by professional installers, or are moved beyond 50 meters horizontally and 3 meters vertically by non-professional installers. CBSD should relinquish all grants before the move and re-register to SAS with updated locations after the move. To re-register to the SAS, CBSD should send a Registration Request indicating either registration information update or new registration.   These re-registration or new registration requests may occur upon every start-up cycle (CBSD power cycling or re-boot) to account for the possibility that the CBSD may have been disconnected from power and moved.

<u>CBSD revocation</u>: If the SAS determines or is instructed that the CBSD violates the rules or is a security threat, the SAS can revoke the CBSD privileges and stop approving any request from the CBSD. The revoked state for a revoked CBSD should be system-wide and apply to any SAS. The SAS response messages to revoked CBSD should include an error code indicating the CBSD in the revoked state. The process for the CBSD's user to appeal the revocation and then for a CBSD to move out of the revoked state is up for further discussion. The revoke response from the SAS may be in response to any CBSD request message.

<u>CBSD decommission:</u> If the CBSD's user requests to terminate services, the CBSD may be removed from active service. The CBSD should send a Deregistration Request to the SAS. When the CBSD is brought back to service, it should send a Registration Request to SAS and then return the CBSD to the Registered state after SAS response. It is for further discussion regarding SAS behavior when a CBSD is decommissioned without sending a Deregistration Request to SAS. If the SAS (or any SAS) does not receive any request messages from the CBSD for a long period (TBD), the SAS shall deem the CBSD decommissioned or out-of-service. The SAS may send a message to the Registered user to confirm the CBSD device removal from service.