

CBRS Enhanced Features and Self Testing

WinnForum Webinar Series #28



Webinar Administrivia

Slides presented during this webinar are available in the handouts and will be posted here:

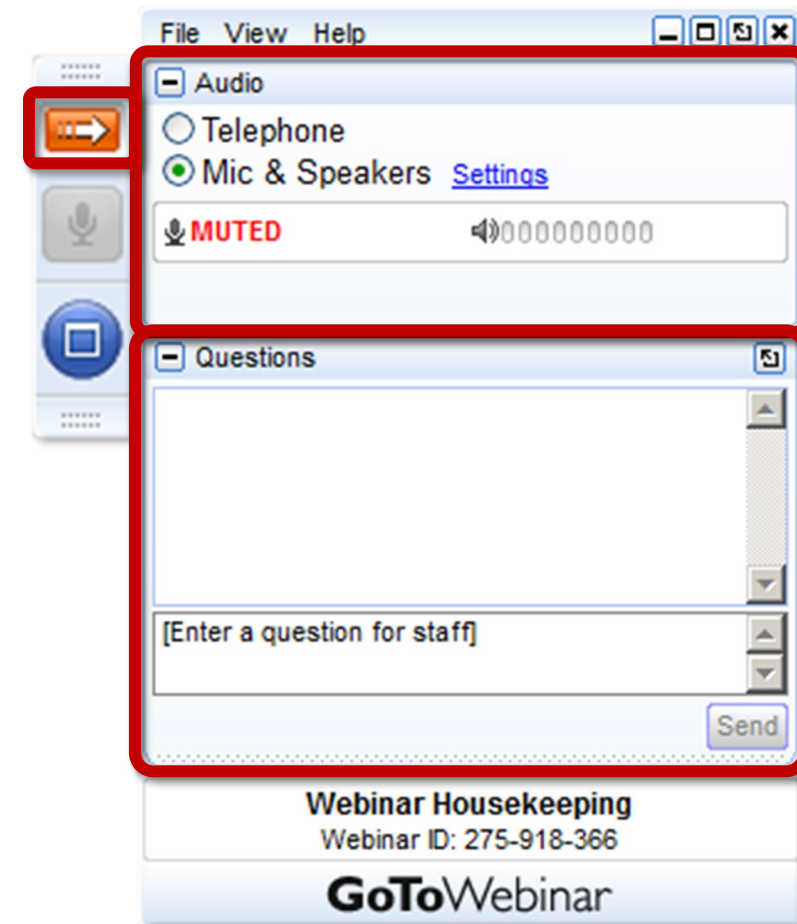
- <http://www.wirelessinnovation.org/webinars>

Recorded Webinar will be available on the Forum's You Tube Channel:

- <https://www.youtube.com/channel/UCYUeZvOuJTP27OzoKsyys0w>

Email

Lee.Pucker@wirelessinnovation.org if you need more information



Introducing Today's Moderator

Richard Bernhardt
National Spectrum Advisor, Wireless
Internet Service Providers Association
(WISPA)
Co-Chair, WinnForum Spectrum Sharing
Committee (SSC)
Chair, SSC WG5 (CBRS Operations)
rbernhardt@wispa.org



Agenda

1. **Protocols overview by Andrew Clegg, Spectrum Engineering Lead, Google**
2. **Protocols supporting features by Navin Hathiramani, Senior Standardization Specialist, Nokia**
3. **Self-testing overview by Virgil Cimpu, Ericsson**
4. **CBSD self-testing by Idan Raz, Inter-Operability Lead, Airspan**
5. **SAS self-testing by Masoud Olfat, VP Technology Development, Federated Wireless**

CBRS Release 2 Features

Andy Clegg

Google

aclegg@google.com

Release 2 Functional and Operational Requirements

- **Release 1 requirements are in WInnForum Technical Specification TS-0112**
- **Spectrum Access Systems (SASs) were certified by FCC against Release 1 standards**
- **Release 2 requirements are contained in TS-1001**
- **Release 2 represents the innovation and evolution of SAS control of shared spectrum in CBRS**
- **The Release 2 TS is designed to be easily extensible**
 - All Release 2 features (except for capability exchange) are implemented as separate Annexes to the document, and can therefore be added and balloted separately from the remainder of the contents
- **Some applications of some Release 2 features could impact protection of protected entities**
 - Regulatory certification of such applications of such features is TBD (see later presentation by Virgil)
 - Most applications of Release 2 features do not have regulatory impacts
- **The following is a high-level overview of Release 2 features that have been adopted in the current version of Release 2 (v 1.2.0)**

Capability Exchange (required)

- **Capability exchange allows SASs and CBSDs to understand which (if any) Release 2 features are mutually supported**
- **Currently, capability exchange is the only required feature under Release 2**
- **If any Release 2 feature (including capability exchange itself) is not understood by either the SAS or the CBSD, then SAS management of the CBSD defaults to Release 1**
 - In any geographic area with a mix of Release 1 and Release 2 SASs, the SAS operators shall cooperate as needed, with the default being Release 1
 - “[A]ny Release 2 entity must support backward compatibility to Release 1 entities using SAS-CBSD and SAS-SAS protocols, and any feature requiring coordination among SASs.”

Grouping

- **Many Release 2 features are related to support for “groups” of CBSDs**
 - Groups allow multiple CBSDs to identify themselves to a SAS as being as being related (or grouped) with other CBSDs to enable implementation of certain use cases
 - The SAS can use grouping information to handle those CBSDs belonging to a particular group in a coordinated manner when needed
- **Release 2 Feature: Enhanced CBSD Group Handling**
 - This Release 2 feature implements the necessary hooks to allow CBSDs to identify themselves to a SAS as a member of one or more groups
- **Release 2 Feature: Principal-Subordinate Single Frequency Group (SFG)**
 - Supports one or more instances of CBSDs that are connected as BTS-CBSD/CPE-CBSD pairs (for example, a central hub CBSD providing Internet backhaul to one or more CPE CBSDs in a rural broadband deployment)
 - The SAS attempts to move all members of the group to the same frequency when a frequency change is needed, although it’s possible that not all CPE-CBSDs may be accommodated
- **Release 2 Feature: Interdependent Single Frequency Group**
 - An interdependent SFG is a set of CBSDs that are required by their hardware to operate on a single frequency
 - If all members cannot be accommodated, then no members receive a grant
- **Release 2 Feature: Separable Frequency Group**
 - Similar to Interdependent Frequency Group, but individual members can be denied grants
- **A member of a group is not afforded any special treatment by SASs in calculation of protection of protected entities**

Enhanced Antenna Patterns

- **Enhanced antenna patterns refers to the SAS using both azimuth and elevation in its determination of antenna gain for the purpose of co-existence, incumbent protection, etc.**
 - Note: Many entities incorrectly refer to such patterns as “3D antenna patterns.” The proper term is 2D, since *two* dimensions are taken into account (azimuth and elevation)
- **Release 2 provides methods for estimating the antenna gain at an arbitrary azimuth and elevation when only the principal-plane horizontal and vertical antenna patterns are available**
 - The algorithm also provides for estimation when a nominal mechanical downtilt is used. Equations to support large mechanical downtilt scenarios are for future study.
- **Release 2 provides methods for interpolating antenna gain at an arbitrary azimuth and elevation when a gridded 2D pattern is available to the SAS, and the desired azimuth and elevation do not correspond to specific data points in the provided pattern**
- **Enhanced antenna pattern implementation is currently being reviewed by FCC. Changes may be forthcoming.**

CPE-CBSD Indicator

- **Enables a CBSD to identify itself to a SAS as a CPE-CBSD**
- **The CBSD must meet the Release 1 requirements of a CPE-CBSD**
 - A CPE-CBSD may “bootstrap” its registration through another CBSD
- **A CPE-CBSD is not afforded any special treatment by SASs in calculation of protection of protected entities**

Passive DAS

- **Release 2 supports a passive DAS architecture in which a central radio unit provides signals to multiple transmission points via splitters, etc.**
 - Each TP is considered an individual CBSD
- **Members of the passive DAS chain declare their association to the DAS using the Release 2 Enhanced Group Handling feature**
- **All CBSDs in a passive DAS group must be professionally installed regardless of Category**
- **All members of a passive DAS group must be granted the same frequency(s)**
- **If one member of a passive DAS is not authorized to transmit, the other CBSDs must cease transmission within 60 seconds**

CBRS Release 2 Protocols

Navin Hathiramani

Nokia

navin.hathiramani@nokia.com

WInnForum SSC WG3 Protocols

- Release 1 Technical Specifications

- WINNF-TS-0016 Signaling Protocols and Procedures for Citizens Broadband Radio Service (CBRS): Spectrum Access System (SAS) - Citizens Broadband Radio Service Device (CBSD) Interface Technical Specification
- WINNF-TS-0096 Signaling Protocols and Procedures for Citizens Broadband Radio Service (CBRS): Spectrum Access System (SAS) - SAS Interface Technical Specification

- Release 2 Technical Specifications

Optional

- WINNF-TS-3002 Signaling Protocols and Procedures for Citizens Broadband Radio Service (CBRS): Extensions to Spectrum Access System (SAS) - Citizens Broadband Radio Service Device (CBSD) Interface Technical Specification (Release 2)
- WINNF-TS-3003 Signaling Protocols and Procedures for Citizens Broadband Radio Service (CBRS): Extensions to Spectrum Access System (SAS) – SAS Interface Technical Specification (Release 2)

- Release 2 Policy

- WINNF-SSC-0010 Signaling Protocols and Procedures for Citizens Broadband Radio Service (CBRS): WInnForum Recognized CBRS Grouping Information
- WINNF-SSC-0012 WInnForum Registry of CBRS Vendor/Admin IDs for Third-Party Proprietary Feature Prefixes



Release 2 Compliance for SAS-CBSD Protocol:

- To support Feature Capability Exchange
- To support “RELEASE 2 ENHANCEMENT” parameters marked as “*Mandatory*”
- To support “RELEASE 2” parameters marked as “*Mandatory*”
- To support “RELEASE 2” response codes marked as “*Mandatory*”.

SAS/CBSD operation mode:

- Determined based on Feature Capability Exchange and based on the Backward and Forward compatibility principle

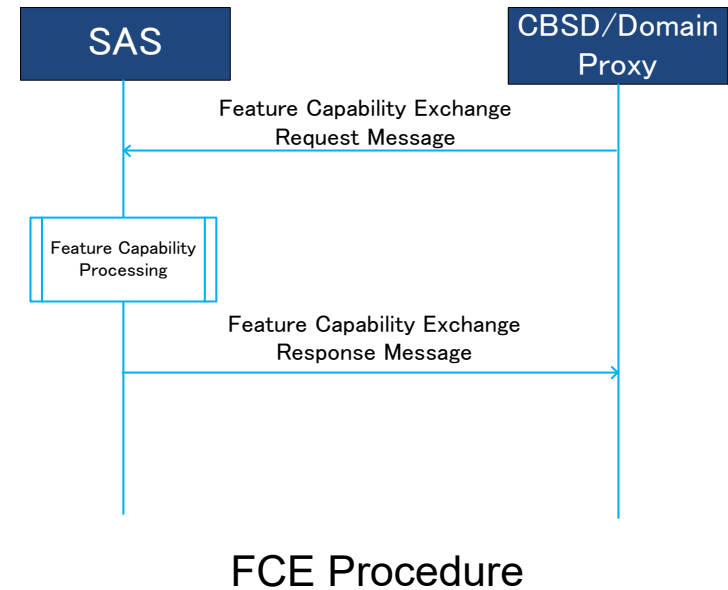
SAS/CBSD Operation Mode

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

Feature Capability Exchange (FCE):

- Enables Exchange of Feature Capability List during Registration and upon change of Operationally Supported features
- Enables SAS and CBSD to operate on a common list of Operationally Supported Features
- Feature list may contain Features IDs(FID) defined in TS-3002 or third-party proprietary features
- An empty Feature Capability List implies support of only Release 2 Mandatory parameter and response codes in addition to the FCE procedure
- Upon modification of Operationally Supported features, SAS/CBSD have to include all their current Operationally Supported features
- SAS can request the CBSD to initiate a FCE procedure via response messages to CBSD Spectrum Inquiry, Grant, Heartbeat and Relinquishment procedures

Currently only new method introduced in Release 2



SAS method	Release 2 Enhancements	Comments
registration (Release 1)	<ul style="list-style-type: none"> • Feature Capability Exchange • Enhanced CBSD Group Handling • Enhanced Antenna Pattern • CPE-CBSD Indicator • antennaGain: floating point value • eirpCapability: floating point value 	Only registration critical parameters of Release 2 features are exchanged.
featureCapabilityExchange (Release 2)	<ul style="list-style-type: none"> • Enhanced CBSD Group Handling • Enhanced Antenna Pattern • CPE-CBSD Indicator 	In addition to exchange of the feature capability list , also allows for parameters associated with the features to be exchanged.
spectrumInquiry (Release 1)	<ul style="list-style-type: none"> • Enhanced CBSD Group Handling • Trigger for CBSD to initiate Feature Capability Exchange in the response message 	
grant (Release 1)	<ul style="list-style-type: none"> • Enhanced CBSD Group Handling • Trigger for CBSD to initiate Feature Capability Exchange in the response message 	
heartbeat (Release 1)	<ul style="list-style-type: none"> • Enhanced CBSD Group Handling • Trigger for CBSD to initiate Feature Capability Exchange in the response message 	
relinquishment (Release 1)	<ul style="list-style-type: none"> • Trigger for CBSD to initiate Feature Capability Exchange in the response message 	
deregistration (Release 1)		

Release 2 Warning Enhancements (Mandatory):

- **Purpose:** Allow for reduced outage time while non-critical issues are resolved
- In Release 2 a SAS can inform a CBSD about a parameter warning in successfully completed procedures (i.e. response code 0 (SUCCESS)) by using `responseData` and `responseMessage`.
- New requirement for CBSD to accept `responseData` and `responseMessage` with response code 0 (SUCCESS).
- Only the format of the `responseData` is specified in TS-3002
- Example: 2D Antenna pattern cannot be located in the Antenna database

New Response code: 106 NOT_PROCESSED (Mandatory)

- 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

Response Codes	Data Type of <i>responseData</i>	Description of <i>responseData</i>
VALUE (NAME): 0 (SUCCESS) EXTENSION TYPE: RELEASE 2 ENHANCEMENT FEATURE ID: <i>Mandatory</i>	array of string	<p>Not applicable to Release 1 operation. For Release 2 operation, the value of the first element of the array shall be either of the followings:</p> <ul style="list-style-type: none"> ▪ “GENERAL” ▪ “PARAM_WARNING” ▪ “FID_WARNING” <p>“GENERAL” notifies supplemental general information (not related specifically to a Feature ID or parameter) is available in the <i>responseMessage</i>. No subsequent element of the array is included.</p> <p>“PARAM_WARNING” notifies the warning about the parameters indicated by the subsequent elements of the array. The value(s) of the subsequent element(s) shall be name(s) of non-critical parameter(s) (see section 6.2.3).</p> <p>“FID_WARNING” notifies CBSDs that one or more common operationally supported feature(s), listed in subsequent element(s) of the array, miss critical information and therefore not considered operational by the SAS. The value(s) of the subsequent element(s) shall be FID(s).</p>

- **A SAS administrator may choose to use the same or different URLs for transporting messages defined in different releases of SAS-CBSD protocols.**
- **All operational URLs should be able to properly receive and respond to request messages from CBSDs/DPs supporting different releases of SAS-CBSD protocols as per backward and forward compatibility principles of TS-3002**
- **Employing the same URL for release 1 and 2 allows for SAS upgrades to Release 2 without impacting CBSD grants**

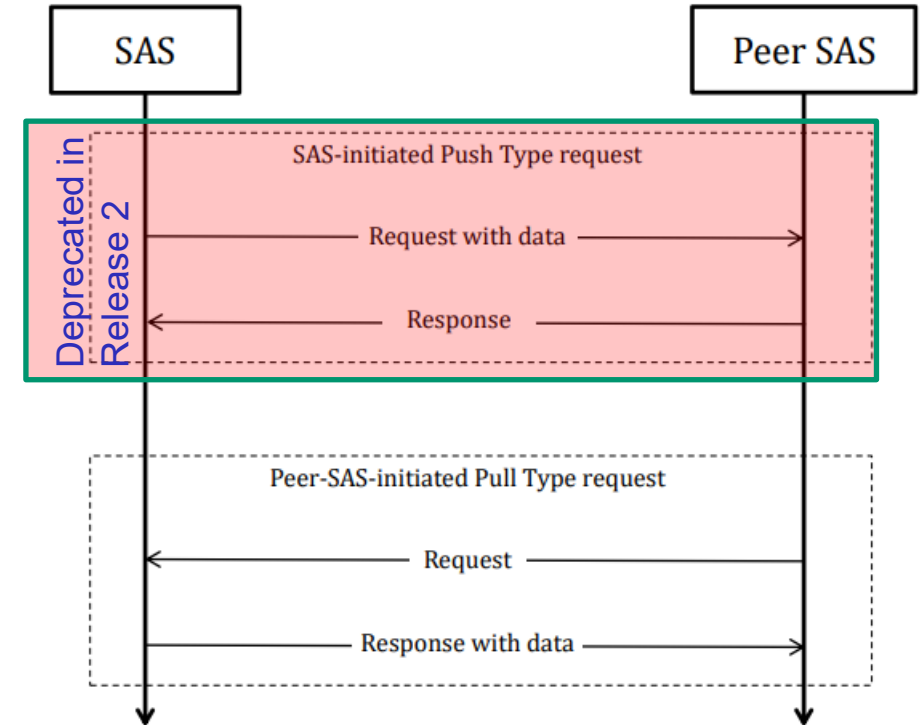
Feature Capability Exchange (FCE):

- Enables exchange of WInnForum and third-party proprietary features between SASs
- Any SAS beyond Release 1 shall exchange Feature Capability List in the synchronization process
- If a SAS does not receive the Feature Capability List from a peer SAS, the peer SAS shall be treated as a Release 1 SAS.
- WInnForum FID permitted in the SAS-SAS FCE are defined in TS-3003

Release 2 Optional Features:

- Enhanced CBSD Group Handling (FID: WF_ENHANCED_GROUP_HANDLING)
- Enhanced Antenna Pattern (FID: WF_ENH_ANTENNA_PATTERN)
- CPE-CBSD Indicator (FID: WF_CPE_CBSD_INDICATOR)

SAS-SAS Synchron	Release 2 Changes
Time-range request	Deprecated
By-ID request	Deprecated
Push Support	Deprecated
Full record dump	<p>New record: SAS Feature Capability Record, which includes the Non-Regulatory Impacting Feature Capability List and the Regulatory Impacting Feature Capability List;</p> <p>Deprecated objects:</p> <ul style="list-style-type: none"> • sasAdministrator object • SasImplementation • terminated parameter • groupingParam parameter



“Push” and “Pull” methods are directly mapped to the ‘POST’ and ‘GET’ methods respectively as defined in the HTTP protocol

Questions?



Slide 21



Release 2 Test and Certification

Virgil Cimpu

Ericsson

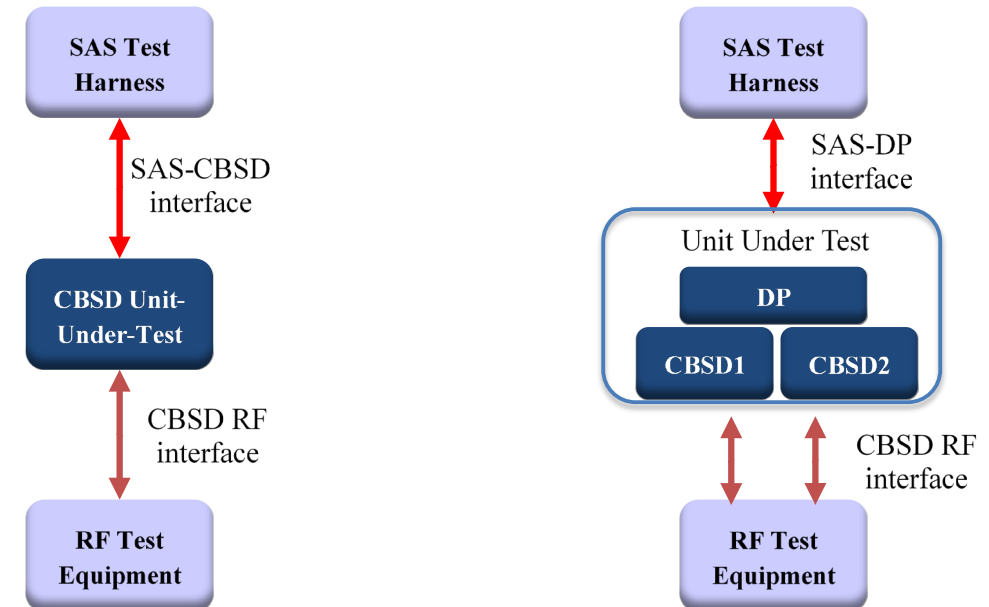
virgil.cimpu@ericsson.com



WinnForum Release 1 Test Specifications

- FCC has agreed to allow the use of the **WINNF-TS-0061** and **WINNF-TS-0122** Test Specifications, along with their associated Test Harnesses, for certifying CBSDs and SASs to operate in CBRS band
- Currently, WinnForum Release 1 Test Specifications are used for FCC certification purposes for both SAS and CBSD

- Example of high level test configurations for BTS-CBSD and DP/BTS-CBSD:



Types of Release 2 Features

1. “Non-Regulatory Impacting” Features: Do not impact Part 96

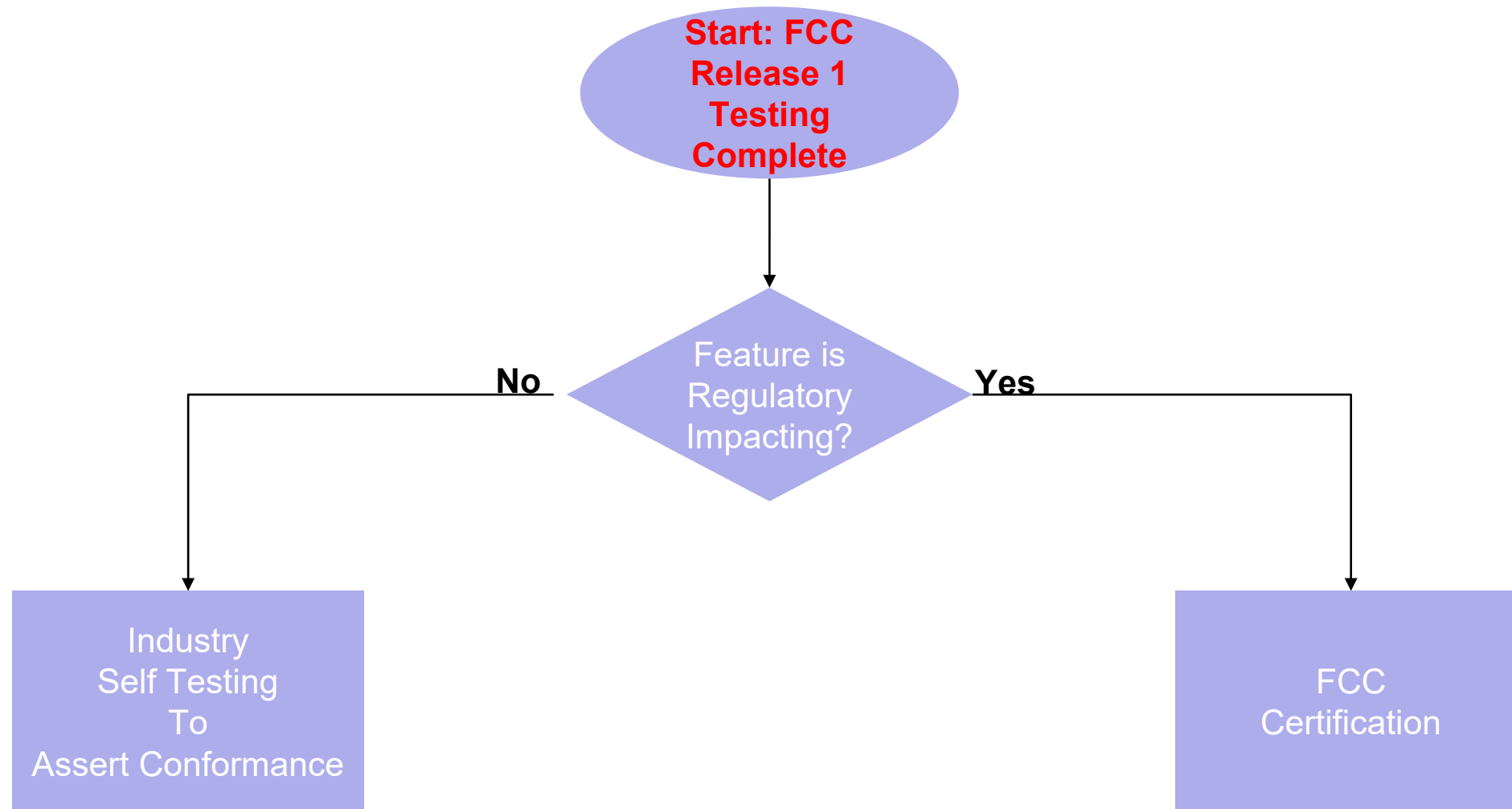
- Examples:
 - Feature Capability Exchange (mandatory WINNForum Release 2 feature)
 - Enhanced CBSD Group Handling
 - Principal-Subordinate Single Frequency Group
 - CPE-CBSD Indicator
 - Enhanced Antenna Pattern used for GAA coexistence

2. Features that may impact Part 96 certification

- Example:
 - Enhanced Antenna Pattern used for PAL and incumbent protection
- Impact of these features will be different for SAS and CBSD

These two types of features need to be treated separately with respect to “certification”

Release 2 Testing



Self Testing for Features Not Impacting Part 96

- **WinnForum CBRS Release 2 Self-Testing Policy is defined in document **WINNF-TS-4005****
- **Companies (members and non-members) must agree to Policies and Procedures for Self Testing to claim “conformance” with WinnForum Standards for that feature, including:**
 - Agreeing to follow the test specifications defined by the WinnForum CBRS Test and Certification work group for the mandatory Release 2 capability exchange and for supported Release 2 optional features
 - Agreeing to use the WinnForum test harness developed by the WinnForum CBRS Test and Certification work group for supported features
 - Agree to submit, on company letter head, a signed letter to the WinnForum summarizing the testing for each feature, including the output of the test harness, if applicable, and indicating that all tests were passed
- **Release 2 testing will start with Feature-by-Feature case, but may later use feature bundle profiles**
- **Interoperability testing “in addition to” the self testing**
 - Not required as part of WinnForum Self Testing Policy
 - Entities might require that as part of their business agreement

Self-Testing Agreement

Companies wishing to self-test a SAS or CBSD/DP product for CBRS Release 2 features shall:

- (i) sign an agreement;
- (ii) successfully test appropriate Licensee products in conformance with WInnForum Policy demonstrating compliance of such products with the Specification as defined by the WInnForum CBRS Test and Certification work group for the mandatory Release 2 procedures and for supported Release 2 optional features;
- (iii) if applicable, use of the WInnForum test harness developed by the WInnForum SSC WG4 (CBRS Test and Certification) for supported Release 2 features;
- (iv) include a declaration on the packaging and in any materials relating to any self-tested product of the optional Release 2 features supported by the product as to which compliance is asserted;
- (v) submit a statement to WInnForum on company letter head signed by an authorized representative of Licensee summarizing the testing for each feature and attesting to the passage by such products with all required tests in compliance with the Policy accompanied by the test report produced in the conduct of such testing demonstrating compliance.

WinnForum Records Optional Features Support

- **WinnForum will maintain a public website detailing which products are compliant with which features:**
 - <https://cbrs.wirelessinnovation.org/cbsd-features-supported>
 - <https://cbrs.wirelessinnovation.org/sas-features-supported>

		Optional Features Supported							Features Key: 1: Enhanced CBSD Group Handling 2: Principal-Subordinate Single Frequency Group 3: Interdependent Single Frequency Group 4: Separable Single Frequency Group 5: Enhanced Antenna Patterns 6: CPE - CBSD Indicator 7: Passive DAS
Company	FCC-ID	1	2	3	4	5	6	7	
Example	XXXX	■			■				

Example of Self-Testing Signed Letter

CBSD Declaration of Compliance to WinnForum Release 2

Company _____ hereby declares that the CBSD named _____ with FCC-ID _____ has passed the WinnForum Release 2 test cases, for the following release 2 features:

Signature _____
Name _____
Position _____
Address _____

SAS Declaration of Compliance to WinnForum Release 2

Company _____ hereby declares that the SAS named _____ with FRN _____ has passed the WinnForum Release 2 test cases for the following release 2 features:

Signature _____
Name _____
Position _____
Address _____



Questions?



Slide 30



Release 2 CBSD/DP Self Testing

Idan Raz

Airspan

iraz@airspan.com

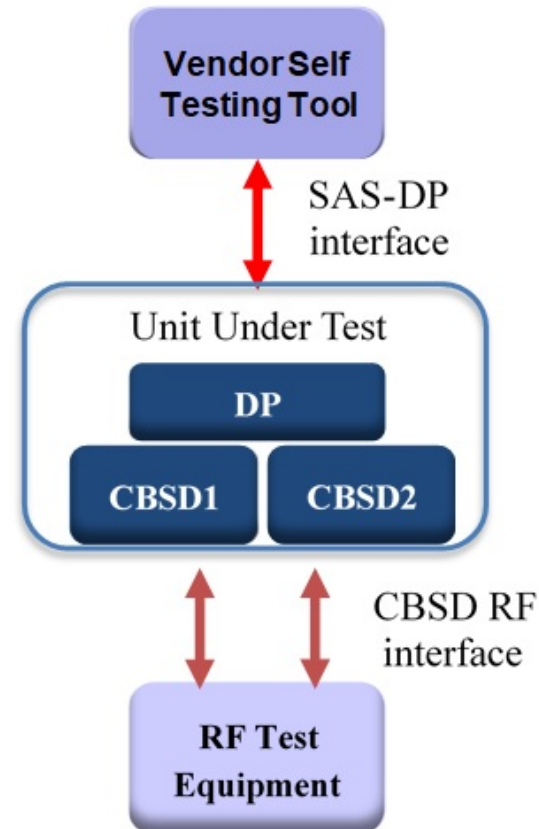
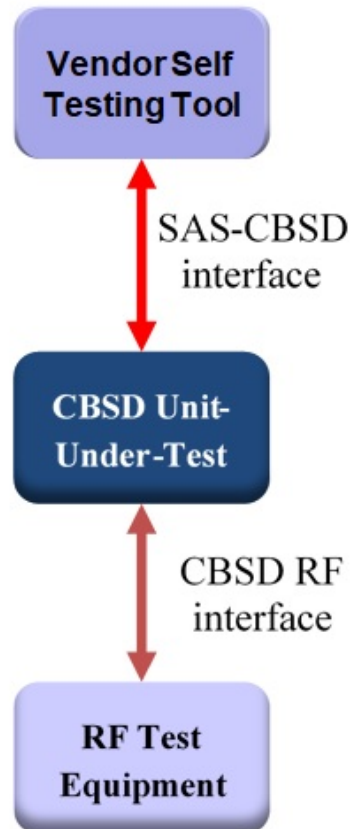


WinnForum Test Specifications for CBSD/DP

- **WinnForum Release 1 CBSD/DP Testing:**
 - **Test Specification Document:** WINNF-TS-0122 Test and Certification for Citizens Broadband Radio Service (CBRS): Conformance and Performance Test Technical Specification; CBSD/DP as Unit Under Test (UUT)
 - **Test Tool:** Official WinnForum software Test Harness for CBSD, v1.0.0.3 (available for public download from WinnForum Github)
- WinnForum Release 1 CBSD/DP Testing is executed in formal Test Labs as part of obtaining Part 96 FCC-ID (FCC Equipment Class Type “CBD”)
- **WinnForum Release 2 CBSD/DP Self Testing:**
- Preliminary requirement for CBSD/DP is to have Part 96 FCC-ID prior to executing testing of WinnForum Release 2
 - **Test Specification Document:** WINNF-TS-4004 Test and Certification for Citizens Broadband Radio Service (CBRS): Conformance and Performance Test Technical Specification; CBSD/DP as Unit Under Test (UUT) (Release 2)
 - **Test Tool:** Self Testing with CBSD/DP vendor self developed test tools. WinnForum does not provide test harness for CBSD/DP Release 2 testing.
- All test cases in current published version of WINNF-TS-4004 are Non Regulatory Impacting (NRI) which do not impact CBSD/DP existing FCC Part 96 certification

WinnForum Release 2 Test Specifications for CBSD/DP: WINNF-TS-4004

- WINNF-TS-4004 has same methodology and structure of WINNF-TS-0122:
- Test Case Naming:
{TestRequirement}.{TestCategory}.{UnitUnderTest}.REL{X}.{FCCRegulationImpact}.{TestFunction}.{SubTestNumber}
- Example:
 - WINNF.FT.C.REL2.NRI.FCE.5 for CBSD without Domain Proxy
 - WINNF.FT.D.REL2.NRI.FCE.6 for Domain Proxy with two CBSDs



Slide 33

WInnForum Release 2 Test Specifications for CBSD/DP: WINNF-TS-4004

- For WInnForum Release 2 it is mandatory for CBSD/DP to support Feature Capability Exchange
- Each CBSD/DP vendor decides for its equipment which additional WInnForum Release 2 features to implement
- WINNF-TS-4004 Table 6-3 lists all the test cases with their designation:
 - REL2.M : Mandatory for WInnForum Release 2 Compliance
 - REL2.O : Optional. Not required for WInnForum Release 2 Compliance
 - REL2.C : Conditional. Required to execute the test case if CBSD/DP supports relevant functionality of WInnForum Release 2 features.
- WINNF-TS-4004 Table 6-2 has the definition for conditional test case execution:

REL2.C1	For UUT capable of manually triggering Feature Capability Exchange Request message (from CBSD/DP management system)
REL2.C2	For UUT which start as “Release 2 CBSD/DP” sending in Registration Request cbsdFeatureCapabilityList . If SAS replies in Registration Response as “Release 1 SAS”, then UUT De-Registers and changes to a “Release 1 CBSD/DP” implementation.
REL2.C3	Test Cases for CBSD/DP which remain in Registered state and continue to Authorized state without De-Registration, in case SAS replies in Registration Response as “Release 1 SAS”.
REL2.C4	For UUT which Operationally-Supports Enhanced Group Handling (UUT which supports Single Frequency Group, or Coexistence Group or other proprietary group types)

WinnForum Release 2 Test Specifications for CBSD/DP: WINNF-TS-4004

- **WINNF-TS-4004 Table 6-3:**

Section	CBSD	DP	Required for Conformance	Test Case ID	Test Case Title
6.1.4.2.1	X	--	REL2.M	WINNF.FT.C.REL2.NRI.FCE.5	CBSD Successful Feature Capability Exchange with Release 2 SAS: Registration Response includes <i>sasFeatureCapabilityList</i> with partial match to <i>cbSDFeatureCapabilityList</i>
6.1.4.2.2	--	X	REL2.M	WINNF.FT.D.REL2.NRI.FCE.6	DP Successful Feature Capability Exchange with Release 2 SAS: Registration Response includes <i>sasFeatureCapabilityList</i> with partial match to <i>cbSDFeatureCapabilityList</i>
6.3.4.1.1	X	--	REL2.C4	WINNF.FT.C.REL2.NRI.EGH.1	CBSD successful <i>groupingParam</i> as part of Registration. Release 2 SAS Operationally-Supports the group types of the CBSD.
6.3.4.1.2	--	X	REL2.C4	WINNF.FT.D.REL2.NRI.EGH.2	DP successful <i>groupingParam</i> as part of Registration. Release 2 SAS Operationally-Supports the group types of the DP.

WInnForum Release 2 Test Specifications for CBSD/DP: WINNF-TS-4004

- **WINNF-TS-4004 test case sequence methodology is similar to WINNF-TS-0122:**
 - Starting each test case with CBSD/DP UUT in “Un-Registered state”
 - CBSD/DP UUT sends WInnForum SAS<->CBSD Request messages
Verify the Request messages from UUT are formatted correctly with relevant parameters specified in the test step to determine PASS/FAIL
 - CBSD/DP UUT receives WInnForum SAS<->CBSD Response messages from CBSD/DP vendor Self Testing Tool (WInnForum does not provide test harness for CBSD/DP Release 2 testing)
 - Last step is verifying the RF of the CBSD/DP UUT (UUT RF started only from a certain step, UUT shall not transmit RF, etc)
- **Example Test WINNF.FT.C.REL2.NRI.EGH.1 for CBSD as UUT:**

6.3.4.1.1 [WINNF.FT.C.REL2.NRI.EGH.1] CBSD Successful *groupingParam* as part of Registration. Release 2 SAS Operationally-Supports the group types of the CBSD.

#	Test Execution Steps	Results	
1	Ensure the following conditions are met for test entry: <ul style="list-style-type: none"> • UUT has successfully completed SAS Discovery and Authentication with SAS Test Harness • UUT is in the Unregistered state 	--	--
2	UUT sends Registration Request message to SAS Test Harness: <ul style="list-style-type: none"> • The Registration Request is in proper format and parameters are within acceptable ranges. • <i>cbSDFeatureCapabilityList</i> is included with FID: WF_ENH_GROUP_HANDLING • <i>groupingParam</i> is included with values according to WINNF-SSC-0010 [n.8] (CxG, SFG, etc. according to UUT supported groups) 	PASS	FAIL
3	SAS Test Harness sends a Registration Response message, with the following parameters: <ul style="list-style-type: none"> • <i>cbSDId</i> = C • <i>responseCode</i> = 0 • <i>sasFeatureCapabilityList</i> = WF_ENH_GROUP_HANDLING (only this FID is supported by SAS) • <i>groupingConfig</i> is included and matches the group values from 	--	--

Test Case Next Steps

15	Monitor the RF output of the UUT from start of test until UUT transmission commences. Verify: <ul style="list-style-type: none"> • UUT does not transmit at any time prior to completion of the first heartbeat response • UUT transmits after step 12 is complete, and its transmission is limited to within the bandwidth range F. 	PASS	FAIL
----	--	------	------



WinnForum Release 2 Test Specifications for CBSD/DP: WINNF-TS-4004

- **Example Test WINNF.FT.D.REL2.NRI.EGH.2 for CBSD/DP as UUT:**

6.3.4.1.2 [WINNF.FT.D.REL2.NRI.EGH.2] DP Successful *groupingParam* as part of Registration. Release 2 SAS Operationally-Supports the group types of the DP.

#	Test Execution Steps	Results	
1	Ensure the following conditions are met for test entry: <ul style="list-style-type: none"> • UUT has successfully completed SAS Discovery and Authentication with SAS Test Harness • UUT is in the Unregistered state 	--	--
2	DP with two CBSDs sends Registration Request in the form of one 2-element Array or as individual messages to SAS Test Harness: <ul style="list-style-type: none"> • The Registration Request is in proper format and parameters are within acceptable ranges. • <i>cbsdFeatureCapabilityList</i> is included with FID: WF_ENH_GROUP_HANDLING • <i>groupingParam</i> is included with values according to WINNF-SSC-0010 [n.8] (CxG, SFG, etc. according to UUT supported groups) 	PASS	FAIL
3	SAS Test Harness sends a Registration Response message, with the following parameters: <ul style="list-style-type: none"> • <i>cbsdId</i> = Ci, i={1,2} • <i>responseCode</i> = 0 for each CBSD • <i>sasFeatureCapabilityList</i> = WF_ENH_GROUP_HANDLING (only this FID is supported by SAS) • <i>groupingConfig</i> is included and matches the group values from CBSD with <i>supportedBySas</i> = true 	--	--
4	Depending on the existence of additional information for the UUT Release 2 Operationally Supported Features, UUT sends Feature Capability Exchange Request message to SAS Test Harness: <ul style="list-style-type: none"> • The Feature Capability Exchange Request is in proper format and parameters are within acceptable ranges. 	PASS	FAIL

Test Case Next Steps

15	Monitor the RF output of the UUT from start of test until UUT transmission commences. Verify: <ul style="list-style-type: none"> • UUT does not transmit at any time prior to completion of the first heartbeat response • UUT transmits after step 12 is complete, and its transmission is limited to within the bandwidth range Fi. 	PASS	FAIL
----	---	------	------

WinnForum Release 2 Test Specifications for CBSD/DP: WINNF-TS-4004

- **Test Report of CBSD/DP vendor for WINNF-TS-4004 remains internal for the vendor due to the Self-Testing policy**
- **CBSD/DP vendor can proceed to claim compliance to WinnForum Release 2 according to WinnForum CBRS Release 2 Self-Testing Policy as defined in document WINNF-TS-4005**



Questions?



Slide 39



Release 2 SAS Testing/Certification

Masoud Olfat, PhD

WG4 Chair

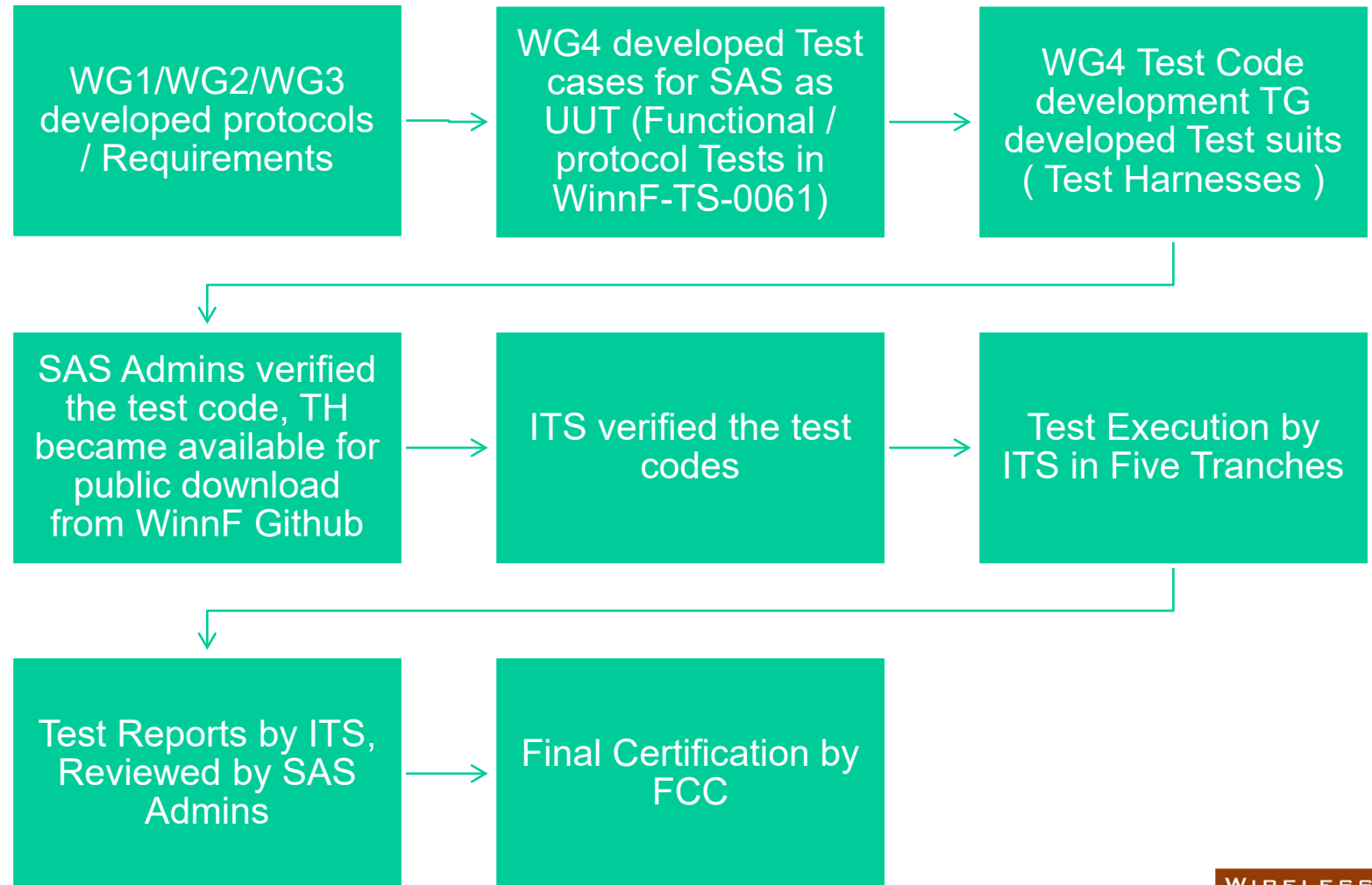
Federated Wireless

Masoud.olfat@federatedwireless.com

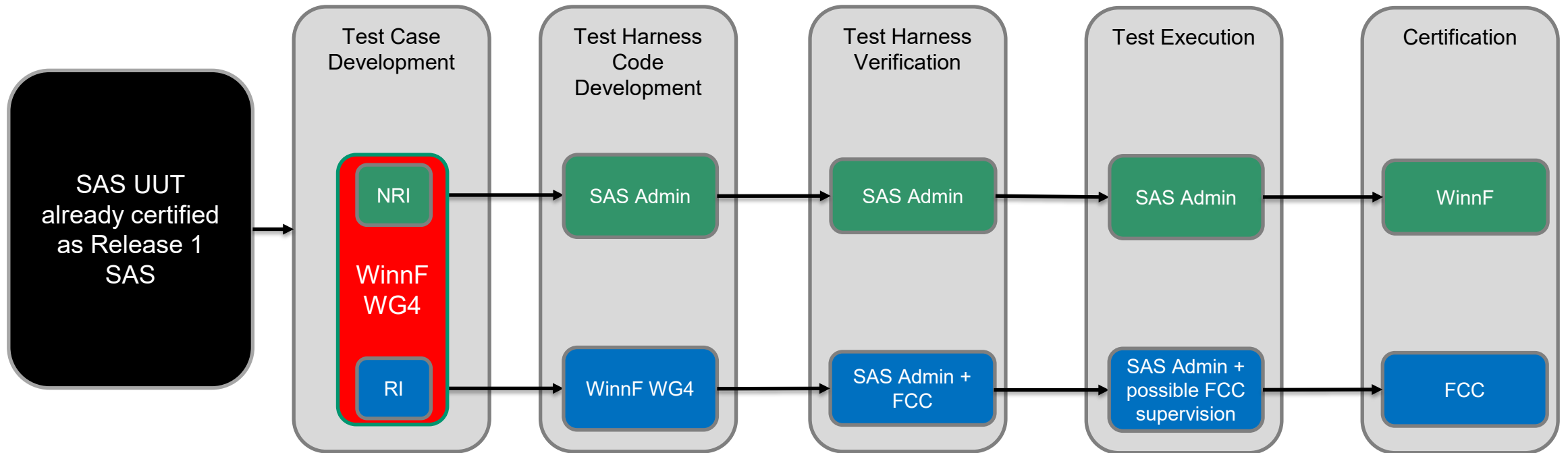


Release 1 WinnForum Test Specifications for SAS

- Five SAS administrators are approved as Release 1 Wave 1 FCC certified
 - Commscope (January 2020)
 - Federated Wireless (January 2020)
 - Google (January 2020)
 - Sony (January 2020)
 - Amdocs (July 2020)
- Keybridge is in process of being certified as Release 1 Wave 1 SAS Administrator
- RED Technologies, and Nokia are in process to become FCC Release 1 Wave 2 certified



Release 2 Test/Specifications process for SAS



Slide 42

WinnForum Release 2 Test Specifications for SAS

- For testing SAS in Release 2 WG4 has two documents
 - WINNF-TS-4003 to address non-Regulatory Impacting (NRI) Test cases
 - WINNF-TS-4006 to address Regulatory Impacting (RI) Test cases
- Test Case Naming:
 - *{TestRequirement}.{TestCategory}.{UnitUnderTest}.REL{X}.NRI.{TestFunction}.{SubTestNumber}* for NRI in 4003
 - *{TestRequirement}.{TestCategory}.{UnitUnderTest}.REL{X}.RI.{TestFunction}.{SubTestNumber}* for RI in 4006
- Example:
 - WINNF.FT.S.REL2.NRI.REG.1
 - No test available for RI

NRI Features in WinnF-TS-4003

Value	Feature/Procedure	Sub-Feature	Description
REG	CBSD Registration procedure	Feature Capability Exchange	Tests the feature capability exchange process as part of CBSD Registration procedure (Request and Response)
FCE	Feature Capability Exchange	Feature Capability Exchange	Tests the feature capability exchange process as independently using the Feature Capability Exchange protocol messages (Request and Response)
EGH	Enhanced CBSD Group Handling	General Enhanced Group messages	Tests the inclusion and correct handling of grouping parameters and grouping configurations in Request and Response messages
		SFG: Principal Subordinate	Not explicitly tested: Handling Principal-Subordinate groups (an example is CPE-BTS group)
		SFG: Passive DAS	Test the correct handling of passive DAS groups as a single frequency group with restrictions on transmission power
		Co-existence Group	Not explicitly tested: Handling Co-existence Group
		Self Coordinating Interference Group	Not explicitly tested: Handling group of CBSDs handling interference among each other
EAP	Enhanced Antenna Pattern	2D antenna model	CBSD 2D antenna model for Coexistence purposes
CPE	CPE-CBSD Indicator	CPE CBSD Indication	A CPE indicates that it is a CPE
FAD	Full Activity Dump Message	Feature Capability Exchange	Exchanging SAS capability with other SASs

Slide 44

Release 2 Feature Capability Test Cases

Test ID	Objective
WINNF.FT.S.REL2.NRI.REG.1	Array Multi-Step Registration for CBSDs (Cat A and B)
WINNF.FT.S.REL2.NRI.REG.2	Array Single-Step Registration for CBSDs (Cat A and B)
WINNF.FT.S.REL2.NRI.REG.3	Invalid cbsdFeatureCapabilityList in Array Registration Request (responseCode 103)
WINNF.FT.S.REL2.NRI.REG.4	[Configurable] CBSD Feature Capability List cbsdFeatureCapabilityList exchange
WINNF.FT.S.REL2.NRI.FCE.1	Array Feature Capability Exchange Request for CBSDs
WINNF.FT.S.REL2.NRI.FCE.2	Invalid Array Feature Capability Exchange Request for CBSDs
WINNF.FT.S.REL2.NRI.FAD.1	[Configurable] SAS UUT Response to a Full Activity Dump Pull Request
WINNF.FT.S.REL2.NRI.FAD.2	[Configurable] Full Activity Dump Pull Command by SAS UUT
WINNF.FT.S.REL2.NRI.FCE.3 (To be added)	SAS requesting CBSD to initiate Feature Capability Exchange

Release 2 Enhanced Group Handling Tests and Passive DAS

Test ID	Objective
WINNF.FT.S.REL2.NRI.EGH.1	Release 2 CBSDs exchange messages with Group types that are supported and not supported by SAS
WINNF.FT.S.REL2.NRI.EGH.2	Release 2 CBSD does not send the groupingParam object
WINNF.FT.S.REL2.NRI.EGH.3	Release 2 CBSD changes the Group it belongs to on the messages
WINNF.FT.S.REL2.NRI.EGH.4	CBSD sends the groupingParam object with incorrect Group Type
WINNF.FT.S.REL2.NRI.EGH.5	Release 1 CBSDs sends a Registration message with Grouping Information to a Release 2 SAS operationally supporting EGH
WINNF.FT.S.REL2.NRI.EGH.6	Passive DAS CBSDs send Registration message with Grouping Information to a Release 2 SAS operationally supporting EGH
WINNF.FT.S.REL2.NRI.EGH.7	CBSDs request membership in a Passive DAS Group on Spectrum Inquiry message
WINNF.FT.S.REL2.NRI.EGH.8	CBSDs request membership in a Passive DAS Group on Grant Request message
WINNF.FT.S.REL2.NRI.EGH.9	CBSDs request membership in a Passive DAS Group on Heartbeat message
WINNF.FT.S.REL2.NRI.EGH.10	Passive DAS CBSDs changes membership
WINNF.FT.S.REL2.NRI.EGH.11	CBSDs send incomplete groupingParam object
WINNF.FT.S.REL2.NRI.EGH.12	Partial CBSDs in a Passive DAS Group operable on a Frequency (Functional Test; Under Discussion)



Other Release 2 NRI Test Cases

Test ID	Objective
WINNF.FT.S.REL2.NRI.EAP.1	Antenna gain calculation using the release 1 method
WINNF.FT.S.REL2.NRI.EAP.2	Antenna gain calculation using the horizontal antenna pattern
WINNF.FT.S.REL2.NRI.EAP.3	Antenna gain calculation using the horizontal and vertical beamwidths
WINNF.FT.S.REL2.NRI.EAP.4	Antenna gain calculation using the horizontal and vertical antenna patterns
WINNF.FT.S.REL2.NRI.CPE.1	Registration and Feature Capability Exchange of Release 2 CBSDs supporting the WF_CPE_CBSD_INDICATOR feature

A Sample Test: WINNF.FT.S.REL2.NRI.FCE.1

- **Initial Condition:**

- Unless otherwise specified, CBSDs registered have their FCC IDs and user IDs already whitelisted by the SAS UUT.
- The SAS UUT must be reset at the beginning of each test case to a baseline state.

Step	Instructions
1	<p>Ensure no cbsdId exists in the SAS for the CBSDs being tested. Ensure that information about a CPI is loaded into the SAS. Use the same CPI information for Step 2.</p> <ul style="list-style-type: none">• SAS Administrator configures Admin Test Harness with the SAS Operationally-Supported FIDs offline.• SAS Administrator configures Admin Test Harness with the SAS Operationally-Supported FIDs (offline) that requires re-registration.
2	<p>Ensure the DP Test Harness sends correct Registration Request in the form of one 3-element Array to the SAS.</p> <ul style="list-style-type: none">• CBSD 1 and 2 shall have no cbsdFeatureCapabilityList included.• CBSD 3 shall have at least one feature included in its cbsdFeatureCapabilityList
CHECK	<p>SAS UUT approves the request by sending a CBSD Registration Response in the form of one 3-element Array to the DP Test Harness as follows:</p> <ul style="list-style-type: none">• SAS response includes a valid cbsdId for each CBSD.• The responseCode parameter contained in the response parameter is 0 for each CBSD concluding an approved Registration,• For CBSD 1 and CBSD 2, NO sasFeatureCapabilityList is included in the response.• For CBSD 3, SAS shall include sasFeatureCapabilityList with all its SAS Operationally-Supported FIDs.

A Sample Test: WINNF.FT.S.REL2.NRI.FCE.1 (Continue)

Step	Instructions
3	<p>The DP Test Harness sends correct Feature Capability Exchange Request in the form of one 3-element Array to the SAS, such that:</p> <ul style="list-style-type: none">• featureCapabilityExchangeRequest contains 3 objects for 3 cbsdIds from the previous Step, and their corresponding cbsdFeatureCapabilityLists such that:<ul style="list-style-type: none">○ For CBSD 1, cbsdFeatureCapabilityList is included but left blank. No cbsdFeatureInfo is included.○ If the list of Operationally-Supported FIDs for the SAS UUT that require Re-registration (see Step 1) is empty, skip CBSD 2. Otherwise, at least one feature is included in its cbsdFeatureCapabilityList. cbsdFeatureInfo contains corresponding array of properly formed FeatureInfo objects with at least one FeatureId requiring Re-registration, included in the SAS UUT Operationally-Supported FIDs requiring Re-registration.○ For CBSD 3, at least one feature is included in its cbsdFeatureCapabilityList. cbsdFeatureInfo contains corresponding array of properly formed FeatureInfo objects with at least one featured, but none requiring Re-registration.
CHECK	<p>SAS UUT responds by sending a Feature Capability Exchange Response in the form of one 3-element Array to the DP Test Harness as follows:</p> <ul style="list-style-type: none">• featureCapabilityExchangeResponse contains 3 objects for 3 cbsdIds from the previous Step:<ul style="list-style-type: none">○ For CBSD 1 and 3, sasFeatureCapabilityList is included. sasFeatureInfo contains corresponding array of properly formed FeatureInfo objects including all SAS Operationally-Supported FIDs, and their associated parameters. The responseCode contained in the response parameter is 0 for the CBSDs, concluding a successful Feature Capability Exchange○ For CBSD 2, the responseCode contained in the response parameter is 105 requiring De-registration.
4	<p>DP Test Harness sends a Registration Request for CBSD 2:</p> <ul style="list-style-type: none">• The request includes cbsdFeatureCapabilityList with the FIDs identical to those in Step 3
CHECK	<p>SAS UUT approves the request by sending a CBSD Registration Response as follows:</p> <ul style="list-style-type: none">• SAS response includes a valid cbsdId.• The responseCode parameter contained in the response parameter is 0 concluding an approved Registration• SAS shall include its sasFeatureCapabilityList, sasFeatureInfo contains corresponding array of properly formed FeatureInfo objects including all SAS Operationally-Supported FIDs, and their associated parameters.

A Sample Test: WINNF.FT.S.REL2.NRI.EAP.2

- Admin Test Harness registers a CBSD supporting the Enhanced Antenna Pattern feature with the SAS UUT
- Knowing the CBSD receiver location(s), SAS UUT computes CBSD antenna gain toward each receiver and send the results back to the Admin Test Harness through the test API.
- The Main Test Harness calculates CBSD antenna gains with the same configurations using the reference implementation.
- SAS UUT passes test if calculated antenna gains are within a certain range of the results calculated by the reference implementation.

Step	Instructions
1	<p>The CBSD Test Harness initiates the CBSD Registration procedure for one CBSD with the SAS UUT. In the Registration Request,</p> <ul style="list-style-type: none">• CBSD indicates support of the Enhanced Antenna Pattern feature.• <i>antennaVerticalBeamwidth</i> is not provided.• <i>antennaModel</i> is provided.• All Required and REG-Conditional parameters are provided correctly. <p>Configure the CBSD Antenna Pattern database such that there is no record whose <i>antennaPatternId</i> matches the value of <i>antennaModel</i>.</p>
CHECK	The SAS UUT indicates support of the Enhanced Antenna Pattern feature in the Registration Response with a SUCCESS response code.
2	The Admin Test Harness sends a list of receiver locations to the SAS UUT.
3	The Main Test Harness calculates the CBSD antenna gains toward the list of receivers using the reference implementation based on REL2-R3-SGN-52102(e) [n.29].
Check	<ul style="list-style-type: none">• The SAS UUT sends the CBSD antenna gains in dBi toward receiver locations received from the Admin Test Harness.• The CBSD antenna gain calculated by the SAS UUT shall be no less than the CBSD antenna gain calculated by the reference implementation minus 0.2 dB.• The CBSD antenna gain calculated by the SAS UUT shall be no more than the CBSD antenna gain calculated by the reference implementation plus 0.2 dB.

If any of the above conditions do not hold for at least 99.9% of trials, the SAS UUT FAILS this test. Otherwise, it PASSES.

Plan for RI Testing

- Test Cases will be included in the document WINNF-TS-4006
- RI Features being discussed in WG1 / WG3,
 - Enhanced Antenna Pattern for Incumbent Protection
 - Grant Update/Optimization
 - IAP Optimization
 - eHata Propagation model adjustment

Thanks, and Questions?



Slide 52

