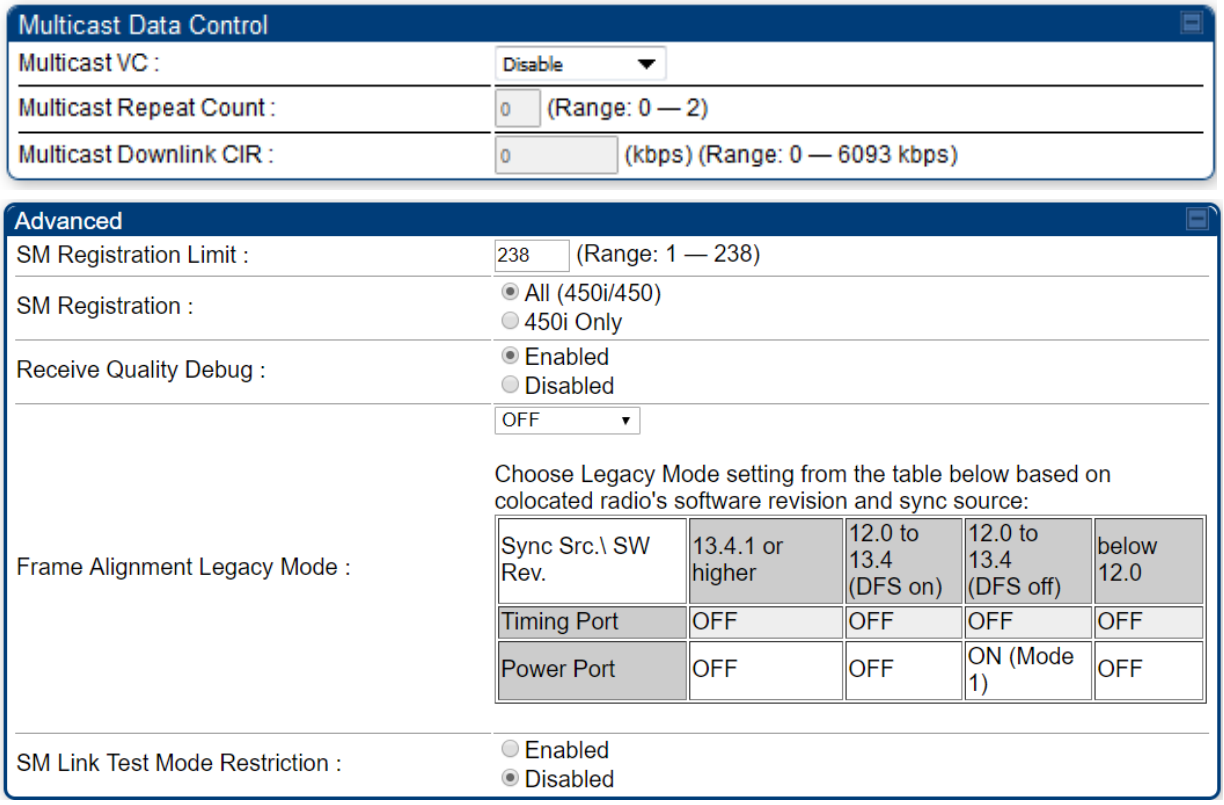


Attribute	Meaning
Frequency Band	See Table 46 PMP 450m AP Radio attributes - 5 GHz on page 1-146
Frequency Carrier	
Alternate Frequency Carrier 1 and 2	Whenever the radio detects a radar pulse in either Channel Availability Check or In-Service Monitoring Modes on carrier frequency it moves the operation to a frequency configured as Alternate Frequency Carrier 1. If the radio detects a radar pulse on Alternate Frequency Carrier 1, it moves the operation to a frequency configured as Alternate Frequency Carrier 2. If the radio detects a radar pulse on Alternate Frequency Carrier 2 it moves the operation back to carrier frequency. So, there are three options in round-robin formation. These parameters are displayed based on Regional Settings. Refer Country on page 1-73
Channel Bandwidth	See Table 46 PMP 450m AP Radio attributes - 5 GHz on page 1-146
Cyclic Prefix	
Frame Period	
Color Code	
Subscriber Color Code Rescan (When not on a Primary Color Code)	

Subscriber Color Code Wait Period for Idle	
Installation Color Code	
Sector ID	
MMO Rate Adapt Algorithm	See Table 46 PMP 450m AP Radio attributes - 5 GHz on page 1-146
Downlink Maximum Modulation Rate	
Uplink Maximum Modulation Rate	
Max Range	
Downlink Data	See Table 46 PMP 450m AP Radio attributes - 5 GHz on page 1-146
Contention Slots (a.k.a. Control Slots)	This field indicates the number of (reserved) Contention slots configured by the operator. The SM uses reserved Contention slots and unused data slots for bandwidth requests. See Contention slots on page1-208.
Auto Contention	This parameter allows the operator to enable or disable Auto Contention.
Broadcast Repeat Count	The default is 2 repeats (in addition to the original broadcast packet, for a total of 3 packets sent for everyone needed), and is settable to 1 or 0 repeats (2 or 1 packets for every broadcast). ARQ (Automatic Repeat reQuest) is not present in downlink broadcast packets, since it can cause unnecessary uplink traffic from every SM for each broadcast packet. For successful transport without ARQ, the AP repeats downlink broadcast packets. The SMs filter out all repeated broadcast packets and, thus, do not transport further. The default of 2 repeats is optimum for typical uses of the network as an internet access system. In applications with heavy download broadcast such as video distribution, overall throughput is significantly improved by setting the repeat count to 1 or 0. This avoids flooding the downlink with repeat broadcast packets.
Transmitter Power	This value represents the combined power of the AP's two transmitters. Nations and regions may regulate transmitter output power. For example • 900 MHz, 5.4 GHz and 5.8 GHz modules are available as connectorized radios, which require the operator to adjust power to ensure regulatory compliance. The professional installer of the equipment has the responsibility to • maintain awareness of applicable regulations. • calculate the permissible transmitter output power for the module.

	• confirm that the initial power setting is compliant with national or regional regulations. • confirm that the power setting is compliant following any reset of the module to factory defaults.
External Gain	This value needs to correspond to the published gain of the antenna used to ensure the radio will meet regulatory requirements.
SM Receive Target Level	See Table 46 PMP 450m AP Radio attributes - 5 GHz on page 1-146
Adjacent Channel Support	For some frequency bands and products, this setting is needed if AP is operating on adjacent channels with zero guard band.
Multicast VC Data Rate	This pull-down menu of the Multicast Data Control screen helps in configuring multicast packets to be transmitted over a dedicated channel at a configurable rate of 2X, 4X or 6X. The default value is “Disable”. If set to the default value, all multicast packets are transmitted over the Broadcast VC data path. This feature is available only for the PMP 450 Series and is not backward compatible with PMP 430 series of radios.
Multicast Repeat Count	This value is the number of packets that are repeated for every multicast VC packet received on the AP (located under **Radio** tab of **Configuration**). Multicast (like Broadcast) packets go over a VC that is shared by all SMs, so there is no guaranteed delivery. The repeat count is an attempt to improve the odds of the packets getting over the link. If the user has issues with packets getting dropped, they can use this parameter to improve the performance at the cost of the overall throughput possible on that channel. The default value is *0*.
Multicast Downlink CIR	This value is the committed information rate for the multicast downlink VC (located under the **Radio** tab of **Configuration**). The default value is *0* kbps. The range of this parameter is based on the number of repeat counts. The higher the repeat count, the lower the range for the multicast downlink CIR.
SM Registration Limit	This parameter allows to configure the limit for maximum number of SMs that can register to a PMP AP. The configurable range is from 1 to 238.  **Note** SM trying to register after the maximum configured limit has been reached is locked out for 15 minutes and a message is displayed at the SM..
SM Registration	All: This field allows to control registration of all type 450 Platform Family SM including 450 Series SM (450i/450b/450/430) or 450i Series SM. 450i Only: This field allows to control registration of 450i Series SM only
Control Message	Controls whether the control messages are sent in MIMO-B or MIMO-A mode. MIMO-A is recommended. However, if an AP on 13.2 is attempting to connect to an SM on 13.1.3 or before, changing to MIMO-B may aid in getting the SM registered.

Receive Quality Debug

To aid in link performance monitoring, the AP and SM now report the number of fragments received per modulation (i.e. QPSK, 16-QAM, 64-QAM) and per channel (polarization).

Note

Due to CPU load, this will slightly degrade packet per second processing.

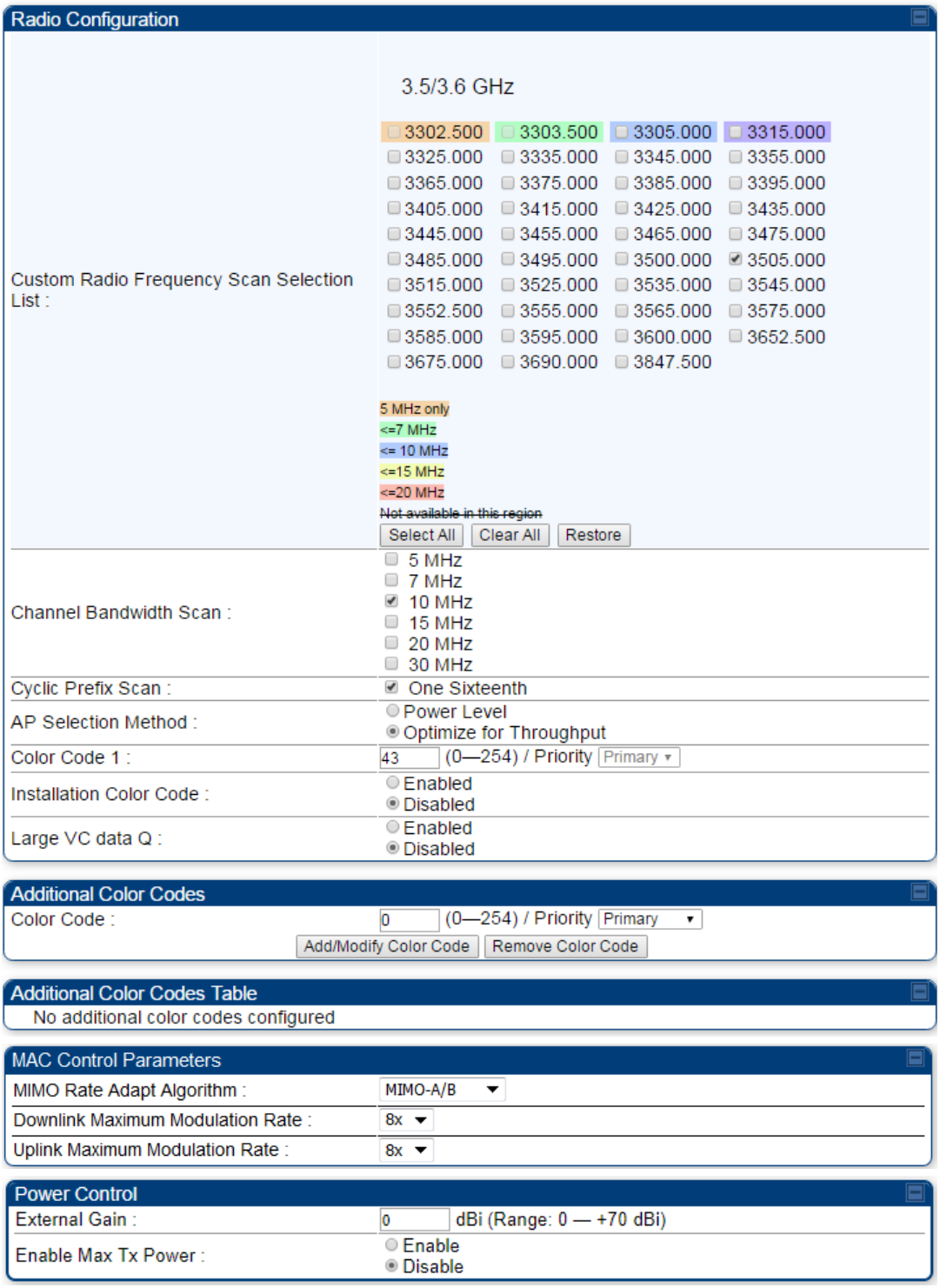
Frame Alignment Legacy Mode

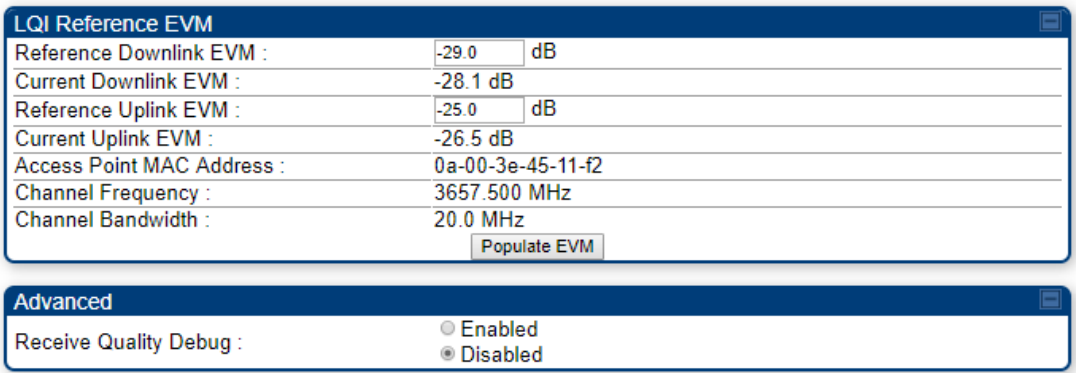
Mode	Behavior (non-900 MHz radios)	Behavior (FSK 900 MHz radios)
OFF	By default, frame start is aligned with devices with Timing Port synchronization If the synchronization source changes (due to Autosync or otherwise) the radio will dynamically adjust its frame start to maintain alignment with the default frame start timing	By default, frame start is aligned with FSK 900 MHz devices with Timing Port synchronization If the synchronization source changes (due to Autosync or otherwise) the radio will dynamically adjust its frame start to maintain alignment with the default frame start timing
ON (Mode 1)	The radio will align with devices running software versions from 12.0 to 13.4.	The radio will align with FSK 900 MHz devices running software versions from 12.0 to 13.4.
ON (Mode 2)	N/A	The radio will align with FSK 900 MHz devices with software versions 11.2 or older.

Radio page - PMP 450i SM 3 GHz

The **Radio** tab of the PMP 450i SM 3 GHz is shown in Figure 25.

Figure 25 PMP 450i SM Radio attributes - 3 GHz





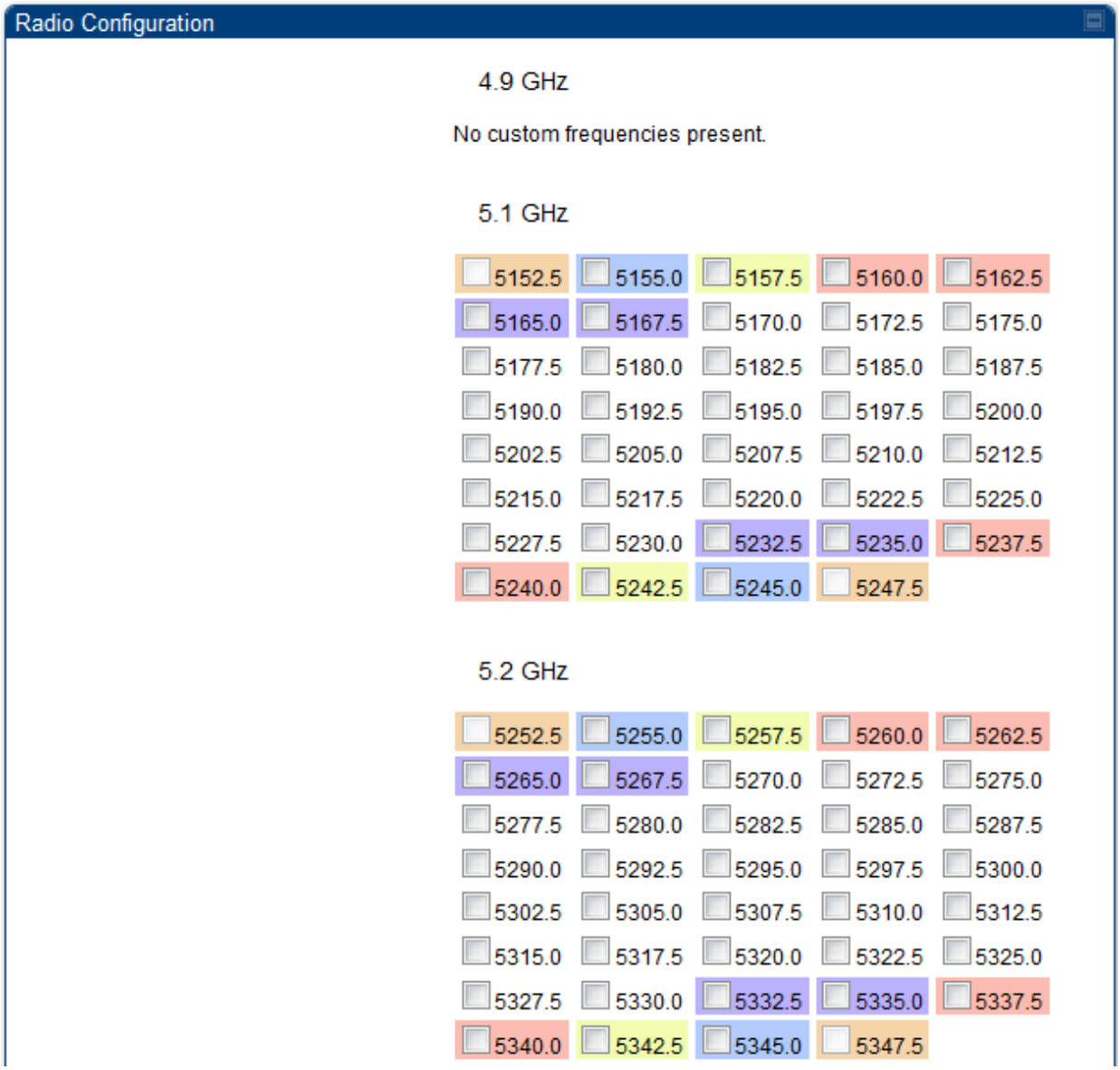
Note

Refer Table 49 PMP 450i SM Radio attributes – 5 GHz **on page 1-163 for parameter details**

Radio page – PMP 450i SM 5 GHz

The **Radio** page of PMP 450i SM is explained in Table 49.

Table 49 PMP 450i SM Radio attributes – 5 GHz



Custom Radio Frequency Scan Selection List :	5.4 GHz ☐ 5472.5 ☐ 5475.0 ☐ 5477.5 ☐ 5480.0 ☐ 5482.5 ☐ 5485.0 ☐ 5487.5 ☑ 5490.0 ☐ 5492.5 ☐ 5495.0 ☐ 5497.5 ☐ 5500.0 ☐ 5502.5 ☐ 5505.0 ☐ 5507.5 ☐ 5510.0 ☐ 5512.5 ☐ 5515.0 ☐ 5517.5 ☐ 5520.0 ☐ 5522.5 ☐ 5525.0 ☐ 5527.5 ☐ 5530.0 ☐ 5532.5 ☐ 5535.0 ☐ 5537.5 ☐ 5540.0 ☐ 5542.5 ☐ 5545.0 ☐ 5547.5 ☐ 5550.0 ☐ 5552.5 ☐ 5555.0 ☐ 5557.5 ☐ 5560.0 ☐ 5562.5 ☐ 5565.0 ☐ 5567.5 ☐ 5570.0 ☐ 5572.5 ☐ 5575.0 ☐ 5577.5 ☐ 5580.0 ☐ 5582.5 ☐ 5585.0 ☐ 5587.5 ☐ 5590.0 ☐ 5592.5 ☐ 5595.0 ☐ 5597.5 ☐ 5600.0 ☐ 5602.5 ☐ 5605.0 ☐ 5607.5 ☐ 5610.0 ☐ 5612.5 ☐ 5615.0 ☐ 5617.5 ☐ 5620.0 ☐ 5622.5 ☐ 5625.0 ☐ 5627.5 ☐ 5630.0 ☐ 5632.5 ☐ 5635.0 ☐ 5637.5 ☐ 5640.0 ☐ 5642.5 ☐ 5645.0 ☐ 5647.5 ☐ 5650.0 ☐ 5652.5 ☐ 5655.0 ☐ 5657.5 ☐ 5660.0 ☐ 5662.5 ☐ 5665.0 ☐ 5667.5 ☐ 5670.0 ☐ 5672.5 ☐ 5675.0 ☐ 5677.5 ☐ 5680.0 ☐ 5682.5 ☐ 5685.0 ☐ 5687.5 ☐ 5690.0 ☐ 5692.5 ☐ 5695.0 ☐ 5697.5 ☐ 5700.0 ☐ 5702.5 ☐ 5705.0 ☐ 5707.5 ☐ 5710.0 ☐ 5712.5 ☐ 5715.0 ☐ 5717.5 ☐ 5720.0 ☐ 5722.5


5.7 GHz
5727.5 5730.0 5732.5 5735.0 5737.5
5740.0 5742.5 5745.0 5747.5 5750.0
5752.5 5755.0 5757.5 5760.0 5762.5
5765.0 5767.5 5770.0 5772.5 5775.0
5777.5 5780.0 5782.5 5785.0 5787.5
5790.0 5792.5 5795.0 5797.5 5800.0
5802.5 5805.0 5807.5 5810.0 5812.5
5815.0 5817.5 5820.0 5822.5 5825.0
5827.5 5830.0 5832.5 5835.0 5837.5
5840.0 5842.5 5845.0 5847.5 5850.0
5852.5 5855.0 5857.5 5860.0 5862.5
5865.0 5867.5 5870.0 5872.5 5875.0
5877.5 5880.0 5882.5 5885.0 5887.5
5890.0 5892.5 5895.0 5897.5 5900.0
5902.5 5905.0 5907.5 5910.0 5912.5
5915.0 5917.5 5920.0 5922.5
5 MHz only
<= 10 MHz
<=15 MHz
<=20 MHz
<=30 MHz
Not available in this region
Select All
Select All 4.9
Select All 5.1
Select All 5.2
Select All 5.4
Select All 5.7
Clear All
Restore

Channel Bandwidth Scan :	☐ 5 MHz ☑ 10 MHz ☐ 15 MHz ☐ 20 MHz ☐ 30 MHz ☐ 40 MHz
Cyclic Prefix :	One Sixteenth
AP Selection Method :	○ Power Level ◉ Optimize for Throughput
Color Code 1 :	150 (0—254) / Priority Primary
Installation Color Code :	◉ Enabled ○ Disabled
Large VC data Q :	○ Enabled ◉ Disabled

Additional Color Codes

Color Code : 0 (0—254) / Priority Primary

Add/Modify Color Code | Remove Color Code

Additional Color Codes Table

No additional color codes configured

MAC Control Parameters

MIMO Rate Adapt Algorithm :	MIMO-A/B
Downlink Maximum Modulation Rate :	8x
Uplink Maximum Modulation Rate :	8x

Power Control

External Gain :	12 dBi (Range: 0 — +40 dBi)
Enable Max Tx Power :	○ Enable ◉ Disable

LQI Reference EVM

Reference Downlink EVM :	-29.0 dB
Current Downlink EVM :	-28.1 dB
Reference Uplink EVM :	-25.0 dB
Current Uplink EVM :	-26.5 dB
Access Point MAC Address :	0a-00-3e-45-11-f2
Channel Frequency :	3657.500 MHz
Channel Bandwidth :	20.0 MHz

Populate EVM

Advanced

Receive Quality Debug :	○ Enabled ◉ Disabled

Attribute	Meaning
Custom Radio Frequency Scan Selection List	Check the frequencies that SM has to scan for AP transmissions. See Radio Frequency Scan Selection List on page 1-200.
Channel Bandwidth Scan	The channel size used by the radio for RF transmission.  **Note** Selecting multiple channel bandwidths will increase registration and re-registration times.
Cyclic Prefix	The cyclic prefix for which AP scanning is executed.
AP Selection Method	Operators may configure the method by which a scanning SM selects an AP. By default, AP Selection Method is set to "Optimize for Throughput", which has been the mode of operation in releases prior to 12.0.3.1. **Power Level**: AP selection based solely on power level  **Note** For operation with a PMP 450m AP, select the Power Level option *or* **Optimize for Throughput**: AP selection based on throughput optimization – the selection decision is based on power level (which affects the modulation state), channel bandwidth (which affects throughput) and number of SM registrations to the AP (which affects system contention performance).
Color Code 1	Color code allows you to force the SM to register to only a specific AP, even where the SM can communicate with multiple APs. For registration to occur, the color code of the SM and the AP must match. Specify a value from 0 to 254. Color code is not a security feature. Instead, color code is a management feature, typically for assigning each sector a different color code. The default setting for the color code value is 0. This value matches only the color code of 0 (*not* all 255 color codes). SMs may be configured with up to 20 color codes. These color codes can be tagged as **Primary**, **Secondary**, or **Tertiary**, or **Disable**. When the SM is scanning for APs, it will first attempt to register to an AP that matches one of the SM's primary color codes. Failing that, the SM will continue scanning and attempt to register to an AP that matches one of the SM's secondary color codes. Failing that, the SM will continue scanning and attempt to register to an AP that matches one of the SM's tertiary color codes. This is all done in the scanning mode of the SM and will repeat until a registration has occurred.

	Color codes in the same priority group are treated equally. For example, all APs matching one of the SM's primary color codes are analyzed equally. Likewise, this evaluation is done for the secondary and tertiary groups in order. The analysis for selecting an AP within a priority group is based on various inputs, including signal strength and number of SMs already registered to each AP. The first color code in the configuration is the pre-Release 9.5 color code. Thus, it is always a primary color code for legacy reasons. The color codes can be disabled, with the exception of the first color code.
Installation Color Code	With this feature enabled on the AP and SM, operators may install and remotely configure SMs without having to configure matching color codes between the modules. When using the Installation Color Code feature, ensure that the SM is configured with the factory default Color Code configuration (Color Code 1 is "0", Color Code 2-10 set to "0" and "Disable"). The status of the Installation Color Code can be viewed on the AP Eval web GUI page, and when the SM is registered using the Installation Color Code the message "SM is registered via ICC – Bridging Disabled!" is displayed in red on every SM GUI page. The Installation Color Code parameter is configurable without a radio reboot for both the AP and SM.
Large VC data Queue	SM and BH have a configurable option used to prevent packet loss in the uplink due to bursting IP traffic. This is designed for IP burst traffic particular to video surveillance applications.
Color Code	Color code allows to force the BHS to register to only a specific BHM, even where the BHS can communicate with multiple BHMs. For registration to occur, the color code of the BHS and the BHM *must* match. Specify a value from 0 to 254. The color codes can be disabled, with the exception of the first color code.
MIMO Rate Adapt Algorithm	This pull-down menu helps in configuring the Rate Adapt Algorithm to MIMO-A/B, MIMO-B only, or MIMO-A only.
Downlink Maximum Modulation Rate	This pull-down menu helps in configuring the Downlink Maximum Modulation Rate at a configurable rate of 1X, 2X, 3X, 4X, 6X, or 8X. The default value is "8X".
Uplink Maximum Modulation Rate	This pull-down menu helps in configuring the Uplink Maximum Modulation Rate at a configurable rate of 1X, 2X, 3X, 4X, 6X, or 8X. The default value is "8X".
External Gain	This value represents the antenna gain. For ODUs with integrated antenna, this is set at the correct value in the factory. For Connectorized ODUs with external antenna, the user must set this value to the overall antenna gain, including any RF cable loss between the ODU and the antenna.
Enable Max Tx Power	This field allows to enable or disable maximum transmission power.

Reference Downlink EVM	
Current Downlink EVM	
Reference Uplink EVM	
Current Uplink EVM	
Access Point MAC Address	
Channel Frequency	
Channel Bandwidth	
Receive Quality Debug	To aid in link performance monitoring, the AP and SM now report the number of fragments received per modulation (i.e. QPSK, 16-QAM, 64-QAM) and per channel (polarization).  **Note** Due to CPU load, this will slightly degrade packet per second processing.

Note

The frequencies that a user can select are controlled by the country or a region and the Channel Bandwidth selected. There can be a case where a user adds a custom frequency (from the Custom Frequencies page on page 1-204) and cannot see it in the pull down menu.

Radio page - PMP 450i AP 900 MHz

The Radio tab of the PMP 450i AP 900 MHz is described in below Table 50.

Table 50 PMP 450i AP Radio attributes - 900 MHz

Radio Configuration

Frequency Carrier :	917.00
Channel Bandwidth :	10 MHz
Cyclic Prefix :	One Sixteenth
Frame Period :	5.0 ms 2.5 ms
Color Code :	65 (0—254)
Subscriber Color Code Rescan (When not on a Primary Color Code) :	0 Minutes (0 — 43200)
Subscriber Color Code Wait Period for Idle :	0 Minutes (0 — 60)
Installation Color Code :	Enabled Disabled

MAC Control Parameters

MIMO Rate Adapt Algorithm :	MIMO-A/B
Downlink Maximum Modulation Rate :	8x
Uplink Maximum Modulation Rate :	8x

Frame Configuration

Max Range :	2 miles (Range: 1 — 40 miles / 64 km)
Downlink Data :	50 % (Range: 15 — 85 %)
Contention Slots :	3 (Range: 1 — 15)
Auto Contention :	Enabled Disabled
Broadcast Repeat Count :	2 (Range: 0 — 2)

Power Control

Transmit Power :	25 dBm (Range: -30 — +25 dBm) (22 dBm B / 22 dBm A)
External Gain :	0 dB (Range: 0 — +40 dB)
SM Receive Target Level :	-52 dBm (Range : -77 — -37 dBm) combined power

Multicast Data Control

Multicast VC Data Rate :	Disable
Multicast Repeat Count :	0 (Range : 0 — 2)
Multicast Downlink CIR :	0 (kbps) (Range: 0— 0 kbps)

Advanced

Control Messages :	SISO MIMO-A
Receive Quality Debug :	Enabled Disabled
Pager Reject Filter :	Enabled Disabled (NOTE: Frequencies 920 MHz and above will not work when enabled.)
Frame Alignment Legacy Mode :	OFF Choose Legacy Mode setting from the table below based on colocated 900 MHz FSK's software revision and sync source:

Sync Src.\ SW Rev.	13.4.1 or higher	12.0 to 13.4	below 12.0
Timing Port	OFF	OFF	OFF
Power Port	OFF	ON (Mode 1)	ON (Mode 2)

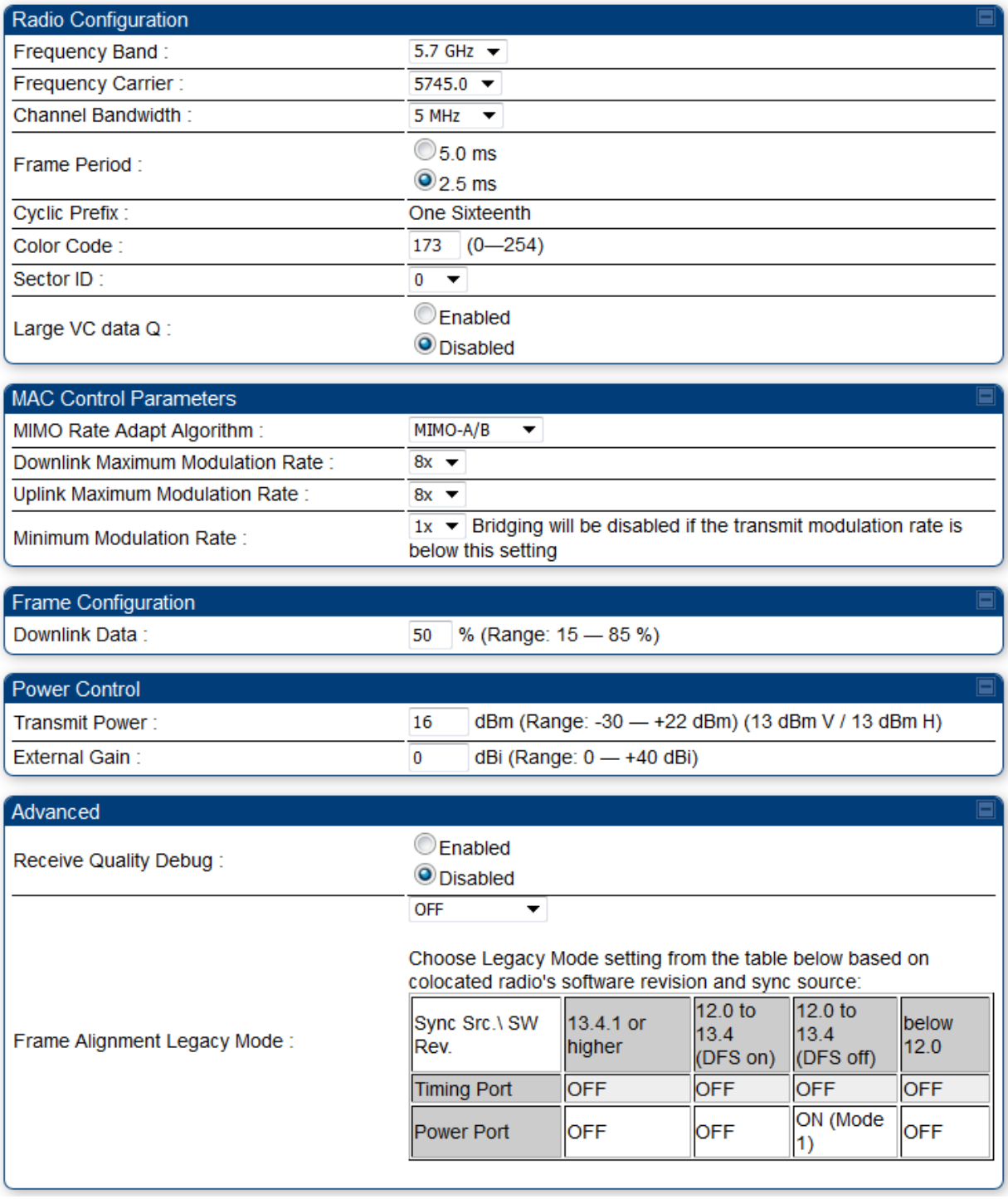
Attribute	Meaning
Frequency Carrier	Specify the frequency for the module to transmit. The default for this parameter is **None**. For a list of channels in the band, see the drop-down list on the radio GUI.
Channel Bandwidth	The channel size used by the radio for RF transmission. The setting for the channel bandwidth must match between the AP and the SM. The supported Channel Bandwidths are 5, 7, 10 and 20 MHz.
Cyclic Prefix	See Table 46 PMP 450m AP Radio attributes - 5 GHz on page 1-146.
Frame Period	
Color Code	
Subscriber Color Code Rescan (When not on a Primary Color Code)	
Subscriber Color Code Wait Period for Idle	
Installation Color Code	
MIMO Rate Adapt Algorithm	
Downlink Maximum Modulation Rate	
Uplink Maximum Modulation Rate	
Max Range	See Table 46 PMP 450m AP Radio attributes - 5 GHz on page 1-146.
Downlink Data	
Contention Slots (a.k.a. Control Slots)	
Auto Contention	
Broadcast Repeat Count	
Transmitter Output Power	See Table 48 PMP 450i AP Radio attributes - 5 GHz on page 1-156.
External Gain	
SM Receive Target Level	See Table 46 PMP 450m AP Radio attributes - 5 GHz on page 1-146
Multicast VC Data Rate	
Multicast Repeat Count	

Multicast Downlink CIR	
Control Message	
Receive Quality Debug	
Pager Reject Filter	In 900 MHz, Pager Reject filter is placed on the AP to block Pager signals which could cause interference to the whole band. The Pager signals typically operate in the 928-930 frequency range. When the filter is enabled, the signals of 920 MHz and above are attenuated which enables better reception of signals in the rest of the band. Note that the AP/SM should not be configured on the frequencies of 920 MHz and above when this filter is enabled.
Frame Alignment Legacy Mode	See Table 48 PMP 450i AP Radio attributes - 5 GHz on page 1-156.

Radio page - PTP 450i BHM 5 GHz

The **Radio** page of PTP 450i BHM is explained in Table 51.

Table 51 PTP 450i BHM Radio page attributes – 5 GHz



Attribute	Meaning
Frequency Band	Select the operating frequency band of the radio. The supported bands are 4.9 GHz, 5.4 GHz and 5.7 GHz.
Frequency Carrier	Specify the frequency for the module to transmit. The default for this parameter is **None**. For a list of channels in the band, see the drop-down list on the radio GUI.
Channel Bandwidth	The channel size used by the radio for RF transmission. The setting for the channel bandwidth must match between the BHM and the BHS.
Cyclic Prefix	OFDM technology uses a cyclic prefix, where a portion of the end of a symbol (slot) is repeated at the beginning of the symbol to allow multi-pathing to settle before receiving the desired data. A 1/16 cyclic prefix means that for every 16 bits of throughput data transmitted, an additional bit is used.
Frame Period	Select the Frame Period of the radio. The supported Frame Periods are: 5 ms and 2.5 ms.
Color Code	Specify a value from 0 to 254. For registration to occur, the color code of the BHM and the BHS must match. Color code is not a security feature. Instead, color code is a management feature, typically for assigning each link a different color code. Color code allows you to force a BHS to register to only a specific BHM. The default setting for the color code value is 0. This value matches only the color code of 0 (not all 255 color codes).
Sector ID	This pull-down menu helps in configuring the Sector ID at a configurable value from 0 to 15.
Large VC data Q	**Enable** Large VC Q for applications that burst data high rates. Large Qs may decrease effective throughput for TCP application. **Disable** Large VC Q if application need not handle bursts of data. Large Qs may decrease effective throughput for TCP application.
MIMO Rate Adapt Algorithm	This pull-down menu helps in configuring the Rate Adapt Algorithm to MIMO-A/B, MIMO-B only, or MIMO-A only.

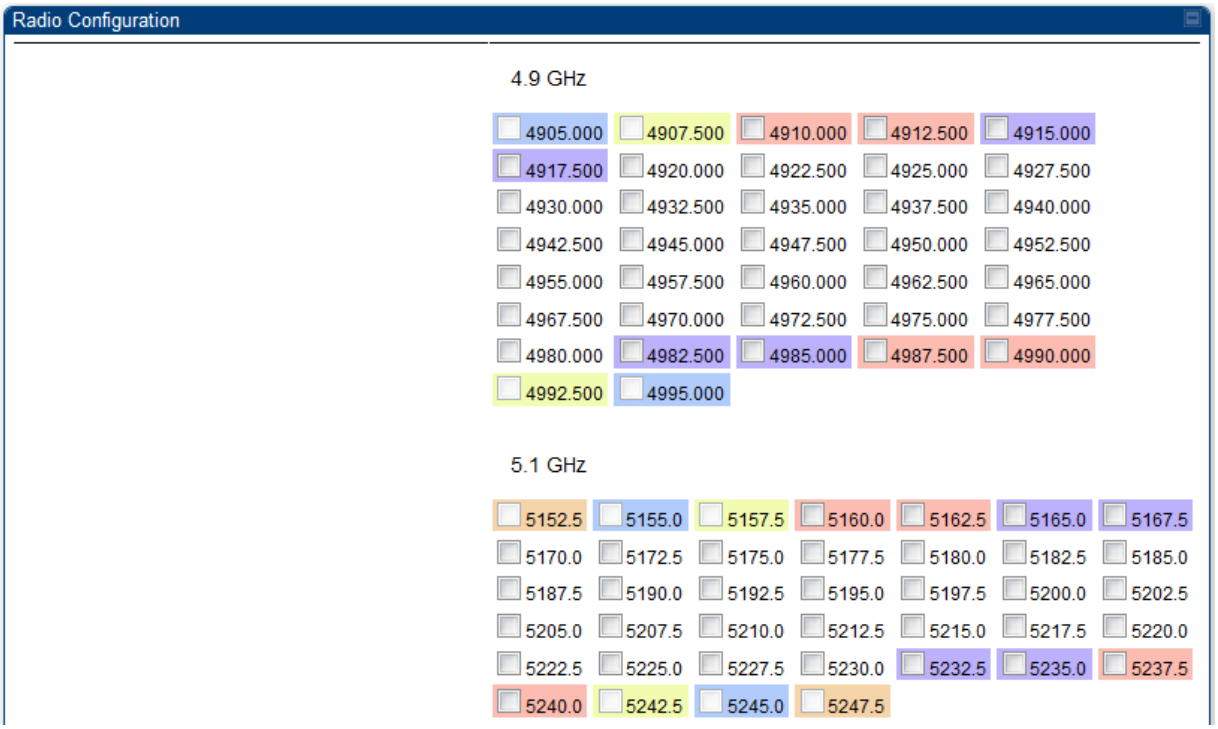
Downlink Maximum Modulation Rate	This pull-down menu helps in configuring the Downlink Maximum Modulation Rate at a configurable rate of 1X, 2X, 3X, 4X, 6X, or 8X. The default value is “8X”. The Rate Adapt Algorithm does not allow the modulation to go beyond this limit.
Uplink Maximum Modulation Rate	This pull-down menu helps in configuring the Uplink Maximum Modulation Rate at a configurable rate of 1X, 2X, 3X, 4X, 6X, or 8X. The default value is “8X”. The Rate Adapt Algorithm does not allow the modulation to go beyond this limit.
Minimum Modulation Rate	This pull-down menu helps in configuring the Minimum Modulation Rate at a configurable rate of 1X, 2X, 3X, 4X, 6X, or 8X. The default value is “1X”. If the Rate Adapt Algorithm is below this limit, then bridging is disabled. This is used if PTP network can route the traffic through another path.
Downlink Data	Specify the percentage of the aggregate throughput for the downlink (frames transmitted from the BHM to the subscriber). For example, if the aggregate (uplink and downlink total) throughput on the BHM is 132 Mbps, then 75% specified for this parameter allocates 99 Mbps for the downlink and 33 Mbps for the uplink. The default for this parameter is 50%. This parameter must be set in the range of 15% - 85%, otherwise the invalid input will not be accepted and the previously-entered valid setting is used.  **Note** In order to prevent self-interference, the frame configuration needs to align. This includes Downlink Data, Max Range and Contention slots.
Transmit Power	This value represents the combined power of the BHM’s two transmitters. Nations and regions may regulate transmit power. For example • PTP 450i Series modules are available as connectorized radios, which require the operator to adjust power to ensure regulatory compliance. The professional installer of the equipment has the responsibility to: • Maintain awareness of applicable regulations. • Calculate the permissible transmitter output power for the module. • Confirm that the initial power setting is compliant with national or regional regulations. Confirm that the power setting is compliant following any reset of the module to factory defaults.
External Gain	This value needs to correspond to the published gain of the antenna used to ensure the radio will meet regulatory requirements.
Receive Quality Debug	To aid in link performance monitoring, the BHM and BHS now report the number of fragments received per modulation (i.e. QPSK, 16-QAM, 64-QAM and 256-QAM) and per channel (polarization).

	Note Due to CPU load, this slightly degrades the packet during per second processing.
Frame Alignment Legacy Mode	See Table 48 PMP 450i AP Radio attributes - 5 GHz on page 1-156.

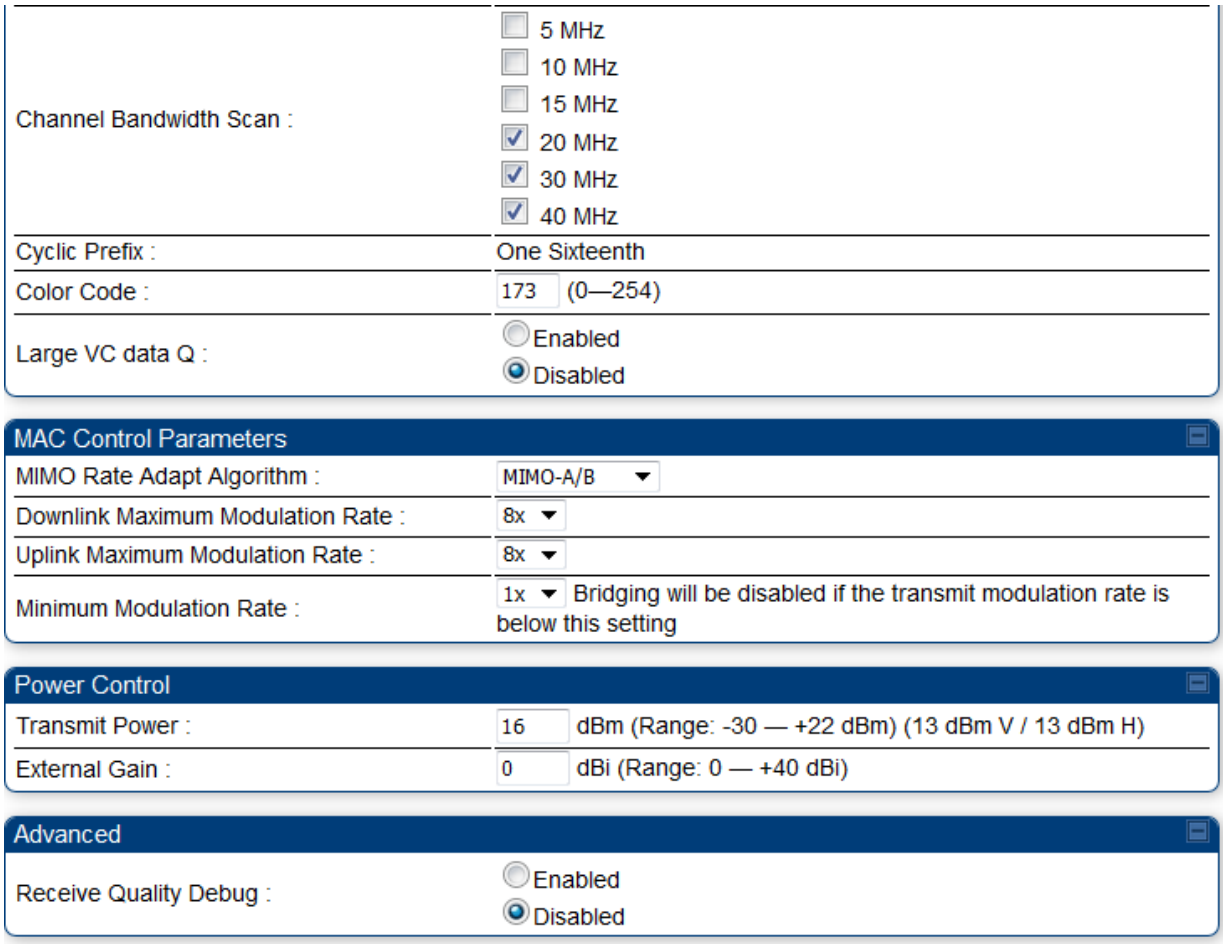
Radio page – PTP 450i BHS 5 GHz

The **Radio** page of PTP 450i BHS is explained in Table 52.

Table 52 PTP 450i BHS Radio attributes – 5 GHz




Custom Radio Frequency Scan Selection List :
5.4 GHz
5472.5 5475.0 5477.5 5480.0 5482.5 5485.0 5487.5
5490.0 5492.5 5495.0 5497.5 5500.0 5502.5 5505.0
5507.5 5510.0 5512.5 5515.0 5517.5 5520.0 5522.5
5525.0 5527.5 5530.0 5532.5 5535.0 5537.5 5540.0
5542.5 5545.0 5547.5 5550.0 5552.5 5555.0 5557.5
5560.0 5562.5 5565.0 5567.5 5570.0 5572.5 5575.0
5577.5 5580.0 5582.5 5585.0 5587.5 5590.0 5592.5
5595.0 5597.5 5600.0 5602.5 5605.0 5607.5 5610.0
5612.5 5615.0 5617.5 5620.0 5622.5 5625.0 5627.5
5630.0 5632.5 5635.0 5637.5 5640.0 5642.5 5645.0
5647.5 5650.0 5652.5 5655.0 5657.5 5660.0 5662.5
5665.0 5667.5 5670.0 5672.5 5675.0 5677.5 5680.0
5682.5 5685.0 5687.5 5690.0 5692.5 5695.0 5697.5
5700.0 5702.5 5705.0 5707.5 5710.0 5712.5 5715.0
5717.5 5720.0 5722.5
5.7 GHz
5727.5 5730.0 5732.5 5735.0 5737.5 5740.0 5742.5
5745.0 5747.5 5750.0 5752.5 5755.0 5757.5 5760.0
5762.5 5765.0 5767.5 5770.0 5772.5 5775.0 5777.5
5780.0 5782.5 5785.0 5787.5 5790.0 5792.5 5795.0
5797.5 5800.0 5802.5 5805.0 5807.5 5810.0 5812.5
5815.0 5817.5 5820.0 5822.5 5825.0 5827.5 5830.0
5832.5 5835.0 5837.5 5840.0 5842.5 5845.0 5847.5
5850.0 5852.5 5855.0 5857.5 5860.0 5862.5 5865.0
5867.5 5870.0 5872.5 5875.0 5877.5 5880.0 5882.5
5885.0 5887.5 5890.0 5892.5 5895.0 5897.5 5900.0
5902.5 5905.0 5907.5 5910.0 5912.5 5915.0 5917.5
5920.0 5922.5
5 MHz only
<= 10 MHz
<=15 MHz
<=20 MHz
<=30 MHz
Not available in this region
Select All
Select All 4.9
Select All 5.1
Select All 5.2
Select All 5.4
Select All 5.7
Clear All
Restore



Attribute	Meaning
Custom Radio Frequency Scan Selection List	Check any frequency that you want the BHS to scan for BHM transmissions. See Radio Frequency Scan Selection List on page 1-200.
Channel Bandwidth Scan	The channel size used by the radio for RF transmission. **Note** Selecting multiple channel bandwidths will increase registration and re-registration times.
Cyclic Prefix Scan	The cyclic prefix for which BHM scanning is executed.
Color Code	Color code allows to force the BHS to register to only a specific BHM, even where the BHS can communicate with multiple BHMs. For registration to occur, the color code of the BHS and the BHM *must* match. Specify a value from 0 to 254. The color codes can be disabled, with the exception of the first color code.

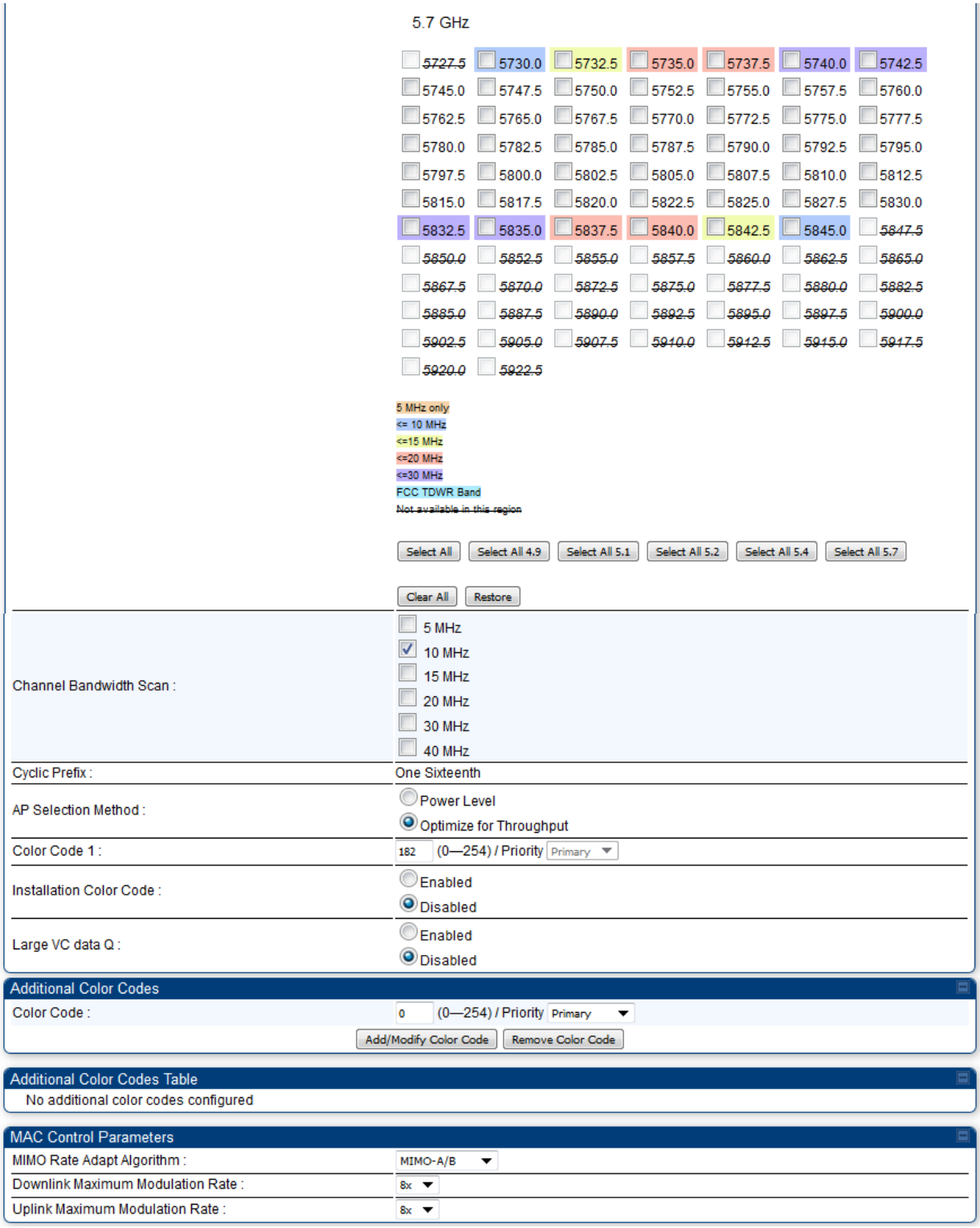
Large VC data Q	BHM and BHS have a configurable option used to prevent packet loss in the uplink due to bursting IP traffic. This is designed for IP burst traffic particular to video surveillance applications.
MIMO Rate Adapt Algorithm	This pull-down menu helps in configuring the Rate Adapt Algorithm to MIMO-A/B, MIMO-B only, or MIMO-A only.
Downlink Maximum Modulation Rate	This pull-down menu helps in configuring the Downlink Maximum Modulation Rate at a configurable rate of 1X, 2X, 3X, 4X, 6X, or 8X. The default value is “8X”. The Rate Adapt Algorithm does not allow the modulation to go beyond this limit.
Uplink Maximum Modulation Rate	This pull-down menu helps in configuring the Uplink Maximum Modulation Rate at a configurable rate of 1X, 2X, 3X, 4X, 6X, or 8X. The default value is “8X”. The Rate Adapt Algorithm does not allow the modulation to go beyond this limit.
Minimum Modulation Rate	This pull-down menu helps in configuring the Minimum Modulation Rate at a configurable rate of 1X, 2X, 3X, 4X, 6X, or 8X. The default value is “1X”. If the Rate Adapt Algorithm is below this limit, then bridging is disabled. This is used if PTP network can route the traffic through another path.
Transmit Power	Refer Table 51 PTP 450i BHM Radio page attributes – 5 GHz on page 1-173
External Gain	
Receive Quality Debug	

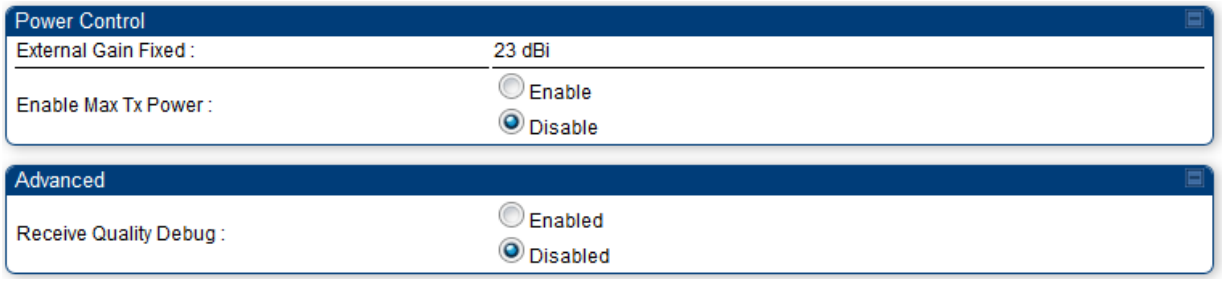
PMP/PTP 450b Series - configuring radio

Radio page – PMP/PTP 450b Mid-Gain/High Gain SM 5 GHz

The Radio page of PMP/PTP 450b Mid-Gain/High Gain SM is explained in Table 53.

Table 53 PMP/PTP 450b Mid-Gain/High Gain SM Radio attributes – 5 GHz


5.7 GHz
5727.5 5730.0 5732.5 5735.0 5737.5 5740.0 5742.5
5745.0 5747.5 5750.0 5752.5 5755.0 5757.5 5760.0
5762.5 5765.0 5767.5 5770.0 5772.5 5775.0 5777.5
5780.0 5782.5 5785.0 5787.5 5790.0 5792.5 5795.0
5797.5 5800.0 5802.5 5805.0 5807.5 5810.0 5812.5
5815.0 5817.5 5820.0 5822.5 5825.0 5827.5 5830.0
5832.5 5835.0 5837.5 5840.0 5842.5 5845.0 5847.5
5850.0 5852.5 5855.0 5857.5 5860.0 5862.5 5865.0
5867.5 5870.0 5872.5 5875.0 5877.5 5880.0 5882.5
5885.0 5887.5 5890.0 5892.5 5895.0 5897.5 5900.0
5902.5 5905.0 5907.5 5910.0 5912.5 5915.0 5917.5
5920.0 5922.5
5 MHz only
<= 10 MHz
<=15 MHz
<=20 MHz
<=30 MHz
FCC TDWR Band
Not available in this region
Select All
Select All 4.9
Select All 5.1
Select All 5.2
Select All 5.4
Select All 5.7
Clear All
Restore
Channel Bandwidth Scan :
5 MHz
10 MHz
15 MHz
20 MHz
30 MHz
40 MHz
Cyclic Prefix :
One Sixteenth
AP Selection Method :
Power Level
Optimize for Throughput
Color Code 1 :
182
(0—254) / Priority
Primary
Installation Color Code :
Enabled
Disabled
Large VC data Q :
Enabled
Disabled
Additional Color Codes
Color Code :
0
(0—254) / Priority
Primary
Add/Modify Color Code
Remove Color Code
Additional Color Codes Table
No additional color codes configured
MAC Control Parameters
MIMO Rate Adapt Algorithm :
MIMO-A/B
Downlink Maximum Modulation Rate :
8x
Uplink Maximum Modulation Rate :
8x



Attribute	Meaning
Custom Radio Frequency Scan Selection List	Check the frequencies that SM has to scan for AP transmissions. See Radio Frequency Scan Selection List on page 1-200.
Channel Bandwidth Scan	The channel size used by the radio for RF transmission. **Note** Selecting multiple channel bandwidths will increase registration and re-registration times.
Cyclic Prefix Scan	The cyclic prefix for which AP scanning is executed.
AP Selection Method	Operators may configure the method by which a scanning SM selects an AP. By default, AP Selection Method is set to “Optimize for Throughput”, which has been the mode of operation in releases prior to 12.0.3.1. **Power Level**: AP selection based solely on power level **Note** For operation with a PMP 450m AP, select the Power Level option *or* **Optimize for Throughput**: AP selection based on throughput optimization – the selection decision is based on power level (which affects the modulation state), channel bandwidth (which affects throughput) and number of SM registrations to the AP (which affects system contention performance).
Color Code 1	Color code allows you to force the SM to register to only a specific AP, even where the SM can communicate with multiple APs. For registration to occur, the color code of the SM and the AP *must* match. Specify a value from 0 to 254. Color code is not a security feature. Instead, color code is a management feature, typically for assigning each sector a different color code. The default setting for the color code value is 0. This value matches only the color code of 0 (*not* all 255 color codes).

	SMs may be configured with up to 20 color codes. These color codes can be tagged as **Primary**, **Secondary**, or **Tertiary**, or **Disable**. When the SM is scanning for APs, it will first attempt to register to an AP that matches one of the SM's primary color codes. Failing that, the SM will continue scanning and attempt to register to an AP that matches one of the SM's secondary color codes. Failing that, the SM will continue scanning and attempt to register to an AP that matches one of the SM's tertiary color codes. This is all done in the scanning mode of the SM and will repeat until a registration has occurred. Color codes in the same priority group are treated equally. For example, all APs matching one of the SM's primary color codes are analyzed equally. Likewise, this evaluation is done for the secondary and tertiary groups in order. The analysis for selecting an AP within a priority group is based on various inputs, including signal strength and number of SMs already registered to each AP. The first color code in the configuration is the pre-Release 9.5 color code. Thus, it is always a primary color code for legacy reasons. The color codes can be disabled, with the exception of the first color code.
Installation Color Code	With this feature enabled on the AP and SM, operators may install and remotely configure SMs without having to configure matching color codes between the modules. When using the Installation Color Code feature, ensure that the SM is configured with the factory default Color Code configuration (Color Code 1 is "0", Color Code 2-10 set to "0" and "Disable"). The status of the Installation Color Code can be viewed on the AP Eval web GUI page, and when the SM is registered using the Installation Color Code the message "SM is registered via ICC – Bridging Disabled!" is displayed in red on every SM GUI page. The Installation Color Code parameter is configurable without a radio reboot for both the AP and SM.
Large VC data Queue	SM and BH have a configurable option used to prevent packet loss in the uplink due to bursting IP traffic. This is designed for IP burst traffic particular to video surveillance applications.
MIMO Rate Adapt Algorithm	This pull-down menu helps in configuring the Rate Adapt Algorithm to MIMO-A/B, MIMO-B only, or MIMO-A only.
Downlink Maximum Modulation Rate	This pull-down menu helps in configuring the Downlink Maximum Modulation Rate at a configurable rate of 1X, 2X, 3X, 4X, 6X, or 8X. The default value is "8X".
Uplink Maximum Modulation Rate	This pull-down menu helps in configuring the Uplink Maximum Modulation Rate at a configurable rate of 1X, 2X, 3X, 4X, 6X, or 8X. The default value is "8X".
External Gain Fixed	This value represents the fixed antenna gain. The fixed antenna gain for Mid-Gain is 16 dBi and High Gain is 23 dBi. For ODUs with integrated antenna, this is set at the correct value in the factory.

	For Connectorized ODUs with external antenna, the user must set this value to the overall antenna gain, including any RF cable loss between the ODU and the antenna.
Enable Max Tx Power	This field allows to enable or disable maximum transmission power.
Receive Quality Debug	To aid in link performance monitoring, the AP and SM now report the number of fragments received per modulation (i.e. QPSK, 16-QAM, 64-QAM) and per channel (polarization).

Note

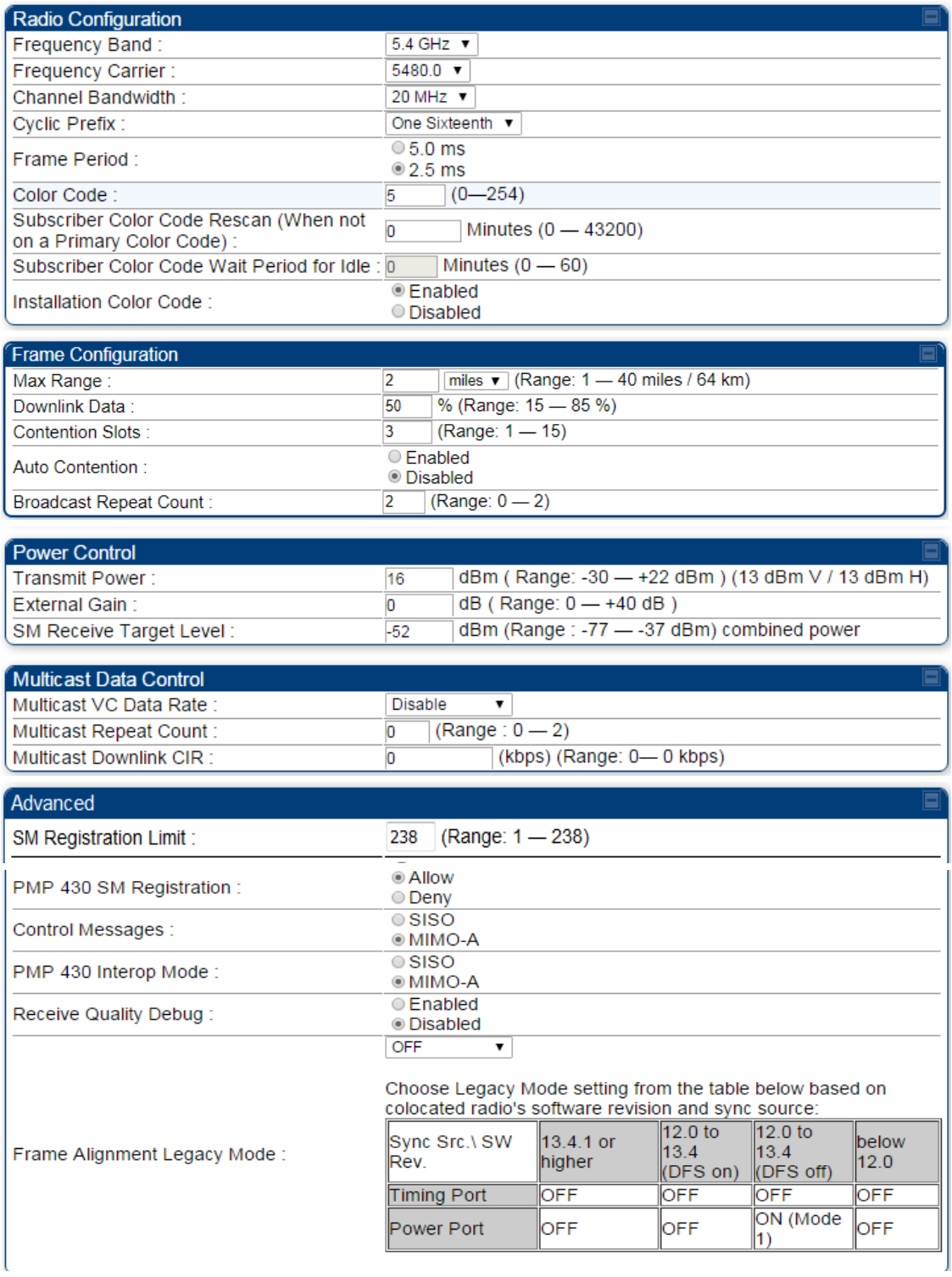
The frequencies that a user can select are controlled by the coun
Channel Bandwidth selected. There can be a case where a user a
(from the Custom Frequencies page on page 1-204) and cannot s
menu.

PMP/PTP 450 Series – configuring radio

Radio page - PMP 450 AP 5 GHz

The Radio tab of the AP for 5 GHz is as shown in Table 54.

Table 54 PMP 450 AP Radio attributes - 5 GHz



Radio Configuration

Frequency Band :	5.4 GHz
Frequency Carrier :	5480.0
Channel Bandwidth :	20 MHz
Cyclic Prefix :	One Sixteenth
Frame Period :	5.0 ms 2.5 ms
Color Code :	5 (0—254)
Subscriber Color Code Rescan (When not on a Primary Color Code) :	0 Minutes (0 — 43200)
Subscriber Color Code Wait Period for Idle :	0 Minutes (0 — 60)
Installation Color Code :	Enabled Disabled

Frame Configuration

Max Range :	2 miles (Range: 1 — 40 miles / 64 km)
Downlink Data :	50 % (Range: 15 — 85 %)
Contention Slots :	3 (Range: 1 — 15)
Auto Contention :	Enabled Disabled
Broadcast Repeat Count :	2 (Range: 0 — 2)

Power Control

Transmit Power :	16 dBm (Range: -30 — +22 dBm) (13 dBm V / 13 dBm H)
External Gain :	0 dB (Range: 0 — +40 dB)
SM Receive Target Level :	-52 dBm (Range : -77 — -37 dBm) combined power

Multicast Data Control

Multicast VC Data Rate :	Disable
Multicast Repeat Count :	0 (Range : 0 — 2)
Multicast Downlink CIR :	0 (kbps) (Range: 0— 0 kbps)

Advanced

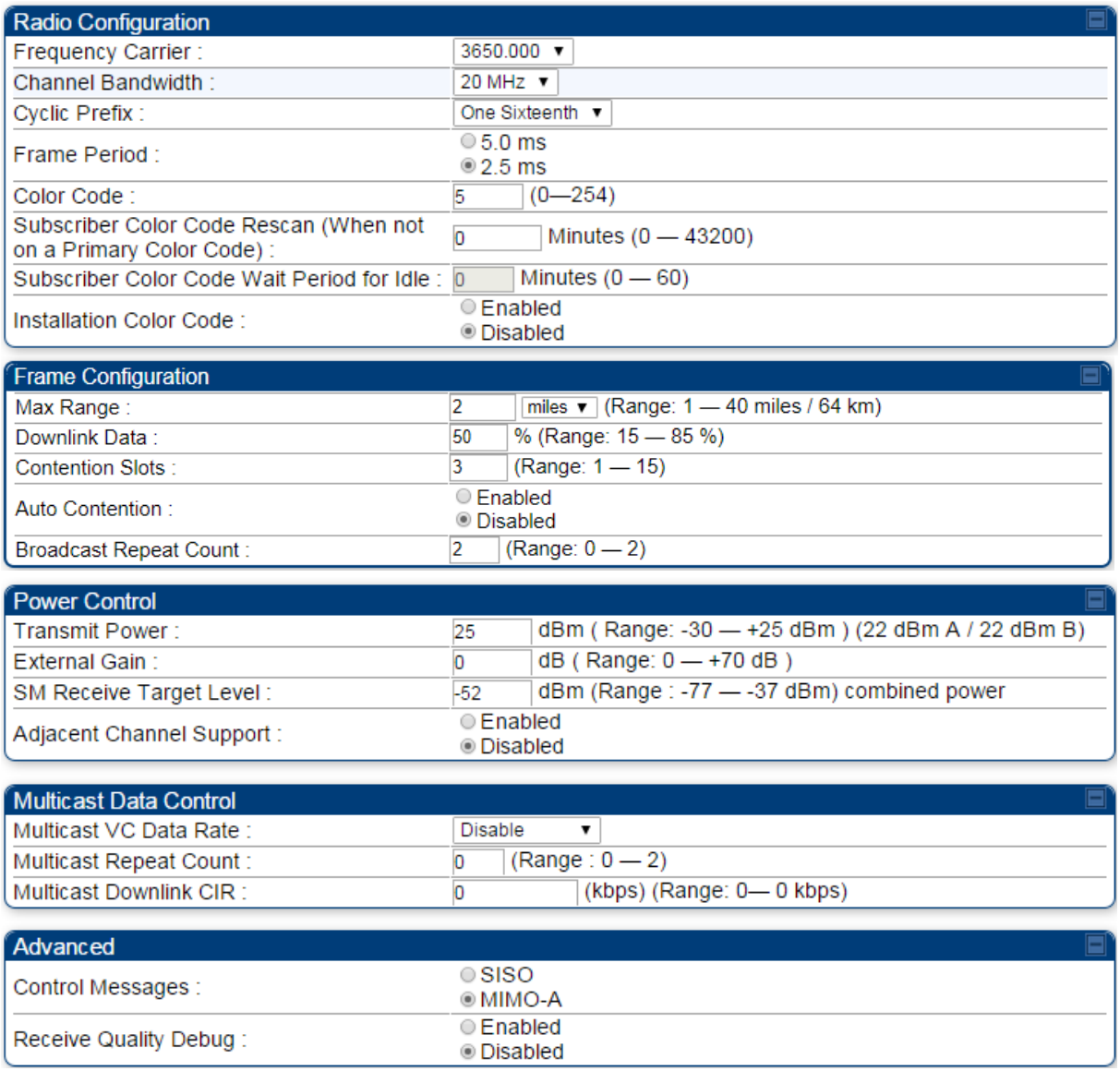
SM Registration Limit :	238 (Range: 1 — 238)
PMP 430 SM Registration :	Allow Deny
Control Messages :	SISO MIMO-A
PMP 430 Interop Mode :	SISO MIMO-A
Receive Quality Debug :	Enabled Disabled
Frame Alignment Legacy Mode :	OFF Choose Legacy Mode setting from the table below based on colocated radio's software revision and sync source:

Sync Src.\ SW Rev.	13.4.1 or higher	12.0 to 13.4 (DFS on)	12.0 to 13.4 (DFS off)	below 12.0
Timing Port	OFF	OFF	OFF	OFF
Power Port	OFF	OFF	ON (Mode 1)	OFF

Attribute	Meaning
Radio Configuration, Frame Configuration, Power Control, Multicast Data Control and Advance tab	See Table 48 PMP 450i AP Radio attributes - 5 GHz on page 1-156.
SM Registration Limit	
PMP 430 SM Registration	
PMP 450/430 Legacy Mode	
Control Messages	See Table 48 PMP 450i AP Radio attributes - 5 GHz on page 1-156.
PMP 430 Interop Mode	
Receive Quality Debug	
Frame Alignment Legacy Mode	

Radio page - PMP 450 AP 3.65 GHz

Table 55 PMP 450 AP Radio attributes - 3.65 GHz



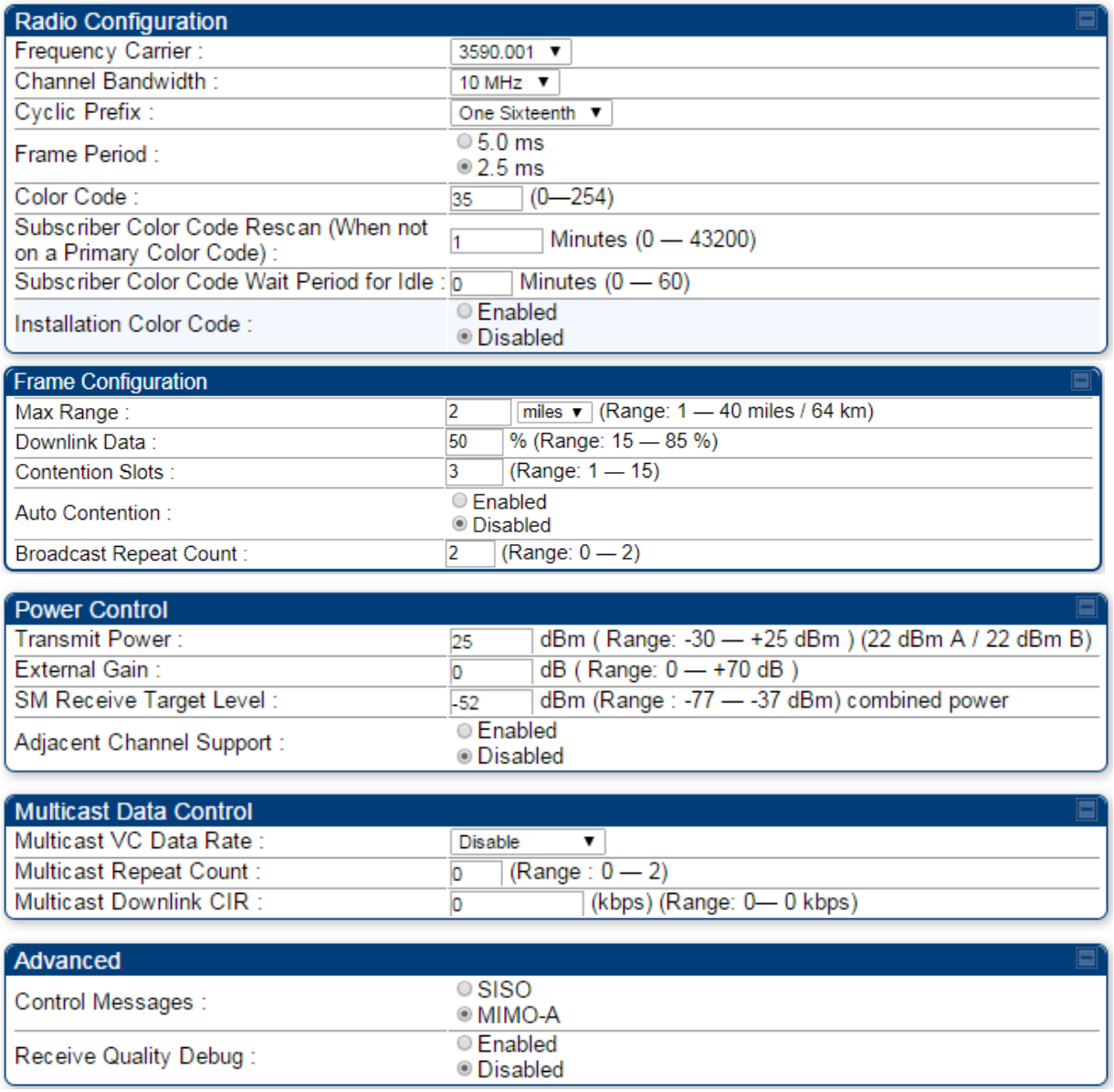
Attribute	Meaning
Radio Configuration, Frame Configuration, Power Control, Multicast Data Control and Advance tab	See Table 48 PMP 450i AP Radio attributes - 5 **GHz** on page 1-156.

Note

When the Channel bandwidth is updated from 20 MHz to 30 MHz not more than 59 subscribers can be registered.

Radio page - PMP 450 AP 3.5 GHz

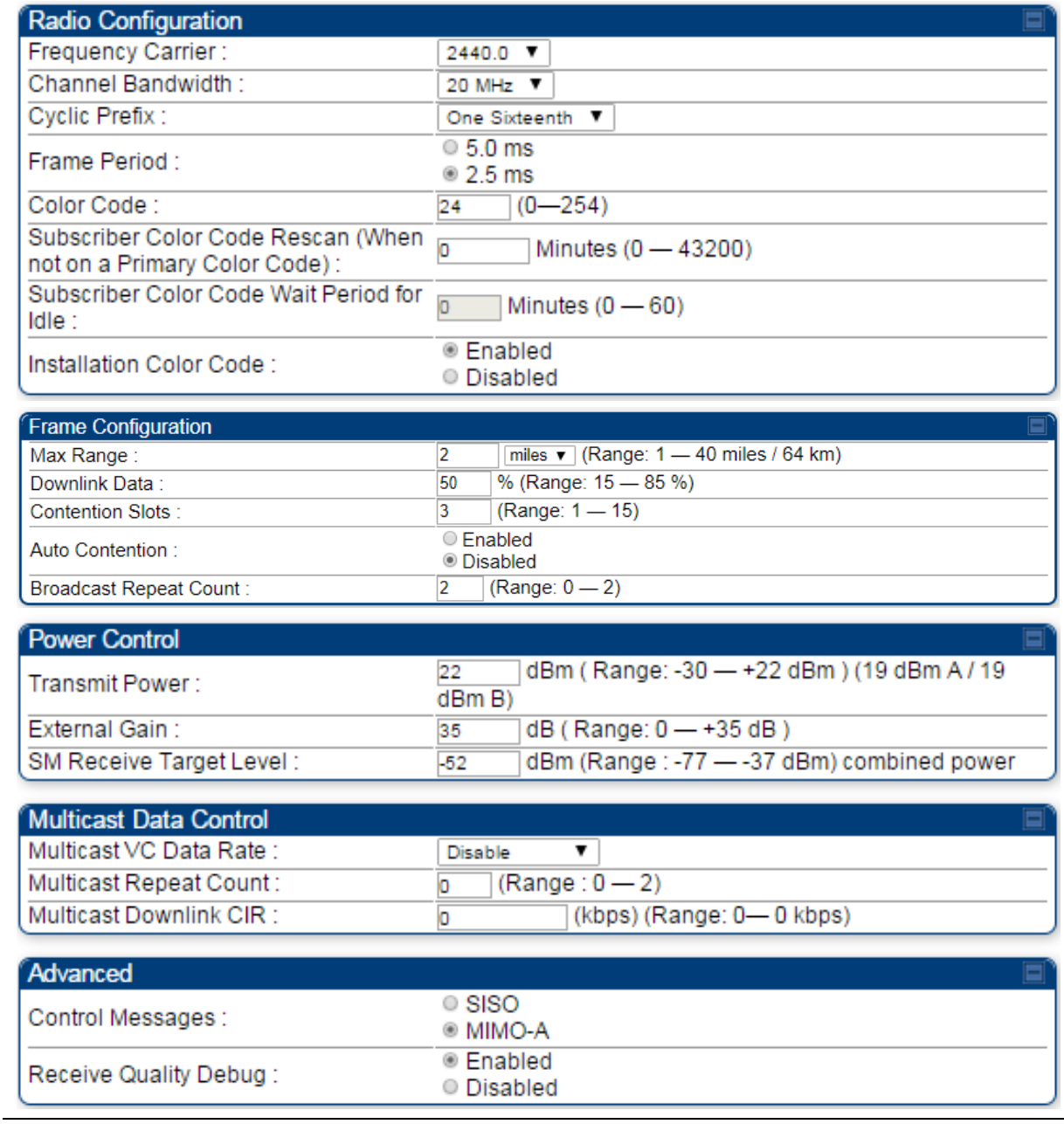
Table 56 PMP 450 AP Radio attributes - 3.5 GHz



Attribute	Meaning
Radio Configuration, Frame Configuration, Power Control, Multicast Data Control and Advance tab	See Table 48 PMP 450i AP Radio attributes - 5 GHz on page 1-156.

Radio page - PMP 450 AP 2.4 GHz

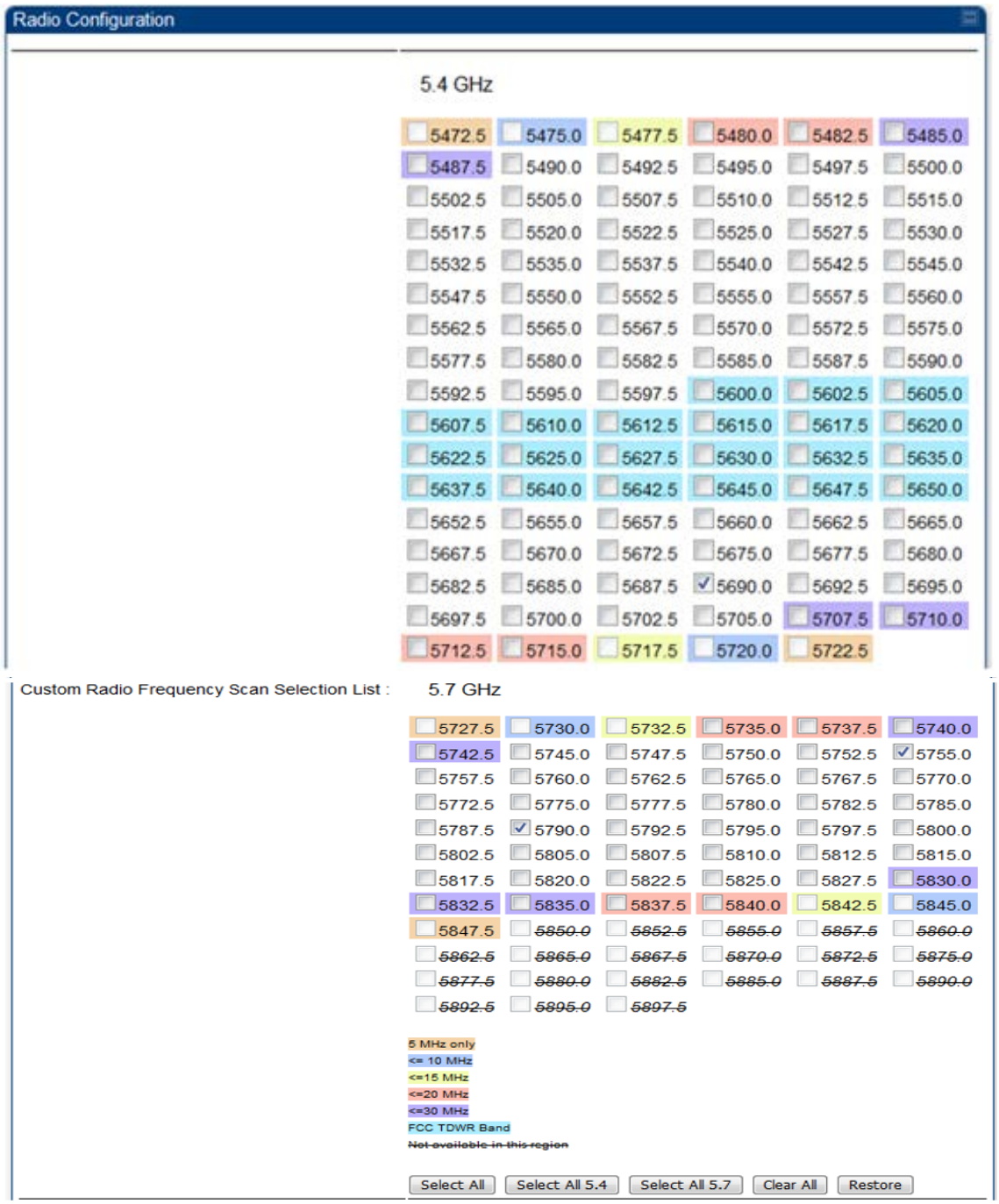
Table 57 PMP 450 AP Radio attributes - 2.4 GHz

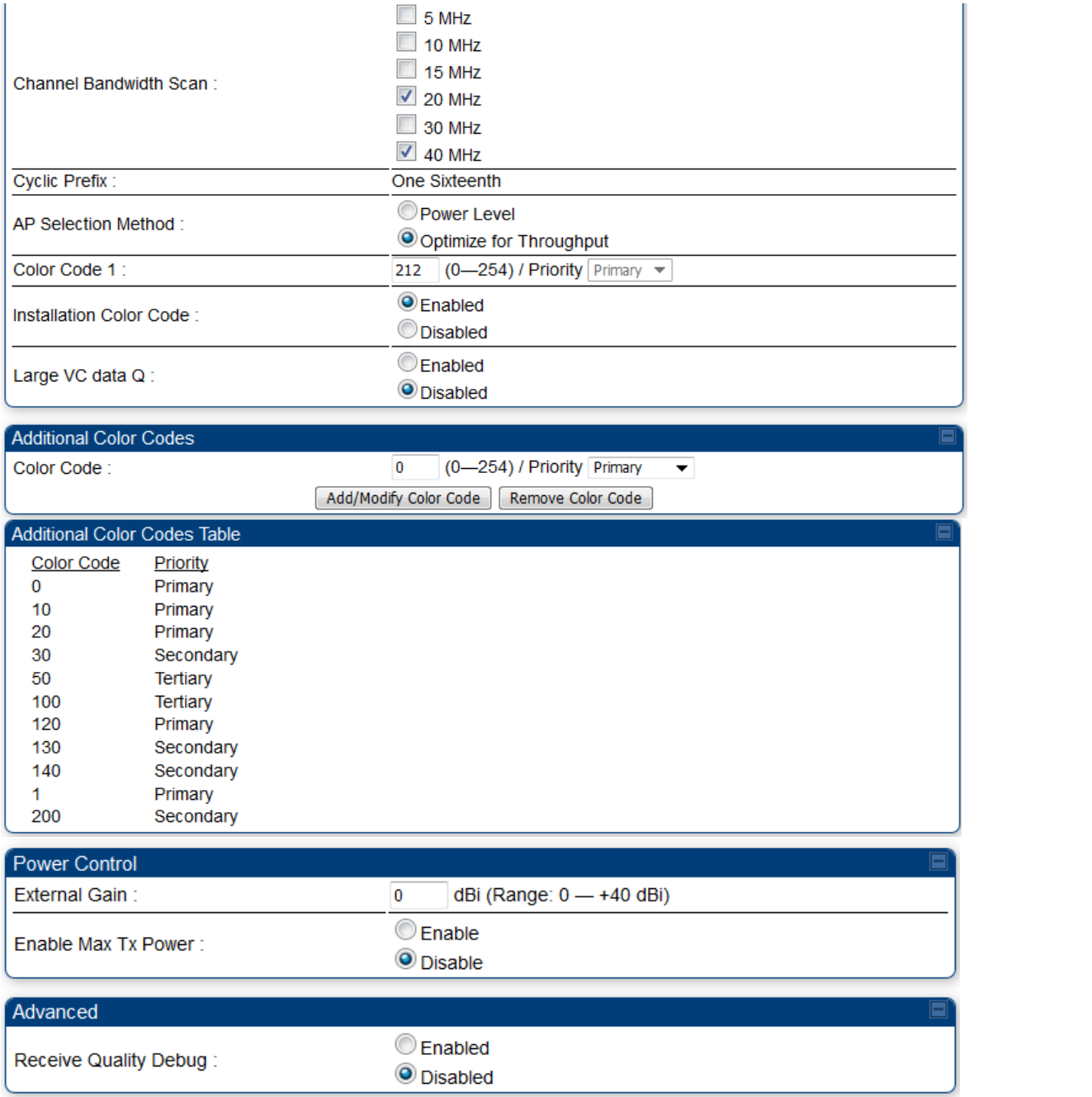


Attribute	Meaning
Radio Configuration, Frame Configuration, Power Control, Multicast Data Control and Advance tab	See Table 48 PMP 450i AP Radio attributes - 5 GHz on page 1-156.

Radio page - PMP 450 SM 5 GHz

Table 58 PMP 450 SM Radio attributes – 5 GHz



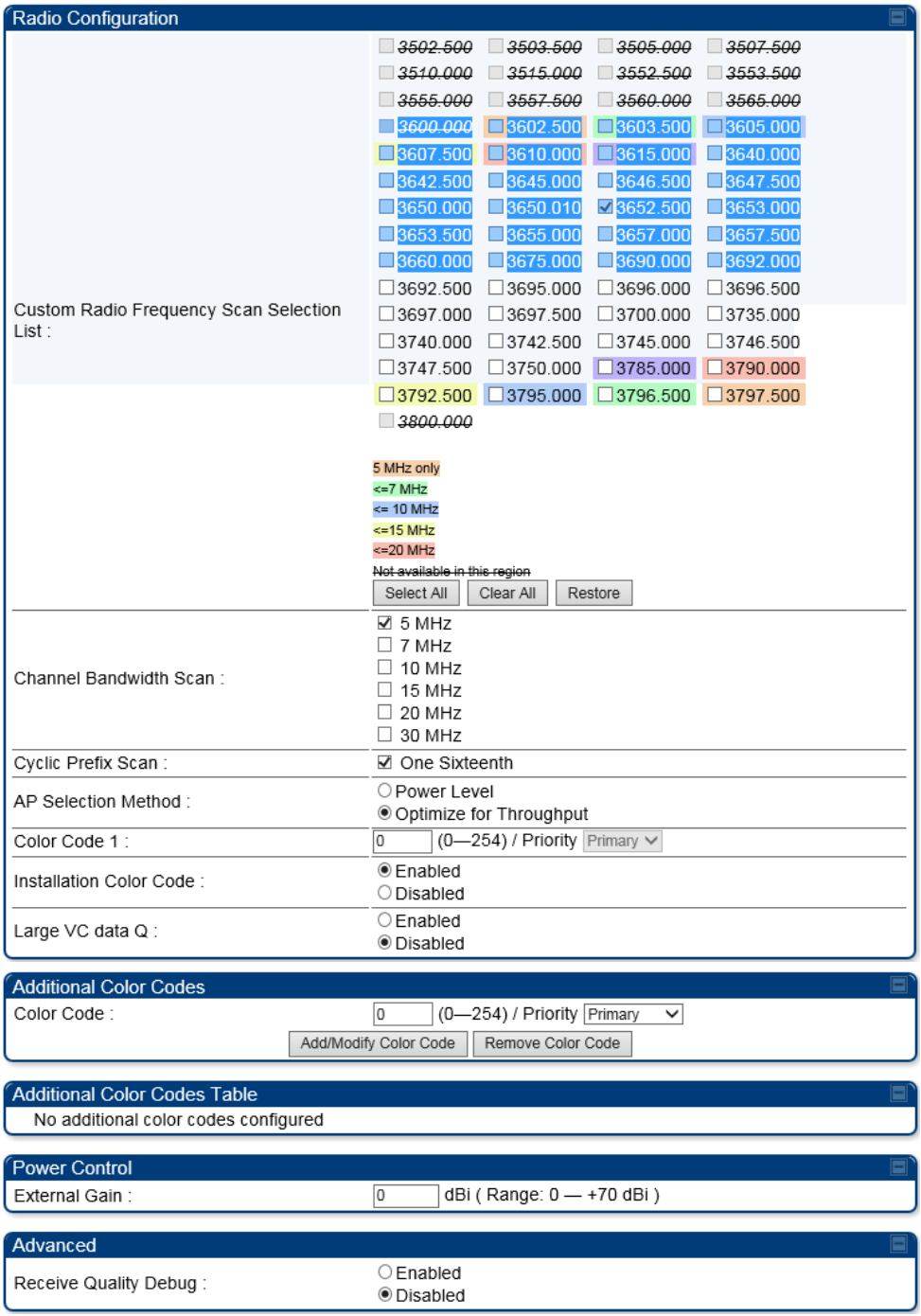


Attribute	Meaning
Custom Radio Frequency Scan Selection List	Check the frequencies that SM has to scan for AP transmissions. See Radio Frequency Scan Selection List on page 1-200.

See Table 48 PMP 450i AP Radio attributes - 5 GHz on page 1-156.

Radio page - PMP 450 SM 3.65 GHz

Table 59 PMP 450 SM Radio attributes – 3.65 GHz

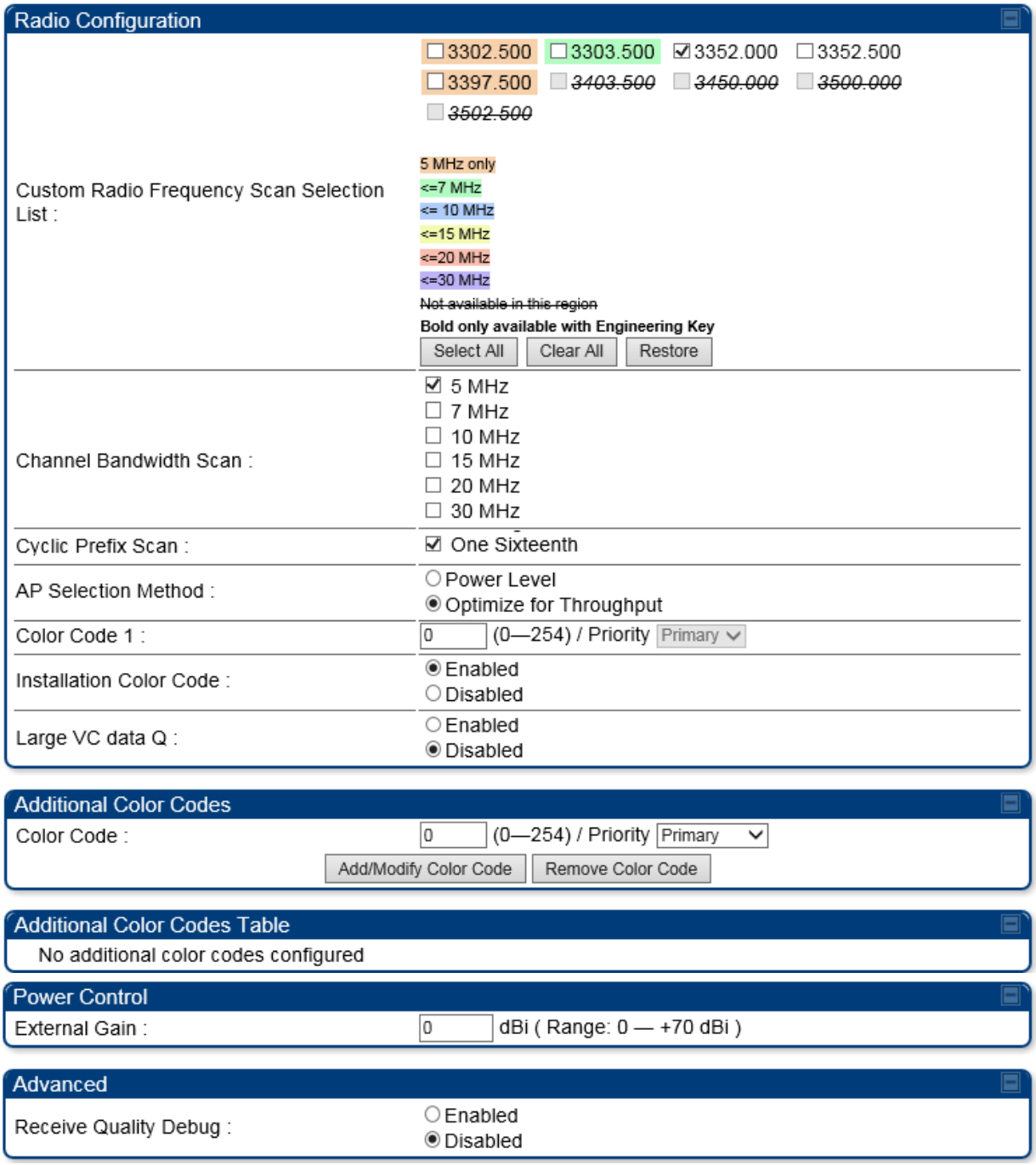


Attribute	Meaning
Custom Radio Frequency Scan Selection List	Check the frequencies that SM has to scan for AP transmissions. See Radio Frequency Scan Selection List on page 1-200.

See Table 48 PMP 450i AP Radio attributes - 5 GHz on page 1-156.

Radio page - PMP 450 SM 3.5 GHz

Table 60 PMP 450 SM Radio attributes – 3.5 GHz

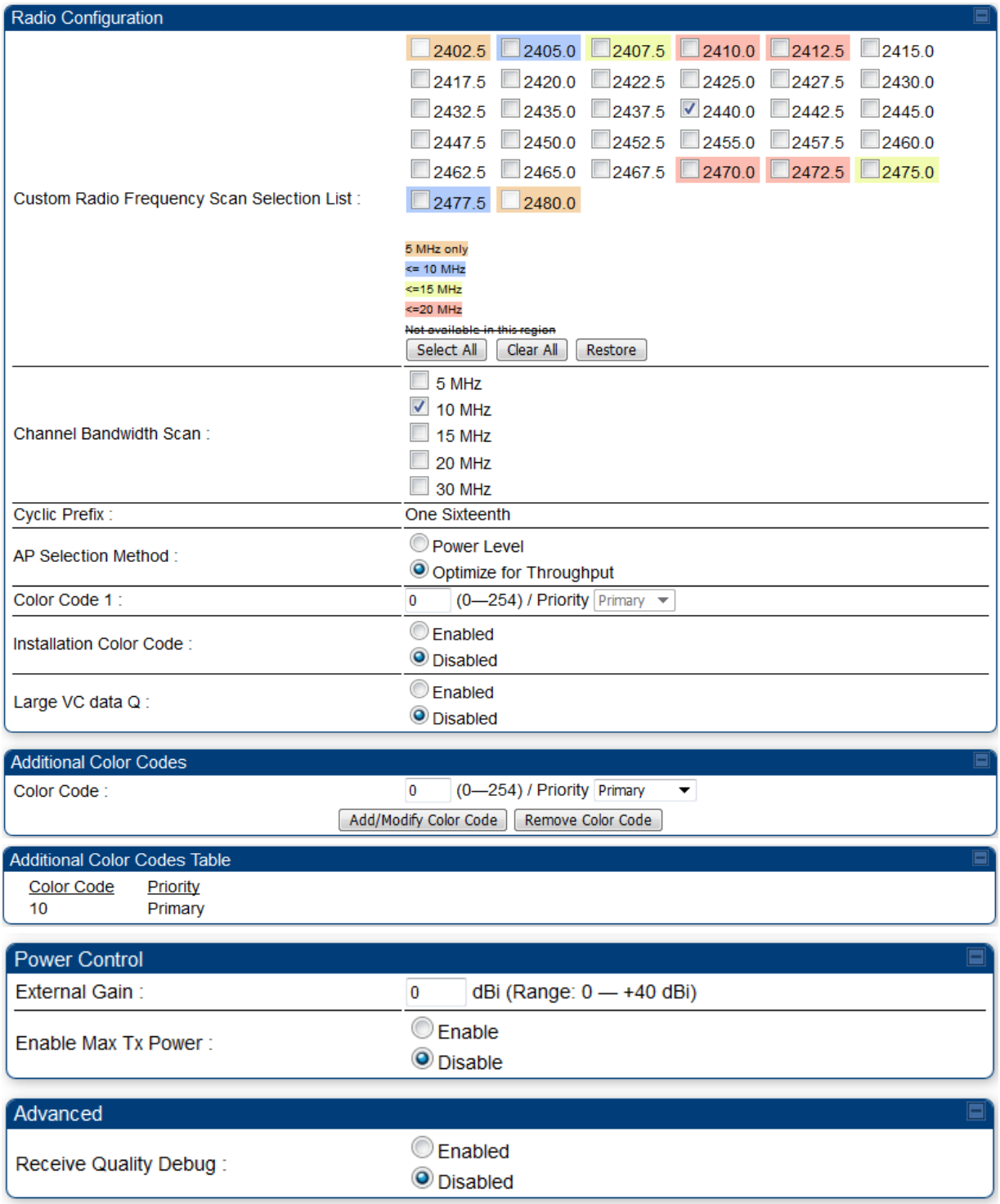


Attribute	Meaning
Custom Radio Frequency Scan Selection List	Check the frequencies that SM has to scan for AP transmissions. See Radio Frequency Scan Selection List on page 1-200.

See Table 48 PMP 450i AP Radio attributes - 5 GHz on page 1-156.

Radio page - PMP 450 SM 2.4 GHz

Table 61 PMP 450 SM Radio attributes – 2.4 GHz



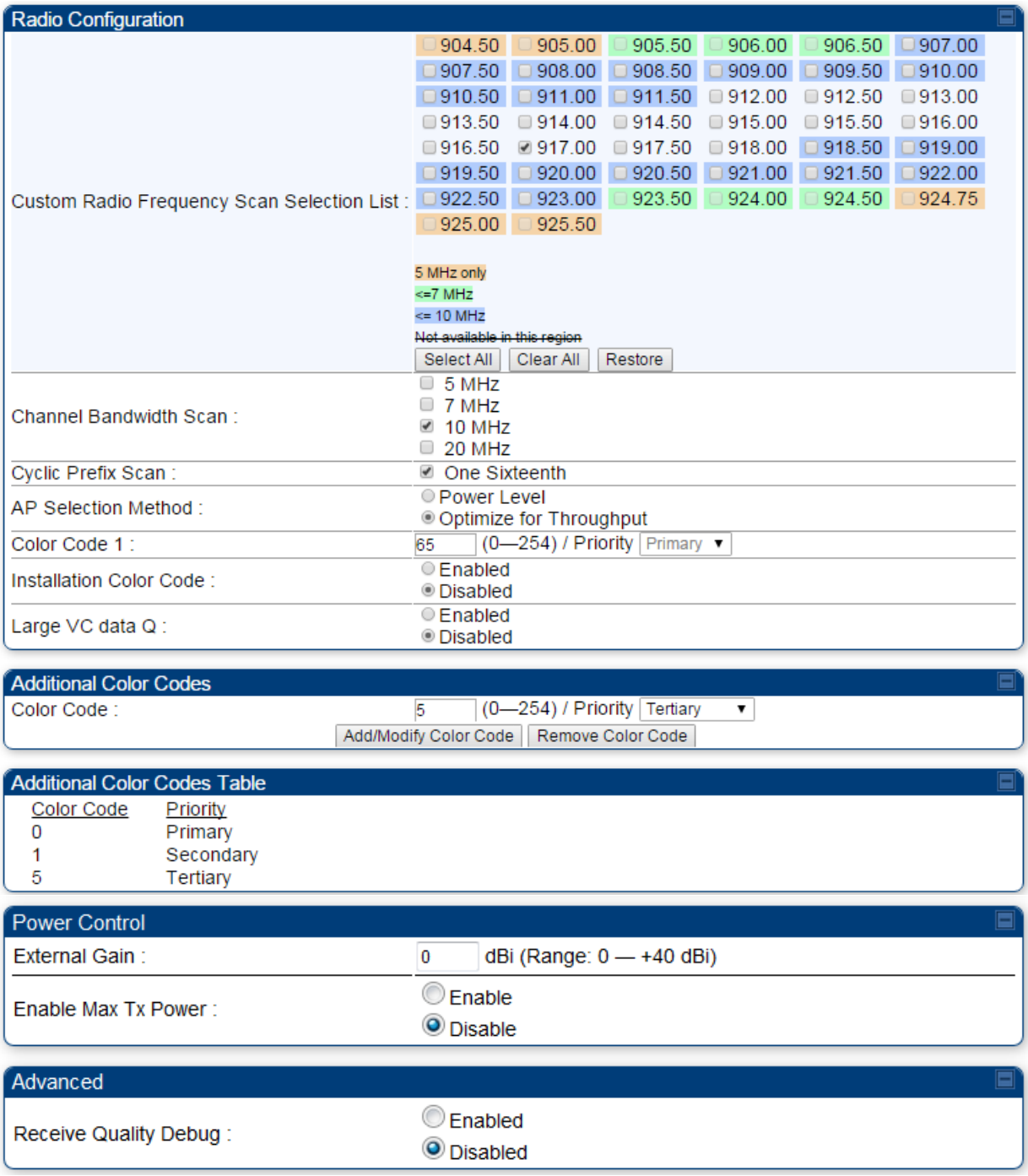
Attribute	Meaning
Custom Radio Frequency Scan Selection List	Check the frequencies that SM has to scan for AP transmissions. See Radio Frequency Scan Selection List on page 1-200.

See Table 48 PMP 450i AP Radio attributes - 5 GHz on page 1-156.

Attribute	Meaning
Custom Radio Frequency Scan Selection List	Check the frequencies that SM has to scan for AP transmissions. See Radio Frequency Scan Selection List on page 1-200.

Radio page - PMP 450 SM 900 MHz

Table 62 PMP 450 SM Radio attributes –900 MHz



Attribute	Meaning
Custom Radio Frequency Scan Selection List	See Table 48 PMP 450i AP Radio attributes - 5 GHz on page 1-156.

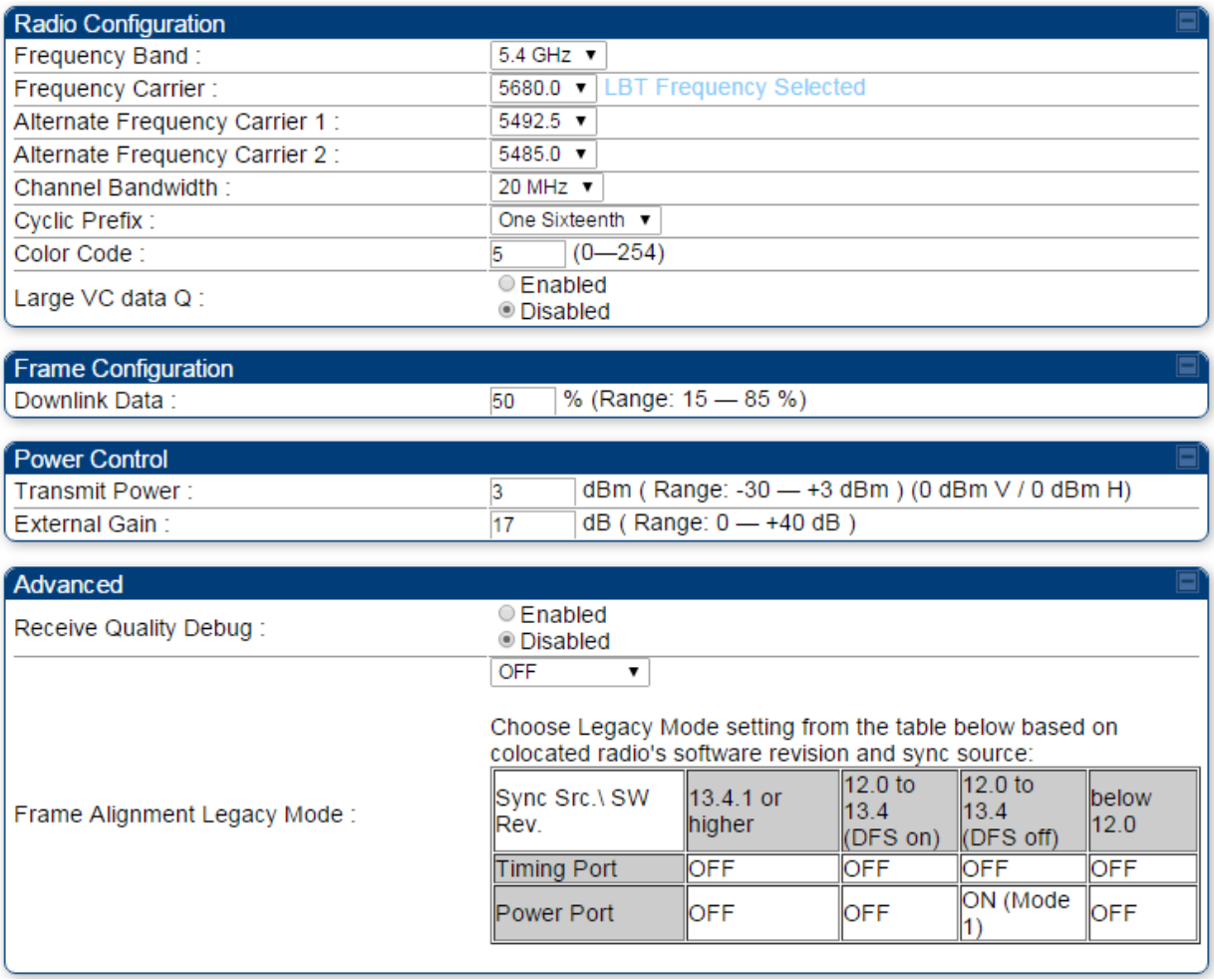
Channel Bandwidth Scan	See Table 48 PMP 450i AP Radio attributes - 5 GHz on page 1-156.
Cyclic Prefix Scan	
AP Selection Method	
Color Code 1	
Installation Color Code	
Large VC data Queue	
Color Code	
External Gain	See Table 48 PMP 450i AP Radio attributes - 5 GHz on page 1-156
Enable Max Tx Power	See Table 48 PMP 450i AP Radio attributes - 5 GHz on page 1-156
Receive Quality Debug	See Table 48 PMP 450i AP Radio attributes - 5 GHz on page 1-156.

Note

The frequencies that a user can select are controlled by the country or a region and the Channel Bandwidth selected. There can be a case where a user adds a custom frequency (from the Custom Frequencies page on page 1-204) and cannot see it in the pull down menu.

Radio page - PTP 450 BHM 5 GHz

Table 63 PTP 450 BHM Radio attributes –5 GHz

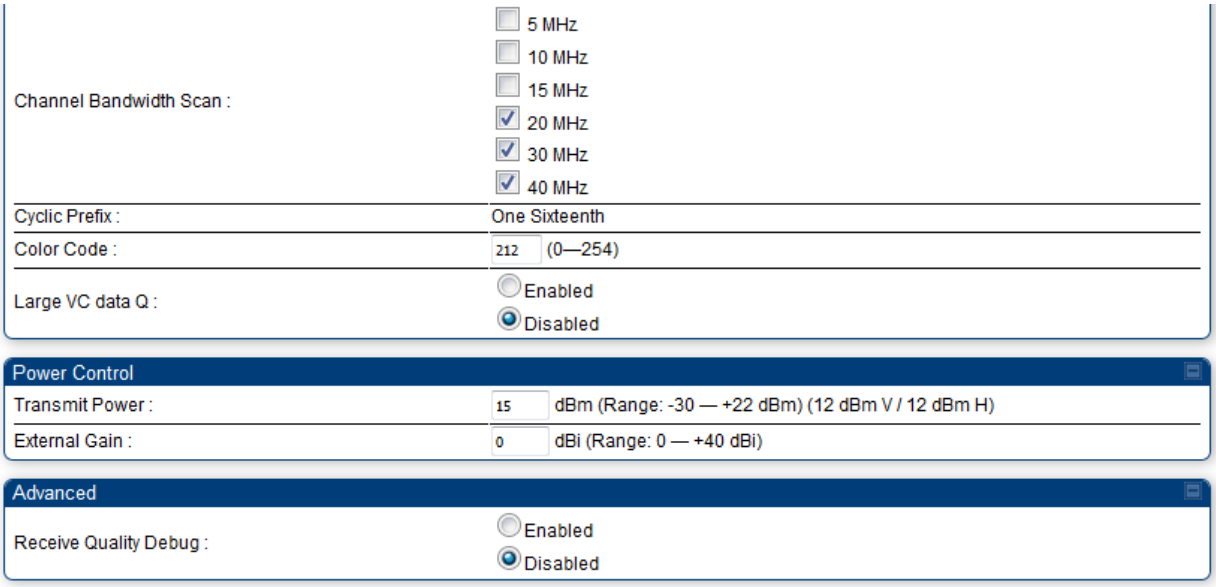


Attribute	Meaning

Refer Table 51 PTP 450i BHM Radio page attributes – 5 GHz on page 1-173 for all parameters details.

Radio page - PTP 450 BHS 5 GHz

Table 64 PTP 450 BHM Radio attributes –5 GHz



Attribute	Meaning
Refer Table 52 PTP 450i BHS Radio attributes – 5 GHz on page 1-176 for all parameters details.	

Radio Frequency Scan Selection List

The SM or BHS scans complete spectrum as per Full Spectrum Band Scan feature. SMs or BHS first boot into the smallest selected channel bandwidth (10 MHz, if selected) and scan all selected frequencies across both the 5.4 GHz and 5.7 GHz frequency bands.

After this scan, if a wider channel bandwidth is selected (20 MHz), the SM/BHS automatically changes to 20 MHz channel bandwidth and then scans for APs/BHSs. After the SM/BHS finishes this final scan it will evaluate the best AP/BHM with which to register. If required for registration, the SM/BHS changes its channel bandwidth back to 10 MHz to match the best AP/BHM.

The SM/BHS will attempt to connect to an AP/BHM based on power level (which affects the modulation state), channel bandwidth (which affects throughput) and number of SM/BHS registrations to the AP/BHM (which affects system contention performance).

If it is desired to prioritize a certain AP/BHM over other available APs/BHMs, operators may use the Color Code Priority feature on the SM/BHS. Utilization of the Color Code feature on the AP/BHM is recommended to further constrain the AP selection.

If the SM does not find any suitable APs/BHMs for registration after scanning all channel bandwidths, the SM restarts the scanning process beginning with the smallest configured channel bandwidth.

Selecting multiple frequencies and multiple channel bandwidths impacts the SM/BHS scanning time. The biggest consumption of time is in the changing of the SM/BHS channel bandwidth setting.

The worst case scanning time is approximately two minutes after boot up (SM/BHS with all frequencies and channel bandwidths selected and registering to an AP/BHM at 10 MHz). If only one channel bandwidth is selected the time to scan all the available frequencies and register to an AP/BHM is approximately one minute after boot up.

Other scanning features such as Color Code, Installation Color Code, and RADIUS authentication are unaffected by the Full Band Scan feature.

Dedicated Multicast Virtual Circuit (VC)

A Multicast VC allows to configure multicast packets to be transmitted over a dedicated channel at a configurable rate of 1X, 2X, 4X or 8X. This feature is available only for the PMP 450 and PMP 450i and is not backward compatible with PMP 430 series of radios.

To configure Multicast VC, the AP must have this enabled. This can be enabled in the "Multicast Data Control" section (under **Configuration > Radio** page). The default value is "Disable". If set to the *default* value, all multicast packets are transmitted over the Broadcast VC data path. To enable, select the data rate that is desired for the Multicast VC Data Rate parameter and click **Save Changes** button. The radio requires no reboot after any changes to this parameter.

The multicast VC allows three different parameters to be configured on the AP. These can be changed on the fly and are saved on the flash memory.

Note

If the Multicast VC Data Rate is set to a modulation that the radio is not currently capable of or operates in non-permitted channel conditions, multicast data is sent but not received.

Ex: If Multicast VC Data Rate is set to 6x and the channel conditions only permit 4x mode of operation, then multicast data is sent at 6x modulation but the SM will not receive the data.

Note

The PMP 450 AP supports up to 119 VCs (instead of 238 VCs) when configured for 30 MHz channel bandwidth or 5 ms Frame Period. This limitation is not applicable for PMP 450i/450m Series.

Note

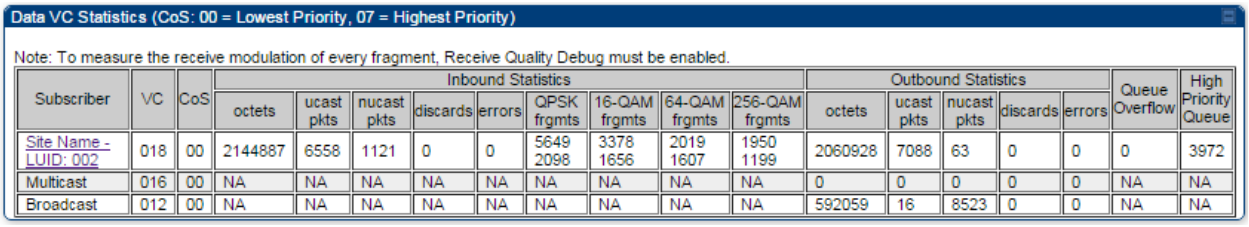
- Actual Multicast CIR honored by the AP = Configured Multicast CIR/ (Multicast Repeat Count + 1).
- Increasing the Multicast data rate has no impact on the Unicast data rate.
- For multicast and unicast traffic mix scenario examples, see Table 65.

Table 65 Example for mix of multicast and unicast traffic scenarios

Repeat Count	Multicast Data Rate (Mbps)	Unicast Data Rate (Mbps)	Aggregate DL Data Rate (Mbps)
0	10	40	50
1	5	40	45
2	3.33	40	43.33

The statistics have been added to the **Data VC** page (under **Statistics > Data VC**). The table displays the multicast row on the PMP 450 Platform Family AP. The SM displays the multicast row if it is a PMP 450 Platform Family.

Figure 26 Multicast VC statistics



Data VC Statistics (CoS: 00 = Lowest Priority, 07 = Highest Priority)

Note: To measure the receive modulation of every fragment, Receive Quality Debug must be enabled.

Subscriber	VC	CoS	Inbound Statistics									Outbound Statistics					Queue Overflow	High Priority Queue
			octets	ucast pkts	nucast pkts	discards	errors	QPSK frgmts	16-QAM frgmts	64-QAM frgmts	256-QAM frgmts	octets	ucast pkts	nucast pkts	discards	errors		
Site Name - LUID: 002	018	00	2144887	6558	1121	0	0	5649 2098	3378 1656	2019 1607	1950 1199	2060928	7088	63	0	0	0	3972
Multicast	016	00	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	NA	NA
Broadcast	012	00	NA	NA	NA	NA	NA	NA	NA	NA	NA	592059	16	8523	0	0	NA	NA

The AP and SM display Transmit and Receive Multicast Data Count (under the **Statistics > Scheduler** page), as shown in Figure 27.

Figure 27 Multicast scheduler statistics

Radio Statistics	
Transmit Unicast Data Count :	20778
Transmit Broadcast Data Count :	13
Transmit Multicast Data Count :	0
Receive Unicast Data Count :	20828
Receive Broadcast Data Count :	206042
Receive Multicast Data Count :	0
Transmit Control Count :	160
Receive Control Count :	39
In Sync Count :	62
Out of Sync Count :	0
Overrun Count :	0
Underrun Count :	0
Receive Corrupt Data Count :	0
Receive Corrupt Control Data Count :	0
Receive Bad Broadcast Control Count :	0
Unsupported Feature Beacon Received :	0
Unknown Feature Beacon Received :	0
Old Version Beacon Received :	0
Wrong Frequency Beacon Received :	0
Non Lite Beacon Received :	0
Bad In Sync ID Received :	0
Rcv LT Start :	0
Rcv LT Start HS :	0
Rcv LT Result :	0
Xmt LT Result :	0
Frame Too Big :	0
Bad Acknowledgment :	0

Custom Frequencies page

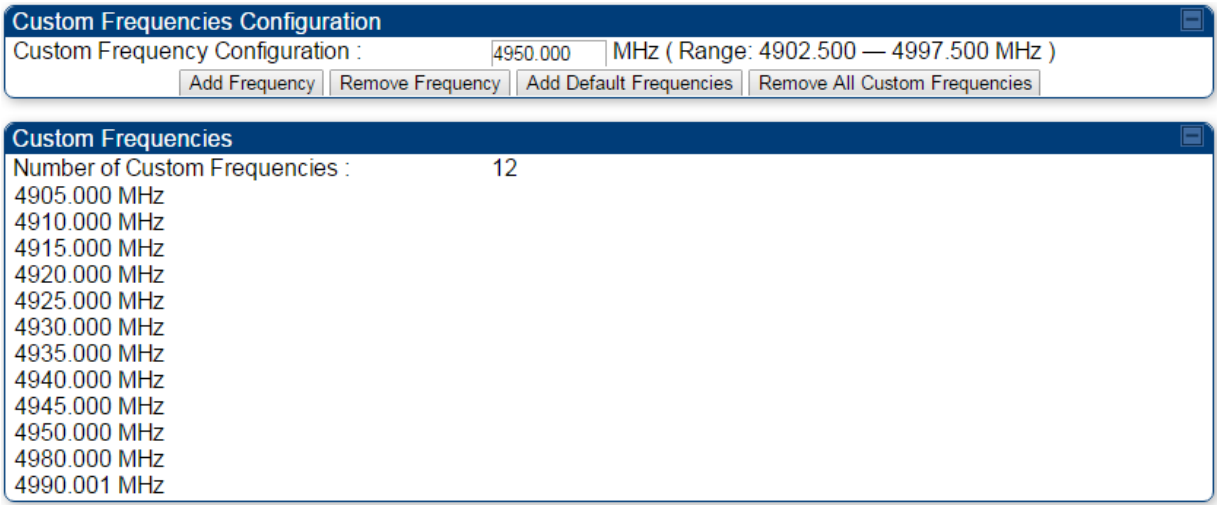
In addition to the **Radio** tab, AP/SM/BH has another tab called **Custom Frequencies** as shown in Table 66.

The custom frequency tab allows to configure custom frequency at 1 KHz raster. It means that the custom frequencies can be at granularity of 1 KHz e.g. 4910.123 MHz, 4922.333 MHz, 4933.421 MHz etc.

Note

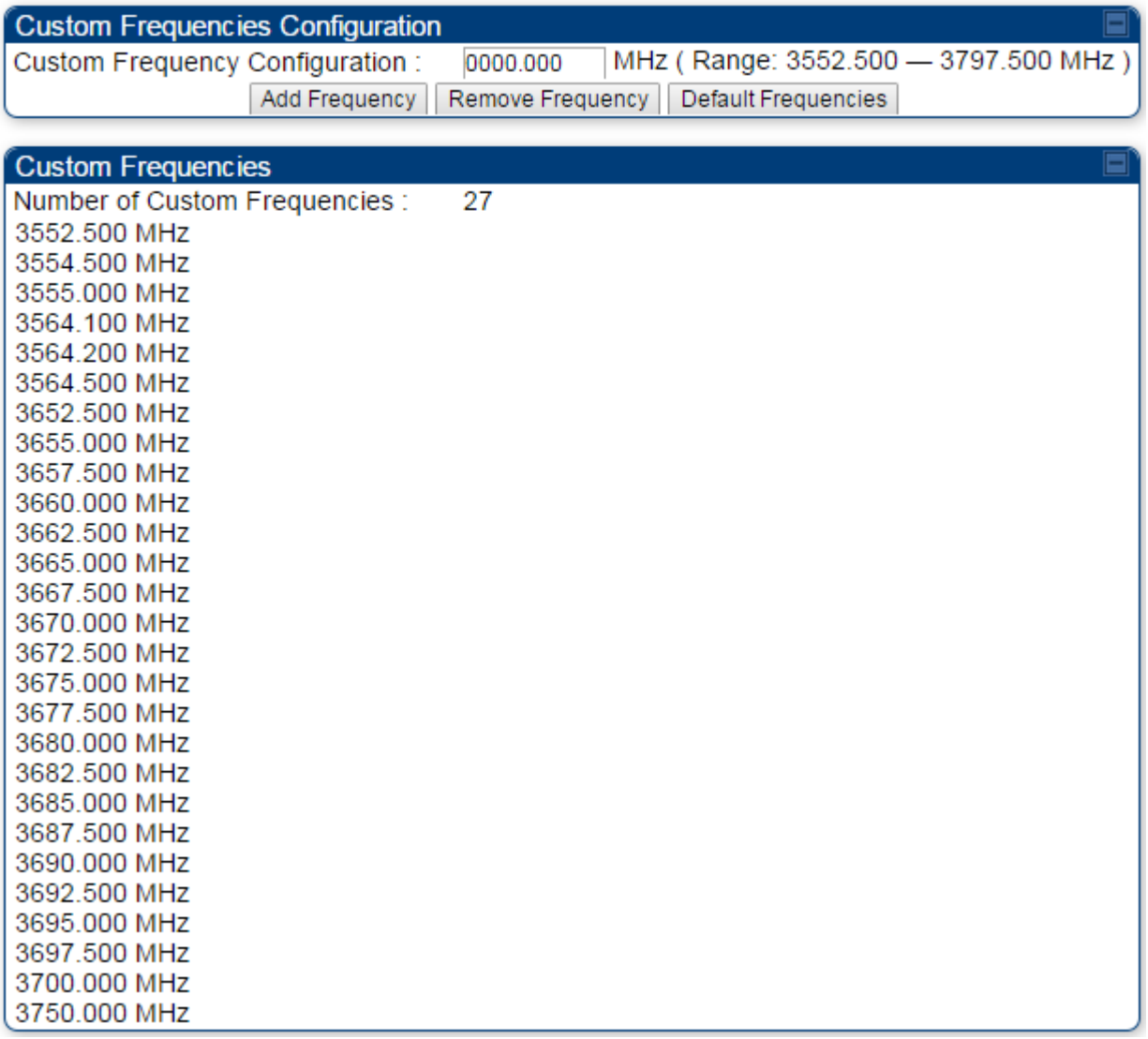
Ensure that a customer frequency exists before using SNMP to set the radio to a Custom Frequency.

Table 66 450 Platform Family AP/SM/BH Custom Frequencies page – 5 GHz



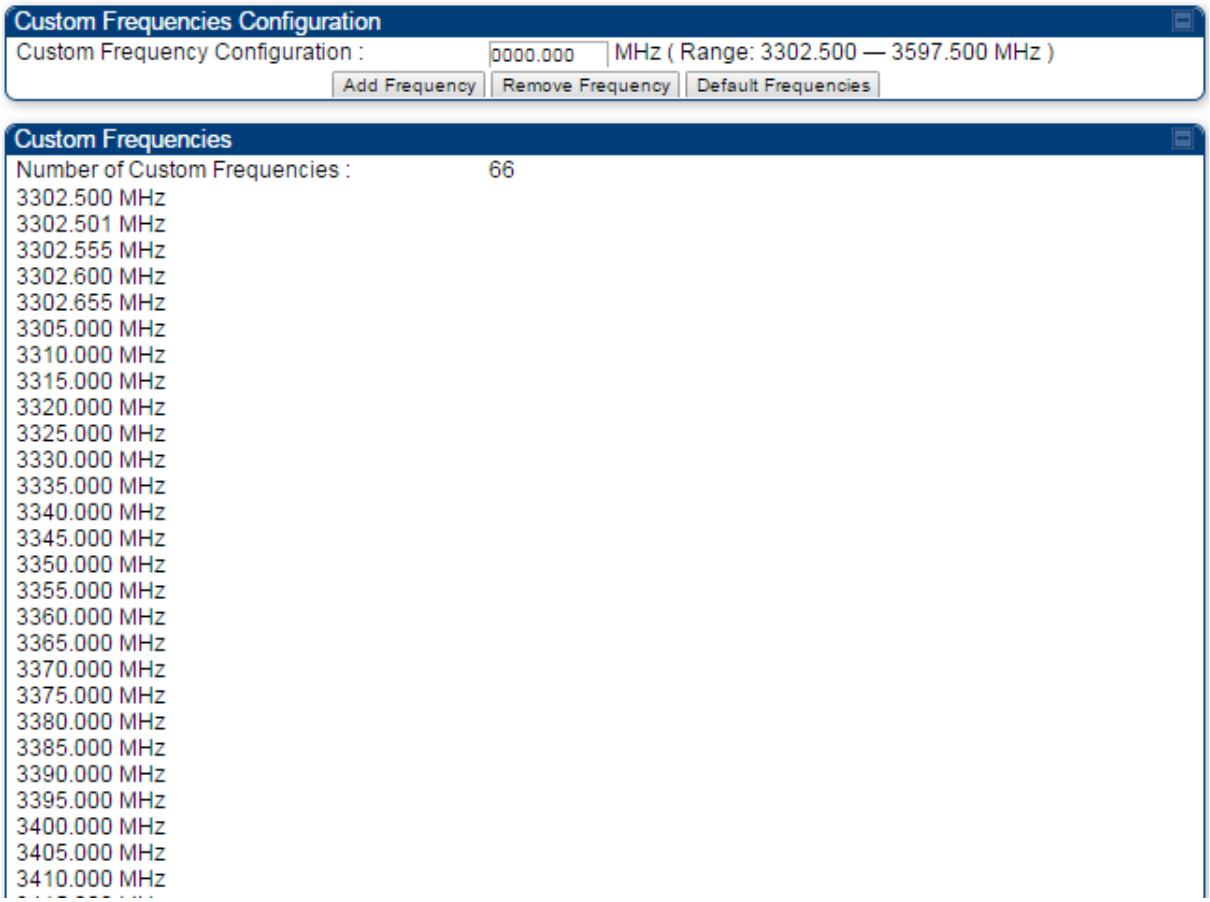
Attribute	Meaning
Custom Frequency Configuration	Custom frequencies with a channel raster of 1 KHz can be added from the available range by keying in the frequency and then clicking the **Add Frequency** button. Click **Remove Frequency** button to delete a specific frequency keyed in the text box. Click **Default Frequencies** button to add a pre-defined list of frequencies that can be used in this band. This list can be reduced or increased by manually removing or adding other custom frequencies.
Custom Frequencies	Displays the complete list of user configured custom frequencies.

Table 67 PMP/PTP 450 SM/BH Custom Frequencies page – 3.65 GHz



Attribute	Meaning
Custom Frequency Configuration	Custom frequencies with a channel raster of 1 KHz can be added from the available range by keying in the frequency and then clicking the **Add Frequency** button. Click **Remove Frequency** button to delete a specific frequency keyed in the text box. Click **Default Frequencies** button to add a pre-defined list of frequencies that can be used in this band. This list can be reduced or increased by manually removing or adding other custom frequencies.
Custom Frequencies	Displays the complete list of user configured custom frequencies.

Table 68 PMP/PTP 450 SM/BH Custom Frequencies page – 3.5 GHz



Attribute	Meaning
Custom Frequency Configuration	Custom frequencies with a channel raster of 1 KHz can be added from the available range by keying in the frequency and then clicking the **Add Frequency** button. Click **Remove Frequency** button to delete a specific frequency keyed in the text box. Click **Default Frequencies** button to add a pre-defined list of frequencies that can be used in this band. This list can be reduced or increased by manually removing or adding other custom frequencies.

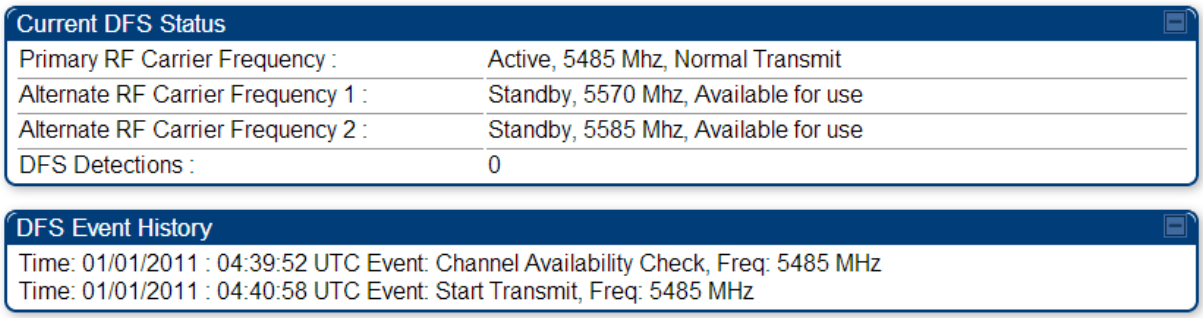
DFS for 5 GHz Radios

Dynamic Frequency Selection (DFS) is a requirement in several countries and regions for 5 GHz unlicensed systems to detect radar systems and avoid co-channel operation. DFS and other regulatory requirements drive the settings for the following parameters, as discussed in this section:

- Country Code
- Primary Frequency
- Alternate 1 and Alternate 2 Frequencies
- External Antenna Gain

On the AP, the **Home > DFS Status** page shows current DFS status of all three frequencies and a DFS log of past DFS events.

Figure 28 AP DFS Status



DFS operation

The ODUs use region-specific DFS based on the **Country Code** selected on the module's Configuration, General page. By directing installers and technicians to set the Country Code correctly, the operator gains confidence the module is operating according to national or regional regulations without having to deal with the details for each region.

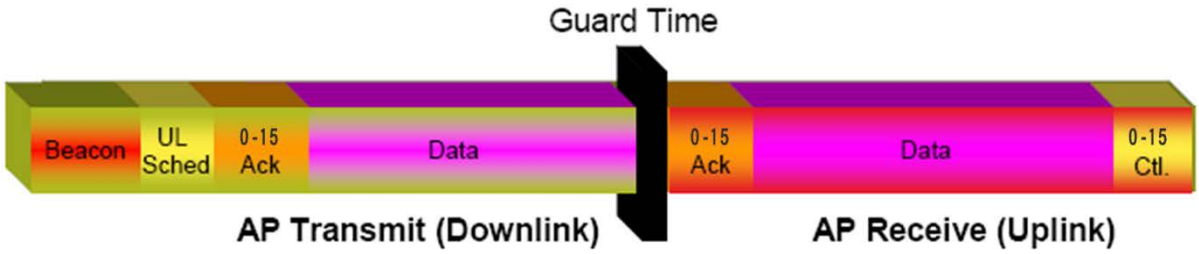
The details of DFS operation for each Country Code, including whether DFS is active on the AP, SM, and which DFS regulations apply is shown in Table 172 on page 4-61.

Contention slots

Contention slots are symbols at the end of the uplink subframe that are reserved for random access (network entry and bandwidth requests) and cannot be used for data transmission. These symbols form the contention space.

The frame is 2.5 ms or 5 ms long, and it is divided into a downlink subframe (data transmitted from the AP to the SM) and an uplink subframe (data transmitted from the SM to the AP).

Figure 29 Frame structure



The symbols in the uplink subframe can be scheduled or unscheduled. All scheduled symbols come before all unscheduled symbols. The number of scheduled and unscheduled symbols changes frame by frame depending on the amount of uplink requests received by the AP.

The contention slots number is selected by the operator and indicates the number of symbols that are reserved in the unscheduled portion of the uplink. The total number of unscheduled symbols in each frame is the sum of the contention slots and any additional symbol that was not used in uplink data transmission. This means that the unscheduled portion of the uplink can be as small as the number of contention slots, or as big as the whole uplink. This allows SMs in sectors with a small number of contention slots configured to still successfully transmit bandwidth requests using unused data slots.

Random access

When an SM needs to send an unscheduled message (for network entry or a bandwidth request), it randomly selects one symbol out of the unscheduled portion of the uplink subframe and uses that symbol for transmission. The higher the number of unscheduled symbols, the lower the probability two or more SMs will select the same symbol for transmission and their messages will collide. When two messages collide at the AP receiver, most likely neither will be decoded correctly, and both SMs need to start the random-access process one more time. If this happens frequently, the latency of the system increases.

A higher number of contention slots give higher probability that an SM's bandwidth request will be correctly received when the system is heavily loaded, but with the tradeoff that sector capacity is reduced, so there will be less capacity to handle the request. The sector capacity reduction is about 200 kbps for each contention slot configured in a 20 MHz channel at QPSK SISO modulation, for 2.5 ms frame sizes. The reduction in sector capacity is proportionally higher at MIMO modulations, as shown in the following table.

Table 69 Throughput penalty per modulation

Modulation mode	Throughput penalty for each additional contention slot	
	2.5 ms frame	5 ms frame
QPSK SISO (1X)	204 kbps	102 kbps
QPSK MIMO (2X)	409 kbps	204 kbps
16-QAM MIMO (4X)	819 kbps	409 kbps
64-QAM MIMO (6X)	1.22 Mbps	614 kbps
256-QAM MIMO (8X)	1.63 Mbps	819 kbps

Table 69 shows that the throughput penalty for each additional contention slot increases with modulation mode. The reason is that at higher modulation modes more fragments can be transmitted in a symbol. If additional symbols are reserved for random access, the number of fragments that cannot be sent in these symbols is higher at higher modulations, and therefore the throughput penalty is higher. However, the penalty expressed as a percentage of the throughput is the same for each modulation mode. For example, if a frame has 80 total symbols, each additional symbol reserved for random access reduces the sector throughput by 1.25%, regardless of the modulation mode.

Selection of contention slots parameter

The number of contention slots has to be selected according to the specific deployment parameters in each sector. If the number of contention slots is too small, then latency increases in high traffic periods. If the number of contention slots is too high, then the maximum capacity is unnecessarily reduced.

The two main contributing factors to the selection of the number of contention slots are the number of SMs in a sector, and the type of traffic in the sector.

Number of SMs in a sector

If the number of SMs in a sector is large, it is recommended to increase the number of contention slots, in order to reduce the probability of two or more requests colliding. The suggested contention slot settings as a function of the number of active Data channels in the sector are shown in Table 70.

Table 70 Contention slot settings

Number of SMs	Recommended Number of Contention slots
1 to 10	3
11 to 50	4
51 to 150	6
151 and above	8

Type of traffic in a sector

Besides the number of SMs, the other main factor in contention slots selection is the type of traffic. If the sector experiences a lot of uplink traffic composed of small packets, for example in a sector that serves several VoIP streams, the average number of bandwidth requests transmitted by each SM is high. Another scenario with constant uplink traffic is video surveillance, which also generate a large number of uplink bandwidth requests.

In these cases, the probability of two or more SMs transmitting a request in the same symbol is high. When this happens, the latency of the system increases, and it is recommended to increase the number of contention slots from the number in Table 70. If an AP is experiencing latency or SM-servicing issues, increasing the number of contention slots may increase system performance, depending on traffic mix over time.

Recommendation on Contention Slots number selection

1. Calculate the number of active SMs in the sector.
2. Evaluate the traffic mix that is expected in the sector, more specifically the expected percentage of real-time traffic (ex. VoIP, gaming, video conferencing, and video surveillance).
3. If the expected amount of real-time traffic is small, select the number of contention slots according to Table 70.
4. If the expected amount of real-time traffic is large, select a number of contention slots larger than the number in Table 70.
5. Monitor latency in your system. If the percentage of real-time traffic increases and the sector experiences increasing latency and SM-servicing issues, increase the number of contention slots from the current setting.
   This is the reason why the maximum number of contention slots is 15, even if Table 2 shows 8 contention slots for more than 150 data channels. If the number of data channels is more than 150 and a significant portion of the traffic is real-time, the frequency with which bandwidth request messages are transmitted requires a higher number of contention slots, potentially as high as 15. A sector with a high number of video surveillance cameras would also require a larger number of contention slots to reduce the probability of collision between requests.
6. Monitor the percentage of BW requests successfully received and the UL frame utilization: if the frame utilization is high (close to 100%), then it is not recommended to change the number of contention slots, even if the percentage success rate of BW requests is low. However, if the percentage success rate of BW requests is low and the frame utilization is also low, then increasing the number of contention slots is recommended.

Cluster of APs

It is recommended to use care when changing the contention slots configuration of only some APs in a cluster, because changes affect the effective downlink/uplink ratio and can cause co-location issues. In a typical cluster, each AP should be configured with the same number of contention slots to assure proper timing in the send and receive cycles. The number of contention slots is used by the frame calculator to define the downlink and uplink times, which should not overlap from one AP to another. However, if the traffic experienced by two APs in the same cluster is different (for example, one supports significantly more VoIP traffic), the number of contention slots selected for each AP may not be the same. For APs in a cluster of mismatched contention slots setting, it is recommended to use the frame calculator to verify that send and receive times do not overlap (see the Frame calculator for co-location).

Note

Change contention slot configuration in an operating, stable system cautiously and with a back-out plan. After changing a contention slot configuration, monitor the system closely for problems as well as improvements in system performance.

Frame calculator for co-location

The frame calculator is a tool available for the PMP 450 series systems, that calculates the length of the transmit and receive times, together with the number of downlink and uplink symbols, for a given set of configuration parameters. The frame calculator can be used to verify that co-location of APs using different contention slots settings does not create overlapping transmit and receive times.

Basic rules

For co-location of AP1 and AP2, we want to ensure that AP1 stops transmitting before AP2 starts receiving, and that AP2 stops transmitting before AP1 starts receiving.

These are the rules that have to be satisfied for a correct co-location of the two APs:

- AP1 Receive Start > AP2 Transmit End
- AP2 Receive Start > AP1 Transmit End

Steps for co-location

Let us assume that in a cluster of multiple APs with all the same settings, one AP's settings are modified with a different number of contention slots.

1. Obtain all configuration settings for the APs that do not change parameters (duty cycle, contention slots, max distance)
2. Input these configuration parameters into the OFDM Frame Calculator tool found under "Tools".
3. Click "Calculate"
4. Note the following values from the results:

   AP Antenna Transmit End: _____

   AP Antenna Receive Start: _____
5. Access the AP that needs to have a different contention slots setting and use the frame calculator tool found under "Tools"

6. Input the configuration parameters for this AP (same duty cycle and max distance as the other APs, different contention slots)
7. Click “Calculate”
8. Note the following values from the results:

   AP Antenna Transmit End: _____

   AP Antenna Receive Start: _____
9. Check that the two following equations are both true:

   AP1 Receive Start > AP2 Transmit End

   AP2 Receive Start > AP1 Transmit End
10. If one or both equations are not true, adjust the duty cycle until they become true (or the max distance if possible).

Example

Let us assume that all APs in a cluster have the same Max range settings, a 2.5 ms frame length and a 20 MHz channel BW, but the operator has fine-tuned the DL duty % per AP as follows:

AP1:

Max range: 2 miles

Contention slots: 3

DL duty cycle = 75%

AP2:

Max range: 2 miles

Contention slots: 3

DL duty cycle = 80%

Running the frame calculator as explained in the Steps for co-location, the AP1 Antenna Transmit End and Antenna Receive start times are:

- AP1 Antenna Transmit End = 1.6440 ms
- AP1 Antenna Receive Start = 1.7972 ms

AP2’s Antenna Transmit End and Antenna Receive start times are:

- AP2 Antenna Transmit End = 1.7411 ms
- AP2 Antenna Receive Start = 1.8943 ms

The settings in AP1 in the cluster are now modified by changing the number of contention slots from 3 to 7, for example because this sector is constantly experiencing a higher volume of VoIP traffic.

Running the frame calculator again, the new AP1 Antenna Transmit End and Antenna Receive start times are:

- AP1 Antenna Transmit End = 1.5711 ms
- AP1 Antenna Receive Start = 1.7243 ms

The two equations above have to be checked for correct co-location:

- AP1 Antenna Receive Start > AP2 Antenna Transmit End → 1.7243 ms >1.7411 ms NOT OK
- AP2 Antenna Receive Start > AP1 Antenna Transmit End → 1.8943 ms >1.5711ms OK

The first of the two equations are not true. AP2 is still transmitting when AP1 has already started receiving. This creates interference at the AP1 receiver.

To avoid this interference scenario, the duty cycle of AP2 can be further adjusted slightly. For example, changing the duty cycle of AP2 from 80% to 79% changes the AP2 Antenna Transmit End and Antenna Receive start times as follows:

- AP2 Antenna Transmit End = 1.7168 ms
- AP2 Antenna Receive Start = 1.8700 ms

The two equations have to be checked again for co-location:

- AP1 Antenna Receive Start > AP2 Transmit End → 1.7243 ms >1.7168 ms OK
- AP2 Receive Start > AP1 Transmit End → 1.8700 ms >1.5711 ms OK

Now both equations are true and the APs can be co-located.

Cambium co-location tool

As an alternative to using the frame calculator on the AP GUI, cambium provides a co-location tool for these calculations. This tool is a free download available on the Cambium website:

https://support.cambiumnetworks.com/files/colocationtool/#r2

PMP/PTP 450/450i/450m CO-LOCATION TOOL AND THROUGHPUT CALCULATOR

Release 15.1.1

Device 1 Configuration	
Mode	PMP
Channel Bandwidth (MHz)	20
Max Range (mi)	2
Dowlink Data	75%
Contention slots	3
Frame Period (ms)	2.5

Device 1 Timing (ms)	
DL end	1.644
UL start	1.797
DL/UL symbols	61/20
DL/UL/Total Throughput (Mbps)	98.3/31.1/129.4

Device 2 Configuration	
Mode	PMP
Channel Bandwidth (MHz)	20
Max Range (mi)	2
Downlink Data	80%
Contention Slots	3
Frame Period (ms)	2.5

Device 2 Timing (ms)	
DL end	1.741
UL start	1.894
DL/UL symbols	65/16
DL/UL/Total Throughput (Mbps)	104.9/24.6/129.5

CHECKS					
Device 1 DL end	1.644	<	Device 2 UL start	1.894	OK
Device 2 DL end	1.741	<	Device 1 UL start	1.797	OK

MIMO-A mode of operation

450 Platform Family supports MIMO-B mode using the following modulation levels: QPSK, 16-QAM, 64-QAM and 256-QAM. System Release 13.2 introduces MIMO-A mode of operation using the same modulation levels as the MIMO-B mode. With MIMO-B, the radio sends different streams of data over the two antennas whereas with MIMO-A, the radio uses a scheme that tries to optimize coverage by transmitting the same data over both antennas. This redundancy improves the signal to noise ratio at the receiver making it more robust, at the cost of throughput.

In addition to introducing MIMO-A modes, improvements have been made to the existing rate adapt algorithm to switch between MIMO-A and MIMO-B seamlessly without any intervention or added configuration by the operator. The various modulation levels used by the 450 Platform Family are shown in Table 71.

Table 71 450 Platform Family Modulation levels

Rate	MIMO-B	MIMO-A
QPSK	2X MIMO-B	1X MIMO-A
16-QAM	4X MIMO-B	2X MIMO-A
64-QAM	6X MIMO-B	3X MIMO-A
256-QAM	8X MIMO-B	4X MIMO-A

System Performance

For System Performance details of all the 450 Platform Family ODUs, refer to the tools listed below:

- Link Capacity Planner for PMP/PTP 450 and 450i:

https://support.cambiumnetworks.com/files/capacityplanner/

- LINKPlanner for PMP/PTP 450/450i and PMP 450m:

https://support.cambiumnetworks.com/files/linkplanner/

Table 72 Co-channel Interference per (CCI) MCS

MCS of Victim	MCS of Interferer	Channel BW (MHz)	CCI
1X (QPSK SISO)	6X (64-QAM MIMO-B)	5, 7, 10, 15, 20, 30, or 40	10 dB
2X (16-QAM SISO)	6X (64-QAM MIMO-B)	5, 7, 10, 15, 20, 30, or 40	17 dB
3X (64-QAM SISO)	6X (64-QAM MIMO-B)	5, 7, 10, 15, 20, 30, or 40	25 dB
1X (QPSK MIMO-A)	6X (64-QAM MIMO-B)	5, 7, 10, 15, 20, 30, or 40	7 dB
2X (16-QAM MIMO-A)	6X (64-QAM MIMO-B)	5, 7, 10, 15, 20, 30, or 40	14 dB
3X (64-QAM MIMO-A)	6X (64-QAM MIMO-B)	5, 7, 10, 15, 20, 30, or 40	22 dB
4X (256-QAM MIMO-A)	6X (64-QAM MIMO-B)	5, 7, 10, 15, 20, 30, or 40	30 dB
2X (QPSK MIMO-B)	6X (64-QAM MIMO-B)	5, 7, 10, 15, 20, 30, or 40	10 dB
4X (16-QAM MIMO-B)	6X (64-QAM MIMO-B)	5, 7, 10, 15, 20, 30, or 40	17 dB
6X (64-QAM MIMO-B)	6X (64-QAM MIMO-B)	5, 7, 10, 15, 20, 30, or 40	25 dB
8X (256-QAM MIMO-B)	6X (64-QAM MIMO-B)	5, 7, 10, 15, 20, 30, or 40	33 dB

Table 73 Adjacent Channel Interference (ACI) per MCS

MCS of Victim	MCS of Interferer	Channel BW (MHz)	Guard Band
1X (QPSK SISO)	6X (64-QAM MIMO-B)	5, 7, 10, 15, 20, 30, or 40	None
2X (16-QAM SISO)	6X (64-QAM MIMO-B)	5, 7, 10, 15, 20, 30, or 40	None
3X (64-QAM SISO)	6X (64-QAM MIMO-B)	5, 7, 10, 15, 20, 30, or 40	None
1X (QPSK MIMO-A)	6X (64-QAM MIMO-B)	5, 7, 10, 15, 20, 30, or 40	None
2X (16-QAM MIMO-A)	6X (64-QAM MIMO-B)	5, 7, 10, 15, 20, 30, or 40	None
3X (64-QAM MIMO-A)	6X (64-QAM MIMO-B)	5, 7, 10, 15, 20, 30, or 40	None
4X (256-QAM MIMO-A)	6X (64-QAM MIMO-B)	5, 7, 10, 15, 20, 30, or 40	None
2X (QPSK MIMO-B)	6X (64-QAM MIMO-B)	5, 7, 10, 15, 20, 30, or 40	None
4X (16-QAM MIMO-B)	6X (64-QAM MIMO-B)	5, 7, 10, 15, 20, 30, or 40	None
6X (64-QAM MIMO-B)	6X (64-QAM MIMO-B)	5, 7, 10, 15, 20, 30, or 40	None
8X (256-QAM MIMO-B)	6X (64-QAM MIMO-B)	5, 7, 10, 15, 20, 30, or 40	None

Guard Band

When synchronized, no Guard Bands are needed for the 450*, 450i, and 450m Series.

- For PMP 450 AP (3.6 GHz) and 450 series APs with 450b SM (5 GHz) connected, Configuration -> Radio -> Power Control -> Adjacent Channel Support must be enabled.

Improved PPS performance of 450 Platform Family

The 450m, 450i, and 450b Series provides improved packets per second (PPS) performance compared to 450 Series.

Through hardware and software enhancements, the PPS performance of the PMP 450i Series AP and PMP 450b SM has been improved to 40k packets/second, measured through a standard RFC2544 test using 64 bytes packets. With this enhancement, operators are able to provide higher bandwidth including better VoIP and video services to end customers using existing SM deployments.

PMP 450m is capable of supporting more than 100k PPS (packets per second).

Setting up SNMP agent

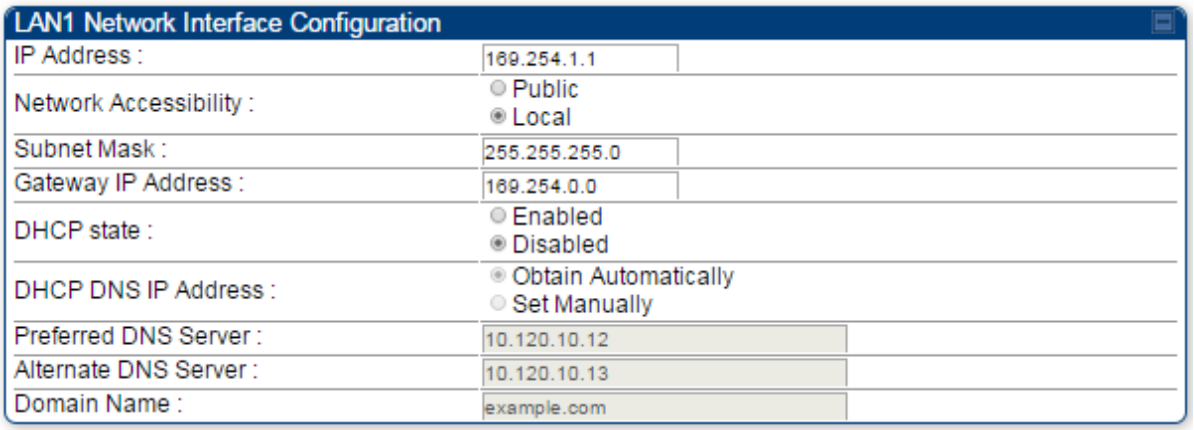
Operators may use SNMP commands to set configuration parameters and retrieve data from the AP and SM modules. Also, if enabled, when an event occurs, the SNMP agent on the 450 Platform Family sends a trap to whatever SNMP trap receivers configured in the management network.

- SNMPv2c
- SNMPv3

Configuring SM/BHS's IP over-the-air access

To access the SM/BHS management interface from a device situated above the AP, the SM/BHS's **Network Accessibility** parameter (under the web GUI at **Configuration > IP**) may be set to **Public**.

Table 74 LAN1 Network Interface Configuration tab of IP page attributes



Attribute	Meaning
IP Address	Internet Protocol (IP) address. This address is used by family of Internet protocols to uniquely identify this unit on a network.
Network Accessibility	Specify whether the IP address of the SM/BHS must be visible to only a device connected to the SM/BHS by Ethernet (**Local**) or be visible to the AP/BHM as well (**Public**).
Subnet Mask	If **Static IP** is set as the **Connection Type** of the WAN interface, then this parameter configures the subnet mask of the SM/BHS for RF management traffic.
Gateway IP Address	If **Static IP** is set as the **Connection Type** of the WAN interface, then this parameter configures the gateway IP address for the SM/BHS for RF management traffic.
DHCP state	If **Enabled** is selected, the DHCP server automatically assigns the IP configuration (IP address, subnet mask, and gateway IP address) and the values of those individual parameters (above) are not used. The setting of this DHCP state parameter is also viewable (read only), in the Network Interface tab of the Home page.
DNS IP Address	Canopy devices allow for configuration of a preferred and alternate DNS server IP address either automatically or manually. Devices must set DNS server IP address manually when DHCP is disabled for the management interface of the device. The default DNS IP addresses are 0.0.0.0 when configured manually.
Preferred DNS Server	The first address used for DNS resolution.
Alternate DNS Server	If the Preferred DNS server cannot be reached, the Alternate DNS Server is used.

Domain Name	The operator's management domain name may be configured for DNS. The domain name configuration can be used for configuration of the servers in the operator's network. The default domain name is example.com, and is only used if configured as such.

Configuring SNMP

The SNMP page configuration is explained below.

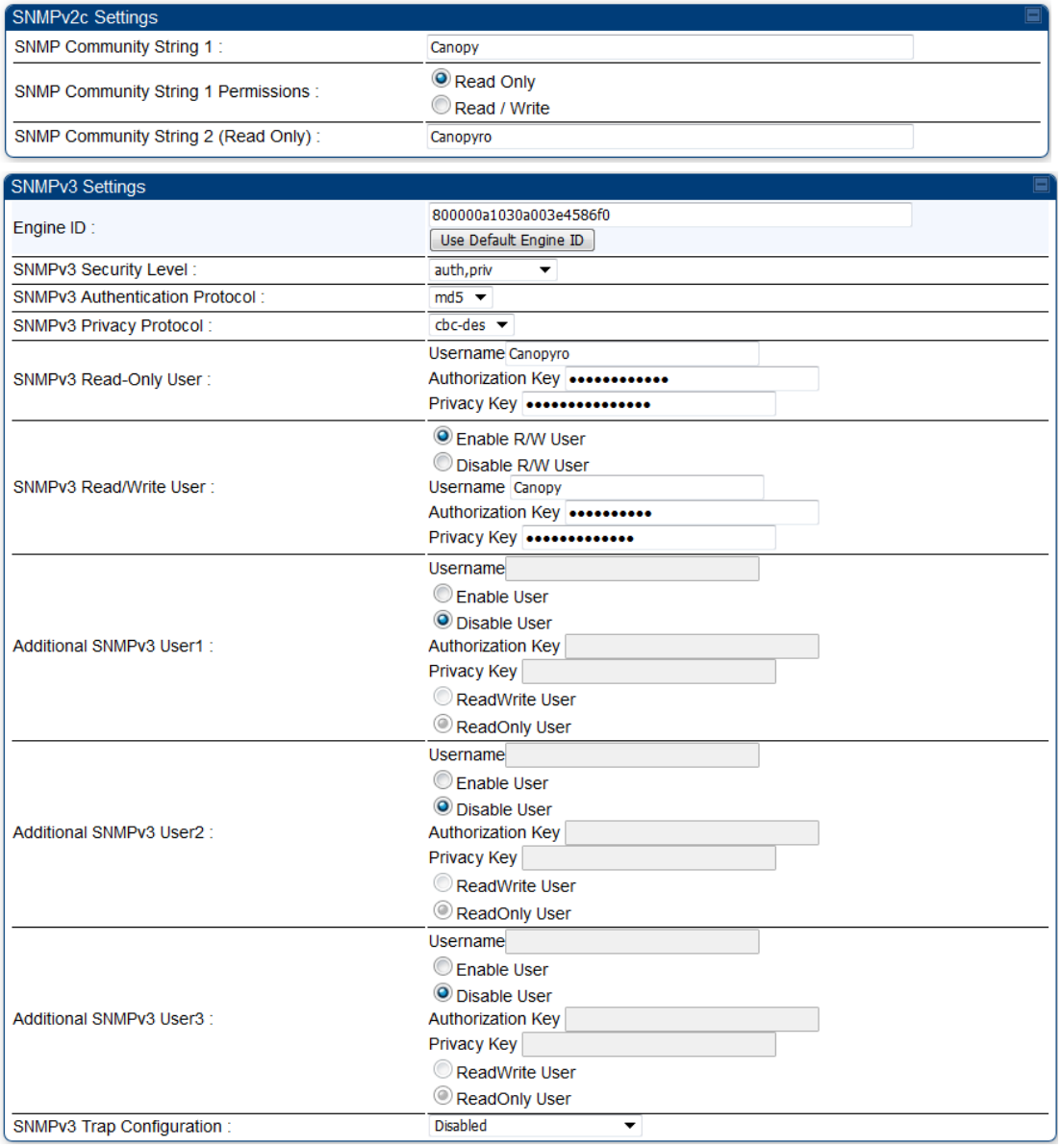
Note

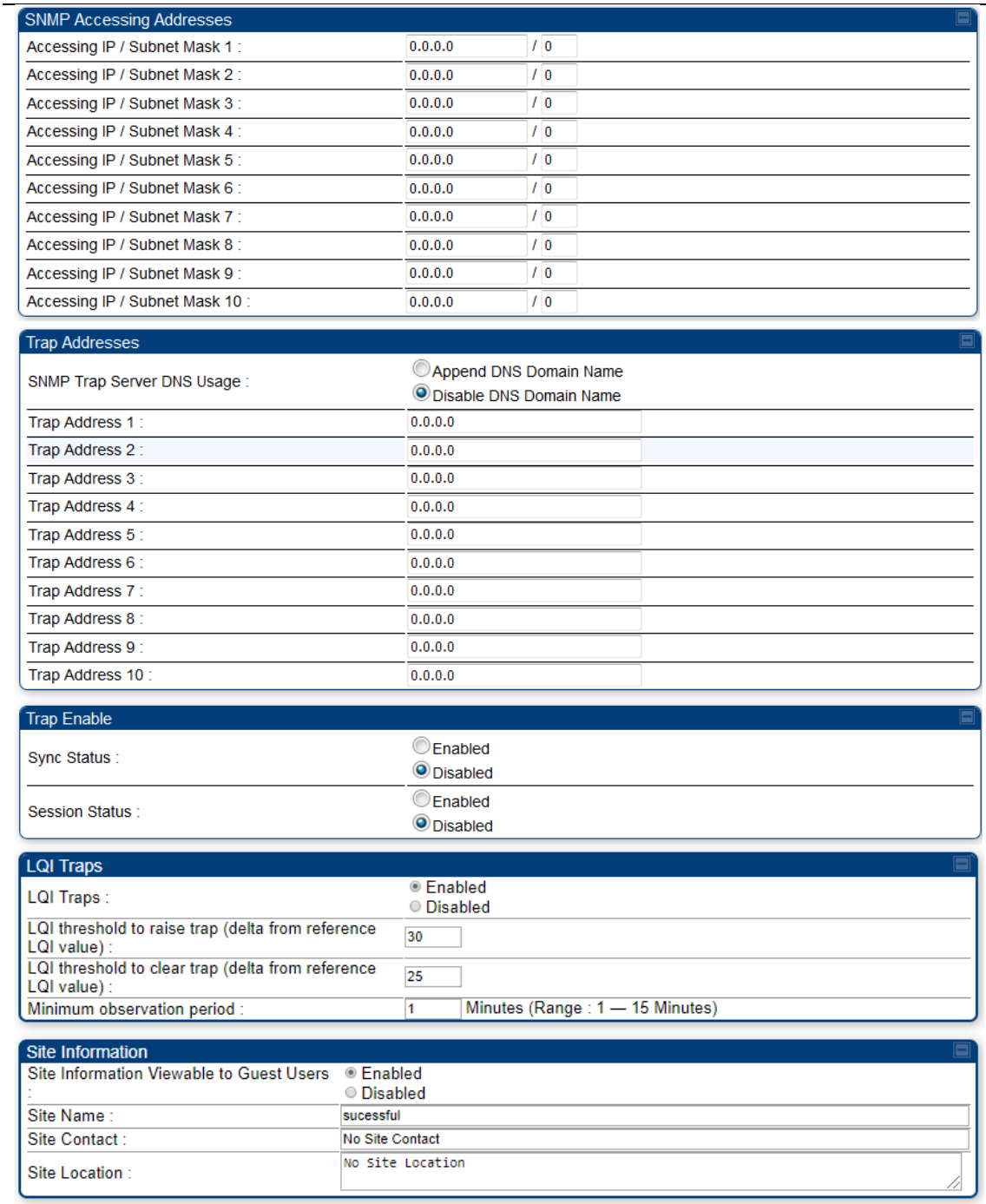
The SNMP page for AP, SM, BHM and BHS has the same parameter attributes.

SNMP page – AP/SM/BHM/BHS

The SNMP page is explained in Table 75.

Table 75 SNMP page attributes





Attribute	Meaning
SNMP Community String 1	Specify a control string that can allow a Network Management Station (NMS) to access SNMP information. No spaces are allowed in this string. The default string is **Canopy**.
SNMP Community String 1 Permissions	You can designate the **SNMP Community String 1** to be the password for WM, for example, to have **Read / Write** access to the module via SNMP or for all SNMP access to the module to be **Read Only**.

SNMP Community String 2 (Read Only)	Specify an additional control string that can allow a Network Management Station (NMS) to read SNMP information. No spaces are allowed in this string. The default string is **Canopyro**. This password will never authenticate a user or an NMS to read/write access. The **Community String** value is clear text and is readable by a packet monitor. Additional security derives from the configuration of the **Accessing Subnet**, **Trap Address**, and **Permission** parameters.
Engine ID	The Engine ID may be between 5 and 32 hex characters. The hex character input is driven by RFC 3411 recommendations on the Engine ID. The default Engine ID is the MAC address of the device
SNMPv3 Security Level	Specify security model where users are defined and authenticated before granting access to any SNMP service. Each device can configure the security level of SNMPv3 to No authentication/No privacy, Authentication/No privacy, or Authentication/Privacy.
SNMPv3 Authentication Protocol	Currently, the SNMPv3 authentication protocol **MD5** is supported.
SNMPv3 Privacy Protocol	Currently, the SNMPv3 privacy protocol **CBC-DES** is supported.
SNMPv3 Read-Only User	This field allows for a read-only user per devices. The default values for the Read-Only users is: • Username = Canopyro • Authentication Password = authCanopyro • Privacy Password = privacyCanopyro
SNMPv3 Read/Write User	Read-write user by default is disabled. The default values for the Read/Write users is: • Username = Canopy • Authentication Password = authCanopy • Privacy Password = privacyCanopy
Additional SNMP v3 User 1	This field allows to configure the Additional SNMP v3 User 1. The configurations include: • Enable/Disable User: These fields allow to enable or disable the user using the Enable User or Disable User radio buttons. • Authorizaton Key: This field allows to configure an authorization key for the user. • Privacy Key: This field allows to configure a privacy key for the user.  **Note** Set SNMP v3 Security Level field to: auth, priv to enable the Authorization Key and Privacy Key fields.

	Enabled User can be set with following privacy settings: • ReadWrite User • ReadOnly User
Additional SNMP v3 User 2	This field allows to configure the Additional SNMP v3 User 2. The configurations include: • Enable/Disable User: These fields allow to enable or disable the user using the Enable User or Disable User radio buttons. • Authorizaton Key: This field allows to configure an authorization key for the user. • Privacy Key: This field allows to configure a privacy key for the user.  **Note** Set SNMP v3 Security Level field to: auth, priv to enable the Authorization Key and Privacy Key fields. Enabled User can be set with following Privacy settings: • ReadWrite User • ReadOnly User
Additional SNMP v3 User 3	This field allows to configure the Additional SNMP v3 User 3. The configurations include: • Enable/Disable User: These fields allow to enable or disable the user using the Enable User or Disable User radio buttons. • Authorizaton Key: This field allows to configure an authorization key for the user. • Privacy Key: This field allows to configure a privacy key for the user.  **Note** Set SNMP v3 Security Level field to: auth, priv to enable the Authorization Key and Privacy Key fields. Enabled User can be set with following Privacy settings: • ReadWrite User • ReadOnly User
SNMPv3 Trap Configuration	When enabling transmission of SNMPv3 traps the read-only or read-write user credentials must be used and selected properly in order for the SNMP manager to correctly interpret the traps. By default transmission of SNMPv3 traps is disabled and all traps sent from the radios are in SNMPv2c format.
Accessing IP / Subnet Mask *1 to 10*	Specify the addresses that are allowed to send SNMP requests to this AP. The NMS has an address that is among these addresses (this subnet). You must enter both • The network IP address in the form xxx.xxx.xxx.xxx • The CIDR (Classless Interdomain Routing) prefix length in the form /xx For example:

	• the /16 in 198.32.0.0/16 specifies a subnet mask of 255.255.0.0 (the first 16 bits in the address range are identical among all members of the subnet). • 192.168.102.0 specifies that any device whose IP address is in the range 192.168.102.0 to 192.168.102.254 can send SNMP requests to the AP, presuming that the device supplies the correct **Community String** value. The default treatment is to allow all networks access. For more information on CIDR, execute an Internet search on "Classless Interdomain Routing." You are allowed to specify as many as 10 different accessing IP address, subnet mask combinations. RECOMMENDATION: The subscriber can access the SM/BHS by changing the subscriber device to the accessing subnet. This hazard exists because the **Community String** and **Accessing Subnet** are both visible parameters. To avoid this hazard, configure the SM/BHS to filter (block) SNMP requests.
SNMP Trap Server DNS Usage	The management DNS domain name may be toggled such that the name of the trap server only needs to be specified and the DNS domain name is automatically appended to that name. The default SNMP trap server addresses for all 10 available servers is 0.0.0.0 with the appending of the DNS domain name disabled.
Trap Address *1 to 10*	Specify ten or fewer IP addresses (xxx.xxx.xxx.xxx) or DNS names to which SNMP traps must be sent. Traps inform Wireless Manager or an NMS that something has occurred. For example, trap information is sent • after a reboot of the module. • when an NMS attempts to access agent information but either • supplied an inappropriate community string or SNMP version number. • is associated with a subnet to which access is disallowed.
Trap Enable, Sync Status	If the sync status traps (sync lost and sync regained) have to be sent to Wireless Manager or an NMS, select **Enabled**. If these traps have to be suppressed, select **Disabled**.
Trap Enable, Session Status	If you want session status traps sent to Wireless Manager or an NMS, select **Enabled**.
LQI Traps	This field enables and disables traps for LQI.
LQI threshold to raise trap (delta from reference LQI value)	It is configured in percentage. The LQI trap is raised if the LQI values goes below the configured threshold to raise trap from reference LQI. For example, if the LQI threshold to raise trap is set as 30, the LQI trap will be raised once the LQI goes below 70% (100-30).
LQI threshold to clear trap (delta from reference LQI value)	It is configured in percentage. The LQI trap is cleared if the LQI values goes above the configured threshold to clear trap from reference LQI. For example, if the LQI threshold to clear trap is set as 25, the LQI trap will be clear once the LQI goes above 75% (100-25).

Minimum observation period	It is minimum observation period to raise and clear the traps after LQI threshold. It can be configured between 1 to 15 minutes.
Site Information Viewable to Guest Users	Operators can enable or disable site information from appearing when a user is in GUEST account mode.
Site Name	Specify a string to associate with the physical module. This parameter is written into the *sysName* SNMP MIB-II object and can be polled by Wireless Manager or an NMS. The buffer size for this field is 128 characters.
Site Contact	Enter contact information for the module administrator. This parameter is written into the *sysContact* SNMP MIB-II object and can be polled by Wireless Manager or an NMS. The buffer size for this field is 128 characters.
Site Location	Enter information about the physical location of the module. This parameter is written into the *sysLocation* SNMP MIB-II object and can be polled by Wireless Manager or an NMS. The buffer size for this field is 128 characters.

Configuring syslog

450 Platform Family includes:

- Syslog event logging
- Configuring system logging

Syslog event logging

Following events are logged in syslog as explained in Table 76.

Table 76 Syslog parameters

Attribute	Meaning
Timestamp	All syslog messages captured from the radio have a timestamp.
Configuration Changes	This includes any device setting that has changed and includes the old or new parameter value, including the device reboots.
User Login and Logout	Syslog records each user login and logout, with username.
Add or Delete of user accounts through GUI and SNMP	Syslog captures any user accounts that are added or deleted.
Spectrum Analysis	Syslog records a message every time Spectrum Analysis runs. **Note** Since the AP/BHM must be set to a SM/BHS for Spectrum Analysis, syslog messages are not reported from the radio until the scan is done and the radio mode is switched back to AP/BHM.
Link Test	Syslog records a message every time a Link Test is run.
Clear Statistics	Syslog sends a message when Statistics are cleared. This is done individually for each statistics page that is cleared.
SM Register or De-register	Syslog records a message when a SM registers or deregisters.
BHS Connect or Disconnect	Syslog records a message when a BHS connects or disconnects.

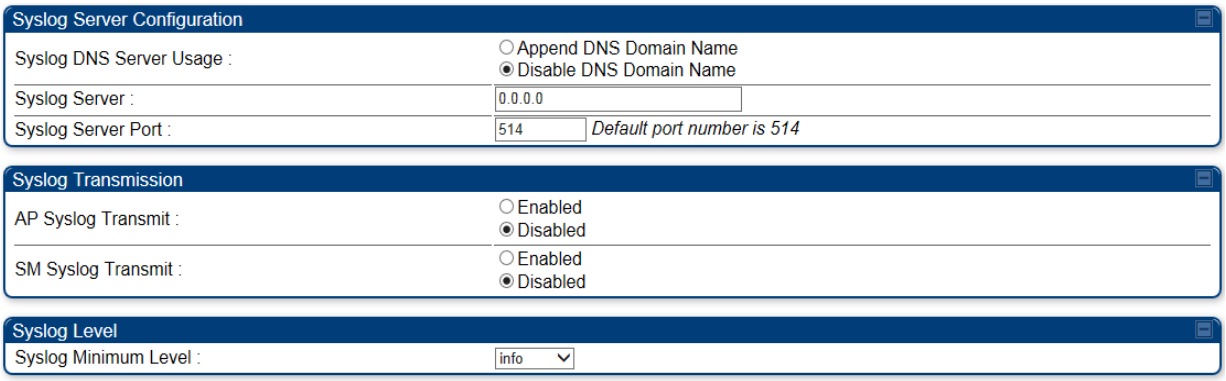
Configuring system logging

To configure system logging, select the menu option **Configuration > Syslog**.

Syslog page of AP/BHM

The Syslog Configuration page for AP/BHM is shown in Table 77.

Table 77 Syslog Configuration attributes - AP

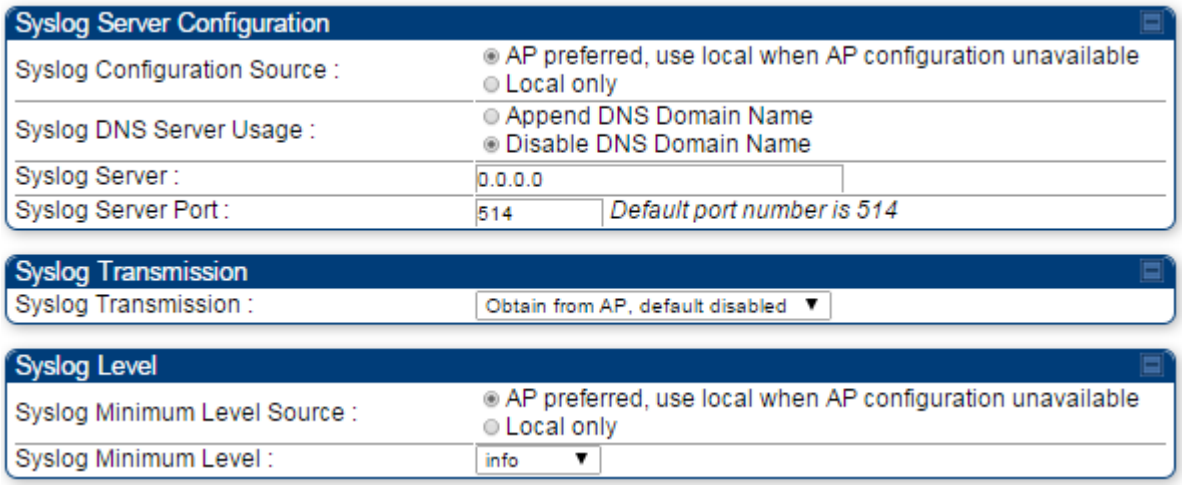


Attribute	Meaning
Syslog DNS Server Usage	To configure the AP/BHM to append or not append the DNS server name to the syslog server name.
Syslog Server	The dotted decimal or DNS name of the syslog server address.
Syslog Server Port	The syslog server port (default 514) to which syslog messaging is sent.
AP Syslog Transmit Or BHM Syslog Transmit	When enabled, syslog messages are sent from the AP/BHM.
SM Syslog Transmit Or BHS Syslog Transmit	When enabled, syslog messages are sent from all the registered SMs/BHS, unless they are individually set to override this.
Syslog Minimum Level	This provides a selection for the minimum syslog message severity that is sent to the syslog server. Values range from fatal (highest severity and least verbose) to info (lowest severity, maximum verbosity). For example: If the Syslog Minimum Level is set to notice, then only messages with severity notice and above are sent.

Syslog page of SM

To configure system logging, select the menu option **Configuration > Syslog**. The Syslog Configuration page is shown in Table 78.

Table 78 Syslog Configuration attributes - SM



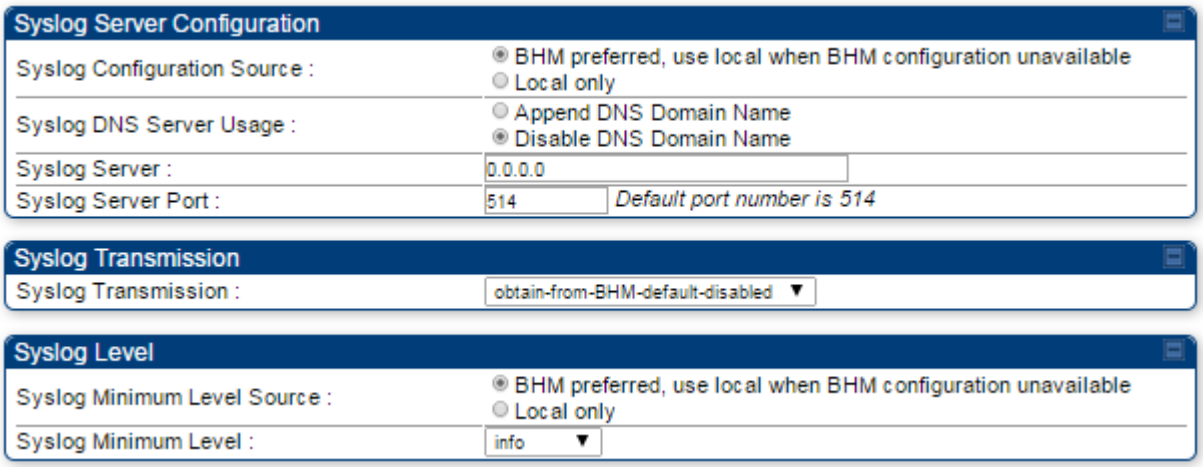
Attribute	Meaning
Syslog Configuration Source	This control determines whether the SM will attempt to use the syslog server definition from the AP, or whether it will use a local server definition. When set to **AP preferred, use local when AP configuration unavailable**, and if the SM can register with an AP, then it uses the syslog server defined on that AP. If the SM cannot register then it will syslog to its locally defined syslog server through its wired connection, if any. When set to **Local only** the SM ignores the AP's definition of the syslog server and allows the syslog server to be configured individually for each SM.
Syslog DNS Server Usage	To configure the SM to append or not the DNS server name to the syslog server name.
Syslog Server	The dotted decimal or DNS name of the syslog server address.
Syslog Server Port	The syslog server port (default 514) to which syslog messaging is sent.
Syslog Transmission	Controls the SMs ability to transmit syslog messages. When set to "Learn from AP" the AP will control whether this SM transmits syslog messages. When set to "enable" or "disable" the SM will control whether it sends syslog messages. This allows an operator to override the AP settings for individual SMs in a sector.
Syslog Minimum Level Source	This control determines whether the SM attempts to use the minimum syslog level defined by the AP, or whether it uses a local defined value using the "Syslog Minimum Level" parameter. When set to "AP preferred, use local when AP configuration unavailable", and if the SM can register with an AP, then it uses the Syslog Minimum Level defined on that AP. If the SM cannot register then it uses its own Syslog Minimum Level setting. When set to "Local only" the SM will always use its own Syslog Minimum Level setting and ignores the AP's setting.

Syslog Minimum Level	This provides a selection for the minimum syslog message severity that is sent to the syslog server. Values range from fatal (highest severity and least verbose) to info (lowest severity, maximum verbosity). For example: If the Syslog Minimum Level is set to notice, then only messages with severity notice and above are sent.

Syslog page of BHS

The Syslog Configuration page is shown in Table 79.

Table 79 Syslog Configuration attributes - BHS



Attribute	Meaning
Syslog Configuration Source	This control determines whether the BHS will attempt to use the syslog server definition from the BHM, or whether it will use a local server definition. • When set to **BHM preferred, use local when BHM configuration unavailable**, and if the BHS can register with a BHM, then it uses the syslog server defined on that BHM. If the BHS cannot register then it will syslog to its locally defined syslog server through its wired connection, if any. • When set to **Local only** the BHS ignores the BHM's definition of the syslog server and allows the syslog server to be configured individually for each BHS.
Syslog DNS Server Usage	To configure the BHS to append or not to append the DNS server name to the syslog server name.
Syslog Server	The dotted decimal or DNS name of the syslog server address.
Syslog Server Port	The syslog server port (default 514) to which syslog messaging is sent.
Syslog Transmission	Controls the BHSs ability to transmit syslog messages. When set to **Learn from BHM** the BHM will control whether this BHS transmits syslog messages. When set to **enable** or **disable** the BHS will

	control whether it sends syslog messages. This allows an operator to override the BHM settings for individual BHSs in a sector.
Syslog Minimum Level Source	This control determines whether the BHS attempts to use the minimum syslog level defined by the BHM, or whether it uses a local defined value using the **Syslog Minimum Level** parameter. • When set to **BHM preferred, use local when BHM configuration unavailable**, and if the BHS can register with a BHM, then it uses the Syslog Minimum Level defined on that BHM. If the BHS cannot register then it uses its own Syslog Minimum Level setting. When set to **Local only** the BHS will always use its own Syslog Minimum Level setting and ignores the BHM's setting.
Syslog Minimum Level	This provides a selection for the minimum syslog message severity that is sent to the syslog server. Values range from fatal (highest severity and least verbose) to info (lowest severity, maximum verbosity). For example: If the Syslog Minimum Level is set to notice, then only messages with severity notice and above are sent.

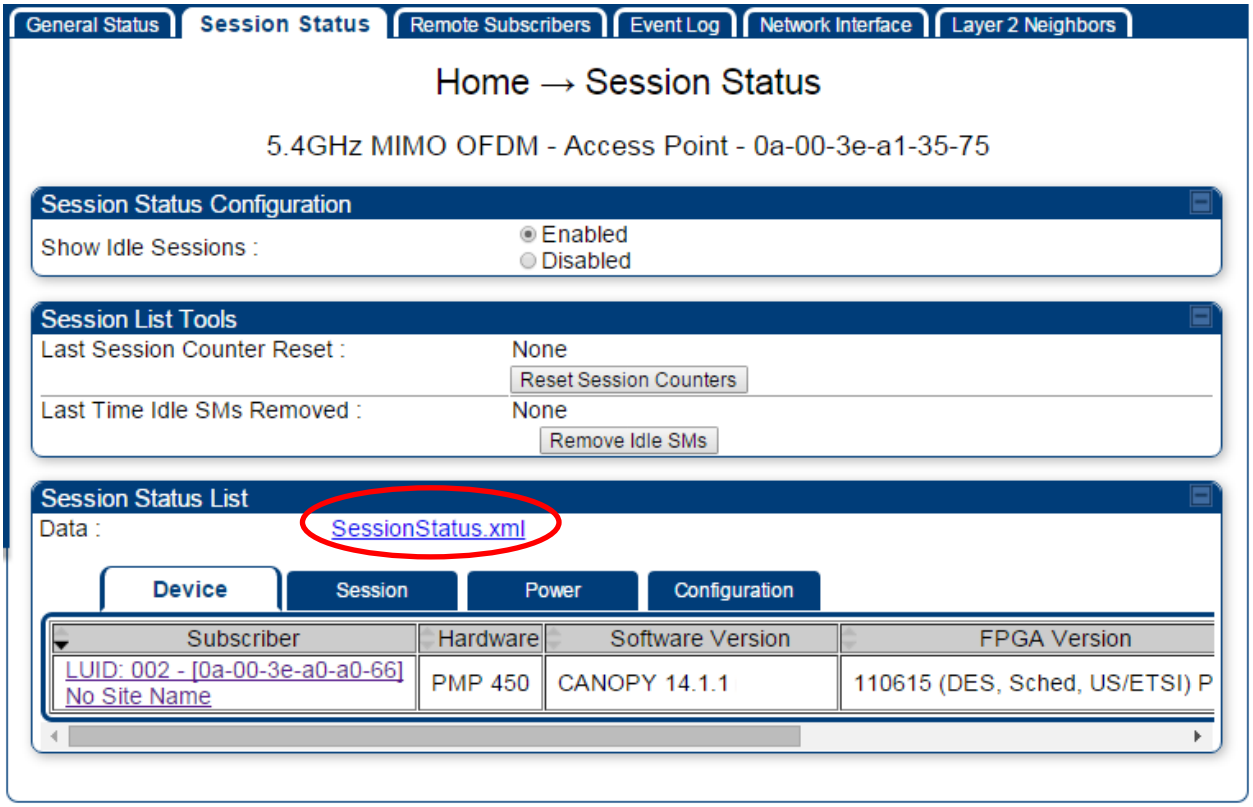
Configuring remote access

Accessing SM/BHS over-the-air by Web Proxy

The SM/BHS may be accessed via the AP/BHM management GUI by navigating to **Home > Session Status** (or **Home** > **Remote Subscribers** for AP only) and clicking on the SM's hyperlink.

For example, to access one of the SMs, click **LUID: 002 – [0a-00-3e-37-b9-fd]**, as shown in Figure 30.

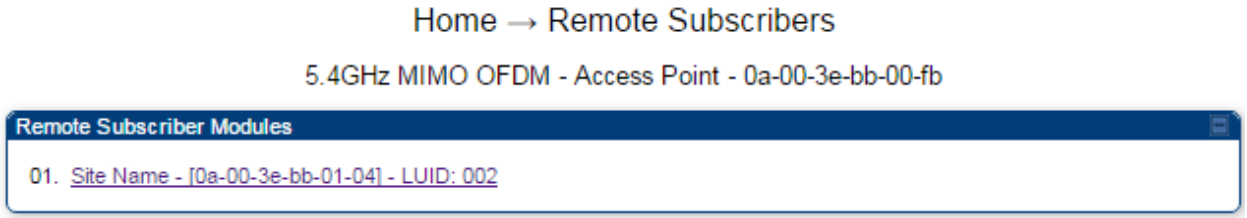
Figure 30 AP Session Status page



The **SessionStatus.xml** hyper link allows user to export all displayed SM data in Session Status table into an xml file.

To access any one of the SMs, click 450 Platform Family - SM hyperlink, as shown in Figure 31.

Figure 31 AP Remote Subscribers page



Monitoring the Link

Link monitoring procedure

After configuring the link, either an operator in the network office or the SM/BHS INSTALLER user in the field (if read access to the AP/BHM is available to the INSTALLER) must perform the following procedure. Who is authorized and able to do this depends on local operator password policy, management VLAN setup and operational practices.

To monitor the link for performance, follow these instructions:

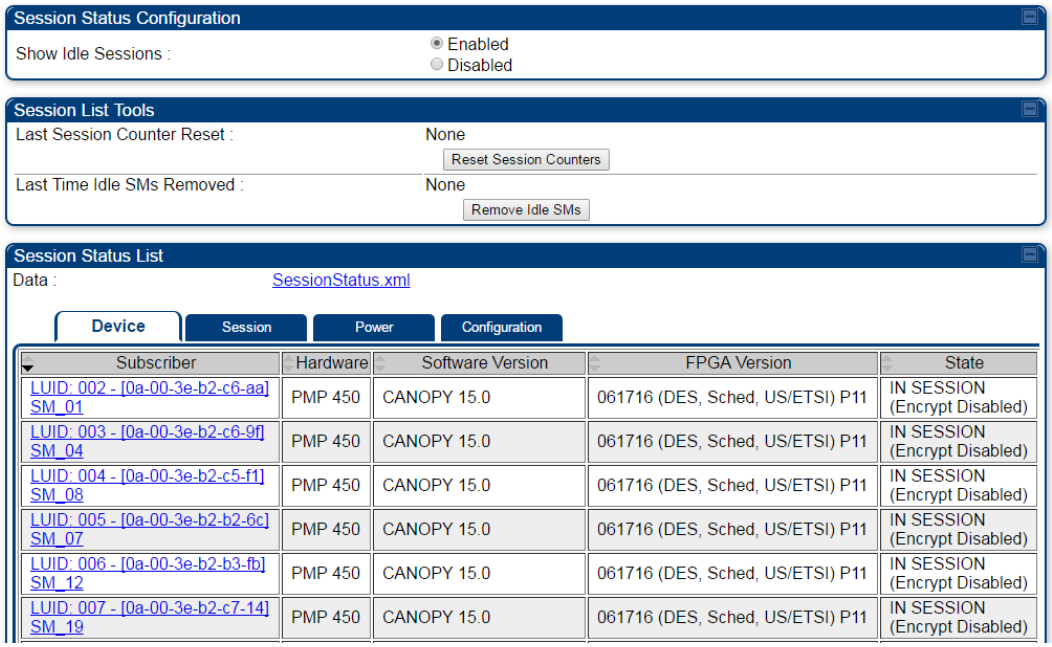
Procedure 14 Monitoring the AP-SM link

1 Access the web interface of the AP/BHM

2 In the left-side menu of the AP/BHM interface, select **Home**.

3 Click the **Session Status** tab.

Figure 32 Session Status page



4 The **Device** tab of Session Status List display all displayed SMs – MAC address, PMP/PTP Hardware, Software Version, FPGA Version and State

5 Click **Session Count** tab of Session Status List to display values for **Session Count**, **Reg Count**, and **Re-Reg Count**.

- **Session Count**: This field displays how many sessions the SM/BHS has had with the AP/BHM. Typically, this is the sum of Reg Count and Re-Reg Count. However, the result of internal calculation may display here as a value that slightly differs from the sum.
- **Reg Count**: When a SM/BHS makes a Registration Request, the AP/BHM checks its local session database to see whether it was registered earlier. If the AP/BHM concludes that the SM/BHS is not currently in session database and it is valid Registration Request, then the request increments the value of this field.
- **Re-Reg Count**: When a SM/BHS makes a Registration Request, the AP/BHM checks its local session database to see whether it was registered earlier. If the AP/BHM concludes that the SM/BHS is currently in session database, then the request increments the value of this field.
- Typically, a Re-Reg is the case where both
  - SM/BHS attempts to reregister for having lost communication with the AP/BHM.
  - AP/BHM has not yet observed the link to the SM/BHS as being down.

See Session tab on page 3-26

6 Click **Power** tab of Session Status list to display Downlink Rate, AP Rx Power (dBm), Signal Strength Radio (dB) for Uplink and Signal to Noise Radio (dB) for Uplink.

See Power tab on page 3-27

7 Click **Configuration** tab of Session Status list to get QoS configuration details:

- Sustained Data Rate (kbps)
- Burst Allocation (kbit)
- Max Burst Rate (kbit)
- Low Priority CIR (kbps)

See

Configuration tab on page 3-30

8 Briefly monitor these values, occasionally refreshing this page by clicking another tab and then the Session Status tab again.

9 If these values are low (for example, 1, 1, and 0, respectively, meaning that the SM/BHS registered and started a stable session once) and are not changing:

- Consider the installation successful.
- Monitor these values from the network office over the next several hours and days.

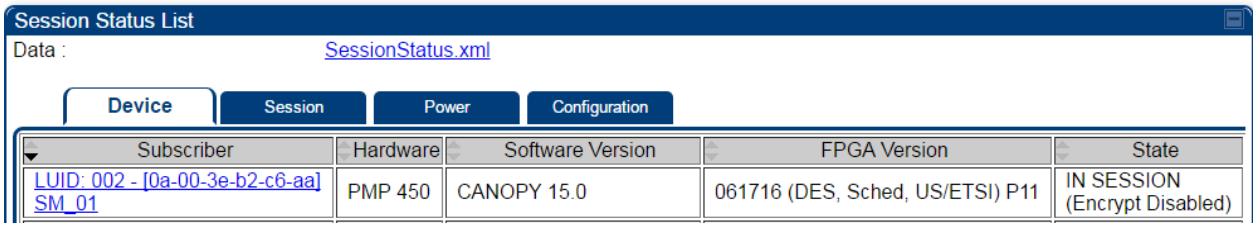
If these values are greater than 1, 1, and 0, or they increase while you are monitoring them, troubleshoot the link. (For example, Use **Receive Power Level** for aiming and then use Link Tests to confirm alignment).

Refer Viewing Session Status on page 3-24 for more details.

Exporting Session Status page of AP/BHM

The SessionStatus.xml hyper link allows user to export all displayed SMs or BHS data in Session Status table into an xml file.

Figure 33 Exporting Session Status page of PMP 450m AP



In case of PMP, if the session status page does not list any SM, the SessionStatus.xml will still be visible but the file would be empty. The file will contain data from all of the 5 different tables.

Export from command line

The scripts users can also get this file from command line, you have to authenticate successfully in order to download the file.

wget

http://169.254.1.1/SessionStatus.xml?CanopyUsername=test&CanopyPassword=test

Configuring quality of service

Maximum Information Rate (MIR) Parameters

Point-to-multipoint links use the following MIR parameters for bandwidth management:

- Sustained Uplink Data Rate (kbps)
- Uplink Burst Allocation (kb)
- Sustained Downlink Data Rate (kbps)
- Downlink Burst Allocation (kb)
- Max Burst Downlink Data Rate (kbps)
- Max Burst Uplink Data Rate (kbps)

Set each of these parameters per AP or per SM independently.

Note

You can refer below whitepaper for 450 Platform Family Max Burst MIR:

http://www.cambiumnetworks.com/resources/pmp-450-maxburst/

Token Bucket Algorithm

The software uses a *token bucket* algorithm that has the following features:

- Stores credits (tokens) for the SM to spend on bandwidth for reception or transmission.
- Drains tokens during reception or transmission.
- Refills with tokens at the sustained rate set by the network operator.

For each token, the SM can send toward the network in the uplink (or the AP can send toward the SM in the downlink) an equivalent number of kilobits. Two buckets determine the permitted throughput: one in the SM for uplink and one in the AP for downlink.

The applicable set of **Uplink Burst Allocation** and **Downlink Burst Allocation** parameters determine the *number* of tokens that can fill each bucket. When the SM transmits (or the AP transmits) a packet, the equivalent number of tokens is removed from the uplink (or downlink) bucket.

Except when full, the bucket is continuously being refilled with tokens at *rates* that the applicable set of **Sustained Uplink Data Rate** and **Sustained Downlink Data Rate** parameters specify. The bucket often drains at a rate that is much faster than the sustained data rate but can refill at only the sustained data rate. Thus, the effects of the allocation and rate parameters on packet delay are as follows:

- The burst allocation affects how many kilobits are processed before packet delay is imposed.
- The sustained data rate affects the packet delay that is imposed.

MIR Data Entry Checking

Uplink and downlink MIR is enforced as shown in Figure 34.

Note

In these figures, *entry* refers to the setting in the data rate parameter, not the burst allocation parameter.

Figure 34 Uplink and downlink rate caps adjusted to apply aggregate cap

$$\text{uplink cap enforced} = \frac{\text{uplink entry} \times \text{aggregate cap for the SM}}{\text{uplink entry} + \text{downlink entry}}$$

$$\text{downlink cap enforced} = \frac{\text{downlink entry} \times \text{aggregate cap for the SM}}{\text{uplink entry} + \text{downlink entry}}$$

For example, in the SM, if you set the **Sustained Uplink Data Rate** parameter to 2,000 kbps and the **Sustained Downlink Data Rate** parameter to 10,000 kbps, then the uplink and downlink MIR that is enforced for the SM can be calculated as shown in Figure 35.

Figure 35 Uplink and downlink rate cap adjustment example

$$\text{uplink cap enforced} = \frac{2{,}000 \text{ kbps} \times 7{,}000 \text{ kbps}}{2{,}000 \text{ kbps} + 10{,}000 \text{ kbps}} = 1{,}167 \text{ kbps}$$

$$\text{downlink cap enforced} = \frac{10{,}000 \text{ kbps} \times 7{,}000 \text{ kbps}}{2{,}000 \text{ kbps} + 10{,}000 \text{ kbps}} = 5{,}833 \text{ kbps}$$

In this example case, the derived 1,167-kbps uplink and 5,833-kbps downlink MIR sum to the fixed 7,000-kbps aggregate cap of the SM.

Committed Information Rate (CIR)

The Committed Information Rate (CIR) capability feature enables the service provider to guarantee to any subscriber that bandwidth will never decrease to below a specified minimum unless CIR is oversubscribed or RF conditions are degraded. CIR is oversubscribed when there is not enough available bandwidth to support CIR configuration for all subscribers. In this condition, SMs which are configured with a nonzero CIR will all operate at the maximum data rate supported by the link (subject to Maximum Information Rate and Burst Rate/Allocations). SMs which are configured with a CIR of 0 kbps will not transmit until CIR-configured SMs have completed transmission. CIR may be configured independently for low priority traffic, medium priority traffic, high priority traffic, and ultra high priority traffic.

Note

CIR settings only apply to the Legacy scheduler. Starting in release 16.1 a new Proportional scheduler can optionally be enabled via **Configuration** -> **Quality of Service** -> **Scheduler setting**. If Proportional Scheduler is set, CIR's are not used.

CIR parameters may be configured in the following ways:

- Web-based management GUI
- SNMP
- Authentication Server (RADIUS) - when an SM successfully registers and authenticates, CIR information is retrieved from the RADIUS server.

Active CIR configuration can be verified via the AP's **Home > Session Status** page.

Bandwidth from the SM Perspective

In the SM, normal web browsing, e-mail, small file transfers and short streaming video are rarely rate limited with practical bandwidth management (QoS) settings. When the SM processes large downloads such as software upgrades and long streaming video or a series of medium-size downloads, the bucket rapidly drains, the burst limit is reached, and some packets are delayed. The subscriber experience is more affected in cases where the traffic is more latency sensitive.

Interaction of Burst Allocation and Sustained Data Rate Settings

If the Burst Allocation is set to 1200 kb and the Sustained Data Rate is set to 128 kbps, a data burst of 1000 kb is transmitted at full speed because the Burst Allocation is set high enough. After the burst, the bucket experiences a significant refill at the Sustained Data Rate. This configuration uses the advantage of the settable Burst Allocation.

If both the Burst Allocation and the Sustained Data Rate are set to 128 kb, a burst is limited to the Burst Allocation value. This configuration does not take advantage of the settable Burst Allocation.

If the Burst Allocation is set to 128 kb and the Sustained Data Rate is set to 256 kbps, the actual rate is the burst allocation (but in kbps). As above, this configuration does not take advantage of the settable Burst Allocation.

SM Prioritization

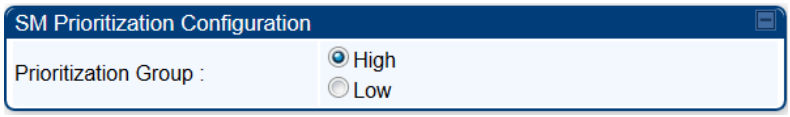
Note

This feature is not supported on PMP 450m.

SM Prioritization provides a way to designate a subset of a PMP sector's SMs with a guaranteed portion of air interface resources - slots, which are handled first during scheduling. SMs by default are configured in the SM Prioritization Low Group, and can be configured for the SM Prioritization High Group if desired.

The selection of which prioritization group each SM is configured in **Configuration** -> **Quality of Service** tab -> **SM Prioritization Configuration** on the SM GUI, as shown in Figure 36.

Figure 36 SM Prioritization on SM



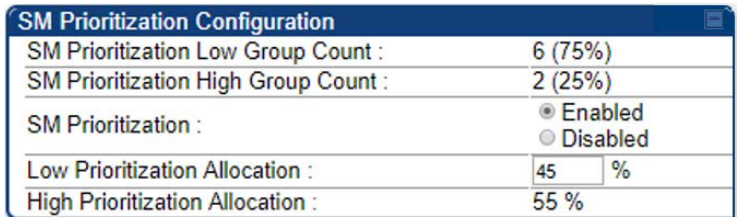
The feature does not take effect, however, until SM Prioritization is enabled on the AP, because the scheduler runs on the AP. Prioritization Allocation percentages per group are configured on the AP to determine how many timeslot resources are dedicated to each priority group.

Enabling of the feature and allocation percentages per group are configured in **Configuration** -> **Quality of Service** tab -> **SM Prioritization Configuration** on the AP GUI as shown in Figure 37.

With Cambium's SM prioritization feature, we guarantee a percentage of slot resources to each prioritization group. If the resource allocation demands of the SMs in the High Priority allocation group are met without allocating all of that group's allocation percentage, the remaining resources can be used for any unmet demands for SMs in the Low Group. Similarly, if the resource allocation demands of the SMs in the Low Priority allocation group are met without allocating all of that group's allocation percentage, the remaining resources can be used for any unmet demands for SMs in the High Group. If the sector has 100% utilization, the resource allocation per group will equal the percentages configured on the AP. This feature can be used to provide guaranteed frame allocation to high priority clients, such as business customers. Although SM Prioritization Group 1 is called the "High Priority" group, and SM Prioritization Group 2 is called the "Low Priority" group, this does not mean that 1 group is scheduled resources before the other group. The intention is, by adjusting the number of SMs in the High Priority group and the allocation percentages per group, the SMs in the High Priority group will have a higher "slots/SMs" ratio.

The following figure shows the SM Prioritization configuration at the AP with this feature enabled.

Figure 37 SM Prioritization on AP



In the example shown in Figure 37, 2 of the 8 SMs have been configured for the High Priority Group. The other 6 are in the Low Priority group. 45% of the air interface timeslot resources have been allocated to the Low Priority group. If, for example, all SMs are fully active and all resources in this sector are fully utilized, then 55% of the air interface slot resources will be shared between the 2 High Priority SMs, per direction, and the remaining 45% of the resources will be shared between the other 6 SMs.

If, on the other hand, only 40% of the resources are needed to meet the scheduling demands of the 2 High Priority SMs, the additional 15% that was pre-allocated to the High Priority group can then be used for the Low Priority group, maintaining 100% slot utilization in the sector.

SM Prioritization with CIR

When the SM Prioritization feature is used with CIR, Cambium's scheduler will first prioritize scheduling of data channels configured with a CIR, but only within the limits of that SMs Prioritization Group allocation. In the example configuration shown in Figure 37, there are 6 SMs in the Low Prioritization group. If 3 of those 6 SMs each have a 1Mbps CIR configured, the Cambium scheduler will attempt to meet this 1Mbps CIR per SM before scheduling the other 3 SMs. But if both prioritization groups are overloaded, this 3Mbps committed load on these 3 SMs will only be achieved if it can be done with 55% of the resources or less – per direction.

Weighted Fair Queuing (WFQ)

Note

This feature is not supported on PMP 450m.

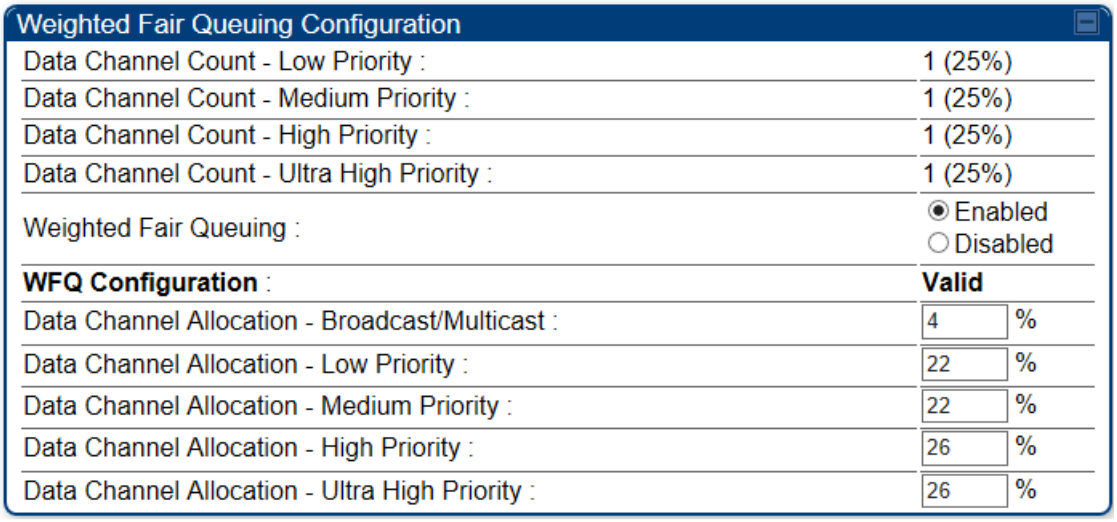
This feature lets the user assign a percentage of air interface resources to each of the Data Channel levels. The WFQ apply both to the DL and the UL. Note that there is no BC/MC traffic in the UL direction.

One of the benefits of WFQ is that the configuration can be accomplished at the AP rather than at each individual SMs. This feature can be used with or in place of existing CIR settings. Unlike CIR, which is set in kbps independent of the modulation rate, the WFQ feature operates on a percentage of air interface resources, or timeslots.

Figure 38 is an example of a WFQ configuration on the AP. This can be found in **Configuration** -> **Quality of Service** tab -> **Weighted Fair Queuing Configuration** on the AP GUI.

In this particular sector, we have 30 Data channels spread across 8 registered SM's. 4 levels of QoS have been configured on 7 of the SM's, 2 levels of QoS have been configured on 1 of the SM's.

Figure 38 Weighted Fair Queuing Configuration



The above figure shows that 4% of the air interface resources have been reserved for Broadcast/Multicast traffic, 22% of the available air interface timeslot have been reserved for the lowest priority traffic, 22% for medium priority traffic, 26% for high priority traffic, and 26% for the highest priority traffic (Ultra High Priority).

If, at any point in the time, the aggregate traffic load across all SMs on 1 QoS level is less than that level's Weighted Fair Queue allocation, then those unused slots will be allocated for traffic in other QoS levels, based on strict priority.

For example, if, during peak traffic hours, the Ultra High, High, and Low priority Data channels were experiencing heavy traffic loads, but the medium priority aggregate traffic load was light and only used 10% of the scheduling slots in a particular direction, the remaining unused 12% of the slots would be allocated first to the Ultra High priority traffic in queue. When all the Ultra High priority traffic has been scheduled, then any remaining unused slots would be used for High Priority traffic. Finally, after High Priority traffic has been serviced, any remaining slots would be used for Low Priority traffic. The “Low Priority” in the sub-heading “Low Priority SM’s WFQ Configuration” shown above simply indicates that the SM Prioritization feature is turned off in this example above. The “Valid” indication in this screenshot is a simple software check to make sure that the configured percentages add up to 100%.

WFQ with CIR

Note

This feature is not supported on PMP 450m.

The WFQ feature can be used with, or as a replacement for, configuring Committed Information Rates (CIR) per data channel. When the WFQ feature is used with CIR’s, Cambium’s scheduler will first prioritize scheduling of the Data channels configured with a CIR, but only within the limits of that QoS level’s WFQ allocation.

Using the example configuration show in Figure 38, there are 8 high priority Data channels. If 5 of those 8 Data channels have a CIR configured, then the Cambium scheduler will prioritize traffic on those 5 Data channels up to their CIR limits, for those 26% of the timeslots allocated to that QoS level. Operators should try to avoid oversubscription of CIR’s. But if CIR’s have been oversubscribed at any 1 QoS level such that the desired CIR rates cannot be met within the limits of that level’s WFQ allocation, the scheduler will use unallocated slots from another QoS level in strict priority order.

From the prior example, if there is less than 22% of timeslots worth of traffic on the medium priority Data channels, those unused slots would be allocated to Ultra High Priority traffic on Data channels that had not met their CIR commitment within the WFQ allocation, then on High Priority Data channels that had not met their CIR commitment within WFQ allocation, then on Low Priority Data channels that had not met their CIR commitment with WFQ allocation, then on Ultra High Priority traffic above and beyond any CIR configurations, and so on.

WFQ with SM Prioritization

Note

This feature is not supported on PMP 450m.

Figure 39 shows a WFQ configuration with the SM Prioritization feature also enabled.

Figure 39 WFQ with SM Prioritization

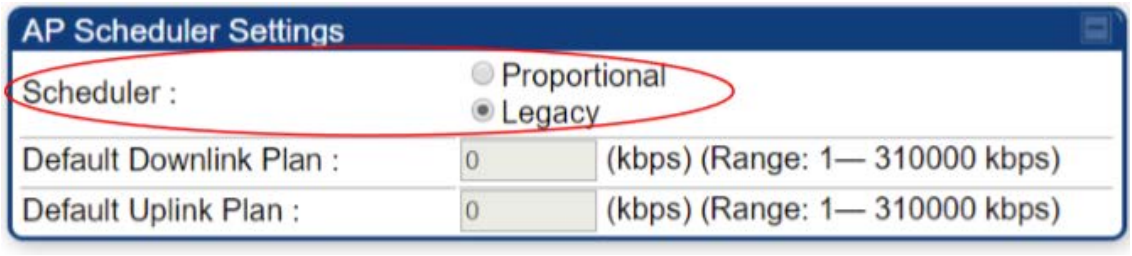
Weighted Fair Queuing Configuration	
Data Channel Count - Low Priority :	1 (25%)
Data Channel Count - Medium Priority :	1 (25%)
Data Channel Count - High Priority :	1 (25%)
Data Channel Count - Ultra High Priority :	1 (25%)
Weighted Fair Queuing :	(•) Enabled ( ) Disabled
WFQ Configuration (SM Prioritization Low Group) :	**Valid**
Data Channel Allocation - Broadcast/Multicast :	4 %
Data Channel Allocation - Low Priority :	22 %
Data Channel Allocation - Medium Priority :	22 %
Data Channel Allocation - High Priority :	26 %
Data Channel Allocation - Ultra High Priority :	26 %
WFQ Configuration (SM Prioritization High Group) :	**Valid**
Data Channel Allocation - Low Priority :	25 %
Data Channel Allocation - Medium Priority :	25 %
Data Channel Allocation - High Priority :	25 %
Data Channel Allocation - Ultra High Priority :	25 %

In the example shown in Figure 39, 2 of the 8 SMs have been configured for the High Priority Group. The other 6 are in the Low Priority group. 45% of air interface timeslot resources have been allocated to the Low priority group. The same allocation rules described above still apply to the WFQ allocation, but now these allocations are done within the confines of each Prioritization group. So, in this configuration shown in Figure 39, the 2 Medium Priority QoS level Data channels in the High Priority SM Prioritization Group together share 12% of the committed air interface resources per direction. (.55 x .22 = .12) The same CIR allocation rules apply. The Cambium scheduler will attempt to meet those CIR allocations within the confines of that 12% allocation. If the traffic load on those 2 data channels is light, for example using only 5% of the available slots, then the remaining 7% of resources can be used for other traffic in a strict priority manner. (i.e. attempt to honor CIR's first, then Ultra High Priority traffic, then High Priority traffic, and so on, as described previously).

Proportional Scheduler

This feature, also known as the Rate Plan feature, allows a user to set Plans per SM in units of Kbps. The proportional scheduler maintains the proportions of the SMs' plans when the sector is congested. A default plan setting per direction also exists on the AP and is used in case an SM is not configured with a Plan (for example, the SM is not upgraded to system release 16.1 yet).

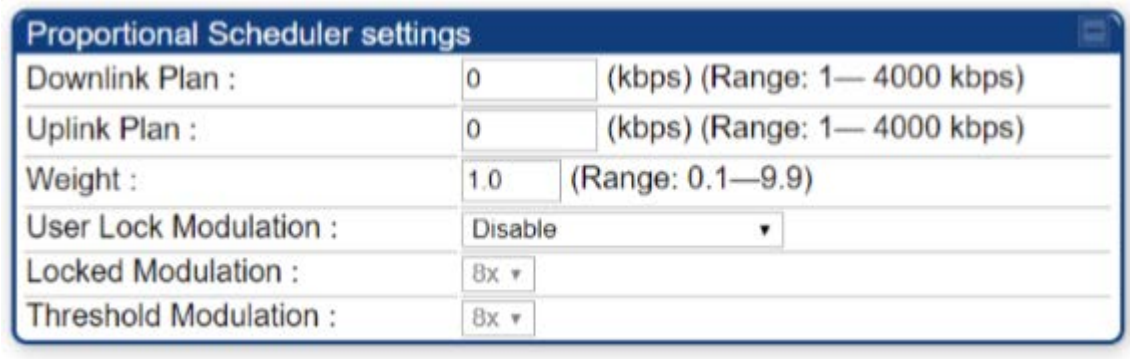
Figure 40 Scheduler Settings on AP



When selecting the Proportional scheduler, CIR is no longer applicable.

In system release 16.1, the SM supports a Proportional Scheduler setting section in the **Configuration-> Quality of Service (QoS)** page. These settings are applicable only if the AP is configured to use the Proportional scheduler.

Figure 41 Proportional Scheduler Settings on AP



The above 6 settings parameters are described in detail in the Quality of Service (QoS) page of SM later in this document.

The proportional scheduler works in conjunction with the Weighted Fair Queuing feature (in the products that support it), but preserving the plans ratios takes precedence in the scheduler decisions over honoring the WFQ percentages

High-priority Bandwidth Traffic

To support low-latency traffic such as VoIP (Voice over IP) or video, or critical traffic such as control packets, the system implements priority data channels. Prior to PMP 450 Release 15.2, the system allowed for a single High Priority Channel to be configured per SM and per direction, in addition to the default low priority channel. This channel did not affect the inherent latencies in the system but allowed high-priority traffic to be immediately served. The high-priority pipe separates low-latency traffic from traffic that is latency tolerant, such as standard web traffic and file downloads.

From system release 15.2, the system supports up to 4 QoS levels, or data channels, per SM. These are called Low, Medium, High, and Ultra High data channels.

The number of data channels available on the AP is still limited to 238 in release 15.2 This could be 238 SM's each configured with a single Low Priority channel, or, for example, 59 SMs with 4 data channels configured and 1 SM with 2 data channels configured.

A module prioritizes traffic by:

- reading the 802.1p field of the 802.1Q header in a received packet, where VLAN is enabled on the module.
- comparing the 6-bit Differentiated Services Code Point (DSCP) field in the ToS byte of a received packet to a corresponding value in the Diffserv tab of the Configuration page of the module.

Modules monitor ToS bytes with DSCP fields, but with the following differences:

- The 6-bit length of the field allows it to specify one of 64 service differentiations.
- These correlate to 64 individual (**CodePoint**) parameters in the **Diffserv** tab of the Configuration page.
- The 8 Class Selector code points are fixed in code and not user settable.
- For any or all of the remaining 56 CodePoint parameters, you can specify a value of
  - 0, 1 for low-priority handling.
  - 2, 3 for medium-priority handling.
  - 4,5 for high-priority handling.
  - 6, 7 for ultra-high-priority handling.

The above mapping applies if 4 QoS levels are configured. If fewer than that are configured, see the mapping table in the IPv4 and IPv6 Prioritization of this document.

Note

Ensure that your Differentiated Services domain boundary nodes mark any entering packet, as needed, so that it specifies the appropriate Code Point for that traffic and domain. This prevents theft of service level.

An example of the **Diffserv** page in the Configuration menu and parameter descriptions are provided under DiffServ attributes – AP/BHM on page 1-62. This tab and its rules are identical from module type to module type. However, any of the 61 configurable Code Points can be set to a different value from module to module, thus defining unique per-hop behavior for some traffic.

This tab in the AP sets the priorities for the various packets in the downstream (sent from the public network). This tab in the SM sets the priorities for the various packets in the upstream (sent to the public network).

Typically, some SMs attach to older devices that use the ToS byte as originally formatted, and others to newer devices that use the DSCP field. The *default* values in the **Diffserv** page allow your modules to prioritize traffic from the older devices roughly the same as they traditionally have. However, these default values may result in more high-priority traffic as DSCP fields from the newer devices are read and handled. So, after making changes in the **Diffserv** page, carefully monitor the high-priority channel for high packet rates

- in SMs that you have identified as those to initially set and watch.
- across your network when you have broadly implemented Code Point values, such as via SNMP.

Traffic Scheduling

The characteristics of traffic scheduling in a sector are summarized in Table 80.

Table 80 Characteristics of traffic scheduling

Category	Factor	Treatment
Throughput	Aggregate throughput, less additional overhead	132 Mbps for 20 MHz Higher for 30 MHz or 40 MHz and lower for smaller bandwidths.
Latency	Number of frames required for the scheduling process	1
	Round-trip latency	≈ 6 ms
	AP broadcast the download schedule	No
Priority Data Channels	Allocation for *uplink* high-priority data channel traffic on amount of traffic at these higher QoS levels.	Dynamic, based on amount of high-priority traffic
	Allocation for *downlink* high-priority data channel traffic on amount of traffic at these higher QoS levels	Dynamic, based on amount of high-priority traffic
	Order of transmission	1- Ultra High Priority data channels below CIR limit 2- High Priority data channel's below CIR limit 3- Medium Priority data channels below CIR limit 4- Low Priority data channels below CIR limit 5- Ultra High Priority data channels above CIR limit 6- High Priority data channels above CIR limit 7- Medium Priority data channels above CIR limit 8- Low Priority data channels above CIR limit

Note

This strict priority transmission order is only true in all cases if the SM Prioritization and Weighted Fair Queue features are disabled. If either feature is enabled, see the description of those features in this document for how they impact and interact with this transmission order.

Setting the Configuration Source

The AP includes a **Configuration Source** parameter, which sets where SMs that register to the AP are controlled for MIR, CIR, VLAN, and the high-priority channel as follows. The **Configuration Source** parameter affects the source of:

- all MIR settings:
  - Sustained Uplink Data Rate
  - Uplink Burst Allocation
  - Max Burst Uplink Data Rate
  - Sustained Downlink Data Rate
  - Downlink Burst Allocation
  - Max Burst Downlink Data Rate
- all CIR settings:
  - Low Priority Uplink CIR
  - Low Priority Downlink CIR
  - Medium Priority Uplink CIR
  - Medium Priority Downlink CIR
  - High Priority Uplink CIR
  - High Priority Downlink CIR
  - Ultra High Priority Uplink CIR
  - Ultra High Priority Downlink CIR
- all SM VLAN settings
  - Dynamic Learning
  - Allow Only Tagged Frames
  - VLAN Aging Timeout
  - Untagged Ingress VID
  - Management VID
  - VLAN Membership
- the High Priority Channel setting

Table 81 Recommended combined settings for typical operations

Most operators who use...	must set this parameter...	in this web page/tab...	in the AP to...
no authentication server	Authentication Mode	Configuration/ Security	Disabled
	Configuration Source	Configuration/ General	SM
Wireless Manager (Authentication Server)	Authentication Mode	Configuration/ Security	Authentication Server
	Configuration Source	Configuration/ General	Authentication Server
RADIUS AAA server	Authentication Mode	Configuration/ Security	RADIUS AAA
	Configuration Source	Configuration/ General	Authentication Server

Table 82 Where feature values are obtained for an SM registered under an AP with Authentication Mode set to something other than "DISABLED"

Configuration Source Setting in the AP	Values are obtained from		
	MIR Values	VLAN Values	Data Channel Count per SM
Authentication Server	Authentication Server	Authentication Server	Authentication Server
SM	SM	SM	SM
Authentication Server+SM	Authentication Server	Authentication Server, then SM	Authentication Server, then SM

Note

Where Authentication Server, then SM is the indication, parameters for which Authentication Server does not send values are obtained from the SM. This is the case where the Authentication Server is operating on an Authentication Server release that did not support the feature. This is also the case where the feature enable/disable flag in Authentication Server is set to disabled. The values are those previously set or, if none ever were, then the default values.

Where Authentication Server is the indication, values in the SM are disregarded.

Where SM is the indication, values that Authentication Server sends for the SM are disregarded.

For any SM registered under an AP with Authentication Mode set to something other than "DISABLED", the listed settings are derived as shown in Table 83.

Table 83 MIR, VLAN, HPC, and CIR Configuration Sources, Authentication Disabled

	Values are obtained from

Configuration Source Setting in the AP	MIR Values	VLAN Values	Data Channel Count per SM	CIR Values
Authentication Server	AP	AP		
SM	SM	SM	SM	SM
Authentication Server+SM	SM	SM	SM	SM

Note

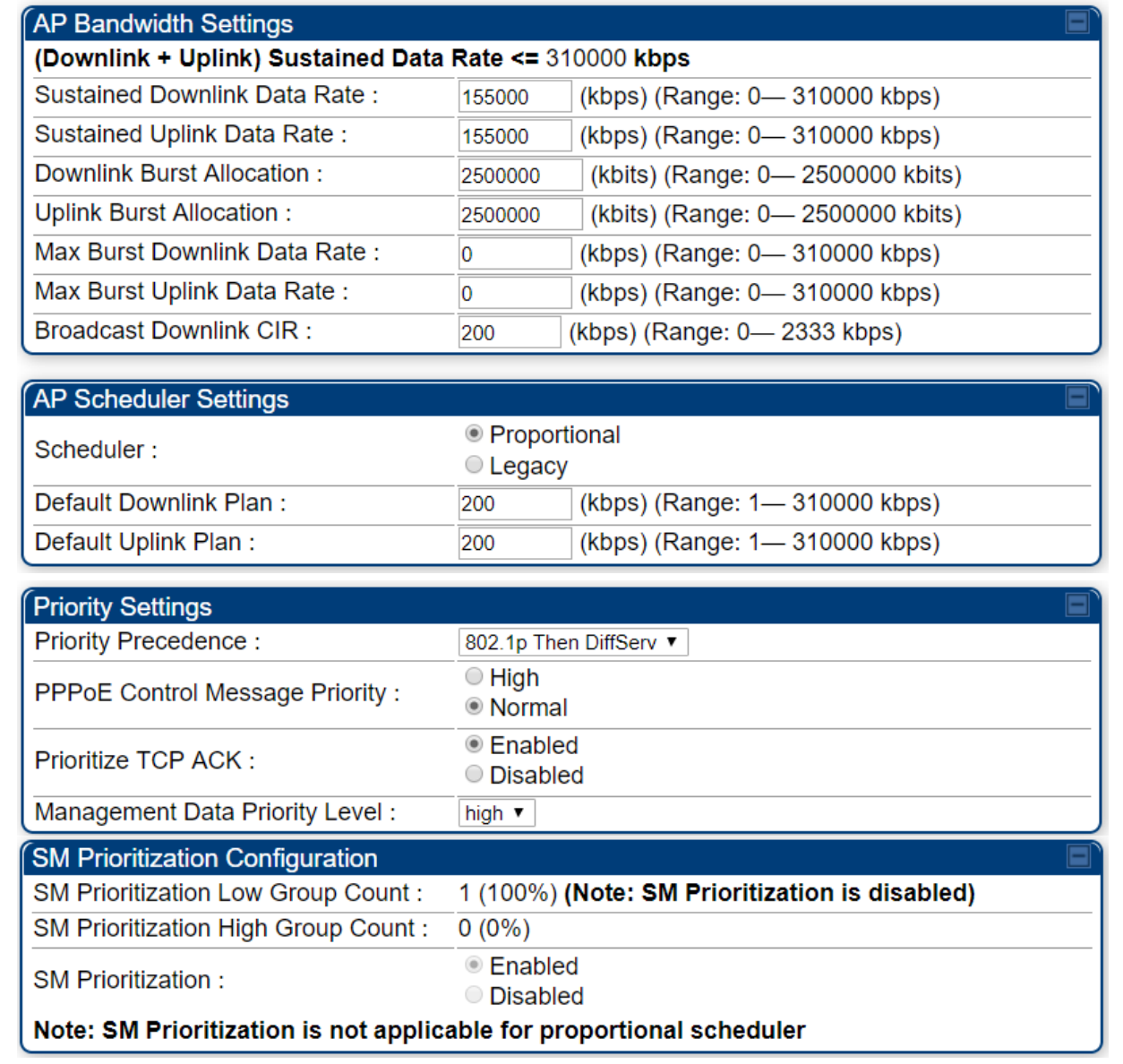
For the case where configuration source is set to Authentication Server, the Data Channel Count per SM, and the CIR values for those data channels, is defaulted to Low Priority data Channel only with no CIR's configured.

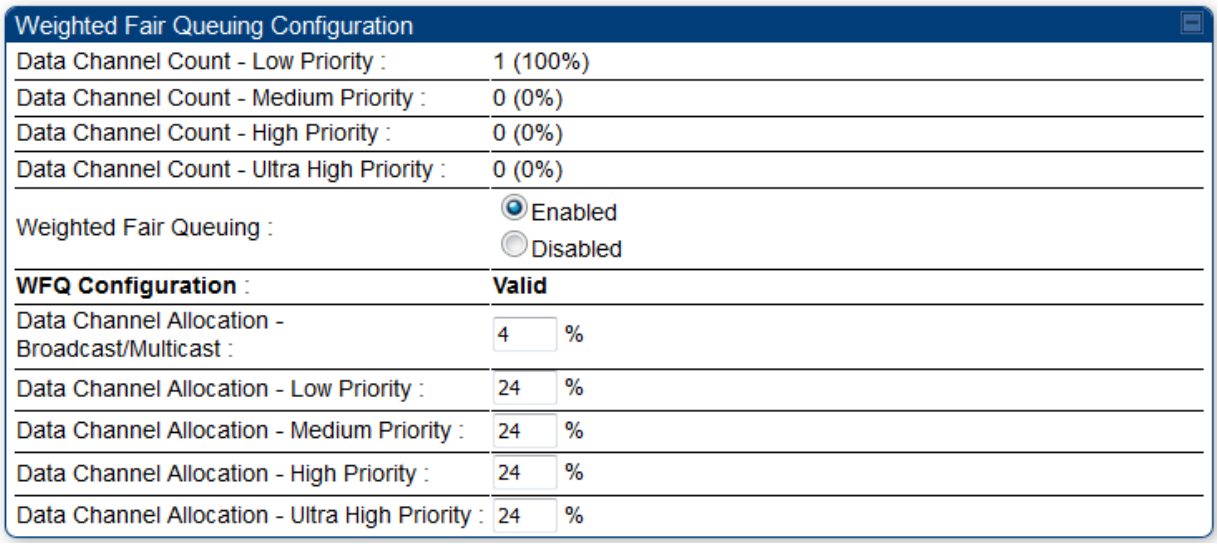
Configuring Quality of Service (QoS)

Quality of Service (QoS) page of AP

The QoS page of AP is explained in Table 84.

Table 84 QoS page attributes - AP





Attribute	Meaning
Sustained Downlink Data Rate	Specify the rate at which the AP is replenished with credits (tokens) for transmission to each of the SMs in its sector. This default imposes no restriction on the uplink. See Maximum Information Rate (MIR) Parameters on page 1-236 • Interaction of Burst Allocation and Sustained Data Rate Settings on page 1-238 • Configuration Source on page 1-73
Sustained Uplink Data Rate	Specify the rate that each SM registered to this AP is replenished with credits for transmission. This default imposes no restriction on the uplink. See • Maximum Information Rate (MIR) Parameters on page 1-236 • Interaction of Burst Allocation and Sustained Data Rate Settings on page 1-238 • Configuration Source on page 1-73
Downlink Burst Allocation	Specify the maximum amount of data to allow the AP to transmit to any registered SM before the AP is replenished with transmission credits at the **Sustained Downlink Data Rate**. See • Maximum Information Rate (MIR) Parameters on page 1-236 • Interaction of Burst Allocation and Sustained Data Rate Settings on page 1-238 • Configuration Source on page 1-73
Uplink Burst Allocation	Specify the maximum amount of data to allow each SM to transmit before being recharged at the **Sustained Uplink Data Rate** with credits to transmit more. See Maximum Information Rate (MIR) Parameters on page 1-236 • Interaction of Burst Allocation and Sustained Data Rate Settings on page 1-238

	• Configuration Source on page 1-73
Max Burst Downlink Data Rate	These parameters allow operators to specify the data rate at which an SM is allowed to transmit (until burst allocation limit is reached) before being recharged at the **Sustained Downlink Data Rate** with credits to transit more. When set to 0 (default), the burst rate is unlimited.
Max Burst Uplink Data Rate	These parameters allow operators to specify the data rate at which an SM is allowed to transmit (until burst allocation limit is reached) before being recharged at the **Sustained Uplink Data Rate** with credits to transit more. When set to 0 (default), the burst rate is unlimited.
Broadcast Downlink CIR	Broadcast Downlink CIR (Committed Information Rate, a minimum) supports system designs where downlink broadcast is desired to have higher priority than other traffic. For many other system designs, especially typical internet access networks, leave the Broadcast Downlink CIR at the default. Broadcast Downlink CIR is closely related to the Broadcast Repeat Count parameter, which is settable in the Radio tab of the Configuration page in the AP: when the Broadcast Repeat Count is changed, the total of available bandwidth is also changed, since packets are being sent one, two, or three times, according to the setting in the Broadcast Repeat Count parameter.
Scheduler	This parameter allows the operator to either select the Proportional scheduler or the Legacy scheduler.
Default Downlink Plan	This parameter allows the operator to configure the default downlink plan. The value range for this parameter is 1 – 310000 kbps. Note: Configure this parameter when an SM is not configured with a plan or an SM is still running software older than system release 16.1.
Default Uplink Plan	This parameter allows the operator to configure the default uplink plan. The value range for this parameter is 1 – 310000 kbps. Note: Configure this parameter when an SM is not configured with a plan or an SM is still running software older than system release 16.1.
Priority Precedence	Allows operator to decide if 802.1p or DiffServ priority bits must be used first when making priority decisions.
PPPoE Control Message Priority	Operators may configure the SM to utilize the high priority channel for PPPoE control messages. Configuring the SM in this fashion can benefit the continuity of PPPoE connections when there are issues with PPPoE sessions being dropped in the network. This prioritization may be configured in the DiffServ tab in the Configuration menu of the SM.
Prioritize TCP ACK	To reduce the likelihood of TCP acknowledgement packets being dropped, set this parameter to **Enabled**. This can improve throughput that the end user perceives during transient periods of congestion on the link that is carrying acknowledgements.
Management Data Priority Level	This parameter allows to set the priority level of the VC used by Management data.

	Low: Management data uses low priority VC. High: Management data uses highest priority VC
SM Prioritization Low Group Count	This parameter displays the number and percentage of SMs allocated with low prioritization.
SM Prioritization High Group Count	This parameter displays the number and percentage of SMs allocated with high prioritization.
SM Prioritization	To associate a group of SMs at the same prioritization level with a guaranteed percentage of time for data to/from SMs in the group, enable this parameter. Low Prioritization Allocation and High Prioritization Allocation parameters are visible when SM Prioritization is enabled. **Note:** SM Prioritization is not applicable for proportional scheduler.
Low Prioritization Allocation	This parameter configures the percentage of timeslots dedicated to low prioritization group of SMs
High Prioritization Allocation	Once the Low Prioritization Allocation parameter is configured, this parameter automatically allocates the percentage of slots dedicated to high prioritization group of SMs such that the sum of parameters Low Prioritization Allocation and High Prioritization Allocation is 100%.
Data Channel Count - Low Priority	This parameter displays the percentage of time committed to transfer data to/from VCs at Low Priority QoS level.
Data Channel Count - Medium Priority	This parameter displays the percentage of time committed to transfer data to/from VCs at Medium Priority QoS level.
Data Channel Count - High Priority	This parameter displays the percentage of time committed to transfer data to/from VCs at High Priority QoS level.
Data Channel Count - Ultra High Priority	This parameter displays the percentage of time committed to transfer data to/from VCs at Ultra High Priority QoS level.
Weighted Fair Queuing	To provide a committed frame space for all QoS levels, enable this parameter.
WFQ Configuration (SM Prioritization Low Group): If the percentage of Low Priority SMs is configured as 100%, or SM Prioritization is disabled, or the WFQ feature is disabled, then the GUI displays the following set of five WFQ configuration parameters	

Data Channel Allocation - Broadcast/Multicast	This parameter allows to configure the percentage of frame space allocated for broadcast/multicast.
Data Channel Allocation - Low Priority	This parameter allows to configure the percentage of frame space allocated for low priority QoS level.
Data Channel Allocation - Medium Priority	This parameter allows to configure the percentage of frame space allocated for medium priority QoS level.
Data Channel Allocation - High Priority	This parameter allows to configure the percentage of frame space allocated for high priority QoS level.
Data Channel Allocation - Ultra High Priority	This parameter allows to configure the percentage of frame space allocated for ultra high priority QoS level.

WFQ Configuration (SM Prioritization High Group):

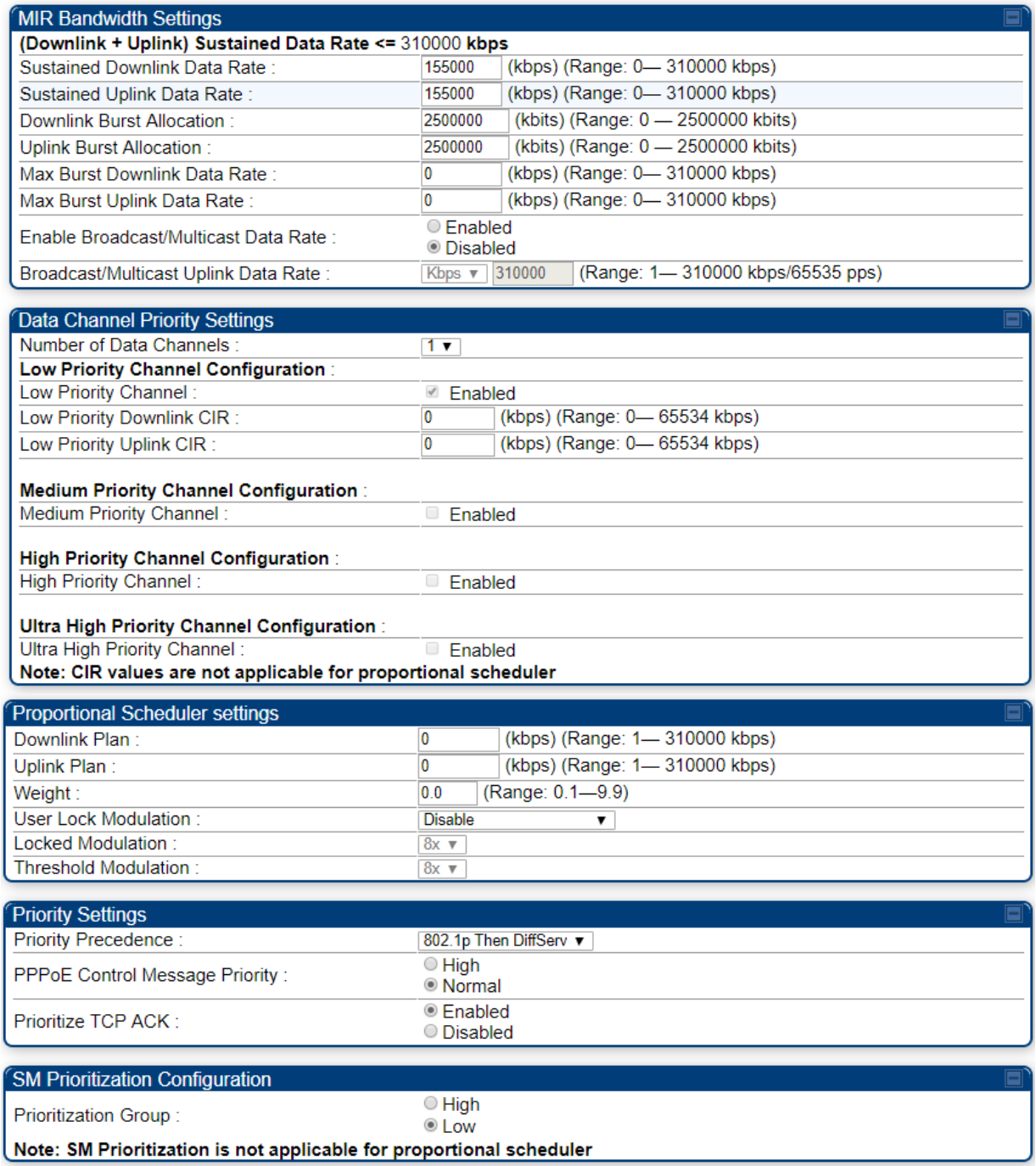
If SM Prioritization is enabled and the percentage of Low Priority SMs is configured as anything less than 100%, which means that the percentage of High Priority SMs is not 0, and the WFQ feature is enabled, then the GUI displays the WFQ Configuration (SM Prioritization Low Group) and the following set of five WFQ configuration parameters for High group.

Data Channel Allocation - Low Priority	This parameter allows to configure the percentage of frame space allocated for low priority QoS level.
Data Channel Allocation - Medium Priority	This parameter allows to configure the percentage of frame space allocated for medium priority QoS level.
Data Channel Allocation - High Priority	This parameter allows to configure the percentage of frame space allocated for high priority QoS level.
Data Channel Allocation - Ultra High Priority	This parameter allows to configure the percentage of frame space allocated for ultra high priority QoS level.

Quality of Service (QoS) page of SM

The QoS page of SM is explained in Table 85.

Table 85 QoS page attributes - SM



Attribute	Meaning

Sustained Uplink Data Rate	Specify the rate that this SM is replenished with credits for transmission. This default imposes no restriction on the uplink. See Maximum Information Rate (MIR) Parameters on page 1-236 • Interaction of Burst Allocation and Sustained Data Rate Settings on page 1-238 • Configuration Source on page 1-73
Sustained Downlink Data Rate	Specify the rate at which the AP is replenished with credits (tokens) for transmission to this SM. This default imposes no restriction on the uplink. See Maximum Information Rate (MIR) Parameters on Page 1-236 • Interaction of Burst Allocation and Sustained Data Rate Settings on page 1-238 • Configuration Source on page 1-73
Downlink Burst Allocation	Specify the maximum amount of data to allow the AP to transmit to this SM before the AP is replenished at the **Sustained Downlink Data Rate** with transmission credits. See Maximum Information Rate (MIR) Parameters on page 1-236 • Interaction of Burst Allocation and Sustained Data Rate Settings on page 1-238 Configuration Source on page 1-73
Uplink Burst Allocation	Specify the maximum amount of data to allow this SM to transmit before being recharged at the **Sustained Uplink Data Rate** with credits to transmit more. See Maximum Information Rate (MIR) Parameters on page 1-236 • Interaction of Burst Allocation and Sustained Data Rate Settings on page 1-238 • Configuration Source on page 1-73
Max Burst Downlink Data Rate	These parameters allow operators to specify the data rate at which a SM is allowed to transmit (until burst allocation limit is reached) before being recharged at the **Sustained Downlink Data Rate** with credits to transit more. When set to 0 (default), the burst rate is unlimited.
Max Burst Uplink Data Rate	These parameters allow operators to specify the data rate at which a SM is allowed to transmit (until burst allocation limit is reached) before being recharged at the **Sustained Uplink Data Rate** with credits to transit more. When set to 0 (default), the burst rate is unlimited.
Enable Broadcast / Multicast Data Rate	This parameter allows the operator to specify if Broadcast and Multicast data is rate-limited. This data rate can be entered in Kbps or PPS (Packets Per Second).
Broadcast / Multicast Data Rate	This parameter allows the operator to specify a data rate at which Broadcast and Multicast traffic is sent via the radio link.
Number of Data Channels	This parameter allows the operator to specify the number of priority channels to be used for data transmission which is configurable from 1 to 4. • 1: Select 1 to enable Low Priority channel.

	• 2: Select 2 to enable Low and High Priority channels. • 3: Select 3 to enable Low, Medium, and High Priority channels. • 4: Select 4 to enable all channels. For each enabled channel, configure the respective Downlink CIR and Uplink CIR.
Low Priority Channel	This parameter shows whether low priority data channel is enabled or not. Its value is derived based on the number of data channels selected. This parameter is enabled by default.
Low Priority Downlink CIR	This field indicates the minimum rate at which low priority traffic is sent over the downlink (unless CIR is oversubscribed or RF link quality is degraded). • Committed Information Rate (CIR) on page 1-237 • Setting the Configuration Source on page 1-246 Note: CIR values are not applicable for proportional scheduler.
Low Priority Uplink CIR	This field indicates the minimum rate at which low priority traffic is sent over the uplink (unless CIR is oversubscribed or RF link quality is degraded). • Committed Information Rate (CIR) on page 1-237 • Setting the Configuration Source on page 1-246 Note: CIR values are not applicable for proportional scheduler.
Medium Priority Channel	This parameter shows whether medium priority data channel is enabled or not. Its value is derived based on the number of data channels selected.
Medium Priority Downlink CIR	This field indicates the minimum rate at which medium priority traffic is sent over the downlink (unless CIR is oversubscribed or RF link quality is degraded). • Committed Information Rate (CIR) on page 1-237 • Setting the Configuration Source on page 1-246 Note: CIR values are not applicable for proportional scheduler.
Medium Priority Uplink CIR	This field indicates the minimum rate at which medium priority traffic is sent over the uplink (unless CIR is oversubscribed or RF link quality is degraded). • Committed Information Rate (CIR) on page 1-237 • Setting the Configuration Source on page 1-246 Note: CIR values are not applicable for proportional scheduler.
High Priority Channel	
High Priority Downlink CIR	This field indicates the minimum rate at which high priority traffic is sent over the downlink (unless CIR is oversubscribed or RF link quality is degraded). • Committed Information Rate (CIR) on page 1-237 • Setting the Configuration Source on page 1-246

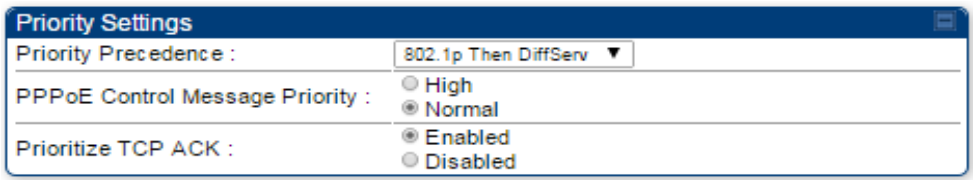
	Note: CIR values are not applicable for proportional scheduler.
High Priority Uplink CIR	This field indicates the minimum rate at which high priority traffic is sent over the uplink (unless CIR is oversubscribed or RF link quality is degraded). • Committed Information Rate (CIR) on page 1-237 • Setting the Configuration Source on page 1-246 Note: CIR values are not applicable for proportional scheduler.
Ultra High Priority Channel	This parameter allows the operator to enable or disable one of the data channels with the highest priority bandwidth.
Downlink Plan	This parameter allows the operator to configure the default downlink plan. The value range for this parameter is 1 – 310000 kbps.
Uplink Plan	This parameter allows the operator to configure the default uplink plan. The value range for this parameter is 1 – 310000 kbps.
Weight	This parameter ranges from 0.1 to 9.9 to prioritize SM services. This is a scaling factor to be applied to the Downlink and Uplink plan. **Note:** There is only one weight used for a plan in both directions. The default value for this parameter is 1.0.
User Lock Modulation	This parameter contains the following three modes. **Disable:** When disabled, the Proportional scheduler allocates resources to meet the configured plan. When there is congestion, the Proportional scheduler allocates a reduced value proportional to the other plans regardless of the modulation. If the modulation of one SM degrades, the resources allocated to meet this SM's plan increases, affecting the overall sector capacity. The reduced capacity is divided among all SMs proportional to their plans affecting all SMs. **Enable:** When enabled, the Locked Modulation drop-down list is enabled supporting values from 1x to 8x. **Enable Below Threshold:** When enabled, the Threshold Modulation drop-down list is enabled supporting values from 2x to 8x. In this mode, the proportional scheduler behaves as per the Disabled mode until SM's modulation is above the configured Threshold Modulation. If the modulation goes below the Threshold Modulation, then proportional scheduler behaves as per the Enabled mode using the Threshold Modulation as Locked Modulation.
Locked Modulation	Using Locked Modulation, the proportional scheduler guarantees an amount of resources required to transfer data corresponding to the configured plan. If the SM's modulation decreases, the resource allocation is not changed but the SM's throughput is reduced which is no longer proportional to the configured plan. Therefore, the SM's plan is scaled down proportional to the reduced modulation resulting in not affecting other SMs' throughput based on one SM's modulation degrading.

Threshold Modulation	Using Threshold Modulation, if one SM's modulation degrades, then all other SMs' throughputs are affected as long as the degraded modulation is above the threshold. Once the modulation goes below the threshold, the reaources are no longer increased for that SM, effectively capping the effect to other SMs.
Priority Precedence	Allows operator to decide if 802.1p or DiffServ priority bits must be used first when making priority decisions.
PPPoE Control Message Priority	Operators may configure the SM to utilize the high priority channel for PPPoE control messages. Configuring the SM in this fashion can benefit the continuity of PPPoE connections when there are issues with PPPoE sessions being dropped in the network. This prioritization may be configured in the DiffServ tab in the Configuration menu of the SM.
Prioritize TCP ACK	To reduce the likelihood of TCP acknowledgement packets being dropped, set this parameter to Enabled. This can improve throughput that the end user perceives during transient periods of congestion on the link that is carrying acknowledgements. This parameter, when enabled, can be particularly useful when running bi-direction FTP sessions over the link. If a link is primarily used for video surveillance, it is recommended to configure this parameter to **Disabled**.
Prioritization Group	This parameter allows to configure the SM with high or low prioritization.

Quality of Service (QoS) page of BHM

The QoS page of BHM is explained in Table 86.

Table 86 QoS page attributes - BHM



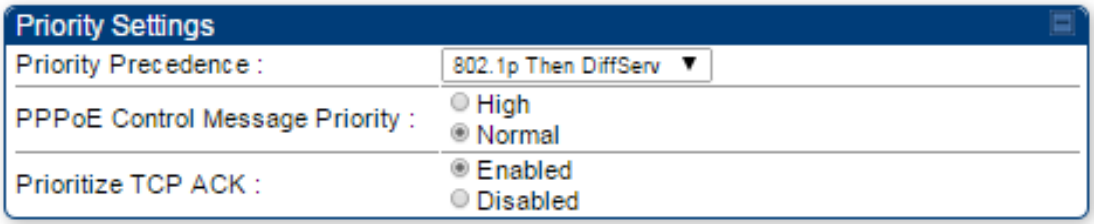
Attribute	Meaning
PPPoE Control Message Priority	Operators may configure the BHM to utilize the high priority channel for PPPoE control messages. Configuring the BHM in this fashion can benefit the continuity of PPPoE connections when there are issues with PPPoE sessions being dropped in the network. This prioritization may be configured in the DiffServ tab in the Configuration menu of the BHS.

Prioritize TCP ACK	To reduce the likelihood of TCP acknowledgement packets being dropped, set this parameter to Enabled. This can improve throughput that the end user perceives during transient periods of congestion on the link that is carrying acknowledgements. This parameter, when enabled, can be particularly useful when running bi-direction FTP sessions over the link. If a link is primarily used for video surveillance, it is recommended to configure this parameter to **Disabled**.

Quality of Service (QoS) page of BHS

The QoS page of BHS is explained in Table 87.

Table 87 QoS page attributes - BHS

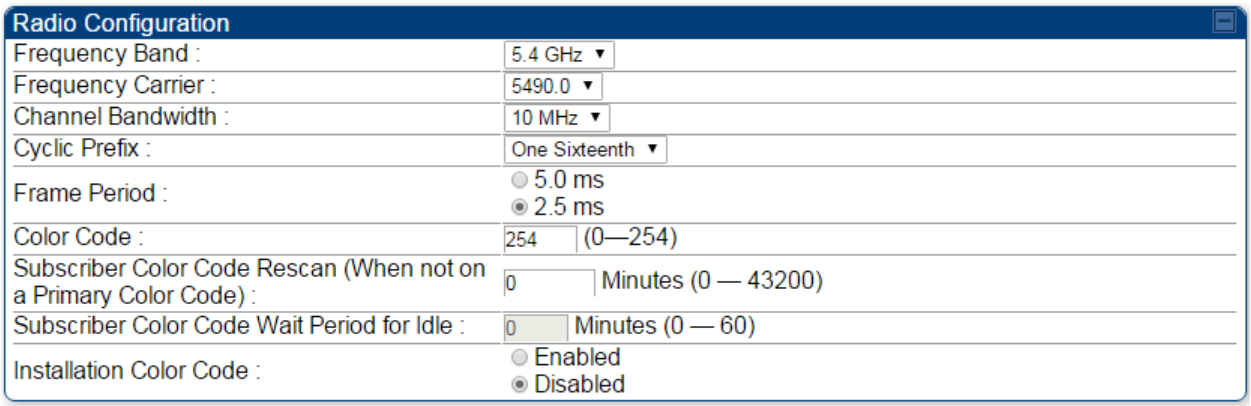


Attribute	Meaning
PPPoE Control Message Priority	Operators may configure the BHS to utilize the high priority channel for PPPoE control messages. Configuring the BHS in this fashion can benefit the continuity of PPPoE connections when there are issues with PPPoE sessions being dropped in the network. This prioritization may be configured in the DiffServ tab in the Configuration menu of the BHS.
Prioritize TCP ACK	To reduce the likelihood of TCP acknowledgement packets being dropped, set this parameter to Enabled. This can improve throughput that the end user perceives during transient periods of congestion on the link that is carrying acknowledgements. This parameter, when enabled, can be particularly useful when running bi-direction FTP sessions over the link. If a link is primarily used for video surveillance, it is recommended to configure this parameter to **Disabled**.

Installation Color Code

With this feature enabled on the AP and SM, operators may install and remotely configure SMs without having to configure matching color codes between the modules. While the SM is accessible for configuration from above the AP (for remote provisioning) and below the SM (for local site provisioning), no user data is passed over the radio link. When using the Installation Color Code feature, ensure that the SM is configured with the factory default Color Code configuration (Color Code 1 is "0", Color Code 2-10 set to "0" and "Disable"). The status of the Installation Color Code can be viewed on the AP Eval web GUI page, and when the SM is registered using the Installation Color Code the message "SM is registered via ICC – Bridging Disabled!" is displayed in red on every SM GUI page. The Installation Color Code parameter is configurable without a radio reboot for both the AP and SM. If an SM is registered via Installation Color Code and the feature is then disabled, operators will need to reboot the SM or force it to reregister (i.e. using the **Rescan APs** functionality on the AP Eval page).

Figure 42 Installation Color Code of AP



Zero Touch Configuration Using DHCP Option 66

This feature allows an SM to get its configuration via DHCP option 66. This can be used for the initial configuration of an SM as well as managing the configuration of SMs on an ongoing basis. Here is how it works in brief:

- When the SM boots up, if it is set to use DHCP client, it will send out a DHCP Discover packet which includes a request for DHCP Option 66.
- In case of a brand new SM out of the box, the DHCP Discover packet is sent out if the SM connects to an AP using Installation Color Code (ICC), even though DHCP client is not enabled in factory default config.
- An appropriately configured DHCP server will respond with a DHCP Offer and include a URL in response to the Option 66 request. The URL should point to the configuration file.
- The device will download the configuration file and apply it. The device will reboot automatically if needed. (Note: this requires “rebootIfRequired” flag to be added to the config file. See Creating a Golden config file on page 1-263.

Configuration Steps

Procedure 15 Zero Touch Configuration steps

1. Create the golden config file(s)
2. Host it on an TFTP/FTP/HTTP/HTTPS server
3. Configure the DHCP server to return the URL of the golden config file in option 66

When the SM boots up, it will get the URL for the golden config from the DHCP server via option 66, download it and apply it.

If all the SMs are configured exactly the same, then you can create just new golden config file that can be used with all SMs.

If the SMs are not configured the same, see if it is possible to group the SMs such that SMs with the same configuration are served by the same DHCP pool. User can then create multiple golden config files and configure the DHCP server to use the appropriate config file for each pool.

User can also create one config file per SM. This provides the most flexibility, but is practical only if you have a software tool/script to generate the config files for each MAC address. The files should be named <mac>.cfg where <mac> is the MAC address of the SM, and stored in the same directory on the file server. The DHCP server should be configured to return the directory name ending with a ‘/’ in option 66. The SM will automatically add “<mac>.cfg” to the path and get its config file.

If some configuration is unique per SM, but rest of the configuration is common, the SMs can be staged with the unique part, and use option 66 to manage the common part. For example, if each SM needs to have its coordinates set, don’t include the coordinates in the golden config file. Instead, configure the coordinates for each SM manually. Manage the rest of the configuration using DHCP option 66.

Creating a Golden config file

The easiest way to create the golden config file is to configure an SM, export its configuration and edit it. To export the configuration file from the GUI of the SM, go to “Configuration > Unit Settings” tab, go to the “Download Configuration File” section and click on the “<mac>.cfg” link. This will give you a text file in JSON format. You can edit this file in a text editor but it’s easier to use a JSON editor like https://www.jsoneditoronline.org/.

Strip down the config file to remove sections and entries that don’t care about, and keep only the items that require changes. If there are many required changes, it can easily get confusing. To identify the exact items changes, first reset the SM to factory default, export the config file, make the necessary changes, export a second config file, then use a tool like WinMerge (http://winmerge.org/) to identify the differences.

The config file contains the following informational entries at the top level.

```
“cfgUtcTimestamp”: “cfgUtcTimestamp”,
“swVersion”: “CANOPY 15.1 SM-AES”,
“cfgFileString”: “Canopy configuration file”,
“srcMacAddress”: “0a-00-3e-a2-c2-74”,
“deviceType”: “5.4/5.7GHz MIMO OFDM - Subscriber Module”,
“cfgFileVersion”: “1.0”
```

The “cfgUtcTimestamp”, “swVersion”, “srcMacAddress” and “deviceType” lines can be deleted. Do not delete the “cfgFileString” and “cfgFileVersion” entries.

Next, create an object named “configFileParameters” at the top level. Under that, add a parameter called “rebootIfRequired” and set it to true. This tells the SM to reboot automatically if a reboot is needed to apply the new configuration.

A sample configuration file that has been edited for use via DHCP option 66 is given below.

```
{
  “userParameters”: {
    “smNetworkConfig”: {
      “networkAccess”: 1
    },
    “location”: {
      “siteName”: “Test site”
    },
    “smRadioConfig”: {
      “frequencyScanList”: [
        5475000,
        5480000
      ],
      “colorCodeList”: [
```

```
        {
          “colorCode”: 42,
          “priority”: 1
        }
      ]
    },
    “networkConfig”: {
      “lanDhcpState”: 1
    }
  },
  “cfgFileVersion”: “1.0”,
  “cfgFileString”: “Canopy configuration file”,
  “configFileParameters”: {
    “rebootIfRequired”: true
  }
}
```

When configuration is imported, only the items that exist in the configuration file are modified. Parameters that are not in the imported file are not changed. If user wish to revert those settings to their factory default values, please add a “setToDefaults” item under “configFileParameters” section with a value of true.

```
  “cfgFileVersion”: “1.0”,
  “cfgFileString”: “Canopy configuration file”,
  “configFileParameters”: {
    “rebootIfRequired”: true,
    “setToDefaults”: true
  }
```

In case, the SM needs to fetch the configuration file on each boot up even when not connecting to AP via ICC, set “Network Accessibility” to “Public” and “DHCP State” to “Enabled” in the “Configuration > IP” page before exporting the configuration.

Hosting the config file

Copy the golden configuration file to an FTP, TFTP, HTTP or HTTPS server. This location can be password protected; you just have to include the user name and password in the URL.

DHCP server configuration

Configure DHCP server to return the full URL to the golden config file as the value of DHCP option 66.

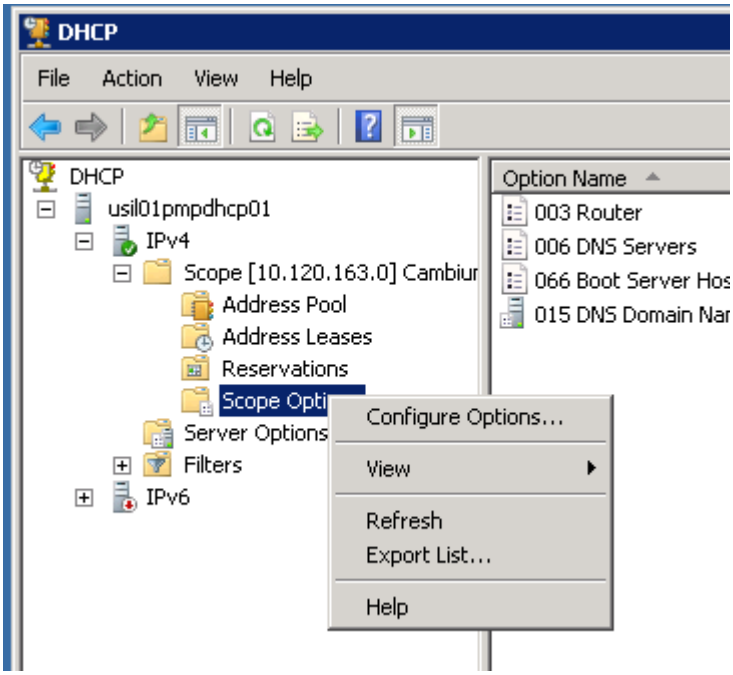
The following example explains how to make the change for Windows Server 2008. Adapt it to your specific DHCP server.

Procedure 16 DHCP server configuration

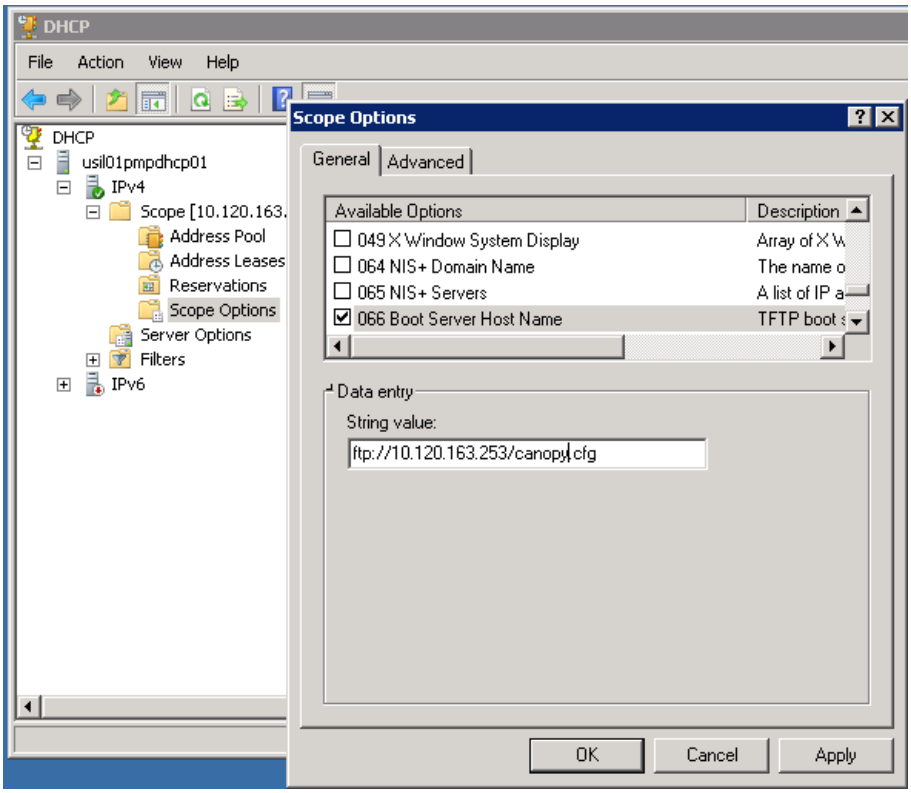
1. Click “Start > Administrative Tools > DHCP”

2 If you have multiple “Scopes” defined, identify the correct “Scope” that will serve IP addresses for the SMs

3 Right click on “Scope Option” under the correct “Scope” and select “Configure Options”



4 In the “Scope Options” dialog, scroll down to “066 Boot Server Host Name”, select the checkbox and enter the full URL to the golden config file as the “String value”. Then click “OK”.



5 In the DHCP snap-in window, right click and “Refresh” to see the DHCP option 66 in the list of DHCP options

Supported URL Formats

FTP, TFTP, HTTP and HTTPS URLs are supported. Some examples are given below.

- ftp://10.120.163.253/canopy.cfg
- ftp://admin:admin123@10.120.163.253/canopy.cfg (login as admin with password admin123)
- tftp://10.120.163.253/canopy.cfg
- http://10.120.163.253/golden-config.cfg
- https://10.120.163.253/smconfig/golden-config.cfg

User can also specify the URL pointing to a directory and not a specific file. Terminate the URL with a ‘/’ to indicate that it is a directory and not a file. Use this format when each SM has its own individual config file. The directory should contain files named “<mac>.cfg”, one for each SM.

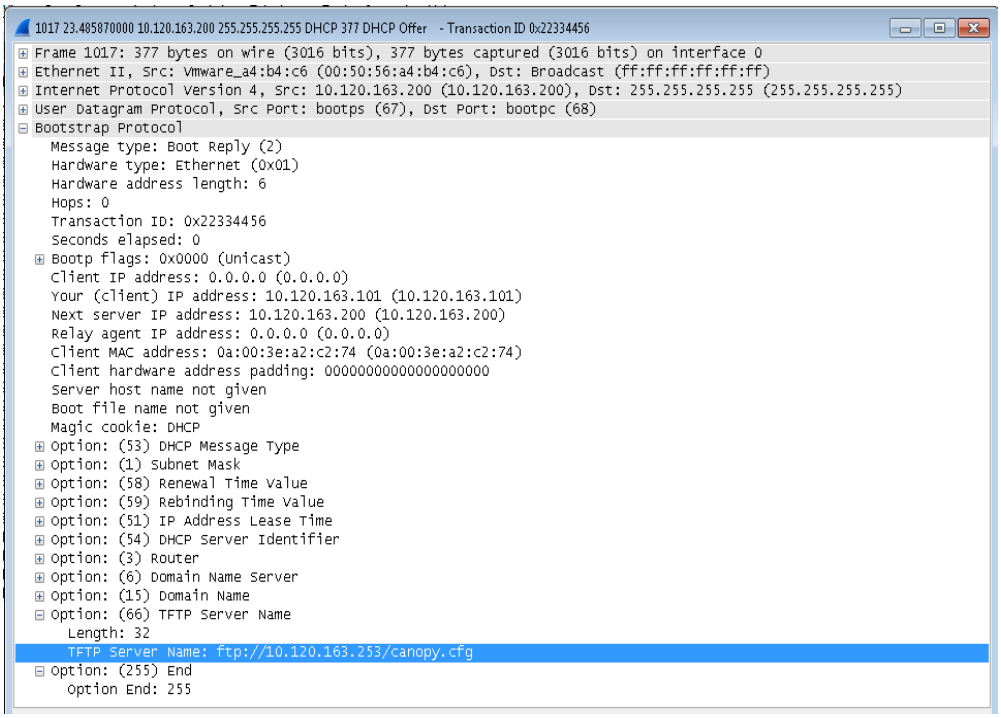
For example:

ftp://10.120.163.253/smconfig/

In this case, the SM will append “<mac>.cfg” to the path and try to get that file. For example, if the SM’s MAC address is 0a-00-3e-a2-c2-74, it will request for ftp://10.120.163.253/smconfig/0a003ea2c274.cfg. This mechanism can be used to serve individual config file for each SM.

Troubleshooting

1. Ensure that the___14 SM is running 13.3 or newer version of software.
2. If the SM has factory default config, confirm ICC is enabled on the AP, so the SM can connect to it.
3. If the SM is connecting to the AP using a color code other than ICC, make sure the SM has “Network Accessibility” set to “Public” and “DHCP State” set to “Enabled” in the “Configuration > IP” page.
4. Make sure the golden config file does not turn off “Network Accessibility” or “DHCP State”. If it does, the SM will no longer request the config file when it is rebooted.
5. Check the event log of the SM to see the status of the configuration file import including any errors that prevented it from importing the file.
6. Capture the DHCP Offer packet from the DHCP server to the SM and verify that Option 66 has the expected URL.



Configuring Radio via config file

The 450 Platform Family supports export and import of a configuration file from the AP or SM as a text file. The configuration file is in JSON format.

To export or import the configuration file, the logged in user needs to be an ADMINISTRATOR and it must not be a “read-only” account.

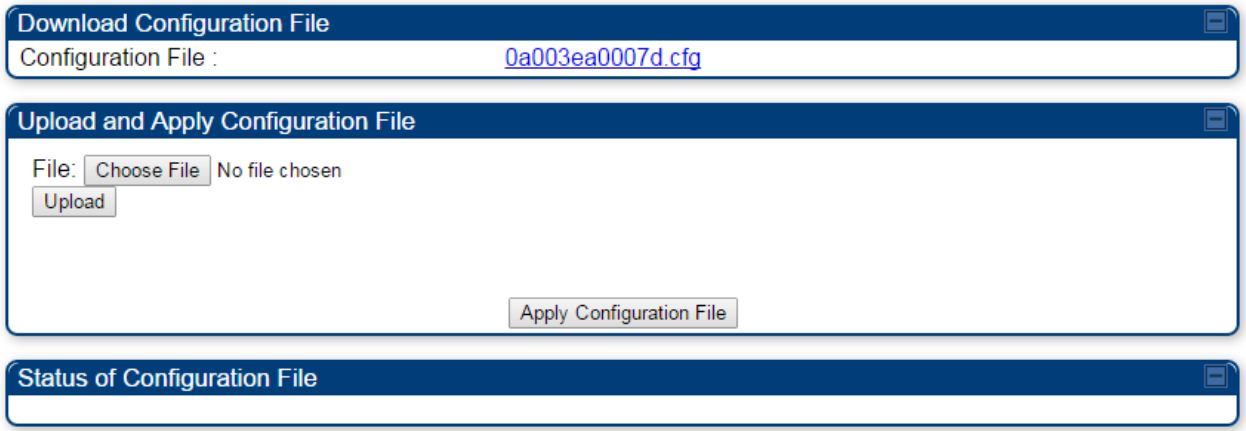
The exported configuration file contains the complete configuration including all the default values. To keep a backup of the current configuration, the file can be saved as-is and imported later.

While importing a configuration file, it can be either imported the full configuration or a sparse configuration containing only the items that need to be changed. If a sparse configuration file is imported, only the items in the file will be imported. Other configuration will remain unchanged. There could also be used a special flag in the configuration file to tell the device to apply the configuration starting from factory default (Refer Special Headers for configuration file on page 1-269).

Import and Export of config file

The config file import and export is supported in **Configuration > Unit Settings** page. The procedure for importing and exporting config file is explained below.

Figure 43 Configuration File upload and download page



The DHCP server configuration procedure is as follows:

Procedure 17 DHCP server configuration

1. Login to the GUI and go to **Configuration** > **Unit Settings.**
2. Under Download Configuration File tab, click on the “<mac>.cfg” link, where <mac> is the MAC address of the device (for example, “01003ea2c274.cfg”).
3. Save the file to the local disk.

The below procedure is to be followed for Importing a config file

Procedure 18 Import the configuration from the GUI

1. Login to the GUI and go to Configuration → Unit Settings.

2 Click on “Browse” button under “Upload and Apply Configuration File” tab and select the configuration file from disk.

3 Click “Upload” followed by “Apply Configuration File” button click.

4 The “Status of Configuration File” section will show the results of the upload.

5 Review it to make sure there are no errors. Then click on “Reboot” to reboot with the imported configuration

The special headers for config file is explained below:

Procedure 19 Special Headers for configuration file

1 A “configFileParameters” section can be added to the header to control the behavior of the device when importing configuration.

2 The “**setToDefaults**” when set to “true” tell the device to reset to factory default configuration and apply the configuration in the file on top of that. So any attribute not in the configuration file will be set to its factory default value. By default, the configuration in the file is merged with the existing configuration on the device.

The “r**ebootIfRequired**” flag when set to “true” tell the device to reboot automatically if needed to apply the configuration change. By default, the device will not reboot automatically.

```
{
 “cfgFileString”: “Canopy configuration file”,
 “cfgFileVersion”: “1.0”,
 “configFileParameters”: {
  “setToDefaults”:true,
  “rebootIfRequired”:true,
 }
}
```

Configuring cnMaestro™ Connectivity

450 Platform Family network can be onboarded, configured and managed using cnMaestro™ Cloud or On Premises Server.

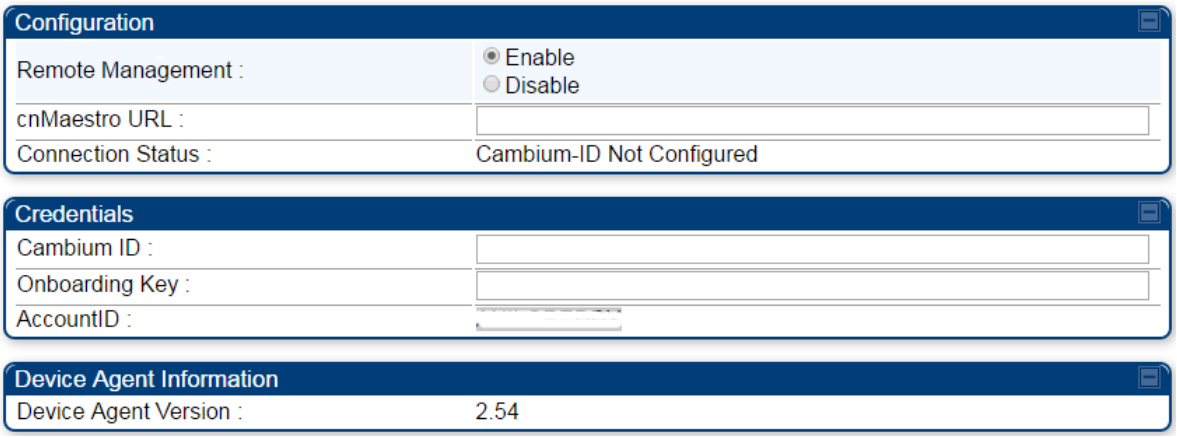
Onboarding

Onboarding can be done in one of several ways:

- Using Cambium ID and Onboarding key
- Using Manufacturer's Serial Number (Only if it starts with an "M" and is 12 characters long)
- On Premises Zero Touch onboarding of AP/SM using DHCP option 43 and 15
- PMP SM Zero touch onboarding to the cnMaestro server where PMP AP is onboarded.

To configure the PMP devices, enable Remote Management under Configuration->cnMaestro as shown in Table 88.

Table 88 Configuring cnMaestro

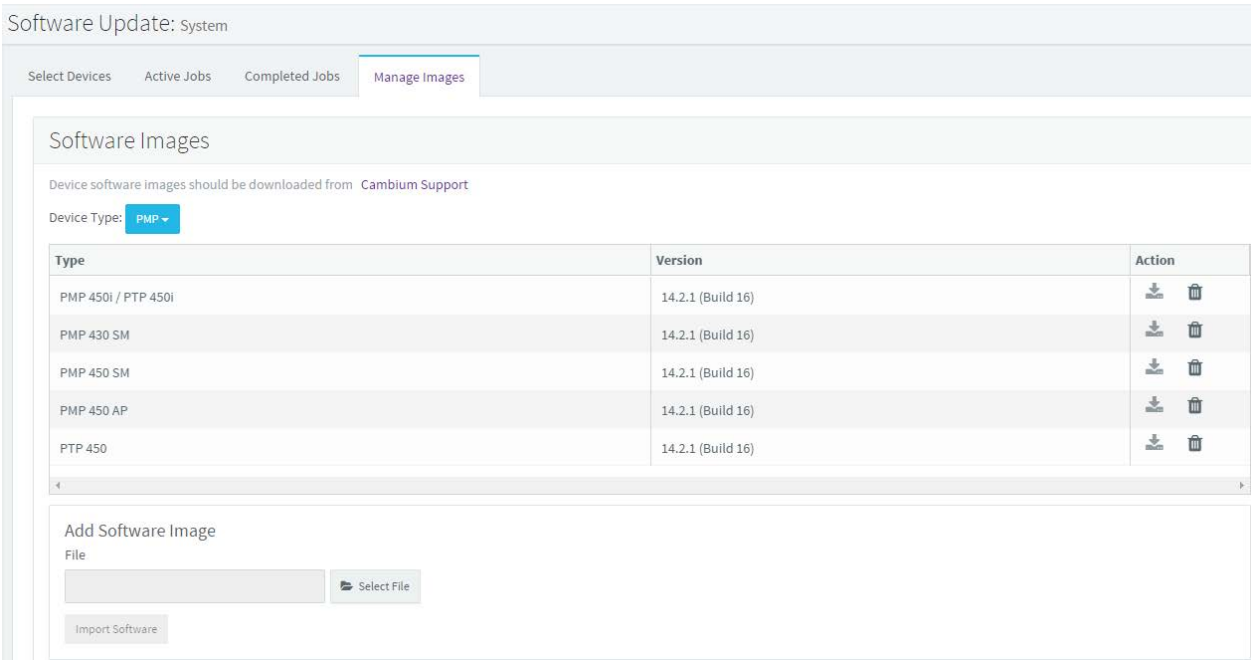


Attribute	Meaning
Remote Management	This field enables/disables remote management of 450 Platform Family products.
cnMaestro URL	This field allows to enter cnMaestro URL e.g. https://cloud.cambiumnetworks.com Or cnMaestro on premises URL
Connection Status	This field indicates cnMaestro connectivity status.
Cambium ID	This field allows to enter Cambium ID for onboarding 450 Platform devices.
Onboarding Key	This field allows to enter Onboarding Key for onboarding.
AccountID	This field indicates Account ID of the customer.
Device Agent Version	This field shows device agent version.

Prerequisites for onboarding to cnMaestro™

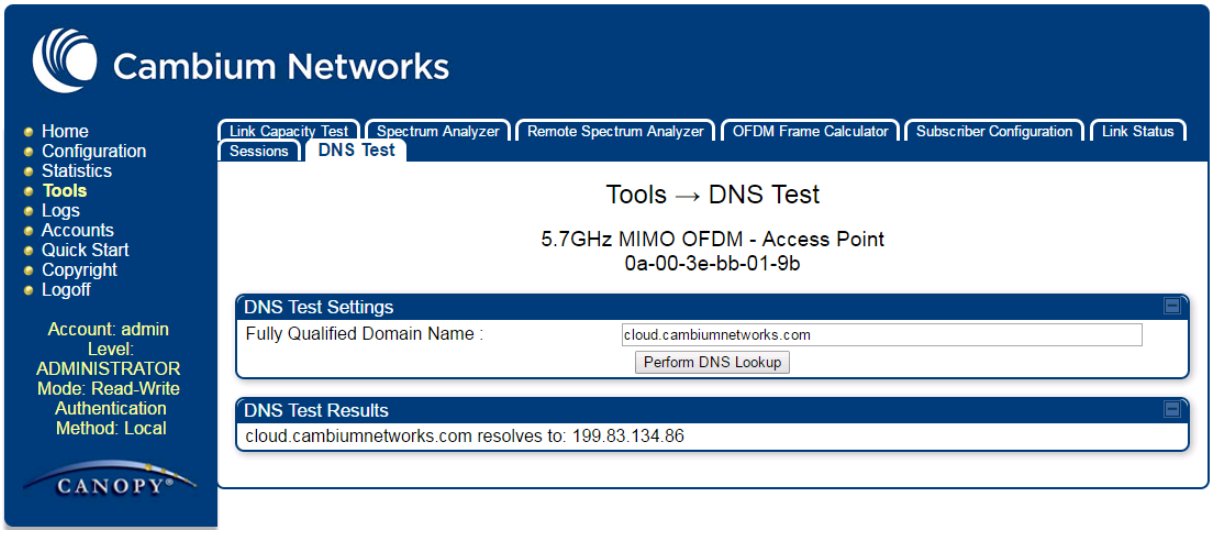
- Devices types must be PMP 450m Series, PMP/PTP 450 Series, PMP/PTP 450i/450b Series or PMP 430 Series SMs (interoperability mode only).
- Minimum required software version of 14.2.1. Device software images can be downloaded from http://support.cambiumnetworks.com or from the On Premises cnMaestro server by navigating to Operate >Software Update->Manage Images. Select
- Device type to display the available images and then click the download icon as shown in Figure 44.

Figure 44 Software Upgrade from cnMaestro™



- IP connectivity between PMP Device and the cnMaestro server is established. Ensure Port 443 is open in the firewall as this port is used for secure communication between the PMP device and the cnMaestro server through web sockets. In addition, if the PMP device and cnMaestro™ server are on different subnets, proper routes should be established for communication.
- For PMP AP, a valid DNS setting is required so that the AP will be able to resolve the cnMaestro URL. DNS settings can be verified by performing a DNS lookup under Tools->DNS Test on the AP as shown in Figure 45.

Figure 45 DNS Test for cnMaestro™ connectivity



- If the SM is in Bridge mode, then LAN1 must have public 1-272equest1-272ility with a public IP assigned and corresponding DNS setting.
- If the SM is in NAT mode, then Remote Management should be enabled with the standalone configuration option and DNS settings.

Knowledge Based articles for onboarding

For onboarding the devices to cloud server and troubleshooting the onboarding issues in cloud server please see the following link:

http://community.cambiumnetworks.com/t5/cnMaestro/Device-On-boarding/td-p/51484

For onboarding the devices to on Premises server and configuring the DHCP server options for on boarding please see the following link:

http://community.cambiumnetworks.com/t5/cnMaestro/Device-Onboarding-and-Linux-DHCP-Options-for-cnMaestro-On/m-p/55187#U55187

Order of Device Onboarding

The device discovery order is as follows in On Permises cnMaestro™ Server. If any of the options is not configured, the discovery method will fallback to the next option:

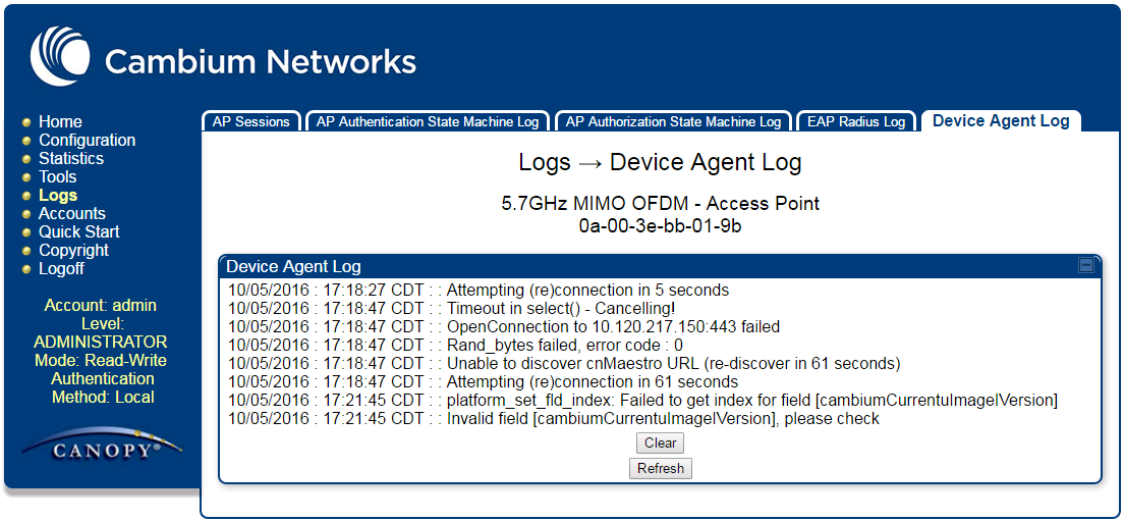
1. Static cnMaestro URL
2. Zero Touch token (on boarding of PMP SMs when the corresponding AP is on boarded)
3. DHCP Option 43
4. DHCP Option 15
5. https://cloud.cambiumnetworks.com

Device Agent Logs

For debugging any onboarding issues please check the device agent logs by navigating to Logs->Device Agent Logs on the PMP device GUI as shown in Figure 46. In addition, a tech support dump can for the PMP device can be obtained from cnMaestro™ by navigating to

Monitor->Tools menu after selecting the particular PMP device in the tree and clicking the tech support file icon. This can be send to Cambium support for further troubleshooting.

Figure 46 Device Agent Logs

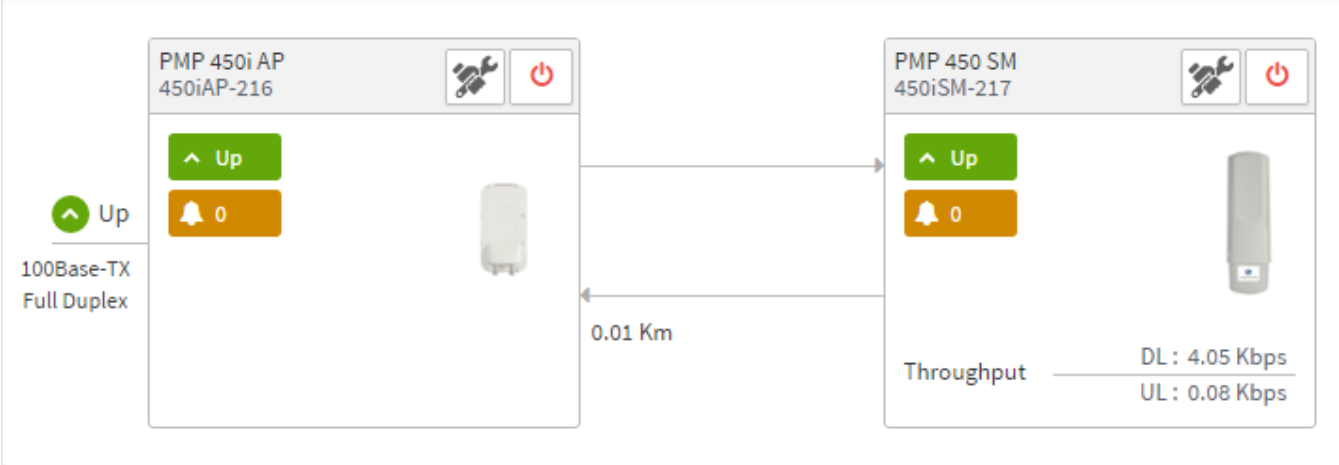


Monitoring Tools for PMP Devices on cnMaestro™

cnMaestro™ as of this release offers several debugging tools for PMP devices. Some examples are:

- Pictorial view of network hierarchy
- Device status
- Tech support file
- Throughput
- Alarms
- Reboot
- Debug Logs
- Network connectivity – ping and DNS lookup

Figure 47 Example cnMaestro™ screenshot



For more information on these tools please see

http://community.cambiumnetworks.com/t5/cnMaestro/How-to-use-the-cnMaestro-Tools-for-Troubleshooting-Device-or/m-p/54503#U54503

Zero Touch on boarding of the PMP SMs when the corresponding AP is on boarded

First a link should be established between the PMP AP and SM either by configuring manually or using the ICC. Once the AP and SM link is established, the AP must be onboarded to cnMaestro™ using one of several ways detailed above under the Onboarding section. Once the AP is onboarded to cnMaestro™ Cloud or On premises cnMaestro™server, the SMs under the AP will automatically onboard to cnMaestro™ using a Zero touch token that is communicated between the AP and SMs. This is applicable to existing SMs registered to the AP as well as new SMs registering to the AP for the first time. The SMs appear on the onboarding queue of cnMaestro™ and the operator must “Approve” the devices in order to manage them.

The following operations for PMP Devices are available on cnMaestro™:

- Monitor the device details in the Dashboard page by navigating to the **Monitor >Dashboard** menu and selecting the PMP AP/SM in the tree.
- Monitor notifications related to the PMP AP/SM by navigating to the **Monitor >Notifications** Menu and selecting the PMP AP/SM in the tree.
- Monitor device statistics on the statistics page by navigating to the **Monitor >Statistics** menu and selecting the PMP AP/SM in the tree, then selecting the PMP AP or PMP SM in the Device type dropdown.
- Monitor Performance graphs related to the PMP AP/SM by navigating to the **Monitor >Performance** menu and selecting the required performance graph (i.e Throughput, SMs, Modulation) and selecting the PMP AP/SM in the tree.
- Troubleshoot the device on the Troubleshooting page by navigating to the **Monitor >Tools** menu and selecting the PMP AP/SM in the tree.
- Configure the devices by navigating to the **Configure >Devices** menu and selecting the PMP AP/SM in the tree and selecting the config template that needs to be pushed to the device. Configuration templates need to be created before the configuration can be pushed to the device. The template can be created by copying the existing configuration from the view device configuration link provided in the same page and then modifying the template as needed and then pushing to the same device or other similar devices. Template needs to be properly reviewed for IP Address and other critical parameters to avoid stranding SMs (resulting in a truck roll) by pushing an incorrect configuration. Configuration templates can be created by navigating to the Configure->Templates page and selecting the PMP device type while creating the template.
- Once on 14.2.1, PMP devices can be upgraded to future supported versions from cnMaestro™ by navigating to the **Operate > Software Update** page and selecting the “PMP Sectors” option from the device type drop-down and the version to which the device needs to be upgraded. It is recommended to upgrade the AP first, then the SMs.
- PMP Device Inventory details can be reviewed by navigating to the **Monitor >Inventory** page.

Configuring a RADIUS server

Configuring a RADIUS server in a PMP 450 Platform network is optional, but can provide added security, increase ease of network management and provide usage-based billing data.

Understanding RADIUS for PMP 450 Platform Family

PMP 450 Platform modules include support for the RADIUS (Remote Authentication Dial In User Service) protocol supporting Authentication and Accounting.

RADIUS Functions

RADIUS protocol support provides the following functions:

- **SM Authentication** allows only known SMs onto the network (blocking "rogue" SMs), and can be configured to ensure SMs are connecting to a known network (preventing SMs from connecting to "rogue" APs). RADIUS authentication is used for SMs, but is not used for APs.
- **SM Configuration:** Configures authenticated SMs with MIR (Maximum Information Rate), CIR (Committed Information Rate), Medium Priority, High Priority, and Ultra High Priority Data channels, and VLAN (Virtual LAN) parameters from the RADIUS server when a SM registers to an AP.
- **User Authentication** allows users to configure a separate User authentication server along with the SM authentication server. If firmware is upgraded while using this functionality and no User authentication servers are configured, then AP continues to use the SM authentication server for User authentication
- **SM Accounting provides** support for RADIUS accounting messages for usage-based billing. This accounting includes indications for subscriber session establishment, subscriber session disconnection, and bandwidth usage per session for each SM that connects to the AP.
- **Centralized AP and SM user name and password management** allows AP and SM usernames and access levels (Administrator, Installer, Technician) to be centrally administered in the RADIUS server instead of on each radio and tracks access events (logon/logoff) for each username on the RADIUS server. This accounting does *not* track and report specific configuration actions performed on radios or pull statistics such as bit counts from the radios. Such functions require an Element Management System (EMS) such as Cambium Networks Wireless Manager. This accounting is *not* the ability to perform accounting functions on the subscriber/end user/customer account.
- **Framed IP** allows operators to use a RADIUS server to assign management IP addressing to SM modules (framed IP address).

Tested RADIUS Servers

The Canopy RADIUS implementation has been tested and is supported on

- FreeRADIUS, Version 2.1.8
- Aradial RADIUS, Version 5.1.12
- Microsoft RADIUS (Windows Server 2012 R2 version)
- Cisco ACS, Version 5.7.0.15

Note

Aradial 5.3 has a bug that prevents “remote device login”, so doesn’t support the user name and password management feature.

Choosing Authentication Mode and Configuring for Authentication Servers - AP

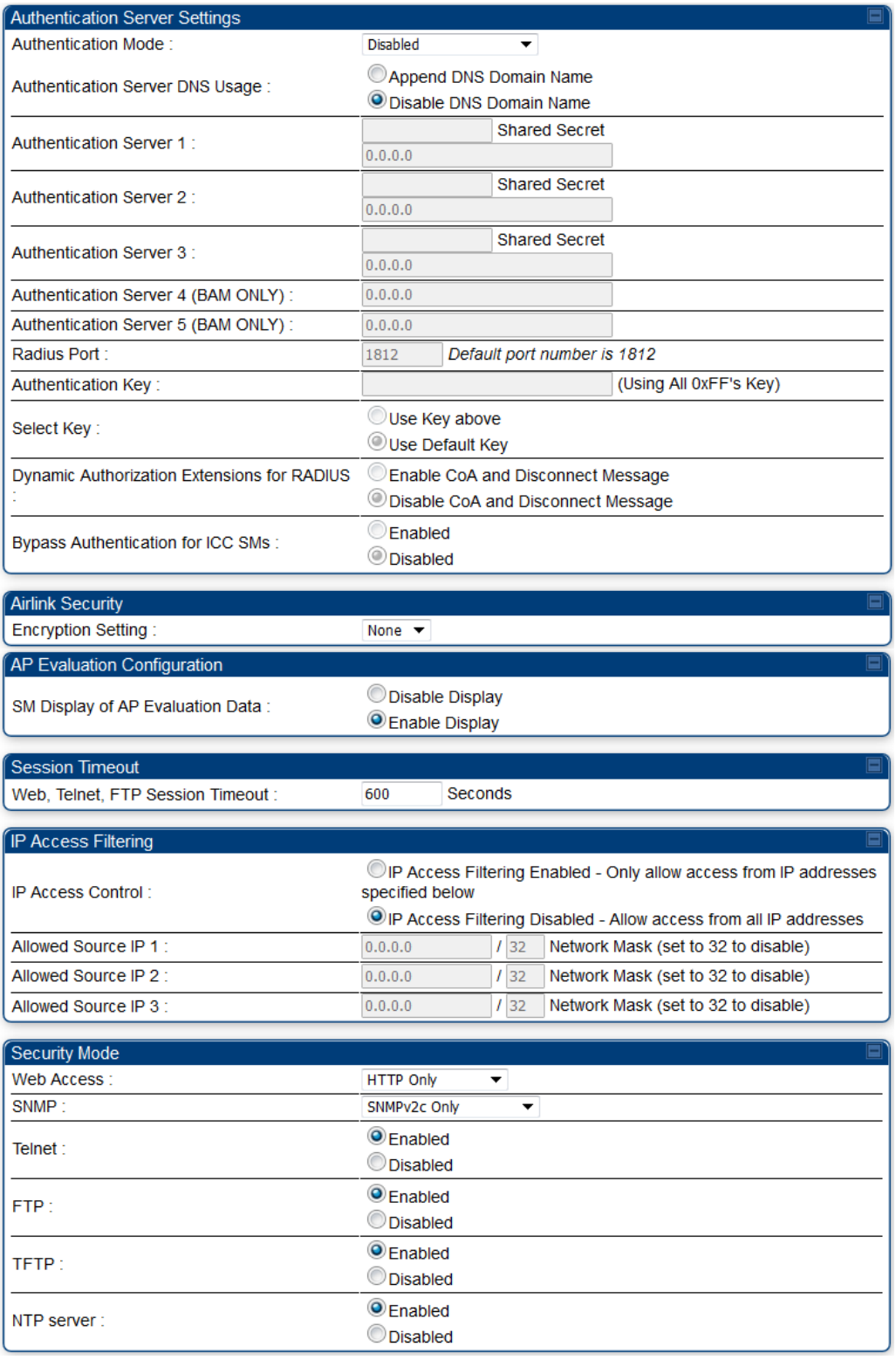
On the AP’s **Configuration > Security** tab, select the **RADIUS AAA Authentication Mode**. The following describes the other **Authentication Mode** options for reference, and then the **RADIUS AAA** option.

- **Disabled:** Requires no authentication. Any SM (except a SM that itself has been configured to *require* RADIUS authentication by enabling Enforce Authentication as described below) is allowed to register to the AP.
- **Authentication Server:** Authentication Server in this instance refers to Wireless Manager in BAM-only mode. Authentication is required for a SM to register to the AP. Only SMs listed by MAC address in the Wireless Manager database is allowed to register to the AP.
- **AP Pre-Shared Key:** Canopy offers a pre-shared key authentication option. In this case, an identical key must be entered in the Authentication Key field on the AP’s Configuration > Security tab and in the Authentication Key field on each desired SM’s Configuration > Security tab.
- **RADIUS AAA:** To support RADIUS authentication of SMs, on the AP’s Configuration > Security tab select RADIUS AAA. Only properly configured SMs with a valid certificate is allowed to register to the AP.

When RADIUS AAA is selected, up to 3 Authentication Server (RADIUS Server) IP addresses and Shared Secrets can be configured. The IP address(s) configured here must match the IP address(s) of the RADIUS server(s). The shared secret(s) configured here must match the shared secret(s) configured in the RADIUS server(s). Servers 2 and 3 are meant for backup and reliability, not splitting the database. If Server 1 doesn’t respond, Server 2 is tried, and then server 3. If Server 1 rejects authentication, the SM is denied entry to the network, and does not progress trying the other servers.

The default IP address is 0.0.0.0. The default Shared Secret is “CanopySharedSecret”. The Shared Secret can be up to 32 ASCII characters (no diacritical marks or ligatures, for example).

Table 89 Security tab attributes



Attribute	Meaning
Authentication Mode	Operators may use this field to select the following authentication modes: **Disabled**—the AP requires no SMs to authenticate. **Authentication Server** —the AP requires any SM that attempts registration to be authenticated in Wireless Manager before registration. **AP PreShared Key** - The AP acts as the authentication server to its SMs and will make use of a user-configurable pre-shared authentication key. The operator enters this key on both the AP and all SMs desired to register to that AP. There is also an option of leaving the AP and SMs at their default setting of using the "Default Key". Due to the nature of the authentication operation, if you want to set a specific authentication key, then you MUST configure the key on all of the SMs and reboot them BEFORE enabling the key and option on the AP. Otherwise, if you configure the AP first, none of the SMs is able to register. **RADIUS AAA** - When RADIUS AAA is selected, up to 3 Authentication Server (RADIUS Server) IP addresses and Shared Secrets can be configured. The IP address(s) configured here must match the IP address(s) of the RADIUS server(s). The shared secret(s) configured here must match the shared secret(s) configured in the RADIUS server(s). Servers 2 and 3 are meant for backup and reliability, not for splitting the database. If Server 1 doesn't respond, Server 2 is tried, and then server 3. If Server 1 rejects authentication, the SM is denied entry to the network and does not progress trying the other servers.
Authentication Server DNS Usage	The management DNS domain name may be toggled such that the name of the authentication server only needs to be specified and the DNS domain name is automatically appended to that name.
Authentication Server 1	Enter the IP address or server name of the authentication server (RADIUS or WM) and the Shared Secret configured in the authentication server. When **Authentication Mode RADIUS AAA** is selected, the default value of **Shared Secret** is "CanopySharedSecret". The **Shared Secret** may consist of up to 32 ASCII characters.
Authentication Server 2	
Authentication Server 3	
Authentication Server 4 (BAM Only)	
Authentication Server 5 (BAM Only)	
Radius Port	This field allows the operator to configure a custom port for RADIUS server communication. The default value is *1812*.
Authentication Key	The authentication key is a 32-character hexadecimal string used when **Authentication Mode** is set to **AP Pre-Shared Key**. By default, this key is set to 0xFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF.

Selection Key	This option allows operators to choose which authentication key is used: **Use Key above** means that the key specified in **Authentication Key** is used for authentication **Use Default Key** means that a default key (based off of the SM's MAC address) is used for authentication
Encryption Key	Specify the type of airlink security to apply to this AP. The encryption setting must match the encryption setting of the SMs. **None** provides no encryption on the air link. **AES** (Advanced Encryption Standard)**:** An over-the-air link encryption option that uses the Rijndael algorithm and 128-bit keys to establish a higher level of security. AES products are certified as compliant with the Federal Information Processing Standards (FIPS 197) in the U.S.A.
SM Display of AP Evaluation Data	You can use this field to suppress the display of data about this AP on the AP Evaluation tab of the Tools page in all SMs that register.
Web, Telnet, FTP Session Timeout	Enter the expiry in seconds for remote management sessions via HTTP, telnet, or ftp access to the AP.
IP Access Control	You can permit access to the AP from any IP address (**IP Access Filtering Disabled**) or limit it to access from only one, two, or three IP addresses that you specify (**IP Access Filtering Enabled**). If you select **IP Access Filtering Enabled**, then you must populate at least one of the three **Allowed Source IP** parameters or have no access permitted from any IP address
Allowed Source IP 1	If you selected **IP Access Filtering Enabled** for the **IP Access Control** parameter, then you must populate at least one of the three **Allowed Source IP** parameters or have no access permitted to the AP from any IP address. You may populate as many as all three.
Allowed Source IP 2 Allowed Source IP 3	If you selected **IP Access Filtering Disabled** for the **IP Access Control** parameter, then no entries in this parameter are read, and access from all IP addresses is permitted.
Web Access	The Radio supports secured and non-secured web access protocols. Select suitable web access from drop-down list: • **HTTP Only** – provides non-secured web access. The radio to be accessed via http://<IP of Radio>. • **HTTPS Only** – provides a secured web access. The radio to be accessed via https://<IP of Radio>. • **HTTP and HTTPS** – If enabled, the radio can be accessed via both http and https.
SNMP	This option allows to configure SNMP agent communication version. It can be selected from drop-down list : • **SNMPv2c Only** – Enables SNMP v2 community protocol. • **SNMPv3 Only** – Enables SNMP v3 protocol. It is secured communication protocol.

	• **SNMPv2c and SNMPv3** – It enables both the protocols.
Telnet	This option allows to **Enable** and **Disable** Telnet access to the Radio.
FTP	This option allows to **Enable** and **Disable** FTP access to the Radio.
TFTP	This option allows to **Enable** and **Disable** TFTP access to the Radio.
NTP server	This option allows to Enable and Disable NTP server access to the Radio.

SM Authentication Mode – Require RADIUS or Follow AP

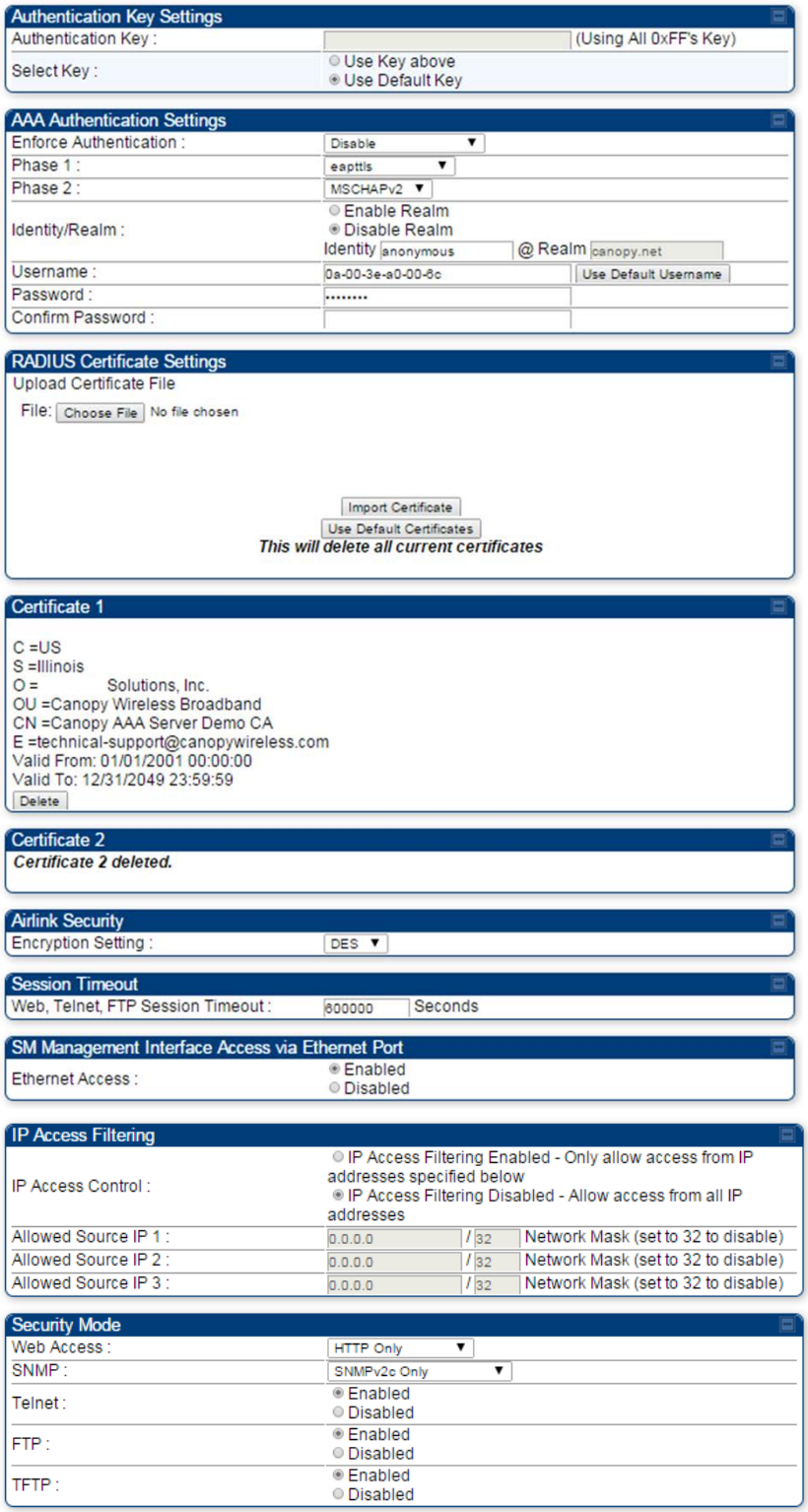
If it is desired that a SM will only authenticate to an AP that is using RADIUS, on the SM's Configuration Security tab set **Enforce Authentication** to **AAA**. With this enabled, SM does not register to an AP that has any **Authentication Mode** other than RADIUS AAA selected.

If it is desired that a SM use the authentication method configured on the AP it is registering to, set **Enforce Authentication** to Disabled. With Enforce Authentication disabled, a SM will attempt to register using whichever Authentication Mode is configured on the AP it is attempting to register to.

Note

Having SMs to use RADIUS by enabling Enforce Authentication avoids the security issue of SMs possibly registering to “rogue” APs, which have authentication disabled.

Table 90 SM Security tab attributes



Attribute	Meaning
Authentication Key	The authentication key is a 32-character hexadecimal string used when **Authentication Mode** is set to **AP PreShared Key**. By default, this key is set to 0xFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF.
Select Key	This option allows operators to choose which authentication key is used: **Use Key above** means that the key specified in **Authentication Key** is used for authentication **Use Default Key** means that a default key (based off of the SM's MAC address) is used for authentication
Enforce Authentication	The SM may enforce authentication types of **AAA** and **AP Pre-sharedKey**. The SM will not finish the registration process if the AP is not using the configured authentication method (and the SM locks out the AP for 15 minutes). Enforce Authentication default setting is **Disable.**
Phase 1	The protocols supported for the **Phase 1** (Outside Identity) phase of authentication are EAPTTLS (Extensible Authentication Protocol Tunneled Transport Layer Security) or MSCHAPv2 (Microsoft Challenge-Handshake Authentication Protocol version 2).
Phase 2	Select the desired **Phase 2** (Inside Identity) authentication protocol from the **Phase 2** options of PAP (Password Authentication Protocol), CHAP (Challenge Handshake Authentication Protocol), and **MSCHAP** (Microsoft's version of CHAP, version 2 is used). The protocol must be consistent with the authentication protocol configured on the RADIUS server.

Identity/Realm	If Realms are being used, select Enable Realm and configure an outer identity in the Identity field and a Realm in the Realm field. These must match the Phase 1/Outer Identity and Realm configured in the RADIUS server. The default Identity is “anonymous”. The Identity can be up to 128 non-special (no diacritical markings) alphanumeric characters. The default Realm is “canopy.net”. The Realm can also be up to 128 non-special alphanumeric characters. Configure an outer Identity in the Username field. This must match the Phase 1/Outer Identity username configured in the RADIUS server. The default Phase 1/Outer Identity Username is “anonymous”. The Username can be up to 128 non-special (no diacritical markings) alphanumeric characters.
Username	Enter a Username for the SM. This must match the username configured for the SM on the RADIUS server. The default Username is the SM’s MAC address. The Username can be up to 128 non-special (no diacritical markings) alphanumeric characters.
Password Confirm Password	Enter the desired password for the SM in the Password and Confirm Password fields. The Password must match the password configured for the SM on the RADIUS server. The default Password is “password”. The Password can be up to 128 non-special (no diacritical markings) alphanumeric characters.
Upload Certificate File	To upload a certificate manually to a SM, first load it in a known place on your PC or network drive, then click on a Delete button on one of the Certificate description blocks to delete a certificate to provide space for your certificate. Click on Choose File, browse to the location of the certificate, and click the Import Certificate button, and then reboot the radio to use the new certificate. When a certificate is in use, after the SM successfully registers to an AP, an indication of In Use will appear in the description block of the certificate being used. The public certificates installed on the SMs are used with the private certificate on the RADIUS server to provide a public/private key encryption system. Up to 2 certificates can be resident on a SM. An installed certificate can be deleted by clicking the Delete button in the certificate’s description block on the Configuration > Security tab. To restore the 2 default certificates, click the Use Default Certificates button in the RADIUS Certificate Settings parameter block and reboot the radio.
Encryption Setting	Specify the type of airlink security to apply to this AP. The encryption setting must match the encryption setting of the SMs. None provides no encryption on the air link. AES (Advanced Encryption Standard): An over-the-air link encryption option that uses the Rijndael algorithm and 128-bit keys to establish a higher level of security. AES products are certified as compliant with the Federal Information Processing Standards (FIPS 197) in the U.S.A.

Web, Telnet, FTP Session Timeout	Enter the expiry in seconds for remote management sessions via HTTP, telnet or ftp access to the AP.
Ethernet Access	If you want to prevent any device that is connected to the Ethernet port of the SM from accessing the management interface of the SM, select **Ethernet Access Disabled**. This selection disables access through this port to via HTTP (the GUI), SNMP, telnet, FTP, and TFTP. With this selection, management access is available through only the RF interface via either an IP address (if **Network Accessibility** is set to **Public** on the SM) or the Session Status or Remote Subscribers tab of the AP. See **IP Access Control** below. If you want to allow management access through the Ethernet port, select **Ethernet Access Enabled**. This is the factory default setting for this parameter.
IP Access Control	You can permit access to the AP from any IP address (**IP Access Filtering Disabled**) or limit it to access from only one, two, or three IP addresses that you specify (**IP Access Filtering Enabled**). If you select **IP Access Filtering Enabled**, then you must populate at least one of the three **Allowed Source IP** parameters or have no access permitted from any IP address
Allowed Source IP 1 Allowed Source IP 2 Allowed Source IP 3	If you selected **IP Access Filtering Enabled** for the **IP Access Control** parameter, then you must populate at least one of the three **Allowed Source IP** parameters or have no access permitted to the AP from any IP address. You may populate as many as all three. If you selected **IP Access Filtering Disabled** for the **IP Access Control** parameter, then no entries in this parameter are read, and access from all IP addresses is permitted.
Web Access	The Radio supports secured and non-secured web access protocols. Select suitable web access from drop-down list: • **HTTP Only** – provides non-secured web access. The radio to be accessed via http://<IP of Radio>. • **HTTPS Only** – provides a secured web access. The radio to be accessed via https://<IP of Radio>. • **HTTP and HTTPS** – If enabled, the radio can be accessed via both http and https.
SNMP	This option allows to configure SNMP agent communication version. It can be selected from drop-down list : • **SNMPv2c Only** – Enables SNMP v2 community protocol. • **SNMPv3 Only** – Enables SNMP v3 protocol. It is secured communication protocol. • **SNMPv2c and SNMPv3** – It enables both the protocols.
Telnet	This option allows to **Enable** and **Disable** Telnet access to the Radio.
FTP	This option allows to **Enable** and **Disable** FTP access to the Radio.

TFTP	This option allows to **Enable** and **Disable** TFTP access to the Radio.

SM - Phase 1 (Outside Identity) parameters and settings

The protocols supported for the Phase 1 (Outside Identity) phase of authentication are

eapttls (Extensible Authentication Protocol Tunneled Transport Layer Security) and eapMSChapV2 (Extensible Authentication Protocol – Microsoft Challenge-Handshake Authentication Protocol).

Configure an outer Identity in the Username field. This must match the Phase 1/Outer Identity username configured in the RADIUS server. The default Phase 1/Outer Identity Username is “anonymous”. The Username can be up to 128 non-special (no diacritical markings) alphanumeric characters. If Realms are being used in the RADIUS system (eapttls only), select Enable Realm and configure an outer identity in the Identity field and a Realm in the Realm field. These must match the Phase 1/Outer Identity and Realm configured in the RADIUS server. The default Identity is “anonymous”. The Identity can be up to 128 non-special (no diacritical markings) alphanumeric characters. The default Realm is “canopy.net”. The Realm can also be up to 128 non-special alphanumeric characters.

SM - Phase 2 (Inside Identity) parameters and settings

If using eapttls for Phase 1 authentication, select the desired Phase 2 (Inside Identity) authentication protocol from the Phase 2 options of PAP (Password Authentication Protocol), CHAP (Challenge Handshake Authentication Protocol), and MSCHAPv2 (Microsoft’s version of CHAP). The protocol must be consistent with the authentication protocol configured on the RADIUS server. Enter a Username for the SM. This must match the username configured for the SM on the RADIUS server. The default Username is the SM’s MAC address. The Username can be up to 128 non-special (no diacritical markings) alphanumeric characters.

Enter the desired password for the SM in the Password and Confirm Password fields. The Password must match the password configured for the SM on the RADIUS server. The default Password is “password”. The Password can be up to 128 non-special (no diacritical markings) alphanumeric characters.

Handling Certificates

Managing SM Certificates via the SM GUI

The default public Canopy certificates are loaded into SMs upon factory software installation. The default certificates are not secure and are intended for use during lab and field trials as part of gaining experience with the RADIUS functionalities or as an option during debug. For secure operation, an operator will want to create or procure their own certificates. Resetting a SM to its factory defaults will remove the current certificates and restore the default certificates.

Up to two certificates can be resident on a SM. An installed certificate can be deleted by clicking the Delete button in the certificate’s description block on the Configuration > Security tab. To restore the 2 default certificates, click the Use Default Certificates button in the RADIUS Certificate Settings parameter block and reboot the radio.

To upload a certificate manually to a SM, first load it in a known place on your PC or network drive, then click on a Delete button on one of the Certificate description blocks to delete a certificate to provide space for your certificate. Click on Choose File, browse to the location of the certificate, and click the Import Certificate button, and then reboot the radio to use the new certificate.

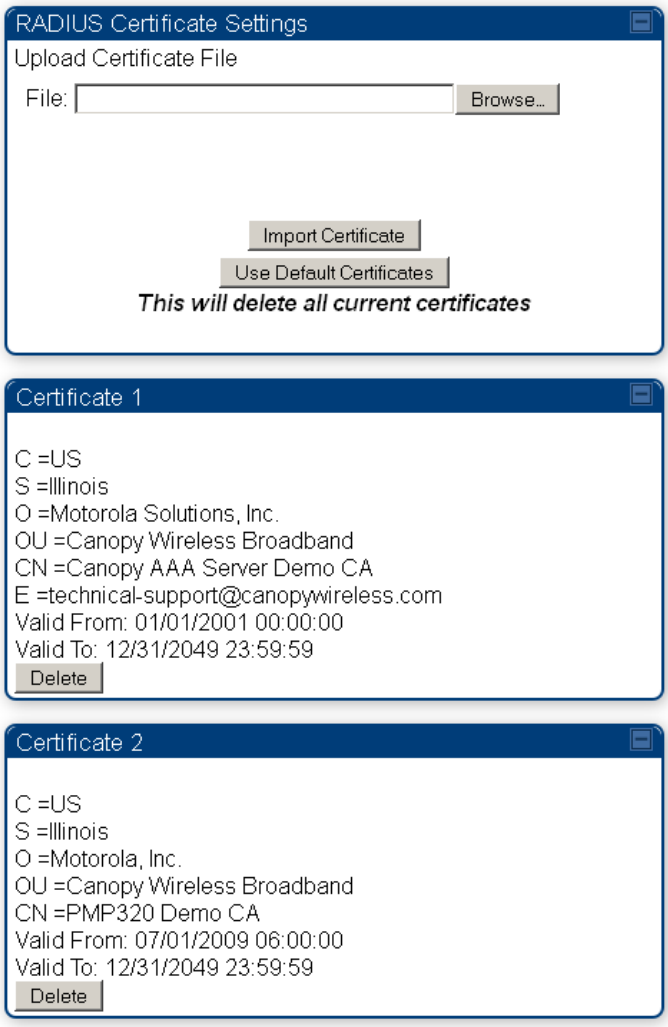
When a certificate is in use, after the SM successfully registers to an AP, an indication of In Use will appear in the description block of the certificate being used.

The public certificates installed on the SMs are used with the private certificate on the RADIUS server to provide a public/private key encryption system.

Note

Root certificates of more than one level (Example - a certificate from someone who received their CA from Verisign) fails. Certificates must be either root or self-signed.

Figure 48 SM Certificate Management



Configuring RADIUS servers for SM authentication

Your RADIUS server must be configured to use the following:

- EAPTTLS or MSCHAPv2 as the Phase 1/Outer Identity protocol.

- If **Enable Realm** is selected on the SM's **Configuration** > **Security** tab, then the same Realm appears there (or access to it).
- The same Phase 2 (Inner Identity) protocol as configured on the SM's **Configuration** > **Security** tab under Phase 2 options.
- The username and password for each SM configured on each SM's **Configuration > Security** tab.
- An IP address and NAS shared secret that is the same as the IP address and **Shared Secret** configured on the AP's **Configuration > Security** tab for that RADIUS server.
- A server private certificate, server key, and CA certificate that complement the public certificates distributed to the SMs, as well as the Canopy dictionary file that defines Vendor Specific Attributes (VSAa). Default certificate files and the dictionary file are available from the software site: https://support.cambiumnetworks.com/files/pmp450 after entering your name, email address, and either Customer Contract Number or the MAC address of a module covered under the 12 month warranty.

Optionally, operators may configure the RADIUS server response messages (Accept or Reject) so that the user has information as to why they have been rejected. The AP displays the RADIUS Authentication Reply message strings in the Session Status list as part of each SM's information. The SM will show this string (listed as Authentication Response on the SM GUI) on the main Status page in the Subscriber Module Stats section.

Note

Aradial AAA servers only support operator-configurable Authentication Accept responses, not Authentication Reject responses.

Assigning SM management IP addressing via RADIUS

Operators may use a RADIUS AAA server to assign management IP addressing to SM modules (framed IP address). SMs now interpret attributes Framed-IP-Address, Framed-IP-Netmask, and Cambium-Canopy-Gateway from RADIUS. The RADIUS dictionary file has been updated to include the Cambium-Canopy-Gateway attribute and is available on the Cambium Software Support website.

In order for these attributes to be assigned and used by the SM, the following must be true:

- The system is configured for AAA authentication
- The SM is *not* configured for DHCP on its management interface. If DHCP is enabled and these attributes are configured in the RADIUS server, the attributes is ignored by the SM.
- The SM management interface must be configured to be publically accessible. If the SM is configured to have local accessibility, the management interface will still be assigned the framed addressing, and the SM iscome publicly accessible via the assigned framed IP addressing.
- When using these attributes, for the addressing to be implemented by the SM operators must configure Framed-IP-Address in RADIUS. If Framed-IP-Address is not configured but Framed-IP-Netmask and/or Cambium-Canopy-Gateway is configured, the attributes is ignored. In the case where only the Framed-IP-Address is configured, Framed-IP-Netmask defaults to 255.255.0.0 (NAT disabled) / 255.255.255.0 (NAT enabled) and Cambium-Canopy-Gateway defaults to 0.0.0.0.

Configuring RADIUS server for SM configuration

Canopy Vendor Specific Attributes (VSAs) along with VSA numbers and other details are listed in Table 91. The associated SM GUI page, tab and parameter are listed to aid cross-referencing and understanding of the VSAs.

A RADIUS dictionary file is available from the software site:

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

The RADIUS dictionary file defines the VSAs and their values and is usually imported into the RADIUS server as part of server and database setup.

Note

Beginning with System Release 12.0.2, two RADIUS dictionary files are available on the Cambium website – "RADIUS Dictionary file – Cambium" and "RADIUS Dictionary file – Motorola".

In addition to a renaming of attributes, the Cambium-branded dictionary file contains two new VSAs for controlling uplink and downlink Maximum Burst Data Rate (these VSAs are listed below in Table 91).

If you are transitioning from the Motorola-branded dictionary file to the Cambium-branded dictionary file, ensure that all RADIUS profiles containing Motorola-Canopy attribute references are updated to include Cambium-Canopy attribute references (for all applicable VSAs listed in Table 91). Also, ensure that all RADIUS configuration files reference the new dictionary file (as an alternative, operators may rename the Cambium-branded dictionary file to the filename currently in use by the RADIUS server). Once the profiles are updated and the new Cambium-branded dictionary file is installed on the RADIUS server, restart the RADIUS server to ensure that the new VSAs and attribute names are enabled.

Table 91 RADIUS Vendor Specific Attributes (VSAs)

Name	Number	Type	Required	Value	
MS-MPPE-Send-Key*	26.311.16	-	Y	-	
-				-	-
MS-MPPE-Recv-Key*	26.311.17	-	Y	-	
-				-	-
Cambium-Canopy-LPULCIR	26.161.1	integer	N	0-65535 kbps	
Configuration > Quality of Service > Low Priority Uplink CIR				0 kbps	32 bits
Cambium-Canopy-LPDLCIR	26.161.2	integer	N	0-65535 kbps	
Configuration > Quality of Service > Low Priority Downlink CIR				0 kbps	32 bits
Cambium-Canopy-HPULCIR	26.161.3	integer	N	0-65535 kbps	
Configuration > Quality of Service > High Priority Uplink CIR				0 kbps	32 bits
Cambium-Canopy-HPDLCIR	26.161.4	integer	N	0-65535 kbps	
Configuration > Quality of Service > High Priority Uplink CIR				0 kbps	32 bits
Cambium-Canopy-HPENABLE	26.161.5	integer	N	0-disable, 1-enable	
Configuration > Quality of Service > High Priority Channel Enable/Disable				0	32 bits
26.161.6		integer	N	0-100000 kbps	
Configuration > Quality of Service > Sustained Uplink Data Rate				dependent on radio feature set	32 bits
Cambium-Canopy-ULBL	26.161.7	integer	N	0-2500000 kbps	

Configuration > Quality of Service > Uplink Burst Allocation				dependent on radio feature set	32 bits
Cambium-Canopy-DLBR	26.161.8	integer	N	0-100000 kbps	
Configuration > Quality of Service > Sustained Downlink Data Rate				dependent on radio feature set	32 bits
Cambium-Canopy-DLBL	26.161.9	integer	N	0-2500000 kbps	
Configuration > Quality of Service > Downlink Burst Allocation				dependent on radio feature set	32 bits
Cambium-Canopy-VLLEARNEN	26.161.14	integer	N	0-disable, 1-enable	
Configuration > VLAN > Dynamic Learning				1	32 bits
Cambium-Canopy-VLFRAMES	26.161.15	integer	N	0-all, 1-tagged, 2-untagged	
Configuration > VLAN > Allow Frame Types				0	32 bits
Cambium-Canopy-VLIDSET	26.161.16	integer	N	VLAN Membership (1-4094)	
Configuration > VLAN Membership				0	32 bits
Cambium-Canopy-VLAGETO	26.161.20	integer	N	5 - 1440 minutes	
Configuration > VLAN > VLAN Aging Timeout				25 mins	32 bits
Cambium-Canopy-VLIGVID	26.161.21	integer	N	1 – 4094	
Configuration > VLAN > Default Port VID				1	32 bits
Cambium-Canopy-VLMGVID	26.161.22	integer	N	1 – 4094	
Configuration > VLAN > Management VID				1	32 bits
Cambium-Canopy-VLSMMGPASS	26.161.23	integer	N	0-disable, 1-enable	
Configuration > VLAN > SM Management VID Pass-through				1	32 bits
Cambium-Canopy-BCASTMIR	26.161.24	integer	N	0-100000 kbps, 0=disabled	
Configuration > Quality of Service > Broadcast/Multicast Uplink Data Rate				dependent on radio feature set	32 bits
Cambium-Canopy-Gateway	26.161.25	ipaddr	N	-	
Configuration > IP > Gateway IP Address				0.0.0.0	-
Cambium-Canopy-ULMB	26.161.26	integer	N	0-100000 kbps	
Configuration > Quality of Service > Max Burst Uplink Data Rate				0	32 bits
Cambium-Canopy-DLMB	26.161.27	integer	N	0-100000 kbps	
Configuration > Quality of Service > Max Burst Downlink Data Rate				0	32 bits

Cambium-Canopy-UserLevel	26.161.50	integer	N	1-Technician, 2-Installer, 3-Administrator	
Account > Add User > Level				0	32 bits
Cambium-Canopy-DHCP-State	26.161.31	integer	N	1-Enable	
Configuration > IP > DHCP state				1	32 bits
Cambium-Canopy-BCASTMIRUNITS	26.161.28	integer	N		
Configuration > QoS > Broadcast Downlink CIR				0	32 bits
Cambium-Canopy-ConfigFileImportUrl	26.161.29	string	N		
Configuration > Unit Settings				0	32 bits
Cambium-Canopy-ConfigFileExportUrl	26.161.30	string	N		
Configuration > Unit Settings				0	32 bits
Cambium-Canopy-UserMode	26.161.51	integer	N	1=Read-Only 0=Read-Write	
Account > Add User > User Mode				0	32 bits

(*) Contains key for encrypting packets sent by the NAS to the remote host (for Microsoft Point-to-Point Encryption Protocol).

Note

VSA numbering:

26 connotes Vendor Specific Attribute, per RFC 2865

26.311 is Microsoft Vendor Code, per IANA

Configuring RADIUS server for SM configuration using Zero Touch feature

The RADIUS VSA (Vendor Specific Attributes) is updated for Zero Touch feature. This feature enables the ability for a SM to get its configuration via RADIUS VSA. The RADIUS VSA is updated for an URL which points to the configuration file of SM (see Table 91 for list of VSA).

The RADIUS will push the vendor specific attribute to SM after successful authentication. The VSA contains URL of config file which will redirect SM to download configuration. If there is any change in SM confirmation, the SM will reboot automatically after applying the configuration.

The RADIUS VSA attributes concerning Zero Touch are as follows:

```
VSA                                          Type       String

Cambium-Canopy-ConfigFileImportUrl (29) string  Maximum Length 127 characters.
Cambium-Canopy-ConfigFileExportUrl (30) string  Maximum Length 127 characters.
```

The updated RADIUS dictionary can be downloaded from below link:
https://support.cambiumnetworks.com/files/pmp450/

Note

The feature is not applicable to the AP.

Using RADIUS for centralized AP and SM user name and password management

AP – Technician/Installer/Administrator Authentication

To control technician, installer, and administrator access to the AP from a centralized RADIUS server:

Procedure 20 Centralized user name and password management for AP

1 Set Authentication Mode on the AP's Configuration > Security tab to RADIUS AAA

2 Set User Authentication Mode on the AP's Account > User Authentication tab (the tab only appears after the AP is set to RADIUS authentication) to Remote or Remote then Local.

- Local: The local SM is checked for accounts. No centralized RADIUS accounting (access control) is performed.
- Remote: Authentication by the centralized RADIUS server is required to gain access to the SM if the SM is registered to an AP that has RADIUS AAA Authentication Mode selected. For up to 2 minutes a test pattern is displayed until the server responds or times out.
- Remote then Local: Authentication using the centralized RADIUS server is attempted. If the server sends a reject message, then the setting of Allow Local Login after Reject from AAA determines if the local user database is checked or not. If the configured servers do not respond within 2 minutes, then the local user database is used. The successful login method is displayed in the navigation column of the SM.

4. User administration and authentication separation

On the AP, it is possible to configure up to three User Authentication servers, along with their Shared Secret. If none of the User Authentication servers are configured, the AP continues to use SM Authorization servers for User Authentication.

If at least one of the IP addresses is configured, all Authentication, Authorization, and Accounting requests now follow the newly configured User Authorization server.

To configure separate User Authentication and SM Authentication:

Procedure 21 User administration and authentication separation

1 Go to the AP's **Account** > **User Authentication And Access Tracking** tab

2 Set **User Authentication Mode** to **Remote** or **Remote then Local**.

3 Set **User Authentication Method** to **EAP-MD5** or **EAP-PEAP-MSCHAPv2**

4 Configure the Shared Secrets and IP Addresses of:

User Authentication Server 1

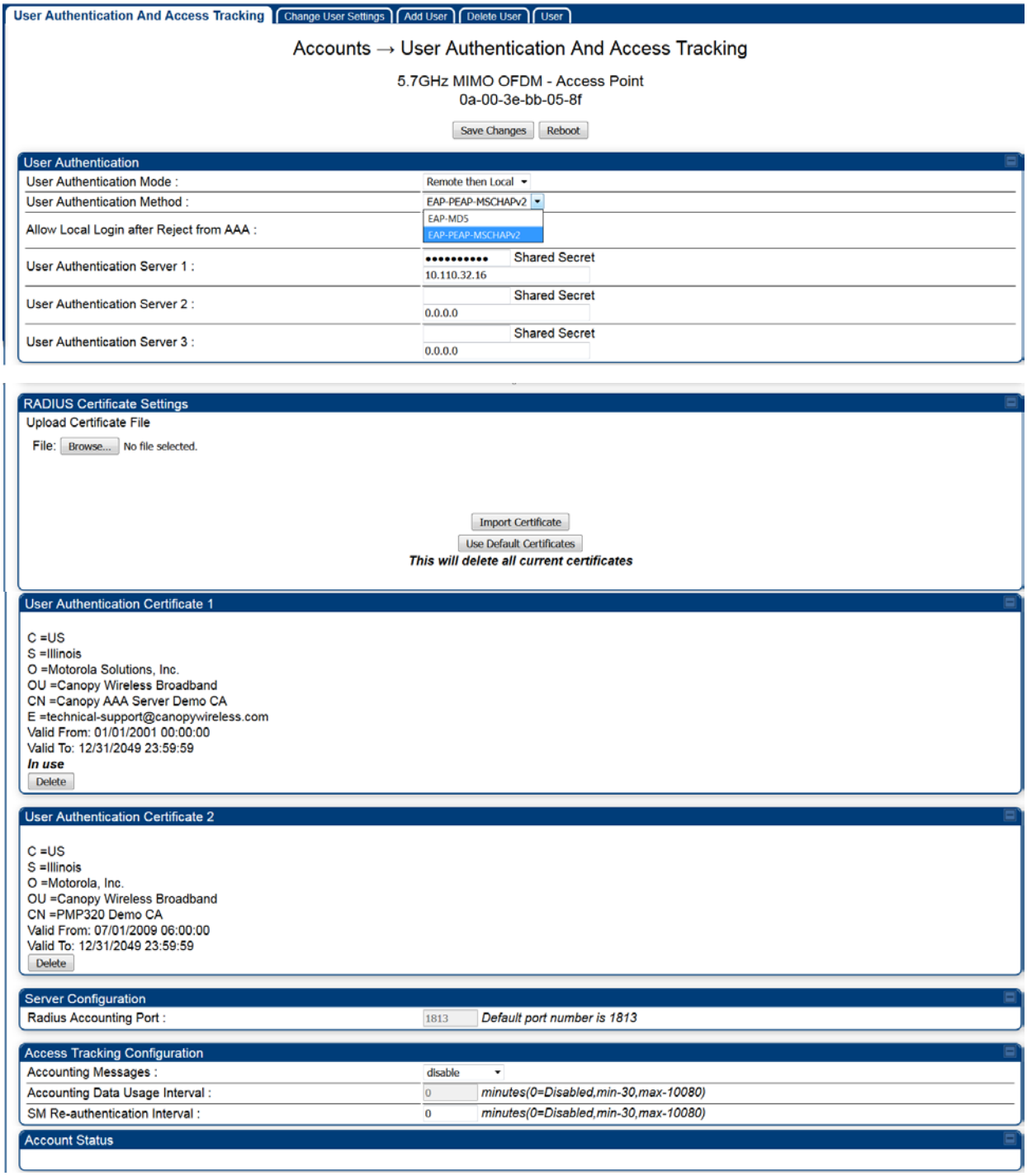
User Authentication Server 2

User Authentication Server 3

Note: If none of the above User Authentication servers are configured, only SM authentication will be performed.

5 Under **RADIUS Certificate Settings**, click **Browse** to upload the RADIUS Certificate files.

Table 92 AP User Authentication and Access Tracking attributes



Attribute	Meaning
User Authentication Mode	• **Local**: The local SM is checked for accounts. No centralized RADIUS accounting (access control) is performed. • **Remote**: Authentication by the centralized RADIUS server is required to gain access to the AP. For up to 2 minutes a test pattern is displayed until the server responds or times out.

	• **Remote then Local**: Authentication using the centralized RADIUS server is attempted. If the server sends a reject message, then the setting of **Allow Local Login after Reject from AAA** determines if the local user database is checked or not. If the configured servers do not respond within 2 minutes, then the local user database is used. The successful login method is displayed in the navigation column of the AP.
User Authentication Method	The user authentication method employed by the radios: • EAP-MD5 • EAP-PEAP-MSCHAPv2
Allow Local Login after Reject from AAA	If a user authentication is rejected from the AAA server, the user is allowed to login locally to the radio's management interface.
User Authentication Server 1	The IP address and the shared secret key of the User authentication RADIUS server 1.
User Authentication Server 2	The IP address and the shared secret key of the User Authentication Server 2 configured in RADIUS Server.
User Authentication Server 3	The IP address and the shared secret key of the User Authentication Server 3 configured in RADIUS Server.
RADIUS Certificate Settings	Import Cetificate – browse and select the file to be uploaded and click on "Import Certificate" to import a new certificate. Use Default Certificates – use the preloaded default certificates.
User Authentication Certificate 1	Cerificate provided by default for User authentication.
User Authentication Certificate 2	Cerificate provided by default for User authentication.
Radius Accounting Port	The destination port on the AAA server used for Radius accounting communication.
Accounting Messages	disable – no accounting messages are sent to the RADIUS server. deviceAccess – accounting messages regarding device access are sent to the RADIUS server (see Table 94). dataUsage – accounting messages regarding data usage are sent to the RADIUS server (see Table 94). All – accounting messages regarding device access and data usage are sent to the RADIUS server.
Accounting Data Usage Interval	The interval for which accounting data messages are sent from the radio to the RADIUS server. If 0 is configured for this parameter, no data usage messages are sent.
SM Re-authentication Interval	The interval for which the SM will re-authenticate to the RADIUS server.
Account Status	Displays the account status.

SM – Technician/Installer/Administrator Authentication

The centralized user name and password management for SM is same as AP. Follow AP – Technician/Installer/Administrator Authentication on page 1-292 procedure.

Note

Remote access control is enabled only after the SM registers to an AP that has **Authentication Mode** set to **RADIUS AAA**. Local access control will always be used before registration and is used after registration if the AP is not configured for RADIUS.

Figure 49 User Authentication and Access Tracking tab of the SM

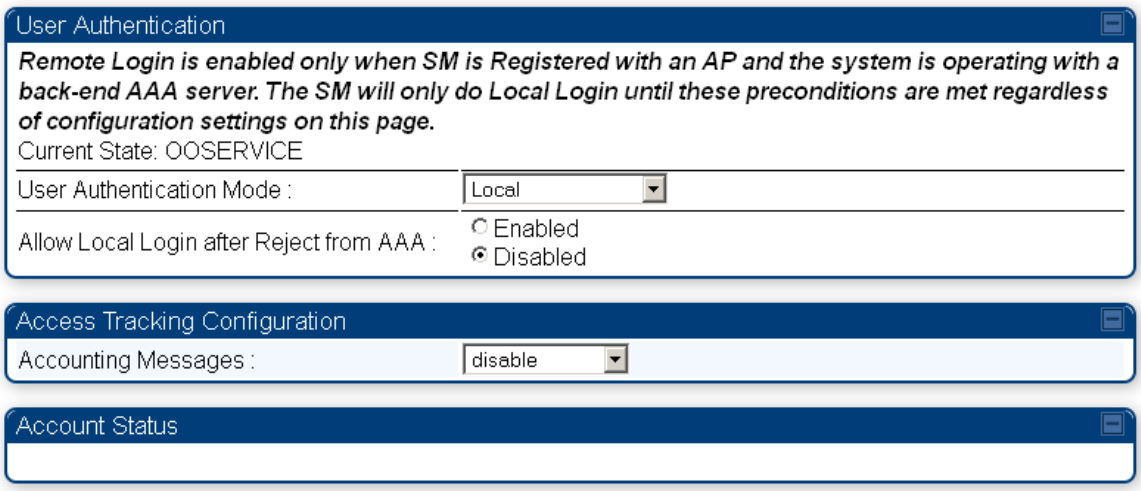
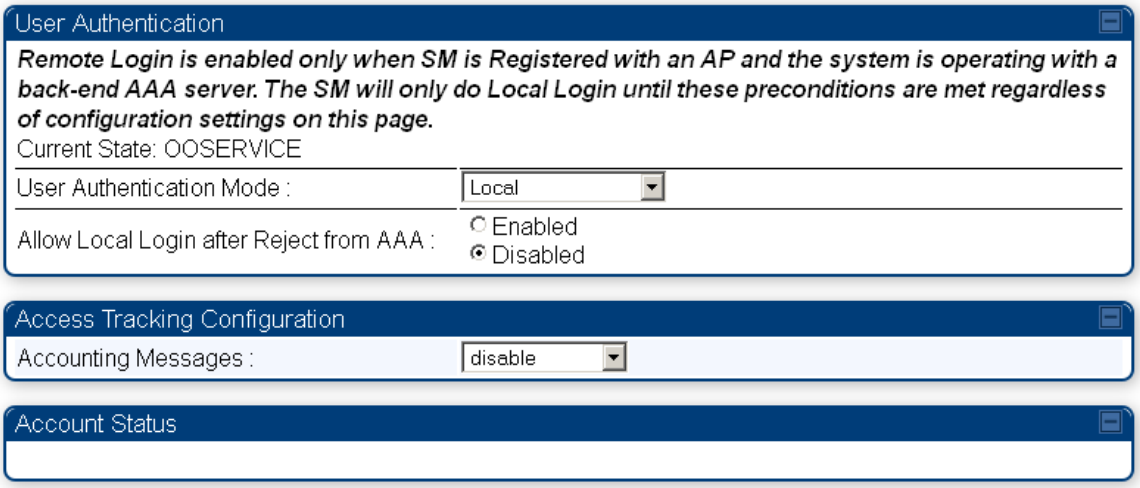


Table 93 SM User Authentication and Access Tracking attributes



Attribute	Meaning
User Authentication Mode	• **Local**: The local SM is checked for accounts. No centralized RADIUS accounting (access control) is performed.

	• **Remote**: Authentication by the centralized RADIUS server is required to gain access to the SM if the SM is registered to an AP that has **RADIUS AAA Authentication Mode** selected. For up to 2 minutes a test pattern is displayed until the server responds or times out. • **Remote then Local**: Authentication using the centralized RADIUS server is attempted. If the server sends a reject message, then the setting of **Allow Local Login after Reject from AAA** determines if the local user database is checked or not. If the configured servers do not respond within 2 minutes, then the local user database is used. The successful login method is displayed in the navigation column of the SM.
Allow Local Login after Reject from AAA	If a user authentication is rejected from the AAA server, the user is allowed to login locally to the radio's management interface. It is applicable ONLY when the **User Authentication Mode** is set to "**Remote then Local**". **Note** When the radio User Authentication Mode is set to "Local" or "Remote", the Allow Local Login after Reject from AAA does not any effect.
Accounting Messages	• disable – no accounting messages are sent to the RADIUS server • deviceAccess – accounting messages are sent to the RADIUS server regarding device access (see Table 94).

Access Tracking

To track logon and logoff times on individual radios by technicians, installers, and administrators, on the AP or SM's Account > User Authentication and Access Tracking tab under Accounting (Access Tracking) set Accounting Messages to "deviceAccess".

Device Access Tracking is enabled separately from User Authentication Mode. A given AP or SM can be configured for both, either, or neither.

RADIUS Device Data Accounting

PMP 450 Platform systems include support for RADIUS accounting messages for usage-based billing. This accounting includes indications for subscriber session establishment, subscriber session disconnection, and bandwidth usage per session for each SM that connects to the AP. The attributes included in the RADIUS accounting messages are shown in the table below.

Table 94 Device data accounting RADIUS attributes

Sender	Message	Attribute	Value	Description
AP		Acct-Status-Type	1 - Start	

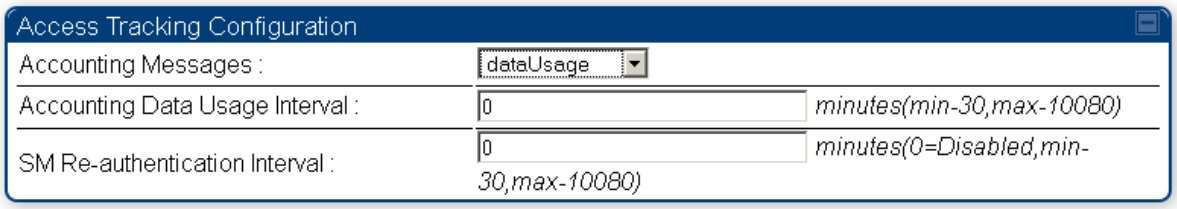
Sender	Message	Attribute	Value	Description
	Accounting-Request	Acct-Session-Id	Unique per AP session. Initial value is SM MAC, and increments after every start message sent of an in session SM.	This message is sent every time a SM registers with an AP, and after the SM stats are cleared.
		Event-Timestamp	UTC time the event occurred on the AP	
AP	Accounting-Request	Acct-Status-Type	2 - Stop	This message is sent every time a SM becomes unregistered with an AP, and when the SM stats are cleared.
		Acct-Session-Id	Unique per AP session. Initial value is SM MAC, and increments after every start message sent of an in session SM.	
		Acct-Input-Octets	Sum of the input octets received at the SM over the Low Priority data channel as well as any Medium, High, and Ultra High Priority data channels configured.. Will not include broadcast.	
		Acct-Output-Octets	Sum of the output octets sent from the SM over the Low Priority data channel as well as any Medium, High, and Ultra High Priority data channels configured..	
		Acct-Input-Gigawords	Number of times the Acct-Input-Octets counter has wrapped around 2^32 over the course of the session	
		Acct-Output-Gigawords	Number of times the Acct-Output-Octets counter has wrapped around 2^32 over the course of the session	
		Acct-Input-Packets	Sum of unicast and multicast packets that are sent to a particular SM over the regular data VC and the high priority data VC (if enabled). It will not include broadcast.	

Sender	Message	Attribute	Value	Description
		Acct-Output-Packets	Sum of unicast and multicast packets that are sent from a particular SM over the Low Priority data channel as well as any Medium, High, and Ultra High Priority data channels configured..	
		Acct-Session-Time	Uptime of the SM session.	
		Acct-Terminate-Cause	Reason code for session termination	
AP	Accounting-Request	Acct-Status-Type	3 - Interim-Update	This message is sent periodically per the operator configuration on the AP in seconds. Interim update counts are cumulative over the course of the session
		Acct-Session-Id	Unique per AP session. Initial value is SM MAC, and increments after every start message sent of an in session SM.	
		Acct-Input-Octets	Sum of the input octets sent to the SM over the Low Priority data channel as well as any Medium, High, and Ultra High Priority data channels configured.. Will not include broadcast.	
		Acct-Output-Octets	Sum of the output octets set from the SM over the Low Priority data channel as well as any Medium, High, and Ultra High Priority data channels configured.	
		Acct-Input-Gigawords	Number of times the Acct-Input-Octets counter has wrapped around 2^32 over the course of the session	
		Acct-Output-Gigawords	Number of times the Acct-Output-Octets counter has wrapped around 2^32 over the course of the session	
		Acct-Session-Time	Uptime of the SM session.	

Sender	Message	Attribute	Value	Description
		Acct-Input-Packets	Sum of unicast and multicast packets that are sent to a particular SM over the regular data VC and the high priority data VC (if enabled). It will not include broadcast.	
		Acct-Output-Packets	Sum of unicast and multicast packets that are sent from a particular SM over the regular data VC and the high priority data VC (if enabled).	

The data accounting configuration is located on the AP's **Accounts** > **User Authentication and Access Tracking** GUI menu, and the AP's **Authentication Mode** must be set to **Radius AAA** for the menu to appear. The accounting may be configured via the AP GUI as shown in the figures below. By default accounting messages are not sent and the operator has the choice of configuring to send only Device Access accounting messages (when a user logs in or out of the radio), only Data Usage messages, or both. When Data Accounting is enabled, the operator must specify the interval of when the data accounting messages are sent (0 – disabled, or in the range of 30-10080 minutes). The default interval is 30 minutes.

Figure 50 RADIUS accounting messages configuration



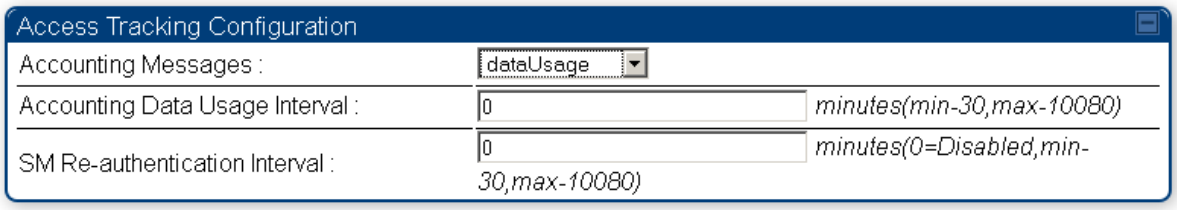
The data accounting message data is based on the SM statistics that the AP maintains, and these statistics may be cleared on the AP by an operator. If an operator clears these messages and data accounting is enabled, an accounting stop message is sent followed by an accounting start message to notify the AAA of the change.

If an operator clears the VC statistics on the device through the management GUI, a RADIUS stop message and data start message is issued for each device affected. The start and stop messages will only be sent once every 5 minutes, so if an operator clears these statistics multiple times within 5 minutes, only one set of data stop/start messages is sent. This may result in inaccurate data accumulation results.

RADIUS Device Re-authentication

PMP 450 Platform systems include support for periodic SM re-authentication in a network without requiring the SM to re-register (and drop the session). The re-authentication may be configured to occur in the range of every 30 minutes to weekly.

Figure 51 Device re-authentication configuration



The re-authentication interval is only configurable on the AP. When this feature is enabled, each SM that enters the network will re-authenticate each the interval time has expired without dropping the session. The response that the SM receives from the AAA server upon re-authentication is one of the following:

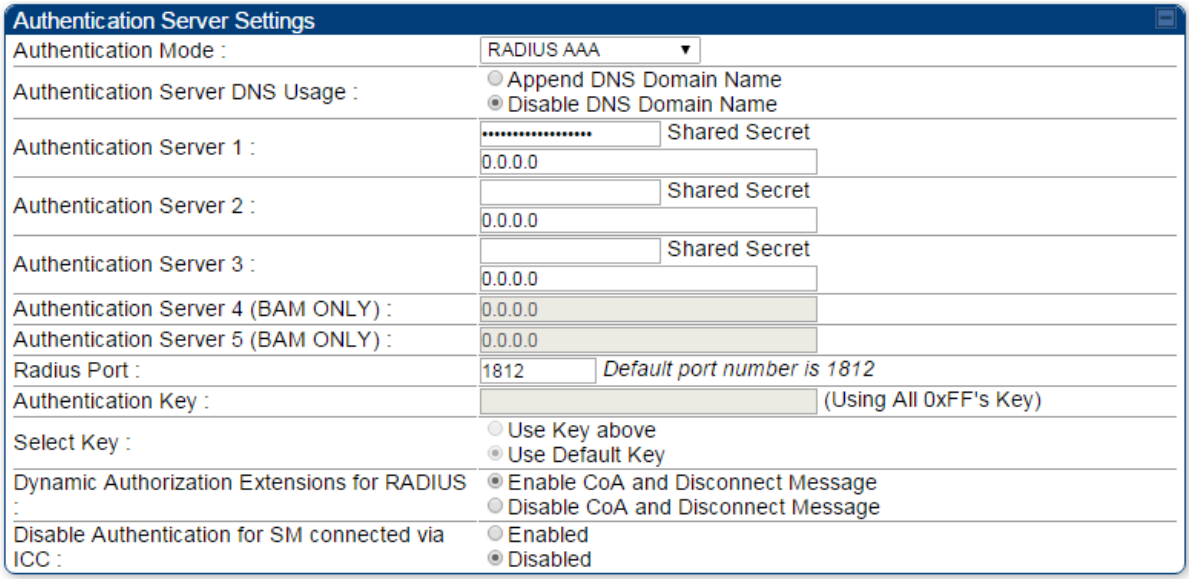
- **Success**: The SM continues normal operation
- **Reject**: The SM de-registers and will attempt network entry again after 1 minute and then if rejected will attempt re-entry every 15 minutes
- **Timeout or other error**: The SM remains in session and attempt 5 times to re-authenticate with the RADIUS-REQUEST message. If these attempts fail, then the SM will go out of session and proceed to re-authenticate after 5 minutes, then every 15 minutes.

Although re-authentication is an independent feature, it was designed to work alongside with the RADIUS data usage accounting messages. If a user is over their data usage limit the network operator can reject the user from staying in the network. Operators may configure the RADIUS 'Reply-Message' attribute with an applicable message (i.e. "Data Usage Limit Reached") that is sent to the subscriber module and displayed on the general page.

RADIUS Change of Authorization and Disconnect Message

Prior to this feature, SM will get configuration parameters from a RADIUS server during authentication process. This feature allows an administrator to control configuration parameters in the SM while SM is in session. The configuration changes in SM are done using RADIUS Change of Authorization method (RFC 3576) on the existing RADIUS authentication framework for AP and SM. A typical use case could be changing the QOS parameters after a certain amount of bandwidth usage by a SM.

Figure 52 RADIUS CoA configuration for AP



The RADIUS CoA feature enables initiating a bi-directional communication from the RADIUS server(s) to the AP and SM.

The AP listens on UDP port 3799 and accepts CoA requests from the configured RADIUS servers. This CoA request should contain SM MAC address in 'User-Name' attribute as identifier and all other attributes which control the SM config parameters. For security reasons, a timestamp also needs to be added as 'Event-Timestamp' attribute. Hence the time should also be synchronized between the RADIUS server(s) and the AP to fit within a window of 300 seconds.

Once the configuration changes are applied on the SM, CoA-ACK message is sent back to RADIUS server. If the validation fails, the AP sends a CoA-NACK response to the RADIUS server with proper error code.

A **Disconnect-Message** is sent by the RADIUS server to NAS in order to terminate a user session on a NAS and discard all associated session context. It is used when the authentication AAA server wants to disconnect the user after the session has been accepted by the RADIUS.

In response of Disconnect-Request from RADIUS server, the NAS sends a Disconnect-ACK if all associated session context is discarded, or a Disconnect-NACK, if the NAS is unable to disconnect the session.

Note

The RADIUS CoA feature will only enabled if Authentication mode is set to RADIUS AAA.

Microsoft RADIUS support

This feature allows to configure Microsoft RADIUS (Network Policy and Access Services a.k.a NPS) as Authentication server for SM and User authentication.

- For SM Authentication, SM will user PEAP-MSCHAPv2 since NPS doesn't support TTLS protocol.
- For User Authentication, the Canopy software will use EAP-MD5 but the user has to do certain configuration in order to enable EAP-MD5 on NPS.

Note

All this configuration has been tested on Windows Server 2012 R2 version.

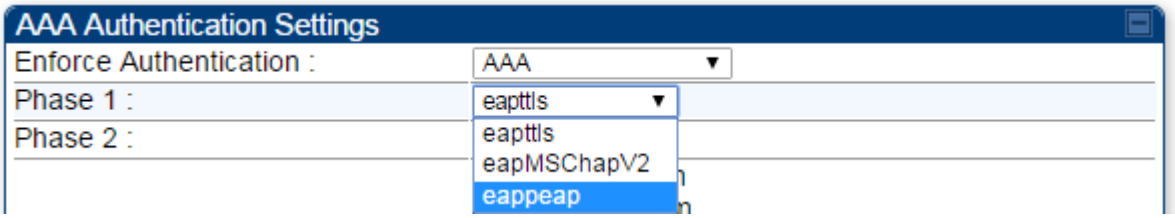
This feature is not supported on hardware board type P9 or lower platforms.

SM Authentication Configuration

There are no new configurations on AP. However, SM has to be configured for PEAP authentication protocol.

1. Go to Configuration > Security page
2. Select "**eappeap**" for Phase 1 attribute under tab AAA Authentication Settings.

Figure 53 EAPPEAP settings



The Phase 2 will change automatically to MSCHAPv2 on select of Phase 1 attribute as EAP-PEAP. Other parameters of Phase 2 protocols like PAP/CHAP will be disabled.

5. Windows Server Configuration

Import Certificate

The SM certificate has to be imported to Windows Server for certificate authentication.

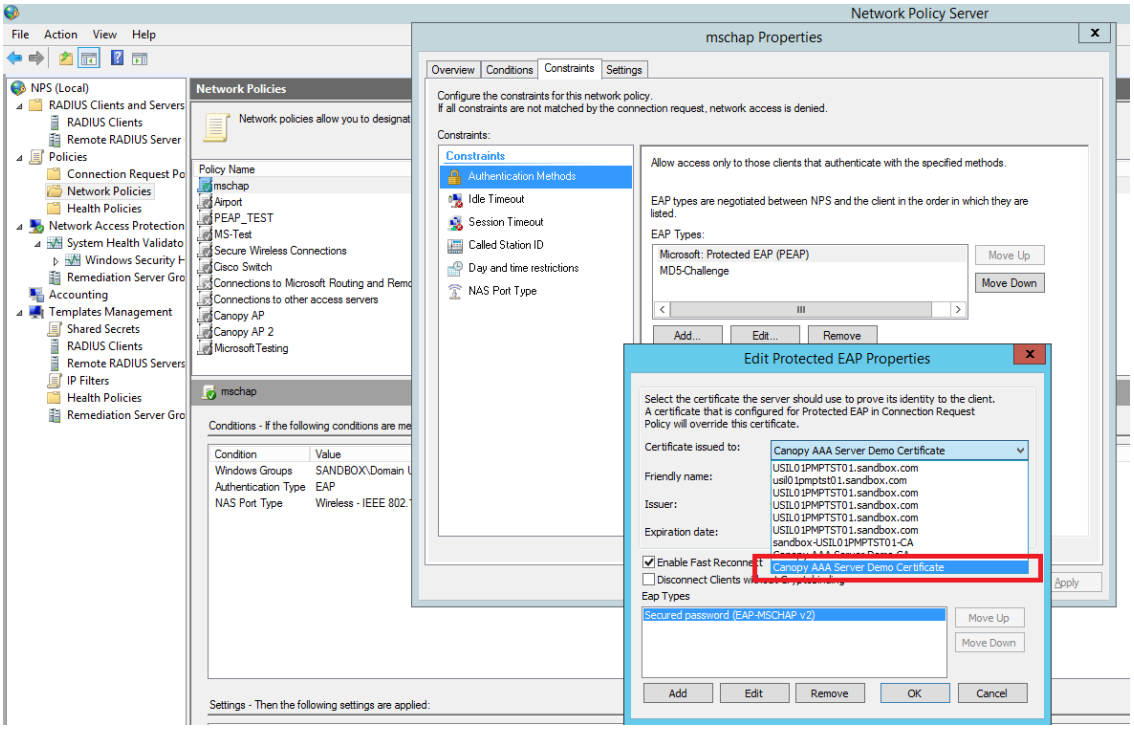
1. Copy the certificate which is configured in SM under **Configuration > Security -> Certificate1** to Windows Server machine.
2. Right click and select 'Install Certificate'. This will install the certificate and it's ready for use. This certificate will be used while configuring PEAP-MSCHAPv2 in NPS.

NPS Configuration (https://technet.microsoft.com/en-us/network/bb545879.aspx)

Following **items** should be configured in NPS Console:

- RADIUS Client
  - https://technet.microsoft.com/en-us/library/cc732929
- Connection Request Policies
  - https://technet.microsoft.com/en-us/library/cc730866
  - Choose 'Wireless-Other' in NAS-Port-Type
- Network Policy
  - https://technet.microsoft.com/en-us/library/cc755309
  - Choose 'Wireless-Other' in NAS-Port-Type.
  - While configuring PEAP, select the above imported certificate.

Figure 54 Importing certificate in NPS



User Authentication Configuration

6. Enabling EAP-MD5

As mentioned earlier, Microsoft has deprecated the support for MD5 from versions of Windows. To enable MD5, the following steps to be followed:

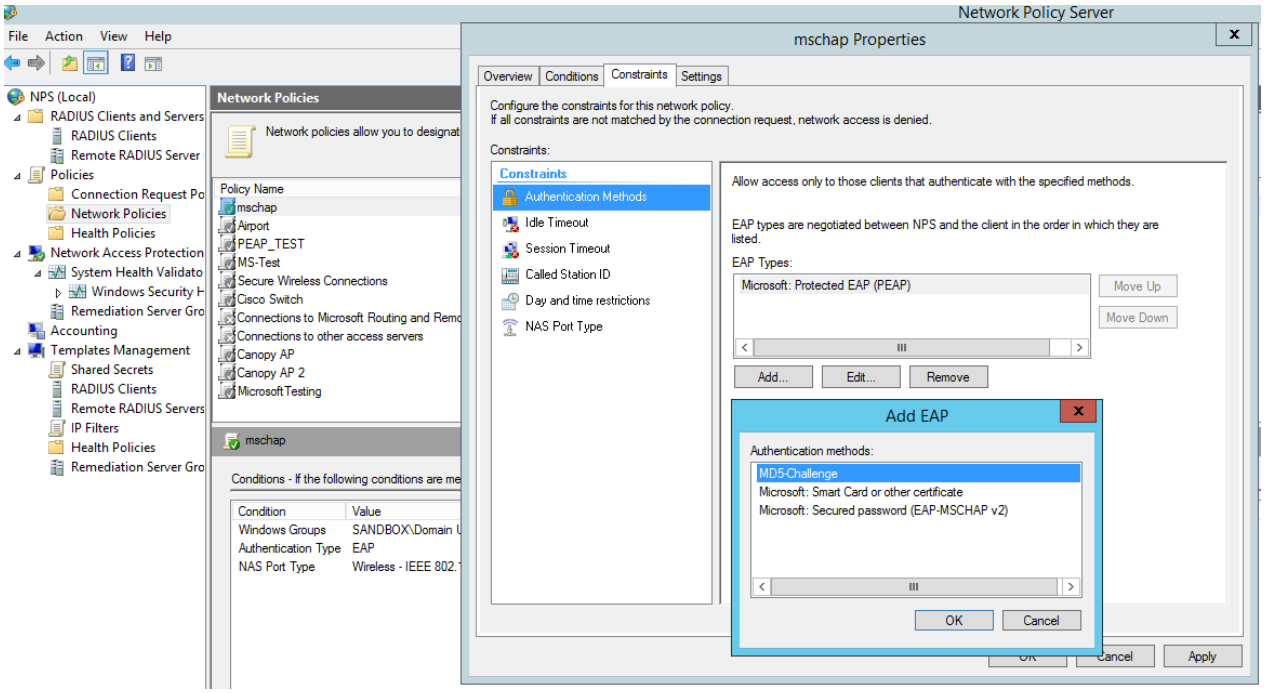
1. Follow the instructions:

   https://support.microsoft.com/en-us/kb/922574/en-us?wa=wsignin1.0

   Optionally, the registry file can be downloaded. It can be installed by double-click it in Windows Registry.

2. From NPS Console **Network Policy >** <Policy Name> **> Properties > Constrains > Authentication Method** and click Add. Select MD5 and click OK.

Figure 55 Selecting MD5 from NPS console

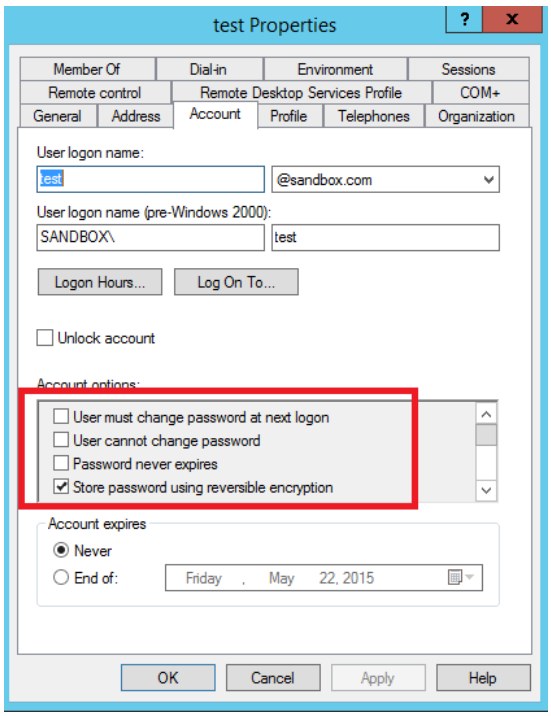


7. User Configuration in Active Directory

Next open '**Active Directory Users and Computers**' and create user.

Make sure user property is configured as shown below.

Figure 56 User configuration



8. RADIUS VSA Configuration

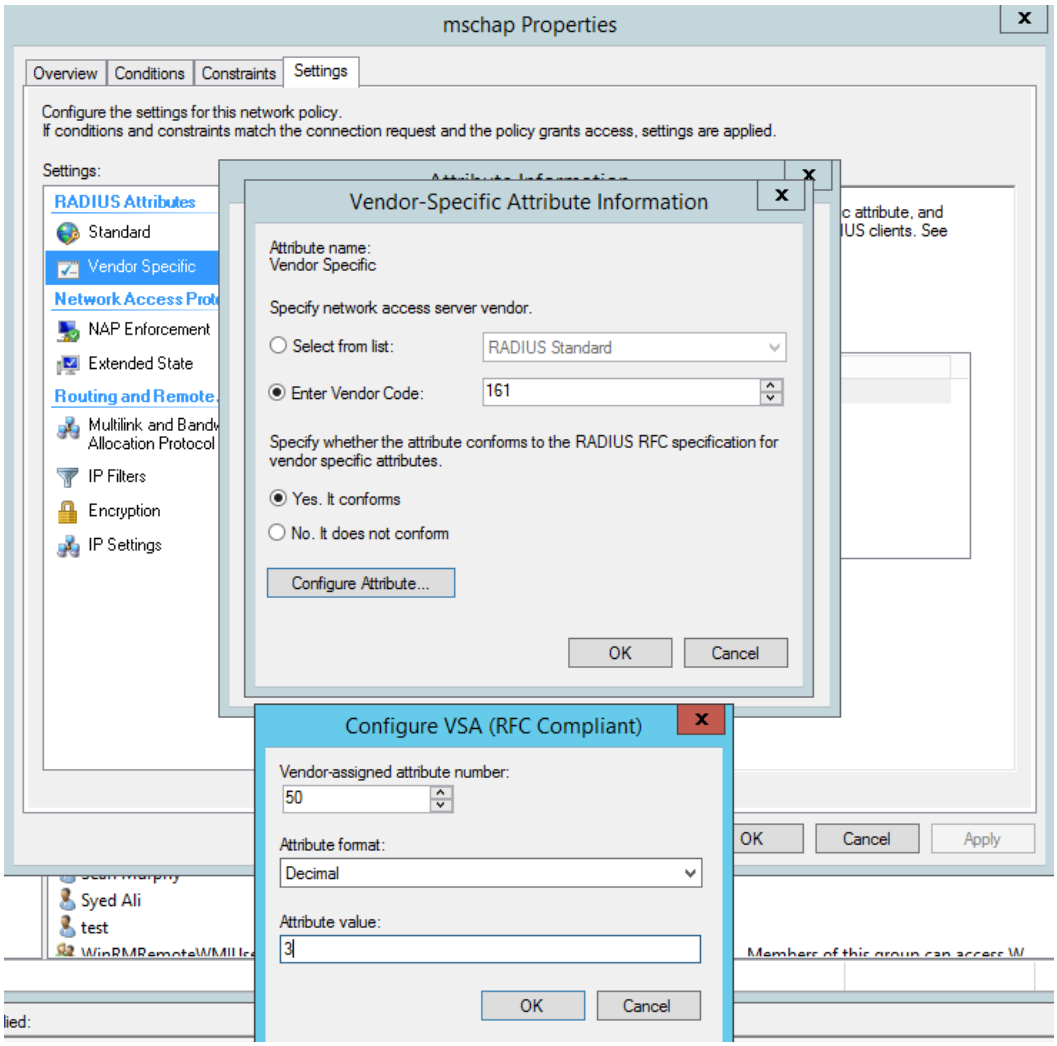
Before using VSA, the **Cambium-Canopy-UserLevel(50)** VSA must be configured with some access level say ADMIN(3).

Follow below link for configuring VSA:

https://technet.microsoft.com/en-us/library/cc731611

The Cambium's vendor code is 161.

Figure 57 RADIUS VSA configuration



9. Accounting

User can enable accounting in NPS under **NPS Console > Accounting > Configure Accounting**.

For more details refer https://technet.microsoft.com/library/dd197475

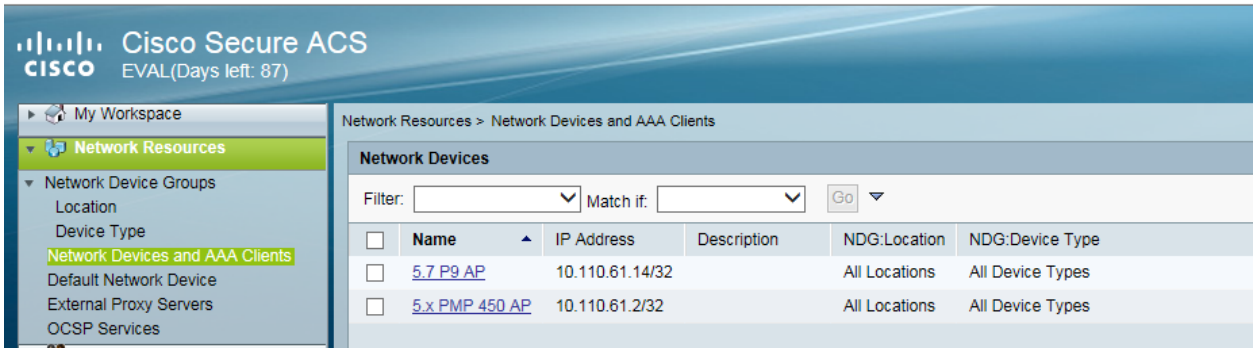
Cisco ACS RADIUS Server Support

This briefly explains how to configure Cisco ACS RADIUS server for PEAP-MSCHAPv2 authentication.

The configuration had been tested on CISCO ACS Version : 5.7.0.15

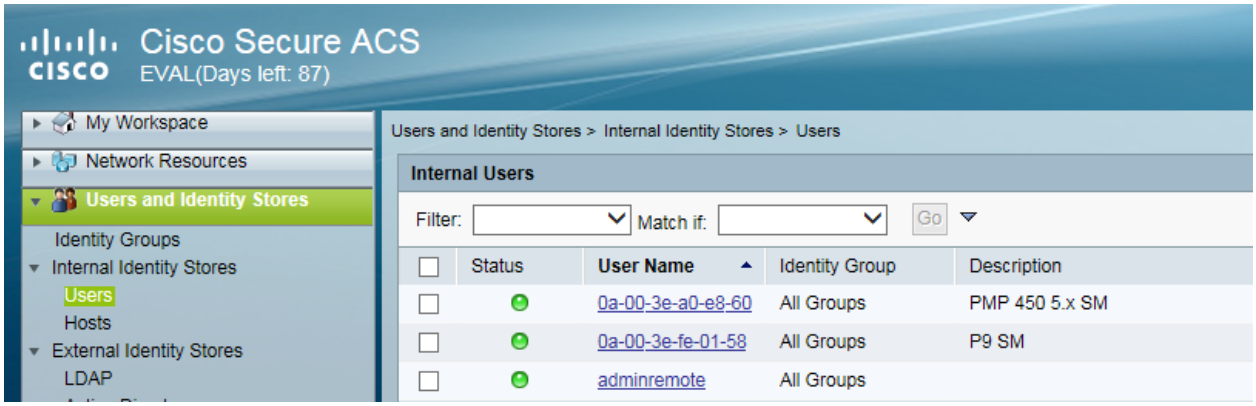
Adding RADIUS client

Figure 58 Adding RADIUS client



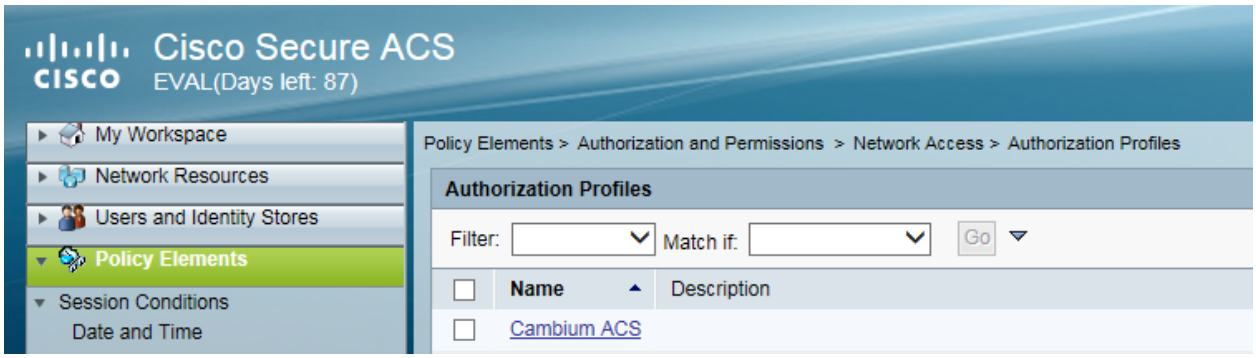
Creating Users

Figure 59 Creating users



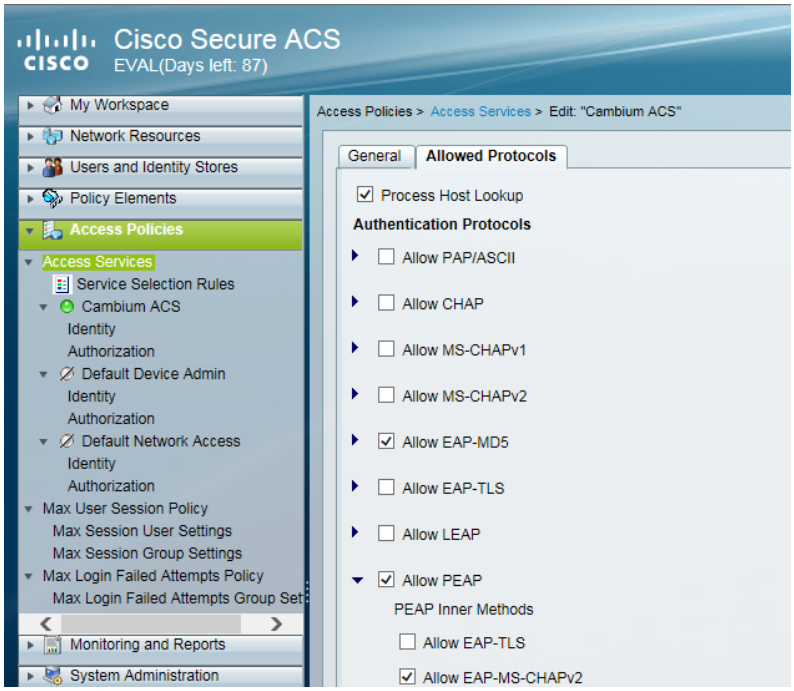
Creating RADIUS instance

Figure 60 Creating RADIUS instance



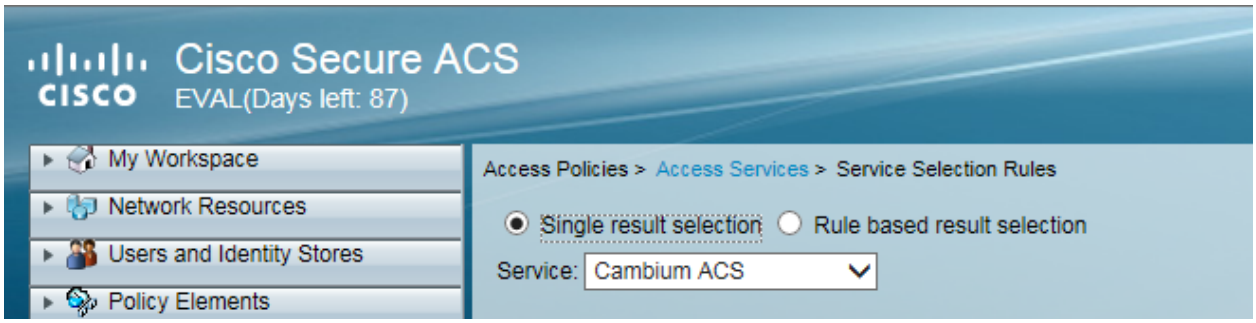
RADIUS protocols

Figure 61 RADIUS protocols



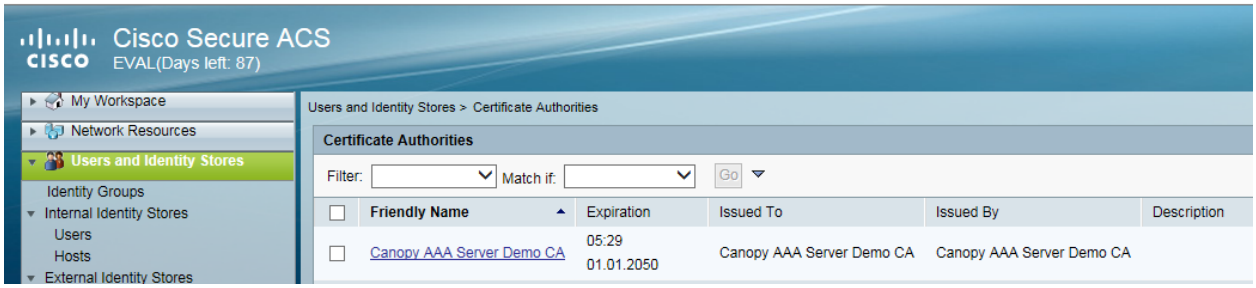
Service selection

Figure 62 Service selection



Adding Trusted CA

Figure 63 Adding Trusted CA



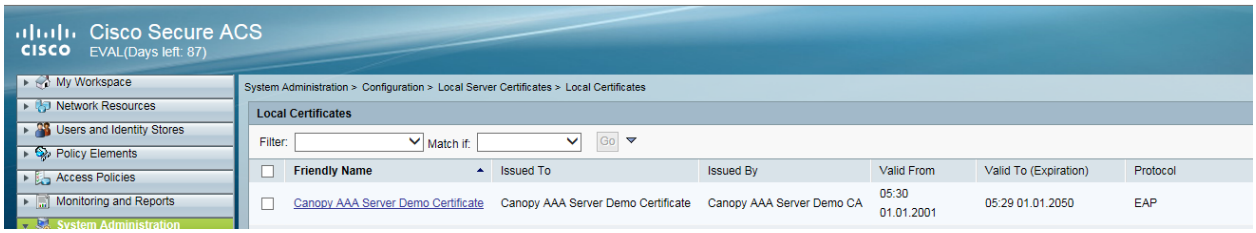
Note that certificate has to be in DER form, so if you have in PEM format convert using openssl.

`Openssl.exe x509 -in <path-to->/cacert_aaasvr.pem -outform DER -out <path-to>/cacert_aaasvr.der`

Installing Server Certificate

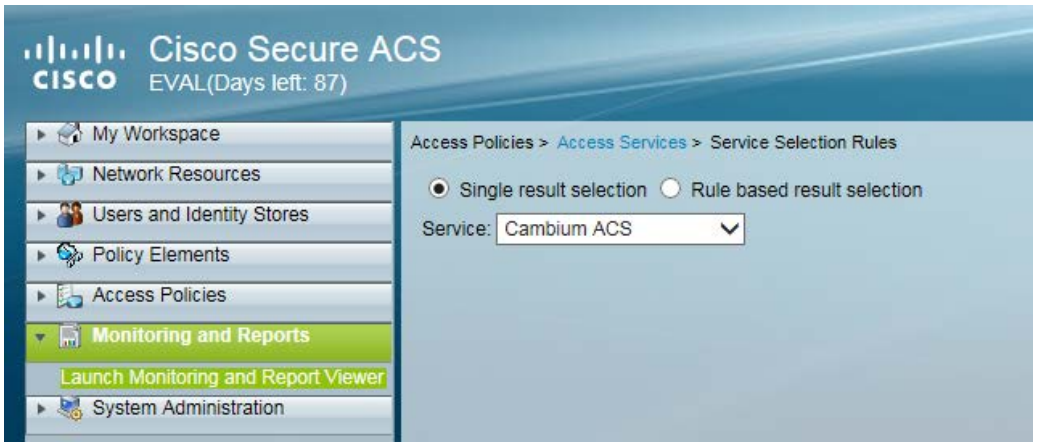
After installing trusted CA, you need to add a server certificate which will be used for TLS tunnel. Generally you have to install same certificate which is installed in your AP, so that AP can trust the radius server.

Figure 64 Installing Server Certificate



Monitoring Logs

Figure 65 Monitoring logs



Configuring VSA

Before using VSA , user has to add Cambium Vendor Specific Attribute

Navigate to System Administration > Configuration > Dictionaries > Protocols > RADIUS > RADIUS VSA > Motorola

If Motorola is not present you can create Vendor with ID 161 and add all the VSA one by one.

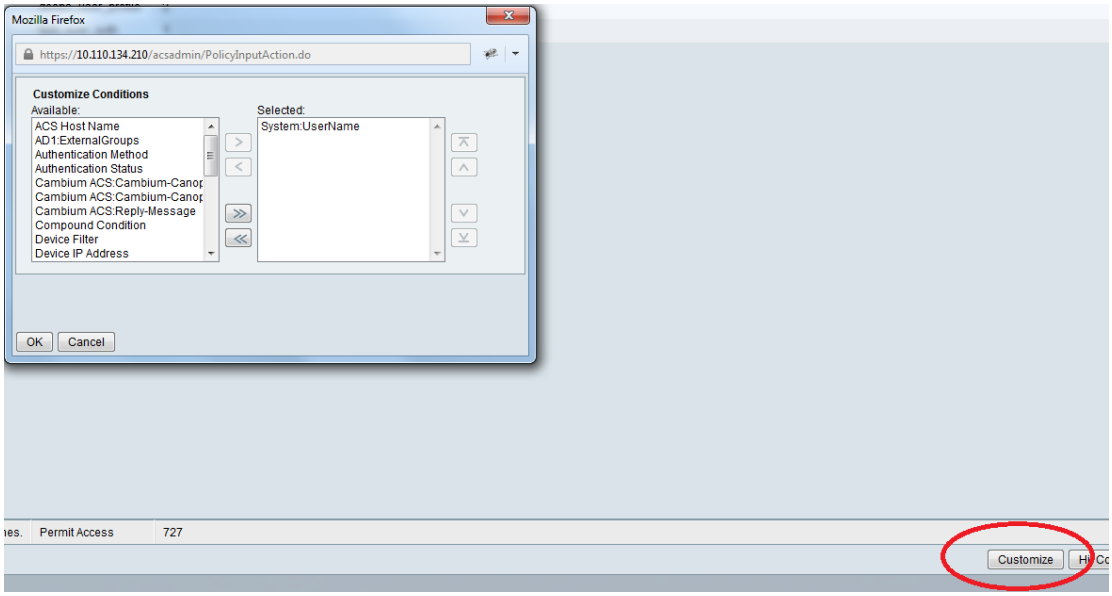
Figure 66 VSA list

Attribute	ID	Type	Direction	Multiple Allowed
Cambium-Canopy-BCASTMIR	24	Unsigned Integer 32	BOTH	false
Cambium-Canopy-DLBL	9	Unsigned Integer 32	BOTH	false
Cambium-Canopy-DLBR	8	Unsigned Integer 32	BOTH	false
Cambium-Canopy-DLMB	27	Unsigned Integer 32	BOTH	false
Cambium-Canopy-Gateway	25	IP Address	BOTH	false
Cambium-Canopy-HPDLCIR	4	Unsigned Integer 32	BOTH	false
Cambium-Canopy-HPENABLE	5	Unsigned Integer 32	BOTH	false
Cambium-Canopy-HPULCIR	3	Unsigned Integer 32	BOTH	false
Cambium-Canopy-LPDLCIR	2	Unsigned Integer 32	BOTH	false
Cambium-Canopy-LPULCIR	1	Unsigned Integer 32	BOTH	false
Cambium-Canopy-ULBL	7	Unsigned Integer 32	BOTH	false
Cambium-Canopy-ULBR	6	Unsigned Integer 32	BOTH	false
Cambium-Canopy-ULMB	26	Unsigned Integer 32	BOTH	false
Cambium-Canopy-UserLevel	50	Unsigned Integer 32	BOTH	false
Cambium-Canopy-UserMode	51	Unsigned Integer 32	BOTH	false
Cambium-Canopy-VLAGETO	20	Unsigned Integer 32	BOTH	false
Cambium-Canopy-VLFRAMES	15	Unsigned Integer 32	BOTH	false
Cambium-Canopy-VLIDSET	16	Unsigned Integer 32	BOTH	true
Cambium-Canopy-VLIGVID	21	Unsigned Integer 32	BOTH	false
Cambium-Canopy-VLLEARNEN	14	Unsigned Integer 32	BOTH	false
Cambium-Canopy-VLMGVID	22	Unsigned Integer 32	BOTH	true
Cambium-Canopy-VLSMMGPASS	23	Unsigned Integer 32	BOTH	false

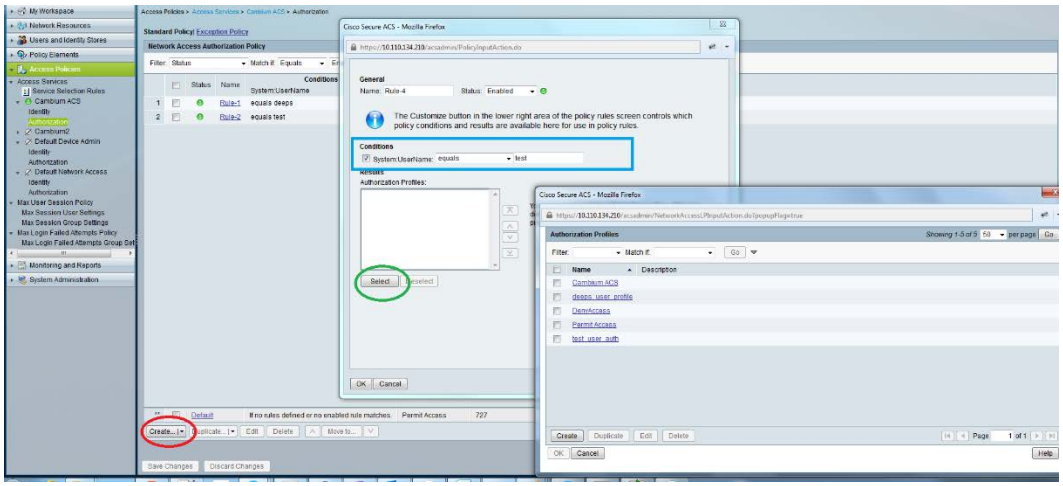
Using VSA for users

Navigate to **Access Policies > Access Services > Cambium ACS > Authorization**

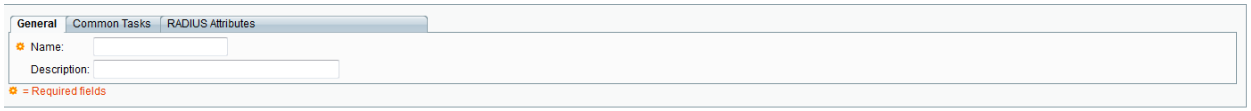
1. Change condition to User name



2. Next click **Create** and then click **Select** see diagram below

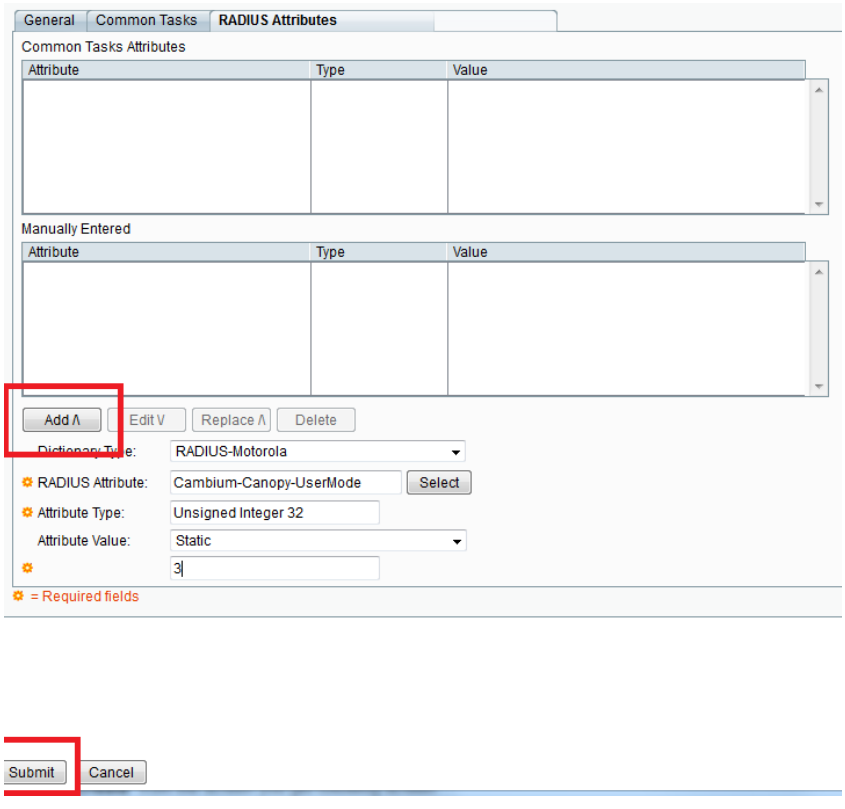


3. Click Create from the screen you get following screen



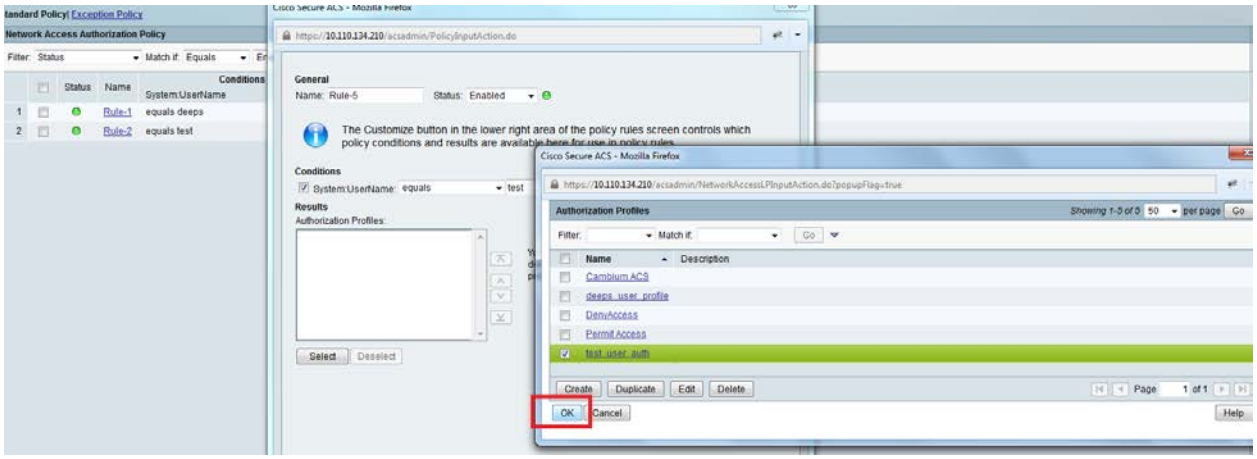
Chose some name and then move to RADIUS Attributes tab

4. Fill attribute which all you want for that particular user



Important: Click Add for each attribute and when done click Submit.

5. Now you are ready to use this Authorization profile for the use Select and Press **OK.**



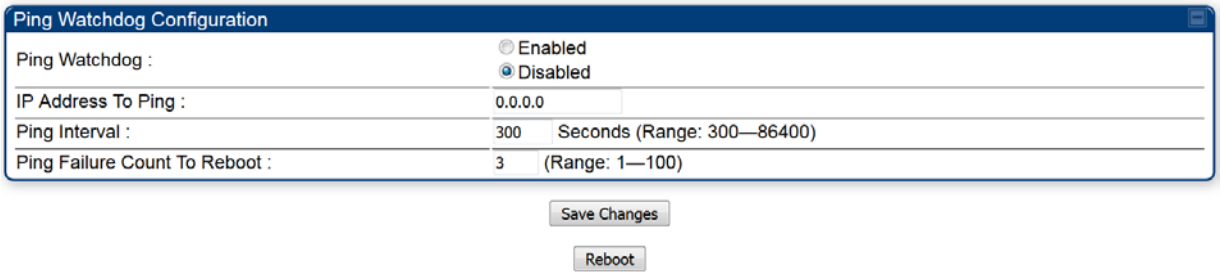
6. Finally press **Save** Changes and you are ready to use it.

Configuring Ping Watchdog

This feature allows administrator to automatically reboot an AP/SM when there is a network issue to avoid power on reset of radios. This feature is disabled by default.

To enable Ping Watchdog feature, select the menu option **Configuration > Ping Watchdog**, and configure the parameters listed in the following table.

Table 95 Ping Watchdog attributes



Attribute	Meaning
Ping Watchdog	This filed enables or disbales Ping Watchdog feature.
IP Address To Ping	This field specifies the IPV4 address of the device which needs to be pinged.
Ping Interval	This field specifies the time interval at which ping needs to be initiated. The time interval needs to be specified in seconds.
Ping Failure Count To Reboot	This field specifies the count of ping failures at which reboot needs to be initiated.

Chapter 2: Tools

The AP and SM GUIs provide several tools to analyze the operating environment, system performance and networking, including:

Using Spectrum Analyzer tool

The integrated spectrum analyzer can be very useful as a tool for troubleshooting and RF planning, but is not intended to replicate the accuracy and programmability of a high-end spectrum analyzer, which sometime can be used for other purposes.

The AP/BHM and SM/BHS perform spectrum analysis together in the Sector Spectrum Analyzer tool.

Caution

On start of the Spectrum Analyzer on a module, it enters a scan mode and drops any RF connection it may have had. When choosing **Start Timed Spectrum Analysis**, the scan is run for time specified in the **Duration** configuration parameter. When choosing **Start Continuous Spectrum Analysis**, the scan is run continuously for 24 hours, or until stopped manually (using the **Stop Spectrum Analysis** button).

Any module can be used to see the frequency and power level of any detectable signal that is within, just above, or just below the frequency band range of the module.

Note

Vary the days and times when you analyze the spectrum in an area. The RF environment can change throughout the day or throughout the week.

Mapping RF Neighbor Frequencies

The neighbor frequencies can be analyzed using Spectrum Analyzer tool. Following modules allow user to:

- Use a BHS or BHM for PTP and SM or AP for PMP as a Spectrum Analyzer.
- View a graphical display that shows power level in RSSI and dBm at 5 MHz increments throughout the frequency band range, regardless of limited selections in the **Custom Radio Frequency Scan Selection List** parameter of the SM/BHS.
- Select an AP/BHM channel that minimizes interference from other RF equipment.

Caution

The following procedure causes the SM/BHS to drop any active RF link. If a link is dropped when the spectrum analysis begins, the link can be re-established when either a 15 minute interval has elapsed or the spectrum analyzer feature is disabled.

Temporarily deploy a SM/BHS for *each* frequency band range that need to monitor and access the Spectrum Analyzer tab in the Tools web page of the module.

- Using Spectrum Analyzer tool

- Using the Remote Spectrum Analyzer tool

Spectrum Analyzer tool

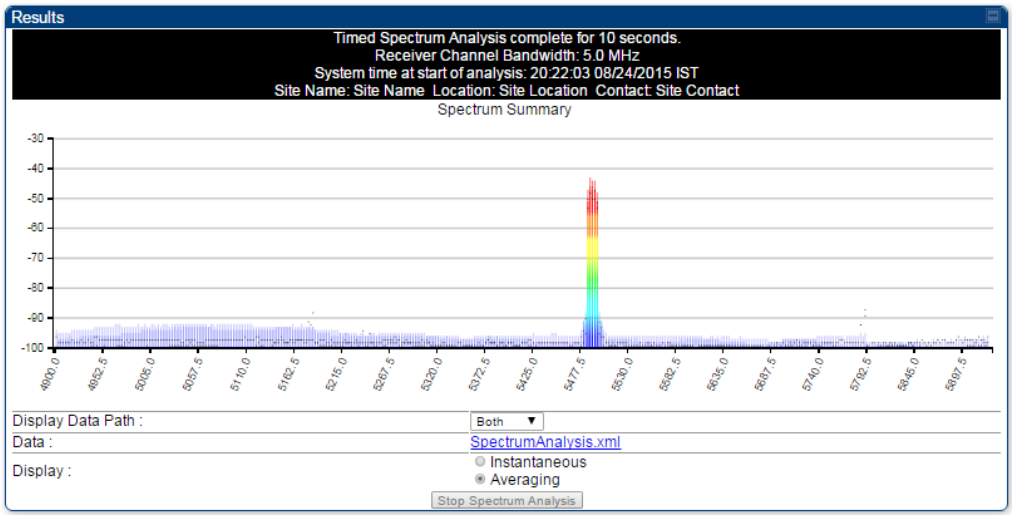
Analyzing the spectrum

To use the built-in spectrum analyzer functionality of the AP/SM/BH, proceed as follows:

Procedure 22 Analyzing the spectrum

1. Predetermine a power source and interface that works for the AP/SM/BH in the area to be analyzed.
2. Take the AP/SM/BH, power source and interface device to the area.
3. Access the **Tools > Spectrum Analyzer** web page of the AP/SM/BH.
4. Enter **Duration** in Timed Spectrum Analyzer Tab. Default value is 10 Seconds
5. Click **Start Timed Sector Spectrum Analysis**
6. The results are displayed:

Figure 67 Spectrum analysis - Results



Note

AP/SM/BH scans for extra 40 seconds in addition to configured **Duration**

7. Travel to another location in the area to BHS.
8. Click **Start Timed Spectrum Analysis**
9. Repeat Steps 4 and 6 until the area has been adequately scanned and logged.

As with any other data that pertains to your business, a decision today to put the data into a retrievable database may grow in value to you over time.

Note

Wherever the operator finds the measured noise level is greater than the sensitivity of the radio that is plan to deploy, use the noise level (rather than the link budget) for your link feasibility calculations.

The AP/SM/BH perform spectrum analysis together in the Sector Spectrum Analyzer feature.

Graphical spectrum analyzer display

The AP/SM/BH display the graphical spectrum analyzer. An example of the **Spectrum Analyzer** page is shown in Figure 67.

The navigation feature includes:

- Results may be panned left and right through the scanned spectrum by clicking and dragging the graph left and right
- Results may be zoomed in and out using mouse

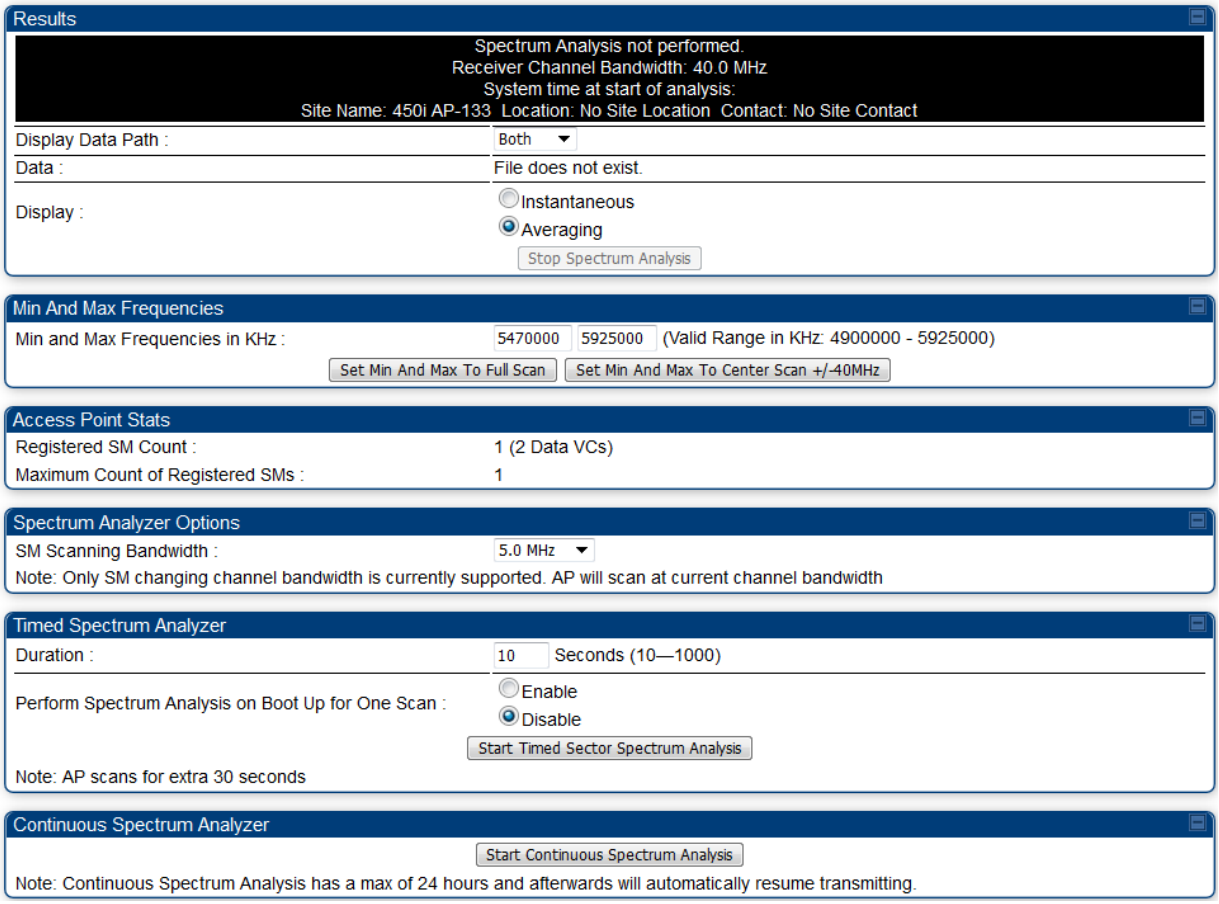
When the mouse is positioned over a bar, the receive power level, frequency, maximum and mean receive power levels are displayed above the graph

To keep the displayed data current, either set “Auto Refresh” on the module’s **Configuration > General.**

Spectrum Analyzer page of AP

The Spectrum Analyzer page of AP is explained in Table 96.

Table 96 Spectrum Analyzer page attributes - AP



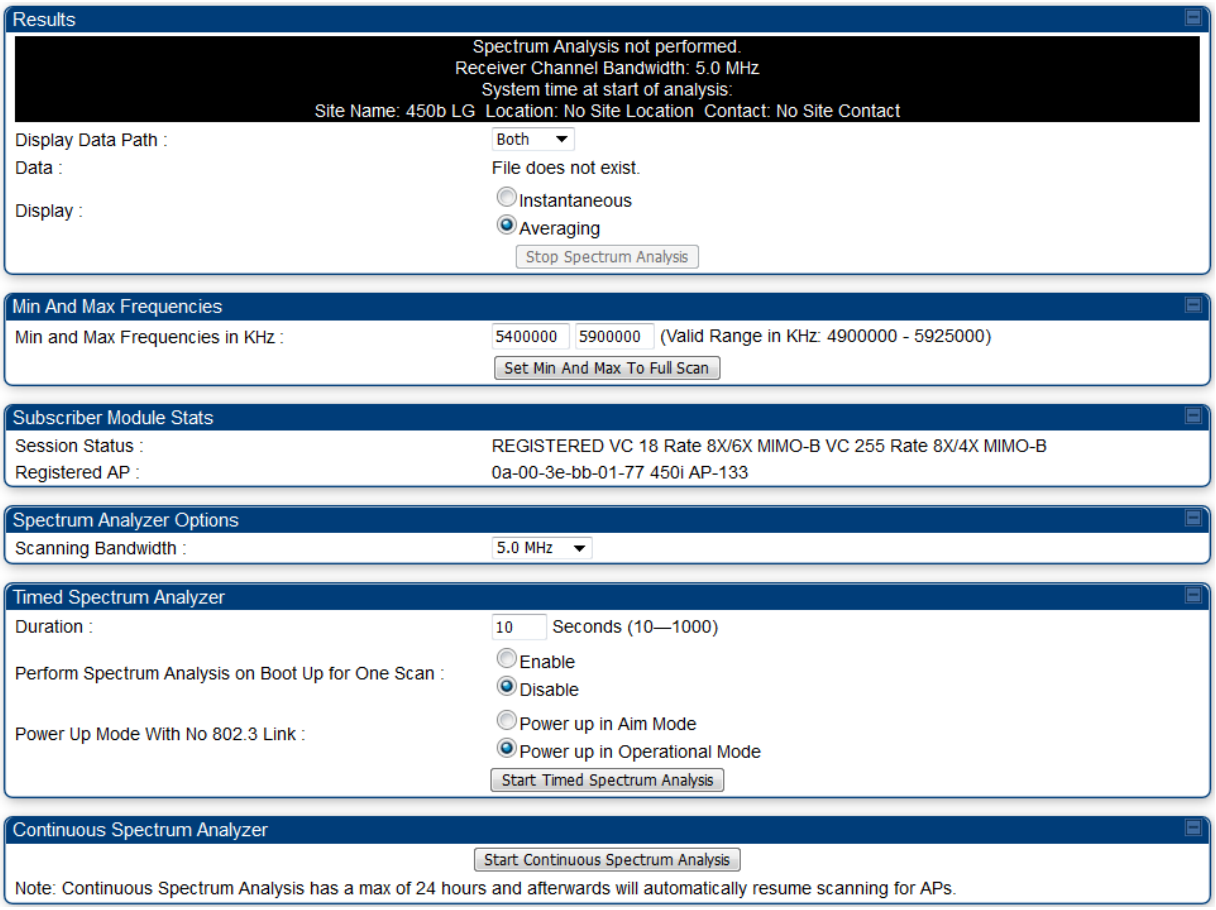
Attribute	Meaning
Display Data Path	**Both** means that the vertical and horizontal paths are displayed or an individual path may be selected to display only a single-path reading.
Data	For ease of parsing data and to facilitate automation, the spectrum analyzer results may be saved as an XML file. To save the results in an XML formatted file, right-click the “SpectrumAnalysis.xml” link and save the file.
Display	**Instantaneous** means that each reading (vertical bar) is displayed with two horizontal lines above it representing the max power level received (top horizontal line) and the average power level received (lower horizontal line) at that frequency. **Averaging** means that each reading (vertical bar) is displayed with an associated horizontal line above it representing the max power level received at that frequency.

Min and Max Frequencies in KHz	Enter minimum and maximum frequencies to be scanned.
Set Min And Max to Full Scan	On the button press, it sets minimum and maximum allowed frequencies for scanning.
Set Min And Max to Center Scan +/-40 MHz	On the button press, it sets minimum and maximum frequencies to ± 40 MHz of center frequency for scanning.
Registered SM Count	This field displays the MAC address and Site Name of the registered SM.
Maximum Count of Registered SMs	This field displays the maximum number of registered SMs.
SM Scanning Bandwidth	This field allows to select SM's scanning bandwidth.
Duration	This field allows operators to configure a specified time for which the spectrum is scanned. If the entire spectrum is scanned prior to the end of the configured duration, the analyzer will restart at the beginning of the spectrum.
Perform Spectrum Analysis on Boot Up for One Scan	This field when enabled performs Spectrum Analysis on every boot up for one scan.
Continuous Spectrum Analyzer	*Start Continuous Spectrum Analysis* button ensures that when the SM is powered on, it automatically scans the spectrum for 10 seconds. These results may then be accessed via the **Tools > Spectrum Analyzer** GUI page.

Spectrum Analyzer page of SM

The Spectrum Analyzer page of SM is explained in Table 99.

Table 97 Spectrum Analyzer page attributes - SM



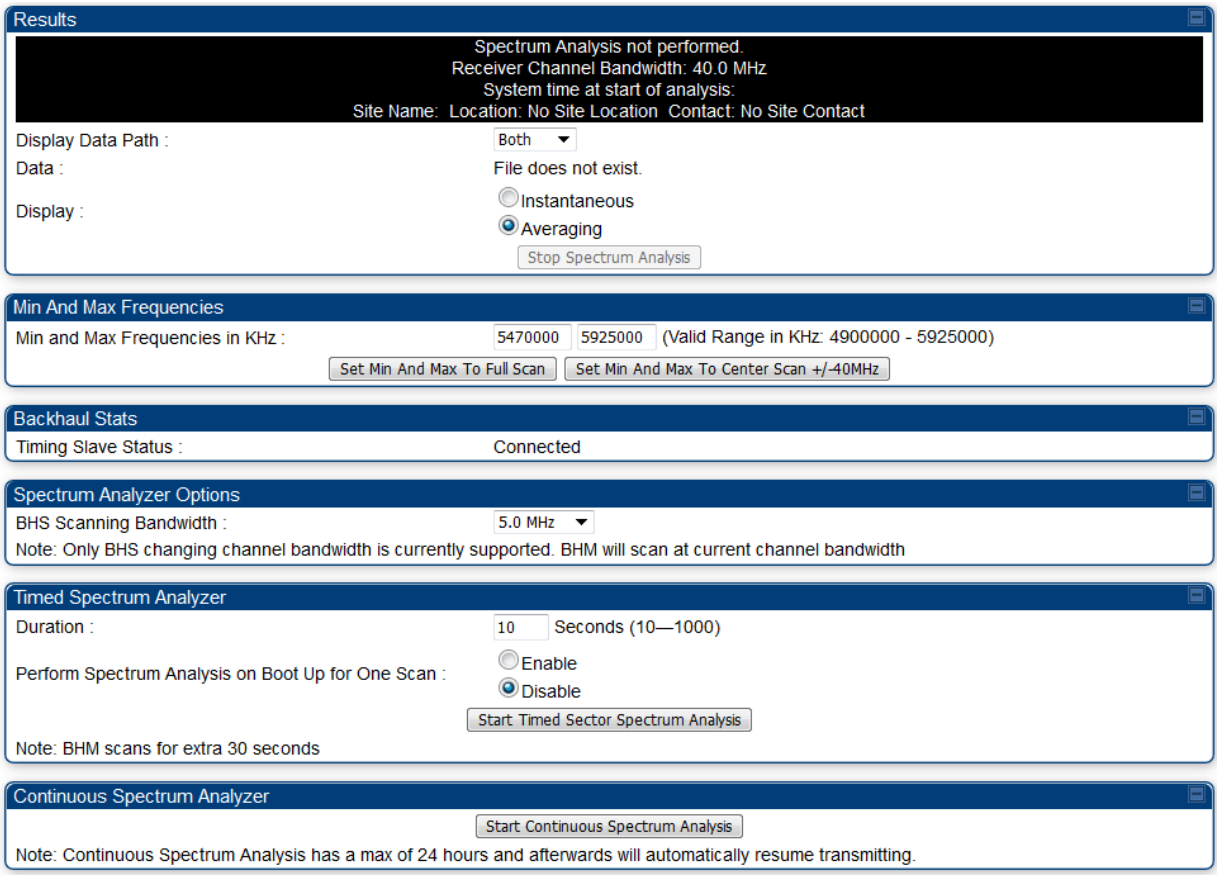
Attribute	Meaning
Display Data Path	Refer Table 96 on page 2-320
Data	Refer Table 96 on page 2-320
Display	Refer Table 96 on page 2-320
Min and Max Frequencies in KHz	To scan min to max range of frequencies, enter min and max frequencies in KHz and press **Set Min and Max to Full Scan** button. To scan +/- 40 MHz from center frequency, enter center frequency in KHz and press **Set Min And Max To Center Scan +/- 40KHz** button.
Session Status	This field displays current session status and rates. The session states can be Scanning, Syncing, Registering or Registered.
Registered AP	This field displays the information of AP to which this device is registered.
Scanning Bandwidth	This field allows to select the scanning bandwidth when running Spectrum Analysis.

Duration	Refer Table 96 on page 2-320
Perform Spectrum Analysis on Boot Up for One Scan	This field when enabled performs Spectrum Analysis on every boot up for one scan.
Power Up Mode With No 802.3 Link	This field indicates whether the link has to operate in Aim mode or in operational mode on power up.
Continuous Spectrum Analyzer	**Start Continuous Spectrum Analysis** button starts the SM in Spectrum Analysis until manually stopped, or it has scanned for 24 hours.

Spectrum Analyzer page of BHM

The Spectrum Analyzer page of BHM is explained in Table 98.

Table 98 Spectrum Analyzer page attributes - BHM



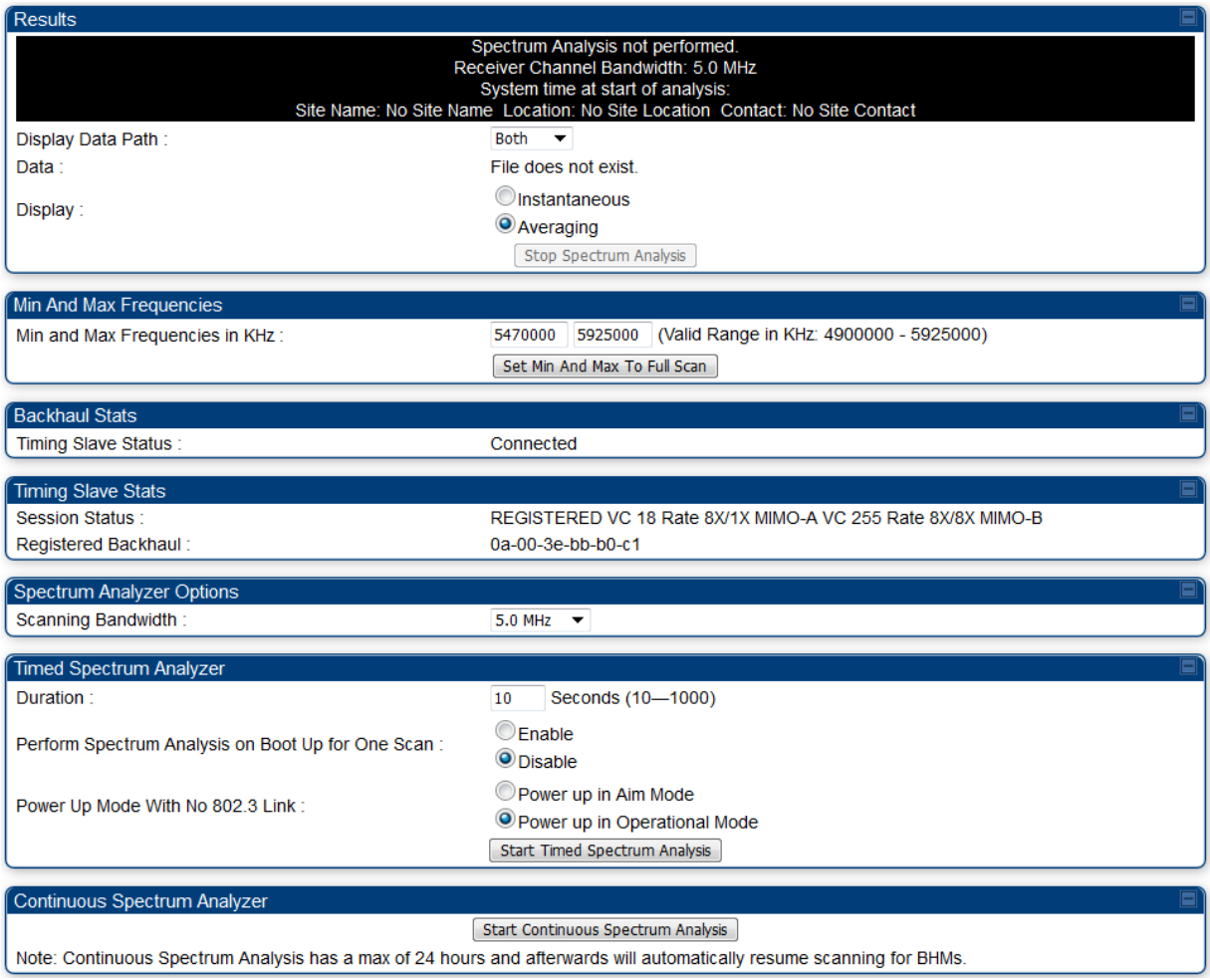
Attribute	Meaning
Data	Refer Table 96 on page 2-320
Display	Refer Table 96 on page 2-320
Duration	Refer Table 96 on page 2-320
Min and Max Frequencies in KHz	Enter minimum and maximum frequencies to be scanned.
Set Min And Max to Full Scan	On the button press, it sets minimum and maximum allowed frequencies for scanning.
Set Min And Max to Center Scan +/-40 MHz	On the button press, it sets minimum and maximum frequencies to ± 40 MHz of center frequency for scanning.
Timing Slave Status	This field displays the status of any registered Timing Slave.

BHS Scanning Bandwidth	This field allows to select BHS's scanning bandwidth.
Duration	This field allows operators to configure a specified time for which the spectrum is scanned. If the entire spectrum is scanned prior to the end of the configured duration, the analyzer will restart at the beginning of the spectrum.
Perform Spectrum Analysis on Boot Up for One Scan	This field when enabled performs Spectrum Analysis on every boot up for one scan.
Continuous Spectrum Analyzer	**Start Continuous Spectrum Analysis** button starts the SM in Spectrum Analysis until manually stopped, or it has scanned for 24 hours.

Spectrum Analyzer page of BHS

The Spectrum Analyzer page of BHS is explained in Table 99.

Table 99 Spectrum Analyzer page attributes - BHS

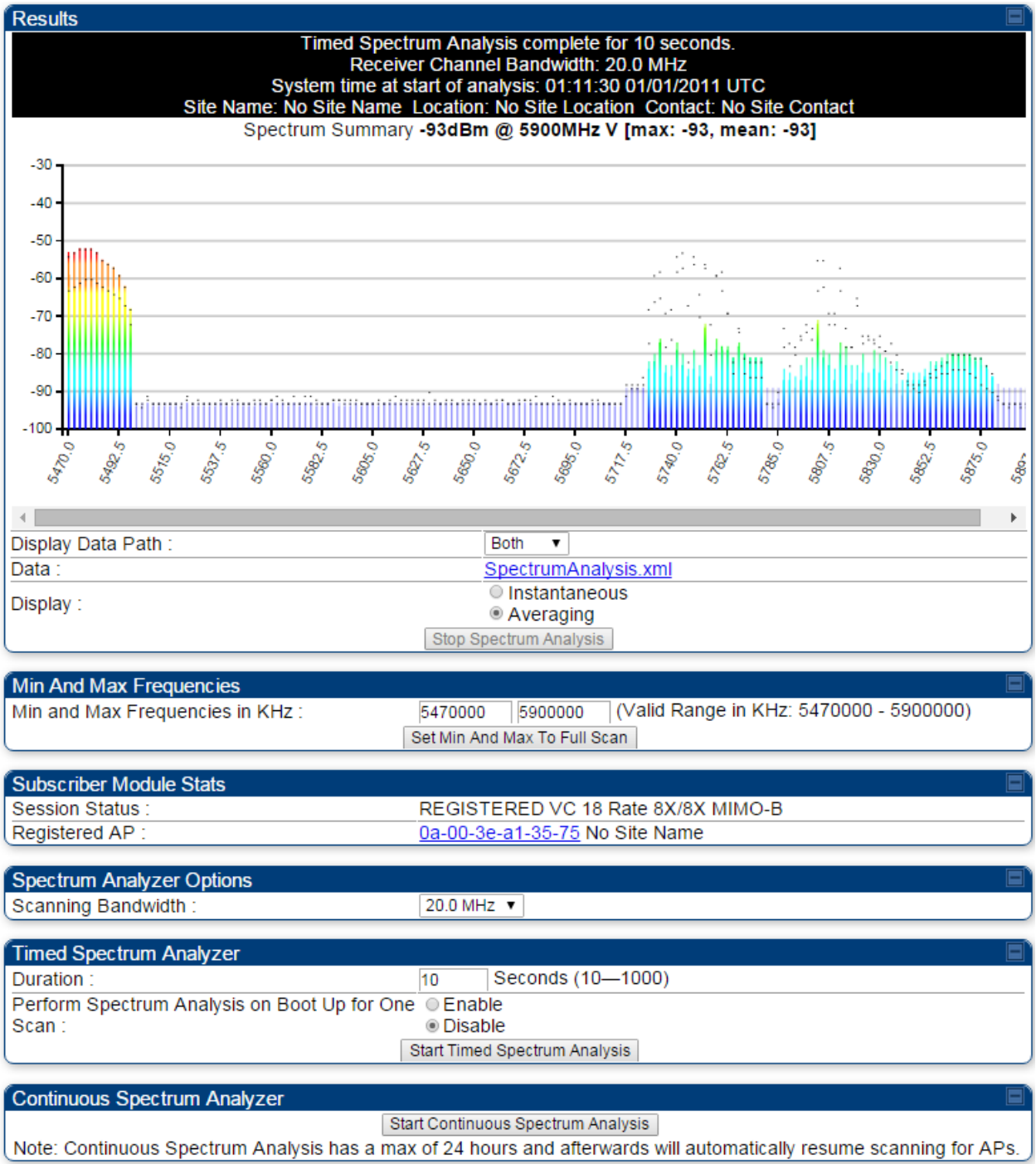


Attribute	Meaning
Data	Refer Table 96 on page 2-320
Display	Refer Table 96 on page 2-320
Session Status	This field displays current session status and rates. The session states can be Scanning, Syncing, Registering or Registered.
Registered Backhaul	This field displays MAC address of BHM and PTP model number
Duration	Refer Table 96 on page 2-320
Perform Spectrum Analysis on Boot Up for one scan	This field allows to Enable or Disable to start Spectrum Analysis on boot up of module for one scan.

Continuous Spectrum Analyzer	Refer Table 96 on page 2-320

Spectrum Analyzer page result of PMP 450 SM

Figure 68 Spectrum Analyzer page result – PMP 450 SM



Remote Spectrum Analyzer tool

The Remote Spectrum Analyzer tool in the AP/BHM provides additional flexibility in the use of the spectrum analyzer in the SM/BHS. Set the duration of 10 to 1000 seconds, then click the **Start Remote Spectrum Analysis** button to launch the analysis from that SM/BHS.

In PMP configuration, a SM must be selected from the drop-down list before launching **Start Remote Spectrum Analysis**.

Analyzing the spectrum remotely

Procedure 23 Remote Spectrum Analyzer procedure

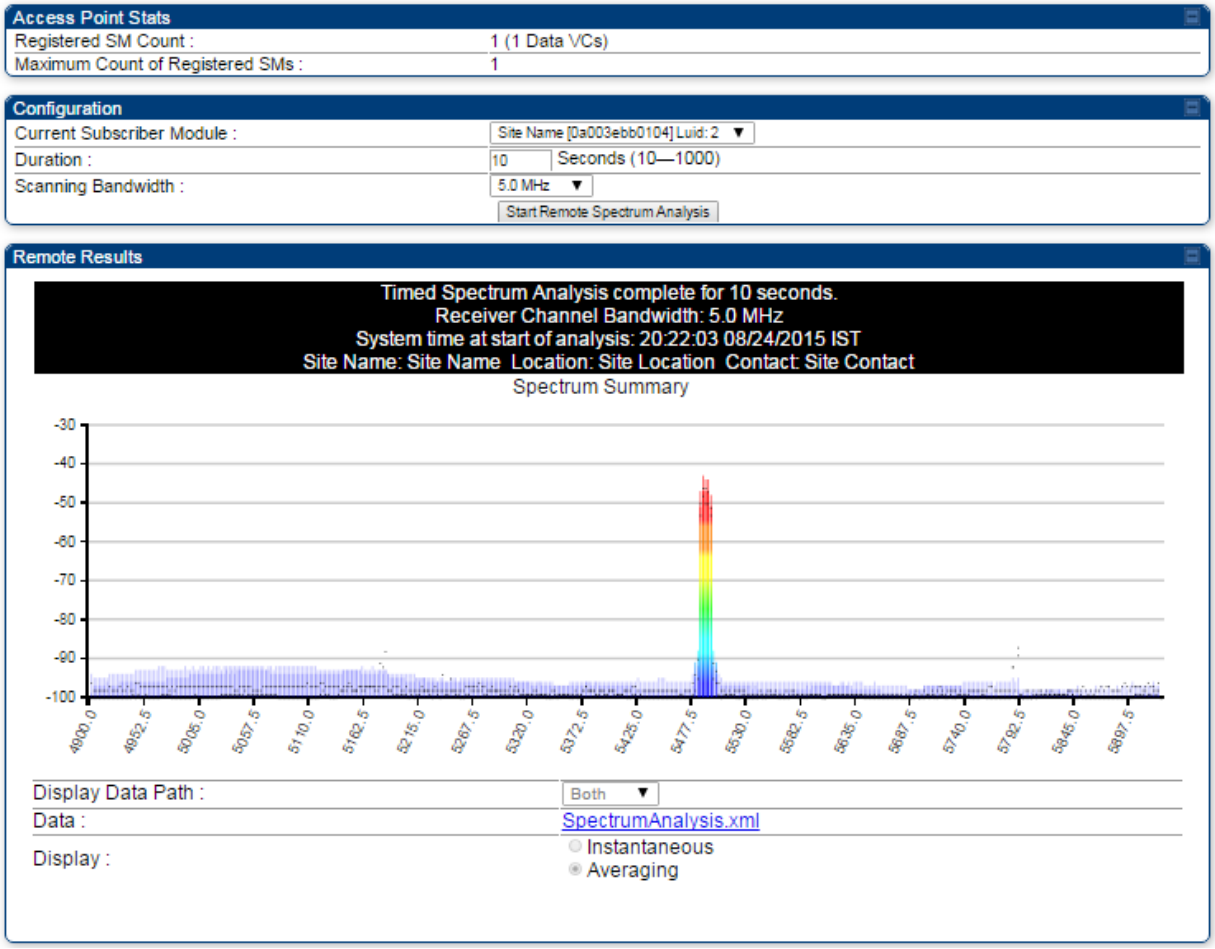
1. The AP/BHM de-registers the target SM/BHS.
2. The SM/BHS scans (for the duration set in the AP/BHM tool) to collect data for the bar graph.
3. The SM/BHS re-registers to the AP/BHM.
4. The AP/BHM displays the bar graph.

The bar graph is an HTML file, but can be changed to an XML file, which is then easy to analyze using scripts that you may write for parsing the data. To transform the file to XML, click the "SpectrumAnalysis.xml" link below the spectrum results. Although the resulting display appears mostly unchanged, the bar graph is now coded in XML. You can now right-click on the bar graph for a **Save Target As** option to save the `Spectrum Analysis.xml` file.

Remote Spectrum Analyzer page of AP

The Remote Spectrum Analyzer page of AP is explained in Table 100.

Table 100 Remote Spectrum Analyzer attributes - AP

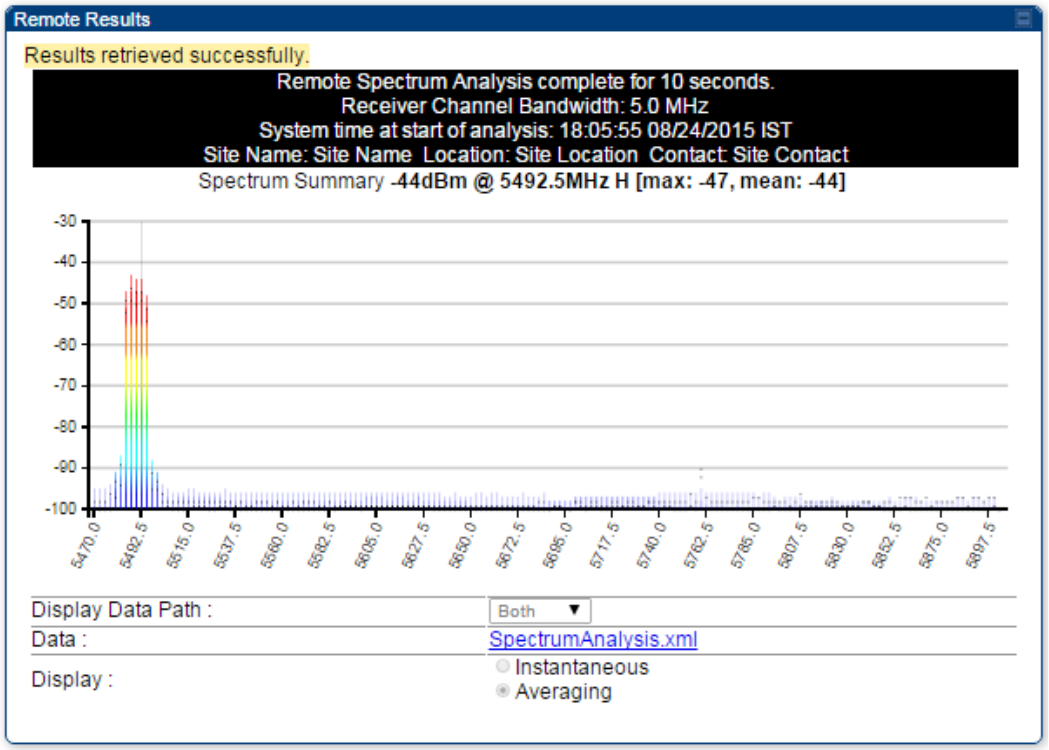


Attribute	Meaning
Registered SM Count	This field displays the number of SMs that were registered to the AP before the SA was started. This helps the user know all the SMs re-registered after performing a SA.
Maximum Count of Registered SMs	This field displays the largest number of SMs that have been simultaneously registered in the AP since it was last rebooted. This count can provide some insight into sector history and provide comparison between current and maximum SM counts at a glance.
Current Subscriber Module	The SM with which the Link Capacity Test is run.
Duration	This field allows operators to configure a specified time for which the spectrum is scanned. If the entire spectrum is scanned prior to the end of the configured duration, the analyzer will restart at the beginning of the spectrum.
Scanning Bandwidth	This parameter defines the size of the channel scanned when running the analyzer.

Remote Spectrum Analyzer page of BHM

The Remote Spectrum Analyzer page of BHM is explained in Table 101.

Table 101 Remote Spectrum Analyzer attributes - BHM



Attribute	Meaning
Duration	Refer Table 96 on page 2-320

Note

To get best performance of the link, the user has to ensure the maximum Receive Power Level during alignment by pointing correctly. The proper alignment is important to prevent interference in other cells. The achieving Receive Power Level green (>- 70 dBm) is not sufficient for the link.