



CBRS Consolidated Procedures Guide

Version 1.8.1



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Version Information

System Release	Description
Version 1.0	Initial Release
Version 1.1	<p>New cnMaestro cloud software</p> <ul style="list-style-type: none"> • Commencement of migrating ALL cnMaestro cloud servers to 2.4.0, removing the need for a migration to specific CBRS enabled cloud servers. • cnMaestro cloud tool improvements, including allowing .1 dB precision on grant requests instead of only integer values. • Additional cnMaestro bug fixes and scalability improvements.
Version 1.2	<p>Misc additions and corrections:</p> <ul style="list-style-type: none"> • Remove mention of the April migration of cloud servers to 2.4.0 (since it's done). • Several corrections to the "Enabling CBRS in On-Premises" section. • Mention of need for Excel vs Excel alternatives. • Additional text from RTM feedback clarifying Management tool "states". • An additional entry and suggested action in the "Management Tool Failure Messages" table. • Additional text to address scenario where an SM is physically moved or decommissioned and stored. • Additional procedures steps for the "Bandwidth Increase" use case. • A suggestion to double check DP or SAS state after a deregistration procedure. • A new procedure/guide for color code management with CBRS has been added. • A reference to our SAS Vendor selection procedure (currently a standalone doc).
Version 1.3	<p>Misc additions and corrections:</p> <ul style="list-style-type: none"> • An additional procedure steps added for Deregister and Delete the devices. • Additional procedure steps added for Grant suspension possibilities from the SAS. • Additional procedures steps for requesting a new grant for a radio's cnMaestro tool instance prior to config sync. • Additional text added explaining the new "Re-import" option available with the CBRS Management Tool.
Version 1.3.1	Minor updates to track new radio and cnMaestro version numbers.
Version 1.4	<ul style="list-style-type: none"> • Additional procedures steps for the Removal of CPI parameters for device storage. • Additional procedures steps for the De-Register and Delete the devices. • A new procedure for Replacing an AP/BHM has been added.
Version 1.4.1	Added a note in the CBSD synced radio parameter changes

System Release	Description
Version 1.4.1.1	<ul style="list-style-type: none"> Added a new procedure for Moving SMs from a part 96 AP to a part 90 AP. Additional procedures steps added for Parent MAC mismatch in Management Tool failure messages. Added a new procedure for Redeployment of an SM that was never physically installed, to another AP.
Version 1.4.2	Minor procedural updates for r20.
Version 1.5	<ul style="list-style-type: none"> Introduction of the co-existence feature for operators using Google SAS. Redesign of portions of the cnMaestro CBRS management tool to support the co-existence feature. <p>This includes:</p> <ul style="list-style-type: none"> Added a new procedure to editing non-installation parameters from cnMaestro. Additional procedures steps added to de-register and delete the devices. Additional procedures steps added to start CBRS procedure. Additional procedures steps added to Using the import and re-import function on an existing sector. Minor procedural updates. <div>  <p>NOTE:</p> <p>Version 1.5 is the documentation that goes with what is being called throughout this document the "December re-release of 2.4.2". This re-release will be the first release of 2.4.2 for NOC, but an update to the 2.4.2 r14 that has been available on cnMaestro cloud since early 4th quarter 2020. Any server running cloud release 2.4.2 r55 or later will have this new CBRS version 1.5 software.</p> </div>
Version 1.5.1	Minor Procedural updates.
Version 1.6	<ul style="list-style-type: none"> Support for Multigrant and PAL. Additional procedures steps for Syncing CBRS parameters to device. Additional procedures steps for Start CBRS procedure. Added a new procedure for Converting Wideband CBRS Grants to MultiGrant, and Preparation for PAL rollout. Additional procedures steps for De-Register and Delete the devices. Added a new procedure for preparing for and handling a grant termination from the SAS and Alternate Channel Selection (Channel Hunting). Additional procedures steps for suspension when the radio is holding the grant. These new additions have been highlighted in purple color text.
Version 1.6.1	Minor Procedural updates.

System Release	Description
Version 1.6.2	Important update to the deregistration procedure when using Cambium Software 20.2 or later. Operator needs to first deregister from the AP, not the cnMaestro tool, to avoid an unexpected channel hunt.
Version 1.6.3	Additions and modifications to cnMaestro On-Premises sections for Anchor account and Organizational improvements in cnMaestro version 3.0.3.
Version 1.7	<ul style="list-style-type: none"> • Support for co-existence for Federated Wireless and CommScope on radio. • Improvements to channel hunt for termination cases, and addition of channel hunt for suspension cases. • Additional procedures steps for Conversions in areas protected by an incumbent (or another PAL). • Additional procedures steps for Editing non-installation parameters directly on the radio. • Additional procedures steps for De-Register, Delete Operations, and Subsequent Re-Registrations. • Added a new procedure for Termination of a subset of multigrants. • Additional procedures steps for Termination of all grants on an AP or BHM. • Added a new procedure for Suspension when the radio is holding the grant.
Version 1.7.1	Minor Procedural updates.
Version 1.7.2	Addition of cnMaestro CBRS Management Tool support for co-existence on Federated Wireless and CommScope.
Version 1.8	<ul style="list-style-type: none"> • Additional procedures steps for co-existence. • Additional procedures steps for Termination of all grants on an AP/BHM. • Minor Procedural updates.
Version 1.8.1	<ul style="list-style-type: none"> • Remove all references to CommScope, as CommScope is dropping their SAS product. • Added support for new System Release 21.1 features: <ul style="list-style-type: none"> ■ Handling of SM terminations and suspensions when AP is not affected. ■ Restriction of CBRS channel hunt to the same bandwidth, for 450m operators who prefer to avoid an AP reboot. ■ Support of SAS Channel enforcement feature.

Citizens Broadband Radio Service (CBRS)

About this guide

This guide describes configuration and operation of Cambium Networks CBRS solution. It is intended to be used along with Cambium Networks PMP/PTP 450 series Configuration guide and cnMaestro user guide. For ease of use, this separate user guide is created to cover procedural steps for both the radio and cnMaestro, rather than splitting these steps between the existing guides.

Getting started with CBRS

This section describes Cambium Networks suggested typical strategy for migrating an existing PMP/PTP sector to CBRS. The complete procedure lists all the required steps to convert to an FCC CFR 47 Part 96 sector, assuming the sector is currently operational under Part 90. However, the same procedure can be used for a brand new installation by skipping a few of the migration steps.

Procedure for enabling CBRS and updates such as:

- Prerequisites for enabling CBRS.
- Enabling CBRS.
- Basic CBRS additions and updates.

This eight part section is a complete procedure for initial account setup, adding devices into the CBRS Management Tool, obtaining grants, and syncing those to the devices. It also includes basic steps for adding new sectors to existing accounts, checking configuration and status, and the new (with CBRS release 1.5) co-existence feature, including enabling the feature on existing sectors.

cnMaestro account requirements

1. Create a cnMaestro cloud account for your company <https://cloud.cambiumnetworks.com/>.



NOTE:

Users must have an account in cnMaestro cloud account prior to enabling CBRS services. Existing customers can use their Cambium Networks user login.

2. Navigate to **Configuration > cnMaestro** and enable **Remote Management**.
3. Configure **cnMaestro URL** to onboard the AP/BHM to cnMaestro.

Configuration → cnMaestro

3.6GHz MU-MIMO OFDM - Access Point
0a-00-3e-60-70-d6

Save Changes Reboot

Configuration

Remote Management : ☒ Enable ☐ Disable

cnMaestro URL : test.cloud.cambiumnetworks.com

Connection Status : Device Approval Pending (test.cloud.cambiumnetworks.com)

Credentials

Cambium ID :

Onboarding Key :

AccountID :

4. Onboarding of APs and BHMs is required. Onboarding of SMs and BHSs is optional.
5. Navigate to **Configuration > cnMaestro** and enable **Remote Management** on the subordinate devices (SM/BHS).
6. The properties of cnMaestro are inherited from the parent device.

Configuration → cnMaestro

3.6GHz MIMO OFDM - Subscriber Module
0a-00-3e-40-e5-bb

[Save Changes](#) [Reboot](#)

Configuration	
Remote Management :	<input checked="" type="radio"/> Enable <input type="radio"/> Disable
cnMaestro URL :	
Connection Status :	Device Approval Pending (test cloud.cambiumnetworks.com - From AP)

Credentials	
Cambium ID :	
Onboarding Key :	
AccountID :	CBRS_SIT_06

- Click **Save Changes**.
- Navigate to **cnMaestro Cloud account > Onboard** and click **Approve** to onboard the devices in queue.

Onboard

[Onboard](#) [Claim from Device](#)

The Onboarding Queue holds devices before they are added to your account. Devices must be approved in order to complete the onboarding process and be managed by cnMaestro. You can pre-provision devices before they are approved by setting location, configuration, or software version. [Learn more](#)

Search

Type	Serial Number	Device	MAC	IP Address	Added By	Status	Duration	Configure	Actions
PMP 450 AP				N/A	Unsolicited	Waiting for Approval	< 1m		Approve Delete
PMP 450 SM				N/A	Unsolicited	Waiting for Approval	< 1m		Approve Delete

Showing 1 - 2 Total: 2 [Previous](#) [Next](#)

*Note: Devices will remain in the queue for 1 week after onboarding successfully.

- The devices must be approved in order to complete the onboarding process.

Onboard

[Onboard](#) [Claim from Device](#)

The Onboarding Queue holds devices before they are added to your account. Devices must be approved in order to complete the onboarding process and be managed by cnMaestro. You can pre-provision devices before they are approved by setting location, configuration, or software version. [Learn more](#)

Search

Type	Serial Number	Device	MAC	IP Address	Added By	Status	Duration	Configure	Actions
PMP 450 SM		Lab-setup-SM		10.110.208.43	VINOD Using Serial Number	Onboarded	1d 17h 36m	Summary	ONBOARDED
PMP 450 AP		Lab-setup-AP		10.110.208.42	VINOD Using Serial Number	Onboarded	1d 17h 36m	Summary	ONBOARDED

Showing 1 - 2 Total: 2 [Previous](#) [Next](#)

*Note: Devices will remain in the queue for 1 week after onboarding successfully.

Device software update

Cambium Networks software version 16.2 and later are the versions that support CBRS currently. Other software versions such as 16.1.1, 16.1, etc, do not supports the CBRS management operations.

Additionally, SMs/BHSs running software versions other than 16.2 do not connect to a CBRS enabled AP/BHM.

In this release, the following options are supported:

- For existing Cambium Networks 3 GHz customers currently operating in the 3650 MHz to 3700 MHz range without CBRS, upgrade the AP/BHM and all SMs/BHS to 16.2.2 or later prior to moving ahead with the next steps to enable and operate with CBRS.
- For new sector deployments, or adding more SMs to an existing sector that is already converted to CBRS, SMs should be upgraded to a CBRS capable release prior to installation.

Managing CBRS devices



1. An Operator can enable the CBRS feature and input the requested account information as described below:
 - a. Login to cnMaestro Cloud account.
 - b. Navigate to **Services > CBRS**.
 - c. Select preferred **Spectrum Access System (SAS)** vendor.
 - d. Click **I accept the CAMBIUM NETWORKS, LTD. "CBRS" TERMS OF SERVICE/I accept the CBRS Service payment terms** checkbox.

CBRS

Account

Enable Citizen Broadband Radio Service subscription for the CBRS-compliant devices in 3.6 GHz band (3550 MHz to 3700 MHz). [Learn more](#)

Spectrum Access System (SAS) ⚠

☐ I accept the CAMBIUM NETWORKS, LTD. "CBRS" TERMS OF SERVICE

☐ I accept the [CBRS Service payment terms](#)

Enable

- e. Click **Enable**.
- f. **Billing Information** window pop-ups and enter the below input/sections:

Business Contact

- First Name
- Last Name
- Email
- Phone
- Street Address
- Zip Code
- Country
- State

Technical Contact

Enable **Same as Business Contact** if the Technical Contact also same.

- First Name
- Last Name
- Email

SAS Portal Contact

Cambium Networks sets up the SAS portal account on behalf of the operator. Please select whether you want to use a Business Contact, Technical Contact, or Other.

- Click **Save**

CBRS Account

We require a Business Contact and a Technical Contact for your account. [Learn more](#)

☐ **Business Contact**

First Name

Last Name

Email

Phone

Street Address

City

Zip Code/Postal Code

State

Country

☐ **Technical Contact**

☐ Same as Business Contact

First Name

Last Name

Email

☐ **SAS Portal Contact**

Cambium will set up a SAS portal account on your behalf. Please indicate whether you want us to use your Business Contact or Technical Contact for this purpose. Note that Google requires a Gmail address for registration.

☒ Business Contact ☐ Technical Contact ☐ Other

Email (if not Business Contact or Technical Contact)

g. The **Account** page displays:


- Token
- Status
- Device Count
- SAS
- Contact Details

■ Payment Details

Services > CBRS


[Account](#) | [Management Tool](#) | [Domain Proxy View](#)

Please contact [Cambium Support](#) to disable CBRS operations or to change SAS Vendor. [Learn more](#)

Token 

Status

- ✓ Account Created
- ✓ Payment Method Verified
- ✓ SAS-ID Allocated
- ✓ Account Enabled
- Effective Mar 06 2020 17:13:24 (124d 14h 54m)

Total Devices  [Usage History](#)

1 APs, 1 SIMs

Spectrum Access System (SAS)

Federated Wireless (Developer-ICD)

Contact Details

To make changes to the contact details, overwrite the existing entry and click "Update". [Learn more](#)

Business Contact

First Name

Last Name

Email

Phone

9876543

Street Address

ertyulo

City

BANGALORE

Zip Code/Postal Code

987654

State

Jharkhand

Country

India

Technical Contact

First Name

Last Name

Kar

Email

SAS Portal Contact

Cambium will set up a SAS portal account on your behalf. Please indicate whether you want us to use your Business Contact or Technical Contact for this purpose. Note that Google requires a Gmail address for registration.

☒ Business Contact ☐ Technical Contact ☐ Other

Email (if not Business Contact or Technical Contact)

[Update](#)

Payment Details

To update your payment method, make a selection under "Add Payment Method" and enter the new payment method details, then click "Submit".

Credit Card

*****1111 (expiration 1/2023)

Add Payment Method



☐ Add Credit Card Details ☐ Add ACH Payment Details

h. Token:

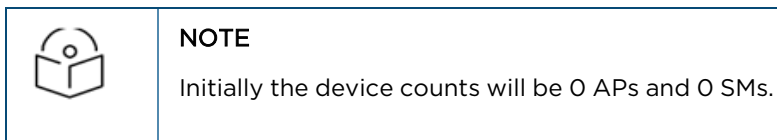
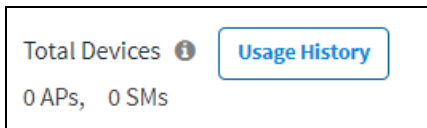
The Token is used for authenticated communication with the SAS through Cambium Domain Proxy. It is generated automatically once CBRS is enabled for the Cloud account.

i. Status:

- Displays the account status.

Pending Status	Success Status
<p>Status</p> <ul style="list-style-type: none"> ✓ Account Created ✗ Payment Method Verification Pending ✗ SAS-ID Allocation Pending <p>● Effective Jul 07 2020 16:54:10 (< 1m)</p> <p>Total Devices  Usage History</p> <p>0 APs, 0 SIMs</p>	<p>Status</p> <ul style="list-style-type: none"> ✓ Account Created ✓ Payment Method Verified ✓ SAS-ID Allocated ✓ Account Enabled ● Effective Mar 19 2020 15:02:02 (110d 2h 0m) <p>Total Devices  Usage History</p> <p>3 APs, 68 SIMs</p>

1. **Account Creation:** Once the CBRS account is enabled it displays the status as **Created**. Refer **Step l** for entering contact information and enabling account.
 2. **Payment Method:** After adding the **Payment Details** and once its verified displays the status as **Verified**. Refer to step m to add payment method after enabling account.
 3. **SAS-ID-** Once the payment details are verified. The SAS ID gets allocated automatically and displays the status as **Allocated**.
 4. **Effective:**
 - **Grey** - Indicates the pending status.
 - **Green** - Indicates success.
 - **Red** - Indicates the account has been deactivated.
- j. **Total Devices:** Displays the count of **Total Devices** registered with the SAS using the Token ID, and **Usage History** provides the list of devices registered with **Month** and **Year**.



- k. **SAS:** An operator needs to select which SAS vendor they prefer.
- l. **Contact Details:**
- For existing CBRS BETA accounts that have been software upgraded to 2.4.0 or later, enter the below input/selections.
- For new CBRS account migrations to the CBRS server, this information would have already been entered in prior **Step f**. Review and update if necessary, else press ahead to **Step m**.
- Cambium Networks selectively communicate with both the **Business Contact** and the **Technical Contact** when changes in the CBRS service may be of interest to both contacts such as useful updates about your SAS administrator, changes in the CBRS initiative from the CBRS Alliance and WinnForum, and announcements of new Cambium CBRS Service features and options.

Business Contact

Cambium Networks communicate with the **Business Contact** for all commercial aspects of the CBRS Service such as invoicing, payment, change in terms, change in pricing, etc.

- **First Name-** Enter the operator's First Name.
- **Last Name** - Enter the operator's Last Name.
- **Email** - Enter the valid email ID.
- **Phone** - Contact phone number.
- **Street Address** - Operator's company address.
- **City** - Enter the city which belongs to selected state.
- **zip code/Postal Code** - Enter the valid zip/postal Code.
- **State** - Select the state from the drop-down.
- **Country** - Select the country from the drop-down.

Technical Contact

Cambium Networks communicate with the **Technical Contact** for all technical aspects of the CBRS Service such as software updates, publication of release notes, learning guides, technical issues, etc.

- **First Name** - Enter the authorized prime technical contact's First Name.
- **Last Name** - Enter the authorized prime technical contact's Last Name.
- **Email** - Enter the authorized prime technical contact's Email.

SAS Portal Contact

Cambium Networks sets up the SAS portal account on behalf of the operator. For that please select whether you want us to use yours **Business Contact**, **Technical Contact**, or **other**.

- Click **Update**

Contact Details

To make changes to the contact details, overwrite the existing entry and click "Update". [Learn more](#)

Business Contact

First Name

Vinod

Last Name

Karadigattu

Email

vinod.karadigattu@cambiumnetworks.com

Phone

9876543

Street Address

ertyjulo

City

BANGALORE

Zip Code/Postal Code

987654

State

Jharkhand

Country

India

Technical Contact

First Name

Vinod

Last Name

Kar

Email

vinod.kau@cambiumnetworks.com

SAS Portal Contact

Cambium will set up a SAS portal account on your behalf. Please indicate whether you want us to use your Business Contact or Technical Contact for this purpose. Note that Google requires a Gmail address for registration.

☐ Business Contact

☐ Technical Contact

☒ Other

Email (if not Business Contact or Technical Contact)

Update



NOTE

Once you click update the **Account Page** will be overwritten by the current entries.

m. Payment Details

Select one of the payment methods below:

- Add Credit Card Details
- Add ACH Payment Method

Payment Details

To update your payment method, make a selection under "Add Payment Method" and enter the new payment method details, then click "Submit".

Credit Card

*****1111 (expiration 1/2023)

Add Payment Method

☒ Add Credit Card Details ☐ Add ACH Payment Details

■ Add Card Details

- Enter the 16 digit valid Credit **Card Number**.
- Select the **Expiration Date** and **Year** mentioned on the card.
- Enter the **CVV** and **Cardholder Name**.
- Click **submit**.

Payment Details

To update your payment method, make a selection under "Add Payment Method" and enter the new payment method details, then click "Submit".






Credit Card

*****1111 (expiration 1/2023)

Add Payment Method


☒ Add Credit Card Details ☐ Add ACH Payment Details

Please Fill in Your Credit Card Details

Card Type     

Card Number

Expiration Date - Select One / - Select One

CVV 

Cardholder Name

☐ = Required Field

■ Add ACH Payment Method

- Enter the **ABA/Routing Number**.
- Enter the **Bank Account Number**.
- Select one of the following **Account Type**:
 - Checking
 - Saving
 - Business Checking
- Enter the **Bank Name** and **Account Holder Name**.

Payment Details

To update your payment method, make a selection under "Add Payment Method" and enter the new payment method details, then click "Submit".


Credit Card


*****1111 (expiration 1/2023)

Add Payment Method

☐ Add Credit Card Details ☒ Add ACH Payment Details

Please Enter Your Payment Details

ABA/Routing Number 

Bank Account Number 

Account Type - Select One

Bank Name

Account Holder Name

☐ = Required Field

- Click **Submit**

Once the information is updated in the **Account** page, an operator receives an email from Cambium support providing them details of newly created account.

CBRS operations and monitoring can be done by cnMaestro platform or Radio user interface.

It is not necessary for an operator to have a direct login to their SAS account. Without the SAS account details from Cambium support an operator can setup the operation of CBRS as described below .

Enabling CBRS in On-Premises



NOTE:

User must have an account in cnMaestro cloud prior to enabling CBRS services in On-Premises. For further information refer to [cnMaestro User Guide](#).

Network Services > CBRS

Account Management Tool

Please contact [Cambium Support](#) to disable CBRS operations or to change SAS Vendor. [Learn more](#)

User must have an account in cnMaestro cloud anchor account prior to enabling CBRS services in On-Premises. As best practice, test the proxy configuration before saving.

Token ⓘ

b6c85cc0fa4b9a78746d7cf9f918086 [Sync From Cloud](#)

Configure CBRS HTTP Proxy

☒ No HTTP Proxy ⓘ

☐ cnMaestro as HTTP Proxy ⓘ

☐ External HTTP Proxy (Recommended) ⓘ

User can configure existing HTTP proxy as an external proxy or can configure new HTTP proxy with the help document. [Learn more](#)

[Save](#) [Domain.proxy.test](#)

Perform the following to enable CBRS. the detailed procedure for performing the following steps of creating an Anchor account, onboarding to it and syncing with it can be found in the "CnMaestro Organization Help Guide found here <https://support.cambiumnetworks.com/files/cnmaestro/>".

1. On successful activation of the CBRS service in the Cloud Anchor account, cnMaestro generates a Token.
2. Onboard the On-Premises to Anchor account.
3. User can Sync the CBRS token from On-premises or Anchor account as shown in the below **Step a** or **Step b**:
 - a. In On-Premises CBRS accounts page click **Sync From Cloud** to synchronize the CBRS token

Network Services > CBRS

Account Management Tool

Please contact [Cambium Support](#) to disable CBRS operations or to change SAS Vendor. [Learn more](#)

User must have an account in cnMaestro cloud anchor account prior to enabling CBRS services in On-Premises. As best practice, test the proxy configuration before saving.

Token ⓘ

b6c85cc0fa4b9a78746d7cf9f918086 [Sync From Cloud](#)

Configure CBRS HTTP Proxy

☒ No HTTP Proxy ⓘ

☐ cnMaestro as HTTP Proxy ⓘ

☐ External HTTP Proxy (Recommended) ⓘ

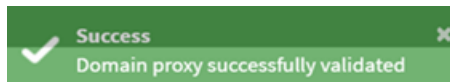
User can configure existing HTTP proxy as an external proxy or can configure new HTTP proxy with the help document. [Learn more](#)

[Save](#) [Domain.proxy.test](#)

- b. Navigate to the **Anchor account > Manage Instances > On-Premises Instances** and click **Sync Now** on CBRS sync status

Name	Type	Status	Last Connected	Onboarded	Uptime	CBRS Sync Status
cnmaestro	CNR	Online	May 28, 2021 14:38	May 12, 2021 21:20	0d 6h 48m	Sync Now

4. Select HTTP proxy mode for SAS communication (refer [CBRS HTTP Proxy Configuration Options](#)).
5. Click **Save token** button. CBRS service will be enabled.
6. Click **Domain ProxyTest** to test domain proxy connectivity. If the test is successful, it will display the following success message:



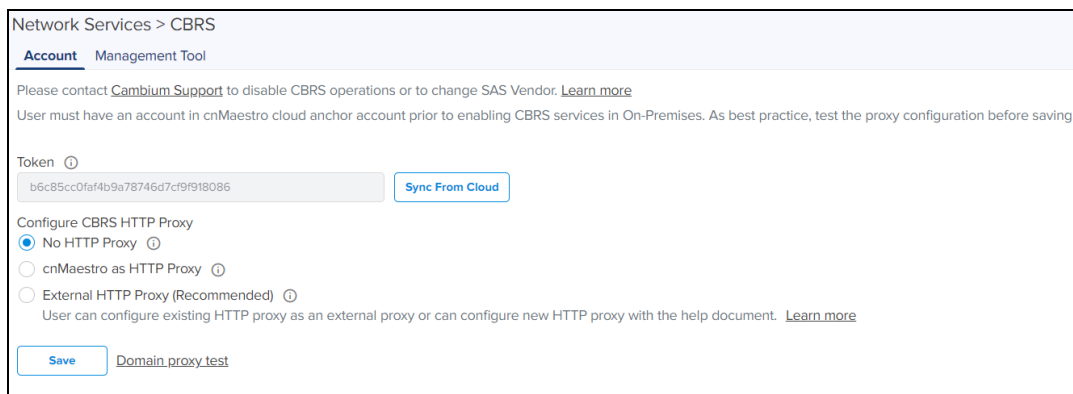
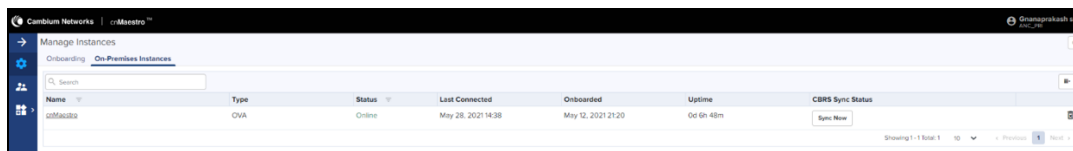
Synchronize CBRS Configuration to the Existing On-Premises Users



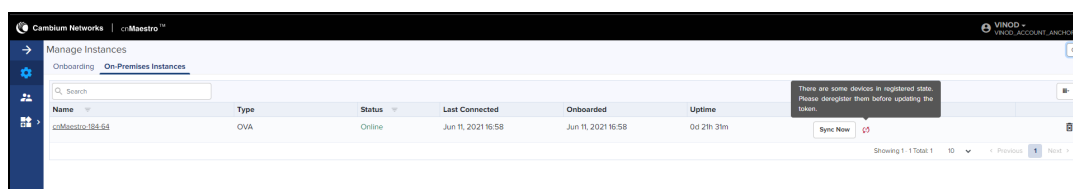
NOTE:

From version 3.0.3 cnMaestro supports Synchronize CBRS Configuration to On-Premises instance.

Once On-Premises is connected to the Anchor account and the link is established between the Anchor account and cnMaestro On-Premises, the user can synchronize the CBRS details (Token, SAS ID) to the cnMaestro On-Premises instance to register CBRS devices.



- If user tries to Sync with the same SAS ID and with different CBRS token, during synchronization it pushes the new token to the existing CBRS devices without any heartbeat loss or deregistration of devices.
- If the user tries to synchronize through Cloud with different SAS ID and CBRS token, it displays an error that the devices should be derigistered from On-Premises and needs to push the token.



CBRS HTTP Proxy Configuration Options

No HTTP Proxy

Network Services > CBRS

Account Management Tool

Please contact [Cambium Support](#) to disable CBRS operations or to change SAS Vendor. [Learn more](#)

User must have an account in cnMaestro cloud anchor account prior to enabling CBRS services in On-Premises. As best practice, test the proxy configuration before saving.

Token ⓘ
b6c85cc0fa4b9a78746d7cf9f918086 [Sync From Cloud](#)

Configure CBRS HTTP Proxy

☒ No HTTP Proxy ⓘ

☐ cnMaestro as HTTP Proxy ⓘ

☐ External HTTP Proxy (Recommended) ⓘ
User can configure existing HTTP proxy as an external proxy or can configure new HTTP proxy with the help document. [Learn more](#)

[Save](#) [Domain.proxy.test](#)

- In On-Premises, No HTTP Proxy is selected by default.
- CBRS-compliant devices communicate with the Domain Proxy directly through the Cambium Domain Proxy.



NOTE:

The On-Premises server and CBRS devices must have Internet access to communicate directly to the Cambium Domain Proxy.

cnMaestro as HTTP Proxy

Network Services > CBRS

Account Management Tool

Please contact [Cambium Support](#) to disable CBRS operations or to change SAS Vendor. [Learn more](#)

User must have an account in cnMaestro cloud anchor account prior to enabling CBRS services in On-Premises. As best practice, test the proxy configuration before saving.

Token ⓘ
b6c85cc0fa4b9a78746d7cf9f918086 [Sync From Cloud](#)

Configure CBRS HTTP Proxy

☐ No HTTP Proxy ⓘ

☒ cnMaestro as HTTP Proxy ⓘ

☐ External HTTP Proxy (Recommended) ⓘ
User can configure existing HTTP proxy as an external proxy or can configure new HTTP proxy with the help document. [Learn more](#)

[Save](#) [Domain.proxy.test](#)

- CBRS-compliant devices communicate with the Cambium SAS Proxy through the local cnMaestro On-Premises HTTP proxy.



NOTE:

cnMaestro On-Premises must have Internet access.

Confirm Selection

Cambium recommends using **External HTTP Proxy** for a highly available deployment, because cnMaestro software updates may take a few minutes to complete, during which time communication with the SAS server will be affected.

Are you sure you still want to proceed with cnMaestro as HTTP Proxy?

[Continue](#) [Cancel](#)



Warning:

Cambium recommends using **No HTTP Proxy** or **External HTTP Proxy** for a highly available deployment, because cnMaestro software updates may take a few minutes to complete, during which time communication with the SAS server will be affected.

External HTTP Proxy

Network Services > CBRS
Account Management Tool

Please contact [Cambium Support](#) to disable CBRS operations or to change SAS Vendor. [Learn more](#)
User must have an account in cnMaestro cloud anchor account prior to enabling CBRS services in On-Premises. As best practice, test the proxy configuration before saving.

Token [Sync From Cloud](#)

Configure CBRS HTTP Proxy

☐ No HTTP Proxy

☐ cnMaestro as HTTP Proxy

☒ External HTTP Proxy (Recommended)

User can configure existing HTTP proxy as an external proxy or can configure new HTTP proxy with the help document. [Learn more](#)

External Proxy URI

[Save](#) Domain proxy.test

CBRS-compliant devices communicate with the Cambium **SAS Proxy** through an **external HTTP Proxy** such as HAProxy. Cambium recommends configuring high availability on the HTTP Proxy. The External HTTP Proxy method is preferred when a direct connection to the Cambium SAS Proxy is unavailable.

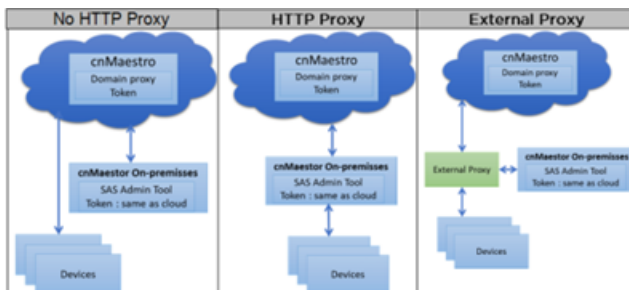
- User needs to configure the external HTTP Proxy to access the SAS server through this option.
- Set the external proxy as <https://proxy-ip:port number>.
- Configure any external proxy IP if available or configure any other cnMaestro IP address which have internet access as HTTP Proxy.

Example: http://x.x.x.x:80



NOTE:

It's not necessary to have internet access by the On-premises.



Management Tool

Cambium Networks CBRS Management Tool provides an easy to use GUI for operators to input parameters necessary to register devices with a SAS, request a grant, and maintain the grant (for a period of time) until an operator is ready to use the grant, thereby reducing potential outage time.

Navigate to **Services > CBRS > Management Tool** page to create a sector.

A sector can be created in two ways:

- **Import Sector:** Uploading a file with all sector devices details.
- **Add AP or BHM:** Manually add all parameters of an AP or BHM.

Import Sector

The **Import Sector** function is a very efficient way of entering radio parameters by allowing addition of all the devices in the sector in a single import step.

- Click **Import Sector** and click **Download Template** from the pop-up menu.
- Click **Download Template** to download the template if user does not have Import Sector template. Users can able to download two different types templates format **PMP Excel** and **PMP ODS**
- Click **Import Excel** button to browse through the path and select Import Sector template file. File must be Microsoft Excel format (.xlsx) or OpenDocument Spreadsheet(ods) formats.

Ensure editing and macros are enabled and populate all the required fields available in the spreadsheet.

RF Link Mode	Device Type	Device name	MAC address	MSN	Latitude	Longitude	Height (m)	Height Type	Integrated Antenna Gain (dBi)	External Antenna Gain (dBi)	Antenna 3-dB Beamwidth (degrees)	Antenna Azimuth (degrees)	Antenna Mechanical Downward (degrees)	Horizontal Accuracy (m)	Vertical Accuracy (m)	E-UTRAN Cell Global Identifier (ECGI)
LTE	3GPP-eNB	3GPP-eNB-001	0-00-00-00-00-01	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-002	3GPP-eNB-002	0-00-3a-05-00-02	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-003	3GPP-eNB-003	0-00-3a-05-00-03	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-004	3GPP-eNB-004	0-00-3a-05-00-04	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-005	3GPP-eNB-005	0-00-3a-05-00-05	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-006	3GPP-eNB-006	0-00-3a-05-00-06	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-007	3GPP-eNB-007	0-00-3a-05-00-07	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-008	3GPP-eNB-008	0-00-3a-05-00-08	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-009	3GPP-eNB-009	0-00-3a-05-00-09	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-010	3GPP-eNB-010	0-00-3a-05-00-10	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-011	3GPP-eNB-011	0-00-3a-05-00-11	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-012	3GPP-eNB-012	0-00-3a-05-00-12	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-013	3GPP-eNB-013	0-00-3a-05-00-13	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-014	3GPP-eNB-014	0-00-3a-05-00-14	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-015	3GPP-eNB-015	0-00-3a-05-00-15	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-016	3GPP-eNB-016	0-00-3a-05-00-16	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-017	3GPP-eNB-017	0-00-3a-05-00-17	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-018	3GPP-eNB-018	0-00-3a-05-00-18	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-019	3GPP-eNB-019	0-00-3a-05-00-19	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-020	3GPP-eNB-020	0-00-3a-05-00-20	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-021	3GPP-eNB-021	0-00-3a-05-00-21	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-022	3GPP-eNB-022	0-00-3a-05-00-22	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-023	3GPP-eNB-023	0-00-3a-05-00-23	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-024	3GPP-eNB-024	0-00-3a-05-00-24	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-025	3GPP-eNB-025	0-00-3a-05-00-25	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-026	3GPP-eNB-026	0-00-3a-05-00-26	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-027	3GPP-eNB-027	0-00-3a-05-00-27	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-028	3GPP-eNB-028	0-00-3a-05-00-28	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-029	3GPP-eNB-029	0-00-3a-05-00-29	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-030	3GPP-eNB-030	0-00-3a-05-00-30	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-031	3GPP-eNB-031	0-00-3a-05-00-31	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-032	3GPP-eNB-032	0-00-3a-05-00-32	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-033	3GPP-eNB-033	0-00-3a-05-00-33	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-034	3GPP-eNB-034	0-00-3a-05-00-34	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-035	3GPP-eNB-035	0-00-3a-05-00-35	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-036	3GPP-eNB-036	0-00-3a-05-00-36	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-037	3GPP-eNB-037	0-00-3a-05-00-37	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-038	3GPP-eNB-038	0-00-3a-05-00-38	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-039	3GPP-eNB-039	0-00-3a-05-00-39	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-040	3GPP-eNB-040	0-00-3a-05-00-40	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-041	3GPP-eNB-041	0-00-3a-05-00-41	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-042	3GPP-eNB-042	0-00-3a-05-00-42	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-043	3GPP-eNB-043	0-00-3a-05-00-43	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-044	3GPP-eNB-044	0-00-3a-05-00-44	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-045	3GPP-eNB-045	0-00-3a-05-00-45	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-046	3GPP-eNB-046	0-00-3a-05-00-46	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-047	3GPP-eNB-047	0-00-3a-05-00-47	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-048	3GPP-eNB-048	0-00-3a-05-00-48	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-049	3GPP-eNB-049	0-00-3a-05-00-49	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-050	3GPP-eNB-050	0-00-3a-05-00-50	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-051	3GPP-eNB-051	0-00-3a-05-00-51	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-052	3GPP-eNB-052	0-00-3a-05-00-52	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-053	3GPP-eNB-053	0-00-3a-05-00-53	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-054	3GPP-eNB-054	0-00-3a-05-00-54	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-055	3GPP-eNB-055	0-00-3a-05-00-55	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-056	3GPP-eNB-056	0-00-3a-05-00-56	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-057	3GPP-eNB-057	0-00-3a-05-00-57	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-058	3GPP-eNB-058	0-00-3a-05-00-58	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-059	3GPP-eNB-059	0-00-3a-05-00-59	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-060	3GPP-eNB-060	0-00-3a-05-00-60	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-061	3GPP-eNB-061	0-00-3a-05-00-61	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-062	3GPP-eNB-062	0-00-3a-05-00-62	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-063	3GPP-eNB-063	0-00-3a-05-00-63	123456789012	42.055774	-88.024154	10	ACL	21	0	12	113	-1	10	3	3318595242364
3GPP-eNB	3GPP-eNB-064	3GPP-eNB-064	0-0													

Import Sector Data

Excel File
cbrs_sector_0A003E453/ Import Spreadsheet Download Template ▾

CPI information is neither stored on client nor on the server. It protects against any misuse of CPI certificate and its password.

Certificate File*
Import Certificate

File Password*

User ID* Ⓞ
SF5W5D

CPIR Name*
Alan Baumgartner

Sector ID
0a-00-3c-45-3a-50 Edit

Spectrum Reuse ID
Select Reuse ID ▾ Add Delete

Merge User ID
Yes ▾

Import

Co-existence

Starting with the December 2020 release of 2.4.2, and radio code R20 or later, two new parameters **Sector ID** and **Spectrum Reuse ID** have been added. These have been added to support the SAS's co-existence feature. Starting in third quarter 2021, Federated Wireless now accepts the co-existence parameters, in addition to Google, and have a number of changes planned in their roadmap to make use of these parameters in their co-existence calculations. cnMaestro version 3.1.0 introduces support for Federated Wireless co-existence, on top of the existing support for Google.

- **co-existence Sector ID:** This parameter is also known as the identifier of a Common Channel Group (CCG) in CBRS Alliance or Principal Subordinate Single Frequency Group (SFG) in WinnForum Release 2. The Google SAS portal currently calls it **Same Frequency** in the Frequency Management subsection of the per-device Config tab as well as at the top of the per-device Coex tab. Federated Wireless uses this to create the SFG ID displayed on its portal. The purpose of the sector ID is, it helps the SAS identify which SMs are grouped with a particular AP (same frequency and Bandwidth as the AP).
- **co-existence Spectrum Reuse ID:** This parameter defines a CBRS interference coordination group. It is called Spectrum Reuse in WinnForum Release 2, or Interference Coordination Group (ICG) in CBRS Alliance. The Google SAS portal currently calls it **Frequency Reuse** in the Frequency Management subsection of the per-device Config tab as well as at the top of the per-device Coex tab. Federated Wireless uses this to create the SRG ID displayed on its portal. Multiple sectors can be assigned the same Spectrum Reuse ID. A SAS will not attempt to co-ordinate interference between devices using the same Spectrum Reuse ID.

For example: an operator using two non-overlapping center frequencies in what's typically called an ABAB deployment could assign one Spectrum Reuse ID to all sectors using center frequency "A", and a second Spectrum Reuse ID to all sectors using center frequency B.

- **Merge User ID:** This parameter will be seen in this pop-up GUI for Federated Wireless and in most cases should be left at its default of YES to handle the possibility of two operators accidentally picking the same co-existence parameters. If an operator wishes to frequency coordinate on the same channel with another operator or between PMP and LTE technology, this parameter can be disabled and the co-existence group parameters set the same - coordinated. For Google, these parameters are unique to an organization, so this parameter is not

available for operators using Google SAS. See Cambium 20.3 training slides for more information. The training slides can be found on the Cambium learning site: <https://learning.cambiumnetworks.com/learn/signin>. After logging in, navigate to the CBRS section in the complete catalog.



NOTE:

If an AP is running software older than 20.3, an operator must change this value to NO when importing or adding a sector. If this is left at its default setting of YES, the subsequent CBRS grant sync attempt will be blocked/prevented by cnMaestro.

A new Spectrum Reuse ID can be added to the database by clicking **Add**. Then select the added value – or existing value previously added. The exact values used for the Spectrum Reuse IDs are left up to the operator.

By default, when an operator upgrades an existing sector to R20 or later, these two new co-existence parameters are added to the database on the AP/BHM, independent of which SAS vendor is in use. As mentioned above, the Sector ID will default to the MAC address of the AP/BHM, while the Spectrum Reuse ID will be empty. The next heartbeat request sent from the AP/BHM after an upgrade from radio software not supporting co-existence for the SAS in use, to software supporting co-existence will include this default Sector ID. For Federated Wireless operators, this sector ID will be included in the next heartbeat request sent after an upgrade to software 20.3 - build official or BETA software or later.

Cambium Networks recommends operators using Federated Wireless to upgrade to software 20.3 or later, for the same reason - to overwrite the SAS default values. If an operator does not provide co-existence parameters, the SAS uses default values.

It is better for the user to provide their own Spectrum Reuse IDs, rather than to rely on default values the SAS assumes, which may or may not match the operator's actual deployment.

The procedure steps listed above describe how to add new Spectrum Reuse IDs to the cnMaestro tool for network expansion or new CBRS deployments. For existing CBRS deployments, another option is to perform the following steps to push a cnMaestro template down to the existing radios that preserves the default sector ID's, but populates the Spectrum Reuse ID.

1. For each Spectrum Reuse ID an operator intends to deploy, assemble a .cfg template with only the Spectrum Reuse ID. An example is shown below:

```
{
  "userParameters": {
    "apCbrsConfig": {
      "cbstdCoexSpectrumReuseId": "${cbstdCoexSpectrumReuseId=B}"
    }
  }
}
```

- If desired, the **Sector ID** and/or **Include User ID** could also be added to the template to modify the default values. In most cases, the default values for these 2 parameters is sufficient.

If using Federated Wireless, an Include User ID field is also available on the **Configuration > CBRS** page of the AP/BHM. The Include User ID field could also be added to the template if using Federated Wireless, if an operator wants to NOT include the CBRS User ID in the Sector ID and Spectrum Reuse ID sent to the SAS. This parameter is included by default for Federated Wireless and in most cases should be included to handle the possibility of two operators accidentally picking the same co-existence parameters. If an operator wishes to frequency co-ordinate on the same channel with another operator or between PMP and LTE technology, this parameter can be disabled and the co-existence group parameters set the same - coordinated. For Google, these parameters are unique to an organization, so this parameter is not available for operators using Google SAS. See Cambium 20.3 training slides for more information.

The training slides can be found on the Cambium learning site:

<https://learning.cambiumnetworks.com/learn/signin>. After logging in, navigate to the CBRs section in the Complete Catalog.

2. Use cnMaestro's configuration update functionality to push the template to every AP/BHM that needs this Spectrum Reuse ID configured.
3. The AP/BHM will get updated, reboot automatically, then send out a new HB request with the updated Spectrum Reuse ID to the SAS.

Add AP or BHM

Users can manually enter the information related to each radio one by one via the pop-up GUI.

- Click **Add AP or BHM**.
- Configure all the mandatory and optional parameters:
 - **Mandatory parameters:**
 - **Common parameters:** Device Name, Mode, Device Type, MAC Address, MSN.
 - **Location related parameters:** Latitude, Longitude, Height, and Height Type.
 - **Antenna related parameters:** External Antenna Gain, Beam width, Azimuth and Down Tilt.
 - Add CPI certificate: Certificate File, File Password, CPIR Name.
 - **Optional parameters:**
 - Horizontal Accuracy and Vertical Accuracy.
 - **co-existence related parameters:** Sector ID, Spectrum Reuse ID, and Merge User ID.



NOTE:

Merge User ID is not applicable for Google SAS, refer Import sector for more details.

- Click **Add**.

Add AP/BHM/RRH

Common parameters

Device Name

Mode*

AP

Device Type*

450 Connectorized

MAC Address*

MSN*

User ID*

cambiumuser

Location related parameters

Antenna related Parameters

Co-Existence related parameters

Sector ID

Edit

Spectrum Reuse ID

Select Reuse ID

Add

Add CPI Certificate

CPI information is neither stored on client nor on the server. It protects against any misuse of CPI certificate and its password.

Certificate File*

Import Certificate

File Password

CPIR Name*

Alan Baumgartner

Add

Cancel

Any newly added device via either the **Add or Import** function which was not previously connected to cnMaestro is automatically claimed in the server. When using cnMaestro Cloud, devices are claimed using the serial number.

If the AP/BHM is not onboarded, onboard the device from the onboarding page before syncing the device, which will be shown later in the procedure.

Onboard
Claim from Device

The Onboarding Queue holds devices before they are added to your account. Devices must be approved in order to complete the onboarding process and be managed by cnMaestro. You can pre-provision devices before they are approved by setting location, configuration, or software version.

Claim Device
Approve All
Export

Type	Serial Number	Device	MAC	IP Address	Added By	Status	Duration	Configure	Approve	Delete
PMP 450 SM				N/A		Waiting for Device	0d 0h 2m		Approve	Delete
PMP 450 AP				N/A		Waiting for Device	0d 0h 2m		Approve	Delete
PMP 450L SM				N/A		Waiting for Device	41d 19h 29m		Approve	Delete
PMP 450L AP				N/A		Waiting for Device	41d 19h 29m		Approve	Delete

Showing 1 - 4 Total: 4

Onboarding stages are as follows:

- **Claimed:** Claiming the device by its serial number automatically makes it visible in the onboarding page.
- **Onboarded:** The device is managed once it is approved via the onboarding page.
- **Waiting for device:** A device is claimed but unable to connect to the server.
- **Waiting for approval:** When a claimed device is online and ready for approval.

Click on the **Device Name** of the newly added/imported AP or BHM to navigate to **Management Tool** page for this specific sector. From this page, an SM or BHS may be manually added or imported if desired.

Start CBRS procedure

Select the newly created parent device which was either manually added or imported. Devices in the sector are UNREGISTERED and Not Synced.

Click **Start** to initiate the CBRS tool process on the devices.

Sectors > Lab-setup-AP

Device Name	Device Type	Mode	Health	MSN	Latitude	Longitude	Sync Expiry Time	Height	Registered	Sync State	Actions
Lab-setup-AP	PMP 450 Conn...	AP	Online		44.426733	-110.473533	N/A	23	AUTHORIZED	Config Synced	
Lab-setup-SM	PMP 450 Integ...	SM	Offline		44.426745	-110.473545	N/A	25	AUTHORIZED	Config Synced	

Showing 1 - 2 Total: 2

Starting with the December 2020 Re-Release of cnMaestro 2.4.2, perform the START procedure as follows:

- The CBRS Management Tool proceeds to register the **AP/BHM** only, and send a Spectrum Inquiry Request to the SAS.
- The tool will then pause and show the following pop-up as explained below:



The SAS provided spectrum availability view shows the results of the spectrum Inquiry Response received from the SAS.

- Two separate views of the same results are provided when using Google or Federated Wireless: one sorted by ranking from the SAS, the other by frequency. From March 2021, all three SAS vendors now provide a Max EIRP value per channel.
- The co-existence Configuration section shows the co-existence parameters entered when importing/adding the sector. These can be edited at this time, if desired. Note however that the AP was already registered with the Spectrum Reuse ID entered prior to clicking on the START button. If the operator elects to change the co-existence parameters at this time a new spectrum inquiry exchange will take place, and for the Google operators, the 8 hour countdown timer shown further down on this GUI will be reset back to 8 hours and begin counting down again. These countdown timers are explained later a few paragraphs ahead in this subsection.

- The Spectrum Reuse ID Statistics tab shows a count of sectors already existing in this cnMaestro account that have Spectrum Reuse ID's configured and the parent AP/BHM of that sector is holding a grant. The number beside the Center Frequency and Channel Bandwidth combination is a count of the number of AP/BHM's that have a grant for this Spectrum Reuse ID. For example, in the given screen-shot two sectors are already configured and granted with Spectrum Reuse ID 100 and 101.
- The last section is the EIRP Computation section. Based on the results shown in the Spectrum availability view and their frequency reuse or deployment strategy, an operator can select the desired Center Frequency and Channel Bandwidth for this sector here, at this time.
- Once that selection is made, a blue color background shaded box will appear for that channel selection in the Spectrum availability view.

Once this desired channel selection has been made by the operator, the SAS Allowed Total Max EIRP value is calculated. This is a conversion from the dBm/MHz units displayed in the spectrum availability view, to Total EIRP the SAS indicated it will allow. For channel selections that span more than one 10 MHz slice of spectrum, the conversion is based on the lowest value of all the bins covered by the operators channel and Bandwidth selection. In the screenshot above, the 19 dBm for 20 MHz at 3660 MHz is a conversion from 6 dBm/MHz. This is likely not a good choice, given the SAS restrictions on the allowed EIRP. A better choice for a 20 MHz grant request might be, for example, a center frequency of 3590. The guidance provided by the SAS vendors via this MaxEIRP is slightly different between SAS vendors as follows:

- For **Google** and **Federated Wireless**, It is the value that can be expected to be Authorized immediately by the SAS. There may be benefits to an operator requesting more than this value, as a higher value could possibly be granted at the next CPAS cycle.

Above this field is a checkbox warning pointing out that although the operator has already registered this AP/BHM with the Sector ID and Spectrum Reuse ID entered during Import/Add at this point, it's expected that Google and Federated Wireless SASs may take several hours before this is reflected in the results of the Spectrum Inquiry Response.

For Federated Wireless: What will be seen is a timer counting down to 1 hour after the completion of the next 11 AM UTC time, which is 1 hour beyond the expected completion of the next CPAS cycle. However, a registration request with such coexistence parameters must be received prior to 4:45 AM UTC time in order for that registration to be considered in the upcoming CPAS cycle. If such registration request is received between 4:45 AM and 11 AM, the operator will likely need to wait 24 hours for the following CPAS cycle, and the countdown timer will reflect this.


For Google: This is an 8 hours countdown timer from the time the Spectrum Inquiry Response is received. An example below illustrate this.

- This screenshot below shows an example where a competing operator already has a 20 MHz Grant in this area spanning 20 MHz of Bandwidth from 3560 to 3580. Notice how the SAS has ranked these two 10 MHz slices as 14 and 15, suggesting these are currently not good choices. What's important to note here is that it might take up to 8 hours for the Google SAS to calculate an optimal sorting.



NOTE:

One limitation of the current 15 vertical bar graph in cnMaestro 3.1.0 is that Federated Wireless may sometimes split a 10 MHz channel into two 5 MHz slices in a co-existence sorted SI response. This is typically done when the SAS wants to indicate that the co-existence suggested channels for this particular sector start or ends on a 5 MHz boundary. The current cnMaestro code does not display these two 5 MHz slices separated. If, for example, all 150 MHz of spectrum is shown as available by the SAS, but this sector's SAS suggested allocation is 3625 through 3650, with the 3620 through 3625 slice listed last in the SI response order, an operator would see the 15 channels in the graph numbered from 2 through 16, with the 3620 through 3630 10 MHz of spectrum listed as channel 16 in priority. A future cnMaestro improvement is expected to more accurately handle this case.

- After the expiration of the 8 hour timer, or anytime during this 8 hour countdown, the operator can click on the refresh  icon in the upper right hand corner of the Spectrum Inquiry Pop-up GUI. At this point, the AP/BHM will be in a Registered State, while the SMs or BHS will be in a **UNREGISTERED** or **DEREGISTERED** state. Alternatively, an operator can close out this Spectrum Inquiry Pop-up screen via the **X** in the upper right hand corner of the GUI, if they wish to use this browser session for something else. The countdown timer for co-existence stats from Google SAS will continue in the background. Then later, clicking on the **START** button from the tool will generate another Spectrum Inquiry exchange and show the current 8 hour countdown timer value. A final Spectrum Inquiry exchange after the 8 hours timer has finished will give the operator the final optimal ranking indications for channel selection. Waiting this 8 hours is optional. If an operator is already confident in their channel decision, they do not need to wait for the optimal ranking from the SAS. This final spectrum Inquiry request must be manually triggered, either with the **START** action button, or with the refresh button in the Spectrum Inquiry pop-up GUI.
- Whether waiting 8 hours or pressing ahead without waiting, the next step is to enter the requested EIRP values per device. To do this, click **Calculate MAX EIRP**. This expands the EIRP computation section into a table of devices in the sector as shown below. Here an operator can enter the requested EIRP per device. By default, the value shown for new devices will be the maximum calculated value based on the selected Bandwidth and the model and antenna gain for each particular device. Depending on the SAS vendor being used

and whether an operator needs an Authorized grant immediately or can wait for the next CPAS cycle should be considered when deciding whether to request an EIRP value that exceeds the SAS Allowed Total Max EIRP value.

It should be noted that the Management Tool sends a Spectrum Inquiry only for the AP/BHM. It does not do this for SMs or BHSs. So the exact EIRP limits for each SM/BHS are unknown. Only some time after a Grant Request will the SAS tell an operator what the limits for each particular SM/BHS installation are. The AP/BHM Spectrum Inquiry response gives limits for the AP/BHM and can provide a rough guide for the general area - the entire sector. See the SAS vendor specific explanations provided earlier in this section.

The above example, with 8 hour timer, applies directly to operators using co-existence with Google SAS. For operators using Federated Wireless SAS, procedures are similar except the countdown timer counts down to the next CPAS cycle as explained earlier. For existing sectors, the sector ID will be present for any sector where the AP is running 20.3 code or later.

When all EIRP selections have been made, click **SAVE** This will trigger a Grant Request for the AP/BHM, and Registration Requests followed by Grant Requests for the BHS/SMs.

EIRP computation

Devices are listed with calculated maxEIRP and requested EIRP based on the selected center frequency and channel bandwidth. Click Save to update the EIRP of devices and continue the procedure

Center Frequency (MHz)*

Channel BW (MHz)*

SAS Allowed Total MaxEIRP (dBm)

Calculate Max EIRP

Device Name	MAC Address	Device Type	Max EIRP (dBm)	Requested EIRP (dBm)
PS 450m AP	0A:00:3E:60:70:F3	PMP 450m	48	<input type="text" value="48"/>
SM1	0A:00:3E:43:1A:7A	PMP 450 Connectorized	30	<input type="text" value="30"/>
SM10	0A:00:3E:42:FD:CF	PMP 450 Connectorized	25	<input type="text" value="25"/>
SM11	0A:00:3E:43:1A:55	PMP 450 Connectorized	25	<input type="text" value="25"/>
SM12	0A:00:3E:43:1A:4C	PMP 450 Connectorized	25	<input type="text" value="25"/>
SM2	0A:00:3E:43:1A:36	PMP 450 Connectorized	30	<input type="text" value="30"/>
SM3	0A:00:3E:43:1A:88	PMP 450 Connectorized	49	<input type="text" value="49"/>
SM4	0A:00:3E:43:1A:39	PMP 450 Connectorized	25	<input type="text" value="25"/>
SM5	0A:00:3E:43:0C:0E	PMP 450 Connectorized	25	<input type="text" value="25"/>
SM6	0A:00:3E:43:1A:4E	PMP 450 Connectorized	25	<input type="text" value="25"/>

Showing 1 - 10 Total: 13

10

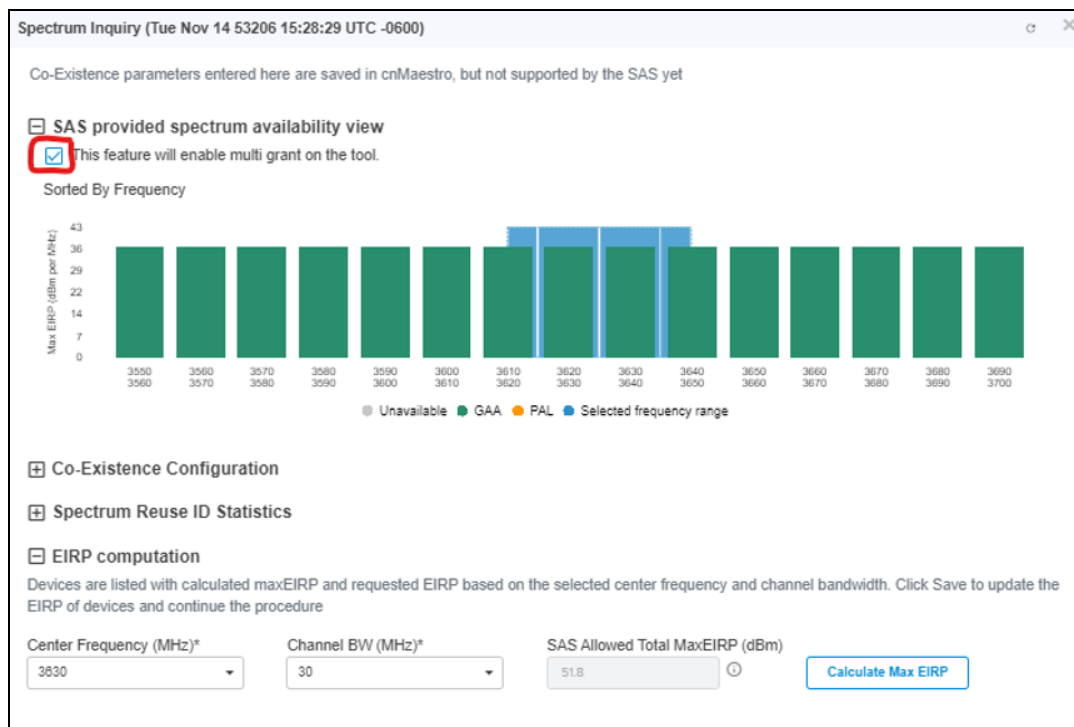
Previous

2

Next

Save

The **CBRS Management Tool** proceeds to register the devices to the SAS and request a grant for each CBSD. Starting with cnMaestro version 3.0.2, the tool will no longer request a single grant for however wide the Bandwidth selected is, but instead will request 1 grant for every 10 MHz of spectrum, assuming the boundaries of the total spectrum request land on 10 MHz boundaries. If instead the boundaries of the total spectrum requested land on 5 MHz boundaries, 5 MHz grants will be needed also. Although not strictly required, Cambium Networks strongly recommends an operator try to maintain 10 MHz boundaries. In other words, for 10 MHz or 30 MHz allocation requests, use a center frequency such as 3565, 3575, etc. For 20 MHz or 40 MHz allocation requests, use center frequencies such as 3570, 3580, etc. This minimizes the number of grants that have to be managed. The one exception to this is, if the cnMaestro management tool sees that the radio is onboarded with a radio software version earlier than 20.2, or that multigrant is disabled on the AP, a single wideband grant will be requested instead of multiple grants. Although in most cases cnMaestro ability to auto-determine where a user needs multigrant or not should be sufficient, Cambium also provides an operator the ability to manually control which type of grant is selected via the Spectrum Inquiry pops-up UI as shown below:



This cnMaestro tool's multi grant enable flag shown in the picture above works as follows:

The proper value will be derived by the cnMaestro tool software the first time the tool is run on 3.0.2 software per sector. After that, an operator can change the flag themselves, for example, if they downgrade the radio software on the sector for some reason and wish to obtain grants from the tool again. One known limitation with this flag is that it is not configurable on a per SM basis. So if, for example, the AP and most of the SMs are operator on 20.2 or later software and multigrant, and a new SM running 20.1 software is added to the sector, the best option would be to use the tool only for signing the installation data for the SM, not for requesting a grant for the SM. When the SM comes on the air interface, the AP will pull the CBRS configuration from the cnMaestro tool, request a widegrant for the SM, then bring the SM to an authorized state using widegrant. That allows an operator to upgrade the SM to 20.2 over the air, then relinquish the wideband grant and allow the AP to request multigrant for it. If, on the other hand, an operator attempted to use the tool to not only sign the installation data, but also request the grant for the SM, the tool will obtain multigrants for the SMs, not single wideband grants. Those won't sync properly to the device and the operator runs the risk of seeing an unwanted deregistration from the tool, 72 hours after obtaining the grant.

The tool updates the CBSD state of the devices accordingly as follows:

- *Unregistered*
- *Registered*
- *Registration Failed*
- *Deregistered*
- *Deregistration*
- *Granted*
- *Heartbeat*
- *Heartbeat Failed*
- *Grant Failed*
- *Grant Suspended*
- *Halt*
- *Authorized*

Starting with cnMaestro release 3.0.2 and the introduction of multigrant, the CBRS Management tool will now show the status of each individual grant slice per CBSD as shown below. As you can see, this operator has requested 30 MHz of Bandwidth from the SAS, four bubbles per CBSD represent the status of each grant. The information bubble per row shows more details on the individual state of each grant and the frequency range the grant covers. As mentioned above, this is a non-standard configuration in that for a 30 MHz request, Cambium Networks recommends the center frequency be 3565 or 3575, not 3570, to keep the boundaries on a 10 MHz raster. This configuration here is shown for demonstration purposes.

Device Name	Device Type	Mode	Health	MNC	Latitude	Longitude	Sync Expiry Time
SA-000-00-40-47-00	PMP 450m	AP	Online	MOBILEWISDOM	40.233	-91.2324	N/A
SA-000-00-40-40-01	PMP 450 Integrated	SM	Offline	6080QUORUM	40.2334	-91.2323	2d 8h 15m
SA-000-00-40-40-22	PMP 450 Connected	SM	Offline	6080QUORUM	40.2334	-91.2324	2d 8h 15m
SA-000-00-40-40-22	PMP 450 Connected	SM	Offline	6080QUORUM	40.2334	-91.2324	2d 8h 15m
SA-000-00-40-40-06	PMP 450 Connected	SM	Offline	6080QUORUM	40.2334	-91.2423	2d 8h 15m
SA-000-00-40-40-06	PMP 450 Integrated	SM	Offline	6080QUORUM	40.2334	-91.2323	2d 8h 15m

If the Grant is in **AUTHORIZED** or in **SUSPENDED** state, the last heartbeat time is updated. If the CBSD state is GRANT_SUSPENDED, this is typically not a failure.

Suspended usually indicates an expected delay in grant Authorization from the SAS. The user must wait overnight for the SAS to perform its CPAS procedure (CPAS stands for Coordinated Periodic Activity among SAS's – for every 24 hours in the middle of the night where SAS's exchange radio usage and request information and decisions are made on grant allocation, suspension, termination, etc.).

If the GRANT is in any other state other than AUTHORIZED or GRANT_SUSPENDED, the tool updates the failed CBSD state with the reason information in a “hover over” bubble.

If the GRANT is in the GRANT_SUSPENDED state, the tool also provides the reason for suspension, assuming the SAS has provided the information to the tool.

In the screenshot above, all grants are authorized. If, for example.

Cambium Networks cnMaestro tool holds a grant for 72 hours, giving a customer 72 hours to sync the grant to the actual device. The “Sync Expiry Time” shows per device how much time an operator has left to sync the grant to the actual device. That time shows as “N/A” if the grant has already been synced. If this timer expires before an operator has chance to use the grant, a new grant will need to be requested. The Management tool continues heartbeating with the SAS to maintain the grant state prior to syncing the grant to the tool. Once the grant it synced to the tool, the device will heartbeat with the SAS.

After the initial grant request, if this CBSD is near an incumbent or a PAL operator, the SAS might offer a lower EIRP as follows:

1. **Federated Wireless:** After a few heartbeat exchanges for interference calculations, the SAS will put the radio in 501 suspended state, but may offer this “Same day grant” via OpParams in the heartbeat response. An operator can leave the tool in suspended state and wait for CPAS, or sync the suspended grant to the radio, which will automatically request the lower EIRP (assuming that EIRP meets some minimum thresholds for that model).
2. **Google:** The SAS will continue to heartbeat the grant in suspended state without offering a same day value via OpParams. See also considerations for color code usage near the end of this document.

For both SAS vendors, the maximum EIRP a device can be expected to be offered should then be seen at CPAS time via either an authorization of the original high request, or a termination and an offered lower value. A START operation at that point will accept and request this EIRP offered value if a termination took place.

As with any Bandwidth change performed by an operator on a single sector, there is always a slight possibility that the change in frame configuration caused by the Bandwidth adjustment could result in interference with other sectors in the area still running the original Bandwidth. 20.2 and later Cambium code includes a warning at the top of the UI as shown below after any automatic Bandwidth adjustment performed by the software: Note that this warning does not mean that self-interference actually occurs. It is only a reminder to double check the configuration via the OFDM frame calculator in the tools page of the AP and see if any action is needed. In many cases, no action will be necessary.

General Status | Session Status | Engineering Event Log | Event Log | Network Interface | Layer 2 Neighbors

Home → General Status

PTP 450i
3.6GHz MIMO OFDM - Backhaul - Timing Master
0a-00-3e-45-31-83

Channel bandwidth changed due to CBRS. To avoid any self-interference with adjacent sectors, it is recommended to use the co-location tool and adjust the duty cycle.
Engineering Key Enabled

Device Information	
Device Type:	3.6GHz MIMO OFDM - Backhaul - Timing Master - 0a-00-3e-45-31-83
Board Type:	P13
Product Type:	PTP 450i
Software Version:	CANOPY 20.2 (Build DEV-29) BHL450
CPU Usage:	CumMac 2%/95%

Note that this banner is shown in 20.2 for All 3 GHz CBRS AP or BHM hardware types EXCEPT 450m. 450m APs can still have frame sync issues, however the banner warning is not currently supported – this is a planned future improvement.

For completeness, a final set of screenshots is shown below for the above scenario, but 12 hours later – after a CPAS cycle. First, we can see that our 3rd grant was AUTHORIZED at CPAS time, albeit at a lower power level than the other three grants.

Select CBSD
Current CBSD: PTP 450i BHM - 10.120.232.100 [0a003e453183] (Lut: BHM)

CBSD Information

CBSD Grant State: Authorized
CBSD State Time: 00:18:14
CBSD ID: 20a09f1002b0a003e453183
EIRP Requested: 18 dBm
EIRP Granted: 13 dBm
Number of Grants: 4

CBSD Grant Information

Channel (MHz)	Grant ID	Grant State	Heartbeat Interval (Seconds)	Last Heartbeat Time	Transmit Expire Time	Grant Expire Time	Channel Allocation Type	Granted EIRP (dBm/MHz)
3640 - 3650	3640-3650-1406	Authorized	200	03/28/2021 10:36:28 CDT	03/28/2021 10:40:25 CDT	04/26/2021 10:27:36 CDT	General Authorized Access	2.0
3650 - 3660	3650-3660-1406	Authorized	200	03/28/2021 10:36:28 CDT	03/28/2021 10:40:25 CDT	04/26/2021 10:27:36 CDT	General Authorized Access	2.0
3660 - 3670	3660-3670-1406	Authorized	200	03/28/2021 10:36:28 CDT	03/28/2021 10:40:25 CDT	04/27/2021 10:20:03 CDT	General Authorized Access	-3.0
3670 - 3680	3670-3680-1406	Authorized	200	03/28/2021 10:36:28 CDT	03/28/2021 10:40:28 CDT	04/26/2021 10:27:38 CDT	General Authorized Access	2.0

CBSD Log

03/28/2021 10:36:28 CDT: [0] Received HeartBeat Response
03/28/2021 10:36:28 CDT: [cbcsd]: "20a09f1002b0a003e453183", "grantId": "3640-3650-1406", "grantExpireTime": "2021-04-26T15:27:36Z", "heartbeatInterval": 200.0, "transmitExpireTime": "2021-03-28T15:40:25Z", "response": {"responseCode": 0.0}
03/28/2021 10:36:28 CDT: [1] Received HeartBeat Response
03/28/2021 10:36:28 CDT: [cbcsd]: "20a09f1002b0a003e453183", "grantId": "3650-3660-1406", "grantExpireTime": "2021-04-26T15:27:36Z", "heartbeatInterval": 200.0, "transmitExpireTime": "2021-03-28T15:40:25Z", "response": {"responseCode": 0.0}
03/28/2021 10:36:28 CDT: [2] Received HeartBeat Response
03/28/2021 10:36:28 CDT: [cbcsd]: "20a09f1002b0a003e453183", "grantId": "3660-3670-1406", "grantExpireTime": "2021-04-27T10:20:03Z", "heartbeatInterval": 200.0, "transmitExpireTime": "2021-03-28T15:40:25Z", "response": {"responseCode": 0.0}
03/28/2021 10:36:28 CDT: [3] Received HeartBeat Response
03/28/2021 10:36:28 CDT: [cbcsd]: "20a09f1002b0a003e453183", "grantId": "3670-3680-1406", "grantExpireTime": "2021-04-26T15:27:36Z", "heartbeatInterval": 200.0, "transmitExpireTime": "2021-03-28T15:40:26Z", "response": {"responseCode": 0.0}

When this 3660-3670 grant did become AUTHORIZED, the radio increased the operating Bandwidth from 20 MHz to 40 MHz (picking up the 3670-3680 grant, since that is now useable also since it's no longer disjoint), and also decreased the Transmit Power of the radio as shown in the following two screenshots. Cambium's radio's use a 6 dB threshold on when making automatic Bandwidth increase decisions. Had the granted EIRP in dBm/MHz for this 3rd grant been, for example, -5.0 instead of -3.0, the radio would have instead maintained the current 20 MHz operating Bandwidth and 2 dBm/MHz (-2 total TX Power) transmission.

Session Status List

Data: SessionStatus.xml

Device: 450i BHM - 10.120.232.101 [0a-00-3e-44-00-92]

Subscriber: 450i BHM - 10.120.232.101 [0a-00-3e-44-00-92] | LUID: 002 | Hardware: NA | Software Version: NA | FPGA Version: NA | State: BH RERANGE | Airlink Security: NA

CBRS Status List

CBSD	LUID	Grant State	Authorized Grants	Time Elapsed In State	EIRP Req / Auth	Missed	Heartbeat	Grant Expiry	Relinquish Grant	De-Register
PTP 450i BHM - 10.120.232.100 [AP]	AP	Authorized	4 / 4	00:31:53	18 / 13	0 / 2510	616 / 2510	04/27/2021 10:20:03 CDT	<input type="checkbox"/>	<input type="checkbox"/>
450i BHM - 10.120.232.101 [0a-00-3e-44-00-92]	002	Granted	0 / 4	00:01:33	NA	20 / 88	3 / 88	04/27/2021 10:29:00 CDT	<input type="checkbox"/>	<input type="checkbox"/>

Clear Statistics | Perform Relinquish/Deregister

Device Information	
Device Type:	3.5GHz MIMO OFDM - Backhaul - Timing Master - 0a-00-3e-45-51-03
Board Type:	P13
Product Type:	PTP 450i
Software Version:	CANOPY 20.2 (Build DEV-29) BHUL450
CPU Usage:	CumMax: 25c95%
Board MSN:	MBUG035PJG63
Board Model:	C030045B002A
	EngineeringKeyDisable
	EngineeringKey
	EngineeringKeyDisable
	EngineeringKey
FPGA Version:	020621
	020621
	020621
	020621
	020621
Uptime:	1d 00:32:29
System Time:	10:52:50 03/28/2021 CDT
Main Ethernet Interface:	1000Base-T Full Duplex
Aux Ethernet Interface:	Disabled (PoE Disabled)
Region Code:	United States
FCC ID:	Z9H69FT0028
Regulatory:	Passed
DFS:	Normal Transmit
Antenna Type:	External
Channel Frequency:	3660.000 MHz
Channel Bandwidth:	40.0 MHz
Cyclic Prefix:	1716
Frame Period:	2.5 ms
Encryption:	AES-128
Over The Air Rekey:	Active: Rekey in 27 Minutes
Color Code:	100
Transmit Power:	-4 dBm
Total Antenna Gain:	17 dBi
Temperature:	24 °C / 75 °F
802.3at Type 2 PoE Status:	Not Present (Ignored)
CBSD Grant State:	Authorized

Finally, note with a 450m, any automatic Bandwidth adjustment results in a reboot. Cambium operators do have the ability to disable automatic Bandwidth adjustments for 450m's to avoid such a reboot via the "Reboot for Channel Bandwidth Change" on the **Configuration > CBRS** page of the AP UI.

Syncing CBRS parameters to device

If the device is in the Authorized state, the user can manually select the **SYNC** button to enable CBRS in the device by sending the configured parameters in the CBRS Management Tool.

Sectors > Lab-setup-AP									
Device Name	Device Type	Mode	Health	MSN	Latitude	Longitude	Sync Expiry Time	Height	Registered
Lab-setup-AP	PMP 450 Conn...	AP	Online		44.426722	-110.473522	N/A	23	AUTHORIZED
Lab-setup-SM	PMP 450 Integ...	SM	Online		44.426733	-110.473533	N/A	23	AUTHORIZED



NOTE:

Even if the device is "AUTHORIZED", it also must be in an "Onboarded" state for the sync procedure.

But syncing the parameters and grant information before authorization is allowed and supported as well.

For an SM or BHS, any **Requested EIRP** value configured on the CBRS Management tool will not be used by the devices after the config sync of that SM or BHS if a grant does not accompany that Requested EIRP value. Instead, the AP or BHM will request a Maximum **Allowed EIRP** for the SM. With the December Re-Release of cnMaestro 2.4.2 or later, the only time this would happen would be if an operator obtained a grant for an SM via the tool, then deregistered that grant via the tool, then this SM tool configuration was Config_Synced to the SM or AP.

If the device sync is successful, the **Management Tool > Sector** page **Sync State** displays as **Config Synced**.

The **Management Tool** allows the operator for 72 hours only to hold onto a grant without syncing it to a device. After 72 hours, the device will be de-registered, and the operator needs to start the registration process again.

Although not as user friendly, an operator also has the option of using the cnMaestro tool only for signing the installation data. The **SYNC** button can be pushed while the Tool states for the radio's are in UNREGISTERED state. The AP will take the installation parameters, reboot, Register, do a Spectrum Inquiry Exchange with the SAS, then request a grant for the AP for the center frequency and Bandwidth that had been preconfigured in the radio page of the AP, followed by the SMs as they come online. While fully supported, disadvantages of this approach vs the tool approach described earlier are:

- An operator does not see the graph of the Spectrum Inquiry Response that they could see from the tool, which can aid an operator in selecting a channel.

- The SMs grants are requested only after the AP is fully authorized, as those SMs come on the air interface. When using the tool, SM grants are requested in parallel with the AP grant.

With Cambium's 20.2 software, use of preconfigured alternate channels on the APs **Configuration > Radio** page have been removed and replaced with a Spectrum Inquiry based channel hunting algorithm for termination scenario's. See the termination handling section later in this document for more details.

Device configuration and status

Once the AP/BHM receives the configuration details via this Sync operation, CBRS is enabled on the device, the device reboots and contacts the Domain proxy to enable the transmission.

Once the AP starts the transmission, when SM tries to connect to the AP, cnMaestro sends the configuration parameters to the SM automatically, no manual intervention is needed.

After successful execution of this [Getting started with CBRS](#) procedure, the user can view their grant state and other grant information under AP **Home > Session status> CBRS Status**. Starting with radio software 20.2, a new "Authorized Grants" column has been added. In this particular example below, the operator is attempting to use 30 MHz of Bandwidth total. But only 10 MHz is currently authorized. The remaining two 10 MHz slices of Bandwidth are in grant suspended state pending the next CPAS cycle.

CBRS Status List												
CBSD	LUID	Grant State	Authorized Grants	Time Elapsed In State	EIRP Req / Auth	Heartbeat			Grant Expiry	Relinquish Grant	De-Register	
PMP 450m - 3.5GHz MIMO OFDM - AP - 10.120.247.131 [AP]	AP	Authorized	1 / 3	00:02:09	15 / 15	0 / 6	4 / 6		04/16/2021 : 15:16:41 CST	<input type="checkbox"/>	<input type="checkbox"/>	

For existing 3 GHz deployments that are converting to CBRS

- Cambium Networks software does not save the EIRP that had been configured on the AP/BHM prior to enabling the feature. If an operator selects to disable CBRS in the future for any reason , the AP or BHM keeps transmitting granted EIRP by SAS.
- An operator would need to manually change the Tx Power or EIRP back to the desired part 90 value if that value was different from what the SAS had granted them.

Alternative Procedures

The above steps list the Cambium recommended procedure.

However, variations on this CBRS Management Tool or alternatives using the tool are available as mentioned below:

- A customer could select to enter CPI signed data (along with JSON header and signature) directly into each radio. However, this requires operator knowledge on how to properly format and sign this data.
- For a greenfield installation where a customer has no plans to operate under part 90 prior to operating with CBRS, there is nothing wrong with enabling the CBRS feature on the AP/BHM prior to running the CBRS tool. An operator can delay onboarding their AP or BHM until the cnMaestro tool receives a grant and is in AUTHORIZED state. At this point, when they onboard their AP or BHM, cnMaestro automatically pushes the configuration to the AP.
- Cambium Networks also supports a user that prefers to enter data directly into the SAS portal. On the radio(s) navigate to **Configuration > CBRS** page, if CPI Data Status shows **Data in Use**, click the **Delete CPI Data** and click **Save Changes**.



NOTE:

If a user decides to enter information directly into the SAS portal, make sure prior to using this information that the radio does not have installation parameters on it from some previous input attempt.

None of these above three variants avoids the potential delay of waiting for full AUTHORIZATION at the next SAS CPAS cycle.

The sync operation does not automatically select the requested channel Bandwidth and frequency on the SMs. This could lead to over-the-air registration failures of SMs. Ensure that the channel Bandwidth and frequency is configured in scan list of all SMs before proceeding for sync operation from **cnMaestro > Management Tool** page.

Example:

If a user wants to sync a sector of cnMaestro which is running with channel Bandwidth 20 MHz and frequency 3600 MHz, all SMs of the sector should have:

- Selection of 3600 MHz frequency in **Configuration > Radio > Custom Radio Frequency Scan** selection list.
- 20 MHz channel Bandwidth in **Configuration > Radio > Channel Bandwidth Scan**.

The screenshot shows the 'Radio Configuration' window. The 'Custom Radio Frequency Scan Selection List' displays a grid of frequency options from 3310.000 to 3690.000 MHz. The 3600.000 MHz option is selected. Below the grid, there are filters for channel bandwidth: 5 MHz only, <= 7 MHz, <= 10 MHz, <= 15 MHz, <= 20 MHz (selected), and <= 30 MHz. The 'Channel Bandwidth Scan' section shows options for 5 MHz, 7 MHz, 10 MHz, 15 MHz, 20 MHz (selected), 30 MHz, and 40 MHz.

It is also extremely important that Cambium AP/BHMs operating with CBRS have accurate time synchronization. AP timing that drifts significantly from the SAS's UTC time can eventually result in AP to SAS timing errors and grant terminations. Cambium Networks is exploring future improvements to provide a backup or alternative clock, but as of PMP release R21 and cnMaestro release 3.1.0, an NTP synchronize is highly recommended. This can be configured on the **Configuration > Time** page of the AP/BHM. See the [PMP Configuration Guide](#) for more details.

Converting Wideband CBRS Grants to MultiGrant, PAL channel support, and preparing for and handling grant terminations triggered by PAL activations

Conversions in areas not protected by an incumbent (or another PAL)

Cambium Networks strongly recommends all operators upgrade to 20.2 or later and convert their existing wideband grants to multigrant. Builds 20.2 through 20.3.1.2 include a multigrant feature flag that can be found on the AP/BHM in **Configuration > CBRS**. With release R21, this feature flag is no longer available and any new grant requests will always be multigrant requests. For software versions 20.2 through 20.3.1.2, the flag is set to enabled as shown in the screenshot below:

For already authorized and configuration synced sectors, after the upgrade the radio's will resume heartbeat on their wideband grants. To convert the existing grant to multiple grants, an operator simply needs to relinquish the existing grant. The radio will automatically request grants for the same center frequency, EIRP, and total Bandwidth the operator was using prior to the relinquish, but in separate 10 MHz and when necessary 5 MHz grants. There are two ways to do this:

- 1. Navigate to **HOME > Session State** page of each and every AP, select the Relinquish Grant for the AP and all the SMs, and then the Relinquish Grant action button.
- 2. A new Relinquish button has been added to the cnMaestro CBRS tool specifically for this purpose. Note that this cnMaestro relinquish button is not intended for general use, only for wideband to multigrant conversion. Relinquish attempts on grants already operating as multigrants will be blocked.

Device Name	Device Type	Mode	Health	MSN	Latitude	Longitude	Sync Expiry Time	Height	Grant Status	Sync State	Actions
EMERG0123456	PMP 450i Connect...	AP	Online	M55L0G9PCU	44.62	-70.6962	N/A	10	Authorized	Config Synced	
0A:00:3E:45:7A:5E											
450i dummy 454b1d	PMP 450i Integrat...	SM	Offline	M5VH3F2Q8NV	48.233	-70.68	N/A	30	Fail	Not Synced	
0A:00:3E:45:4B:1D											
SM1	PMP 450i Connect...	SM	Offline	609GA02SQ	44.62	-70.7	N/A	5	Authorized	Config Synced	
0A:00:3E:40:30:D5											
SM2	PMP 450i Connect...	SM	Offline	609GL0PWL	44.62	-70.71	N/A	5	Authorized	Config Synced	
0A:00:3E:40:69:55											
SM3	PMP 450i Connect...	SM	Offline	609GL0PDP	44.62	-70.72	N/A	5	Authorized	Config Synced	
0A:00:3E:40:6B:C8											
SM4	PMP 450i Connect...	SM	Offline	609GL0GM7	44.62	-70.69	N/A	5	Authorized	Config Synced	
0A:00:3E:40:6A:40											

After a successful conversion, the cnMaestro tool will show the Grant Type as Multiple instead of Single as shown below:

Device Name	Device Type	User ID	Tool Frequency (MHz)	Operating Frequency (MHz)	Grant Type	Sector ID	Spectrum Reuse ID	Status
Neil_FSS_Near_Rumford_Maine	PMP 450m	SAS-Cambium...	3620 - 3650	3620 - 3650	Multiple	0a-00-3a-60-47-aa	N/A	
PMP450i Dummy	PMP 450i Connectorized	SAS-Cambium...	N/A	3590 - 3620	N/A	0a-00-3a-45-7a-ee	N/A	

Another way to see from cnMaestro that a sector has been converted to multigrant is to see the Grant status in the cnMaestro tool per device. There is one status bubble per grant, per device, with the bubble and the hover-over indicating the status of the grant. Below is one screenshot for a 30 MHz sector using single wide grant, followed by a screenshot of a portion of a second sector also using 30 MHz, but with multigrant.

Device Name	Device Type	Mode	Health	MSN	Latitude	Longitude	Sync Expiry Time	Height	Grant Status	Sync State	Actions
EMERG0123456	PMP 450i Connect...	AP	Online	M55L0G9PCU	44.233	-70.204	N/A	10	Authorized	Config Synced	
0A:00:3E:45:7A:5E											
450i dummy 454b1d	PMP 450i Integrat...	SM	Offline	M5VH3F2Q8NV	48.233	-70.204	N/A	30	Unauthorized	Not Synced	
0A:00:3E:45:4B:1D											
SM1	PMP 450i Connect...	SM	Offline	609GA02SQ	44.234	-70.205	N/A	5	Authorized	Config Synced	
0A:00:3E:40:30:D5											
SM2	PMP 450i Connect...	SM	Offline	609GL0PWL	44.235	-70.207	N/A	5	Authorized	Config Synced	
0A:00:3E:40:69:55											
SM3	PMP 450i Connect...	SM	Offline	609GL0PDP	44.236	-70.21	N/A	5	Authorized	Config Synced	
0A:00:3E:40:6B:C8											
SM4	PMP 450i Connect...	SM	Offline	609GL0GM7	44.237	-70.208	N/A	5	Authorized	Config Synced	
0A:00:3E:40:6A:40											

Device Name	Device Type	Mode	Health	MSN	Latitude	Longitude	Sync Expiry Time	Height	Grant Status	Sync State	Actions
Neil_FSS_Near_Rumford_Maine	PMP 450m	AP	Online	M9UE07NLL3...	44.62	-70.7001	N/A	10	Authorized	Config Synced	
0A:00:3E:60:47:AA											
SM1	PMP 450i Rugg...	SM	Online	609QUORR9	44.62	-70.73	N/A	10	Authorized	Config Synced	
0A:00:3E:40:AD:F1											

Cambium Networks 20.2 CBRS training slides explain that in addition to simply converting to Multigrant, Cambium Networks recommends that operators attempt to align the edges of their band to a 10 MHz raster. The screenshot below of the **CBRS > Log** page shows 30 MHz managed as three 10 MHz grants properly aligned to 10 MHz raster.

CBSD Information							
CBSD Grant State :	Authorized						
CBSD State Time :	00:03:58						
CBSD ID :	QWP-30450M/0a003e6047aa						
EIRP Requested :	15 dBm						
EIRP Granted :	15 dBm						
Number of Grants :	3						

CBSD Grant Information							
Channel (MHz)	Grant ID	Grant State	Heartbeat Interval (Seconds)	Last Heartbeat Time	Transmit Expire Time	Grant Expire Time	Granted EIRP (dBm/MHz)
3610 - 3620	3610-3620-1471	Authorized	200	03/17/2021 : 15:21:25 CST	03/17/2021 : 15:25:25 CST	04/16/2021 : 15:16:40 CST	5.0
3620 - 3630	3620-3630-1471	Granted	200	03/17/2021 : 15:21:25 CST	12/31/1969 : 18:00:00 CST	04/16/2021 : 15:16:41 CST	5.0
3630 - 3640	3630-3640-1471	Granted	200	03/17/2021 : 15:21:25 CST	12/31/1969 : 18:00:00 CST	04/16/2021 : 15:16:41 CST	5.0

If these multigrant edges are NOT aligned to a 10 MHz raster, if possible, adjust the center frequency up or down by 5 MHz. This can be done (preferably in a maintenance window) simply by navigating to **Configuration > Radio** on every AP and modifying the frequency carrier. The AP will relinquish the current grants and request new grants for the new channels. It will also request new grants for every SM as those SMs come back online. Note that if this is done in a CPAS area, it's likely that the radio will get quick authorization for 10 MHz frequencies that overlapped the previous grants, while grant requests in a new slice of spectrum may be suspended until CPAS or have to use a lower Same day grant EIRP until CPAS, depending on the SAS vendor in use. That might result in a lower Bandwidth temporarily.

A final step as part of a conversion from wide grant to multigrant is to consider adding a more complete list of Bandwidths and center frequencies to every SMs scan list. If a subset of an APs multigrants are terminated due to the activation of another operators PAL, or suspended due to activation of a DPA, or all of an APs multigrants are terminated due to PAL activation resulting in automatic code selection of a new channel, an operator will want to have these additional Bandwidths and center frequencies configured in their SMs. Cambium provides a cfg file that can be used for this purpose. After formal 20.2 release, that configuration file can be found here:

<https://support.cambiumnetworks.com/files/pmp450>

This template will add all center frequencies in the 150 MHz CBRS spectrum at a 2.5 MHz raster, and will add all Bandwidths. It's a modification to an existing script that was already posted on the Cambium Networks forum, we have now just added 5 MHz to it. This can be and should be pruned down by operators that don't need all of this. For example, it is not necessary or desired to add a scanning Bandwidth for any Bandwidth larger than your current operating Bandwidth. If you have your sector on the Cambium advised 10 MHz raster as discussed above, 5 MHz and 15 MHz Bandwidths are not necessary, and the 2.5 MHz scanning Bandwidths are not needed. Only 5 MHz scanning Bandwidths would be necessary. Also, PAL triggered terminations of GAA's and DPA suspensions won't occur for operators using the upper 50 MHz of the 150 MHz CBRS spectrum.

Conversions in areas protected by an incumbent (or another PAL)

All three SAS vendors support a conversion from single wideband grant to multigrant by simply relinquishing the existing grant and letting the radio software request new multigrants. However, the procedure to get back to maximum power - back to the EIRP level an operator just relinquished, is slightly different per SAS vendor:

For Federated Wireless customers, the Federated Wireless SAS supports an immediate authorization on multigrant up to the power level that was just relinquished on wideband grant, even if the radio's are in an area near an incumbent.

The AP/BHM will request and granted the same power level that had previously been relinquished. The AP may or may not request higher power for the SMs than had previously been relinquished, depending on if the enable Max Tx Power is in use on the SMs. For SMs that do get higher power requests than was previously relinquished, the SAS will immediately offer the EIRP that had been previously relinquished, for which the AP will take and request. In summary, a widegrant to multi grant conversion using Federated Wireless is relatively quick.

Google does support a conversion from wide grant to multigrant similar to the Federated Wireless conversion feature as explained above, for AP or BHM. However, there are still a few scenarios where the grant conversion on AP or BHM does not work cleanly and a suspended state waiting for CPAS is seen. In addition, that Google does not support the Same Day Grant feature via Operational Parameters that other SAS vendors support. So at this point in

time - as of the release of the 20.3 and R21 software, Cambium Networks recommends operators attempting a wide grant conversion near incumbents follow the second of the 2 paragraphsh above and the 4 sub-bullets below that paragraph, if they are using Google SAS.

In other words, the best course of action may be for the operator to deregister the CBSD's and take operations back to the cnMAestro tool. If and when Cambium and Google are able to get a clean conversion from widegrant to multigrant working for the AP/BHM, Cambium would still advise Google operators to do the conversion in the hours just prior to a CPAS cycle. Due to the lack of a "same day" offering in EIRP from the Google SAS for the SM's, it's quite possible the SM's will go into suspended state until CPAS.

APs can operate with a subset of grants authorized. If, for example, 2 out of 3 grants are AUTHORIZED right away and the third grant is suspended pending CPAS or the clearing of a DPA, the AP will temporarily lower it's Bandwidth and adjust it's center frequency. The SMs will then need to scan to the lower Bandwidth and adjusted center frequency.

If on the other hand, the AP is authorized on all of its multigrants, but some of those same grants are suspended for an SM, the SM will remain in suspended state, accessible but not capable of passing traffic, until those remaining grants are AUTHORIZED. Below is an example of an SM latched to a 40 MHz AP where only one of the grants is AUTHORIZED on the SM.

Select CBSD

Current CBSD: [PUP450-30Hz-SM2 [a003e406955] Linc 2]

CBSD Information

CBSD Grant State

Suspended

CBSD State Time

00:12:04

CBSD ID

Z8H89FT0009/0a003e406955

EIRP Requested

38 dBm

EIRP Granted

NA

Number of Grants

4

CBSD Grant Information

Channel (MHz)	Grant ID	Grant State	Heartbeat Interval (Seconds)	Last Heartbeat Time	Transmit Expire Time	Grant Expire Time	Channel Allocation Type	Granted EIRP (dBm/MHz)
3615 - 3620	3615-3620-1583	Authorized	200	03/30/2021 22:11:30 CDT	03/30/2021 22:15:30 CDT	04/29/2021 21:53:43 CDT	General Authorized Access	23.2
3620 - 3630	3620-3630-1583	Suspended	200	03/30/2021 22:11:30 CDT	03/30/2021 18:32:39 CDT	04/29/2021 21:59:54 CDT	General Authorized Access	23.2
3630 - 3640	3630-3640-1583	Suspended	200	03/30/2021 22:11:30 CDT	03/30/2021 18:32:39 CDT	04/29/2021 21:59:54 CDT	General Authorized Access	23.2
3640 - 3645	3640-3645-1583	Suspended	200	03/30/2021 22:11:30 CDT	03/30/2021 18:32:39 CDT	04/29/2021 21:59:54 CDT	General Authorized Access	23.2

CBSD Log

03/30/2021 22:11:30 CDT: [3] Heartbeat Request: ["cbidid": "Z8H89FT0009/0a003e406955", "operationState": "GRANTED", "grantid": "3640-3645-1583", "grantRenew": false]

03/30/2021 22:11:30 CDT: Added heartbeat message for sending

03/30/2021 22:11:30 CDT: [0] Received Heartbeat Response

03/30/2021 22:11:30 CDT: ["cbidid": "Z8H89FT0009/0a003e406955", "grantid": "3615-3620-1583", "grantExpireTime": "2021-04-30T02:53:43Z", "heartbeatInterval": 200, "transmitExpireTime": "2021-03-31T03:15:30Z", "response": {"responseCode": 0, "responseMessage": "CPAS-IAP Pending"}]

03/30/2021 22:11:30 CDT: [1] Received Heartbeat Response

03/30/2021 22:11:30 CDT: ["cbidid": "Z8H89FT0009/0a003e406955", "grantid": "3620-3630-1583", "grantExpireTime": "2021-04-30T02:59:54Z", "heartbeatInterval": 200, "transmitExpireTime": "2021-03-31T03:11:30Z", "response": {"responseCode": 501, "responseMessage": "CPAS-IAP Pending"}]

03/30/2021 22:11:30 CDT: CBRs spectrum grant suspended by SAS

03/30/2021 22:11:30 CDT: SAS Error: CPAS-IAP Pending

03/30/2021 22:11:30 CDT: [2] Received Heartbeat Response

03/30/2021 22:11:30 CDT: ["cbidid": "Z8H89FT0009/0a003e406955", "grantid": "3630-3640-1583", "grantExpireTime": "2021-04-30T02:59:54Z", "heartbeatInterval": 200, "transmitExpireTime": "2021-03-31T03:11:30Z", "response": {"responseCode": 501, "responseMessage": "CPAS-IAP Pending"}]

03/30/2021 22:11:30 CDT: CBRs spectrum grant suspended by SAS

03/30/2021 22:11:30 CDT: SAS Error: CPAS-IAP Pending

03/30/2021 22:11:30 CDT: [3] Received Heartbeat Response

03/30/2021 22:11:30 CDT: ["cbidid": "Z8H89FT0009/0a003e406955", "grantid": "3640-3645-1583", "grantExpireTime": "2021-04-30T02:59:54Z", "heartbeatInterval": 200, "transmitExpireTime": "2021-03-31T03:11:30Z", "response": {"responseCode": 501, "responseMessage": "CPAS-IAP Pending"}]

03/30/2021 22:11:30 CDT: CBRs spectrum grant suspended by SAS

03/30/2021 22:11:30 CDT: SAS Error: CPAS-IAP Pending

Note also that APs and SMs will operate at the lowest of the granted values.

CBSD Grant Information								
Channel (MHz)	Grant ID	Grant State	Heartbeat Interval (Seconds)	Last Heartbeat Time	Transmit Expire Time	Grant Expire Time	Channel Allocation Type	Granted EIRP (dBm/MHz)
3600 - 3610	3600-3610-1471	Authorized	200	03/24/2021 11:19:40 CST	03/24/2021 11:23:40 CST	04/22/2021 17:15:02 CST	General Authorized Access	7.2
3610 - 3620	3610-3620-1471	Authorized	200	03/24/2021 11:19:40 CST	03/24/2021 11:23:40 CST	04/22/2021 17:15:02 CST	General Authorized Access	7.2
3620 - 3630	3620-3630-1471	Authorized	200	03/24/2021 11:19:40 CST	03/24/2021 11:23:40 CST	04/23/2021 09:20:12 CST	General Authorized Access	2.0

Once these conversions from wide grant to multigrant are complete, an operator is now much better positioned to handle possible suspensions and terminations than before. See the sections:

- Preparing for and handling a grant termination from the SAS.
- Grant suspension possibilities from the SAS.

See further sections later in this document for more details on these termination and suspensions events and how Cambium Networks multigrant code handles these events.

For Federated Wireless and Google, PAL protection is automatically applied when a device is registered and granted in the area and on the channel that the operator owns a PAL license for. Whether a PAL device has partial protection prior to the first CPAS, or no protection until the CPAS even following protection being applied depends on the particular SAS vendor being used.

For all the SAS operators Cambium supports, a PAL protected sector in the presence of an incumbent may or may not be offered and granted the maximum possible allowed EIRP automatically by the SAS. It depends on the timing of when PAL protection is applied vs when the maximum power grant request was originally made. The following explanation assumes an operator asked for more power than they were granted, prior to PAL activation.

1. If PAL protection is applied to newly requested grants before the next CPAS cycle, no additional operator actions will be required, assuming the AP and not the tool is holding the grants. At CPAS time, if the SAS has additional power margin to offer to this PAL owner due to termination of GAA's, the SAS will offer this to the Radio via a heartbeat response. It may or may not come with a termination, but either way the Cambium AP will automatically request for the higher power terminating the existing grant if that wasn't already done by the SAS.
2. If a CPAS cycle occurs after the original grant requests were made, but before PAL protection is applied, the SAS cannot be expected to automatically offer higher EIRP to the PAL CBSD at CPAS time following the association of PAL protection. Instead, AFTER this next CPAS cycle, Cambium Networks suggests operators navigate to the **HOME > Session Status** page of their AP and manually relinquish all grants that were not granted as much power as the operator originally requested. An operator then has 2 minutes to navigate to the **APs Configuration > Radio** page and bump up the Transmit Power (for a 450/450i AP) or the EIRP (for a 450m AP). The two screenshots below show one example of such a sequence and the outcome:

- **Day 1:** An Operator that owns a PAL license moves their radios to the channels they own the PAL for and request GAA grants on those channels. Due to the presence of an incumbent and other nearby GAA operators on the same channel, the EIRP available is limited to 19 dBm Total across 30 MHz of Bandwidth after the first CPAS cycle:

CBSD Status List												
CBSD	LUID	Grant State	Authorized Grants	Time Elapsed In State	EIRP Req / Auth	Missed	Failed	Skipped	Grant Expiry	Relinquish Grant	De-Register	
PMP 450m - 3.5GHz MIMO OFDM - AP - 18 120 247 131 [AP]	AP	Authorized	3 / 3	00:09:06	49 / 19	0 / 255	237 / 255		05/01/2021 12:54:37 CDT	<input type="checkbox"/>	<input type="checkbox"/>	
Clear Statistics Perform Relinquish/DeRegister												

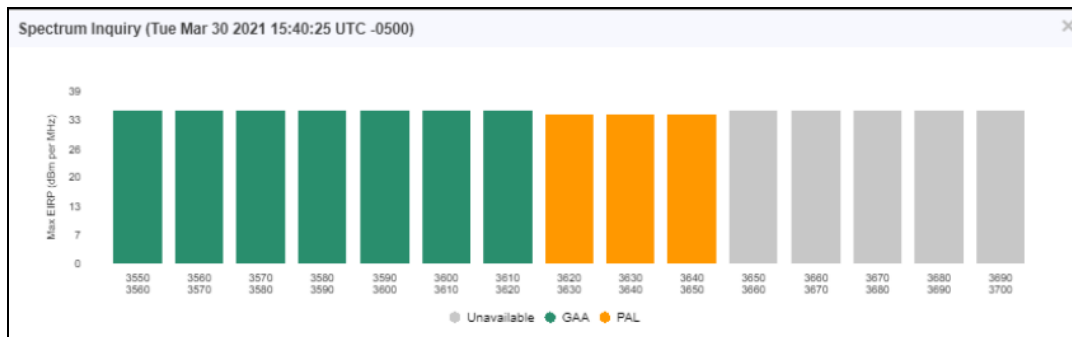
- **Day 2:** Protection is applied in the SAS to this CBSD, either automatically by the SAS code, or manually by the operator via the SAS portal, depending on the SAS vendor. On the evening of two days, the second CPAS cycle terminates the nearby GAA's and begins providing full protection on the PMP 450m. However, granted power remains at 19 dBm total.
- **Day 3:** An operator manually relinquishes this AP's 19 dBm grant (along with any SM grants that also didn't achieve maximum desired power, causing new grant requests to be sent. Depending on the SAS vendor and the particular area in use, the CBSD might be authorized immediately for higher power, the device might go into suspended state pending CPAS, or a lower Same Day Grant value might be offered initial per CBSD, until a third CPAS cycle. In this particular example here, a "same day" value of 17 dBm for the 30 MHz spectrum was offered and authorized right away. Then at this next CPAS cycle - the 3rd CPAS cycle in this example, 22 dBm was offered and authorized as shown below: Operators should not be alarmed if they go into suspended state pending CPAS after the relinquish or if they are offered a same day value lower than what that had just relinquished. However, it is advised to perform this relinquish later in the evening - just prior to a CPAS cycle, to minimize impact.

CBSD Status List												
CBSD	LUID	Grant State	Authorized Grants	Time Elapsed In State	EIRP Req / Auth	Missed	Failed	Skipped	Grant Expiry	Relinquish Grant	De-Register	
PMP 450m - 3.5GHz MIMO OFDM - AP - 18 120 247 131 [AP]	AP	Authorized	3 / 3	00:03:40	49 / 22	0 / 363	246 / 363		05/01/2021 14:01:37 CDT	<input type="checkbox"/>	<input type="checkbox"/>	
Clear Statistics Perform Relinquish/DeRegister												

Confirming PAL protection

The best and most complete method is, an operator can login to their SAS portal and check for the presence of protection contours, or check the grant state in the portal. See vendor specific SAS documentation.

An operator can also use the spectrum Inquiry function in cnMaestro get to a graphical decode of the spectrum inquiry response to see the channels currently under protection for this AP. However, this can only be done on the AP/BHM, not on the SMs.



A note of caution on using the Channel Allocation Type shown in the **Logs > CBRS** page of the AP: This is simply a display of what comes in the Grant Response message from the SAS. In many cases – maybe the majority of cases, an operator and the SAS vendor will be converting an existing GAA grant to a PAL grant without service interruption. In those cases, this field shown below will continue to show General Authorized Access long after protection has been put in place. The example screenshot below shows three grants where sometime after protection was put in place, a relinquish and new grant request was performed.

CBRS Grant Information								
Channel (MHz)	Grant ID	Grant State	Heartbeat Interval (Seconds)	Last Heartbeat Time	Transmit Expire Time	Grant Expire Time	Channel Allocation Type	Granted EIRP (dBm/MHz)
3620-3630	3620-3630-1471	Authorized	200	04/02/2021 08:38:07 CDT	04/02/2021 08:42:08 CDT	05/01/2021 14:01:36 CDT	Priority Access License	7.0
3630-3640	3630-3640-1471	Authorized	200	04/02/2021 08:38:07 CDT	04/02/2021 08:42:08 CDT	05/01/2021 14:01:37 CDT	Priority Access License	7.0
3640-3650	3640-3650-1471	Authorized	200	04/02/2021 08:38:07 CDT	04/02/2021 08:42:08 CDT	05/01/2021 14:01:37 CDT	Priority Access License	7.0

CBRS Log	
04/02/2021 08:38:07 CDT	[{"cbcid": "QWP-30450M0a003a6047aa", "grantId": "3620-3630-1471", "transmitExpireTime": "2021-04-02T13:42:08Z", "grantExpireTime": "2021-05-01T19:01:36Z", "heartbeatInterval": 200, "response": {"responseCode": 0}}]
04/02/2021 08:38:07 CDT	[{"cbcid": "QWP-30450M0a003a6047aa", "grantId": "3630-3640-1471", "transmitExpireTime": "2021-04-02T13:42:08Z", "grantExpireTime": "2021-05-01T19:01:37Z", "heartbeatInterval": 200, "response": {"responseCode": 0}}]
04/02/2021 08:38:07 CDT	[{"cbcid": "QWP-30450M0a003a6047aa", "grantId": "3640-3650-1471", "transmitExpireTime": "2021-04-02T13:42:08Z", "grantExpireTime": "2021-05-01T19:01:37Z", "heartbeatInterval": 200, "response": {"responseCode": 0}}]
04/02/2021 08:38:07 CDT	[{"cbcid": "QWP-30450M0a003a6047aa", "grantId": "3620-3630-1471", "transmitExpireTime": "2021-05-01T19:01:36Z", "heartbeatInterval": 200, "response": {"responseCode": 0}}]
04/02/2021 08:38:07 CDT	[{"cbcid": "QWP-30450M0a003a6047aa", "grantId": "3630-3640-1471", "transmitExpireTime": "2021-05-01T19:01:37Z", "heartbeatInterval": 200, "response": {"responseCode": 0}}]
04/02/2021 08:38:07 CDT	[{"cbcid": "QWP-30450M0a003a6047aa", "grantId": "3640-3650-1471", "transmitExpireTime": "2021-05-01T19:01:37Z", "heartbeatInterval": 200, "response": {"responseCode": 0}}]

Avoiding grant power reductions on an operators GAA devices near their own PPAs

Federated Wireless released new SAS software on 9/23/2021 to allow operators to opt in to have their current GAA grants not impacted by their PPAs in CPAS.

In order to take advantage of this feature, you have to open a support case with Federated Wireless. Federated Wireless informs you when your ticket has been processed and you can start taking advantage of this feature.

At that point, if you have any devices operating as GAA at a reduced EIRP to protect your own PAL channel, relinquish all grants for these devices navigate to **Home > Session Status** page of the AP.

All SMs will ask for new grants at maximum power, so nothing else needs to be done for the SMs.

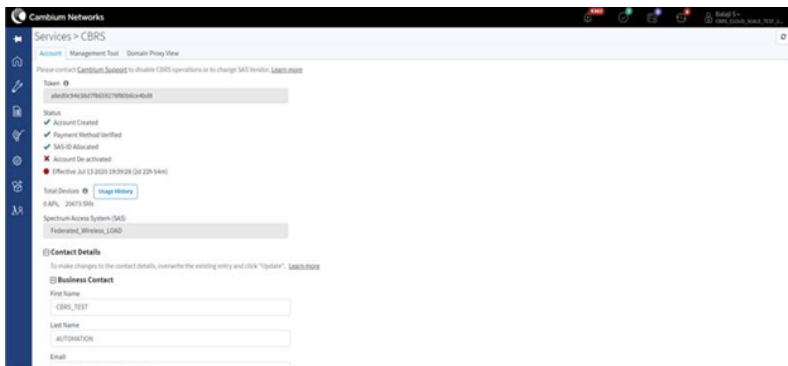
However, if the affected device is an AP, you have two minutes to navigate to the **Configuration > Radio** page and increase the Tx power (or EIRP if using a 450m AP). During these two minutes the allowed range for the Tx power (or EIRP) is opened up to the maximum for your configured Bandwidth, and you can select a value higher than the current one. If you have not made a change within the two minutes, the AP will send a grant request at the same current EIRP, and you would have to repeat the process and relinquish the grants again. When the grant request is sent at the higher EIRP, the Federated Wireless SAS will authorize it immediately at the maximum allowed power considering potential incumbents in the area.

Notification of Billing Issues

The [Managing CBRS Devices](#) section earlier in this document contained screenshots of the CBRS Account page on an operator's cnMaestro Cloud account showing, for example, Payment Method Verified, Account Enabled, etc. In addition, payment problems such as expired or invalid information can later trigger an alarm and a "Payment Pending" notification on this accounts page as shown in the screenshot below:



Operators should check their entered payment information at the bottom of this accounts page, and if necessary, add an update. If operators believe the information is correct but the warnings persist, contact Cambium support. Cambium also provides multiple warnings via email, and a sufficient period of time to allow an operator to make the necessary billing updates. Eventually the account will be deactivated by Cambium as shown in the below screenshot:



Failed Registration/Grant procedure corrective action

Possible failure scenarios are listed below in two sections:

- Management Tool
- SAS Response Failures

The failure messages list an error of some sort of internal to the Cambium software or the configuration entered and **SAS Response failures** which follows the WInnForum documentation.

Management Tool failure messages

Error Description	Cause	Corrective Action
"Found different parent mac" or "Parent MAC mismatch"	Device has sent request with different parent MAC.	<ol style="list-style-type: none"> 1. Check if the SM is mapped to an AP in cnMaestro, but connected over the air to another AP. 2. Although improvements in cnMaestro 2.4.1 make this error less likely to be seen, if such an error is seen, deregister options have been added to the onboarding queue and inventory pages to allow an operator to more easily get past this. See the Deregistration from the cnMaestro Tree or onboarding queue subsection of the DeRegister and Delete the Devices section later in this document for details.
CBRS active on device. Tool is not permitted	This can occur if CBRS is already active and the device is heartbeating (the AP or BHM), the tool instance is removed and then re-added and then an attempt is made to obtain a grant with the tool START procedure.	Attempting to obtain a grant from the tool while the device itself is already holding and heartbeating an existing grant, is not supported. Follow grant relinquish or de-registration procedures listed elsewhere in this document if user desires to clear an existing grant and request a new one.
If device is registered with another account	This can occur when attempting to move a sector from 1 cnMaestro account to another in cnMaestro cloud. The AP/BHM was successfully moved, but one of the children SM's was not deregistered prior to the move.	From Services →Sector→domain proxy view, do a search on the SM's MAC. Once it is found, issue a deregistration from this domain proxy view.

SAS response failures

If the device has failed to get the Authorized state from the SAS for any reason, both the reason and failure message is displayed or in some cases an event has caused the SAS to suspend or terminate an existing grant or revoke the registration. The most commonly seen WInnForum Response Code Definitions are listed below with Cambium Networks suggested actions to take. For all other error codes, consult WInnForum documentation or contact Cambium Networks support.

Error Code	Description	Cause and End Result	Corrective Action
103	Invalid value in parameter	<p>The most likely cause and result of this error is:</p> <p>Invalid CBSD ID returned from the SAS in a heartbeat response to the radio. Editing an installation parameter of a config synced device using the tool, as described in CBSD synced radio parameter changes, can results in a heartbeat response to the radio with a 103 reason code if the heartbeat exchange occurs after the previous grant has been relinquished from the SAS. So it's possible to see this after the edit has been submitted, but before the modified tool configuration has been synced to the radio.</p>	Corrective action is simply to complete the procedure with a sync (or a reboot) as described in CBSD synced radio parameter changes to obtain a new successful registration and grant.
105	Deregistered by SAS	CBSD is automatically deregistered by the SAS. CBSD state is marked as "HALT" by Management Tool	For a CBSD that has not yet been Config_Synced, simply attempt another registration by hitting the RE-INIT on the CBRs Management Tool. For CBSD's that have been Config_Synced, on the AP/BHM, navigate to HOME > Session status page > uncheck the De-Register checkbox per radio, then reboot the AP/BHM.
400	Grant request parameters cause too much interference	The requested grant would interfere with a protected area, such as an incumbent or a border or quiet zone. CBSD state will change to "HALT" after 3 attempts if this is a tool initiated grant request.	In most cases, Cambium suggests an operator attempt another grant request with a different center frequency or Bandwidth or possibly EIRP value. If this was tool initiated grant request that failed, deregister the device instance from the tool, make the modifications, then issue a Re-Init. Although unlikely, it is possible for the SAS to offer a lower EIRP in the grant Response message with a 400 response, for this same requested center frequency and Bandwidth. If such a suggestion is included by the SAS, for cnMaestro version 2.4.1 or later that suggested value can be found in the "SAS recommended EIRP" column on the cnMaestro tool page. On operator can then simply click "START" to force the tool to send another grant request with this SAS recommended lower EIRP value.

Error Code	Description	Cause and End Result	Corrective Action
			If this was an actual device initiated grant request, see CBSD synced radio parameter changes .
500	Grant terminated	See Preparing for and handling a grant termination from the SAS .	Follow Preparing for and handling a grant termination from the SAS .
501	Grant suspended	<p>The Grant is suspended. This condition occurs if incumbent status has changed temporarily.</p> <p>The Cambium Networks CBRS management tool will continue to heartbeat suspended grants for initiated grants not yet synced to the devices. For grants synced to the devices, the AP will continue the periodic heartbeat requests while in suspended state.</p>	Follow Grant suspension possibilities from the SAS .

CBSD synced radio parameter changes

Editing installation parameters on a single radio using the CBRS Management Tool

Consider a device is in Config Sync state or Not Synced state and a change to any installation parameters (CPI signed data) such as Height, Accuracy, Antenna gain, etc. is desired as follows:

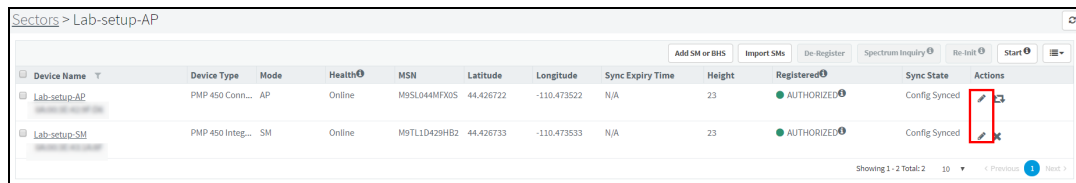
cnMaestro release 2.4.1 has added support for such edits on Not Synced states other than Unregistered or Deregistered.



Note:


This procedure also covers the scenario where an SM is being physically moved to a new location, so that the GPS co-ordinates change also.


1. Click **Edit** in the **Actions** column, change the desired parameters and configure the CPI parameters,





2. Enable the checkbox for **The device will be de-registered from SAS, if it is registered** and click **Save**.

Add CPI Certificate
CPI information is neither stored on client nor on the server. It protects against any misuse of CPI certificate and its password.


Certificate File* 

File Password 

CPIR Name* 

☐  The device will be deregistered from SAS, if it is registered and synced.

- Be aware that the triggered deregistration from the SAS removes the device's grant. When the new grant is requested, there is always a risk of having to wait until the next CPAS has occurred. This deregisters the device from the SAS.



NOTE:

Sync state on the cnMaestro Management tool changes from Config Synced to Not Synced if prior state was Config Synced.

- For an AP or BHM, the user can force a manual sync operation from the cnMaestro management tool to obtain the new installation parameters.
- For an SM or BHS, a manual sync is not necessary since the SM/BHS automatically picks up the config changes from cnMaestro.
- After the edit of a config_synced SM/BHS, navigate to **HOME > Session status > CBRS Status List** uncheck the **De-Register checkbox**. This allows the SM/BHS to request a new grant using the modified parameters.

CBRS Status List										
CBSD	LUID	Grant State	Time Elapsed In State	EIRP Req / Auth	Heartbeat			Grant Expiry	Relinquish Grant	De-Register
					Missed	Failed	Skipped			
Lab-setup-AP [AP]	AP	Authorized	00:04:54	20 / 20	0 / 2	0 / 2		11/12/2019 : 03:43:50 UTC	<input type="checkbox"/>	<input type="checkbox"/>
Lab-setup-SM - [0a-00-3e-43-1a-8f]	002	Deregistered	00:02:35	NA	0 / 1	1 / 1	1 / 1	NA	<input type="checkbox"/>	<input type="checkbox"/>

- A variation on the above procedure would be to use the Management Tool's Re-init function to have the tool request and obtain the grants for the modified devices prior to sync, after the above step 3. When the sync operations take place, the AP would not need to request Grants, but would instead use the Grant's from the tool.

Editing non-installation parameters directly on the radio

If the radio has already synced with the cnMaestro tool, indicated by a "Sync State" = Config Synced" on the cnMaestro Management tool, the non-installation parameters should be edited directly on the radio as follows:

- Editing Channel Bandwidth or Center Frequency use the AP UI:
 - Center Frequency changes:
 - On the AP, navigate to **Configuration > Radio** page, simply modify the center frequency of the primary carrier and click **Save Changes**. The existing grants are relinquished, the AP attempts to move the SMs to the new channel via the follow-me feature, and new grants is requested on the new center frequency.
 - The updated center frequency will be automatically synced to cnMaestro and displayed as **Operating Frequency** (MHz) in the upper left hand corner of the CBRS Management tool per sector.

- An improvement introduced in release 20.3 is that the AP software now internally keeps track of the most recent user configured EIRP value - the operator desired value. This improvement is useful when a center frequency change is made. For example, a case where an operator has requested maximum EIRP for 20 MHz grants centered at 3660. The SAS offers 7 dBm/MHz. The AP becomes authorized at 7 dBm/MHz centered at 3660. Later, if the operator performs a spectrum Inquiry on the configuration synced sector from the cnMaestro Management tool and the result shows higher power available if the radio is moved up to 3690. With 20.3 code, an operator can simply modify the center frequency and save. The new grant requests will be sent out at high power - up to this internally stored user configured EIRP value the operator desires. This is the 20.3 operation with any center of frequency change where the new channels do not overlap with the prior configured channel space. With pre-R20.3 radio code, a simple frequency change would result in new grant requests being sent at the same reduced values that were being used for the old grants. An operator would have to perform a relinquish before or after the frequency change to request increased power.



Note

The 20.3 or cnMaestro 3.0.4 software combination does have a limitation in that the User Configured EIRP synced to the AP from cnMaestro will only reflect the total EIRP for the subset of the channels that are AUTHORIZED. It will not include the EIRP for the suspended portion of spectrum. See the 20.3 release notes also.

b. Bandwidth changes:

- For a 450m AP navigate to **Configuration > Radio** page > select the **Channel Bandwidth** to the desired value, click **Save Changes** and **Reboot**.
- For 450/450i/450b AP/BHMs, click only **Save Changes**. Reboot is not required.
- When Bandwidth is increased, total EIRP allowed to be requested increases also, assuming the hardware in use allows for such an increase - supports the increase. After performing a Bandwidth edit with an increase in Bandwidth, the AP/BHM will request a new grant with total EIRP as the same was configured and authorized prior to the Bandwidth edit. If the operator wishes to increase the total EIRP used by the AP/BHM with the Bandwidth increase:
 - After the Bandwidth edit, navigate to **HOME > Session Status** and click **Relinquish Grant** for the AP/BHM.
 - After performing the relinquish, navigate to **Configuration > Radio** and modify the **Tx Power** or **EIRP** to the desired higher value and click **SAVE**. After approximately 2 minutes, the AP/BHM automatically request a new grant at this higher power allowed by the Bandwidth increase.
 - Alternatively, for a 450/450i/450b AP/BHM, because the Bandwidth edit does not require a reboot (like it does for a 450m AP), after clicking SAVE for a Bandwidth edit, an operator has a short window of time to edit the TX Power to the higher value while the spectrum is being relinquished due to the Bandwidth change. Performing the EIRP edit quickly after the Bandwidth edit in this manner saves the additional step - and the 2 grant requests as explained above. Software R20 and later no longer requires a reboot for an EIRP edit on 450/450i/450b AP's/BHM's.
- The updated Bandwidth will be automatically synced to cnMaestro and displayed as Operating Frequency (MHz) in the upper left hand corner of the CBRS Management tool per sector.



Note

The above mentioned 2 sub-steps are not necessary for an SM/BHS. When Bandwidth is increased, the SM's new grant will be requested at the higher EIRP allowed by the increased Bandwidth (up to the limits allowed by the hardware).

2. Editing Channel Bandwidth and/or Center Frequency using a configuration template push from cnMaestro

Due to the 2nd quarter 2021 PAL rollout, it's likely operators may need to move a large number of sectors to a different center frequency, and possibly even a different Bandwidth. An alternative to the manual GUI steps listed directly above, an operator can make these edits via a template push from cnMaestro. An example template can be found here after the formal software release:

<https://support.cambiumnetworks.com/files/pmp450>

3. Editing co-existence Parameters directly on the radio

a. After making Bandwidth or Center frequency changes on an AP as described above, it is likely an operator wants to change the co-existence parameters currently assigned to this sector Or, an operator might want to modify co-existence parameters without any change to the frequency or Bandwidth:

- Navigate to **Configuration > CBRS** on the AP. Now change the Sector ID and Reuse ID to the desired values. If using Federated Wireless, an Include User ID field will also be available. This parameter is included by default for Federated Wireless and in most cases should be included to handle the possibility of two operators accidentally picking the same co-existence parameters. If an operator wishes to frequency coordinate on the same channel with another operator or between PMP and LTE technology, this parameter can be disabled and the co-existence group parameters set the same - coordinated. For Google, these parameters are unique to an organization, so this parameter is not available for operators using Google SAS. See Cambium 20.3 training slides for a more detailed explanation.
- Save the changes and reboot the AP.

b. After the reboot the AP will update the SAS with the new co-existence parameters in the next heartbeat request. Note that a new Grant or Registration is NOT necessary for such edits unless these co-existence parameter edits are accompanied with center frequency or Bandwidth changes.

4. Editing co-existence Parameters on the radio via cnMaestro configuration template push

Like the above method for directly editing the parameters on the AP/BHM GUI, this method avoids the deregistration associated with modifying co-existence parameters from cnMaestro. It is a good solution if only the co-existence parameters are changed without a corresponding frequency or Bandwidth change.

- For each Spectrum Reuse ID an operator intends to deploy, assemble a .cfg template with only the Spectrum Reuse ID.

An example template can be found here:

<https://support.cambiumnetworks.com/files/pmp450>

Or as shown below:

```
{
  "userParameters": {
    "apCbrsConfig": {
      "cbsdCoexSpectrumReuseId": "${cbsdCoexSpectrumReuseId=B}"
    }
  }
}
```

- If desired, the **Sector ID** and/or **Include User ID** could also be added to the template to modify the default values. In most cases, the default values for these 2 parameters is sufficient.
- Use cnMaestro's configuration update functionality to push the template to every AP/BHM that needs this Spectrum Reuse ID configured.

- The AP/BHM will get updated, reboot automatically, then send out a new Heartbeat Request with the updated Spectrum Reuse ID to the SAS.
5. Edit EIRP for a 450m AP, or Tx Power for a 450/450i/450b AP/BHM:
 - a. If desired EIRP (Tx Power plus antenna gain for non-450m radios) is higher than the current SAS granted power, which is visible from the **HOME > Session Status** page:
 - Navigate to **HOME > Session Status** page > and click **Relinquish** the AP/BHMs grant.
 - Then navigate to **Configuration > Radio** page and increase the EIRP or Tx Power to the desired level.
 - Click **Save Changes**.
 - After saving the changes , with in approximately two minutes the AP will automatically request a new grant with the higher EIRP.
 - b. If the desired EIRP (Tx Power plus antenna gain for non-450m radios) is equal to or lower than the current SAS granted power:
 - Navigate to the Configuration > Radio page, modify the EIRP or TX Power and click **Save** Changes.



NOTE

- If the area is congested, channels may appear unavailable, because they are unavailable at the higher power with the above method.
- If the device operates at a lower power than the grant, the SAS performs the calculations using the granted power, not the used power.
- These steps do not avoid a potentially long outage waiting for the new grant from the SAS. In the Bandwidth, Frequency, or Higher EIRP edit case (but not the lower EIRP), there is potentially a two night outage waiting for first the new grant for the AP/BHM, then the new grants for the SMs.

An operator could consider timing the change such that they disable CBRS late in the evening and switch back to part 90 operation in the 3650 to 3700 range long enough to get a new grant from the SAS via the cnMaestro management tool.



NOTE

After October 2020 most part 90 licenses are no longer valid and this suggestion no longer applies - for most operators.

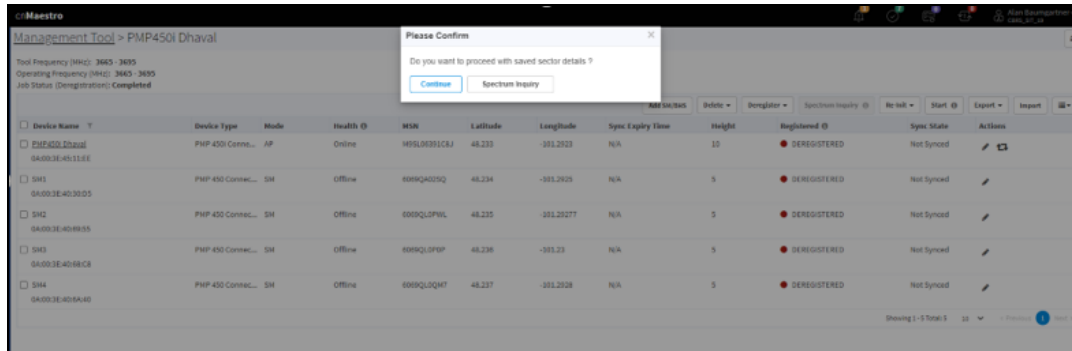
Editing non-installation parameters from cnMaestro CBRS Management Tool

As an alternative to editing Bandwidth, center frequency, EIRP, Sector ID, or the Spectrum Reuse ID directly on the radio, these changes can also be done from cnMaestro as follows:

1. Editing Channel Bandwidth or Center Frequency:
 - a. From the CBRS **Management Tool**, Select **Deregister > All**. WARNING: This will of course take the entire sector off the air. Additionally, the new resulting grant requests might be not be **AUTHORIZED** right away, but require a CPAS cycle. When done in areas that do require a CPAS cycle, the cnMaestro edit method does have an advantage over the direct AP edit in that grants for the AP and SMs will be requested at the same time. In the direct radio edit method, the request

for the SM grants might require an additional 24 hours, since they will not be made until the AP itself is AUTHORIZED and transmitting.

- b. Now click on **Re-Init > ALL**. Select the **Spectrum Inquiry** option in the pop-up GUI as shown below:



- c. A new registration and Spectrum Inquiry exchange takes place for the existing defined co-existence parameters for this sector, and the existing parameters are shown. Because a frequency or Bandwidth change is being done, an operator may wish to change the Spectrum Reuse ID associated with this sector. This can be done by expanding the **co-existence Configuration** section, clicking on EDIT, then selecting a different Spectrum Reuse ID and Saving. The Spectrum Reuse ID must already exist in the database to select it via this Spectrum Inquiry pop-up GUI. The action of saving this change will result in a new Registration Request with this new Spectrum Reuse ID, and a new Spectrum Inquire exchange. If an operator wants to add and assign a brand new Spectrum Reuse ID that doesn't already exist in the cnMaestro account, the devices in the tool for this sector must be deleted and re-added.

- If the Sector ID or Spectrum Reuse ID is being changed, note carefully the warning that the operator may need to wait several hours to get an updated Spectrum Inquiry Result as explained in prior sections of this document. After this wait, the refresh icon in the upper right of this screen can be selected to get an updated Spectrum Inquiry Response based on the updated co-existence parameter.
- If the co-existence parameters were not changed, there is no need to wait before pressing ahead with the following steps.
- Check the **I understand.** warning, select the desired new Center Frequency and/or Channel Bandwidth, then click on **Calculate Max EIRP**.
- The allowed limits for EIRP entries will be based on the newly selected Bandwidth. Enter the desired **Requested** EIRP values for each device, then click **SAVE**. A grant Request will be sent for the AP. The SMs will be Registered with the SAS, and grant requests will be sent for them as well. Once this tool procedure has completed, the grants can be pushed to the AP/BHM by clicking on the SYNC action button.

2. Editing EIRP

- a. A Reimport spreadsheet can be used to edit multiple device Requested EIRP's. After the values are modified in the **Update EIRP** pop-up GUI, the devices will be automatically deregistered. The Re-init button can then be used to request a new grant.
- b. A single Requested EIRP value can be changed from cnMaestro via the Edit function – the pencil icon, in the Actions column of the CBRS Management Tool for each and every device. After modifying the EIRP, the device will be deregistered and the Sync state flipped to **Not Synced**. The Re-Init button can then be used to request a new grant.
- Note however that with CBRS release 1.5, the MaxEIRP limits in the tool and the individual edit Pop-up GUI's will not reflect any Bandwidth modifications done on the the AP/BHM devices themselves, if that running operating Bandwidth does not match the existing Tool Bandwidth. The Reimport method does not have this problem. Therefore, the Reimport method is currently

the better method for modifying the requested values if the operating Bandwidth and the device doesn't match the current tool Bandwidth.

3. Editing CoEx parameters on an existing sector

The following procedure can be used on the Management tool to modify the Sector ID or Spectrum Reuse ID of a sector if an operator also wants to see the resulting change in SAS Spectrum Inquiry response and possibly select a new center frequency or Bandwidth after that. However, if an operator simply wants to change the Sector ID or Spectrum Reuse ID without any modification to operating frequency or Bandwidth, a direct edit via radio or cnMaestro template push is likely a better option, as that will not result in a new registration and grant request

- a. From the CBRS management tool, Select **Deregister > All**. WARNING: This will of course take the entire sector off the air. Additionally, the new resulting grant requests might be not be **AUTHORIZED** right away, but require a CPAS cycle. When done in areas that do require a CPAS cycle, and an operator wishes to modify the Bandwidth or center frequency along with this Sector ID or Spectrum Reuse ID change, the cnMaestro edit method does have an advantage over the direct AP edit in that grants for the AP and SMs will be requested at the same time. In the direct radio edit method, the request for the SM grants might require an additional 24 hours, since they will not be made until the AP itself is **AUTHORIZED** and transmitting.
- b. Now click on **Re-Init > ALL**. Select the **Spectrum Inquiry** option in the pop-up GUI.
- c. In the co-existence Configuration section, select **EDIT** and modify the Sector ID and/or Spectrum Reuse ID to the desired values and click **SAVE**. This will result in a new spectrum inquiry exchange with the SAS with the new co-existence parameters sent from the tool in the spectrum inquiry request, updating the SAS. At this point the operator can wait the suggested 8 hours (for Google) or until the next CPAS cycle (for Federated Wireless) as indicated in the countdown timer near the bottom of this GUI, before sending another spectrum inquiry request via the refresh icon in the upper right hand corner of the Spectrum Inquiry pop-up, making any desired center frequency or Bandwidth changes, then clicking **SAVE** at the bottom of the pop-up GUI to press ahead with grant requests.
- d. Check the **I understand**. checkbox warning and click on Calculate Max EIRP. Adjust the Requested EIRP values as desired and click on **SAVE** at the bottom of the pop-up GUI

4. Deleting unused CoEx Spectrum Reuse ID's

- a. Although not required, at some point an operator might want to remove co-existence Spectrum Reuse ID's that are no longer used – no longer linked to a sector. The method to do this is to use the **IMPORT** function on the CBRS Management Tool, then look for the **Delete** action in the lower right hand corner of the **Import Sector Data** Pop-Up GUI as shown in the screenshot below:

De-Register, Delete Operations, and Subsequent Re-Registrations

De-Registration from the Management Tool, AP/BHM, or Domain Proxy and Subsequent Re-Registrations

- Starting with CnMaestro release 2.4.1, deregistration is supported on the **Management Tool** for both config synced and not synced devices in the following states:
 Note: however that when using Radio version 20.2 or later, it is no longer recommended to do deregistration operations on Config_Synced devices just from the Management tool. You must first deregister the devices from the APs **HOME > Session Status** page or alternatively, an operator can do the deregistration from only cnMaestro, but it's critical to pause at least 140 seconds after the tool initiated deregistration before attempting another grant request from the tool to ensure the AP itself has picked up the deregistration state.
- For Config_synced tool state devices: perform the deregistrations from the AP itself by navigating to the **HOME > Session Status** page on the AP and click the checkboxes in the far right column, along with the deregistration action button at the bottom of the page. If the deregistration was performed on the AP, the AP stops the transmission, and the AP-SM link drops. If the deregistration was performed for an SM, the AP continues to transmit, but the SM disconnects from the AP. This will complete the deregistration for the radio at the device and in the domain proxy and the SAS.
- For Not_Synced Management Tool state devices: Authorized, Grant, Grant_Suspended, Halt (due to failed grant).
 If the device is in any of the above mentioned states, then select the device intended for de-registration by clicking the checkboxes on the left column, then select the Deregister button and choose "Selected". Or, an operator can select "All" to deregister all devices in this sector
 Navigate to **Services > CBRS > Management Tool > Sectors** page click **De-Register**.

Sectors > Lab-setup-AP

Device Name	Device Type	Mode	Health	MSN	Latitude	Longitude	Sync Expiry Time	Height	Registered	Sync State	Actions
Lab-setup-AP	PMP 450 Conn...	AP	Online		44.426712	-110.473512	0d 5h 47m	23	AUTHORIZED	Not Synced	
Lab-setup-SM	PMP 450 Integ...	SM	Online		44.426734	-110.473534	0d 5h 45m	23	AUTHORIZED	Not Synced	

Showing 1 - 2 Total: 2

- For Config_Synced Management Tool state devices: If an operator wishes to use the cnMaestro Management Tool again to request another grant, after performing the deregistration from the AP as explained in **Step 2** above, it is still necessary to navigate to the cnMaestro Management Tool and perform the deregistration there also. What this will do is flip the sync state from Config_synced back to Not_Synced in the tool and allow the operator to use the tool again to request new grant.
- In order to Register the device again, user can manually disable the de-register flag in the devices.

■ **Home > Session status > CBRS status List > uncheck De-register.**

CBRS Status List

CBSD	LUID	Grant State	Time Elapsed In State	EIRP Req / Auth	Heartbeat			Grant Expiry	Relinquish Grant	De-Register
					Missed	Failed	Skipped			
Lab-setup-AP [AP]	AP	Authorized	00:04:54	20 / 20	0 / 2	0 / 2		11/12/2019 : 03:43:50 UTC	<input type="checkbox"/>	<input type="checkbox"/>
Lab-setup-SM - [0a-00-3e-43-1a-8f]	002	Deregistered	00:02:35	NA	0 / 1	1 / 1	1 / 1	NA	<input type="checkbox"/>	<input type="checkbox"/>

- The AP or BHM requires a reboot to Re-Register and obtain new grants, while the SMs alone will not. When new multi-grants are requested for the AP, by the AP, the 6 dB threshold decision to accept some grants but not others works as follows:
 - Federated Wireless SAS:** Same day grant offerings from a Federated Wireless SAS are made via Heartbeat responses without a termination. New grant requests for these same day grant offerings will be made even if the 6 dB criteria is not met. At CPAS time, increases from the same day offering will be accepted and granted even if those offerings are still weaker than 6 dB less than that of the APs other grants. Any decrease in EIRP from the same day value will be done via grant termination. The APs decision to request a new grant or shrink the Bandwidth will be made based on the 6 dB threshold.
 - Google SAS:** EIRP reductions at CPAS time are done via heartbeat response terminations. The APs decision to request a new grant or shrink the Bandwidth will be made based on the 6 dB threshold.
- The older Domain Proxy View deregistration button is still supported for flipping the DP and SAS state to deregistered, but in general not recommended, as it does not offer any advantages and in many cases still requires use of a deregistration first from the AP and/or from the Management Tool to flip the sync state of the devices:

Navigate to **Services > CBRS > Domain Proxy View > Sectors** page and click **De-Register**.

Sectors > Lab-setup-AP

Device	Device Type	Mode	Health	MSN	CBSD ID	Latitude	Longitude	Height	Registered	Actions
Lab-setup-AP	PMP	AP	Online			44.426712	-110.473512	23	No	De-Register
Lab-setup-SM	PMP	SM	Online			44.426734	-110.473534	23	Yes	De-Register

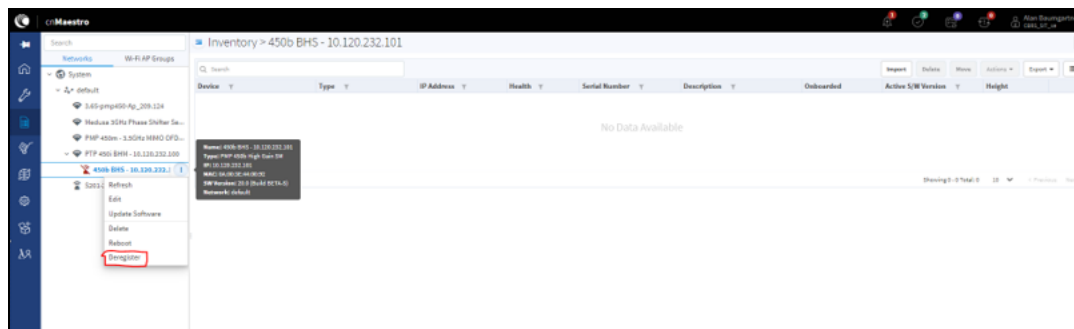
Showing 1 - 2 Total: 2

A Deregistration initiated from the Domain Proxy will not immediately update the Management Tool state to deregistered, and hence a reason for using the Management Tool for such operations in most cases. However, the next heartbeat attempt, either from the tool or the AP/BHM, will cause an AP or tool state update to Deregistered state or Halt state.

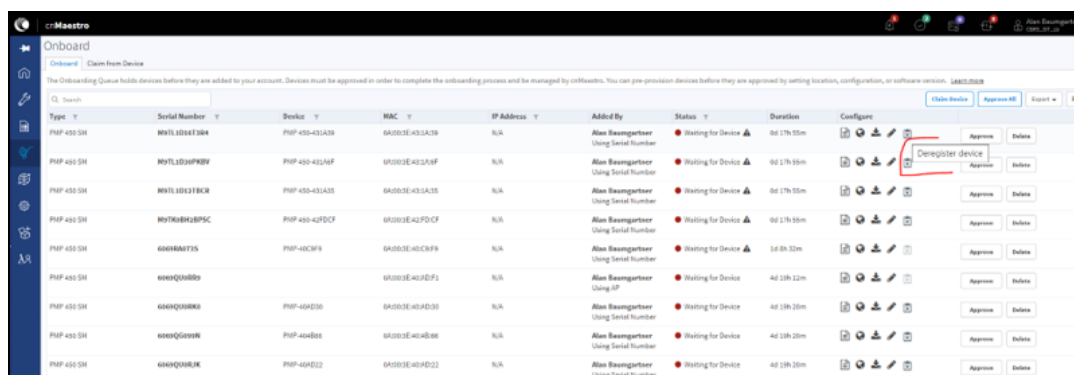
De-Registration from the cnMaestro Tree or onboarding queue

New to the December Re-Release of 2.4.2, De-registration options are supported now on both the cnMaestro Device Tree page and the onboarding queue as shown in the two screenshots below. These deregistration actions were added here not for day to day general use, but specifically to recover from failed SM reparenting scenarios between AP's. In most basic reparenting scenarios, the cnMaestro code cleanly handles the move of the Tool instance from 1 sector to another. In rare cases where a failure is seen, usually indicated by a Parent MAC Mismatch Failure these deregistration options can be used to recover the SM.

If the SM has been onboarded:



Or if the SM has not yet been onboarded:



Deleting devices:

The device can be deleted from the cnMaestro CBRS Management tool, only when CBSD state is Unregistered, Deregistered, registration failure or by selecting the deregister option in the **Please Confirm** pop-up GUI when attempting to delete a device in another state.

- Starting with cnMaestro version 2.4.1, the individual “X” delete actions in the far right column of the cnMaestro management tool page have been replaced by a **Delete** action button. The operator can select the devices in the sector they wish to delete from the tool, the choose Delete – Selected. A Delete ALL option is also available.
- Starting with cnMaestro version 2.4.1, the **Registered** column in the CBRS Management Tool now shows the actual live CBSD status of the physical device rather than the cnMaestro internal tool status, when the radio is in **Config_synced** state. As mentioned above, it's the internal tool state of the device that must be **UnRegistered**, **Deregistered**, or **Registration_Failed** to allow for a deletion of the device from the tool (without selecting the “deregister” checkbox). Although this internal tool state is not directly visible during steady state operations (when in **Config_Synced** state), if a deletion attempt without checking the optional **Deregister** checkbox fails, the details of the error – and in this case the internal tool state, can be viewed in the job status results in the upper left hand corner of the tool page.

**NOTE:**

How quickly the “deregister and delete” action takes to finish will depend on how many devices we are operating on. For a maximum sized sector of 238 SMs and 1 AP, this complete operation can take 10 to 15 minutes.

Using the Import and Reimport Function on an Existing Sector

When using the Import button, a new checkbox will be seen at the bottom of interface Reimport Devices. Operation is as follows:

Immediately upon importing the spreadsheet, the user will see an **Update EIRP** Pop-up GUI with Requested EIRP values.

If the Reimport checkbox was left unchecked, the operator can set the desired EIRP value for the newly added SM's at this time.. By default, the tool populates and will request the maximum allowed value based on the SM model type, antenna gain, and Bandwidth of this sector.

The purpose of the Import function without selecting the Reimport checkbox is strictly to add new SMs to an existing sector. After any desired modifications to **Requested EIRP** are made, click **SAVE** to exit the Pop-up.

The remaining steps are:

- Use the START button on the Management Tool to register and request grants for the newly added SMs.
- Whether the Spectrum Inquiry Pop-up is offered or not at this point depends on the state of the parent AP/BHM of the sector.
 - If the frequency or Bandwidth of the sector has not already been selected – meaning the AP/BHM is in a REGISTERED, UNREG, Dereg, or HALT state, then the spectrum Inquiry pop-up will be offered to the user to select not only the EIRP of this newly added SM, but the Bandwidth and center frequency of this sector.
 - If the frequency or Bandwidth of the sector has already been selected – meaning the AP/BHM is in a GRANTED, GRANT_SUSP, or AUTH state, then the spectrum Inquiry pop-up will not be offered to the

user. In this case the operator either needs to select the desired EIRP of the newly added SM via the EDIT pencil icon prior to START, or just accept that by default the Maximum EIRP will be requested for this SM.

- After the grants have been obtained on the tool, when the newly installed SMs air-interface register with the parent AP, the AP will automatically pull down the grants and configurations for these new SMs.

Leaving the Reimport check box unchecked is a good practice to avoid accidentally triggering a deregistration on devices the operator did not intend to modify if the purpose of the operation is simply to add new SMs to an existing sector.

If the check box is checked, the tool will look for modifications:

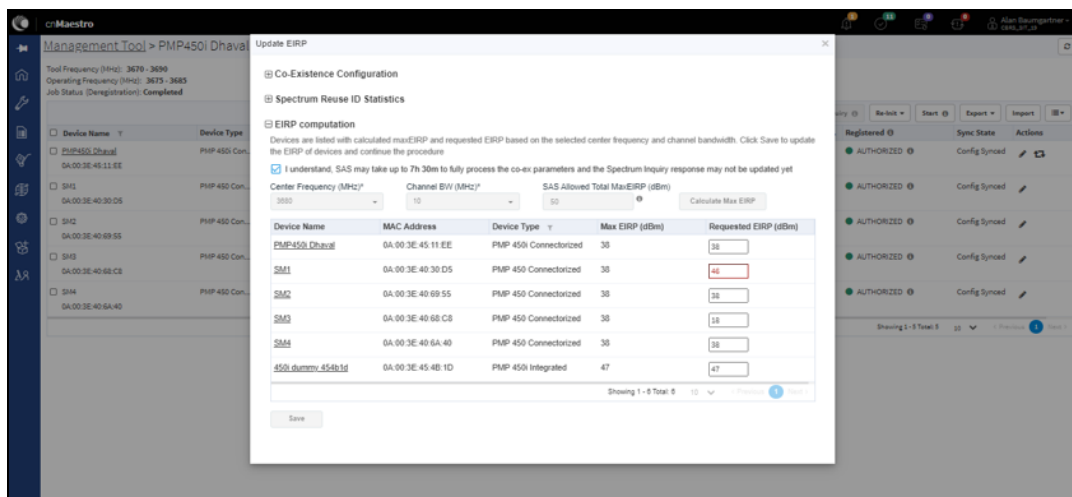
The original intended purpose of the Reimport option was to provide a method where an operator can correct 1 common mistake they made on multiple SMs after the sector has already been provisioned and is in operation.

One example use case for this new Reimport function would be a user that converted to part 96 some time ago, then recognizes that they entered the wrong antenna gain for every SM. Their SM tool states could be, for example, AUTHORIZED/config_synced. They could use their existing spreadsheet, or create a new one with an export from the tool, then modify/correct the antenna gains in the sheet for every SM.

An export will not, however, export the current Azimuth values for the SMs. Instead the formula's in the spreadsheet that calculate this based on coordinates will remain. If for some reason a change in any running values for SM Azimuth had been made since the last tool import, these changes will need to be made again in the spreadsheet by the operator before the next import. It is also important that any tool exported spreadsheet be opened and saved by an operator prior to importing. This is necessary for some calculated fields such as SM Azimuth and device type to be properly populated. If this is not done, the subsequent import will fail

- Use the Reimport to correct all the requested EIRP values that need correction, via the **Update EIRP** pop-up GUI, then click on **SAVE**.
- The SAVE action will deregister the devices that have a database difference between the newly entered values and the current operational values, and set their sync state to **Not_synced**. This will also cause the deregister flag to be set to deregistered for all these devices at the AP itself. Since the deregistration action will take the device out of servers, it's advised this be done during a maintenance window, preferably before a CPAS cycle.
- Now use the Re-init button in the management tool to re-register and request new grants for these currently **DEREGISTERED** devices.
- If the operator is presented with the options **continue** or **Spectrum Inquiry**, select continue, unless a center frequency or Bandwidth change is desired.
- Finally, the modified configuration and new grants can be synced to the devices:
 - If a new grant was obtained for the AP, click on the manual **SYNC** icon in the tool.
 - If only the SM's were modified/re-granted, navigate to AP itself, to the HOME → Session Status page, and uncheck the De-Register flag. After some time, the AP will automatically pull the new grant – with the updated configuration, down to the AP/SM.

The screenshot below is an example of a Reimport. In this case, the antenna gain for SM1 has been corrected via Reimport to the correct value of 13. The red text for the Requested EIRP 46 shows by default the current running value in the device, but indicates this is wrong and needs to be corrected to 38 or lower prior to saving the Re-imported config. In this example, the operator has modified the Bandwidth on the device itself from the original tool value of 20 MHz to 10 MHz, and this is properly displayed here. The Maximum value allowed of 47 dBm for the newly added 450i properly reflects the 10 MHz operating Bandwidth as well. The 47 dBm is allowed due to an extremely high external antenna gain configured in this example for demonstration purposes.



Relinquishing a grant for a config synced radio

1. An existing grant on a config synced device - AP or BHM or SM or BHS, can be relinquished by navigating to the **HOME > Session status** tab of the AP/BHM of this sector and selecting the checkbox of the device or devices we wish to relinquish (give up) the grant on, in the CBRS Status List table.
2. Then click on the **Perform Relinquish/Deregister** button.
3. The radios grants will be removed on the SAS at this point. Once the relinquish is complete, another grant request will be sent from the radio automatically in approximately 2 minutes. If the operator wants that grant request to be sent with different parameters than the previous grant, the operator should modify such parameters (i.e. EIRP, Bandwidth (BW), or center frequency) just before the relinquish, or just after, as described in previous sections of this document.
4. When multiple AP grants are requested and the EIRP available from the SAS is different for the different 10 MHz grants, the decision to accept the lower EIRP grant offerings or shrink the Bandwidth instead is described in detail in the previous De-Register and Delete operations and subsequent Re-Registration section.

Preparing for and handling a grant termination from the SAS and Alternate Channel Selection (Channel Hunting)

Getting a grant termination via a heartbeat response on a previously authorized CBSD is a possibility.

Although Cambium Networks has the Follow me feature, which attempts to add missing frequencies into the SMs scan list as the channel is changed, this functionality does not cover all possible scenarios. Therefore it is still suggested that all SMs under this sector have these alternate frequencies configured in their scan list. See the Converting Wideband CBRS Grants to MultiGrant, and Preparation for PAL rollout section earlier in this document for a link to a template that can be pushed from cnMaestro to make these frequency scan list and Bandwidth additions to the SMs.

Termination of a subset of multigrants

For AP software versions R21.0 and prior:

If some but not all of the grants on an AP are terminated and either no lower EIRP is offered by the SAS, or any offered EIRP is more than 6 dB weaker than the remaining grants, the AP will reduce the operating Bandwidth and adjust the center frequency to the center of the remaining grants. All this is handled automatically by the AP software. The operator action that might be necessary, if the terminated grants were already at a lower granted power than the remaining grants, the TX Power or operating EIRP will remain low after the terminations, until an

operator increases the power. Here's an extreme example below of a sector using Federated Wireless SAS. Here maximum EIRP was requested, but with an incumbent in the area in the 3620 to 3640 channel space, the SASs same day grant functionality authorized only -11.5 dBm/MHz on these 2 channels. The sector would be operating at 4 dBm EIRP total at this point, across 40 MHz.

Channel (MHz)	Grant ID	Grant State	Heartbeat Interval (Seconds)	Last Heartbeat Time	Transmit Expire Time	Grant Expire Time	Channel Allocation Type	Granted EIRP (dBm/MHz)
3600 - 3610	6972119922829096165	Authorized	200	06/17/2021 21:57:36 UTC	06/17/2021 22:01:11 UTC	06/24/2021 21:22:25 UTC	General Authorized Access	35.0
3610 - 3620	8009897347297765212	Authorized	200	06/17/2021 21:57:36 UTC	06/17/2021 22:01:11 UTC	06/24/2021 21:22:25 UTC	General Authorized Access	35.0
3620 - 3630	3103877511692613479	Authorized	200	06/17/2021 21:57:36 UTC	06/17/2021 22:01:11 UTC	06/24/2021 21:22:26 UTC	General Authorized Access	-11.5
3630 - 3640	8418471401926655645	Authorized	200	06/17/2021 21:57:36 UTC	06/17/2021 22:01:11 UTC	06/24/2021 21:22:26 UTC	General Authorized Access	-11.5

At the next CPAS cycle, those 2 grants were terminated without an offered EIRP. While the AP will automatically adjust its Bandwidth and center frequency to 20 MHz and 3610 as shown below, the APs total EIRP will remain at only 4 dBm.

Channel (MHz)	Grant ID	Grant State	Heartbeat Interval (Seconds)	Last Heartbeat Time	Transmit Expire Time	Grant Expire Time	Channel Allocation Type	Granted EIRP (dBm/MHz)
3600 - 3610	6972119922829096165	Authorized	200	06/18/2021 22:25:26 UTC	06/18/2021 22:29:06 UTC	06/25/2021 17:09:37 UTC	General Authorized Access	35.0
3610 - 3620	8009897347297765212	Authorized	200	06/18/2021 22:25:26 UTC	06/18/2021 22:29:06 UTC	06/25/2021 17:09:37 UTC	General Authorized Access	35.0

An operator would simply need to navigate to **Configuration > Radio**, increase the TX power (or EIRP for 450m), and save.

For AP software version R21.1 and later:

If some, but not all of the grants on an AP are terminated and the terminated grants all have a SAS offered lower EIRP, pre-R21.1 actions are taken as described in the previous text

If some, but not all of the grants on an AP are terminated and at least 1 of the terminated grants does not have a SAS offered lower EIRP, the AP will initiate a channel hunt procedure to move the sector to a new frequency channel. While the activation of a PAL license by a competing operator has been and will continue to be a possible cause of a grant termination, such terminations can also be initiated by the Federated Wireless or Google SAS as part of channel enforcement of a frequency plan. This Channel Enforcement feature is expected to be rolled out by both SAS vendors roughly late 2nd quarter of 2022. With this SAS feature, the spectrum Inquiry response will show most channels in the spectrum as unavailable, guiding the radio to specific channels per the SAS frequency plan they are enforcing.

Termination of all grants on an AP/BHM

Prior to release 20.2, Cambium Networks software used a couple of Alternate carrier center frequencies called ALT 1 and ALT 2 in the Configuration > Radio page that an operator could preconfigure for use in the event that the primary carrier was terminated. With the introduction of PAL licenses, grant terminations are more likely, so Cambium has replaced these ALT's with a channel hunt algorithm. Basically, when all grants of an AP/BHM have been terminated, the AP will send a spectrum inquiry request, inquiring on the availability of the entire 150 MHz spectrum. The software will identify the list of available channels for the configured Bandwidth, select that center frequency, then send a new grant request.

In release **20.3 and later**, the channel hunt algorithm has been improved. The 20.2 implementation randomly selected any available channels of the same Bandwidth as was previously in use. If no set of adjacent channels of the configured Bandwidth were available, then and only then would the hunt algorithm try to identify a smaller Bandwidth set to hunt to:

- The 20.3 implementation will take spectrum scan RSSI, SAS provided Maximum EIRP, and SAS provided co-existence ranking information (if using Google or Federated Wireless SAS) to more optimally select a channel. As part of this, the 20.3 hunt algorithm may identify a smaller Bandwidth set of channels to move to, even if channels for the existing Bandwidth are available, if predicted performance is significantly better with the lower Bandwidth.

- PMP 450m APs require a reboot when the channel bandwidth is changed. For PMP 450m operators that prefer to use the CBRS Alternate Channel Selection feature, but avoid the outage caused when the bandwidth is automatically adjusted, with System Release 21.1 they can now leave their Alternate Channel Selection feature enabled, while disabling the “Reboot for Channel Bandwidth Change” feature. When a channel hunt is automatically invoked due to terminations or suspensions, the AP will only hunt for channels with the same total bandwidth currently in use. While disabling this reboot flag avoids the automatic reboot, it limits channel selection to only the bandwidth that was in operation, even if Cambium's algorithm would predict better performance with smaller bandwidth. Operators should also be aware that when Google and Federated Wireless begin channel enforcement, currently expected late in the 2nd quarter of 2022, this termination via enforcement might shrink the operating bandwidth of a sector. In those cases, it's much preferred to have the “Reboot for Channel Bandwidth Change” feature flag enabled. However, the SAS vendors are expected to notify operators before such terminations, giving operators a chance to temporarily enable this feature, for sector normally operating with the feature flag disabled.
- When using Google SAS, the 20.3 implementation will also restrict the requested EIRP in a grant request to the new channels to only the Maximum EIRP offered by the Google SAS in the Spectrum Inquiry response message. This improvement avoids the channels going into suspended state pending CPAS due to too high of a grant request. This change does not apply to Federated Wireless deployments, since same day grant will typically bring the sector on air immediately. The tradeoff with this improvement is, that although it avoids an outage while waiting in a suspended state for the next CPAS cycle, the operating transmission power of the AP/BHM might not be the maximum available from the Google SAS. Operators who experienced Channel hunts - CBRS triggered channel changes, should consider performing a Spectrum Inquiry using the cnMaestro tool for this sector the following day to see if more power is available from the SAS on this channel post-CPAS. This can be done without service impact. If the response from the SAS indicates more power is available than was granted at termination time, an operator should consider scheduling a time late in the evening to attempt to obtain higher-powered grants from the SAS. This can be accomplished by performing a relinquish operation from the **HOME > Session Status** page of the AP, then quickly navigating to the **Configuration > Radio** page of the AP and bumping up the TX power or EIRP. The SAS will likely put AP into a suspended state until CPAS, so there will be an outage. But TX power might likely be higher after the CPAS cycle.
- For **20.3 and later**, If the channel hunt mechanism selects a target Bandwidth that is smaller than the current Bandwidth, the grant requests will be sent out at a higher dBm/MHz value than was previously used, up to the previous user configured/selected EIRP/TX Power (or up to the MaxEIRP in the SI Response for Google SAS, whichever is lower). This is the same improvement described earlier in this document for manual Bandwidth reductions performed by an operator.
- Release 21 further improves the channel hunt mechanism with a couple of improvements:
 - When the spectrum inquiry response indicates that some channels are unavailable, the maximum allowed bandwidth the AP is allowed to hunt to will be adjusted depending on the number of available channels. The more channels are unavailable, the lower the allowed bandwidth that will be available to channel hunt.
 - An additional optimization to the algorithm that selects a channel to hunt to based on recent improvements to the Federated Wireless co-existence algorithm.

An operator can identify that a termination and channel hunt has taken place by looking for a termination alarm on cnMaestro, and a difference in the operating frequency on the cnMaestro tool vs the original tool frequency as shown in the two screenshots below:

Below is an example of an alarm seen on cnMaestro due to a grant termination from the SAS.

Alarm History Details

Device Name	3.65-pmp450-Ap_209124
Device Type	PMP 450i AP
Mode	AP
Device (MAC)	0A:00:3E:45:11:EE
Source Device (MAC)	-
Parent Device (MAC)	-
Network	default
Tower	-
Severity	Critical
Category	CBRS_GRANT_TERMINATE
Status	INACTIVE
Raised	Mon Mar 22 2021 11:17:11 UTC -0500
Message	SAS terminated the Grant
Cleared	Mon Mar 22 2021 11:17:13 UTC -0500
Resolution	-
Duration	< 1m

<

>

In PMP software release R21.0, additional alarms and events have been added. Additional detail is also now provided for new and existing events and alarms related to CBRS. To properly view all these additions and changes, cnMaestro version 3.1.0 or later is needed.

One of the new alarms added in R21 is part of a small feature called Report SM Reconnection Failure After Channel/EIRP Change. When the AP has determined it is about to change the frequency, the Bandwidth or the EIRP/Tx Power, it first takes note of the number of SMs that are currently attached to it, and any SM's that had been attached anytime in the last 12 hours.

After the switch to the new parameter, the AP compares the number of SMs re-attaching to it to the original number. After 10 minutes, if the two numbers do not match, the AP raises an alarm indicating that not all SMs have re-attached, along with a warning banner on the AP.

cnMaestro 3.1.0 or later will be required to view and clear the new alarm.

This functionality was designed primarily for CBRS operators, where such changes might be initiated by the SAS. It is, however, supported on non-CBRS sectors as well. See the PMP 450 Configuration guide for details on how to configure the feature, and the counters that can be seen on the **HOME > Session** Session status page of the AP.

Release R21 also adds new CBRS statistics tables that can be viewed on the AP under **Statistics > CBRS** and also **Statistics > Channel history**. These tables show history of channel bandwidth changes, center frequency changes, and EIRP changes along with the time of the change and the reason for the change. For screenshots of these new tables and detailed explanations of each field, see the release 21.0 [PMP Configuration Guide](#).

Below is an example of a cnMaestro tool page for a sector that was originally operating on 20 MHz centered at 3630, but then experienced grant terminations and channel hunted over to 3610. Notice the difference between the original tool frequency and the operating frequency in the upper left corner of this screenshot. The new 3610 center frequency can also be seen on the **HOME > General Status** page of the AP.

Management Tool > Upgrade_downgrade_450i									
Tool Frequency (MHz): 3620 - 3640 Operating Frequency (MHz): 3600 - 3620 Job Status (Procedure): Completed									
<input type="checkbox"/> Device Name 3.65-pmp450-Ap_209124	Device Type	Mode	Health	MSN	Latitude	Longitude	Sync	Expiry Time	
3.65-pmp450-Ap_209124	PMP 450i Core...	AP	Online	MSV07ULS-RX	42.8539	91.4054	N/A		

Grant Status
 1 Authorized
 Last Heartbeat: Apr 01 2021 18:52:37
 Frequency (MHz): 3600 - 3650
 Channel BW (MHz): 10
 1 Authorized
 Last Heartbeat: Apr 01 2021 18:52:37
 Frequency (MHz): 3600 - 3650
 Channel BW (MHz): 10

If an AP channel hunting selects a channel where only a subset of the grants are AUTHORIZED right away, while the rest are in suspended state, the AP will switch channels temporarily, narrowing it's Bandwidth until other channels become AUTHORIZED.

An SM must have AUTHORIZED states on at least the subset of grants the AP is authorized and transmitting on. If it does not, it will remain in suspended state, reachable over the air interface, but not capable of bridging traffic.

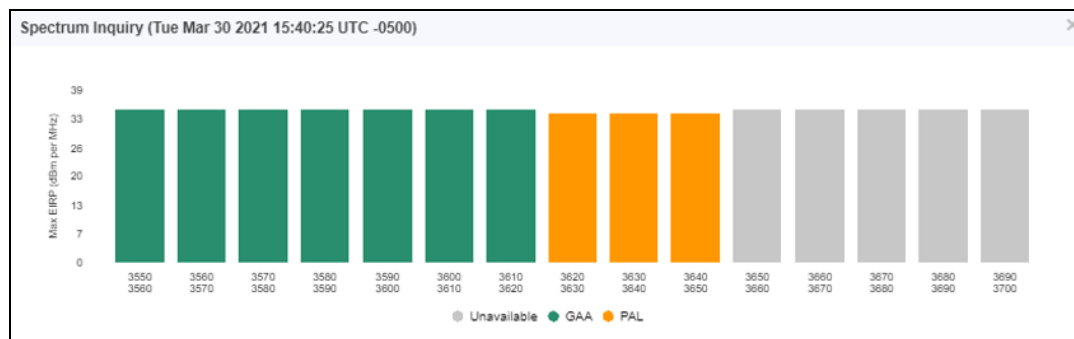
Channel hunting is enabled by default via a Alternate Channel Selection flag in the **Configuration > CBRS** page of the AP. Cambium strongly recommends operators leave this enabled. However, the option to disable this functionality is there. Instead of channel hunting on a termination, the AP would simply remain in REGISTERED state.

Identifying and moving to a different channel after being redirected to an automatically selected channel

If the SAS terminates an operator off of their entire Bandwidth for their preferred channel, as mentioned above, Cambium Networks 20.2 or later radio code will send a spectrum Inquiry to the SAS, select a channel based on the SAS response, and move operations to this channel as explained earlier. However, an operator may want to examine the available spectrum themselves to see if a more optimal channel exists. The 3.0.2 cnMaestro tool code has been modified to allow a simple spectrum Inquiry check for this purpose while the radio is operating and holding the grants.

Here is an example below of a Spectrum Inquiry Response shown on the tool on a Config_Synced Sector (a sector where the AP, not the tool, is holding grants).

In this example below, the first 7 channels are available for GAA use, the next three channels are protected channels for this operator, while the last five channels are unavailable due to a nearby incumbent.



NOTE:

When running 20.3 software or later, the improved channel hunt algorithm attempts to select an optimal or near optimal channel, so this operator action is no longer as important and possibly not necessary.

Handling a Grant Termination for 1 or more SMs or BHSs only – AP remains granted

System Release 21.1 introduces a new feature that allows the AP to automatically find and move to a new channel, or lower bandwidth, in cases where a significant number of SMs have been impacted by termination or suspension, even though the AP itself has not been impacted.

Three new configuration items are added to the **Configuration > CBRS > Configuration** table and are described below:

Configuration	
Citizens Broadband Radio Service :	<input checked="" type="checkbox"/> Enable <input type="checkbox"/> Disable
Log Level :	Debug
Reboot for Channel Bandwidth Change :	<input checked="" type="checkbox"/> Enable <input type="checkbox"/> Disable
Alternate Channel Selection :	<input checked="" type="checkbox"/> Enable <input type="checkbox"/> Disable
Change Channel if Only SMs are Impacted :	<input checked="" type="checkbox"/> Enable <input type="checkbox"/> Disable
SM Percentage Threshold for Channel Change :	10 % (Range: 1% — 99%)
Original Channel Restore Time :	15 minutes (Range: 0 — 60)

Change Channel if only SMs are impacted: This parameter enables the feature. This allows the AP to automatically find and move to a new channel or decrease the bandwidth, in cases where more than **SM Percentage Threshold for Channel Change** percentage of SMs have been impacted by termination or suspension, even though the AP itself has not been impacted. Note that the "Alternate Channel Selection" feature must also be enabled for the AP to hunt for a new channel due to the **Change Channel if SMs are Impacted** feature. If an operator elects to run with **Alternate Channel Selection** enabled but **Change Channel if SMs are impacted** disabled, the AP will still perform automatic channel selection, but only in cases where the AP is directly impacted by terminations or suspensions.

Original Channel Restore Time: In cases where this feature is triggered via SM suspensions, the AP continues to heartbeat the original channels for itself and all the SMs, while operating on the temporary channels or reduced bandwidth for at least this length of the period after moving to these temporary channels or reducing bandwidth. When this timer expires, the AP can move back to the original channels and/or bandwidth if enough suspended SMs have become authorized on the original channels.

On the bottom of the **HOME > Session Status** page of the AP, a new counter associated with this feature has been introduced. It is a computation of the number of SMs that need to experience a termination or suspension before this feature is invoked. For example, if "Threshold for Channel Change" is left at its default value of 10%, the 4 shown below would indicate that this is a sector with 40 SMs.

Channel Change When SMs are Impacted	
Impacted SM Threshold to Change Channel :	4

System Release 21.1 does not support this feature for PTP BHM/BHS setups. Such support is expected to be added later in 2022.

Requesting a new grant for a radio's cnMaestro tool instance prior to Configuration Synchronization

Requesting a new grant for a radio's cnMaestro tool instance prior to config sync are as follows in 2 scenarios:

Management Tool > PMP450i Dhaval														
Tool Frequency (MHz): 3675 - 3685 Operating Frequency (MHz): N/A														
Device Name	Device Type	Mode	Health	MSN	Latitude	Longitude	Sync Expiry Time	Height	Max EIRP...	Request...	Granted...	SAS Rec...	Registered	Sync State
PMP450i Dhaval 0A003E4D51EE	PMP 450i Int...	AP	Online	MISL0633C3J	41.981	-88.332	2d 2h 41m	10	44	44	null	9	REGISTERED	Not Synced
SM1 0A003E4D39D5	PMP 450i Con...	SM	Offline	6089Q422SQ	41.981	-88.332	2d 2h 52m	5	46	46	null	28	REGISTERED	Not Synced
SM2 0A003E4D6955	PMP 450i Con...	SM	Offline	6089Q422SQ	41.981	-88.332	2d 2h 52m	5	46	46	null	28	REGISTERED	Not Synced
SM3 0A003E4D68C8	PMP 450i Con...	SM	Offline	6089Q422SQ	40.54829	-95.65915	2d 2h 52m	5	46	46	46	N/A	AUTHORIZED	Not Synced
SM4 0A003E4D6A40	PMP 450i Con...	SM	Offline	6089Q422SQ	40.54829	-95.65915	2d 2h 52m	5	46	46	46	N/A	AUTHORIZED	Not Synced

- For any SAS vendor, the SAS has terminated the grant at CPAS time, but has offered a lower EIRP value. This can be identified via the "SAS recommended EIRP" column on the tool, as well as the hover over bubble next to the device status as shown in the screenshot below
 - If the Operator believes the SAS recommended EIRP value will be sufficient, a new request for that value can be issued by simply clicking on the START button again.
 - If the recommended EIRP is too low for reliable operation, the operator can try another Bandwidth or center frequency – see steps below.
- If no lower suggested EIRP was offered by the SAS as indicated by an N/A in the SAS recommended EIRP" column (or if the suggested value is too weak) an operator can try again with a different center frequency or

smaller Channel Bandwidth. To do this, see the Editing Non-Installation Parameters from cnMaestro subsection earlier in this document:

- a. Optionally user click Spectrum Inquiry in an attempt to determine which channels are available. However FCC regulations will not allow SAS vendors to show spectrum usage for all types of DPA events, therefore this might give a false impression that an occupied channel is available.

Grant suspension possibilities from the SAS

Suspension when using cnMaestro Management Tool

When requesting a grant using the CBRS management tool, the SAS might put the device into AUTHORIZED state right away, or it might put device into suspended state pending CPAS or the clearing of a DPA event. IF the SAS suspends the grant pending IAP, the SAS might offer a lower value that the CBSD can use right away via a heartbeat response, if using Federated Wireless SAS. This is called a “same day grant”. With release 2.4.1 or later, the management tool has 1 additional column showing the value of this “SAS recommended EIRP”, assuming the operator has added this column for display via the column selector in the far right of the tool GUI. An operator could, in theory, immediately deregister the existing grant request, EDIT the tool entry changing the EIRP requested to the lower value offered by the SAS, and perform a Re-init to get an immediate authorization. However, Cambium recommends against this in most situations. We suggest operators instead wait for CPAS to see if they can get their originally requested EIRP value authorized, or at least a value larger than the “Same Day Grant” value offered by the SAS. In this latter case, a Termination from the SAS at CPAS time will tell the operator the maximum value they can expect to operate with – see Termination handling section above.

Suspension when the radio is holding the grant

A radio requested grant can also be suspended right away and offered a lower EIRP same day grant, if using Federated Wireless.

Getting a grant suspension via a heartbeat response on a previously authorized CBSD is a possibility (i.e. activation of a DPA zone).

Starting with Cambium Networks release 20.2 software, if an operator has converted their wideband grants to multigrants, DPA activation on a subset of grants on an AP, or an AP and its SMs, will not take the entire sector down. The AP will lower its Bandwidth to that of the remaining AUTHORIZED grants and switch center frequencies temporarily. The SMs also will move to the new lower Bandwidth. The AP will continue to heartbeat the suspended grants until the DPA clears and the suspended grants are re-authorized. At that time the AP will move its Bandwidth and center frequency back to the original Bandwidth. A subset of multigrants in 501 IAP pending state waiting for CPAS is another scenario where the AP will temporarily lower its Bandwidth to enable transmission. In most cases, when using Federated Wireless, this will not occur due to immediate authorization via the **same day grant** feature. But this scenario can be seen when using Google. Additionally, for any SAS vendor, if one of the same day grant offering's EIRP is lower than the platform limit or doesn't meet the 6 dB criteria relative to the other multigrants for this CBSD, a temporary Bandwidth reduction can take place.

Starting with release 20.3, if all the multigrants on an AP are suspended due to DPA activation, the AP attempts to channel hunt to temporary channels, while continuing to heartbeat the original operator selected channels, waiting for the DPA to clear. An example is shown below:

1. This screenshot below shows a starting configuration of an AP with two AUTHORIZED grants between 3560 and 3580, as seen from the **Logs > CBRS** page of the AP.

Select CBSID
Current CBSID : [3.85-pmp450-Ap_209_124 [0a003e4511ee] Luid AP ▼]

CBSID Information
CBSID Grant State : Authorized
CBSID State Time : 00:00:43
CBSID ID : Z8H89FT0028ebdbec8d782454d0b07c9ad43fa0a0e3f8e5c756/12675109672698292519

CBSID Grant Information

Channel (MHz)	Grant ID	Grant State	Heartbeat Interval (Seconds)	Last Heartbeat Time	Transmit Expire Time	Grant Expire Time	Channel Allocation Type	Granted EIRP (dBm/MHz)
3560 - 3570	Z8H89FT0028ebdbec8d782454d0b07c9ad43fa0a0e3f8e5c756/5523760791430246924	Authorized	60	08/19/2021 : 15:00:40 CDT	08/19/2021 : 15:04:42 CDT	08/19/2022 : 15:00:39 CDT	General Authorized Access	34.0
3570 - 3580	Z8H89FT0028ebdbec8d782454d0b07c9ad43fa0a0e3f8e5c756/12675109672698292519	Authorized	60	08/19/2021 : 15:00:40 CDT	08/19/2021 : 15:04:42 CDT	08/19/2022 : 15:00:40 CDT	General Authorized Access	34.0

- A DPA activation then occurs, resulting in these channels being suspended. The two red text strings at the top of the GUI indicating that a Spectrum Analysis is in-progress, as well as a search for another channel. This spectrum scan and channel hunt is typically short – usually ~1 minute or less.

Logs → CBSR Log
PMP 450i
3.6GHz MIMO OFDM - Access Point
0a-00-3e-45-11-ee
Looking for alternative temporary channel as configured channel is suspended. Transmit Disabled!
Spectrum Analysis in progress
[Save Changes] [Reboot]

Select CBSID
Current CBSID : [3.85-pmp450-Ap_209_124 [0a003e4511ee] Luid AP ▼]

CBSID Information
CBSID Grant State : Suspended
CBSID State Time : 00:00:23
CBSID ID : Z8H89FT0028ebdbec8d782454d0b07c9ad43fa0a0e3f8e5c756

CBSID Grant Information

Channel (MHz)	Grant ID	Grant State	Heartbeat Interval (Seconds)	Last Heartbeat Time	Transmit Expire Time	Grant Expire Time	Channel Allocation Type	Granted EIRP (dBm/MHz)
3560 - 3570	Z8H89FT0028ebdbec8d782454d0b07c9ad43fa0a0e3f8e5c756/5523760791430246924	Suspended	60	08/19/2021 : 15:05:06 CDT	08/19/2021 : 15:08:16 CDT	08/19/2022 : 15:00:39 CDT	General Authorized Access	34.0
3570 - 3580	Z8H89FT0028ebdbec8d782454d0b07c9ad43fa0a0e3f8e5c756/12675109672698292519	Suspended	60	08/19/2021 : 15:05:06 CDT	08/19/2021 : 15:08:16 CDT	08/19/2022 : 15:00:40 CDT	General Authorized Access	34.0

- New temporary channels have been selected, in this case between 3620 and 3640. Notice that although the temporary grants are **AUTHORIZED**, the AP is not yet transmitting. The AP will pause 1 more heartbeat exchange to see if any additional changes are coming from the SAS before enabling transmissions.

Logs → CBSR Log
PMP 450i
3.6GHz MIMO OFDM - Access Point
0a-00-3e-45-11-ee
One or more grants in the transmitting frequency range are not authorized. Transmit Disabled!
[Save Changes] [Reboot]

Select CBSID
Current CBSID : [3.85-pmp450-Ap_209_124 [0a003e4511ee] Luid AP ▼]

CBSID Information
CBSID Grant State : Granted
CBSID State Time : 00:00:47
CBSID ID : Z8H89FT0028ebdbec8d782454d0b07c9ad43fa0a0e3f8e5c756

CBSID Grant Information

Channel (MHz)	Grant ID	Grant State	Heartbeat Interval (Seconds)	Last Heartbeat Time	Transmit Expire Time	Grant Expire Time	Channel Allocation Type	Granted EIRP (dBm/MHz)
3560 - 3570	Z8H89FT0028ebdbec8d782454d0b07c9ad43fa0a0e3f8e5c756/5523760791430246924	Suspended	60	08/19/2021 : 15:05:48 CDT	08/19/2021 : 15:08:16 CDT	08/19/2022 : 15:00:39 CDT	General Authorized Access	34.0
3570 - 3580	Z8H89FT0028ebdbec8d782454d0b07c9ad43fa0a0e3f8e5c756/12675109672698292519	Suspended	60	08/19/2021 : 15:05:48 CDT	08/19/2021 : 15:08:16 CDT	08/19/2022 : 15:00:40 CDT	General Authorized Access	34.0
3620 - 3630 (TMP)	Z8H89FT0028ebdbec8d782454d0b07c9ad43fa0a0e3f8e5c756/15038190701202604501	Authorized	60	08/19/2021 : 15:05:48 CDT	08/19/2021 : 15:09:49 CDT	08/19/2022 : 15:05:48 CDT	General Authorized Access	34.0
3630 - 3640 (TMP)	Z8H89FT0028ebdbec8d782454d0b07c9ad43fa0a0e3f8e5c756/3426479092012918305	Authorized	60	08/19/2021 : 15:05:48 CDT	08/19/2021 : 15:09:49 CDT	08/19/2022 : 15:05:47 CDT	General Authorized Access	34.0

- As shown in the screenshot below, the AP is now transmitting on the new temporary channels, while in parallel, maintaining heartbeats on the original operator selected channels.

Logs → CBRs Log									
PMP 450i 3.6GHz MIMO OFDM - Access Point 0a-00-3e-45-11-ee									
Radio is operating with temporary CBRs channels Save Changes Reboot									
Select CBRs									
Current CBRs: [3.65-gmp450-00_124 [0a003e4511ee] Luid: AP ▼]									
CBRs Information									
CBRs Grant State: Authorized									
CBRs State Time: 00:01:13									
CBRs ID: Z8H89FT0028/ebdbec8d782454d0b07c9ad43fa0a0e3f8e5c756									
CBRs Grant Information									
Channel (MHz)	Grant ID	Grant State	Heartbeat Interval (Seconds)	Last Heartbeat Time	Transmit Expire Time	Grant Expire Time	Channel Allocation Type	Granted EIRP (dBm/MHz)	
3560 - 3570	Z8H89FT0028/ebdbec8d782454d0b07c9ad43fa0a0e3f8e5c756/5523760791430246924	Suspended	60	08/19/2021 : 15:07:49 CDT	08/19/2021 : 15:08:19 CDT	08/19/2022 : 15:00:39 CDT	General Authorized Access	34.0	
3570 - 3580	Z8H89FT0028/ebdbec8d782454d0b07c9ad43fa0a0e3f8e5c756/12675109672698292519	Suspended	60	08/19/2021 : 15:07:49 CDT	08/19/2021 : 15:08:19 CDT	08/19/2022 : 15:00:40 CDT	General Authorized Access	34.0	
3620 - 3630 (TMP)	Z8H89FT0028/ebdbec8d782454d0b07c9ad43fa0a0e3f8e5c756/15038190701202604501	Authorized	60	08/19/2021 : 15:07:49 CDT	08/19/2021 : 15:11:51 CDT	08/19/2022 : 15:05:48 CDT	General Authorized Access	34.0	
3630 - 3640 (TMP)	Z8H89FT0028/ebdbec8d782454d0b07c9ad43fa0a0e3f8e5c756/3426479092012918305	Authorized	60	08/19/2021 : 15:07:49 CDT	08/19/2021 : 15:11:51 CDT	08/19/2022 : 15:05:47 CDT	General Authorized Access	34.0	

- Eventually the DPA event clears and the SAS Re-authorizes the original channels. At this point the AP relinquishes the temporary channels and changes center frequency back to the original value. Final state is shown below:

Logs → CBRs Log									
PMP 450i 3.6GHz MIMO OFDM - Access Point 0a-00-3e-45-11-ee									
Save Changes Reboot									
Select CBRs									
Current CBRs: [3.65-gmp450-00_124 [0a003e4511ee] Luid: AP ▼]									
CBRs Information									
CBRs Grant State: Authorized									
CBRs State Time: 00:00:36									
CBRs ID: Z8H89FT0028/ebdbec8d782454d0b07c9ad43fa0a0e3f8e5c756									
EIRP Requested: 47 dBm									
EIRP Granted: 47 dBm									
Number of Grants: 2									
CBRs Grant Information									
Channel (MHz)	Grant ID	Grant State	Heartbeat Interval (Seconds)	Last Heartbeat Time	Transmit Expire Time	Grant Expire Time	Channel Allocation Type	Granted EIRP (dBm/MHz)	
3560 - 3570	Z8H89FT0028/ebdbec8d782454d0b07c9ad43fa0a0e3f8e5c756/5523760791430246924	Authorized	60	08/19/2021 : 15:11:12 CDT	08/19/2021 : 15:15:13 CDT	08/19/2022 : 15:00:39 CDT	General Authorized Access	34.0	
3570 - 3580	Z8H89FT0028/ebdbec8d782454d0b07c9ad43fa0a0e3f8e5c756/12675109672698292519	Authorized	60	08/19/2021 : 15:11:12 CDT	08/19/2021 : 15:15:13 CDT	08/19/2022 : 15:00:40 CDT	General Authorized Access	34.0	

The suspension triggered channel hunt uses the same rules and optimizations implemented for the termination triggered channel hunt. See that section for a more detailed explanation.

Some of the alarms and events that are new or improved in release 21.0 as mentioned in the termination section, also apply to suspension scenarios.

If a subset of grants on only the SMs are suspended due to DPA activation, but all the grants on the AP remain authorized, System Release 21.1 introduces a feature that now better handles this by shrinking the bandwidth or invoking an alternate channel selection, moving operations temporarily to new channels while waiting for the DPA event to clear, at which time the sector will be moved back to the original channels and the temporary channels will be relinquished. See the “Handling a Grant Termination for 1 or more SMs or BHSs only – AP remains granted” prior subsection for more details on the configuration and operation of this new feature. As that subsection explains, one of the new parameters – **Original Channel Restore Time** applies only to these suspension cases, not the termination cases.

The below figure is an example of the **Logs > CBRs** page on an AP where operations have been temporarily moved from 40 MHz centered at 3570 to 20 MHz centered at 3620 due to DPA suspensions on this entire 40 MHz on enough SMs to trigger this feature. Had the AP been impacted by the DPA event also, the 40 MHz of original grants would also be suspended, not AUTHORIZED as can be seen below.

Channel (MHz)	Grant ID	Grant State	Heartbeat Interval (Seconds)	Last Heartbeat Time	Transmit Expiry Time	Grant Expiry Time	Channel Allocation Type	Granted EIRP (dBm/MHz)
3550 - 3570	106342171894899572261852733173	Authorized	190	05/19/2022 13:17:34 CDT	05/19/2022 13:21:16 CDT	05/25/2022 21:44:36 CDT	General Authorized Access	35.0
3570 - 3580	142978189344795423831852733173	Authorized	190	05/19/2022 13:17:34 CDT	05/19/2022 13:21:16 CDT	05/25/2022 21:44:36 CDT	General Authorized Access	35.0
3550 - 3560	74195500583951042291852734079	Authorized	190	05/19/2022 13:17:34 CDT	05/19/2022 13:21:16 CDT	05/25/2022 21:44:36 CDT	General Authorized Access	32.0
3580 - 3590	4107381831858915431852734079	Authorized	190	05/19/2022 13:17:34 CDT	05/19/2022 13:21:16 CDT	05/25/2022 21:44:36 CDT	General Authorized Access	32.0
3610 - 3620 (TEMP)	39130575849367238501852734768	Authorized	190	05/19/2022 13:17:34 CDT	05/19/2022 13:21:16 CDT	05/25/2022 21:44:36 CDT	General Authorized Access	35.0
3620 - 3630 (TEMP)	14575099099675042761852734768	Authorized	190	05/19/2022 13:17:34 CDT	05/19/2022 13:21:16 CDT	05/25/2022 21:44:36 CDT	General Authorized Access	35.0

The figure below shows a slightly different example where DPA suspensions impacted only a portion of the spectrum being used by the sector – and again, on only some SMs, not on the AP.

The AP continues to heartbeat authorized grants on the original 20 MHz of spectrum, while the 2 of the 4 SMs had 10 MHz suspended. Operation in the sector has been temporarily moved to the remaining 10 MHz of the spectrum as can be seen in the **HOME > Sessions Status** table, shown in the below figure.

CBSD											
LUD	Grant State	Authorized Grants	Time Elapsed In State	EIRP Req / Auth	Heartbeat			Grant Expiry	Reassign Grant	De-Register	
					Moved	Failed	Skipped				
PMP 450m - 3.5GHz MMIO OFDM - AP - 10 120 247 131 [AP]	AP	Authorized	2 / 2	01:53:11	37 / 8	0 / 104	0 / 104	05/25/2022 18:16:17 CDT	<input type="checkbox"/>	<input type="checkbox"/>	
SM13 450m - 10 120 247 146 - 10a-05-3a-41-00-10	004	Authorized	2 / 2	01:51:36	22 / 22	0 / 86	0 / 86	05/25/2022 18:27:49 CDT	<input type="checkbox"/>	<input type="checkbox"/>	
SM10 - PMP 450 - 3.5GHz MMIO OFDM - Row 4.5 - 10 120 247 141 - 10a-05-3a-40-a0-30	009	Authorized	1 / 2	01:34:53	39 / 57 (TEMP)	0 / 90	46 / 90	05/25/2022 18:34:35 CDT	<input type="checkbox"/>	<input type="checkbox"/>	
SM12 - PMP 450 - 3.5GHz MMIO OFDM - Row 4.5 - 10 120 247 143 - 10a-05-3a-40-a0-30	011	Authorized	2 / 2	01:50:16	33 / 33	0 / 102	0 / 102	05/25/2022 18:19:06 CDT	<input type="checkbox"/>	<input type="checkbox"/>	
SM17 - PMP 450 - 3.5GHz MMIO OFDM - Row 3.5 - 10 120 247 138 - 10a-05-3a-40-a0-30	013	Authorized	1 / 2	01:49:50	22 / 25	0 / 104	52 / 104	05/25/2022 18:19:38 CDT	<input type="checkbox"/>	<input type="checkbox"/>	
Clear Statistics Perform Reassign/Deassign											

Just like the channel change features where the AP is impacted by DPA suspension, it is only the DPA suspension reason codes on a subset of SMs that will trigger such a move to temporary channels. Other grant suspension reasons such as **501 IAP pending CPAS** or **Interference Calculations Pending** will not trigger a move.

System Release 21.1 does not support moving a PTP set up temporarily to new channels based on only the BHS being impacted by DPA suspension, although this is planned for a future release later in 2022. Until that support is introduced, the BHS will be in a suspended state, reachable but not capable of bridging traffic, until the suspension clears.

Options for migrating SMs from one AP to another in a CBRS deployment

The first 3 procedures listed below assume these different APs are mounted on the same tower such that the SM doesn't have to be physically moved or rotated. If such a move or rotation is necessary, which would of course require new CPI installation parameters, the below procedure [Removal of CPI parameters for device storage](#) can be used.

Moving from a part 90 AP to a part 96 AP

- Moving the SMs to the target AP prior to enabling CBRS on the target AP:

This method works well if an operator can find available Bandwidth on the target AP in the upper 50 MHz of the 3.6 GHz band, and they do not already have some SMs operating under part 96 on the target AP. Even a 5 MHz Bandwidth with marginal RF connections is sufficient, as long as all candidate SMs can connect.

- With both APs operating under part 90, modify the target Bandwidth and center frequency, and if necessary color code, on the SMs that we intend to migrate. Reboot the SMs.
- The SMs will rescan and attach to the new AP.
- cnMaestro code will automatically detect the new parent AP and recognize these migrated SMs under the new AP in **Inventory/Manage** pages of cnMaestro.
- Operators can now follow existing CBRS procedures to enable register, obtain grants, enable CBRS operation, etc on the target AP and it's newly re-parented SMs.

b. **Disabling remote management on SMs prior to moving them:**

This method works well if an operator does not want to try to temporarily operate the target AP with CBRS disabled (Option a), or the operator does not want to try to temporarily enable CBRS on the source AP (Option c). However, it involves disabling remote management on each SM prior to the re-parenting operation, then re-enabling remote management after the SM's have been moved.

- Initial setup: The new target AP has its center frequency set to **None**. Remove this target AP from cnMaestro management: **Inventory** > select the **AP**, click **Delete**. The new AP has remote device management enabled. The part 90 AP is onboarded to cnMaestro as is the SM.
- Proxy into the SM and disable remote management. Now delete the SM or SMs from cnMaestro onboarding queue or inventory in the same manner: **Inventory** > select the **SM**, click **Delete** or from the onboarding queue: **Delete**.
- So now from the cnMaestro CBRS **Management Tool**, import the spreadsheet - new AP and SM and put the AP and SM into tool authorized state by initiating the START procedure.
- Now onboard the new AP by navigating to the **Onboarding** page of cnMaestro and click **Approve**.
- Now sync the CBRS config manually to the AP from the cnMaestro CBRS Management Tool. This will force a reboot of the AP and force the feature enabled and the new AP will now be transmitting. The new AP does come up on the tool grant - it doesn't request a new one. So now the new target AP is authorized with no SMs under it.
- From the part 90 AP, proxy into the SM or SMs and change frequencies, color codes, IP addresses, etc. as desired and reboot to force a rescan and a lock onto the new AP. The SM will use the tool authorized grant. Also, the cnMaestro CBRS tool state flips to config_synched for the SM(s).
- Now re-enable remote management on the SMs themselves by proxying into them from new AP. This will require SM reboots. Finally, onboard these SMs from the onboarding queue on cnMaestro. It is not necessary to enter or reenter cambiumID and onboarding key on the SM.

c. **Briefly enabling CBRS on source AP long enough to push CBRS configuration**

- Follow Cambium Networks procedures to use the cnMaestro CBRS **Management Tool** to request grants for the existing part 90 AP and all the SMs.
- The center frequency and Bandwidth at this point should of course be the values currently used by this source side AP. It is important to add in the correct installation parameters for each SM (i.e. antenna characteristics, GPS coordinates, etc.).
- Push the CBRS config to AP. The SMs will pull their config from cnMaestro automatically after they attach to the CBRS enabled AP.
- Now add the target Bandwidth and center frequency, and if necessary color code, to the SMs that we intend to migrate. Do not remove the Bandwidth, center frequency, or color code of the existing source AP from the scan list at this time.
- Navigate to **HOME > Session Status** on the source AP, select the **De-Register** checkboxes for all radio and click on **Perform Relinquish/Deregister**.
- Navigate to **Configuration > CBRS**, **Disable** CBRS service, then click **Save Changes** and **Reboot**. The SMs will re-register on the AP under part 90 when the AP begins transmitting again, but the SMs will have saved the installation parameters for the future migration.
- Now force a migration of the desired SMs by removing the source APs center frequency and Bandwidth, and if necessary changing the color code or removing the source APs color code from their scan list, then rebooting. The SMs will re-register using the installation parameters it already has, requesting a new grant.

Moving SMs from a part 96 AP to another part 96 AP (load balancing scenario)

- Modify the Bandwidth/Center Frequency/color code as required per SM and **Reboot** the SM.

- The SM locks onto the new AP, re-register, and request a new grant.
- Assuming the same cnMaestro account is hosting both APs, no action is necessary on cnMaestro. Reparenting in the CBRS **Domain Proxy View** as well as the **Manage/Inventory** page occurs automatically. The prior instance of this SM in the CBRS Management Tool under the old AP will be removed automatically by the cnMaestro code when it detects this SM has been reparented.
- The **Home > Session Status** tab of the source AP will still show the old grant in **granted** state.

Moving SMs from a part 96 AP to a part 90 AP

- If the cnMaestro CBRS Management Tool SYNC state of the SM is Config_Synced prior to the move:
 - If a cnMaestro CBRS Management Tool instance of the part 90 AP does not yet exist, add this via spreadsheet import or Pop-Up GUI.
 - Modify the Bandwidth/Center Frequency/color code as required per SM and Reboot the SM. The SM will air interface register on the target AP under part 90. The cnMaestro tool entry for this SM will be automatically moved to the new AP. Assuming the prior state of the SM was **AUTHORIZED** or **GRANT_SUSPENDED**, the SM will show a **GRANTED/config_synced** state in the target AP's tool instance. To prepare for a future cutover of this sector to part 96:
 1. Deregister this SM under the Source APs tool instance.
 2. Delete this SM from the inventory or onboarding queue of cnMaestro. This will auto-remove the tool instance of the SM and allow an operator to import or add the SM back into the tool on the target side AP and Register the SM and request a grant prior to cutting over the sector to part 96. Note, however, that deleting an SM from inventory will remove it's history from cnMaestro. An alternative is planned for a future release that avoids requiring such a delete.
- If the cnMaestro CBRS Management Tool **SYNC** state of the SM Not_Synced prior to the move, it's not necessary to delete the SM inventory/onboarding queue and re-add it back in. After **deregistering** the SM from **cnMaestro Tool**, a new grant for this SM can be requested from the tool.

Redeployment of an SM that was never physically installed, to another AP


This procedure covers a scenario where an operator has entered the SM information for a new SM into the CBRS Management Tool, but the SM was never installed. Later the operator decides to deploy this SM on a different sector.

1. If the operator had entered the SM into the tool under a sector previously, but never requested a grant for this SM via **Re-Init** or **START** actions, simply delete the SM from both the tool instance and the onboarding queue or inventory prior to adding it under the tool instance of the new sector. This also applies to the case where an operator had requested a grant for this SM, but not in the most recent 72 hours.
2. If the operator had requested a grant for this SM under the previous AP instance in the tool in the past 72 hours, be sure to select the **De-Register** checkbox in the pop-up GUI confirmation window when deleting the SM from the Management Tool (And then also delete it from inventory or onboarding queue).

Removal of CPI parameters for device storage

From time to time an operator may wish to de-install an SM and store it temporarily with the idea of eventually re-installing it at a different location at some point in the future. A suggested best practice is to remove the CPI parameters from the radio and from cnMaestro, so that the next time the same SM is used (in another location) it would be as if this is the first time the SM connects to the SAS.

Perform as follows to do this:

1. On the **SM's GUI**, navigate to **Configuration > CBRS** and click on **"Delete CPI Data"**. It is not necessary to reboot the SM, since it's expected to be powered off and stored.
2. On **cnMaestro**, navigate to **Services > CBRS > CBRS Management Tool**, find the SM we are removing, and click on delete icon  to delete it from the **Management Tool**. When doing this, select the **deregister** option in the confirmation pop-up GUI to make sure this SM is deregistered from the SAS and the Domain proxy.
3. As a final step, find the SM in the cnMaestro inventory page and delete it or in the Dashboard onboarding queue if it hasn't been fully onboarded, and delete it from there.



Note:

Deleting an SM from inventory will remove its history from cnMaestro. Starting with the December re-release of cnMaestro 2.4.2, an alternative is to leave the SM in the inventory after it's been stored, if that history is important to the operator. When the device is eventually redeployed, the new deregister options in the onboarding queue and device tree can be used to work past any Parent MAC mismatch errors without removing the device and deleting all its history.

When the SM registers next time, it does not have CPI parameters stored internally, and cannot retrieve CPI data from cnMaestro. The SAS returns an error message saying that the CPI parameters are required. The new location can then be entered in cnMaestro using the tool, either the popups a window or the spreadsheet.



NOTE:

For any of these scenarios where an SM is being moved from a part 96 AP where that AP has been holding a grant for this SM, after the SM has physically moved off this old AP, the stale instance of the SM can (and should) be removed by navigating to the **AP's HOME > Session** status page and clicking on the "Remove Idle Sessions". Removing this stale session from the source AP will prevent old stale state information from being reported on the cnMaestro tool instance for this SM under the new Sector.

Replacing an AP/BHM

Use the following procedure to replace an existing part 96 AP with another AP. This can be to replace a partially defective AP or upgrade an older AP such as a legacy 450 with a newer 450i or 450m model.

1. A typical starting condition for this procedure would be for the devices on the existing AP to be in **AUTHORIZED** state and heartbeating. The cnMaestro CBRS tool had been used at a prior time to obtain the grants for all the radios, and those grants were synced to the devices.
2. Import a spreadsheet with only the replacement AP in it, into the cnMaestro CBRS Management Tool, or alternatively use the **Add AP** Pop-Up GUI. Obtain the AP grant by clicking on **START** on the tool. Do Not press ahead with the outage steps starting in step 4 until the tool state for the new AP is **AUTHORIZED**. This might require a wait overnight for the next **SAS CPAS** cycle.
3. Install and power on the replacement AP. The replacement AP should have basic configuration (i.e. IP address, security settings, etc.) and should be onboarded to cnMaestro. CBRS should be left disabled and the **Configuration > Radio center frequency** can be set to **NONE** so the AP is not transmitting. At this point the tool is heartbeating a grant for the AP only, while the actual AP is not transmitting.

The outage will start with **Step 4** below. Cambium Networks suggests best practice – safest practice, which would be to perform the below steps in a maintenance window, but prior to the **SAS CPAS** cycle, as it's possible the SM grant requests requested in **Step 5** below might require a **CPAS** cycle to become **AUTHORIZED**.

4. Power off the existing AP and click SYNC on the replacement AP in the cnMaestro tool. The AP will reboot, but then will use the tool obtained grant and begin transmission immediately.
5. The SMs, which have been in scanning state, will lock onto this new **AP**, re-register with the SAS, and request new Grants. Those grants might be authorized immediately, or they might require the **SAS** to go through its nightly **CPAS** cycle to flip the state from suspended to Authorized to allow the SMs to bridge traffic.
6. The existing tool entries for the the SMs will be automatically re-parented by cnMaestro under the new AP.
7. For cleanup, on the cnMaestro CBRS Management page, delete the old AP and check the **Deregister** option in the confirmation pop-up GUI.

Limitations when using a legacy 450 AP model

The legacy 450 APs have a limit of only 119 data channels for all bandwidth and frame size configurations (instead of the 238 data channel limit of a 450i or 450m AP).

Even with the 119 data channel restriction, legacy 450 AP CBRS deployments run the risk of overloading the APs CPU. This can cause brief outages due to difficulties maintaining and reestablishing DNS connections to keep the CBRS heartbeats active with the SAS. Operators that experience such issues should either reduce the number of SMs deployed under this AP, restrict the traffic load on those SMs, or replace the legacy 450 AP with a 450i or 450m model.

Considerations on Color Code Usage with CBRS

PMP devices offer color codes as a way of allowing SMs to connect to another AP in case anything happens to the serving AP.

One possible scenario is for an operator to deploy networks with some overlap in APs coverage areas. For the SMs in the overlapping coverage area, there is typically one AP whose signal is received the strongest, and one or more APs whose signal is received at lower power, but it is still decodable and potentially usable in certain situations.

The operator would then configure the SMs in this overlapping coverage areas with a primary color code matching the color code of the AP they expect the SM will attach to, and with secondary (and possibly tertiary) color code matching the color code of any other AP in the area that the SM can successfully connect to.

If the primary AP becomes unavailable (temporarily or permanently), the SM searches for the AP matching its configured secondary color code and connects to it. Then the SM periodically scans to see if the primary AP is available again. If it isn't, it remains connected to the secondary AP; if it is, it reconnects back to the primary AP.

When operating in CBRS mode, for every connection an SM makes an AP to trigger for a re-registration with the SAS. With every re-registration all existing grants are relinquished at the SAS.

It is important that customers understand the mechanics of the CBRS operation to evaluate in which scenarios using the secondary color codes is beneficial and in which scenarios additional problems may arise.

One first distinction is between areas that require CPAS and areas that do not require CPAS.

Areas that require CPAS are areas where incumbent devices are, and areas near the coast.



Note:

Most areas do not require CPAS, but there are several locations across the countries that do.

Areas that do not require CPAS

Operation in areas that do not require CPAS is similar to non-CBRS operation, meaning that the SM will connect to the secondary AP and possibly connect back to the primary AP, without any additional significant delay.

From a CBRS operation point of view, these are the events and messages exchanged between the SM, the AP and the SAS:

- The SM is connected to the primary AP, operating on an authorized grant.
- The primary AP becomes unavailable, and the SM connects to the secondary AP.
- The secondary AP registers the SM with the SAS.
This causes the SAS to relinquish the original grant the SM had under the primary AP.
- The secondary AP requests a grant for the SM, which is granted an authorized.
The SM now operates with an authorized grant under the secondary AP.
- The SM scans to see if the primary AP is available. If it is, it connects back to it.
- The primary AP registers the SM with the SAS.
This causes the SAS to relinquish the grant the SM had under the secondary AP.
- The primary AP requests a grant for the SM, which is granted and authorized.
The SM now operates with an authorized grant under the primary AP.

Even if there was a lot of CBRS activity (re-registrations, grants relinquished and requested, etc.) the SM behavior is still the same as in non-CBRS mode.

Areas that require CPAS

The main difference between the CBRS and the non-CBRS case is if the devices are operating in an area where CPAS is required.

What happens in this case also depends on the SAS vendor the device is connected to, and if the period of unavailability of the primary AP overlaps with the CPAS window of the SAS or not.

Federated Wireless SAS

Period of unavailability of primary AP does not overlap with SAS CPAS window.

The SAS CPAS window happens overnight, typically between 1 am and 5 am.

Assume the period of time the primary AP is not available does not overlap with this window, i.e. it is fully contained during the day.

From a CBRS operation point of view, these are the events and messages exchanged between the SM, the AP and the SAS:

- The SM is connected to the primary AP, operating on an authorized grant.
- The primary AP becomes unavailable, and the SM connects to the secondary AP.
This causes the SAS to relinquish the original grant the SM had under the primary AP.
- The secondary AP requests a grant for the SM, which is suspended, waiting for CPAS.
The SM is now non-operational and waiting with a suspended grant.
- The SM scans to see if the primary AP is available. If it is, it connects back to it.
- The primary AP registers the SM with the SAS.
This causes the SAS to relinquish the suspended grant the SM had under the secondary AP.
- The primary AP requests a grant for the SM, which is granted and authorized.

The SM now operates with an authorized grant under the primary AP.

**Note:**

Under the primary AP the SM did not have to wait for CPAS, because the original grant under the primary AP was already accounted for during the previous CPAS calculation.

In this case, having a secondary color code in the SM did not help during the time the primary AP was unavailable, because the SM could only receive a suspended grant and therefore was non-operational under the secondary AP.

Additionally, if the outage of the primary AP was short, it would have been more advantageous for the SM to not have a secondary color code and wait for the primary AP to become available, because it could have reconnected immediately to it. By moving under the secondary AP, the SM now needs to wait for the programmed time interval to scan again and check if the primary AP is available again.

Ultimately, however, the SM can reconnect to the primary AP without having to wait for CPAS.

Period of unavailability of primary AP overlaps with SAS CPAS window

The critical scenario is if the CPAS window happens while the primary AP is unavailable, and the SM is connected to the secondary AP.

From a CBRS operation point of view, these are the events and messages exchanged between the SM, the AP and the SAS:

- The SM is connected to the primary AP, operating on an authorized grant.
- The primary AP becomes unavailable, and the SM connects to the secondary AP.
This causes the SAS to relinquish the original grant the SM had under the primary AP.
- The secondary AP requests a grant for the SM, which is suspended, waiting for CPAS.
The SM is now non-operational and waiting with a suspended grant.
- The CPAS window starts and the SAS performs calculations on the grant the SM has requested under the secondary AP.
The grant is authorized by the SAS, and the SM starts operating under the secondary AP.
- The SM scans to see if the primary AP is available. If it is, it connects back to it.
- The primary AP registers the SM with the SAS.
This causes the SAS to relinquish the authorized grant the SM had under the secondary AP.
- The primary AP requests a grant for the SM, which is suspended, waiting for CPAS.
The SM is now non-operational until the next CPAS window (the next day) and it will not try to connect to other APs as it is connected to its primary AP.

This is the scenario that needs to be avoided, because the SM may experience an outage of up to a day. One way of avoiding this issue with any maintenance operation is to schedule the maintenance window outside the CPAS window.

Events out of the operator's control can clearly occur at any time of the day.

When operating in CPAS areas, operators should consider if color codes are necessary in the network and understand the risks if an outage of the primary AP occurs during the CPAS window.

Google

When a device operating with the Google SAS and located in an area that requires CPAS relinquishes the grant, it needs to wait for CPAS even if it is requesting the same grant it was operating with during the same day.

From a CBRS operation point of view, these are the events and messages exchanged between the SM, the AP and the SAS:

- The SM is connected to the primary AP, operating on an authorized grant.
- The primary AP becomes unavailable, and the SM connects to the secondary AP.
- The secondary AP registers the SM with the SAS.
This causes the SAS to relinquish the original grant the SM had under the primary AP.
- The secondary AP requests a grant for the SM, which is suspended, waiting for CPAS.
The SM is now non-operational and waiting with a suspended grant.
- If the CPAS window starts, the SAS performs calculations on the grant the SM has requested under the secondary AP.
The grant is authorized by the SAS, and the SM starts operating under the secondary AP.
- The SM scans to see if the primary AP is available. If it is, it connects back to it.
- The primary AP registers the SM with the SAS.
This causes the SAS to relinquish the grant the SM had under the secondary AP.
- The primary AP requests a grant for the SM, which is suspended, waiting for CPAS.
The SM is now non-operational until the next CPAS window (the next day) and it will not try to connect to other APs as it is connected to its primary AP.

In this case having a secondary color code did not help because the SM was suspended under the secondary AP, and therefore non-operational, and it became suspended under the primary AP too after it reconnected to it, causing an outage of up to a day.

If the SM did not have a secondary color code, it would have waited with a suspended grant until the primary AP became available again, and it could have become operational again after the first successful heartbeat.

Changing SAS Vendor Selection

Guidance and procedures for changing the SAS vendor are currently available separately in Cambium Networks documents support found on the production page: <https://support.cambiumnetworks.com/files/pmp450/>.

Contacting Cambium Networks

Cambium Networks

Cambium Networks provides professional grade fixed wireless broadband and microwave solutions for customers around the world. Our solutions are deployed in thousands of networks in over 153 countries, with our innovative technologies providing reliable, secure, cost-effective connectivity that's easy to deploy and proven to deliver outstanding performance.

Our award-winning Point to Point (PTP) radio solutions operate in licensed, unlicensed and defined use frequency bands including specific FIPS 140-2 solutions for the U.S. Federal market. Ruggedized for 99.999% availability, our PTP solutions have an impeccable track record for delivering reliable high-speed backhaul connectivity even in the most challenging non-line-of-sight RF environments.

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