Radio page - PMP 450 AP 3.5 GHz

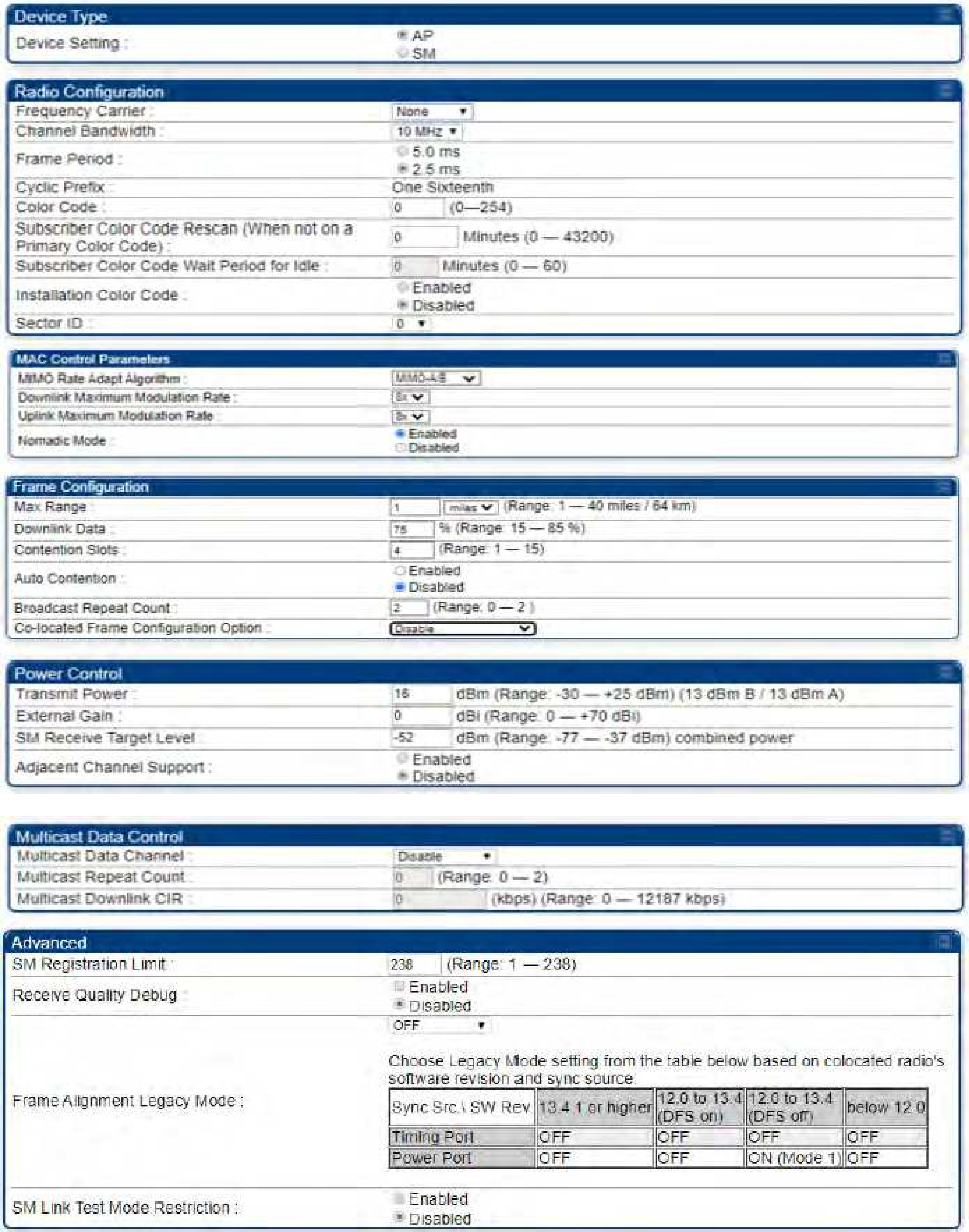


Figure 38: *PMP 450 AP Radio attributes - 3.5 GHz*

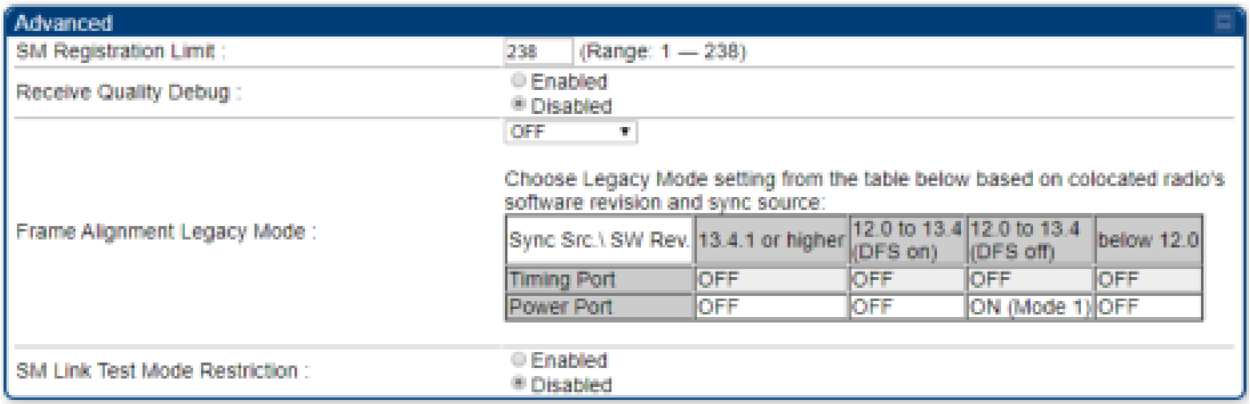
Attribute	Meaning
See PMP/PTP 450i Series – Configuring Radio for all parameters details.	

Note

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

Radio page - PMP 450 AP 2.4 GHz

Table 57: Table 64 PMP 450 AP Radio attributes - 2.4 GHz



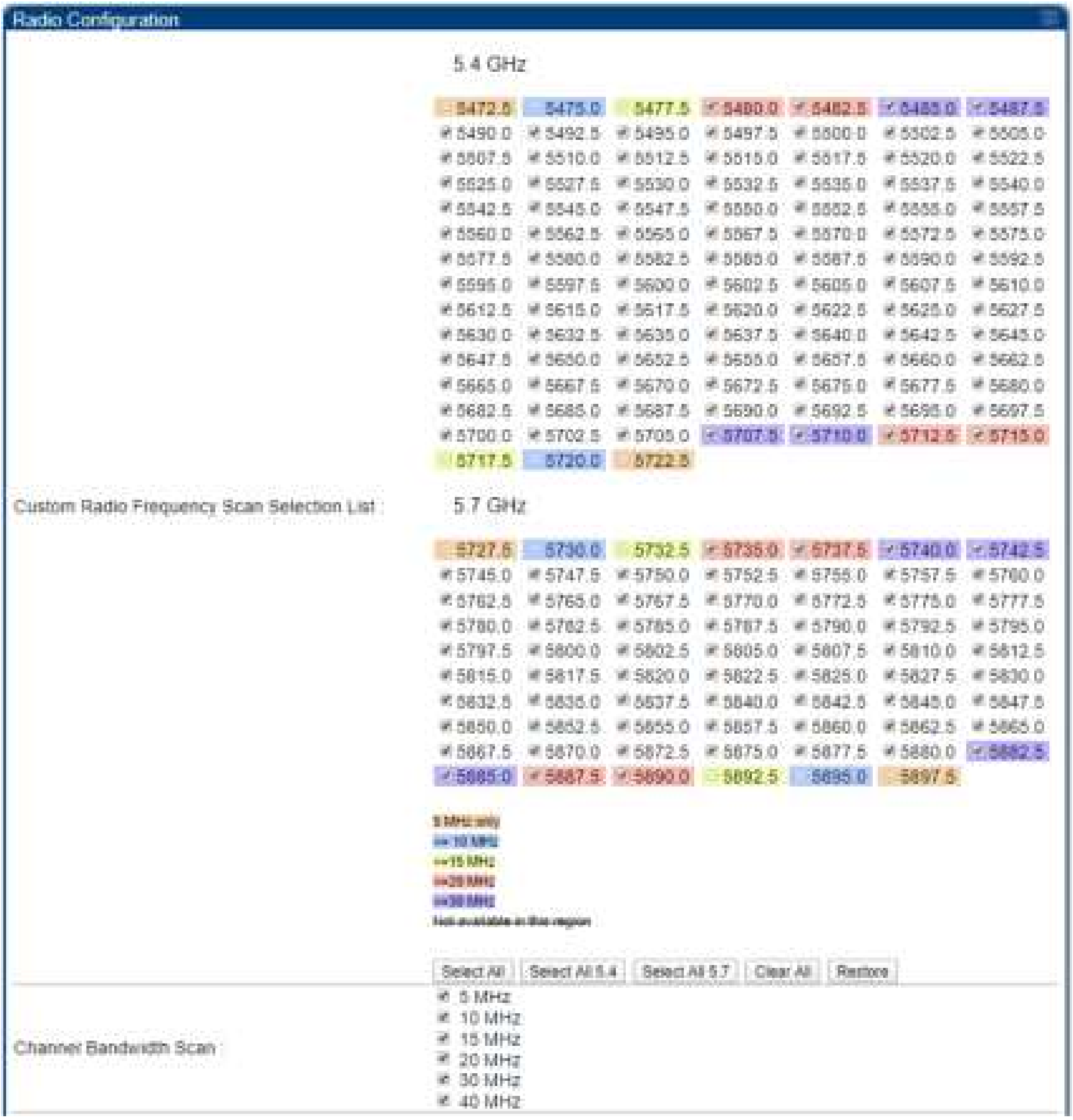
Attribute	Meaning
See PMP/PTP 450i Series – Configuring Radio for all parameters details.	

Note

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

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
See PMP 450i SM Radio attributes – 5 GHz	

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) and cannot see it in the pull down menu.

- 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 IPv4 and IPv6 Prioritization on page IPv4 and IPv6 Prioritization. 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 below table.

Table 79: 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.

Category	Factor	Treatment
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 80: 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 81: 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 below table.

Table 82: MIR, VLAN, HPC, and CIR Configuration Sources, Authentication Disabled

Configuration Source Setting in the AP	Values are obtained from			
	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

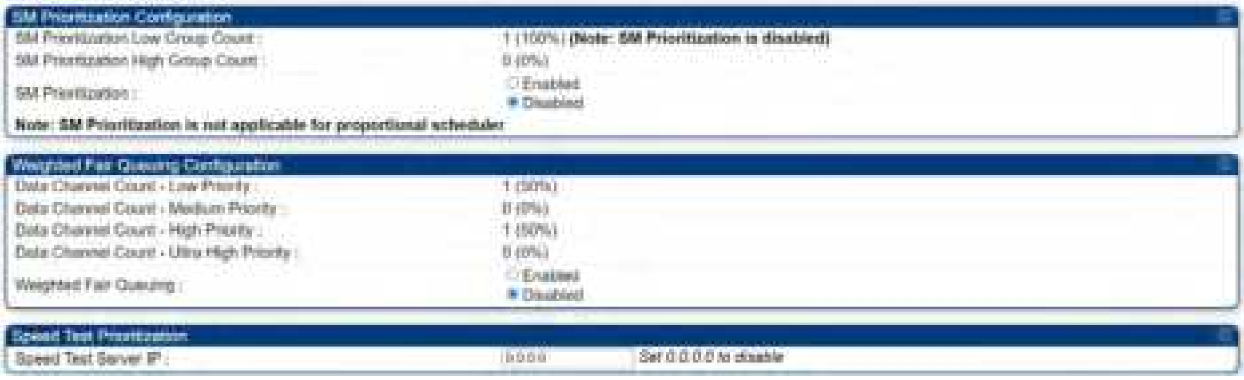
For the case where configuration source is set to Authentication Server, the Data Channel Count per SM, and the CIR values for those data channels, is defaulted to Low Priority data Channel only with no CIR's configured.

Configuring Quality of Service (QoS)

Quality of Service (QoS) page of AP

The QoS page of AP is explained in below table.

Table 83: 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 • Interaction of Burst Allocation and Sustained Data Rate Settings. • Configuration Source
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 • Interaction of Burst Allocation and Sustained Data Rate Settings • Configuration Source
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 • Interaction of Burst Allocation and Sustained Data Rate Settings • Configuration Source
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 • Interaction of Burst Allocation and Sustained Data Rate Settings • Configuration Source
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.

Attribute	Meaning
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.

Attribute	Meaning
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.
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.
Speed Test Server IP	This feature allows AP to prioritize traffic to/from a unique IP address . AP prioritizes any packets to/from a unique IP address in the downlink direction.

Quality of Service (QoS) page of SM

The QoS page of SM is explained in below table.

Figure 56: *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 • Interaction of Burst Allocation and Sustained Data Rate Settings • Configuration Source
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 • Interaction of Burst Allocation and Sustained Data Rate Settings • Configuration Source

Attribute	Meaning
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 • Interaction of Burst Allocation and Sustained Data Rate Settings • Configuration Source
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 • Interaction of Burst Allocation and Sustained Data Rate Settings • Configuration Source
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).

<table>
<tr><th>Attribute</th><th>Meaning</th></tr>
<tr><td></td><td>Committed Information Rate (CIR)
Note: CIR values are not applicable for proportional scheduler.</td></tr>
<tr><td>Low Priority Uplink CIR</td><td>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)
Note: CIR values are not applicable for proportional scheduler.</td></tr>
<tr><td>Medium Priority Channel</td><td>This parameter shows whether medium priority data channel is enabled or not. Its value is derived based on the number of data channels selected.</td></tr>
<tr><td>High Priority Channel</td><td>This parameter shows whether high priority data channel is enabled or not. Its value is derived based on the number of data channels selected.</td></tr>
<tr><td>High Priority Downlink CIR</td><td>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)
Note: CIR values are not applicable for proportional scheduler.</td></tr>
<tr><td>High Priority Uplink CIR</td><td>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)
Note: CIR values are not applicable for proportional scheduler.</td></tr>
<tr><td>Ultra High Priority Channel</td><td>This parameter allows the operator to enable or disable one of the data channels with the highest priority bandwidth.</td></tr>
<tr><td>Downlink Plan</td><td>This parameter allows the operator to configure the default downlink plan. The value range for this parameter is 1 – 310000 kbps.</td></tr>
<tr><td>Uplink Plan</td><td>This parameter allows the operator to configure the default uplink plan. The value range for this parameter is 1 – 310000 kbps.</td></tr>
<tr><td>Weight</td><td>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.</td></tr>
<tr><td>User Lock Modulation</td><td>This parameter contains the following three modes.

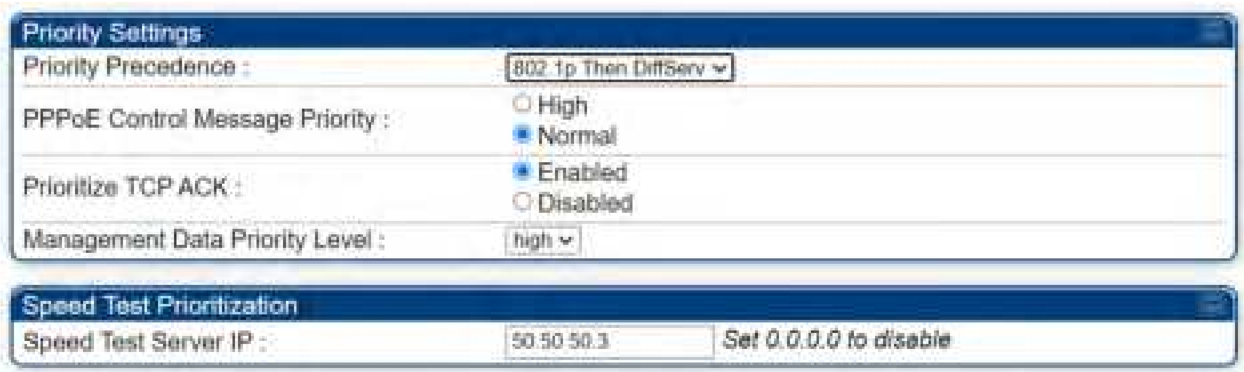
Disable: When disabled, the Proportional scheduler allocates resources to meet the configured plan. When there is congestion, the Proportional scheduler allocates a reduced value proportional to the other plans regardless of the modulation. If the modulation of one SM degrades, the resources allocated 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.</td></tr>
</table>

Attribute	Meaning
	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.
Prioritized Speed Test Servers	This feature allows SM to prioritize traffic to a unique IP address. SM prioritizes any packets to a unique IP address in the uplink direction. SMs learn the Speed Test server's IP address from the AP.

Quality of Service (QoS) page of BHM

The QoS page of BHM is explained in below table.

Table 84: QoS page attributes - BHM

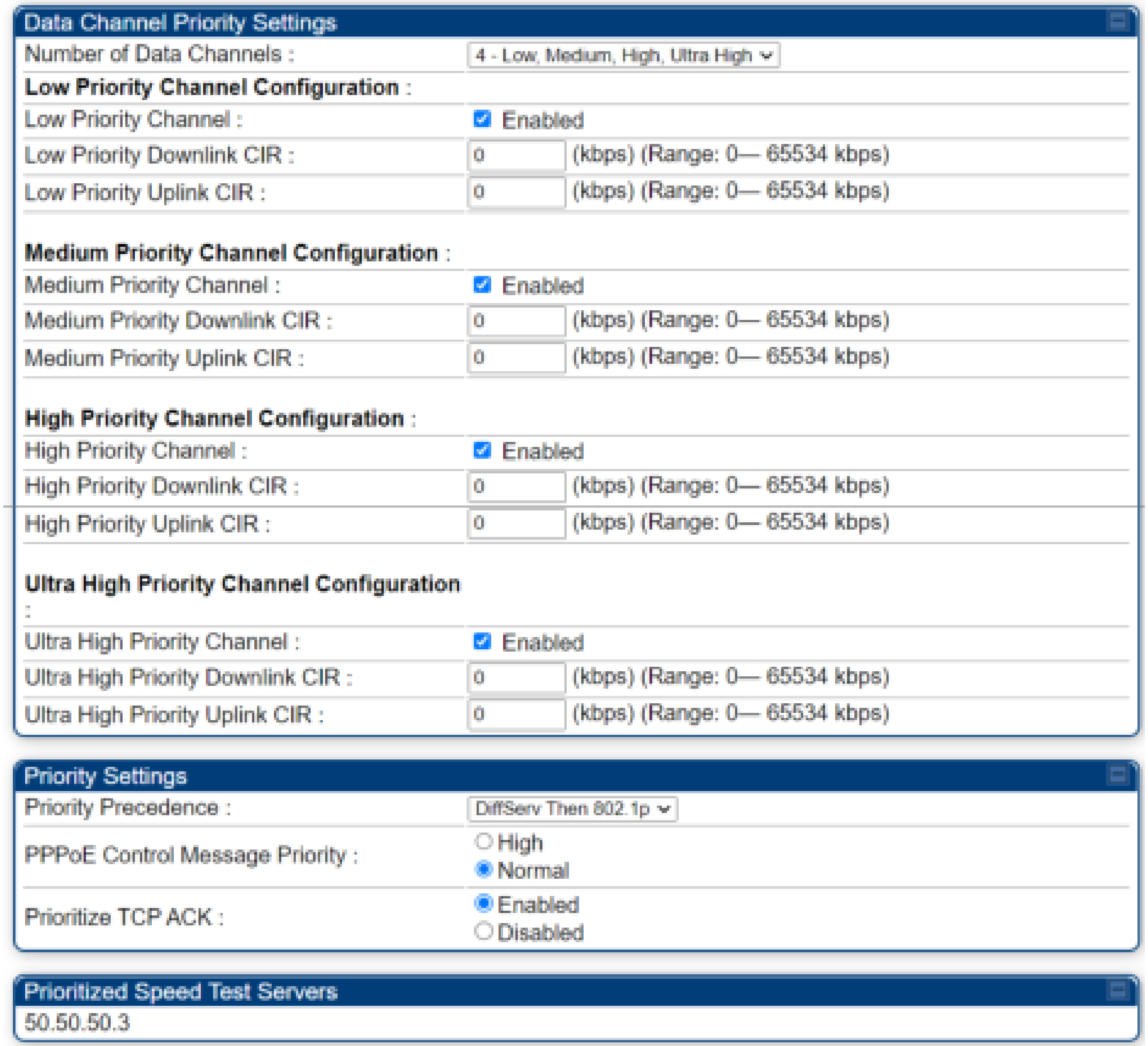


Attribute	Meaning
PPPoE Control Message Priority	Operators may configure the BHM to utilize the high priority channel for PPPoE control messages. Configuring the BHM in this fashion can benefit the continuity of PPPoE connections when there are issues with PPPoE sessions being dropped in the network. 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.
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
Speed Test Server IP	This feature allows BHM to prioritize traffic from a unique IP address. BHM prioritizes any packets from a unique IP address in the downlink direction.

Quality of Service (QoS) page of BHS

The QoS page of BHS is explained in below table.

Table 85: QoS page attributes - BHS



Attribute	Meaning
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.

Attribute	Meaning
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) **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) **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) **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) **Note:** CIR values are not applicable for proportional scheduler.
High Priority Channel	This parameter shows whether high priority data channel is enabled or not. Its value is derived based on the number of data channels selected.
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) **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) **Note**: CIR values are not applicable for proportional scheduler.

Attribute	Meaning
Ultra High Priority Channel	This parameter allows the operator to enable or disable one of the data channels with the highest priority bandwidth.
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 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.
Prioritized Speed Test Servers	This feature allows BHS to prioritize traffic to a unique IP address. BHS prioritizes any packets to a unique IP address in the uplink direction. BHS learn the Speed Test server's IP address from the BHM.

Citizens Broadband Radio Service (CBRS)

Citizens Broadband Radio Service subscription for the CBRS-compliant devices in 3.6 GHz band (3550 MHz to 3700 MHz).

Note

Assuming the user follows the Cambium recommended procedures for using the CBRS cnMaestro Management tool and then syncing those parameters to the radio, nothing at all needs to be set by the operator directly on this Configuration CBRS radio page. All of this will be pushed or pulled from cnMaestro. Definitions are being included for completeness.

PMP 450 Series AP/BHM - CBRS configuration

PMP 450 series CBRS configuration page of AP/BHM is explained in the below table:

Table 86: PMP 450Series AP/BHM - CBRS Configuration

Attribute	Meaning
Citizen Broadband Radio Service	Enable/Disable the CBRS operation until the device is valid.
Log Level	Log level can be increased to Debug or decreased to Error level accordingly and logs will appear. • Debug: Logs used to help in debugging. • Info:Logs the message correspond to normal applicationbehavior. • Error:Logs the issues thataffect the usage orperformance ofthesystem.
Reboot for Channel Bandwidth Change	This attribute applies only the 450m AP. System Release 20.2's multigrant feature supports automatic bandwidth changes as individual multigrants are terminated or suspended or authorized. Disabling this flag will prevent the 450m from automatically making these bandwidth changes on the fly. The 450m is the only Cambium AP that requires a reboot to apply a bandwidth change.
Alternate Channel Selection	This CBRS feature flag enables the AP to automatically search for new channels for the sector to operate on when the existing channels are suspended due to DPA activation, or terminated without a suggested EIRP to use from the SAS.

Attribute	Meaning
	For PMP 450m operators that wish to avoid unexpected reboots due to grant terminations or suspensions, this feature flag could be left enabled, while the **Reboot for Channel Bandwidth Change** flag is disabled. Then, if some or all of the multigrants held by the AP are suspended or terminated, an alternate channel selection (channel hunt) is triggered, but only to channels of the same operating bandwidth. This avoids the potential of an unexpected reboot, but at the possible risk of no such channel being found, in which case the AP will remain off the air until a suspension is automatically cleared or operator action is taken. Additionally, a channel hunt to a channel of the same bandwidth may result in poorer performance than a channel hunt to a cleaner channel of smaller bandwidth.
Change Channel if Only SMs are Impacted	When enabled, this feature allows the AP to automatically find and move to a new channel or decrease the bandwidth, when more than the **SM Percentage Threshold for Channel Change** percentage of SMs have been impacted by termination or suspension, even though the AP itself has not been impacted. Not applicable for PTP configurations.
SM Percentage Threshold for Channel Change	Displays the percentage of SMs that need to be impacted by termination or suspension for the feature to be invoked, even though the AP itself has not been impacted. Note that the **Alternate Channel Selection** feature must also be enabled for the AP to hunt for a new channel due to the **Change Channel if SMs are Impacted** feature. If an operator elects to run with **Alternate Channel Selection** enabled but **Change Channel if SMs are impacted** feature is disabled, the AP still performs automatic channel selection, but only in cases where the AP is directly impacted by terminations or suspensions. If the **Alternate Channel Selection** feature is disabled, but the **Change Channel if SMs are Impacted** feature is enabled, if enough SMs are impacted by terminations or suspensions, the AP still reduces the Bandwidth if authorized grants are available, but it will not hunt for a new channel. Not applicable for PTP configurations.
Original Channel Restore Time	When this feature is triggered via SM suspensions, the AP continues to heartbeat the original channels for itself and all the SMs, while operating on the temporary channels or reduced bandwidth for at least this length of a period after moving to these temporary channels or reducing bandwidth. When this timer expires, the AP can move back to the original channels and/or bandwidth if enough suspended SMs have become authorized on the original channels. Not applicable for PTP configurations.
User ID	User ID assigned by SAS is part of the Registration request message
Include User ID	For operators using Federated Wireless or Commscope SAS, this option will be available and set to Enabled by default. By appending it to the Co-Existence parameters sent to the SAS, it seperates and allows the SAS to handle the possibility of 2 operators accidently picking the same CoExistence parameters. If an operator wishes to frequency coordinate on the same channel with another operator or between PMP and LTE technology, this parameter can be disabled and the Co-Existence group parameters set the same - coordinated. For Google, these parameters are unique to an organization, so this parameter is not available for operators using Google SAS. See Cambium 20.3 training slides for more information.

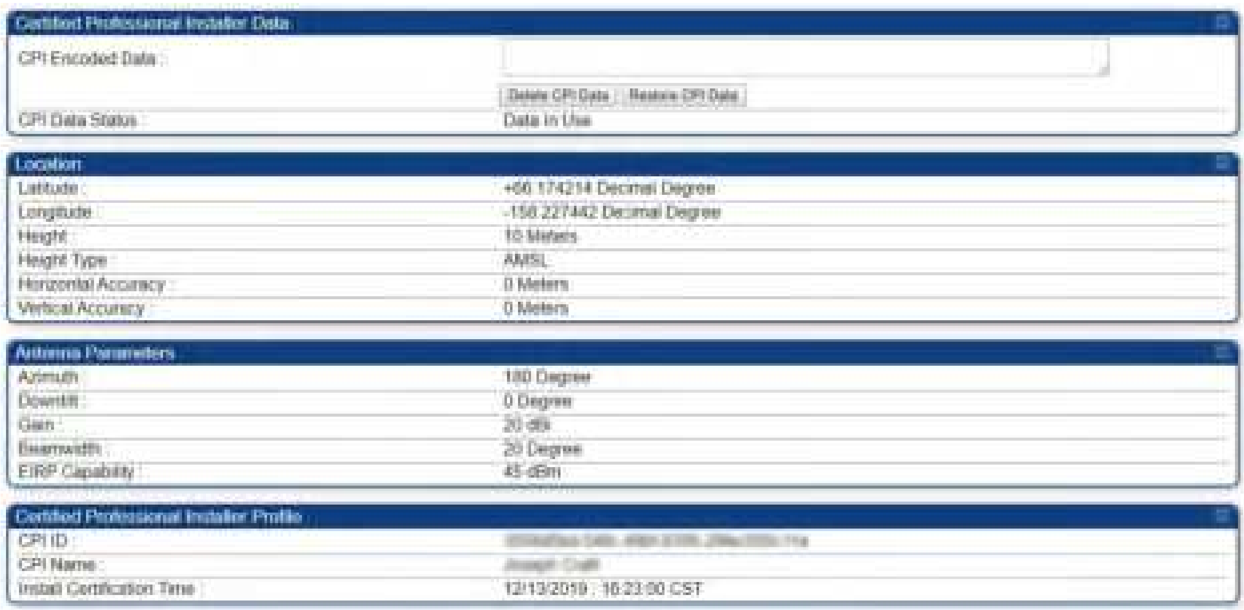
Attribute	Meaning
Coexistence Sector ID	This parameter is also known as the identifier of a Common Channel Group (CCG) in CBRS Alliance or Principal Subordinate Single Frequency Group (SFG) in WinnForum Release 2 . The Google SAS portal currently calls it "Same Frequency" in the Frequency Management subsection of the per-device Configuration Tab as well as at the top of the per-device Coex tab. Although this can be edited, it defaults to the MAC address of the AP/BHM of this sector. The purpose of the sector ID is, it helps the SAS identify which SM's are grouped with a particular AP (same frequency and bandwidth as the AP).
Coexistence Spectrum Reuse ID	This parameter defines a CBRS interference coordination group. It is called Spectrum Reuse in WInnForum Release 2, or Interference Coordination Group (ICG) in CBRS Alliance. The Google SAS portal urrently calls it "Frequency Reuse" in the Frequency Management subsection of the per-device Configuration tab as well as at the top of the per-device Coex tab. Multiple sectors can be assigned the same Reuse ID. ASAS will not attempt to coordinate interference between devices using the same Reuse ID. For example, an operator using 2 non-overlapping center frequencies in what is typically called an ABAB deployment could assign 1 Reuse ID to all sectors using center frequency "A", and a second Reuse ID to all sectors using center frequency "B".
CPI Encoded Data	CPI information is the set of encoded installation parameters by CPI and the signed installation parameter provided by the CPI. It receives the parameter with a registration message from the SAS. • Delete CPI Data: CPI data can be deleted by selecting the Delete CPI Data. • Restore CPI Data: CPI data can be restored by selecting the Restore CPI Data.
CPI Data Status	Displays the status of the CPI data is in use or unchanged.
Latitude	Displays latitude of the device location in degrees.
Longitude	Displays longitude of the CBSD antenna location in degrees.
Height	Displays device antenna height in meters.
Height Type	Should be AGL or AMSL as follows: • AGL height is measured relative to the ground level. • AMSL height is measured relative to the mean sea level.
Horizontal Accuracy	Displays positive number in meters to indicate the accuracy of the device antenna horizontal location.
Vertical Accuracy	Displays positive number in meters to indicate the accuracy of the device antenna vertical location.
Azimuth	Displays Boresight direction of the horizontal plane of the antenna in degrees with respect to true north.
Downtilt	Displays the antenna down tilt in degrees.
Gain	Integrated antenna gain: Peak gain of the integrated antenna. External antenna gain: peak gain of the external antenna connected to a device.

Attribute	Meaning
Beamwidth	Displays the beamwidth of the antenna in the horizontal plane in degrees.
EIRP Capability	Display max Effective Isotropic Radiated Power (EIPR) capability of the device.
CPI ID	The assigned CPI ID unique to the installer that is certifying the CBRS installation.
CPI Name	The entered name of the Certified professional installer.
Install Certification Time	Thetime of thecertifiedinstallation for this radio.

PMP 450 Series SM/BHS-CBRS configuration

PMP 450 series CBRS configuration page of SM/BHS is explained in the below table:

Table 87: PMP 450 Series SM/BHS_CBRS Configuration

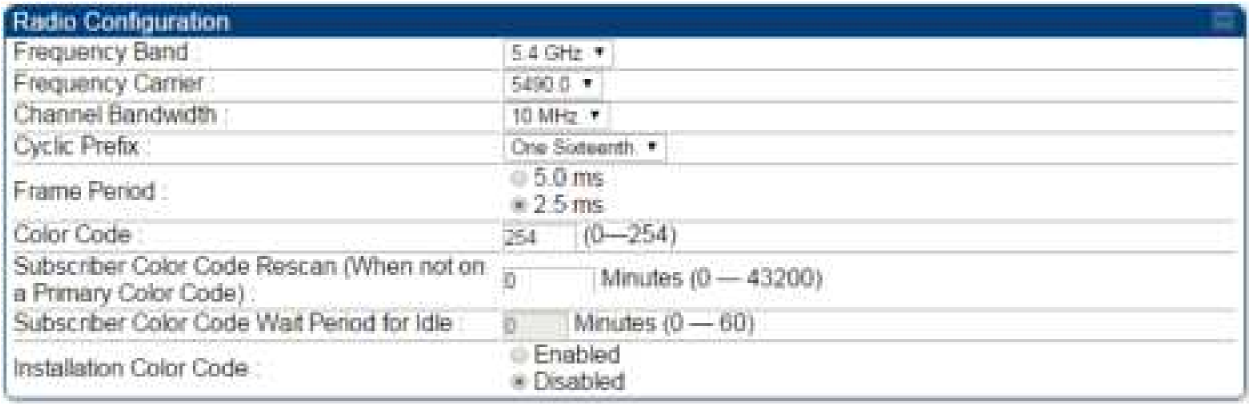


Attribute	Meaning
CPI Encoded Data	Refer table PMP 450Series AP/BHM – CBRS Configuration for parameter descriptions
CPI Data Status	
Latitude	
Longitude	
Height	
Height Type	
Horizontal Accuracy	
Vertical Accuracy	
Azimuth	
Downtilt	
Gain	
Beamwidth	
EIRP Capability	
CPI ID	
CPI Name	
Install Certification Time	

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 57: *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

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

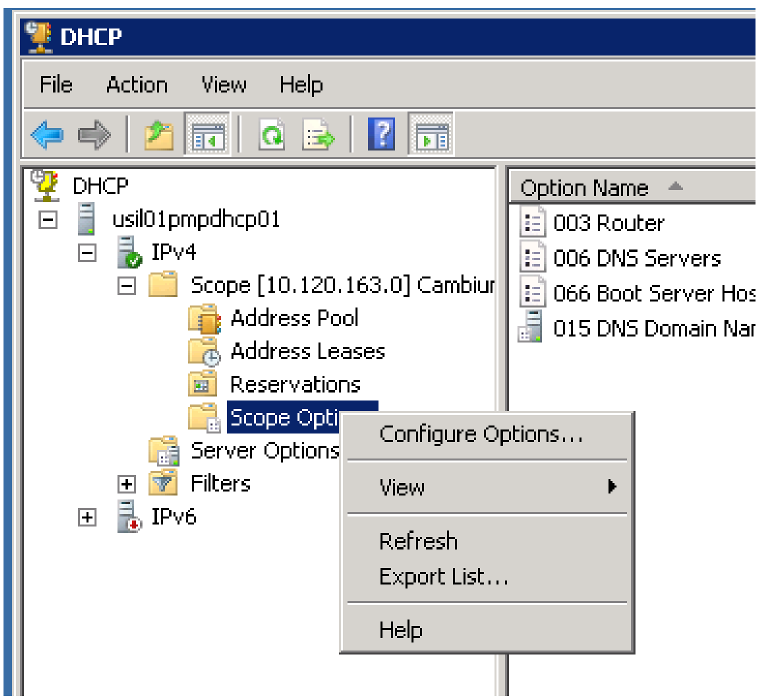
Copy the golden configuration file to an FTP, TFTP, HTTP or HTTPS server. This location can be password protected; you just have to include the user name and password in the URL.

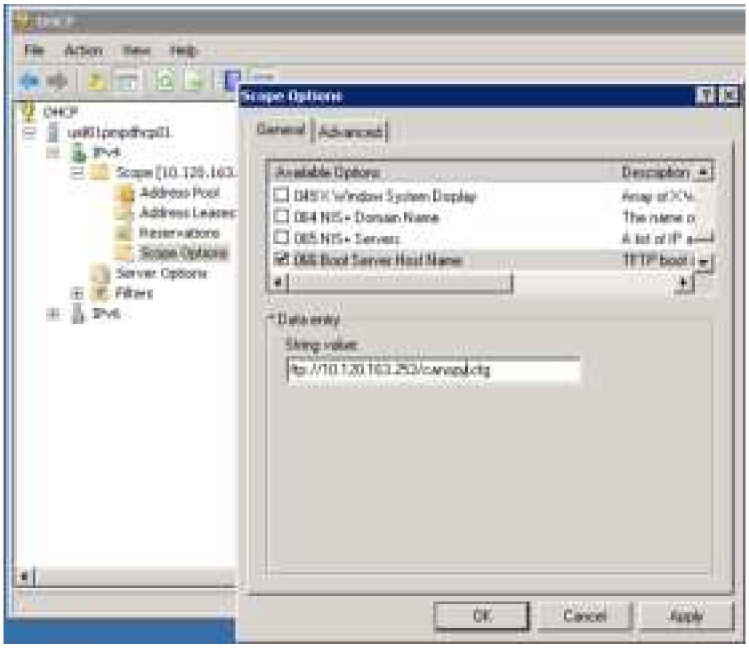
DHCP server configuration

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.

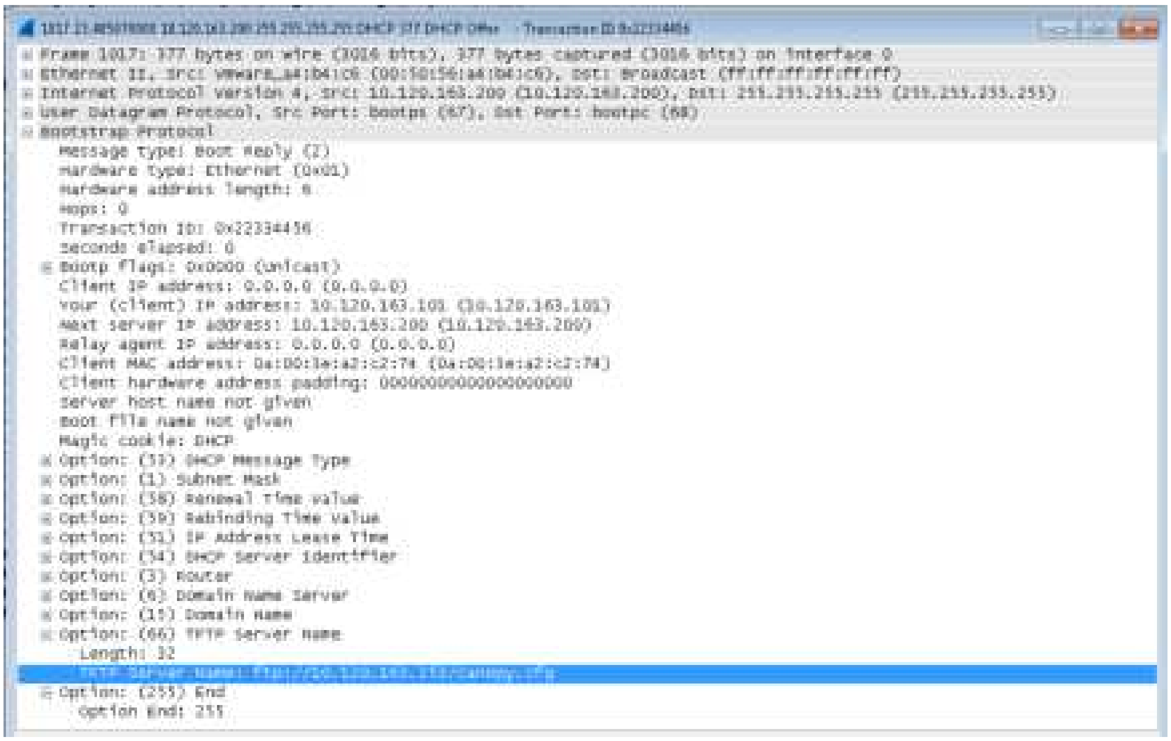
For example:

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 (ReferProcedure 19 Special Headers for configuration file).

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 58: *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 “rebootIfRequired” 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.

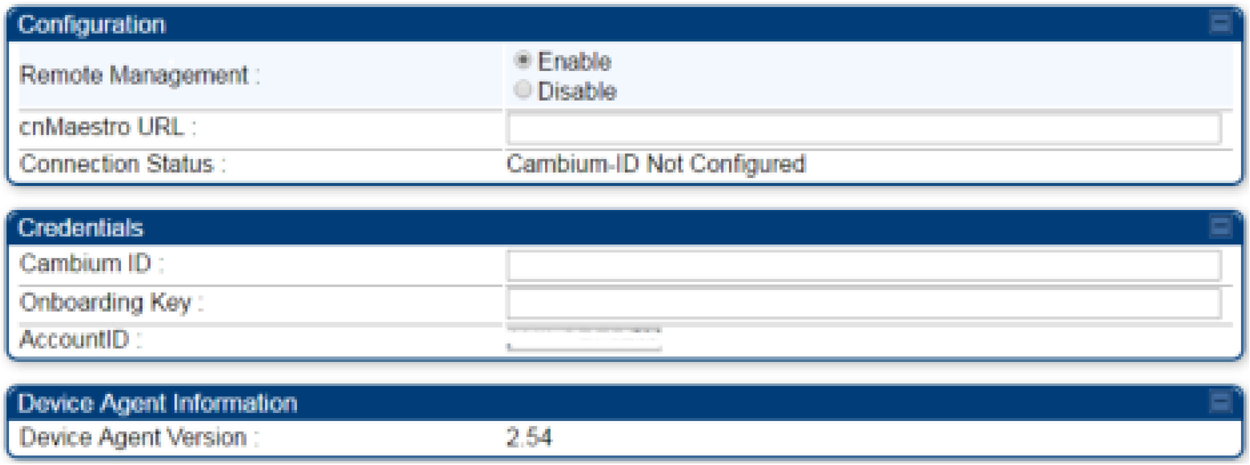
Onboarding

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 below figure.

Figure 59: *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 below figure.

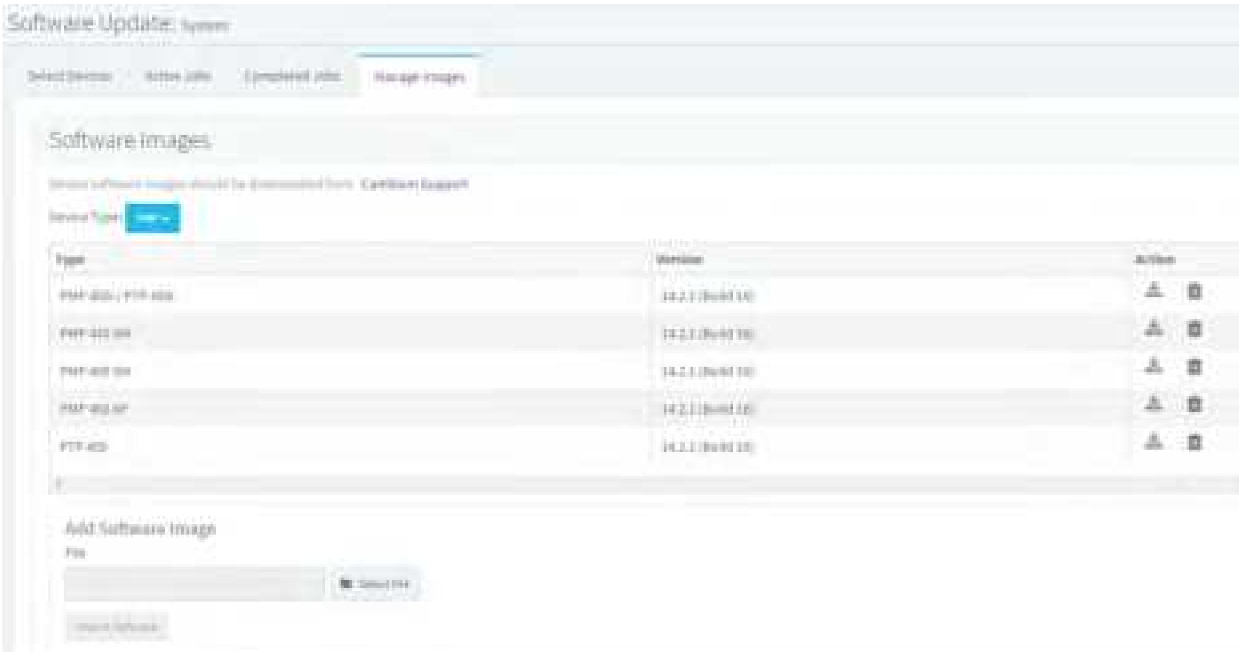


Figure 60: *Software Upgrade from cnMaestro™*

- 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 below figure.

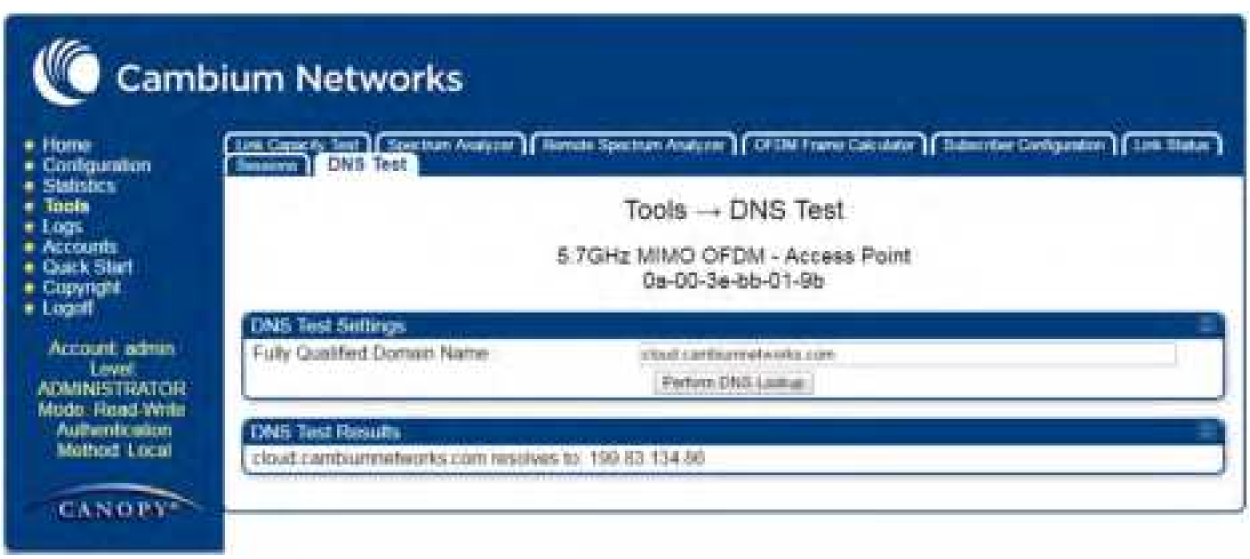


Figure 61: *DNS Test for cnMaestro™ connectivity*

- If the SM is in Bridge mode, then LAN1 must have public equestility 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 Device Agent Logs. 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 62: *Device Agent Logs*

AFC Log

The AFC Log provides records of Automatic Frequency Control (AFC) events and debug data, aiding in diagnosing frequency-related issues and monitoring AFC system performance. Accessible via the device's GUI under the **Logs** > **AFC Log** section, it offers essential insights. For additional troubleshooting support, users can obtain a tech support dump from cnMaestro™, facilitating further analysis by Cambium support.

Figure 63: *AFC Log page - 450v AP*

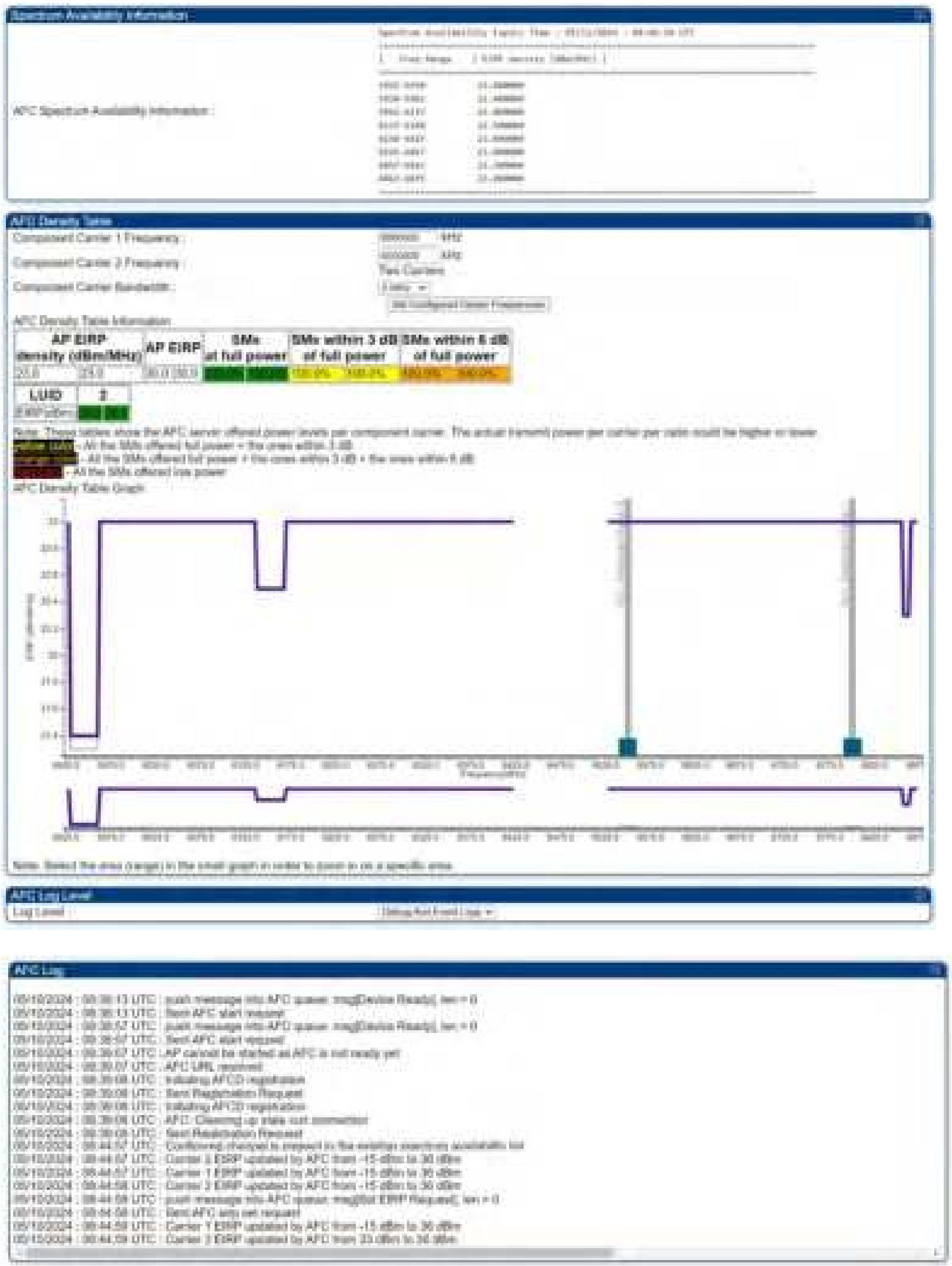


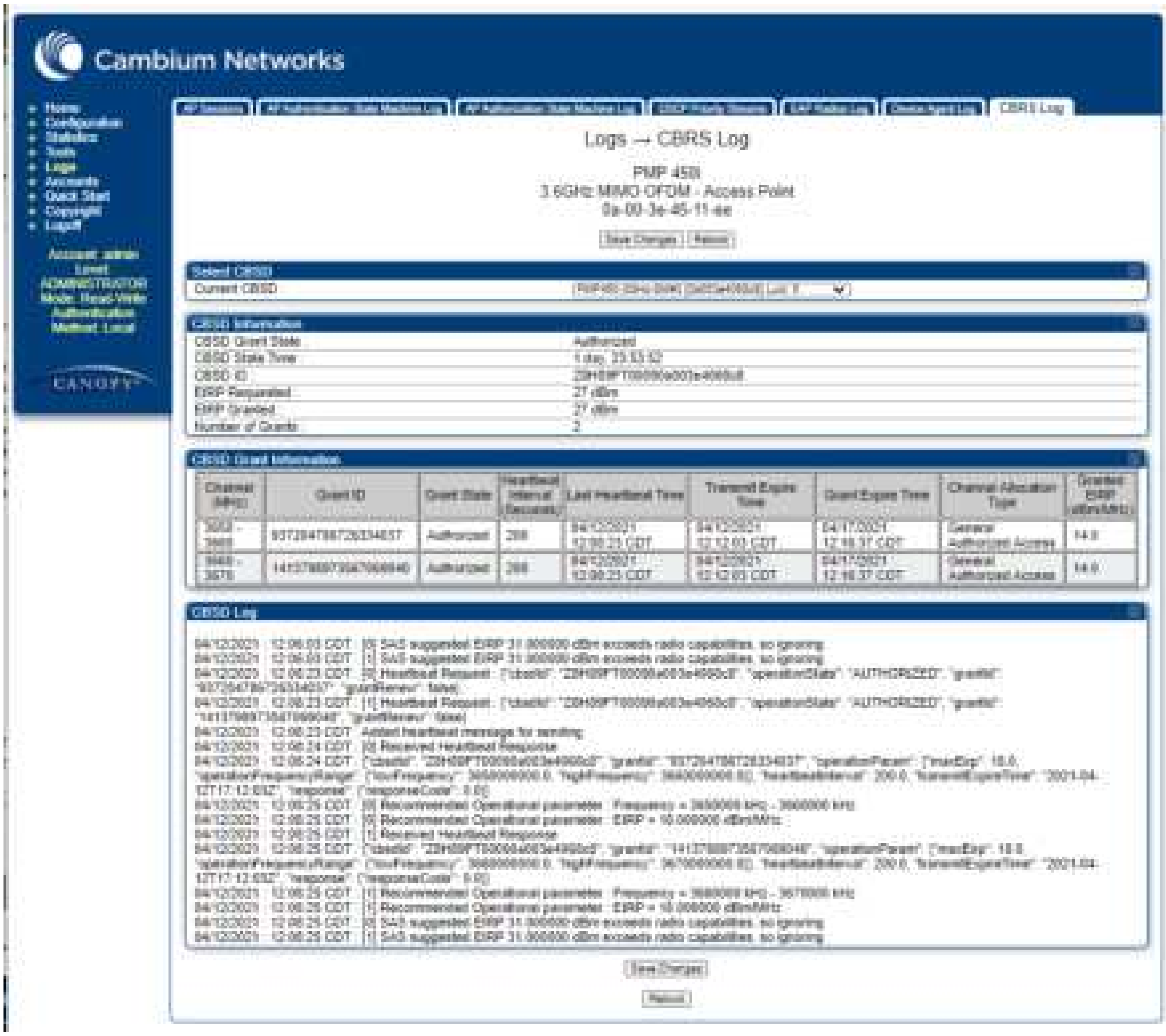
Figure 64: *AFC Log page - 450v SM*

For more information on the Spectrum Availability Information section and the AFC Density Table section, see the **AFC Operation for Cambium PMP Products** document on the Cambium support site: https://support.cambiumnetworks.com/files/pmp450/.

CBRS Log

The CBRS Log page shows detailed information on each CBRS grant per device. Only 1 device is shown on the page at a time. The device can be selected in the "Current CBSD" pull down as shown in the figure below.

Figure 65: *CBRS Log*



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 66: *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.

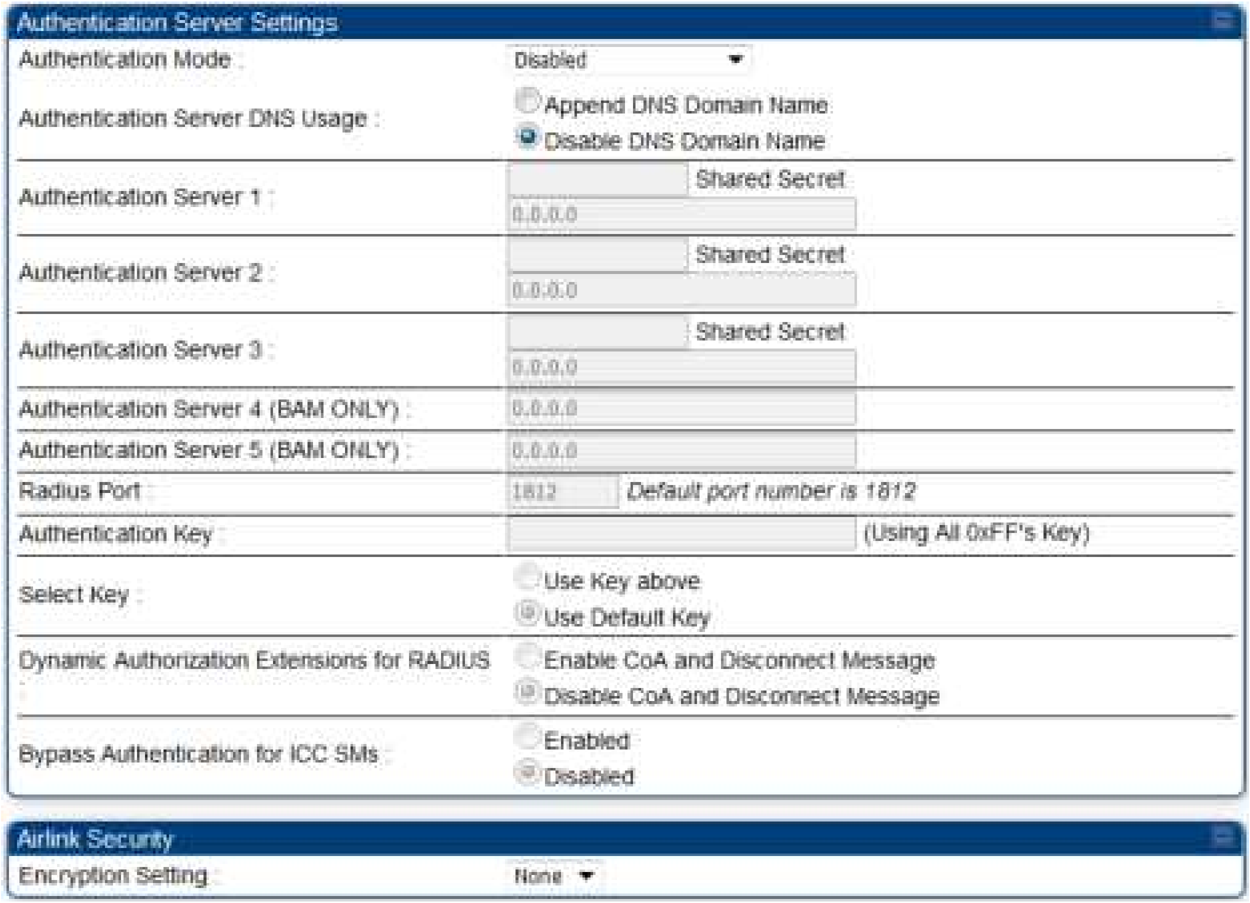
- **AP Pre-Shared Key**: Canopy offers a pre-shared key authentication option. In this case, an identical key must be entered in the Authentication Key field on the AP’s Configuration > Security tab and in the Authentication Key field on each desired SM’s Configuration > Security tab.

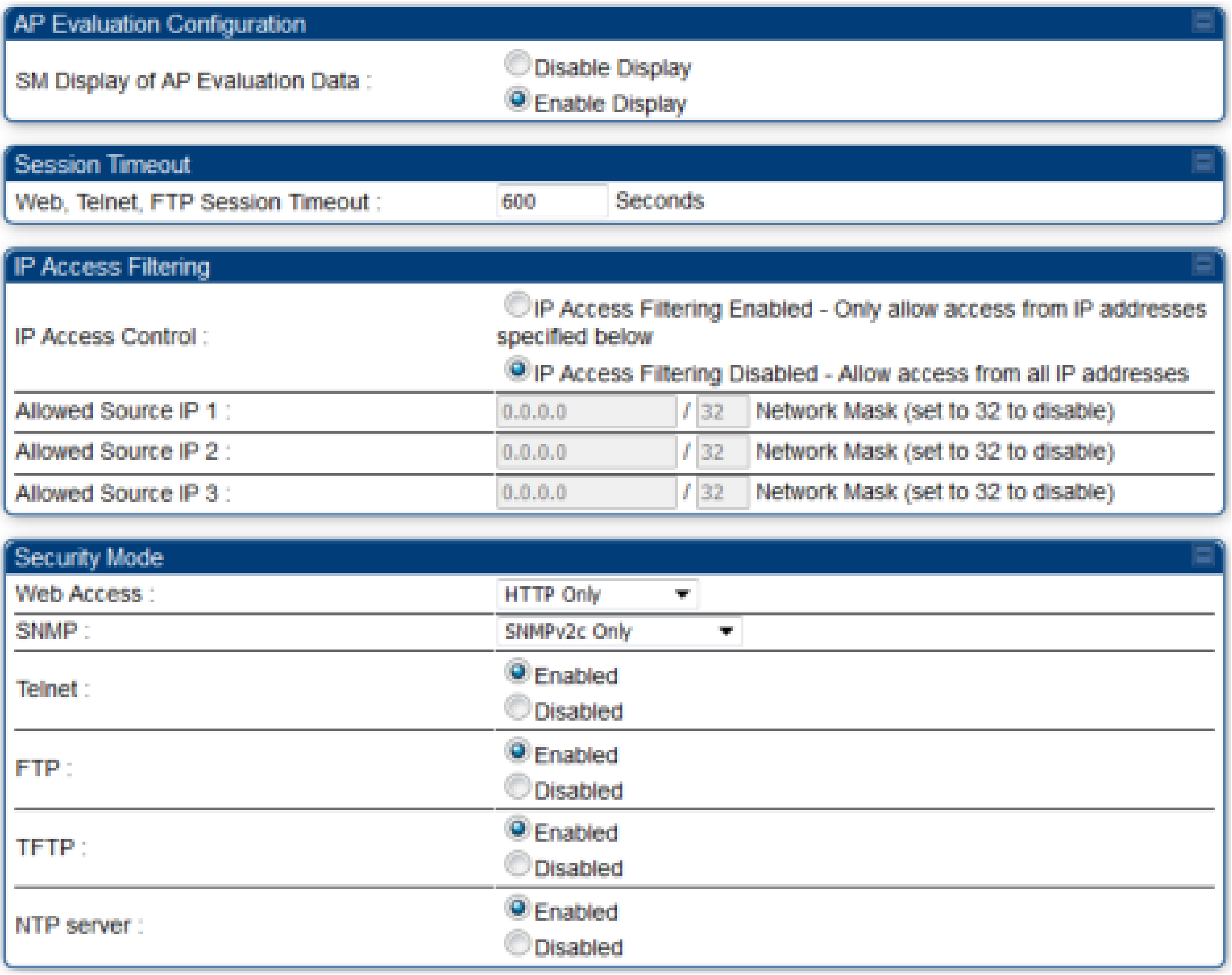
- **RADIUS AAA**: To support RADIUS authentication of SMs, on the AP’s Configuration > Security tab select RADIUS AAA. Only properly configured SMs with a valid certificate is allowed to register to the AP.

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).

Figure 67: *Security tab attributes*




AP Evaluation Configuration
SM Display of AP Evaluation Data :
Disable Display
Enable Display
Session Timeout
Web, Telnet, FTP Session Timeout :
600
Seconds
IP Access Filtering
IP Access Control :
IP Access Filtering Enabled - Only allow access from IP addresses specified below
IP Access Filtering Disabled - Allow access from all IP addresses
Allowed Source IP 1 :
0.0.0.0 / 32 Network Mask (set to 32 to disable)
Allowed Source IP 2 :
0.0.0.0 / 32 Network Mask (set to 32 to disable)
Allowed Source IP 3 :
0.0.0.0 / 32 Network Mask (set to 32 to disable)
Security Mode
Web Access :
HTTP Only
SNMP :
SNMPv2c Only
Telnet :
Enabled
Disabled
FTP :
Enabled
Disabled
TFTP :
Enabled
Disabled
NTP server :
Enabled
Disabled

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:

Attribute	Meaning
	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	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.
Allowed Source IP 3	
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 bothHTTP and HTTPS..
SNMP	This option allows to configure SNMP agent protocol version. It can be selected from drop-down list :

Attribute	Meaning
	• Disable SNMP - To disable SNMP agent. • SNMPv2c Only – Enables SNMP v2c 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 88: 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	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.
Confirm Password	

Attribute	Meaning
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

Attribute	Meaning
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. 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.
Allowed Source IP 2	
Allowed Source IP 3	
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 protocol version. It can be selected from drop-down list : • Disable SNMP - To disable SNMP agent. • SNMPv2c Only – Enables SNMP v2c 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 68: *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 RADIUS Vendor Specific Attributes (VSAs). 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 RADIUS Vendor Specific Attributes (VSAs)).

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 RADIUS Vendor Specific Attributes (VSAs)). 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 89: RADIUS Vendor Specific Attributes (VSAs)

Name	Number	Type	Required	Value	
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 Downlink 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
Cambium-Canopy-ULBR	26.161.6	integer	N	0-100000 kbps	

Name	Number	Type	Required	Value	
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

Name	Number	Type	Required	Value	
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-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-DHCP-State	26.161.31	integer	N	1-Enable	
Configuration > IP > DHCP state				1	32 bits
Cambium-Canopy-SMPrioritizationGroup	26.161.32	integer	N	0-Low, 1-High	32 bits

Name	Number	Type	Required	Value	
Configuration > Quality of Service > Prioritization Group				0	
Cambium-Canopy-DATACHANCOUNT	26.161.35	integer	N	1 - 4	
Configuration > Quality of Service > Number of Data Channels				1	32 bits
Cambium-Canopy-MPULCIR	26.161.36	integer	N	0 - 65534 Kbps	
Configuration > Quality of Service > Medium Priority Uplink CIR				0	32 bits
Cambium-Canopy-MPDLCIR	26.161.37	integer	N	0 - 65534 Kbps	
Configuration > Quality of Service > Medium Priority Downlink CIR				0	32 bits
Cambium-Canopy-UHPULCIR	26.161.39	integer	N	0 - 65534 Kbps	
Configuration > Quality of Service > Ultra High Priority Uplink CIR				0	32 bits
Cambium-Canopy-UHPDLCIR	26.161.40	integer	N	0 - 65534 Kbps	
Configuration > Quality of Service > Ultra High Priority Downlink CIR				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-UserMode	26.161.51	integer	N	1=Read-Only 0=Read-Write	
Account > Add User > User Mode				0	32 bits
Cambium-Canopy-PortMap-Priority	26.161.52	integer	N	0 - 7	
Configuration > VLAN > Port VID MAC Address Mapping -> Priority				0	32 bits
Cambium-Canopy-PortMap-VLANID	26.161.53	integer	N	1 - 4094	32 bits
Configuration > VLAN > Port VID MAC Address Mapping -> VID				1	

Name	Number	Type	Required	Value	
Cambium-Canopy-PortMap-MacAddr	26.161.54	string	N	12 - 17	
Configuration > VLAN > Port VID MAC Address Mapping -> MAC Address				00-00-00-00-00-00	-
Cambium-Canopy-RatePlan-DL	26.161.55	integer	N	1 — 310000 kbps	
Configuration > Quality of Service > Downlink Plan				0	32 bits
Cambium-Canopy-RatePlan-UL	26.161.56	integer	N	1 — 310000 kbps	
Configuration > Quality of Service > Uplink Plan				0	32 bits
Cambium-Canopy-RatePlan-Weight	26.161.57	integer	N	0.1 - 9.9	
Configuration > Quality of Service > Weight				0	32 bits
Cambium-Canopy-RatePlan-UserLckMod	26.161.58	integer	N	0-Disabled, 1-Enabled, 2-Enable below threshold	
Configuration > Quality of Service > User Lock Modulation				0	32 bits
Cambium-Canopy-RatePlan-LockMod	26.161.59	integer	N	8=8x,6=6x,4=4x,3=3x,2=2x,1=1x	
Configuration > Quality of Service > Locked Modulation				8	32 bits
Cambium-Canopy-RatePlan-ThreMod	26.161.60	integer	N	8=8x,6=6x,4=4x,3=3x,2=2x	
Configuration > Quality of Service > Threshold Modulation				8	32 bits
Cambium-Canopy-SMVlan8021pSupport	26.161.61	integer	N	0-disable, 1-enable	
Configuration > VLAN > Support 802.1p Frames (VID 0)				0	32 bits
Cambium-Canopy-UserLevel-AP	26.161.62	integer	N	1-Technician, 2-Installer, 3-Administrator	
Account > Add User > Level				0	32 bits
Cambium-Canopy-UserMode-AP	26.161.63	integer	N	1=Read-Only 0=Read- Write	

Name	Number	Type	Required	Value	
Account > Add User > User Mode				25 mins	32 bits
Cambium-Canopy-UserLevel-SM	26.161.64	integer	N	1-Technician, 2-Installer, 3-Administrator	
Account > Add User > Level				1	32 bits
Cambium-Canopy-UserMode-SM	26.161.65	integer	N	1=Read-Only 0=Read- Write	
Account > Add User > User Mode				1	32 bits
**Cambium-Canopy-VLRemarkVID	26.161.66	String	N	xxxx:yyyy where xxxx is the source vlan with range 1 to 4094, and yyyy is the target vlan with range 1 to 4094. For example: Source VLAN : 2133 Remark to VLAN : 96 Cambium-Canopy-VLREMARKVID = 2133:96	
**Cambium-Canopy-VLRemarkPRI	26.161.67	String	N	xxxx:y where xxxx is the source vlan with range 1 to 4094, and y is the priority with range 0 to 7. For example: Source VLAN : 1024 VLAN Priority : 6 Cambium-Canopy-VLREMARKPRI = 1024:6	

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

(**) When using VLANs with a AAA Radius loaded configuration, Cambium advises operators to configure and load VSA VLLEARNEN, setting this to 1. This ensures dynamic VLAN learning takes place to allow proper traffic bridging.

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 RADIUS Vendor Specific Attributes (VSAs) 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.

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.

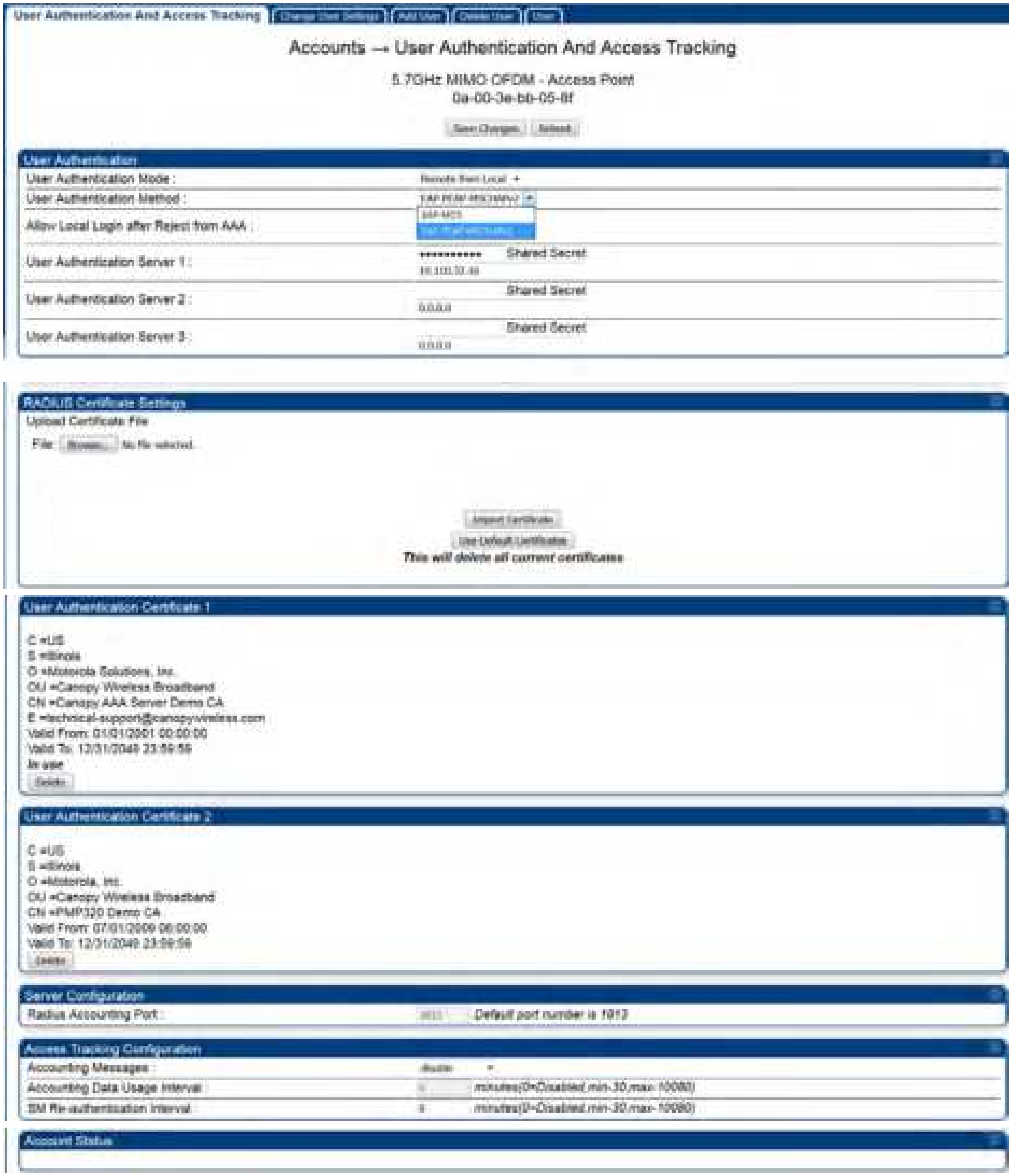
If at least one of the IP addresses is configured, all Authentication, Authorization, and Accounting requests now follow the newly configured User Authorization server.

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.

Figure 69: *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.

Attribute	Meaning
	deviceAccess – accounting messages regarding device access are sent to the RADIUS server (see Device data accounting RADIUS attributes). DataUsage – accounting messages regarding data usage are sent to the RADIUS server (see Device data accounting RADIUS attributes). 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.

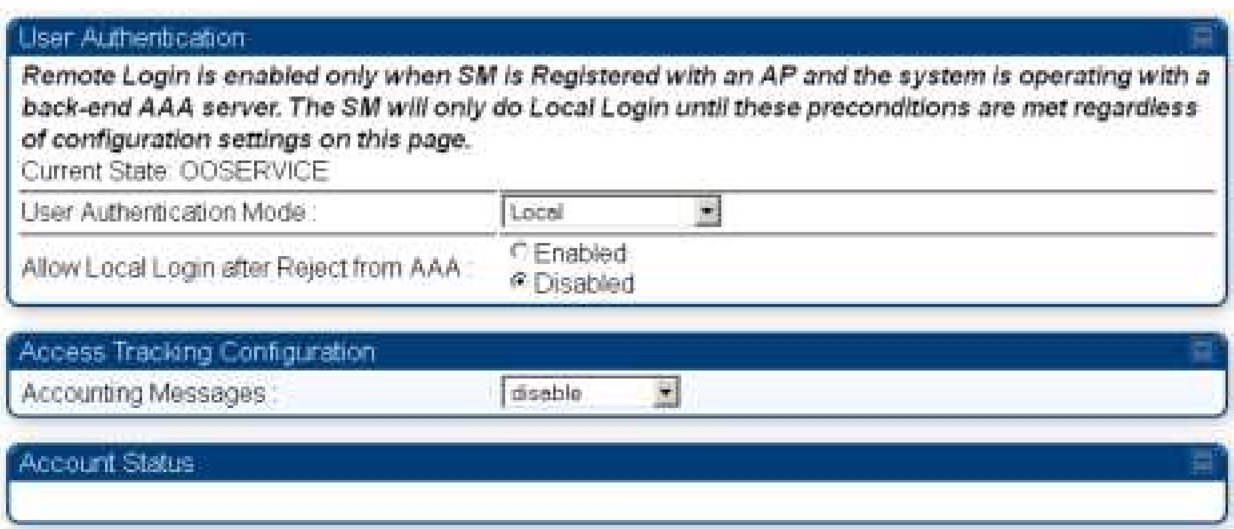
SM – Technician/Installer/Administrator Authentication

The centralized user name and password management for SM is same as AP. Follow AP – Technician/Installer/Administrator Authentication on page AP – Technician/Installer/Administrator Authentication 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 70: *User Authentication and Access Tracking tab of the SM*



Attribute	Meaning
	deviceAccess – accounting messages regarding device access are sent to the RADIUS server (see Device data accounting RADIUS attributes). DataUsage – accounting messages regarding data usage are sent to the RADIUS server (see Device data accounting RADIUS attributes). 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 AP – Technician/Installer/Administrator Authentication 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 70: *User Authentication and Access Tracking tab of the SM*

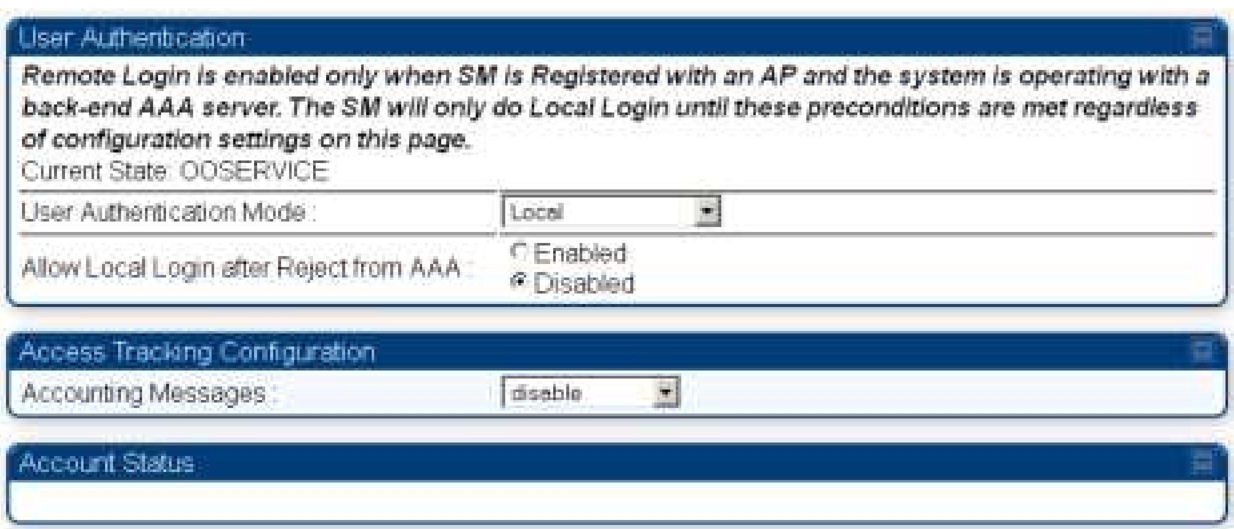
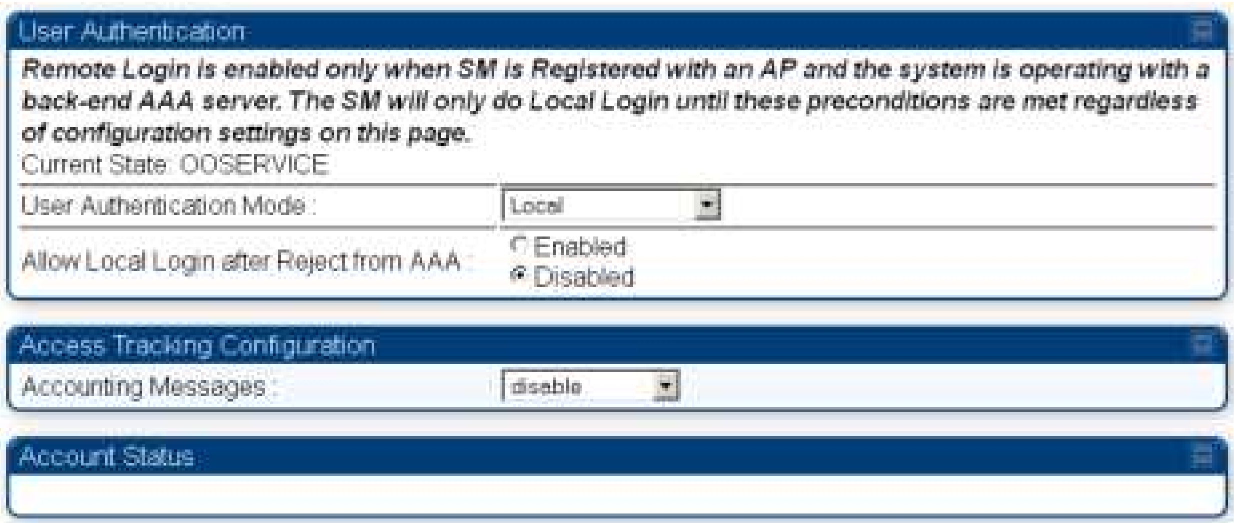


Table 90: SM User Authentication and Access Tracking attributes



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 • deviceccess – accounting messages are sent to the RADIUS server regarding device access (see Device data accounting RADIUS attributes).

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 91: Device data accounting RADIUS attributes

Sender	Message	Attribute	Value	Description
AP	Accounting-Request	Acct-Status-Type	1 - Start	This message is sent every time a SM registers with an AP, and after 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.	
		Event-Timestamp	UTC time the event occurred on the AP	

Sender	Message	Attribute	Value	Description
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.	
		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	

Sender	Message	Attribute	Value	Description
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.	
		Acct-Input-Packets	Sum of unicast and multicast packets that are sent to a particular SM over the regular data channel 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 71: *RADIUS accounting messages configuration*

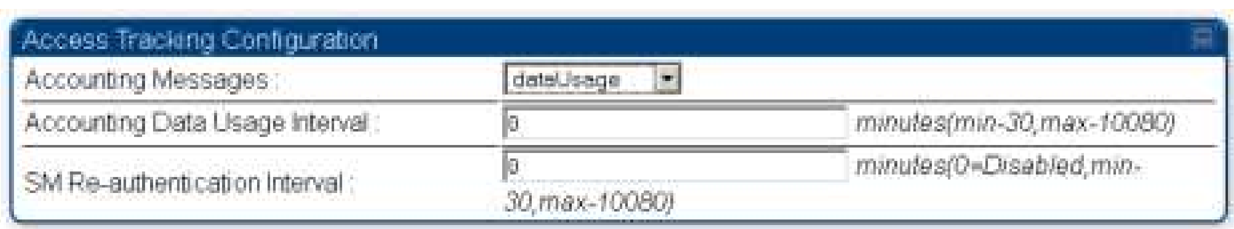
The data accounting message data is based on the SM statistics that the AP maintains, and these statistics may be cleared on the AP by an operator. If an operator clears these messages and data accounting is enabled, an accounting stop message is sent followed by an accounting start message to notify 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 72: *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

  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.

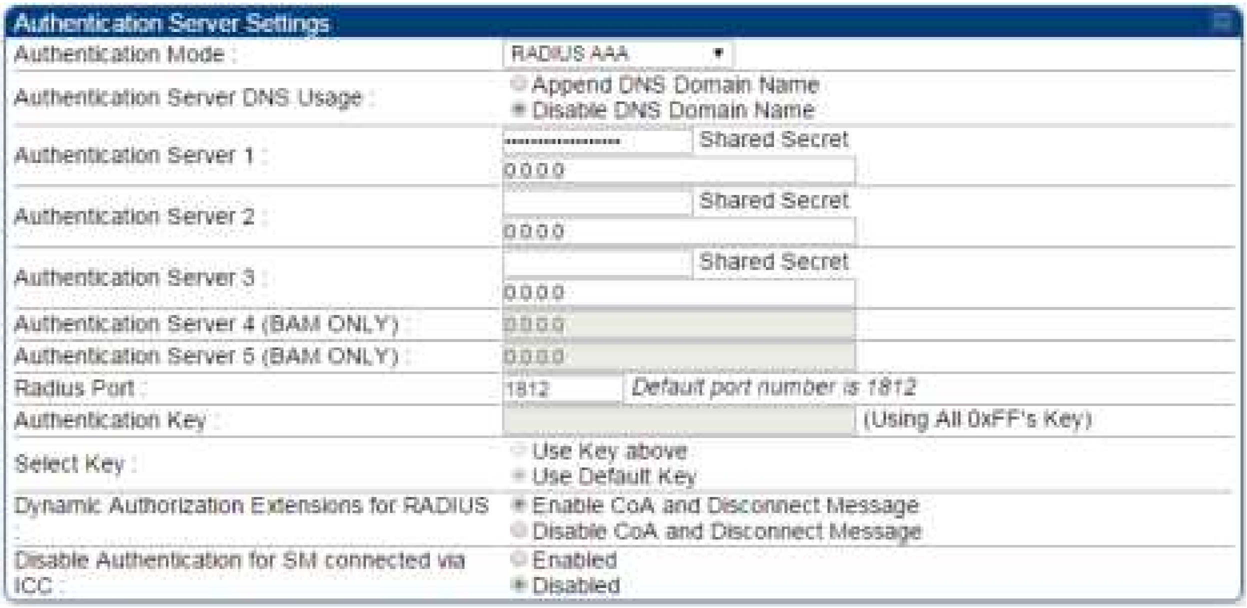
Although re-authentication is an independent feature, it was designed to work alongside with the RADIUS data usage accounting messages. If a user is over their data usage limit the network operator can reject the user from staying in the network. Operators may configure the RADIUS 'Reply-Message' attribute 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 73: *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.

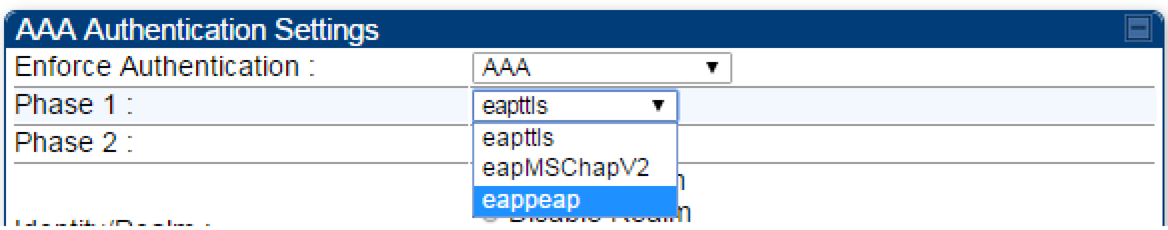
> **Note**
>
> All this configuration has been tested on Windows Server 2012 R2 version.
>
> This feature is not supported on hardware board type P9 or lower platforms.

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 74: *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.

Windows Server Configuration

Import Certificate

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

- Copy the certificate which is configured in SM under Configuration > Security -> Certificate1 to Windows Server machine.
- 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.

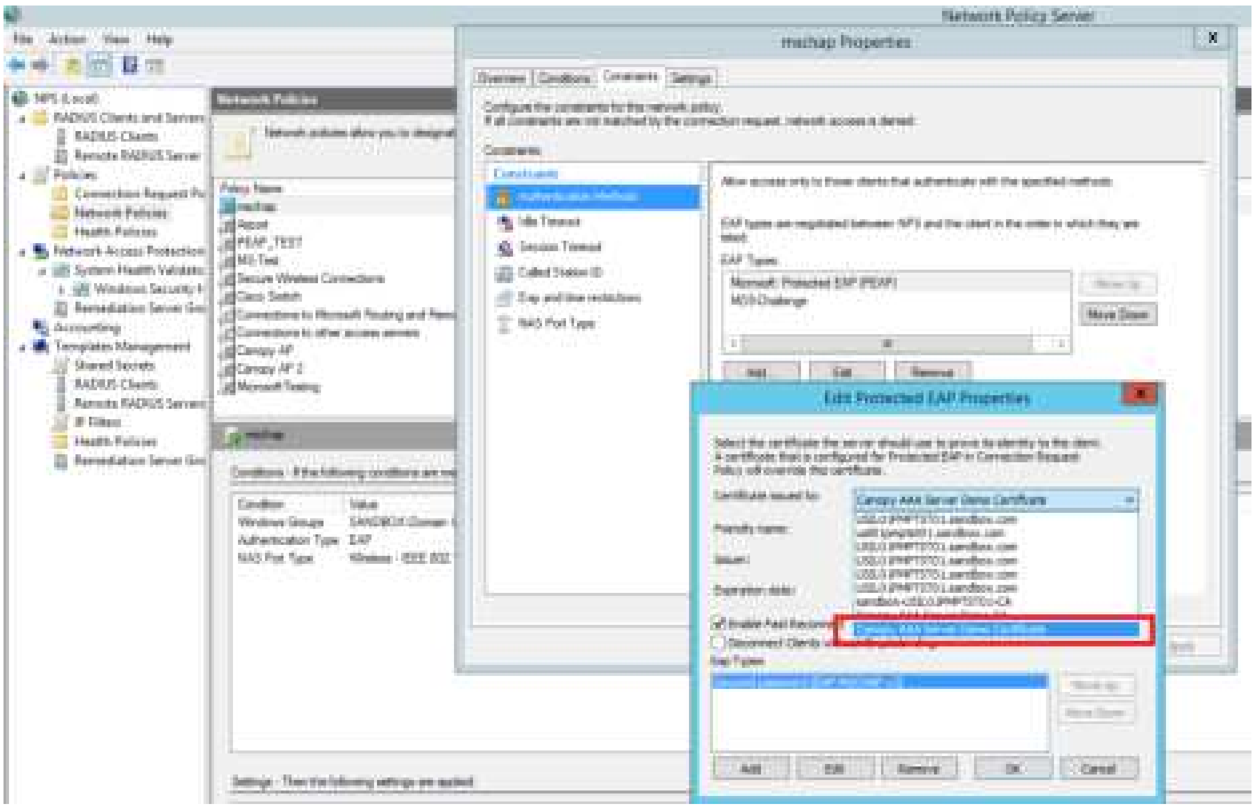
NPS Configuration (https://technet.microsoft.com/en-us/network/bb545879.aspx)

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 75: *Importing certificate in NPS*



User Authentication Configuration

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:

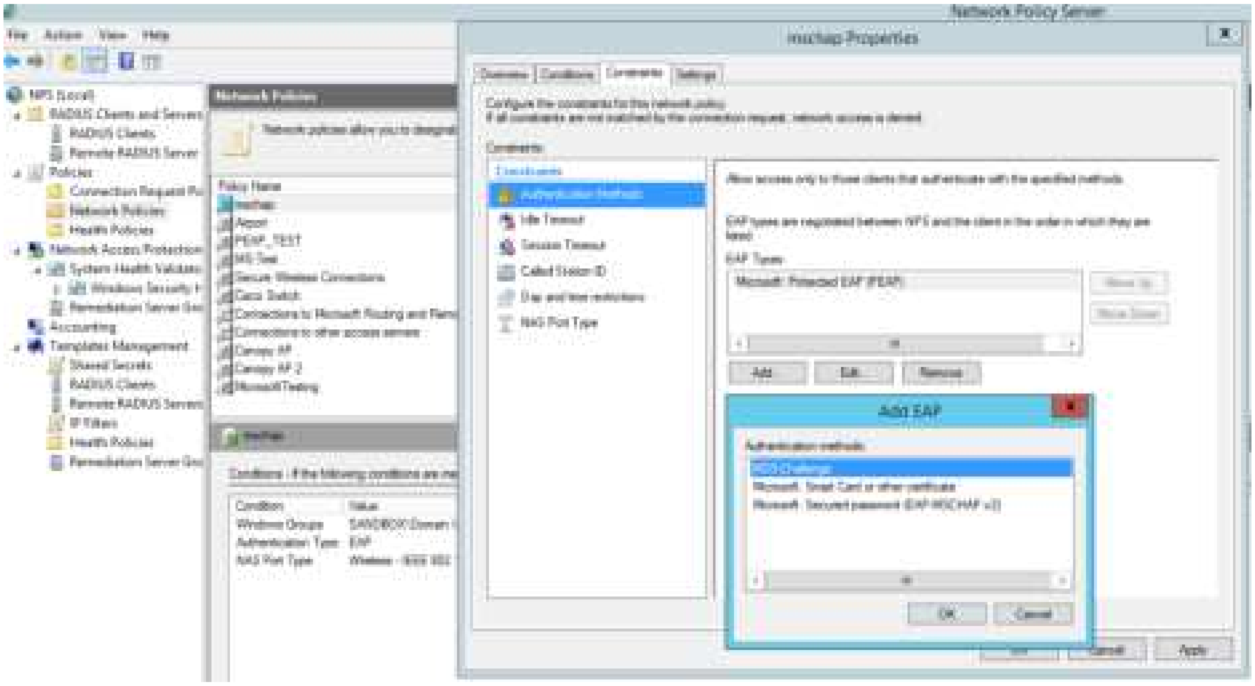
1. Follow the instructions:

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

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

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

Figure 76: *Selecting MD5 from NPS console*

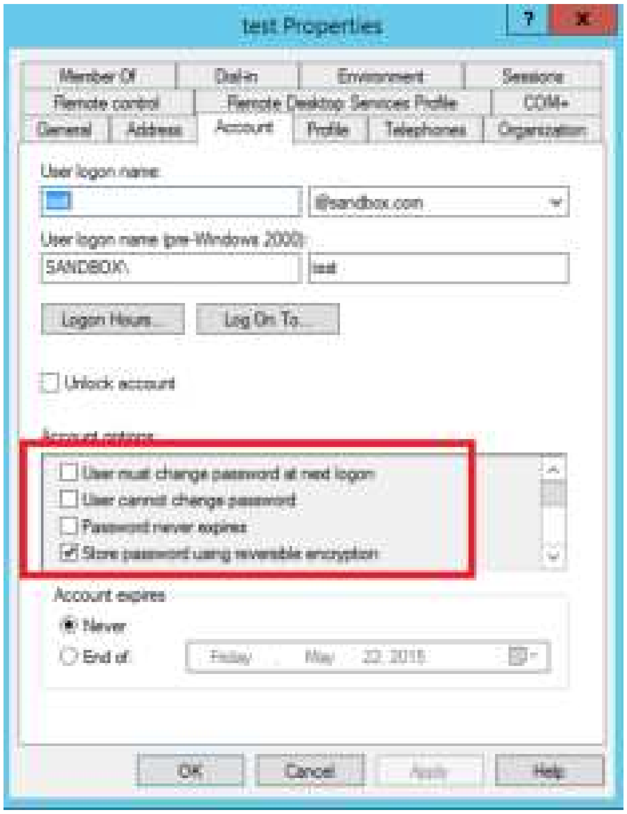


User Configuration in Active Directory

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

Make sure user property is configured as shown below.

Figure 77: *User configuration*



RADIUS VSA Configuration

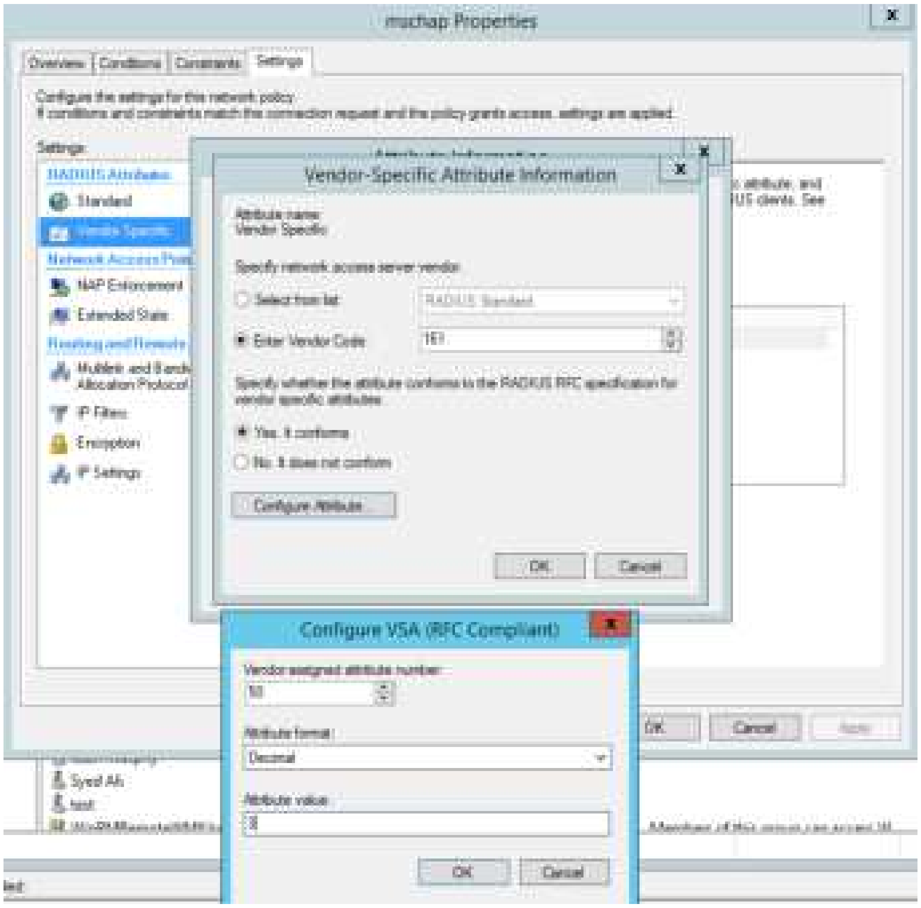
Before using VSA, the **Cambium-Canopy-UserLevel(50)** VSA must be configured with some access level say ADMIN(3).

Follow below link for configuring VSA:

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

The Cambium's vendor code is 161.

Figure 78: *RADIUS VSA configuration*



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 79: *Adding RADIUS client*

Creating Users

Figure 80: *Creating users*

Creating RADIUS instance

Figure 81: *Creating RADIUS instance*

RADIUS protocols

Figure 82: *RADIUS protocols*

Service selection

Figure 83: *Service selection*

Adding Trusted CA

Figure 84: *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 85: *Installing Server Certificate*

Monitoring Logs

Figure 86: *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.

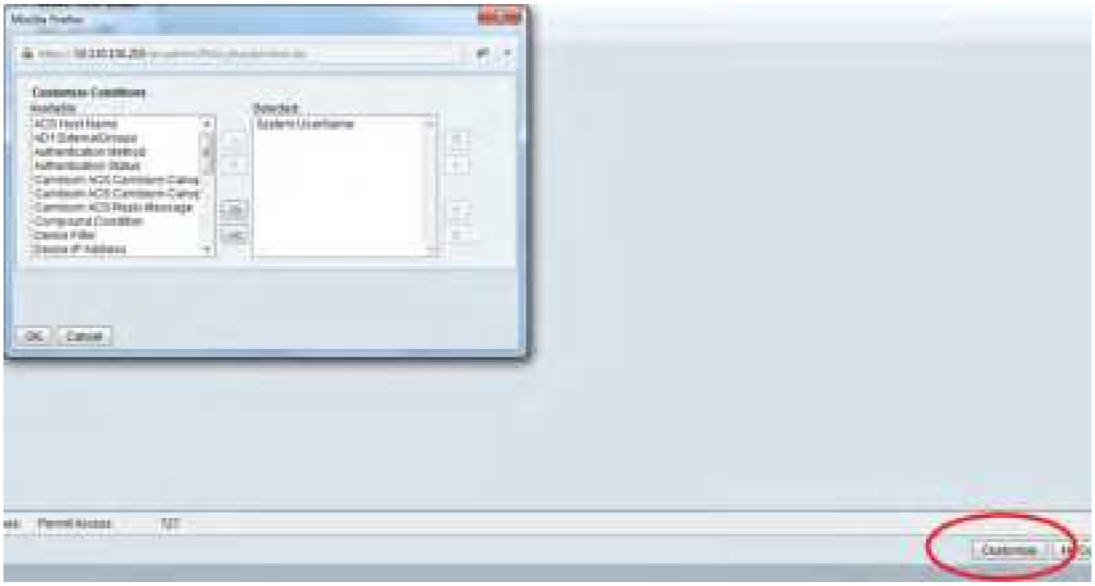
Figure 87: *VSA list*

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

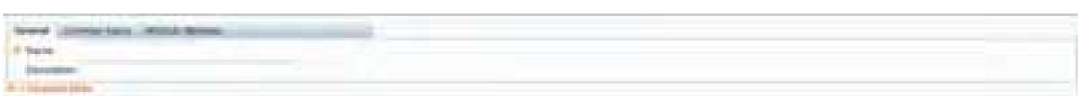
Navigate to **Access Policies > Access Services > Cambium ACS > Authorization**

1. Change condition to User name



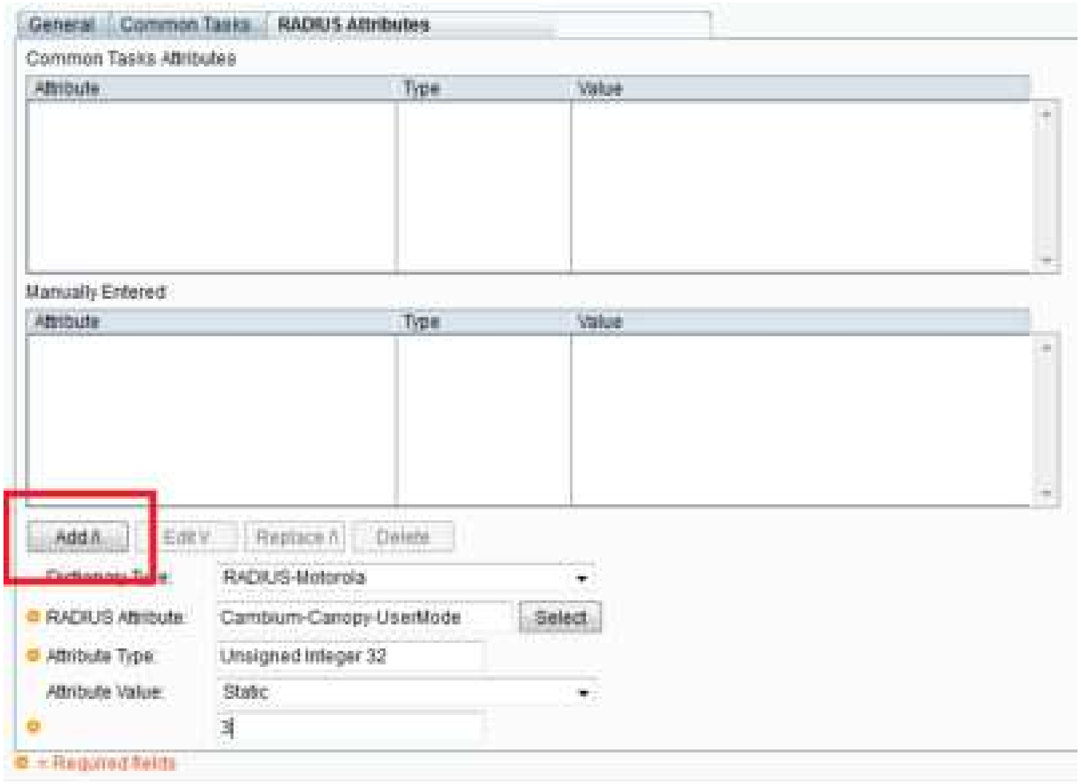
2. Next click Create and then click Select see diagram below

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 92: 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
- Using the Alignment Tool
- Using the Link Capacity Test tool
- Using AP Evaluation tool
- Using BHM Evaluation tool
- Using the OFDM Frame Calculator tool
- Using the Subscriber Configuration tool
- Using the Link Status tool
- Using BER Results tool
- Using the Sessions tool
- Using the Ping Test tool

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).

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.

Caution

If the **Perform Spectrum Analysis on Boot Up for One Scan** option is enabled on the AP (accessible under **Tool** > **Spectrum Analyzer**), and the AP undergoes a reboot (whether due to a Channel Bandwidth change or any other reason) the SMs may switch from the Last known primary AP scan to the normal scan by the time spectrum analysis has completed. To mitigate this, operators may want to consider disabling the **Perform Spectrum Analysis on Boot Up for One Scan** option before reboot.

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

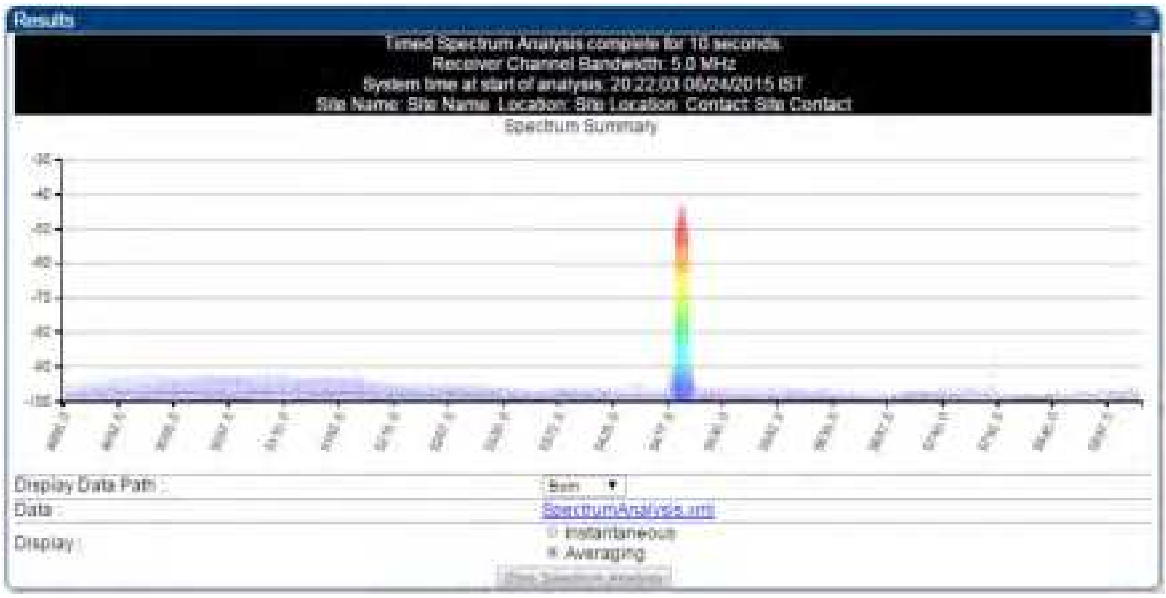
To use the built-in spectrum analyzer functionality of the AP/SM/BH, proceed as follows:

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 88: *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 Spectrum analysis - Results.

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

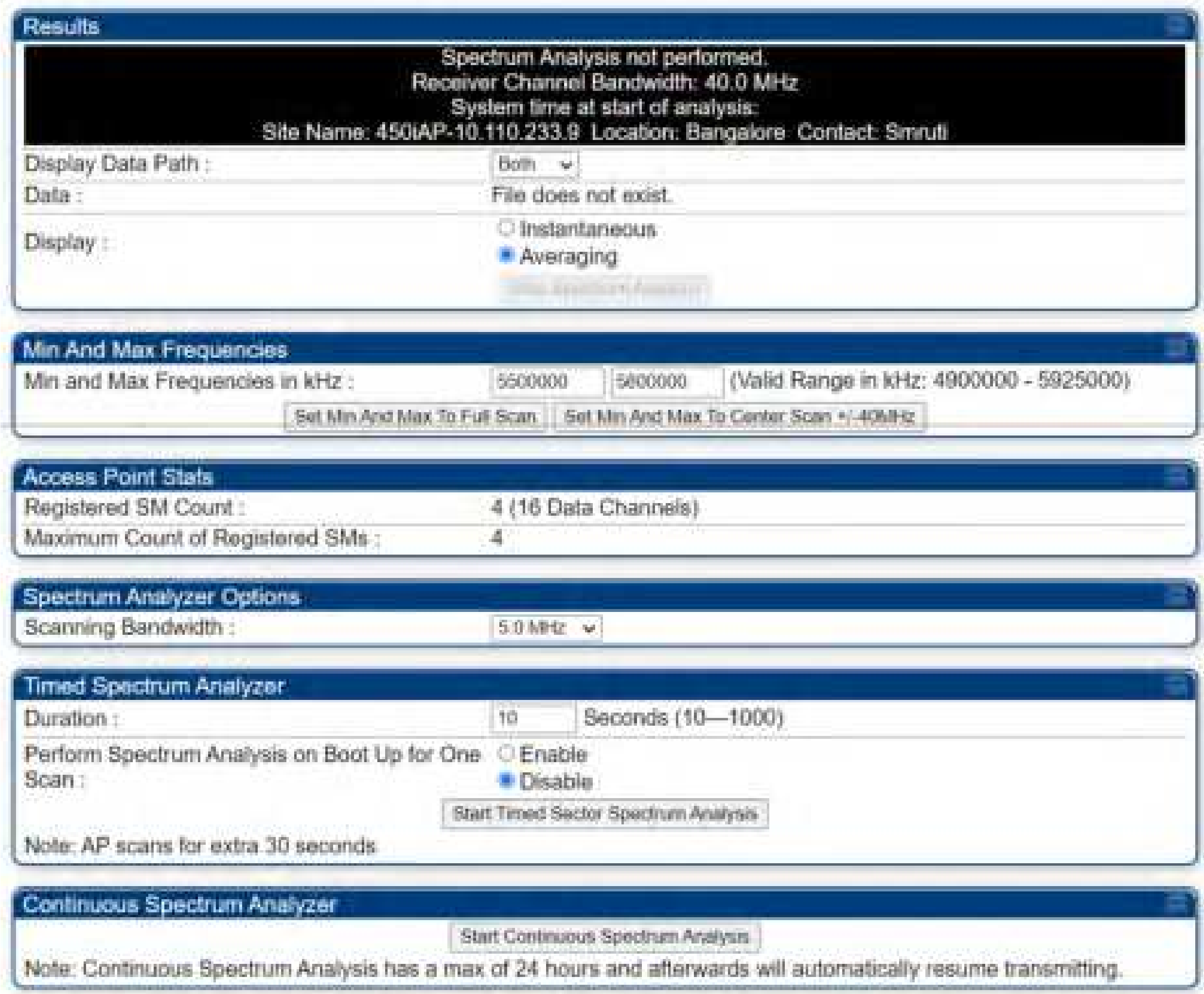
When the mouse is positioned over a bar, the receive power level, frequency, maximum and mean receive power levels are displayed above the graph

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 below table.

Table 93: Spectrum Analyzer page attributes - AP



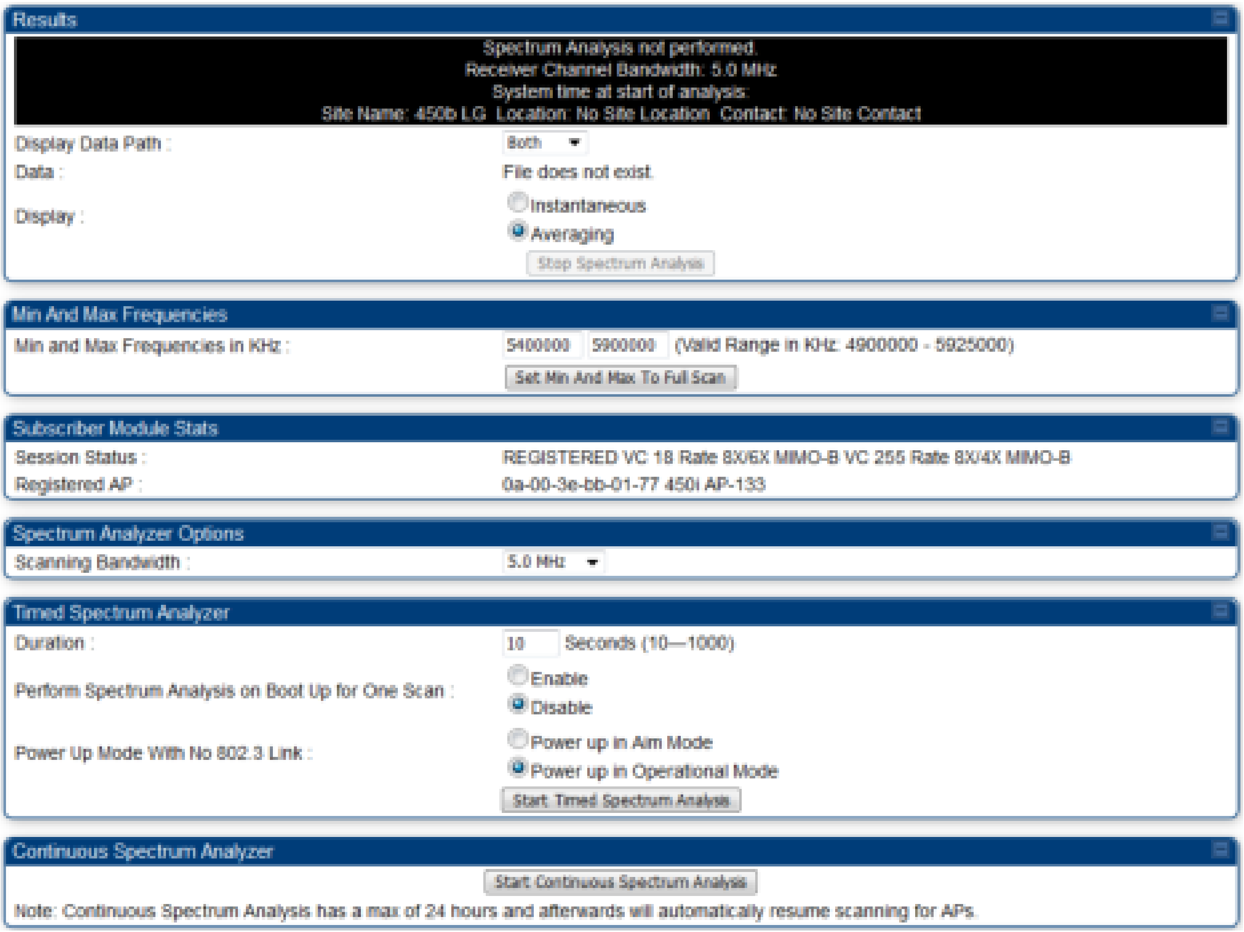
Attribute	Meaning
Display Data Path	Both means that the vertical and horizontal paths are displayed or an individual path may be selected to display only a single-path reading.
Data	For ease of parsing data and to facilitate automation, the spectrum analyzer results may be saved as an XML file. To save 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.

Attribute	Meaning
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.
Scanning Bandwidth	This field allows selecting scanning bandwidth for AP and all the registered SMs. **Note**: This feature is not supported in PMP 450m APs.
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 below table.

Table 94: Spectrum Analyzer page attributes - SM



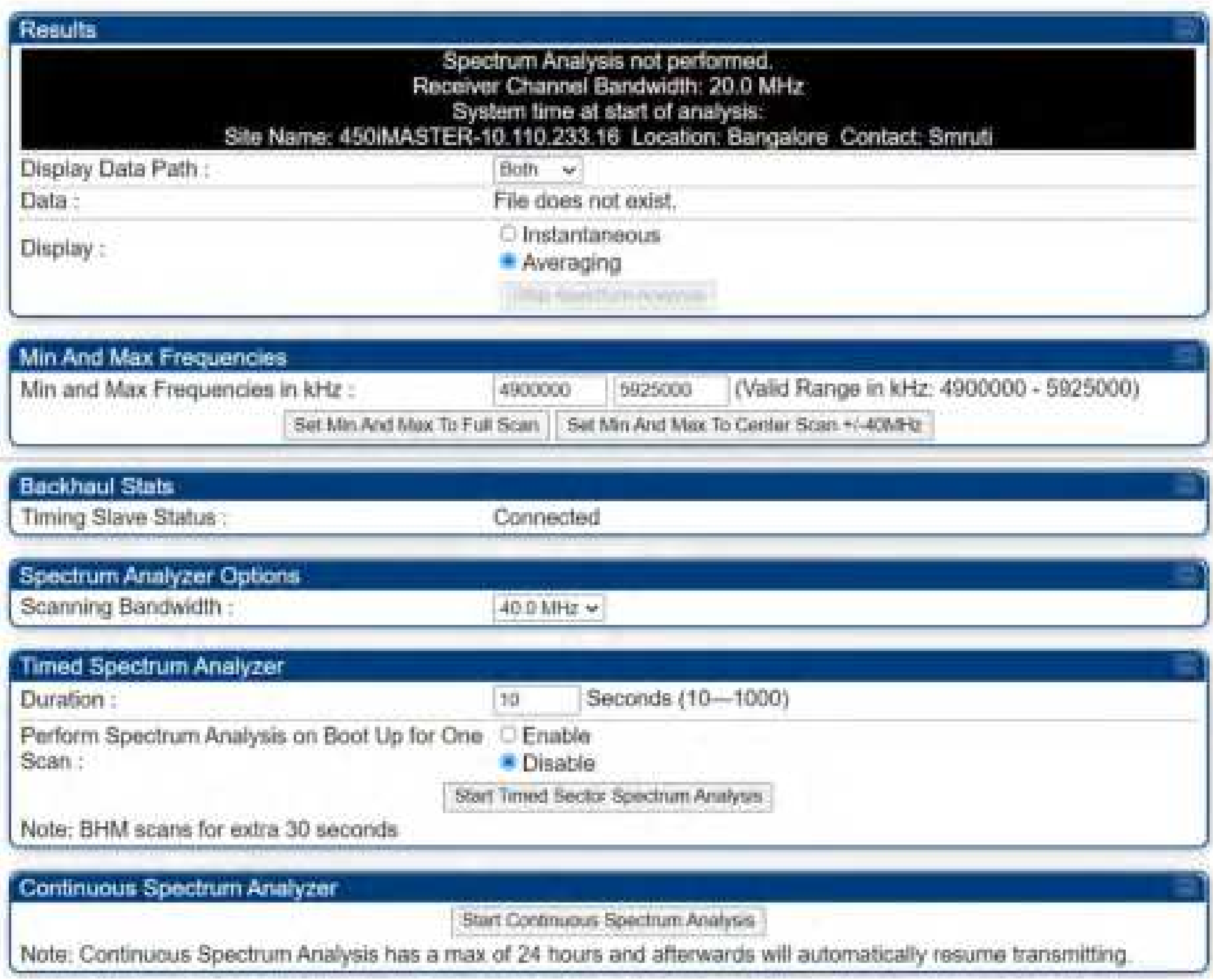
Attribute	Meaning
Display Data Path	Refer Spectrum Analyzer page attributes - AP
Data	
Display	
Min and Max Frequencies in kHz	To scan min to max range of frequencies, enter min and max frequencies in kHz and press Set Min and Max to Full Scan button. To scan +/- 40 MHz from center frequency, enter center frequency in kHz and press Set Min And Max To Center Scan +/- 40 MHz 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 Spectrum Analyzer page attributes - AP .

Attribute	Meaning
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 below table.

Table 95: Spectrum Analyzer page attributes - BHM

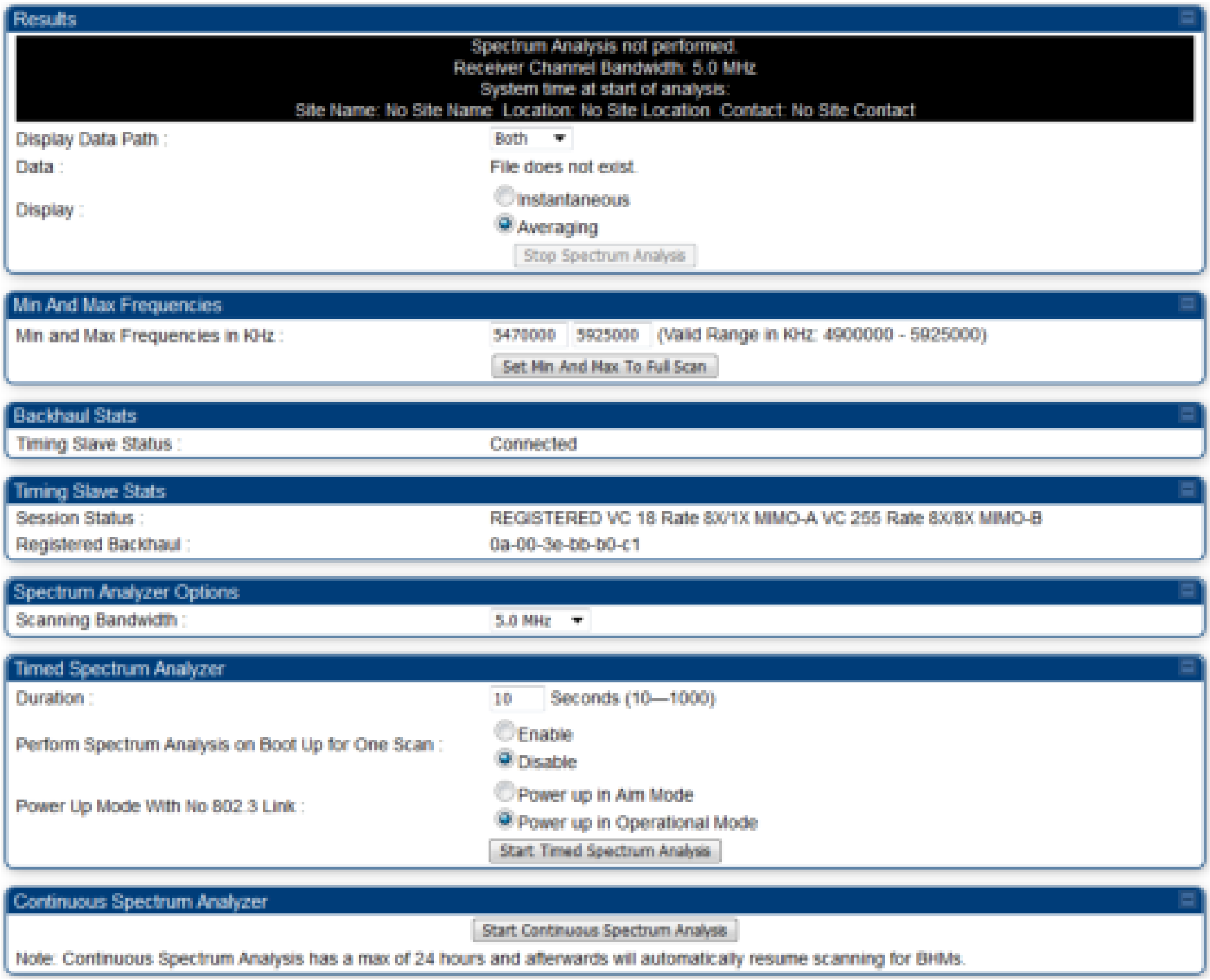


Attribute	Meaning
Data	Refer Spectrum Analyzer page attributes - AP
Display	
Duration	
Min and Max Frequencies in kHz	Enter minimum and maximum frequencies to be scanned.
Set Min And Max to Full Scan	On the button press, it sets minimum and maximum allowed frequencies for scanning.
Set Min And Max to 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.
Scanning Bandwidth	This field allows to select scanning bandwidth for both BHM and BHS.
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 below table.

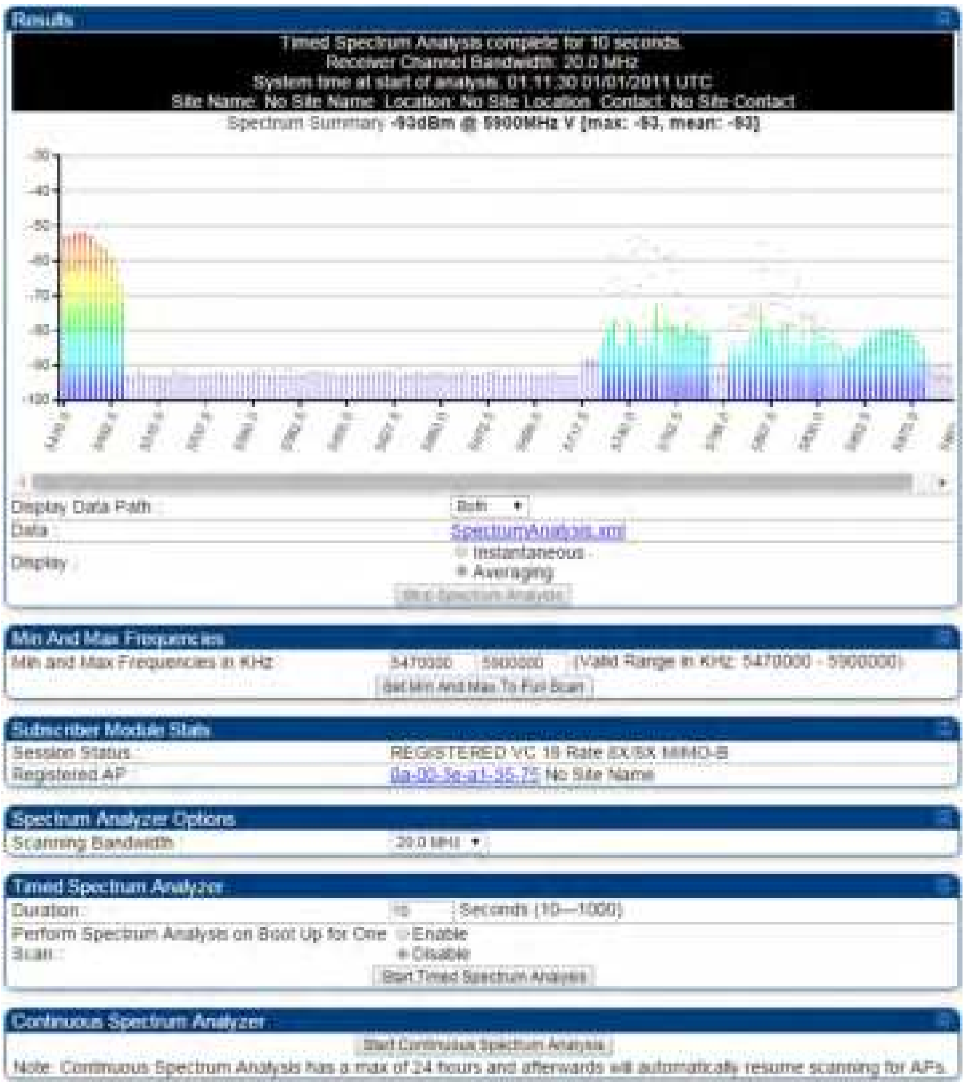
Table 96: Spectrum Analyzer page attributes - BHS



Attribute	Meaning
Data	Refer Spectrum Analyzer page attributes - AP
Display	
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 Spectrum Analyzer page attributes - AP
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 Spectrum Analyzer page attributes - AP on page Spectrum Analyzer page attributes - AP

Spectrum Analyzer page result of PMP 450 SM

Figure 89: *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.

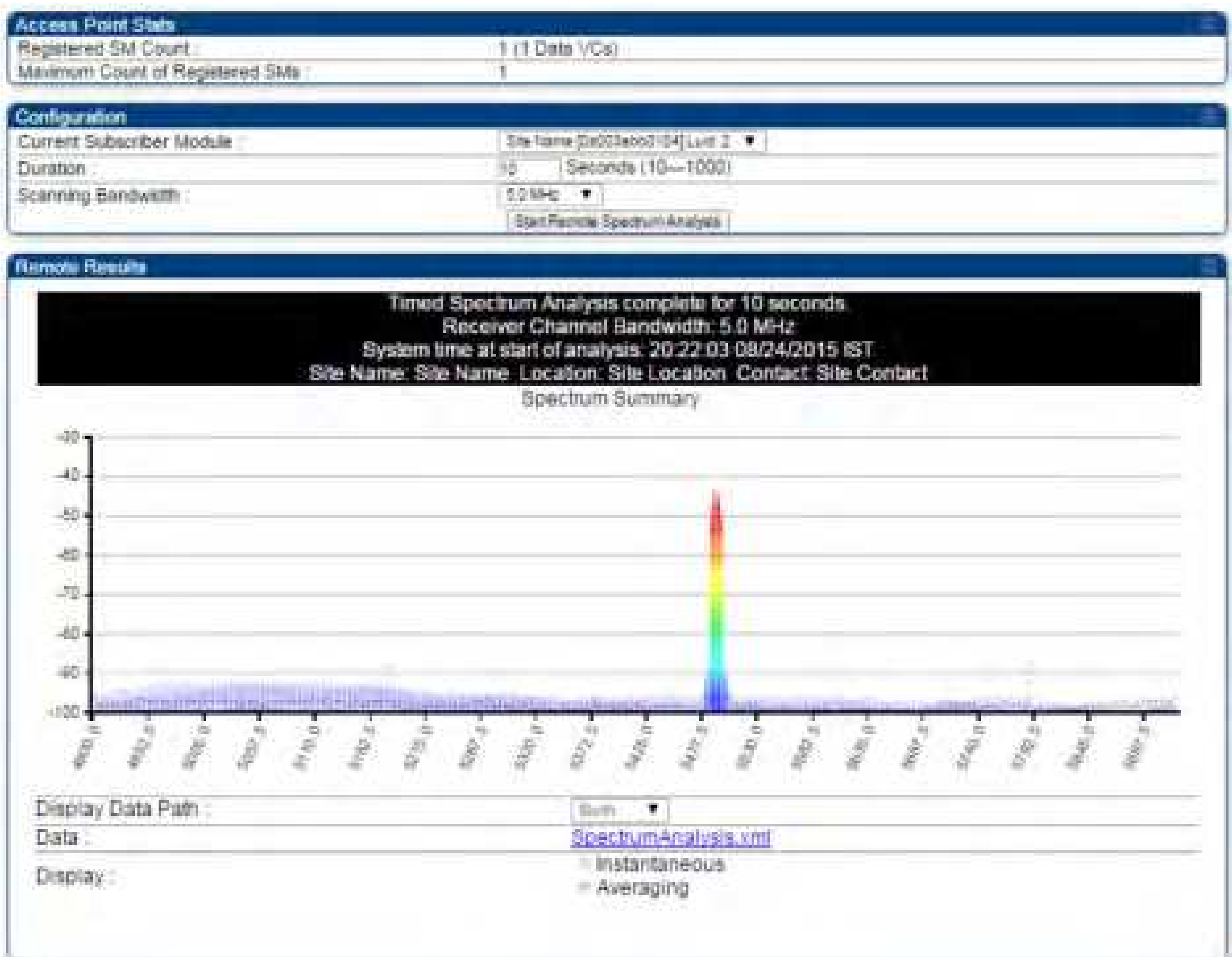
2	The SM/BHS scans (for the duration set in the AP/BHM tool) to collect data for the bar graph.
3	The SM/BHS re-registers to the AP/BHM.
4	The AP/BHM displays the bar graph.

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 below table.

Table 97: Remote Spectrum Analyzer attributes - AP

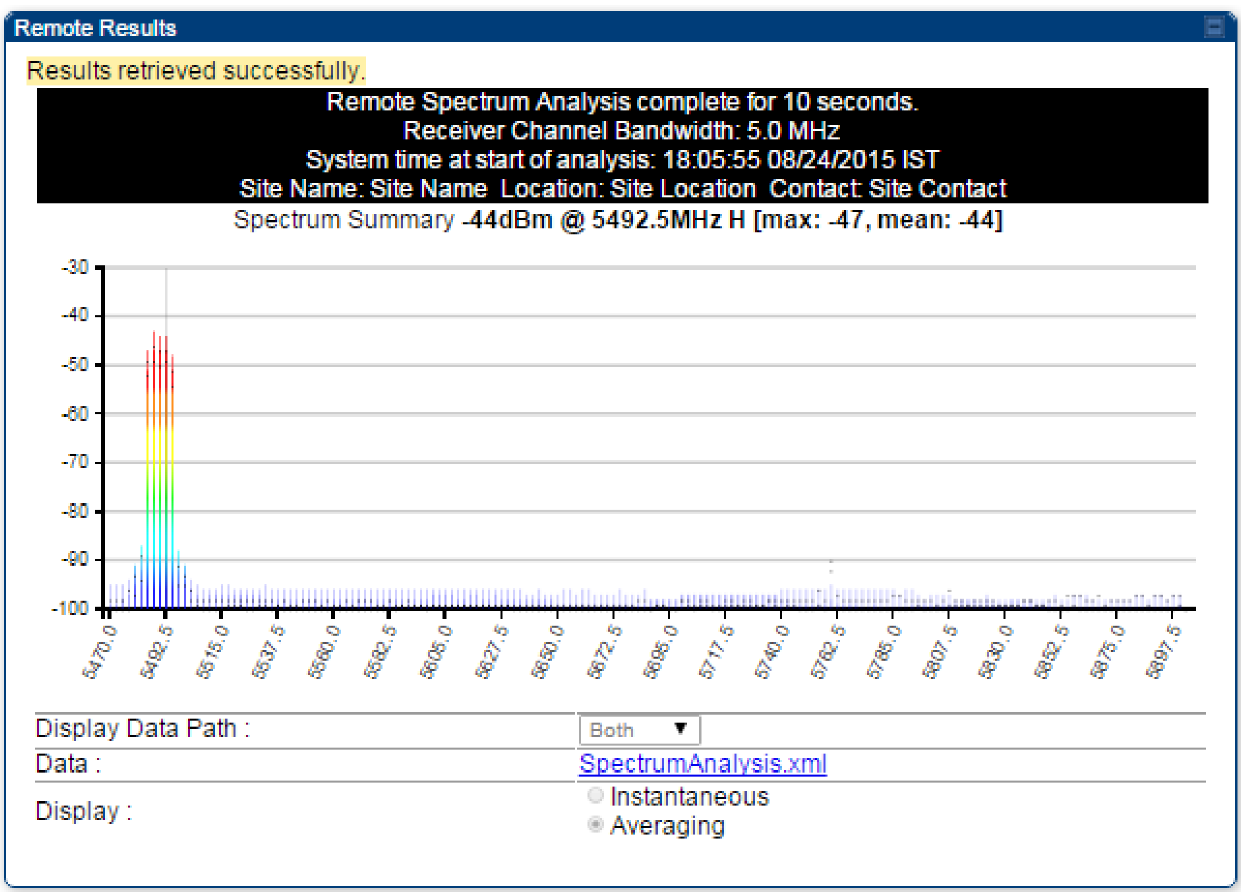


Attribute	Meaning
Registered SM Count	This field displays the number of SMs that were registered to the AP before the SA was started. This helps the user know all the SMs re-registered after performing a SA.
Maximum Count of Registered SMs	This field displays the largest number of SMs that have been 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 currently selected SM. This is used on multiple pages.
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 below table.

Table 98: Remote Spectrum Analyzer attributes - BHM



Attribute	Meaning
Duration	Refer Spectrum Analyzer page attributes - AP

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.

Using the Alignment Tool

The SM's or BHS's Alignment Tool may be used to maximize Receive Power Level, Signal Strength Ratio and Signal to Noise Ratio to ensure a stable link. The Tool provides color coded readings to facilitate in judging link quality.

Figure 90: *Alignment Tool tab of SM – Receive Power Level > -70 dBm*

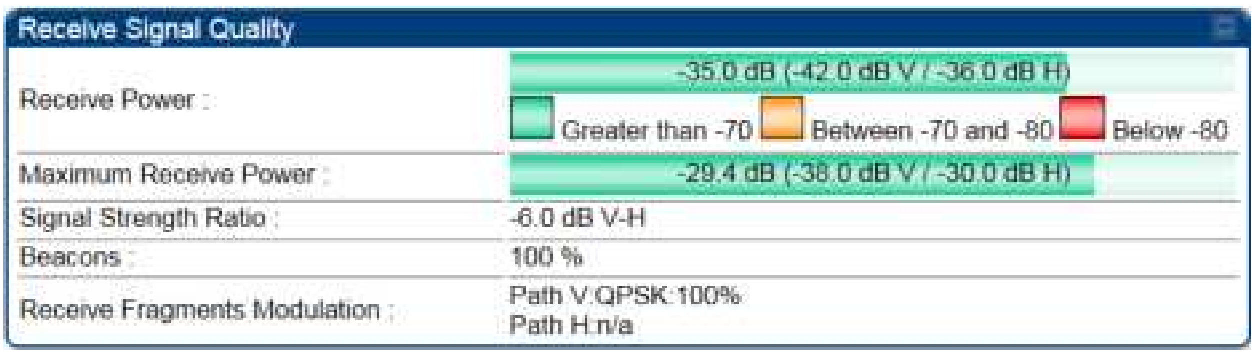


Figure 91: *Alignment Tool tab of SM – Receive Power Level between -70 to -80 dBm*

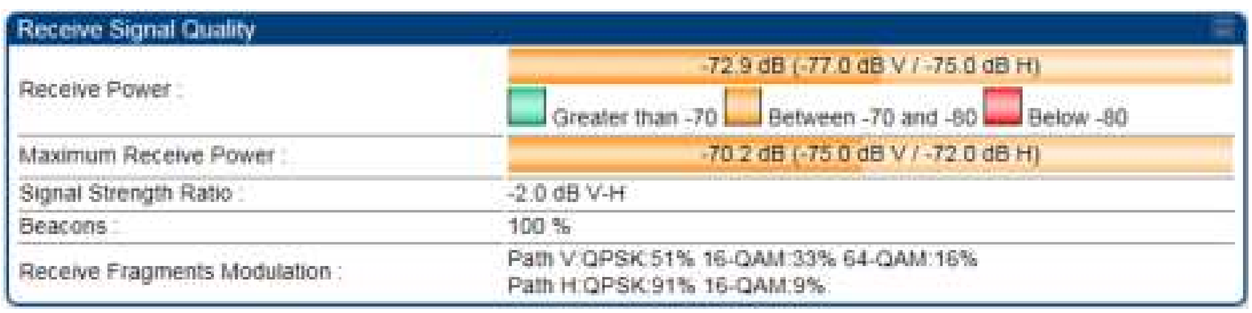
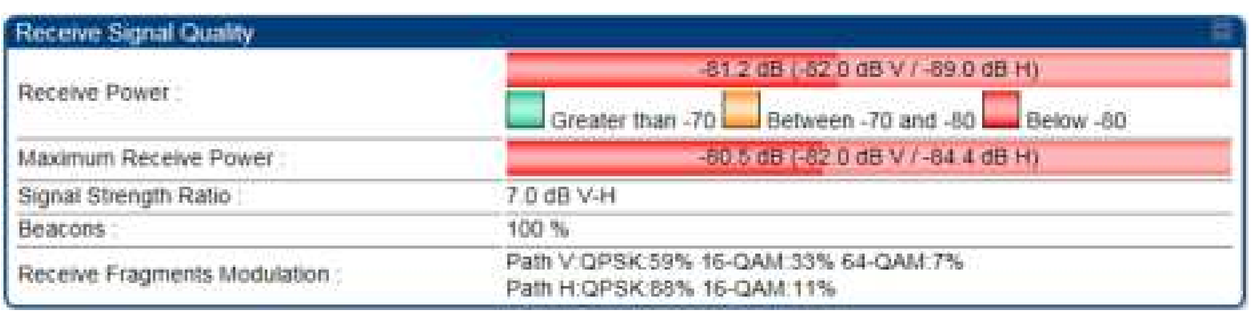


Figure 92: *Alignment Tool tab of SM – Receive Power Level < -80 dBm*



Aiming page and Diagnostic LED – SM/BHS

The SM's/BHS's Alignment Tool (located in GUI **Tools -> Aiming**) may be used to configure the SM's/BHS's LED panel to indicate received signal strength and to display decoded beacon information/power levels. The SM/BHS LEDs provide different status based on the mode of the SM/BHS. A SM/BHS in "operating" mode will register and pass traffic normally. A SM/BHS in "aiming" mode will not register or pass traffic, but will display (via LED panel) the strength of received radio signals (based on radio channel selected via **Tools ->Aiming**). See SM/BHS LEDs in Planning and Installation Guide.

Note
For accurate power level readings to be displayed, traffic must be present on the radio link.

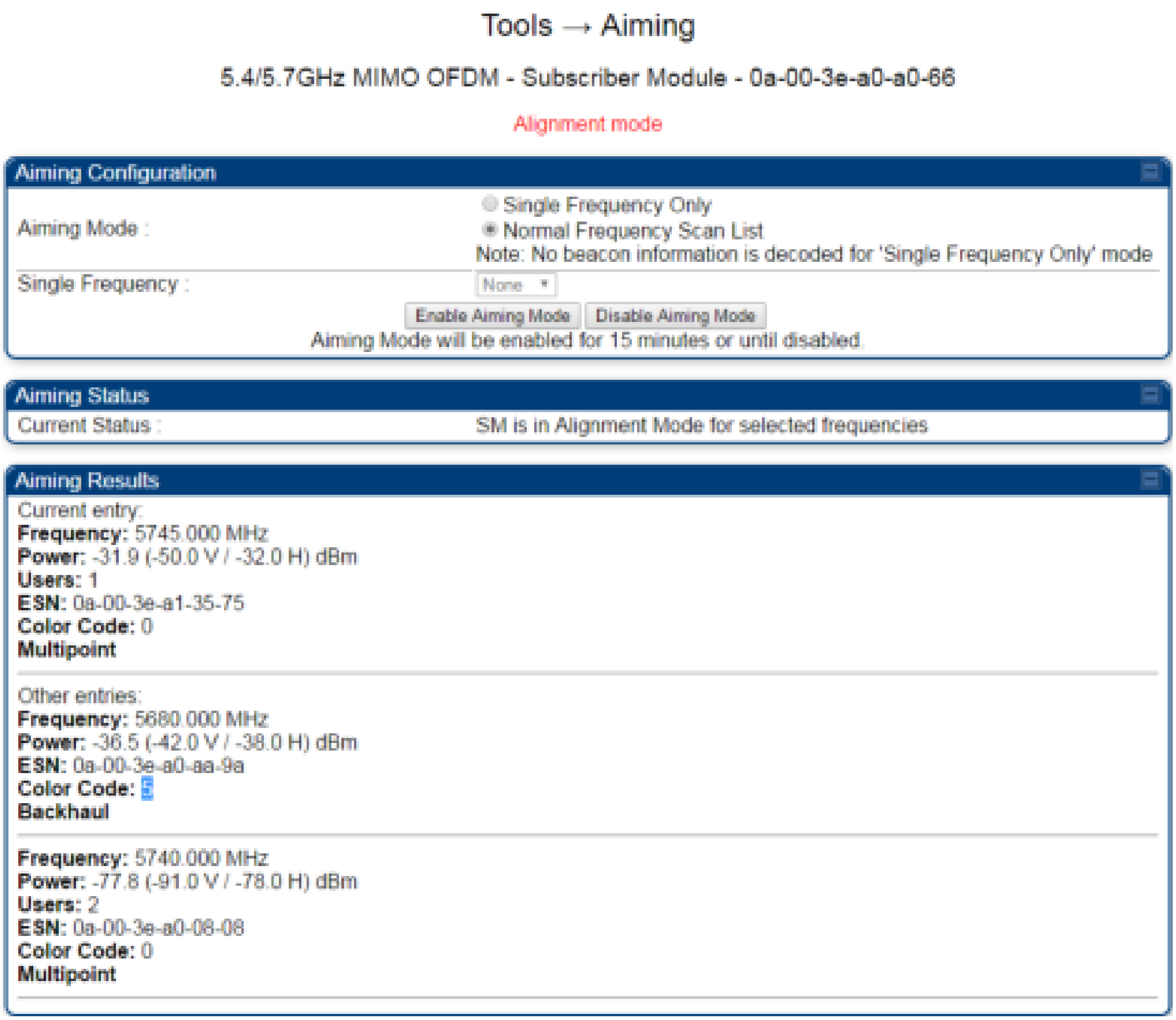
Refer SM/BHS LED description in Planning and Installation Guide for SM/BHS LED details.

Aiming page of SM

The Aiming page is similar to Spectrum Analyzer where it scans the spectrum but it does not establish any session with any APs. It has two modes – Single Frequency Only and Normal Frequency Scan List.

The Aiming page of SM is explained in below table.

Table 99: Aiming page attributes – SM



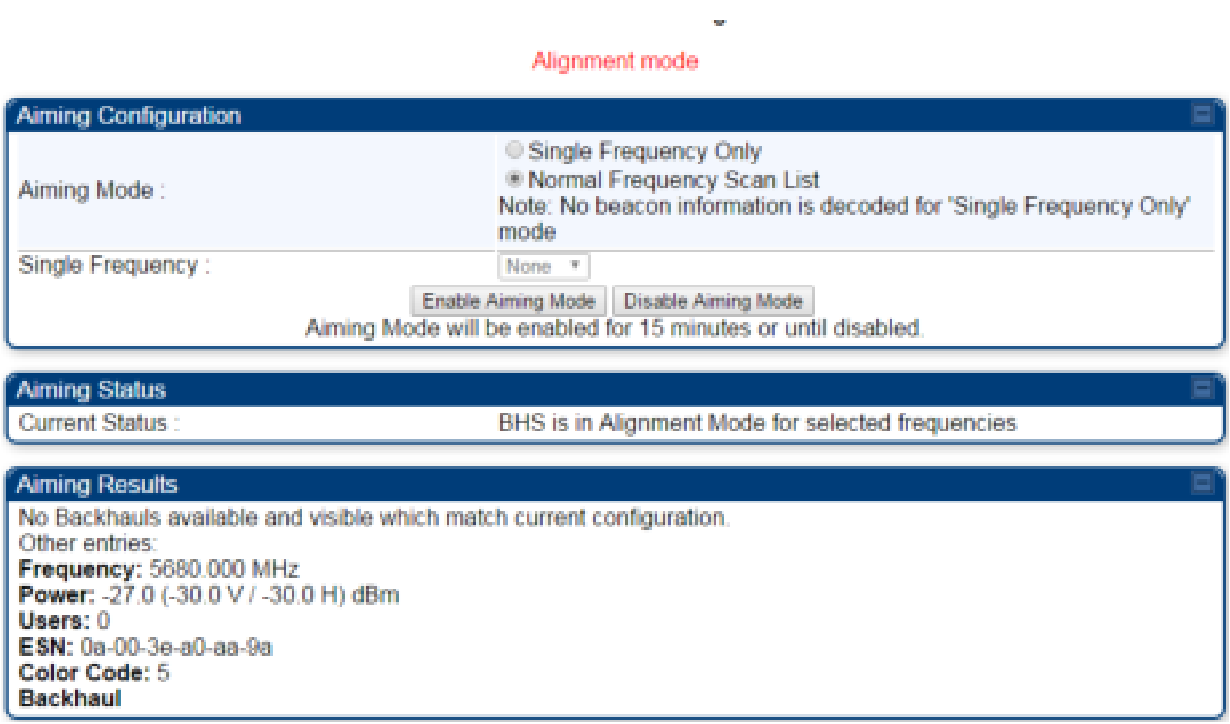
Attribute	Meaning
Aiming Mode	Single Frequency Only: scans only selected single frequency. Normal Frequency Scan List: scans: scans all frequency of scan list.
Single Frequency	Select a particular frequency from drop-down menu for scanning.
Scan Radio Frequency Only Mode	Enabled: the radio is configured to “aiming” or “alignment” mode, wherein the LED panel displays an indication of receive power level. See SM/BHS LED description in Planning and Installation Guide. Disabled: the radio is configured to “operating” mode, wherein the SM registers and passes traffic normally.
Aiming Results	The Aiming Results are displayed in two sections – Current entry and Other entries.

Attribute	Meaning
	Frequency: this field indicates the frequency of the AP which is transmitting the beacon information. Power: This field indicates the current receive power level (vertical channel) for the frequency configured in parameter Radio Frequency. Users: This field indicates the number of SMs currently registered to the AP which is transmitting the beacon information. ESN: This field indicates the MAC, or hardware address of the AP/BHM which is transmitting the beacon information. Color Code: This field displays a value from 0 to 254 indicating the AP's configured color code. For registration to occur, the color code of the SM and the AP must match. Color code is not a security feature. Instead, color code is a management feature, typically for assigning each sector a different color code. Color code allows you to force a SM to register to only a specific AP, even where the SM can communicate with multiple APs. The default setting for the color code value is 0. This value matches only the color code of 0 (not all 255 color codes). Multipoint or Backhaul: this field indicates type of configuration - point-Multipoint (PMP) or Backhaul (PTP).

Aiming page of BHS

The Alignment page of BHS is explained in below table.

Figure 93: *Aiming page attributes - BHS*



Attribute	Meaning
Refer Aiming page attributes – SM for attribute details.	

Note

The Alignment Tone cable for a 450i Series uses an RJ-45 to headset cable whereas the 450 Series alignment tone cable uses an RJ-12 to headset cable.

Alignment Tone

For coarse alignment of the SM/BHS, use the Alignment Tool located at Tools ->Alignment Tool. Optionally, connect a headset alignment tone kit to the AUX/SYNC port of the SM/BHS and listen to the alignment tone, which indicates greater SM/BHS receive signal power by pitch. By adjusting the SM's/BHS's position until the highest frequency pitch is obtained operators and installers can be confident that the SM/BHS is properly positioned. For information on device GUI tools available for alignment, see sections Aiming page and Diagnostic LED – SM/BHS, Using the Link Capacity Test tooland Using AP Evaluation tool.

Figure 94: *PMP/PTP 450i Series link alignment tone*

Alignment Tool Headset and alignment tone adapters can be ordered from Cambium and Best-Tronics (http://btpa.com/Cambium-Products/) respectively using the following part numbers:

Table 100: Alignment Tool Headsets and Alignment tone adapter third party product details

Reference	Product description
ACATHS-01A	Alignment tool headset for the PMP/PTP 450 and 450i Series products
BT-1277	Headset alignment cable (RJ-45) for the PMP/PTP 450i Series products
BT-0674	Headset alignment cable (RJ-12) for the PMP/PTP 450 Series products.

Using the Link Capacity Test tool

The Link Capacity Test tab allows you to measure the throughput and efficiency of the RF link between two modules. Many factors, including packet length, affect throughput.

The Link Capacity Test tool has following modes:

- Link Test with Multiple VCs: Tests radio-to-radio communication across selected or all registered VCs, but does not bridge traffic (PMP 450m Series AP only).
- Link Test without Bridging: Tests radio-to-radio communication, but does not bridge traffic.
- Link Test with Bridging: Bridges traffic to “simulated” Ethernet ports, providing a status of the bridged link.
- Link Test with Bridging and MIR: Bridges the traffic during test and also adheres to any MIR (Maximum Information Rate) settings for the link.
- Extrapolated Link Test: Estimates the link capacity by sending few packets and measuring link quality.

The Link Capacity Test tab contains the settable parameter Packet Length with a range of 64 to 1714 bytes. This allows you to compare throughput levels that result from various packet sizes.

The Current Results Status also displayed date and time of last performed Link Capacity Test. If there is any change in time zone, the date and time will be adjusted accordingly.

Note

The Extrapolated Link Test can be run by Read-Only login also.

Performing Link Test

The link test is a tool that allows the user to test the performance of the RF link. Packets are added to one or more queues in the AP in order to fill the frame. Throughput and efficiency are then calculated during the test. The 450 and 450i APs offer link test options to one SM at a time. The 450m AP offers the option of a link test to multiple VCs at the same time. This allows the user to test throughput in MU-MIMO mode, in which multiple SMs are served at the same time.

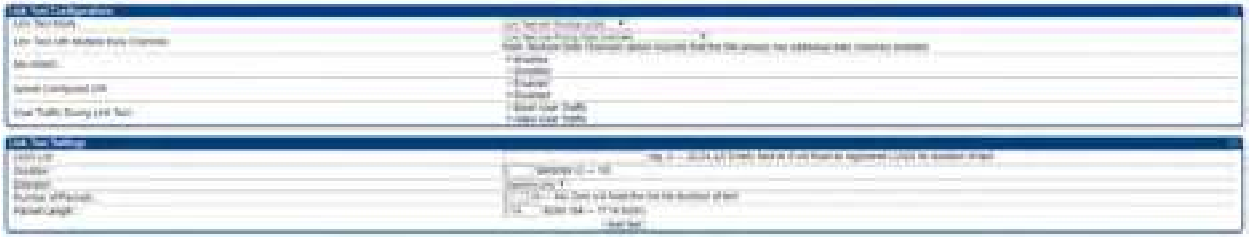
This new link test can be found under **Tools > Link Capacity Test.**

Link Test with Multiple LUIDs

Note

The “Link Test with Multiple LUIDs” Link Capacity Test is supported for PMP 450m Series AP only.

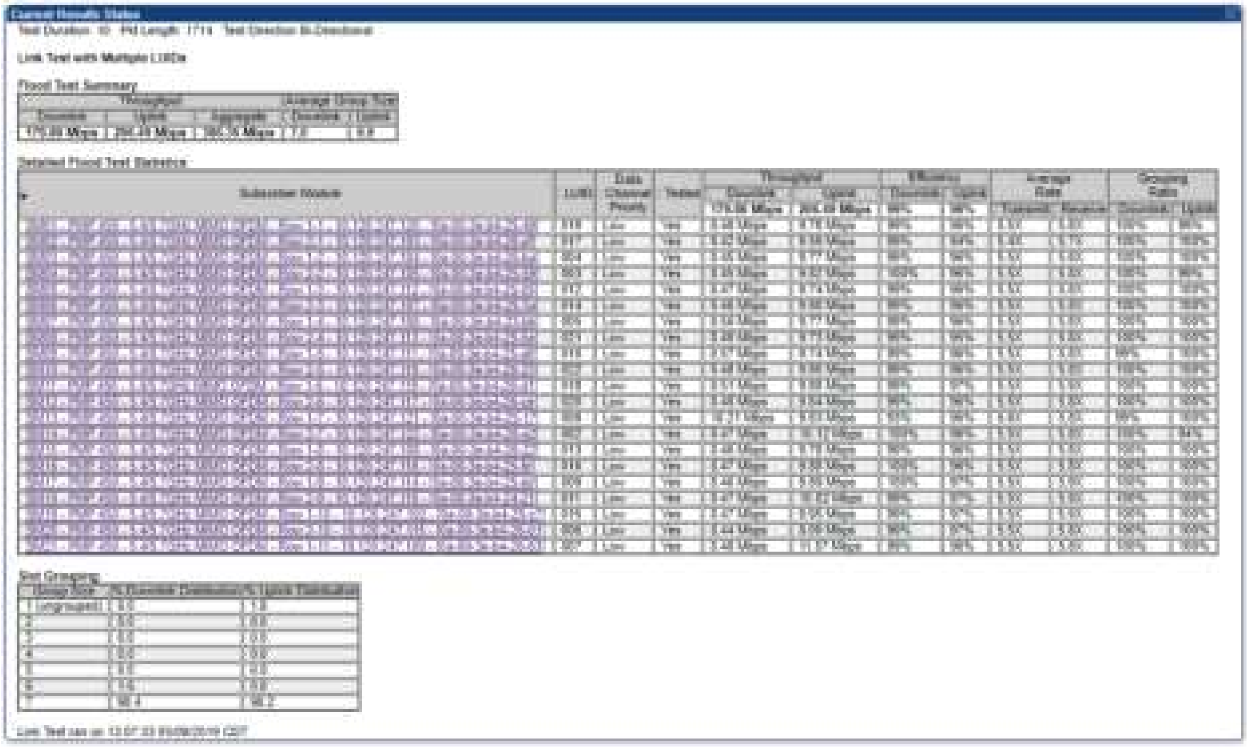
Figure 95: *Link Capacity Test – PMP 450m Series AP*



Procedure 24 Performing a Link Capacity Test - Link Test with Multiple LUIDs

Link Test Configurations parameters	
1	Access the Link Capacity Test tab in the Tools web page of the module.
2	Set Link Test Mode attribute to Link Test with Multiple LUIDs.
3	Set Link with Multiple Data Channels attribute to Link Test Low Priority Data Channels, Link Test Low and Medium Priority Data Channels, Link Test Low, Medium and High Priority Data Channels, or Link Test All Data Channels.
4	Set the MU-MIMO attribute to Enabled or Disabled. Note: The MU-MIMO feature is enabled on the Low Priority Data Channel only
5	Set the Ignore Configured CIR attribute to Enabled or Disabled.
6	Set the User Traffic During Link Test attribute to Block User Traffic or Allow User Traffic.
Link Test Settings parameters	
7	Enter LUID List (applicable for PMP 450m AP only) The Current Subscriber Module and LUID List are valid only when selecting Link Test with Multiple LUIDs. • Current Subscriber Module: select the LUID to perform the link test with • LUID list: select a list or range of LUIDs to include in the link test with multiple LUIDs If left blank, all LUIDs will be included in the link test
8	Type into the Duration field how long (in seconds) the RF link must be tested.
9	Select the Direction attribute to Bi-directional, Uplink Only, or Downlink Only.
10	Type into the Number of Packets field a value of 0 to flood the link for the duration of the test.
11	Type into the Packet Length field a value of 1714 to send 1714-byte packets during the test.
12	Click the Start Test button.

Figure 96: *Link Test with Multiple LUIDs*



Link Test without Bridging, Link Test with Bridging or Link Test with Bridging and MIR

Figure 97: *Link Test without Bridging*

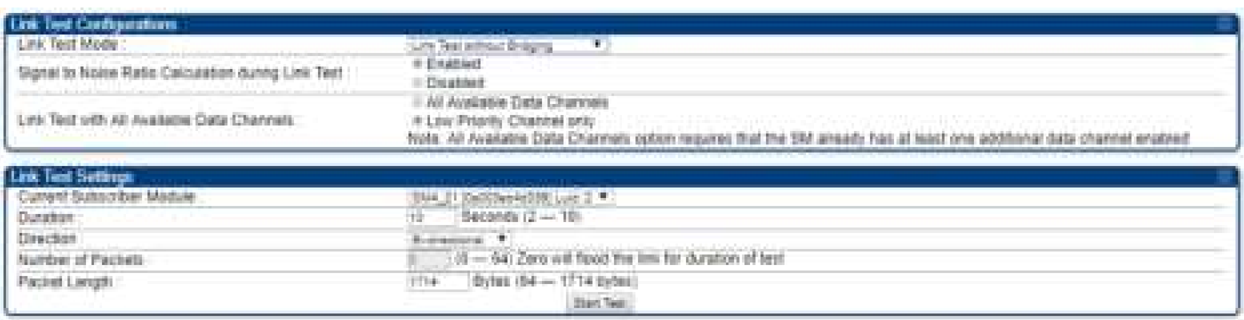
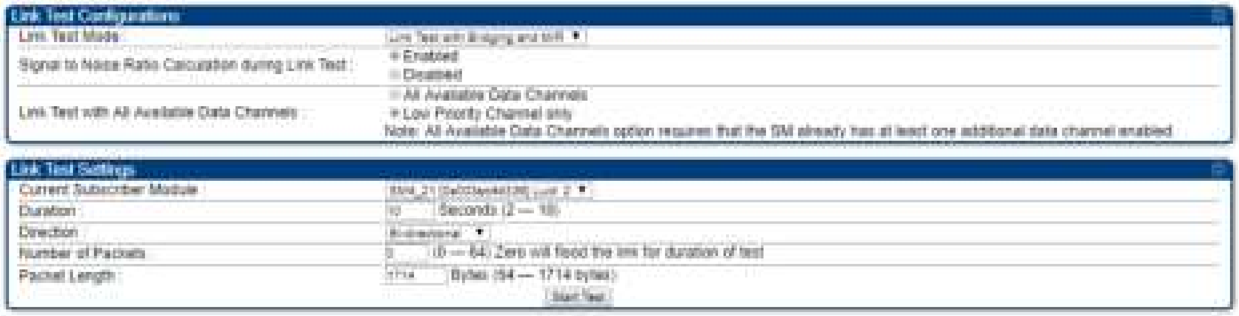
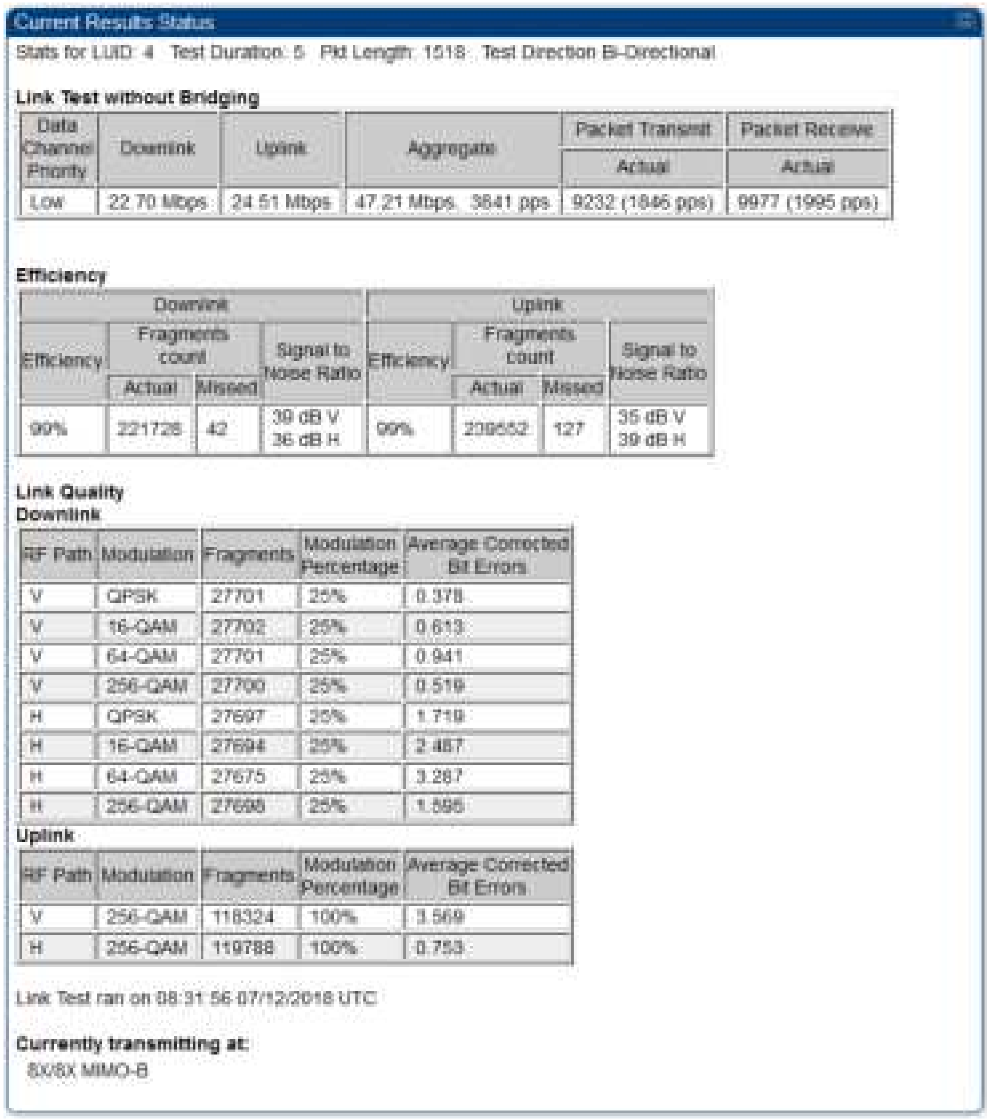


Figure 98: *Link Test with Bridging and MIR*



Refer Link Test with Multiple LUIDs for Link Test procedure.

Figure 99: *Link Test without Bridging (1518-byte packet length)*


Current Results Status

Stats for LUID: 4 Test Duration: 5 Pkt Length: 1518 Test Direction Bi-Directional

Link Test without Bridging

Data Channel Priority	Downlink	Uplink	Aggregate	Packet Transmit	Packet Receive
				Actual	Actual
Low	22.70 Mbps	24.51 Mbps	47.21 Mbps, 3841 pps	9232 (1846 pps)	9977 (1995 pps)

Efficiency

Downlink				Uplink			
Efficiency	Fragments count		Signal to Noise Ratio	Efficiency	Fragments count		Signal to Noise Ratio
	Actual	Missed			Actual	Missed	
99%	221728	42	39 dB V 36 dB H	99%	239552	127	35 dB V 39 dB H

Link Quality

Downlink

RF Path	Modulation	Fragments	Modulation Percentage	Average Corrected Bit Errors
V	QPSK	27701	25%	0.378
V	16-QAM	27702	25%	0.613
V	64-QAM	27701	25%	0.941
V	256-QAM	27700	25%	0.519
H	QPSK	27697	25%	1.719
H	16-QAM	27694	25%	2.487
H	64-QAM	27675	25%	3.287
H	256-QAM	27698	25%	1.595

Uplink

RF Path	Modulation	Fragments	Modulation Percentage	Average Corrected Bit Errors
V	256-QAM	118324	100%	3.569
H	256-QAM	119788	100%	0.753

Link Test ran on 08:31:56 07/12/2018 UTC

Currently transmitting at:

8X/8X MIMO-B

Performing Extrapolated Link Test

The Extrapolated Link Test estimates the link capacity by sending few packets and measuring link quality. Once the test is initiated, the radio starts session at the lower modulation, 1X, as traffic is passed successfully across the link, the radio decides to try the next modulation, 2X. This process repeats until it finds best throughput to estimate capacity of link.

The procedure for performing Extrapolated Link Test is as follows:

Procedure 25 Performing an Extrapolated Link Test

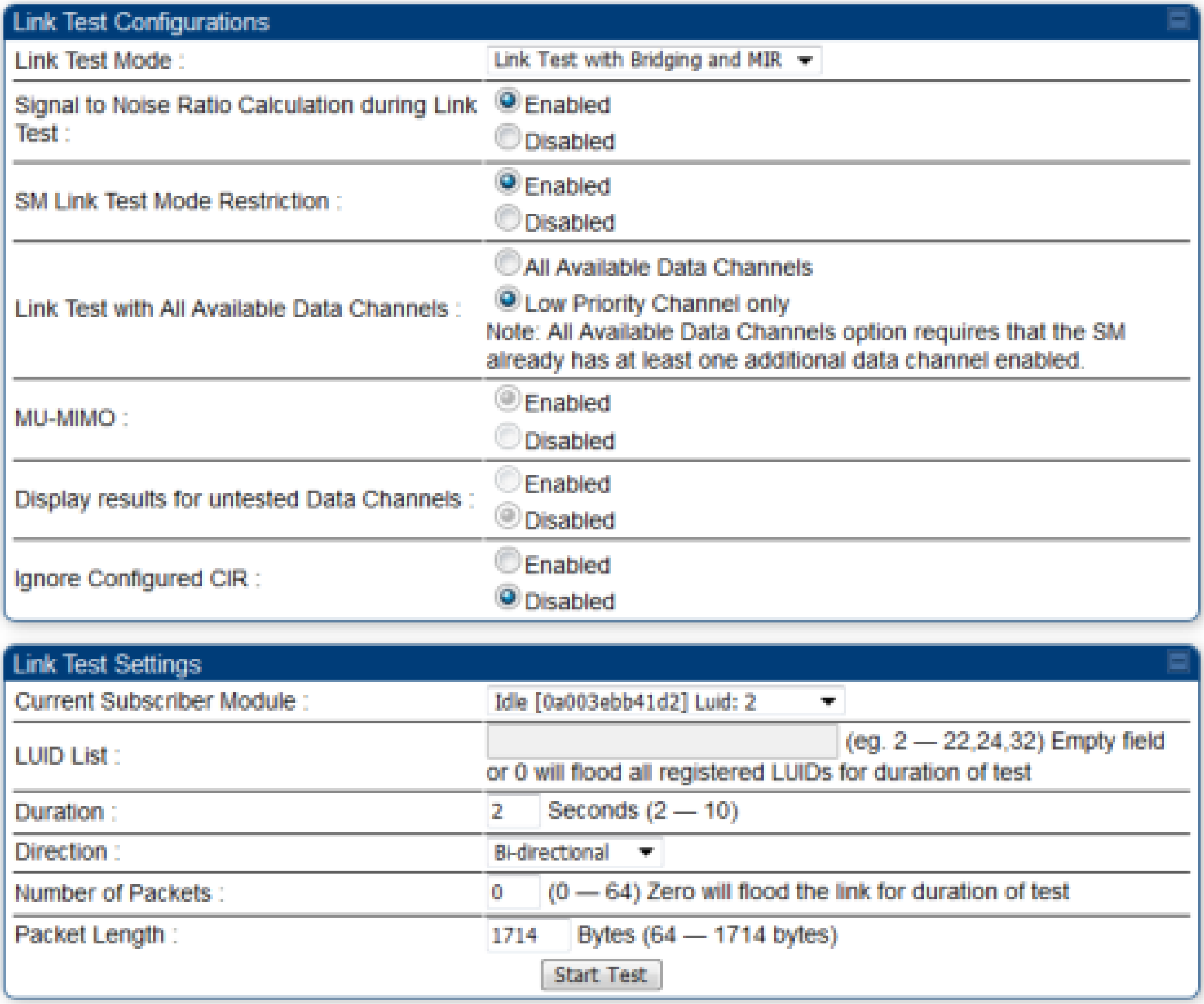
1	Access the Link Capacity Test tab in the Tools web page of the module.
2	Select Link Test Mode Extrapolated Link Test
3	Click the Start Test button.
4	In the Current Results Status block of this tab, view the results of the test.

Figure 100: *Extrapolated Link Test results*

Link Capacity Test page of AP

The Link Capacity Test page of AP is explained in below table.

Table 101: Link Capacity Test page attributes – 450m AP



Attribute	Meaning
Link Test Mode	Select Link Test Mode from drop-down menu: • Link Test with Multiple LUIDs (PMP 450m Series AP only) • Link Test without Bridging • Link Test with Bridging • Link Test with Bridging and MIR • Extrapolated Link Test

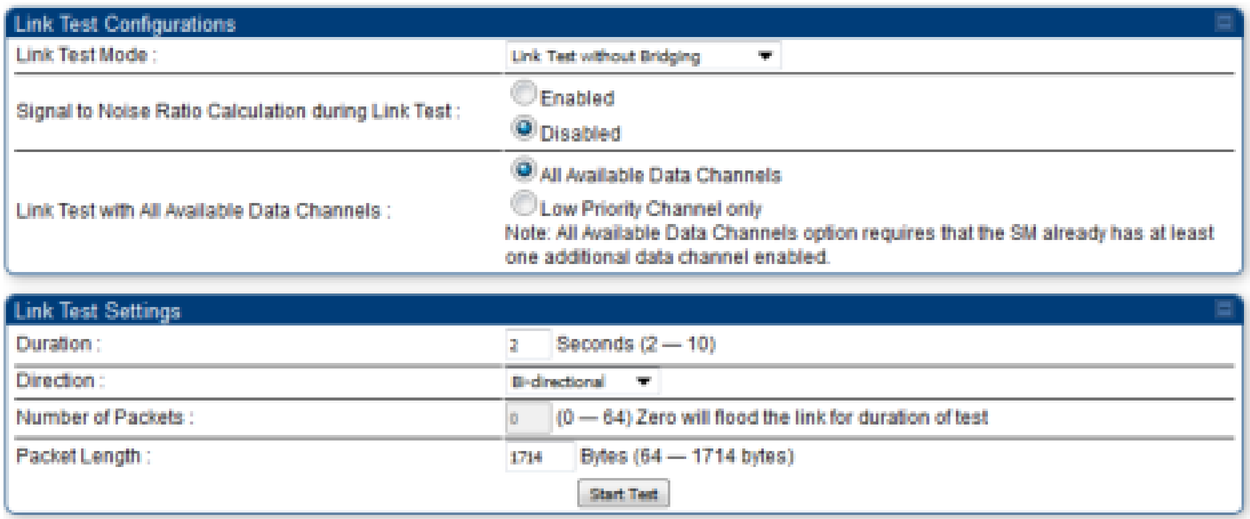
Attribute	Meaning
Signal to Noise Ratio Calculation during Link Test	Enable this attribute to display Signal-to-Noise information for the downlink and uplink when running the link test.
SM Link Test Mode Restriction	Enable this parameter to restrict SM link test mode.
Link Test with All Available Data Channels	This parameter is used to enable or disable usage of either all available data channels or low priority data channel only during the link test.
MU-MIMO	This parameter determines whether the DL flood test packets use MU-MIMO grouping or not. Note: This field is applicable only when the “Link Test Mode” field is set to “Link Test with Multiple LUIDs” option. Note: This field is applicable for PMP 450m APs only.
Display results for untested Data Channels	If “Link test with multiple VC’s” is run and a subset of registered VC’s enters into the VC List field, then enabling this field produces a table that displays results for VC’s with traffic which are in session; but not tested as part of the link test. Note: This field is applicable for PMP 450m flood tests only.
Ignore Configured CIR	Enable this parameter to schedule flood data regardless of the CIR configuration for each SM. For system release 16.1 and beyond, the exact impact of this setting depends on which scheduler "mode" has been configured by the operator on the AP's QoS page. Enabled: ‘Run Link Test with Multiple LUID's using Legacy scheduler, ignoring configured CIR's. Legacy scheduler is used here regardless of which scheduling mode has been configured. Disabled: If Legacy scheduler is enabled, test with legacy scheduler, using configured CIR's. If Proportional scheduler is enabled, test with proportional scheduler.
Current Subscriber Module	The SM with which the Link Capacity Test is run. This field is only applicable for AP (not SM page).
LUID List	This field is displayed for PMP 450m Series AP. It is only applicable for “Link Test with Multiple LUIDs” Test mode. Enter LUID List (e.g. 18 or above for low priority LUIDs and 255 or above for high priority LUIDs or 0 for all registered LUIDs) which needs to be used for link test traffic.
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.

Attribute	Meaning
Direction	Configure the direction of the link test. Specify Downlink or Uplink to run the test only in the corresponding direction only. Specific Bi-Directional to run the test in both directions.
Number of Packets	The total number of packets to be sent during the Link Capacity Test. When Link Test Mode is set to Link Test Without Bridging this field is not configurable.
Packet Length	The size of the packets in Bytes to send during the Link Capacity Test

Link Capacity Test page of BHM/BHS/SM

The Link Capacity Test page of BHM/BHS is explained in below table.

Figure 101: *Link Capacity Test page attributes – BHM/BHS*



Attribute	Meaning
Link Test Mode	See Link Capacity Test page attributes – 450m AP
Signal to Noise Ratio Calculation during Link Test	
Link Test with All Available Data Channels	
Duration	
Direction	
Number of Packets	
Packet Length	

Using AP Evaluation tool

The AP Evaluation tab on Tools web page of the SM provides information about the AP that the SM sees.

Note

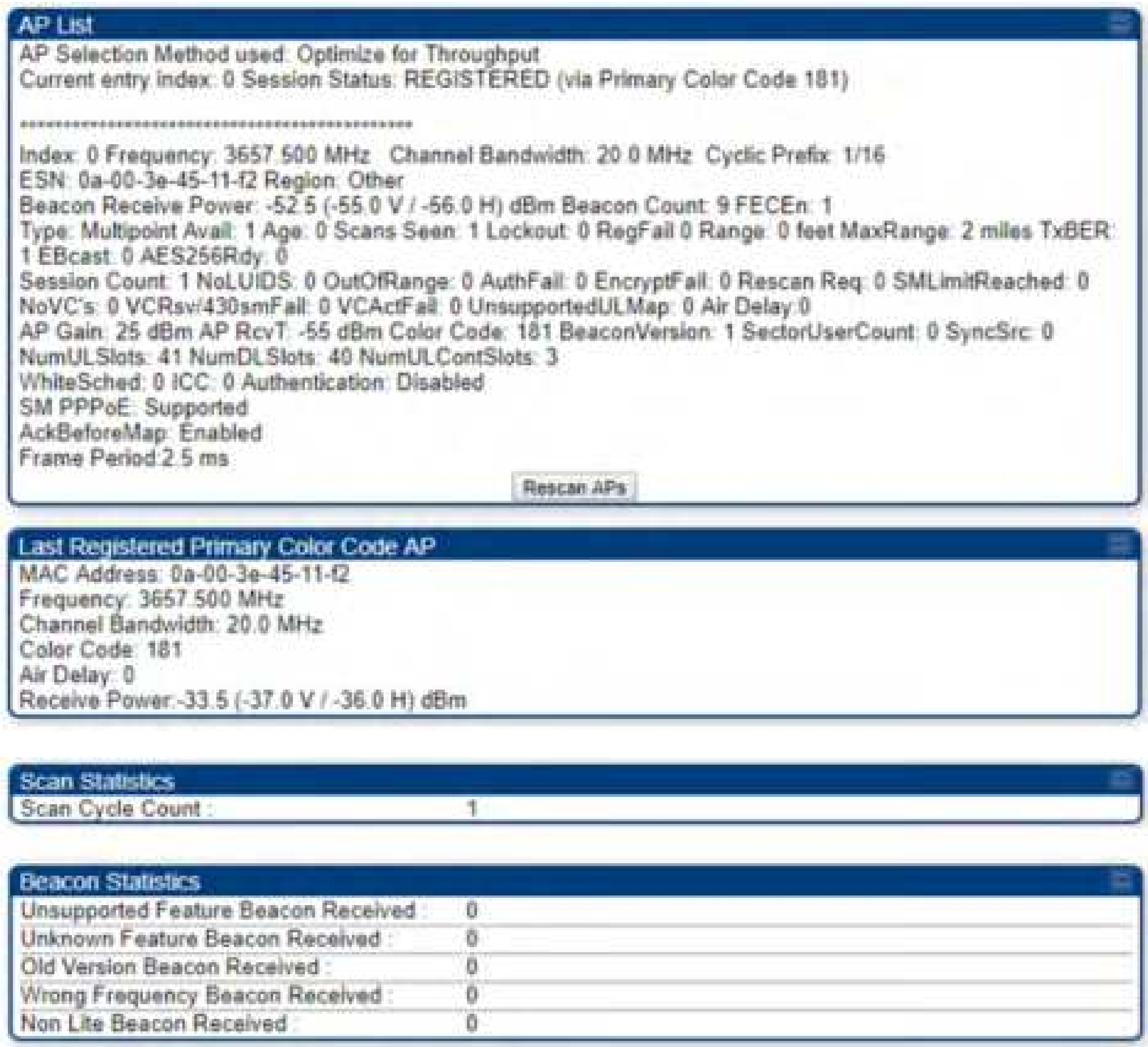
The data for this page may be suppressed by the SM Display of AP Evaluation Data setting in the Configuration > Security tab of the AP.

The AP Eval results can be accessed via SNMP and config file.

AP Evaluation page

The AP Evaluation page of AP is explained in below table.

Table 102: AP Evaluation tab attributes



Attribute	Meaning
Index	This field displays the index value that the system assigns (for only this page) to the AP where this SM is registered.

Attribute	Meaning
Frequency	This field displays the frequency that the AP transmits.
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.
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 prefixes mean that for every 16 bits of throughput data transmitted, an additional bit is used. The Cyclic Prefix 1/16 only can be selected at this time.
ESN	This field displays the MAC address (electronic serial number) of the AP. For operator convenience during SM aiming, this tab retains each detected ESN for up to 15 minutes. If the broadcast frequency of a detected AP changes during a 15-minute interval in the aiming operation, then a multiple instance of the same ESN is possible in the list. Eventually, the earlier instance expires and disappears and the later instance remains to the end of its interval, but you can ignore the early instance(s) whenever two or more are present.
Region	This field displays the AP's configured Country Code setting.
Power Level	This field displays the SM's combined received power level from the AP's transmission.
Beacon Count	A count of the beacons seen in a given time period.
FECEn	This field contains the SNMP value from the AP that indicates whether the Forward Error Correction feature is enabled. 0: FEC is disabled 1: FEC is enabled
Type	Multipoint indicates that the listing is for an AP.
Age	This is a counter for the number of minutes that the AP has been inactive. At 15 minutes of inactivity for the AP, this field is removed from the AP Evaluation tab in the SM.
Lockout	This field displays how many times the SM has been temporarily locked out of making registration attempts.
RegFail	This field displays how many registration attempts by this SM failed.
Range	This field displays the distance in feet for this link. To derive the distance in meters, multiply the value of this parameter by 0.3048.
MaxRange	This field indicates the configured value for the AP's Max Range parameter.
TxBER	A 1 in this field indicates the AP is sending Radio BER.
Ebcast	A 1 in this field indicates the AP or BHM is encrypting broadcast packets. A 0 indicates it is not.

Attribute	Meaning
Session Count	This field displays how many sessions the SM (or BHS) has had with the AP (or 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. In the case of a multipoint link, if the number of sessions is significantly greater than the number for other SMs, then this may indicate a link problem or an interference problem.
NoLUIDs	This field indicates how many times the AP has needed to reject a registration request from a SM because its capacity to make LUID assignments is full. This then locks the SM out of making any valid attempt for the next 15 minutes. It is extremely unlikely that a non-zero number would be displayed here.
OutOfRange	This field indicates how many times the AP has rejected a registration request from a SM because the SM is a further distance away than the range that is currently configured in the AP. This then locks the SM out of making any valid attempt for the next 15 minutes.
AuthFail	This field displays how many times authentication attempts from this SM have failed in the AP.
EncryptFail	This field displays how many times an encryption mismatch has occurred between the SM and the AP.
Rescan Req	This field displays how many times a re-range request has occurred for the BHM that is being evaluated in the AP Eval page of a BHS.
SMLimitReached	This field displays 0 if additional SMs may be registered to the AP. If a 1 is displayed, the AP will not accept additional SM registrations.
NoVC's	This counter is incremented when the SM is registering to an AP which determines that no VC resources are available for allocation. This could be a primary data channel (a low priority data channel) or one of the other possible data channel priorities (a Medium priority data channel, or High priority data channel, or Ultra High priority data channel)
VCRsvFail	This counter is incremented when the SM is registering to an AP which has a VC resource available for allocation but cannot reserve the resource for allocation.
VCActFail	This counter is incremented when the SM is registering to an AP which has a VC resource available for allocation and has reserved the VC, but cannot activate the resource for allocation.
AP Gain	This field displays the total external gain (antenna) used by the AP.
RcvT	This field displays the AP's configured receive target for receiving SM transmissions (this field affects automatic SM power adjust).
Sector ID	This field displays the value of the Sector ID field that is provisioned for the AP.
Color Code	This field displays a value from 0 to 254 indicating the AP's configured color code. For registration to occur, the color code of the SM and the AP must match. Color code is not a security feature. Instead, color code is a management feature, typically for assigning each sector a different color code.

Attribute	Meaning
	Color code allows you to force a SM to register to only a specific AP, even where the SM can communicate with multiple APs. The default setting for the color code value is 0. This value matches only the color code of 0 (not all 255 color codes).
BeaconVersion	This field indicates that the beacon is OFDM (value of 1).
Sector User Count	This field displays how many SMs are registered on the AP.
NumULHalfSlots	This is the number of uplink slots in the frame for this AP.
NumDLHalfSlots	This is the number of downlink slots in the frame for this.
NumULContSlots	This field displays how many Contention Slots are being used in the uplink portion of the frame.
WhiteSched	Flag to display if schedule whitening is supported via FPGA
ICC	This field lists the SMs that have registered to the AP with their Installation Color Code (ICC), Primary CC, Secondary CC or Tertiary CC.
SM PPPoE	This filed provides information to the user whether the SM is supporting PPPoE or not.
Frame Period	This field displays the configured Frame Period of the radio.
Last Registered Primary Color Code AP	
MAC Address	This field displays the last registered AP's MAC address.
Frequency	This field displays the last registered AP's frequency.
Channel Bandwidth	This field displays the last registered AP's channel bandwidth.
Color Code	This field displays the last registered AP's color code.
Air Delay	This field displays the last registered AP's air delay.
Receive Power	This field displays the last registered AP's receive power.
Scan Statitistics	
Scan Cycle Count	The file displays the number of scan cycles. This increments after the SM completes scanning every configured frequency and channel bandwidth.
Beacon Statistics	
Unsupported Feature Beacon Received	Count of beacons that the SM has received that is from a beacon that it does not support, which will prevent registration. If encounter this, upgrade your SM to the latest supported software version.
Unknown Feature Beacon Received	Count of beacons that the SM has received that is from a beacon that is running a feature that is unknown, which will prevent registration. If this stat is encountered, upgrade your SM to the latest supported software version.
Old Version Beacon Received	Count of the beacons where the version in the beacon mismatched and prevented registration.

Attribute	Meaning
Wrong Frequency Beacon Received	Count of beacons that was reported on a different frequency than was received.

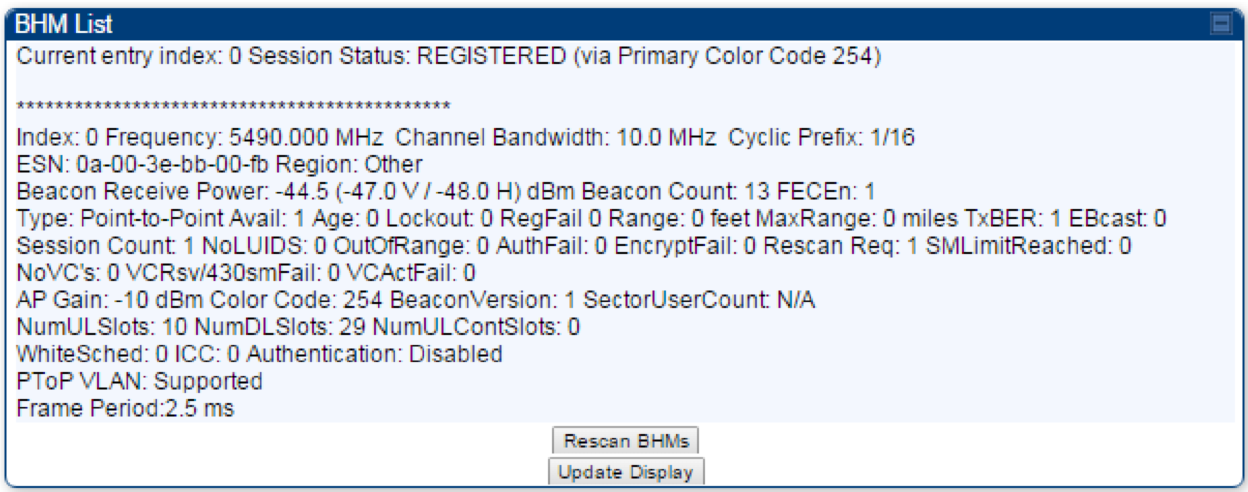
Using BHM Evaluation tool

The BHM Evaluation tab on Tools web page of the BHS provides information about the BHM that the BHS sees.

BHM Evaluation page of BHS

The BHM Evaluation page of BHS is explained in below figure.

Figure 102: *BHM Evaluation tab attributes - BHS*



Attribute	Meaning
Index	This field displays the index value that the system assigns (for only this page) to the BHM where this BHS is registered.
Frequency	This field displays the frequency that the BHM transmits.
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 prefixes mean that for every 16 bits of throughput data transmitted, an additional bit is used.

Attribute	Meaning
ESN	This field displays the MAC address (electronic serial number) of the BHM. For operator convenience during BHS aiming, this tab retains each detected ESN for up to 15 minutes. If the broadcast frequency of a detected BHM changes during a 15-minute interval in the aiming operation, then a multiple instance of the same ESN is possible in the list. Eventually, the earlier instance expires and disappears and the later instance remains to the end of its interval, but you can ignore the early instance(s) whenever two or more are present.
Region	This field displays the BHM's configured Country Code setting.
Power Level	This field displays the BHS's combined received power level from the BHM's transmission.
Beacon Count	A count of the beacons seen in a given time period.
FECEn	This field contains the SNMP value from the BHM that indicates whether the Forward Error Correction feature is enabled. 0: FEC is disabled 1: FEC is enabled
Type	Multipoint indicates that the listing is for a BHM.
Age	This is a counter for the number of minutes that the BHM has been inactive. At 15 minutes of inactivity for the BHS, this field is removed from the BHM Evaluation tab in the BHS.
Lockout	This field displays how many times the BHS has been temporarily locked out of making registration attempts.
RegFail	This field displays how many registration attempts by this BHS failed.
Range	This field displays the distance in feet for this link. To derive the distance in meters, multiply the value of this parameter by 0.3048.
MaxRange	This field indicates the configured value for the AP's Max Range parameter.
TxBER	A 1 in this field indicates the BHM is sending Radio BER.
Ebcast	A 1 in this field indicates the BHM is encrypting broadcast packets. A 0 indicates it is not.
Session Count	This field displays how many sessions the BHS has had with the 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. In the case of a multipoint link, if the number of sessions is significantly greater than the number for other BHS's, then this may indicate a link problem or an interference problem.
NoLUIDs	This field indicates how many times the BHM has needed to reject a registration request from a BHS because its capacity to make LUID assignments is full. This then locks the BHS out of making any valid attempt for the next 15 minutes. It is extremely unlikely that a non-zero number would be displayed here.

Attribute	Meaning
OutOfRange	This field indicates how many times the BHM has rejected a registration request from a BHS because the BHS is a further distance away than the range that is currently configured in the BHM. This then locks the BHS out of making any valid attempt for the next 15 minutes.
AuthFail	This field displays how many times authentication attempts from this SM have failed in the BHM.
EncryptFail	This field displays how many times an encryption mismatch has occurred between the BHS and the BHM.
Rescan Req	This field displays how many times a re-range request has occurred for the BHM that is being evaluated in the BHM Eval page of a BHM.
SMLimitReached	This field displays 0 if additional BHSs may be registered to the BHM. If a 1 is displayed, the BHM will not accept additional BHS registrations.
NoVC's	This counter is incremented when the BHS is registering to a BHM which determines that no data channel resources are available for allocation. This could be a primary data channel (a low priority data channel) or one of the other possible data channel priorities (a Medium priority data channel, or High priority data channel, or Ultra High priority data channel)
VCRsvFail	This counter is incremented when the BHS is registering to a BHM which has a VC resource available for allocation but cannot reserve the resource for allocation.
VCActFail	This counter is incremented when the BHS is registering to a BHM which has a VC resource available for allocation and has reserved the VC, but cannot activate the resource for allocation.
AP Gain	This field displays the total external gain (antenna) used by the BHM.
RcvT	This field displays the AP's configured receive target for receiving BHS transmissions (this field affects automatic BHS power adjust).
Sector ID	This field displays the value of the Sector ID field that is provisioned for the BHM.
Color Code	This field displays a value from 0 to 254 indicating the BHM's configured color code. For registration to occur, the color code of the BHS and the BHM must match. Color code is not a security feature. Instead, color code is a management feature, typically for assigning each sector a different color code. Color code allows you to force a BHS to register to only a specific BHM, even where the BHS can communicate with multiple BHMs. The default setting for the color code value is 0. This value matches only the color code of 0 (not all 255 color codes).
BeaconVersion	This field indicates that the beacon is OFDM (value of 1).
Sector User Count	This field displays how many BHS's are registered on the BHM.
NumULHalfSlots	This is the number of uplink slots in the frame for this BHM.
NumDLHalfSlots	This is the number of downlink slots in the frame for this.

Attribute	Meaning
NumULContSlots	This field displays how many Contention Slots are being used in the uplink portion of the frame.
WhiteSched	Flag to display if schedule whitening is supported via FPGA
ICC	This field lists the BHSs that have registered to the BHM with their Installation Color Code (ICC), Primary CC, Secondary CC or Tertiary CC.
SM PPPoE	This filed provides information to the user whether the BHS is supporting PPPoE or not.
Frame Period	This field displays the configured Frame Period of the radio.

Using the OFDM Frame Calculator tool

The first step to avoid interference in wireless systems is to set all APs/BHMs to receive timing from a synchronization source (Cluster Management Module, or Universal Global Positioning System). This ensures that the modules are in sync and start transmitting at the same time each frame.

The second step to avoid interference is to configure parameters on all APs/BHMs of the same frequency band in proximity such that they have compatible transmit/receive ratios (all stop transmitting each frame before any start receiving). This avoids the problem of one AP/BHM attempting to receive the signal from a distant SM/BHS while a nearby AP transmits, which could overpower that signal.

The following parameters on the AP determine the transmit/receive ratio:

- Max Range
- Frame Period
- Downlink Data percentage
- (reserved) Contention Slots

If OFDM (PMP 430, PMP 450, PTP 230) and FSK (PMP 1x0) APs/BHMs of the same frequency band are in proximity, or if APs/BHMs set to different parameters (differing in their Max Range values, for example), then operator must use the Frame Calculator to identify compatible settings.

The frame calculator is available on the Frame Calculator tab of the Tools web page. To use the Frame Calculator, type various configurable parameter values into the calculator for each proximal AP and then record the resulting AP/BHM Receive Start value. Next vary the Downlink Data percentage in each calculation and iterate until the calculated AP/BHM Receive Start for all collocated AP/BHMs where the transmit end does not come before the receive start.

The calculator does not use values in the module or populate its parameters. It is merely a convenience application that runs on a module. For this reason, you can use any FSK module (AP, SM, BHM, BHS) to perform FSK frame calculations for setting the parameters on an FSK AP and any OFDM module (AP, SM, BHM, BHS) to perform OFDM frame calculations for setting the parameters on an OFDM AP/BHM.

For more information on PMP/PTP 450 Platform co-location, see

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

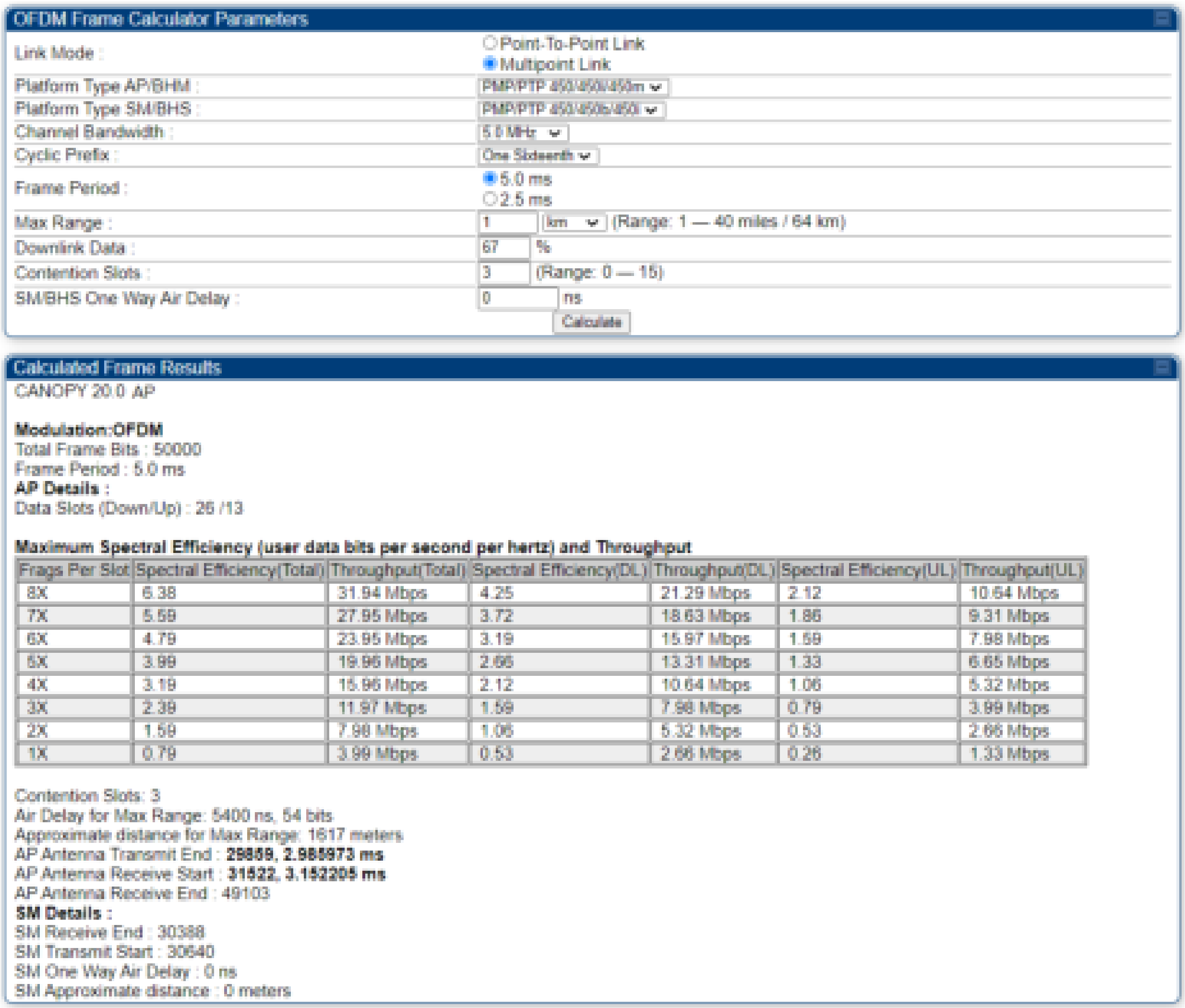
The co-location is also supported for 900 MHz PMP 450i APs (OFDM) and PMP 100 APs (FSK). Please refer Co-location of PMP 450 and PMP 100 systems in the 900 MHz band and migration recommendations document for details.

Caution

APs/BHMs that have slightly mismatched transmit-to-receive ratios and low levels of data traffic may see little effect on throughput. A system that was not tuned for co-location may work fine at low traffic levels, but encounter problems at higher traffic levels. The conservative practice is to tune for co-location before traffic ultimately increases. This prevents problems that occur as sectors are built.

The OFDM Frame Calculator page is explained in below table.

Table 103: OFDM Frame Calculator page attributes



Attribute	Meaning
Link Mode	For AP to SM frame calculations, select Multipoint Link For BHM to BHS frame calculations, select Point-To-Point Link
Platform Type AP/BHM	Use the drop-down list to select the hardware series (board type) of the AP/BHM.
Platform Type SM/BHS	Use the drop-down list to select the hardware series (board type) of the SM/BHS.
Channel Bandwidth	Set this to the channel bandwidth used in the AP/BHM.

Attribute	Meaning
Cyclic Prefix	Set this to the cyclic prefix used in the AP/BHM.
Max Range	Set to the same value as the Max Range parameter is set in the AP(s) or BHM(s).
Frame Period	Set to the same value as the Frame Period parameter is set in the AP(s) or BHM(s).
Downlink Data	Initially set this parameter to the same value that the AP/BHM has for its Downlink Data parameter (percentage). Then, use the Frame Calculator tool procedure as described inProcedure 26 Using the Frame Calculator , you will vary the value in this parameter to find the proper value to write into the Downlink Data parameter of all APs or BHMs in the cluster. PMP 450 Platform Family APs or BHMs offer a range of 15% to 85% and default to 75%. The value that you set in this parameter has the following interaction with the value of the Max Range parameter (above): The default Max Range value is 5 miles and, at that distance, the maximum Downlink Data value (85% in PMP 450 Platform) is functional.
Contention Slots	This field indicates the number of (reserved) Contention Slots configured by the operator. Set this parameter to the value of the Contention Slot parameter is set in the APs or BHMs.
SM/BHS One Way Air Delay	This field displays the time in ns (nano seconds), that a SM/BHS is away from the AP/BHM.

The Calculated Frame Results display several items of interest:

Table 104: OFDM Calculated Frame Results attributes

Attribute	Meaning
Modulation	The type of radio modulation used in the calculation (OFDM for 450 Platform Family)
Total Frame Bits	The total number of bits used in the calculated frames
Data Slots (Down/Up)	This field is based on the Downlink Data setting. For example, a result within the typical range for a Downlink Data setting of 75% is 61/21, meaning 61 data slots down and 21 data slots up.
Contention Slots	This field indicates the number of (reserved) Contention Slots configured by the operator.
Air Delay for Max Range	This is the roundtrip air delay in bit times for the Max Range value set in the calculator
Approximate distance for Max Range	The Max Range value used for frame calculation
AP Transmit End	In bit times, this is the frame position at which the AP/BHM ceases transmission.
AP Receive Start	In bit times, this is the frame position at which the AP/BHM is ready to receive transmission from the SM/BHS.
AP Receive End	In bit times, this is the frame position at which the AP/BHM will cease receiving transmission from the SM/BHS.
SM Receive End	In bit times, this is the frame position at which the SM/BHS will cease receiving transmission from the AP/BHM.
SM Transmit Start	In bit times, this is the frame position at which the SM/BHS starts the transmission.
SM One Way Air Delay	This filed displays the time in ns, that SM/BHS is away from the AP/BHM.
SM Approximate distance	This field displays an approximate distance in miles (feet) that the SM/BHS is away from the AP/BHM.

To use the Frame Calculator to ensure that all APs or BHMs are configured to transmit and receive at the same time, follow the procedure below:

Procedure 26 Using the Frame Calculator

1	Populate the OFDM Frame Calculator parameters with appropriate values as described above.
2	Click the Calculate button.
3	Scroll down the tab to the Calculated Frame Results section
4	Record the value of the AP Receive Start field

5	Enter a parameter set from another AP in the system – for example, an AP in the same cluster that has a higher Max Range value configured.
6	Click the Calculate button.
7	Scroll down the tab to the Calculated Frame Results section
8	If the recorded values of the AP Receive Start fields are within 150 bit times of each other, skip to step 10.
9	If the recorded values of the AP Receive Start fields are not within 150 bit times of each other, modify the Downlink Data parameter until the calculated results for AP Receive Start are within 300 bit time of each other, if possible, 150 bit time.
10	Access the Radio tab in the Configuration web page of each AP in the cluster and change its Downlink Data parameter (percentage) to the last value that was used in the Frame Calculator.

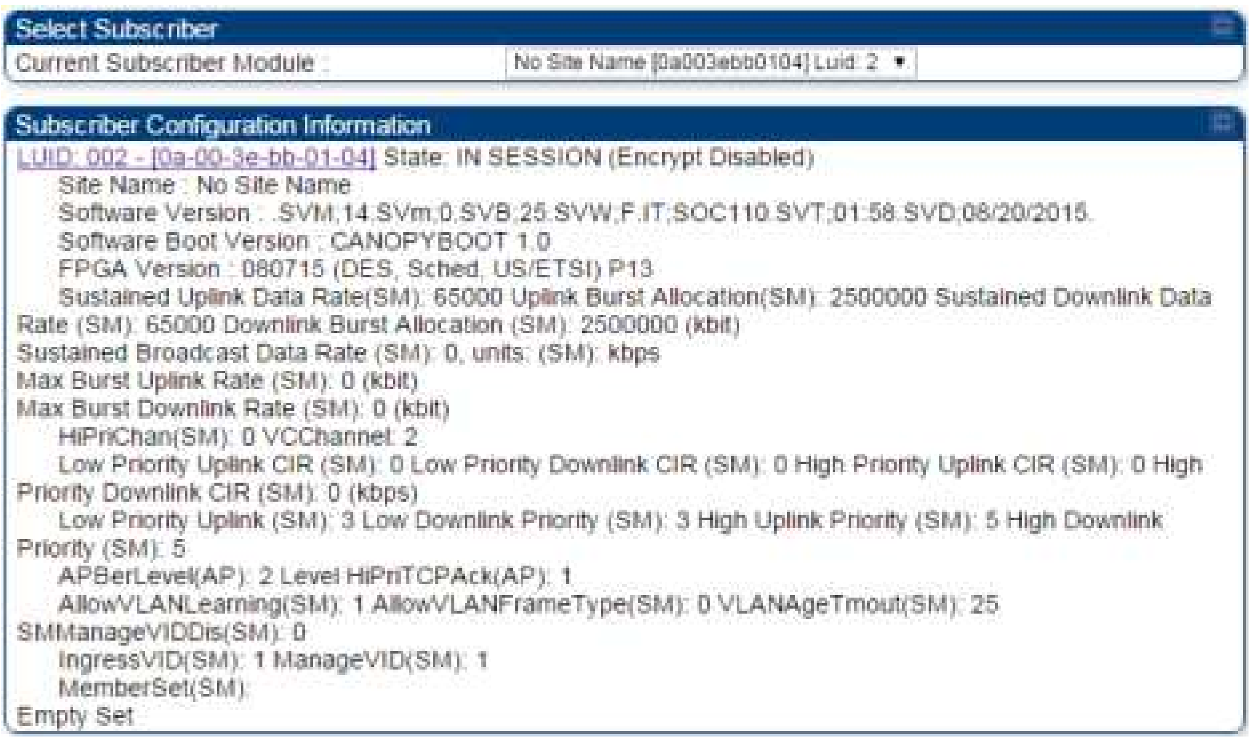
Using the Subscriber Configuration tool

The Subscriber Configuration page in the Tools page of the AP displays:

- The current values whose control may be subject to the setting in the Configuration Source parameter.
- An indicator of the source for each value.

This page may be referenced for information on how the link is behaving based on where the SM is retrieving certain QoS and VLAN parameters.

Figure 103: *SM Configuration page of AP*



The AP displays one of the following for the configuration source:

- (SM) – QoS/VLAN parameters are derived from the SM’s settings
- (APCAP) – QoS/VLAN parameters are derived from the AP’s settings, including any keyed capping (for radios capped at 4 Mbps, 10 Mbps, or 20 Mbps)
- (D) – QoS/VLAN parameters are retrieved from the device, due to failed retrieval from the AAA or WM server.
- (AAA) – QoS/VLAN parameters are retrieved from the RADIUS server
- (BAM) – QoS/VLAN parameters are retrieved from a WM BAM server

Using the Link Status tool

The Link Status Tool displays information about the most-recent Link Test initiated on the SM or BHS. Link Tests initiated from the AP or BHM are not included in the Link Status table. This table is useful for monitoring link test results for all SMs or BHS in the system.

The Link Status table is color coded to display health of link between AP/BHM and SM/BHS. The current Modulation Level Uplink/Downlink is chosen to determine link health and color coded accordingly.

Uplink/Downlink Rate Column will be color coded using current Rate as per the table below:

Table 105: Color code versus uplink/downlink rate column

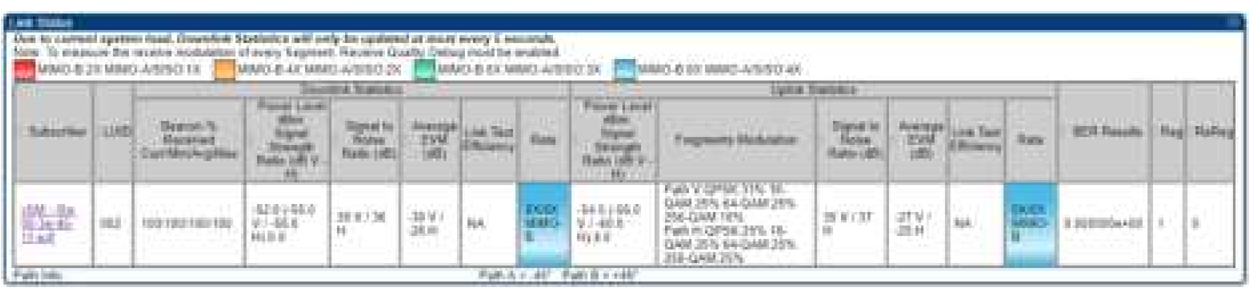
Actual Rate	1x	2x	3x	4x	5x	6x	7x	8x
MIMO-A	Red	Orange	Green	Blue	NA	NA	NA	NA
MIMO B	Red	Red	Orange	Orange	Green	Green	Blue	Blue

Link Status – AP/BHM

The current Uplink Rate for each SM or BHS in Session in now available on AP or BHM Link Status Page. From Release 15.2, a single Rate is used and shown for all data channels of an SM.

The Link Status tool results include values for the following fields for AP/BHM.

Table 106: Link Status page attributes – AP/BHM



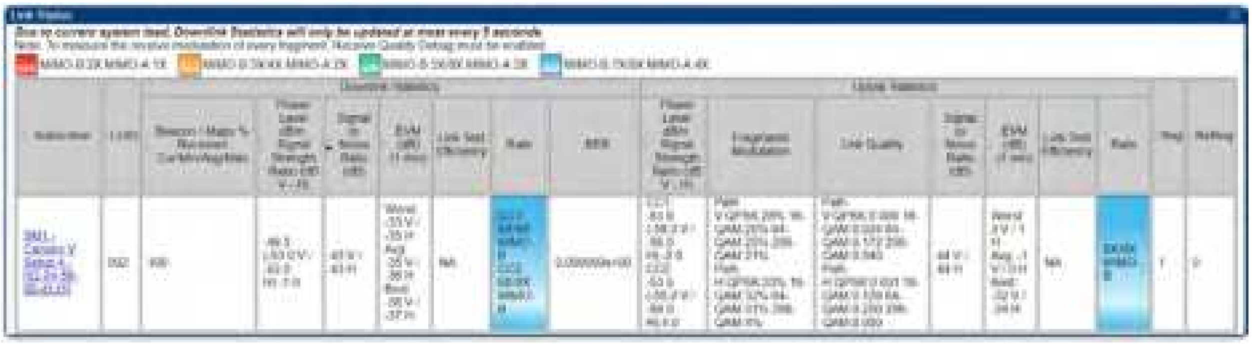
Attribute	Meaning
Subscriber	This field displays the MAC address and Site Name of the SM.

Attribute	Meaning
	Note The MAC is hot link to open the interface to the SM. In some instances, depending on network activity and network design, this route to the interface yields a blank web page. If this occurs, refresh your browser view. Site Name indicates the name of the SM. You can assign or change this name on the Configuration web page of the SM. This information is also set into the sysName SNMP MIB-II object and can be polled by an SNMP management server.
LUID	This field displays the LUID (logical unit ID) of the SM/BHS. As each SM or BHS registers to the AP/BHM, the system assigns an LUID of 2 or a higher unique number to the SM/BHS. If a SM/BHS loses registration with the AP/BHS and then regains registration, the SM/BHS will retain the same LUID. **Note** Both the LUID and the MAC are hot links to open the interface to the SM/BHS. In some instances, depending on network activity and network design, this route to the interface yields a blank web page. If this occurs, refresh your browser view.
Downlink Statistics - Beacon/Maps % Received Curr/Min/Max/Avg	This field displays a count of beacons and maps received by the SM in percentage. SMs operating on System Release 20.2.1 or later will send the the lower of the map and beacon percentages and that will be displayed in this field. SMs operating on System Release 20.2 or earlier will always send only the beacon percentage. This stat is recommended to be between 99-100%. If it is lower than 99%, it indicates a problematic link as beacons and maps are sent in the lowest modulation 1X MIMO-A. This statistic is updated every 15 seconds.
Downlink Statistics – Power Level: Signal Strength Ratio	This field represents the received power level at the SM/BHS as well as the ratio of horizontal path signal strength to vertical path signal strength at the SM/BHS.
Downlink Statistics – Signal to Noise Ratio	This field represents the signal to noise ratio for the downlink (displayed when parameter Signal to Noise Ratio Calculation during Link Test is enabled) expressed for both the horizontal and vertical channels.
Downlink Statistics – Average EVM (dB)	This field displays the average EVM statistics that measures RF signal quality.
Downlink Statistics – Link Test Efficiency	This field displays the efficiency of the radio link, expressed as a percentage, for the radio downlink.
Downlink Statistics – SU-MIMO Rate	The SU-MIMO rate applies to all AP platforms. For 450m, this field indicates the rate being used for symbols where this particular VC is not being MU-MIMO grouped with other SMs. For 450 and 450i platforms, there is no grouping and this field indicates the modulation rate for all symbols.

Attribute	Meaning
Downlink Statistics – MU-MIMO Rate	This field indicates the modulation rate used for symbols where the low or medium priority data channels are MU-MIMO scheduled by grouping it in the same slot with other low or Medium priority data channels from other SM's.
Uplink Statistics - Power Level: Signal Strength Ratio	This field represents the combined received power level at the AP/BHM as well as the ratio of horizontal path signal strength to vertical path signal strength.
Uplink Statistics – Fragments Modulation	The fragments modulation is an approximation at which modulation rate a packet was received. This stat is only for engineering debugging and is not available via SNMP and is not recommended to be used by customers. Different packets sizes can affect the reading to only show lower modulation rates. Also, unless “Receive Quality Debug” is enabled, it will just be a sampling of packets and not all the packets.
Uplink Statistics – Signal to Noise Ratio	This field represents the signal to noise ratio for the uplink (displayed when parameter Signal to Noise Ratio Calculation during Link Test is enabled) expressed for both the horizontal and vertical channels.
Uplink Statistics – Link Test Efficiency	This field displays the efficiency of the radio link, expressed as a percentage, for the radio uplink.
Uplink Statistics – SU-MIMO Rate	The SU-MIMO rate applies to all AP platforms. For 450m, this field indicates the rate being used for symbols where a VC is not being MU-MIMO grouped with other SMs. For 450 and 450i platforms, there is no grouping and this field indicates the modulation rate for all symbols.
Uplink Statistics – MU-MIMO Rate	This field indicates the modulation rate used for symbols where the low or medium priority data channels are MU-MIMO scheduled by grouping it in the same slot with other high or ultra high priority data channels from other SM's.
BER Results	This field displays the over-the-air Bit Error Rates for each downlink. (The ARQ [Automatic Resend Request] ensures that the transport BER [the BER seen end-to-end through a network] is essentially zero.) The level of acceptable over-the-air BER varies, based on operating requirements, but a reasonable value for a good link is a BER of 1e-4 (1×10^{-4}) or better, approximately a packet resend rate of 5%. BER is generated using unused bits in the downlink. During periods of peak load, BER data is not updated as often, because the system puts priority on transport rather than on BER calculation.
Reg Requests	A Reg Requests count is the number of times the SM/BHS registered after the AP/BHM determined that the link had been down. If the number of sessions is significantly greater than the number for other SMs/BHS, then this may indicate a link problem (check mounting, alignment, receive power levels) or an interference problem (conduct a spectrum scan).
ReReg Requests	A ReReg Requests count is the number of times the AP/BHM received a SM/BHS registration request while the AP/BHM considered the link to be still up (and therefore did not expect registration requests).

Attribute	Meaning
	If the number of sessions is significantly greater than the number for other SMs/BHS, then this may indicate a link problem (check mounting, alignment, receive power levels) or an interference problem (conduct a spectrum scan).

Table 107: Link Status page attributes – 450v AP



Attribute	Meaning
Subscriber	This field displays the MAC address and Site Name of the SM. **Note** The MAC is hot link to open the interface to the SM. In some instances, depending on network activity and network design, this route to the interface yields a blank web page. If this occurs, refresh your browser view. Site Name indicates the name of the SM. You can assign or change this name on the Configuration web page of the SM. This information is also set into the sysName SNMP MIB-II object and can be polled by an SNMP management server.
LUID	This field displays the LUID (logical unit ID) of the SM/BHS. As each SM or BHS registers to the AP/BHM, the system assigns an LUID of 2 or a higher unique number to the SM/BHS. If a SM/BHS loses registration with the AP/BHS and then regains registration, the SM/BHS will retain the same LUID. **Note** Both the LUID and the MAC are hot links to open the interface to the SM/BHS. In some instances, depending on network activity and network design, this route to the interface yields a blank web page. If this occurs, refresh your browser view.
Downlink Statistics - Beacon/Maps % Received Curr/Min/Max/Avg	This field displays a count of beacons and maps received by the SM in percentage. SMs operating on System Release 20.2.1 or later will send the the lower of the map and beacon percentages and that will be displayed in this field. SMs operating on System Release 20.2 or earlier will always send only the beacon percentage.

Attribute	Meaning
	This stat is recommended to be between 99-100%. If it is lower than 99%, it indicates a problematic link as beacons and maps are sent in the lowest modulation 1X MIMO-A. This statistic is updated every 15 seconds.
Downlink Statistics – Power Level dBm: Signal Strength Ratio (dBV-H)	This field represents the received power level at the SM/BHS as well as the ratio of horizontal path signal strength to vertical path signal strength at the SM/BHS.
Downlink Statistics – Signal to Noise Ratio	This field represents the signal to noise ratio for the downlink (displayed when parameter Signal to Noise Ratio Calculation during Link Test is enabled) expressed for both the horizontal and vertical channels.
Downlink Statistics – EVM (dB) (1 min)	This field displays the average EVM statistics that measures RF signal quality.
Downlink Statistics – Link Test Efficiency	This field displays the efficiency of the radio link, expressed as a percentage, for the radio downlink.
Downlink Statistics – Rate	This field displays the data rate of the downlink transmission, indicating the speed at which data is transferred from the access point to the subscriber module.
Downlink Statistics – BER	This field displays the over-the-air Bit Error Rates for each downlink. (The ARQ [Automatic Resend Request] ensures that the transport BER [the BER seen end-to-end through a network] is essentially zero.) The level of acceptable over-the-air BER varies, based on operating requirements, but a reasonable value for a good link is a BER of 1e-4 (1×10^{-4}) or better, approximately a packet resend rate of 5%. BER is generated using unused bits in the downlink. During periods of peak load, BER data is not updated as often, because the system puts priority on transport rather than on BER calculation.
Uplink Statistics – Power Level dBm: Signal Strength Ratio (dBV-H)	This field represents the combined received power level at the AP/BHM as well as the ratio of horizontal path signal strength to vertical path signal strength.
Uplink Statistics – Fragments Modulation	The fragments modulation is an approximation at which modulation rate a packet was received. This stat is only for engineering debugging and is not available via SNMP and is not recommended to be used by customers. Different packets sizes can affect the reading to only show lower modulation rates. Also, unless “Receive Quality Debug” is enabled, it will just be a sampling of packets and not all the packets.
Uplink Statistics – Link Quality	This field represents the quality of the uplink connection, indicating the reliability and stability of the wireless link from the subscriber module to the access point.
Uplink Statistics – Signal to Noise Ratio	This field represents the signal to noise ratio for the uplink (displayed when parameter Signal to Noise Ratio Calculation during Link Test is enabled) expressed for both the horizontal and vertical channels.

Attribute	Meaning
Uplink Statistics – EVM (dB) (1 min)	This field displays the average Error Vector Magnitude (EVM) statistics for the uplink transmission over a one-minute interval, indicating the accuracy of the transmitted signal.
Uplink Statistics – Link Test Efficiency	This field displays the efficiency of the radio link, expressed as a percentage, for the radio uplink.
Uplink Statistics – Rate	This field indicates the modulation rate used for symbols where the low or medium priority data channels are MU-MIMO scheduled by grouping it in the same slot with other high or ultra high priority data channels from other SM's.
Reg	A Reg Requests count is the number of times the SM/BHS registered after the AP/BHM determined that the link had been down. If the number of sessions is significantly greater than the number for other SMs/BHS, then this may indicate a link problem (check mounting, alignment, receive power levels) or an interference problem (conduct a spectrum scan).
ReReg	A ReReg Requests count is the number of times the AP/BHM received a SM/BHS registration request while the AP/BHM considered the link to be still up (and therefore did not expect registration requests). If the number of sessions is significantly greater than the number for other SMs/BHS, then this may indicate a link problem (check mounting, alignment, receive power levels) or an interference problem (conduct a spectrum scan).

Link Status – SM/BHS

The Link Status tool of SM/BHS displays Downlink Status and Uplink Status information.

Table 108: Link Status page attributes – SM/BHS

Attribute	Meaning
Downlink Status	
Receive Power	This field lists the current combined receive power level, in dBm.
Path Info	
Signal Strength Ratio	This field displays the difference of the Vertical path received signal power to the Horizontal path received signal power for downlink.
Signal to Noise Ratio	This field lists the current signal-to-noise level, an indication of the separation of the received power level vs. noise floor for downlink.
EVM	This field displays the average EVM statistics that measures RF signal quality.
Beacons/Maps	Displays a count of beacons received by the SM in percentage. This value must be typically between 99-100%. If lower than 99%, it indicates a problematic link. This statistic is updated every 16 seconds.
Received Fragments Modulation	This field represents the percentage of fragments received at each modulation state, per path (polarization)

Attribute	Meaning
Latest Remote Link Test Efficiency Percentage	This field is not applicable.
BER Total Avg Results	This field displays the over-the-air average Bit Error Rates (BER) for downlink.
Beacons Received Last 15 minutes	The beacon count on the SM can be used to estimate the interference in the channel. The min/avg/max beacon percentage displayed based on this value for the last 15 mins.
Uplink Status	
Transmit Power	This field displays the current combined transmit power level, in dBm.
Max Transmit Power	This field displays the maximum transmit power of SM.
Power Level	This field indicates the combined power level at which the SM is set to transmit, based on the Country Code and Antenna Gain settings.
Signal Strength Ratio	This field displays the difference of the Vertical path received signal power to the Horizontal path received signal power for uplink.
Signal to Noise Ratio	This field lists the current signal-to-noise level, an indication of the separation of the received power level vs. noise floor for uplink.
Average EVM	This field displays the average EVM statistics that measures RF signal quality.
Latest Remote Link Test Efficiency Percentage	This field is not applicable.
Local Stats	
Session Status	This field displays the current state, Virtual channel, channel rate adaptation and MIMO-A/MIMO-B/SISO status of SM.
Spatial Frequency	This filed displays the spatial frequency value of the VC or SM.
Run Link Test	Run Link Test See Exploratory Test section of Performing Extrapolated Link Test
Link Quality Indicator	
LQI	This field displays the quality of the link used for data communication between AP and SM. This value is derived by calculating: Downlink LQI value * Uplink LQI value * Re-Registration Quality Index value

Attribute	Meaning
Downlink LQI	This field displays the downlink quality of the link. It is the ratio of Actual Average Modulation Rate of the data packets and the expected modulation rate.
Downlink Actual Average Modulation Rate	This field displays the average value of the actual Downlink modulation rate.
Downlink Expected Modulation Rate	This field displays the expected Downlink modulation rate.
Beacon Quality Index	This field displays the Beacon Quality Index. It is calculated based on the receive beacon percentage.
Uplink LQI	This field displays the uplink quality of the link. It is the ratio of Actual Average Modulation Rate of the data packets and the expected modulation rate.
Uplink Actual Average Modulation Rate	This field displays the average value of the actual uplink modulation rate.
Uplink Expected Modulation Rate	This field displays the expected Uplink modulation rate.
Re-Registration Quality Index	This field displays the number of re-registrations of the SM. When there are no re-registrations, this quality index will be 100%.
Re-Registration Count	This field displays the re-registration count of the SM.
Reference Downlink Quality Index	Downlink reference EVM used for LQI calculations.
Reference Uplink Quality Index	Uplink reference EVM used for LQI calculations.
Access Point MAC Address	This field displays the MAC address of the AP to which this SM is registered.

Table 109: Link Status page attributes – 450v SM

Attribute	Meaning
Receive Power	This field lists the current combined receive power level, in dBm.
Receive Power Carrier 1	Displays signal strength for Carrier 1 in dBm.
Receive Power Carrier 2	Displays signal strength for Carrier 2 in dBm.
Signal Strength Ratio	This field displays the difference of the Vertical path received signal power to the Horizontal path received signal power for downlink.
Signal to Noise Ratio	This field lists the current signal-to-noise level, an indication of the separation of the received power level vs. noise floor for downlink.
EVM	This field displays the average EVM statistics that measures RF signal quality.

Attribute	Meaning
Beacons/Maps	Displays a count of beacons received by the SM in percentage. This value must be typically between 99-100%. If lower than 99%, it indicates a problematic link. This statistic is updated every 16 seconds.
Receive Fragments Modulation	This field represents the percentage of fragments received at each modulation state, per path (polarization)
Latest Remote Link Test Efficiency Percentage	This field is not applicable.
BER Total Avg Results	This field displays the over-the-air average Bit Error Rates (BER) for downlink.
Transmit Power	This field displays the current combined transmit power level, in dBm.
Max Transmit Power	This field displays the maximum transmit power of SM.
Power Level	This field indicates the combined power level at which the SM is set to transmit, based on the Country Code and Antenna Gain settings.
Signal Strength Ratio	This field displays the difference of the Vertical path received signal power to the Horizontal path received signal power for uplink.
Signal to Noise Ratio	This field lists the current signal-to-noise level, an indication of the separation of the received power level vs. noise floor for uplink.
EVM	This field displays the average EVM statistics that measures RF signal quality.
Latest Remote Link Test Efficiency Percentage	This field is not applicable.
Session Status	This field displays the current state, Virtual channel, channel rate adaptation and MIMO-A/MIMO-B/SISO status of SM.
LQI	This field displays the quality of the link used for data communication between AP and SM. This value is derived by calculating: Downlink LQI value * Uplink LQI value * Re-Registration Quality Index value
Downlink LQI	This field displays the downlink quality of the link. It is the ratio of Actual Average Modulation Rate of the data packets and the expected modulation rate.
Beacon / Map Quality Index	This field displays the Beacon Quality Index. It is calculated based on the receive beacon percentage.
Uplink LQI	This field displays the uplink quality of the link. It is the ratio of Actual Average Modulation Rate of the data packets and the expected modulation rate.
Re-Registration Quality Index	This field displays the number of re-registrations of the SM. When there are no re-registrations, this quality index will be 100%.

Attribute	Meaning
Re-Registration Count	This field displays the re-registration count of the SM.
Reference Downlink Quality Index	Downlink reference EVM used for LQI calculations.
Reference Uplink Quality Index	Uplink reference EVM used for LQI calculations.
Access Point MAC Address	This field displays the MAC address of the AP to which this SM is registered.
Latest Local Link Test Results	

Using BER Results tool

Radio BER data represents bit errors at the RF link level. Due to CRC checks on fragments and packets and ARQ (Automatic Repeat Request), the BER of customer data is essentially zero. Radio BER gives one indication of link quality. Other important indications to consider includes the received power level, signal to noise ratio and link tests.

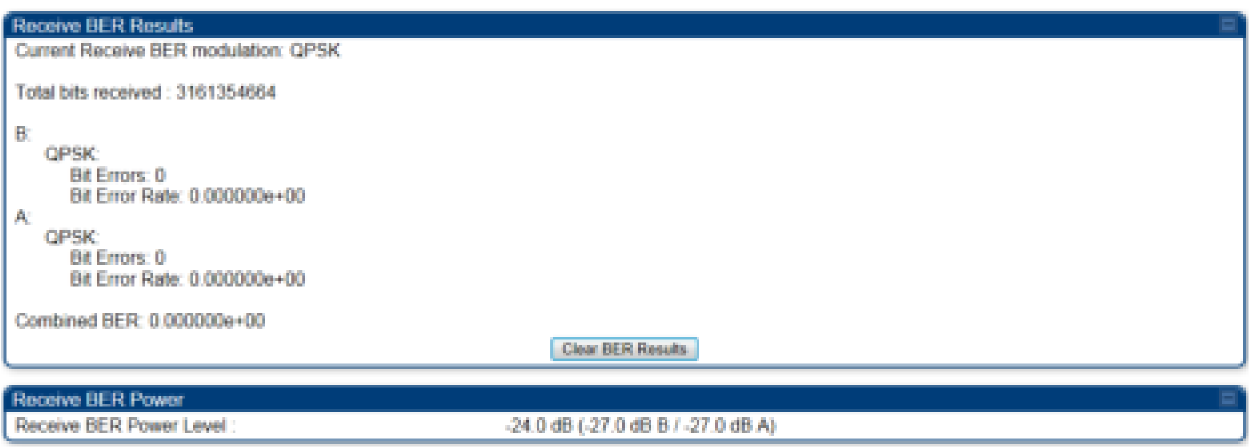
BER is only instrumented on the downlink and is displayed on the BER Results tab of the Tools page in any SM. Each time the tab is clicked, the current results are read and counters are reset to zero.

The BER Results tab can be helpful in troubleshooting poor link performance.

The link is acceptable if the value of this field is less than 10^{-4}. If the BER is greater than 10^{-4}, re-evaluate the installation of both modules in the link.

The BER test signal is broadcast by the AP/BHM (and compared to the expected test signal by the SM/BHS) only when capacity in the sector allows it. This signal is the lowest priority for AP/BHM transmissions.

Figure 104: *BER Results tab of the SM*



Using the Sessions tool

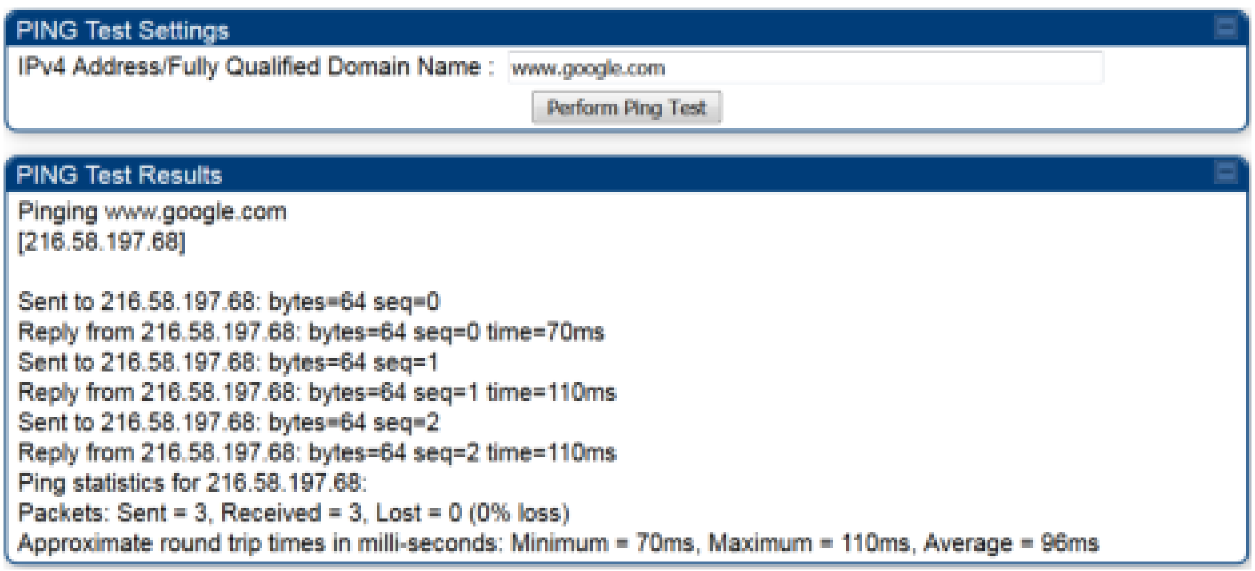
The PMP 450 Platform Family AP has a tab Sessions under the Tools category which allows operators to drop one or all selected SM sessions and force a SM re-registration. This operation is useful to force QoS changes for SMs without losing AP logs or statistics. This operation may take 5 minutes to regain all SM registrations.

Figure 105: *Sessions tab of the AP*

Using the Ping Test tool

The PMP 450 Platform Family AP has a tab Ping Test under the Tools category which allows users to check the accessibility of the given IP V4 address or a valid domain name

Figure 106: *Ping Test tab of the AP*



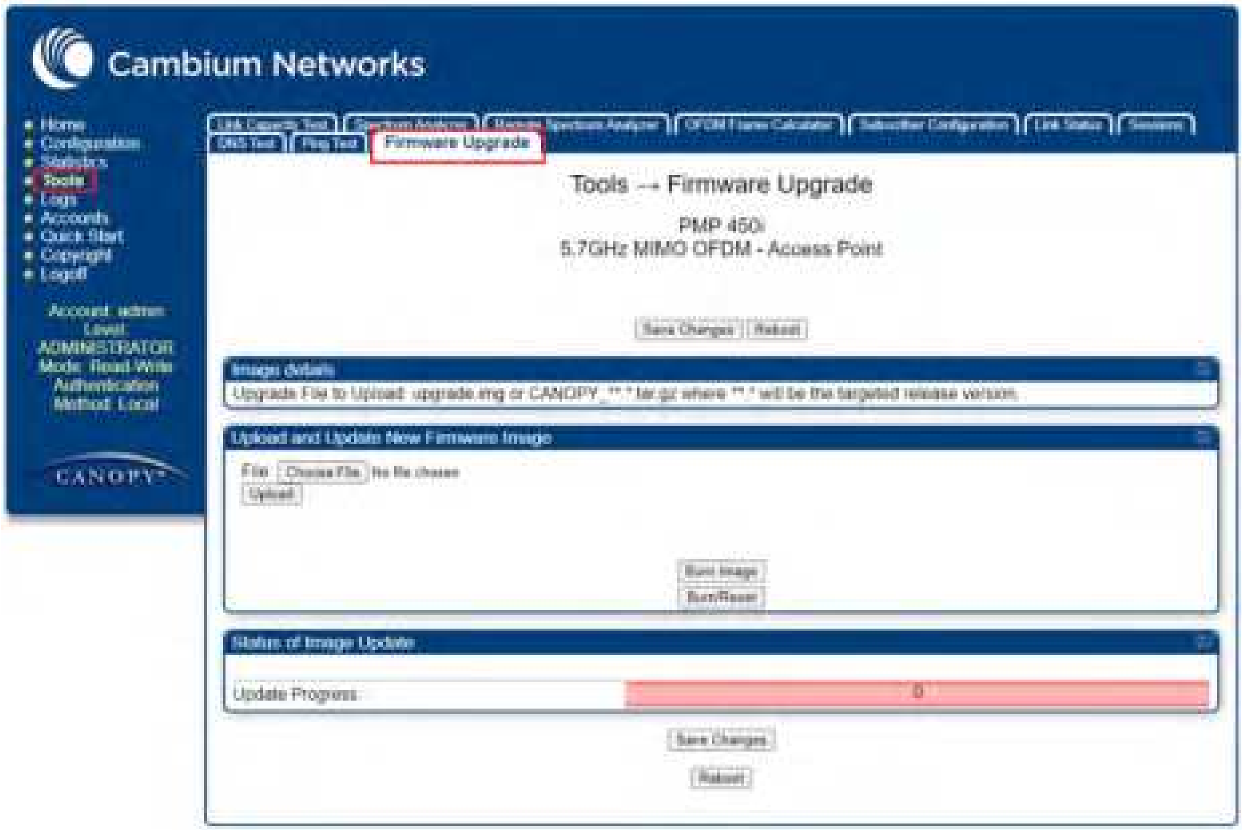
Note

When a domain name (for example, www.google.com) is used for ping test, make sure that Preferred DNS Server and Alternate DNS Server parameters are configured in the Configuration > IP tab of the AP.

Firmware Upgrade

Prior to System Release 22.0, the PMP 450 family of Radios can only be upgraded either from cnMaestro or CNUT. This feature allows the operator to upgrade software from the Radios Graphical User Interface (GUI). The software can be upgraded from the **Tools** -> **Firmware Upgrade** page, under the **Upload and Update New Firmware Image** section, by uploading the cnMaestro Software Package.

Figure 107: *Firmware upgrade*



Note

PMP 450 AP, PMP 450 SM, and PTP 450 Radios do not have enough resources to support uploading the cnMaestro software package.

The operator can upgrade PMP 450 AP, PMP 450 SM, and PTP 450 Radios from Web GUI by uploading a radio-specific image file. The image that can be uploaded to a Radio is listed under the Image details section, on the **Tools** -> **Firmware Upgrade** page and is shown in Figure 108 (for AP) and Figure 109 (for SM).

Figure 108: *Firmware upgrade page for PMP 450 AP*

Figure 109: *Firmware upgrade page for PMP 450 SM*

Radio-specific image files can be extracted from the cnMaestro Software Package, using file extractor tools like WinZip, 7-Zip, etc.

Table 110 lists the image files specific to the Radios and their location in the cnMaestro software package.

Table 110: Image file location for Radio types

Radio Type	Image File	Location
PMP 450 AP	5x_20_cf200.img	\NIOS2\IMAGES\450\AP\SIGNED\
PMP 450 SM	5x_cat120.img	\NIOS2\IMAGES\450\SM_BH\SIGNED\
PTP 450	ptp450_c120.img	\NIOS2\IMAGES\450\SM_BH\SIGNED\

Chapter 3: Operation

This chapter provides instructions for operators of the 450 Platform Family wireless Ethernet Bridge. The following topics are described in this chapter:

- System information
  - Viewing General Status
  - Viewing Session Status
  - Viewing Remote Subscribers
  - Interpreting messages in the Event Log
  - Viewing the Network Interface
  - Viewing the Layer 2 Neighbors
- System statistics
  - Viewing the Scheduler Statistics
  - Viewing list of Registration Failures statistics
  - Interpreting Bridging Table statistics
  - Interpreting Translation Table statistics
  - Interpreting Ethernet statistics
  - Interpreting RF Control Block statistics
  - Interpreting VLAN statistics
  - Interpreting Data Channels statistics
  - Interpreting Proportional Scheduler

- Interpreting MIR/Burst statistics
    - Interpreting Overload statistics
    - Interpreting DHCP Relay statistics
    - Interpreting Filter statistics
    - Viewing ARP statistics
    - Viewing NAT statistics
    - Viewing NAT DHCP Statistics
    - Interpreting Sync Status statistics
    - Interpreting PPPoE Statistics for Customer Activities
    - Interpreting Bridge Control Block statistics
    - Interpreting SNMPv3 Statistics
    - Interpreting syslog statistics
    - Interpreting Frame Utilization statistics
- Radio Recovery

System information

This section describes how to use the summary and status pages to monitor the status of the Ethernet ports and wireless link.

- Viewing General Status
- Viewing Session Status
- Viewing Remote Subscribers
- Interpreting messages in the Event Log
- Viewing the Network Interface
- Viewing the Layer 2 Neighbors

Viewing General Status

The General Status tab provides information on the operation of this AP/BHM and SM/BHS. This is the page that opens by default when you access the GUI of the radio.

General Status page of AP

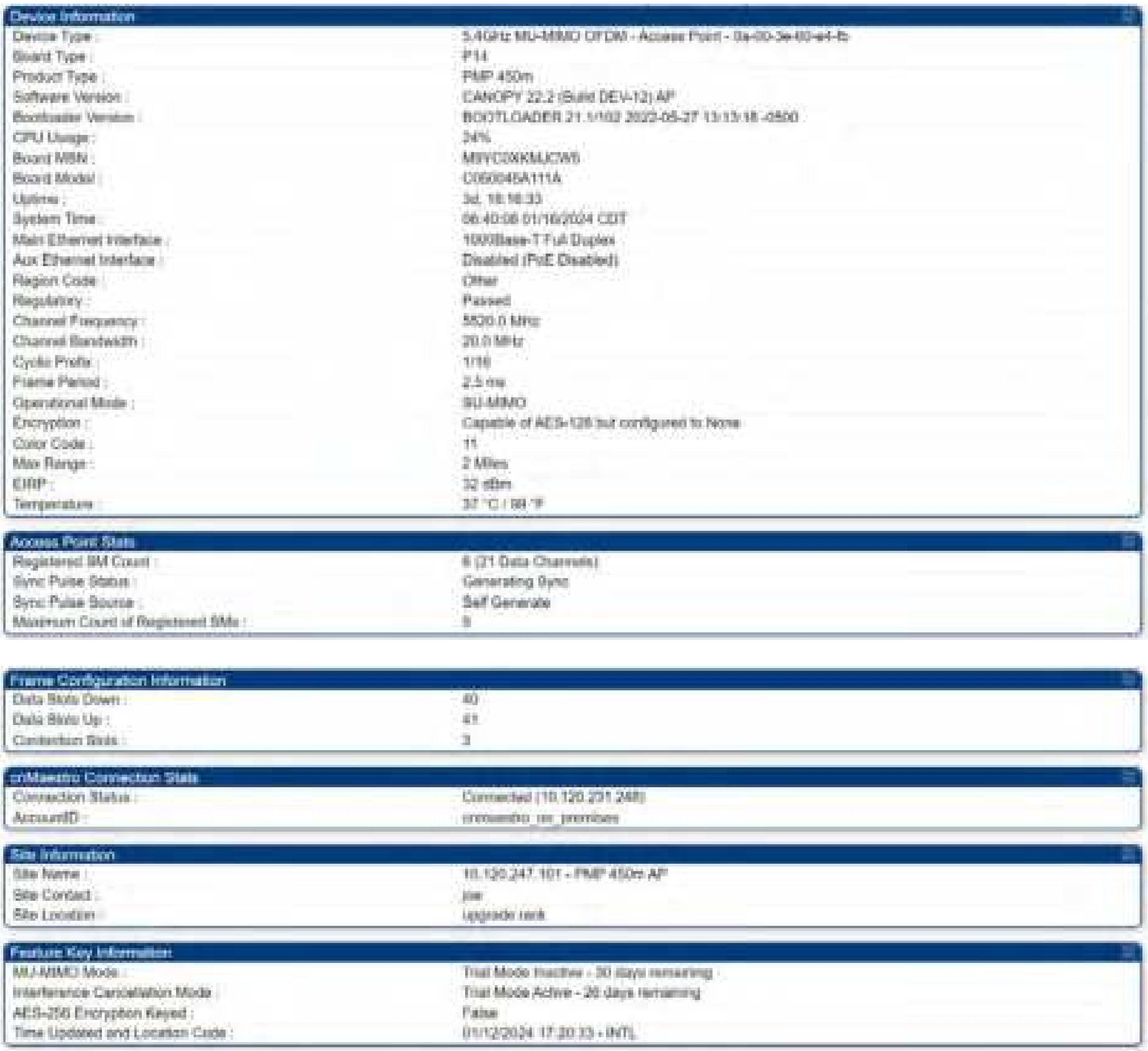
The General Status page of PMP 450m AP is explained in General Status page attributes – PMP 450m AP

The General Status page of PMP 450 AP is explained in General Status page attributes – PMP 450 AP.

The General Status page of PMP 450i AP is explained in General Status page attributes – PMP 450i AP.

The General Status page of 450v AP is explained in General Status page attributes – PMP 450v AP.

Table 111: General Status page attributes – PMP 450m AP



Attribute	Meaning
Device Type	This field indicates the type of the module. Values include the frequency band of the device, its module type and its MAC address.
Board Type	This field indicates the series of hardware.
Product Type	The field indicates model number of 450m device. The 450m Series has two model variants. • PMP 450m: This model works in SU-MIMO mode which is default “limited” mode. The MU-MIMO license can be purchased from Cambium Networks and applied. MU-MIMO: This model works in MU-MIMO mode.

Attribute	Meaning
Software Version	This field indicates the system release, the time and date of the release and whether communications involving the module are secured by AES encryption. If you request technical support, provide the information from this field.
Bootloader Version	This field indicates the version of Uboot running on the 450m AP platform.
CPU Usage	This field indicates the current CPU utilization of the device.
Board MSN	This field indicates the Manufacturer's Serial number. A unique serial number assigned to each radio at the factory for inventory and quality control.
Board Model	This field indicates the Manufacturer's Model number. A unique serial number assigned to each for inventory and quality control.
FPGA Version	This field indicates the version of the field-programmable gate array (FPGA) on the module. If you request technical support, provide the value of this field.
Uptime	This field indicates how long the module has operated since power was applied.
System Time	This field provides the current time. If the AP is connected to a CMM4, then this field provides GMT (Greenwich Mean Time). Any SM that registers to the AP inherits the system time.
Main Ethernet Interface	This field indicates the speed and duplex state of the Ethernet interface to the AP.
Region Code	A parameter that offers multiple fixed selections, each of which automatically implements frequency band range for the selected region. Units shipped to regions other than restrictions the United States must be configured with the corresponding Region Code to comply with local regulatory requirements.
Regulatory	This field indicates whether the configured Country Code and radio frequency are compliant with respect to their compatibility. 450 Platform Family products shipped to the United States is locked to a Country Code setting of "United States". Units shipped to regions other than the United States must be configured with the corresponding Country Code to comply with local regulatory requirements.
DFS (Dynamic Frequency Selection)	This field dynamically selects frequency based on detection of radar pulses.
Channel Frequency	This field indicates the current operating center frequency, in MHz.
Channel Bandwidth	This field indicates the current size of the channel band used for radio transmission.
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	This field indicates the current Frame Period setting of the radio in ms.

Attribute	Meaning
Encryption	This field indicates the capability and the encryption configuration of the device.
Color Code	This field displays a value from 0 to 254 indicating the AP's configured color code. For registration to occur, the color code of the SM and the AP must match. Color code is not a security feature. Instead, color code is a management feature, typically for assigning each sector a different color code. Color code allows you to force a SM to register to only a specific AP, even where the SM can communicate with multiple APs. The default setting for the color code value is 0. This value matches only the color code of 0 (not all 255 color codes).
Max Range	This field indicates the setting of the Max Range parameter, which contributes to the way the radio transmits. Verify that the Max Range parameter is set to a distance slightly greater than the distance between the AP and the furthest SM that must register to this AP.
EIRP	This field indicates the combined power level at which the AP will transmit, based on the Country Code.
Temperature	This field indicates the current operating temperature of the device board.
CBSD Grant State	This field indicates the CBRS Registration and Grant state as described in Winnforum document WINNF-TS-0016. For more information on CBRS procedures and states see the Cambium's **CBRS Consolidated Procedurs** Guide.
Registered SM Count	This field indicates how many SMs are registered to the AP.
Sync Pulse Status	This field indicates the status of synchronization as follows: Generating Sync indicates that the module is set to generate the sync pulse. Receiving Sync indicates that the module is set to receive a sync pulse from an outside source and is receiving the pulse. No Sync Since Boot up / ERROR: No Sync Pulse indicates that the module is set to receive a sync pulse from an outside source and is not receiving the pulse. **Note** When this message is displayed, the AP transmitter is turned off to avoid self-interference within the system.
Sync Pulse Source	This field indicates the status of the synchronization source: Searching indicates that the unit is searching for a GPS fix Timing Port/UGPS indicates that the module is receiving sync via the timing AUX/SYNC timing port Power Port indicates that the module is receiving sync via the power port (Ethernet port). On-board GPS indicates that the module is receiving sync via the unit's internal GPS module

Attribute	Meaning
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.
Data Slots Down	This field indicates the number of frame slots that are designated for use by data traffic in the downlink (sent from the AP to the SM). The AP calculates the number of data slots based on the Max Range, Downlink Data and (reserved) Contention Slots configured by the operator.
Data Slots Up	This field indicates the number of frame slots that are designated for use by data traffic in the uplink (sent from the SM to the AP). The AP calculates the number of data slots based on the Max Range, Downlink Data and (reserved) Contention Slots configured by the operator.
Contention Slots	This field indicates the number of (reserved) Contention Slots configured by the operator. See Contention slots.
Connection Status	This field indicates the device connectivity to cnMaestro (Cambium's cloud-based network management system).
Account ID	This field shows Account ID which is registered with Cambium Networks and it allows operator to manage devices using cnMaestro.
Site Name	This field indicates the name of the physical module. You can assign or change this name in the SNMP tab of the AP Configuration page. This information is also set into the sysName SNMP MIB-II object and can be polled by an SNMP management server.
Site Contact	This field indicates contact information for the physical module. You can provide or change this information in the SNMP tab of the AP Configuration page. This information is also set into the sysName SNMP MIB-II object and can be polled by an SNMP management server.
Site Location	This field indicates site information for the physical module. You can provide or change this information in the SNMP tab of the AP Configuration page.
MU-MIMO Mode	This field displays information about MU-MIMO mode. If the AP is keyed as MU-MIMO, it displays **MU-MIMO** (Multi User - MIMO); otherwise, it displays **SU-MIMO** (Single User - MIMO). If a free trial mode key is installed, this field indicates how many days remain on the free trial and whether the Trial Mode is currently active or not.
Interference Cancellation Mode	This field displays information about the UL Interference Cancellation feature. If a permanent enable key has been applied, it displays **Supported**. If such a key has not been purchased, this field indicates how many days of a free trial license remain and whether the Trial Mode is currently active or not. The Trial Mode can be controlled via SNMP or **Configuration** -> **General** on the AP GUI.
AES-256 Encryption Keyed	This displays the status of the entered AES-256 Encryption Key. Note To enable AES-256 Encryption, a feature key needs to be purchased.

Attribute	Meaning
Time Updated and Location Code	This field displays information about the keying of the radio.

Table 112: General Status page attributes – PMP 450 AP

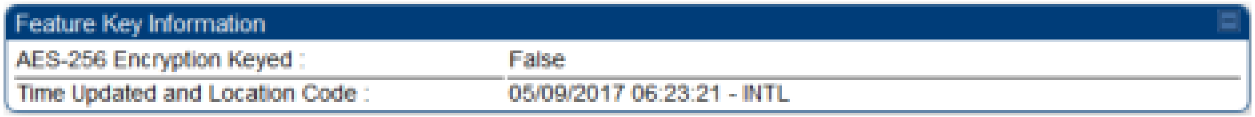
Device Information	
Device Type :	5.7GHz MIMO OFDM - Access Point - 0a-00-3e-b1-2a-78
Board Type :	P12
Product Type :	PMP 450
Software Version :	CANOPY 15.2 AP
CPU Usage :	Curr/Max: 9%/95%
Board MSN :	6069QU0F0C
FPGA Version :	062618
PLD Version :	20
Uptime :	03:44:31
System Time :	09:11:33 07/12/2018 UTC
Main Ethernet Interface :	100Base-TX Full Duplex
Region Code :	Other
Regulatory :	Passed
Antenna Type :	External
Channel Frequency :	5850.0 MHz
Channel Bandwidth :	20.0 MHz
Cyclic Prefix :	1/16
Frame Period :	2.5 ms
Encryption :	Capable of AES-128 but configured to None
Color Code :	171
Max Range :	3 Miles
Transmit Power :	0 dBm
Total Antenna Gain :	0 dBi
Temperature :	29 °C / 85 °F

Access Point Stats	
Registered SM Count :	1 (1 Data Channels)
Sync Pulse Status :	Generating Sync
Sync Pulse Source :	Self Generate
Maximum Count of Registered SMs :	1

Frame Configuration Information	
Data Slots Down :	40
Data Slots Up :	41
Contention Slots :	3

cnMaestro Connection Stats	
Connection Status :	Connected (cloud.cambiumnetworks.com)
AccountID :	GRE001

Site Information	
Site Name :	No Site Name
Site Contact :	No Site Contact
Site Location :	No Site Location



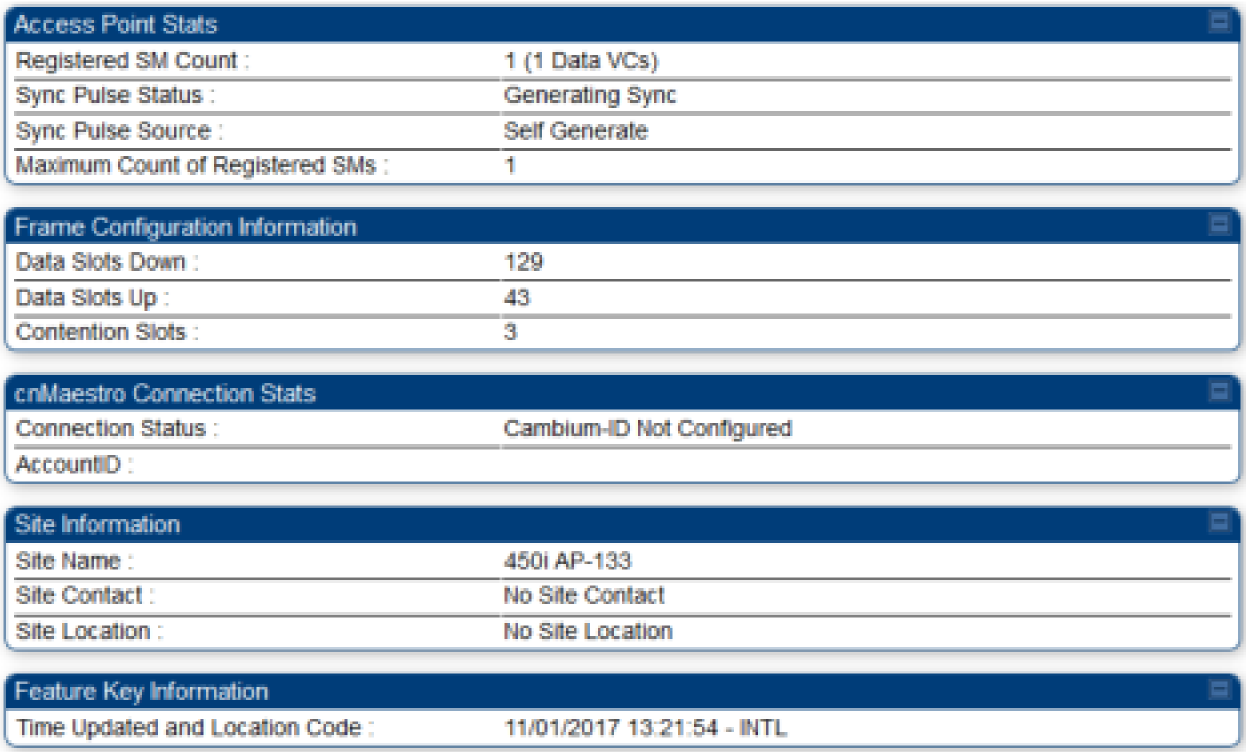
Attribute	Meaning
Device Type	See General Status page of AP for details
Board Type	
Product Type	This indicates model of the device.
Software Version	See General Status page of AP for details
CPU Usage	This field indicates the current CPU utilization of the device.
Board MSN	This field indicates the Manufacturer's Serial number. A unique serial number assigned to each radio at the factory for inventory and quality control.
FPGA Version	See General Status page of AP for details
PLD Version	This field indicates the firmware version on the Programmable Logic Device.
Uptime	See General Status page of AP for details
System Time	
Main Ethernet Interface	
Region Code	See General Status page of AP for details
Regulatory	
Antenna Type	
Channel Center Frequency	
Channel Bandwidth	
Cyclic Prefix	
Frame Period	
Color Code	
Max Range	
Transmit Power	This field indicates the combined power level at which the AP is set to transmit, based on the Country Code and Antenna Gain settings.
Temperature	See General Status page of AP for details
Total Antenna Gain	This field indicates the total antenna gain.

Attribute	Meaning
Sync Pulse Status	See General Status page of AP for details
Sync Pulse Source	
Maximum Count of Registered SMs	
Data Slots Down	
Data Slots Up	
Contention Slots	
Connection Status	
Account ID	
Site Name	
Site Contact	
Site Location	
Time Updated and Location Code	

Table 113: General Status page attributes – PMP 450i AP

Device Information	
Device Type :	5.4GHz MIMO OFDM - Access Point - 0a-00-3e-bb-01-77
Board Type :	P13
Product Type :	PMP 450i
Software Version :	CANOPY 15.1.5 AP-None
CPU Usage :	2%
Board MSN :	PMP450iMSN
Board Model :	C050045A010A
FPGA Version :	020118
Uptime :	2d, 07:56:57
System Time :	17:58:46 01/03/2016 UTC
Main Ethernet Interface :	100Base-TX Full Duplex
Aux Ethernet Interface :	Disabled (PoE Disabled)
Region Code :	Other
Regulatory :	Passed
DFS :	Idle
Antenna Type :	External
Channel Frequency :	5705.0 MHz
Channel Bandwidth :	40.0 MHz
Cyclic Prefix :	1/16
Frame Period :	2.5 ms
Color Code :	133
Max Range :	2 Miles
Transmit Power :	27 dBm
Total Antenna Gain :	40 dBi
Temperature :	36 °C / 97 °F

Access Point Stats	
Registered SM Count :	1 (1 Data Channels)
Sync Pulse Status :	Receiving Sync (100.0% Sync pulses received)
Sync Pulse Source :	Power Port (Canopy Sync)
Maximum Count of Registered SMs :	1



Attribute	Meaning
Device Type	See General Status page of AP for details
Board Type	
Product Type	This indicates model of the device.
Software Version	See General Status page of AP for details
CPU Usage	This field indicates the current CPU utilization of the device.
Board MSN	This field indicates the Manufacturer's Serial number. A unique serial number assigned to each radio at the factory for inventory and quality control.
Board Model	This field indicates the Manufacturer's Model number.
FPGA Version	See General Status page of AP for details
Uptime	
System Time	
Main Ethernet Interface	
Aux Ethernet Interface	See General Status page of AP for details

Attribute	Meaning
Region Code	See General Status page of AP for details
Regulatory	
Antenna Type	
Channel Center Frequency	
Channel Bandwidth	
Cyclic Prefix	
Frame Period	
Color Code	
Max Range	
Transmit Power	This field indicates the combined power level at which the AP is set to transmit, based on the Country Code and Antenna Gain settings.
Total Antenna Gain	This field indicates the total antenna gain.
Temperature	See General Status page of AP for details
802.3at Type 2 PoE Status	The field displays whether PoE Classification functionality is enabled or disabled. It is only applicable for 450i Series devices.
Registered SM Count	See General Status page of AP for details
Sync Pulse Status	
Sync Pulse Source	
Maximum Count of Registered SMs	
Data Slots Down	
Data Slots Up	
Contention Slots	See General Status page of AP for details
Connection Status	
Account ID	
Site Name	
Site Contact	
Site Location	
Time Updated and Location Code	

Table 114: General Status page attributes – PMP 450v AP

Device Information	
Device Type :	5.7GHz MIMO OFDM - Access Point - 02-04-56-00-01-fe
Board Type :	P16
Product Type :	PMP 450v 4x4
Software Version :	CANOPY 24.0 (Build SIT-15-BLEN7) AP
CPU Usage :	22%
Board MSN :	M9ZM02SKKLR8
Board Model :	C060045A401A 450v6GHzEnable
FPGA Version :	041524 FPGA Compiled Info Low_Cost, Wireless-only, RF_Paths=2, Component Carriers=3, AP_only
Uptime :	06:07:11
System Time :	03:46:02 05/07/2024 CST
Main Ethernet Interface :	1000Base-T Full Duplex
Aux Ethernet Interface :	Disabled (PoE Disabled)
Region Code :	United States
Regulatory :	Passed
Antenna Type :	External
Channel Frequency :	5880.0 MHz (Component Carrier 1, Carrier 1) 6860.0 MHz (Component Carrier 2, Carrier 2) Carrier 1 Freq: 5880.0 MHz Carrier 2 Freq: 6860.0 MHz
Channel Bandwidth :	40.0 MHz (20 + 20)
Cyclic Prefix :	1/16
Frame Period :	2.5 ms
Encryption :	Capable of AES-128 but configured to None
Color Code :	180
Max Range :	2 Miles
ERIP :	10 dBm / 10 dBm
Transmit Power :	10 dBm / 10 dBm
Total Antenna Gain :	0 dBi
Temperature :	45 °C / 114 °F

Access Point Stats	
Registered SM Count :	1 (2 Data Channels)
Sync Pulse Status :	Receiving Sync (89.67% Sync pulses received) (1PPS Jitter Filter enabled, active)
Sync Pulse Source :	Main/Power Port (Cambium Sync) (FPGA Status: In Sync)
Maximum Count of Registered SMs :	1

Frame Configuration Information	
Data Slots Down :	81
Data Slots Up :	20
Contention Slots :	3

cnMaestro Connection Stats	
Connection Status :	Connected (qa.cloud.cambiumnetworks.com)
AccountID :	5_0_0_X_CLOUD_REGRESSION

Site Information	
Site Name :	pmp canopy v
Site Contact :	No Site Contact
Site Location :	No Site Location

Feature Key Information	
AES-256 Encryption Keyed :	False
FCC Access to 6 GHz (UNII-5, UNII-7)	True (Engineering Key Override)
Time Updated and Location Code :	10/13/2023 19:48:17 - INTL

Attribute	
Device Type	See General Status page attributes – PMP 450i AP
Board Type	
Product Type	
Software Version	
CPU Usage	
Board MSN	
Board Model	
FPGA Version	
Uptime	
System Time	
Main Ethernet Interface	
Aux Ethernet Interface	
Region Code	See General Status page attributes – PMP 450i AP
Regulatory	
Antenna Type	
Channel Center Frequency	
Channel Bandwidth	
Cyclic Prefix	
Frame Period	
Color Code	
Max Range	
Transmit Power	
Total Antenna Gain	
Temperature	

Attribute	
Registered SM Count	
Sync Pulse Status	
Sync Pulse Source	
Maximum Count of Registered SMs	
Data Slots Down	
Data Slots Up	
Contention Slots	
Connection Status	
Account ID	
Site Name	
Site Contact	
Site Location	
Feature Key Information AES-256 Encryption Keyed	Indicates the presence of the AES-256 encryption key on the device.
Time Updated and Location Code	Provides the day and time of the last update to key information.

General status page - SM

The SMs General Status page is explained in below table.

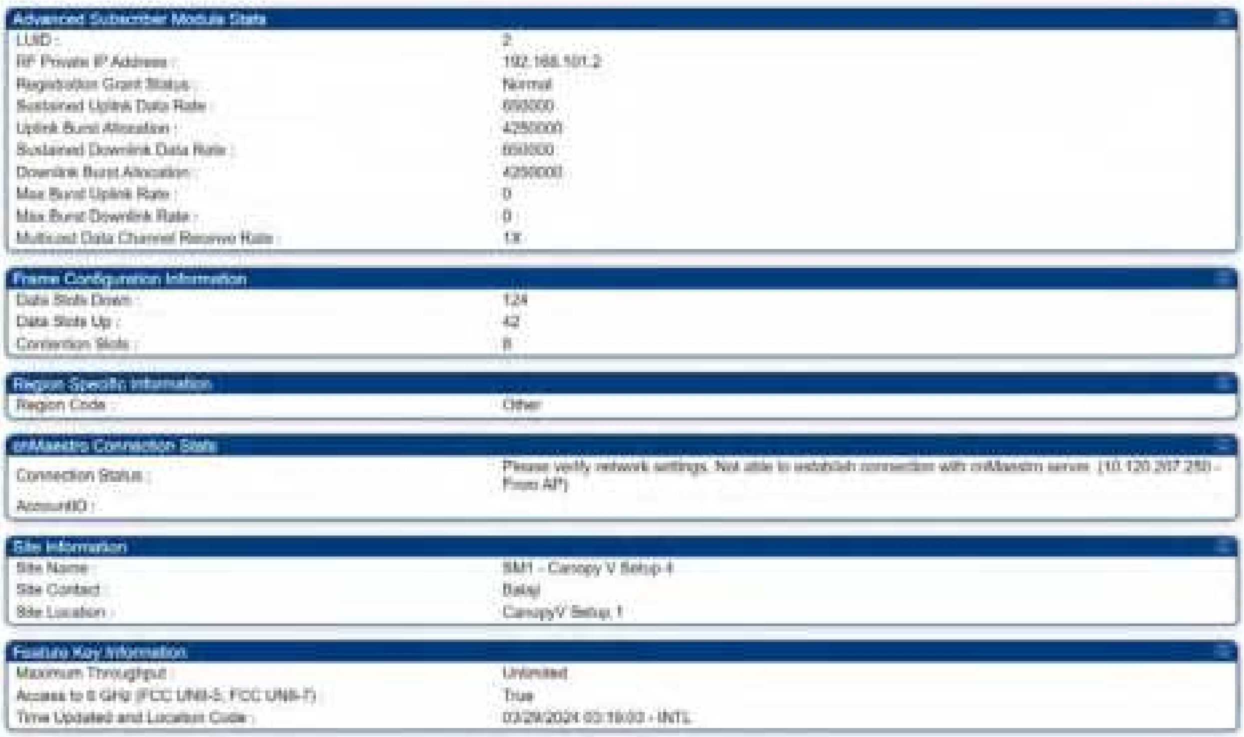
Note

For accurate power level readings to be displayed, traffic must be present on the radio link.

Table 115: General Status page attributes - SM

Device Information	
Device Type :	5.1-7.0GHz MIMO OFDM - Subscriber Module - 02-04-56-00-d1-f1
Board Type :	P18
Product Type :	PMP 450v 4x4
Software Version :	CANOPY 24.0 (Build BETA-6) SM
CPU Usage :	58%
Board MSN :	M0AA02V851MH
Board Model :	C060045C401A 450v6GHzEnable
FPGA Version :	041924
Uptime :	11:01:38
System Time :	00:31:46 05/22/2024 CST
Main Ethernet Interface :	1000Base-T Full Duplex
802.1x Status :	Disabled
Region Code :	Other
DFS :	Idle
Antenna Type :	External
Frame Period :	2.5 ms
Encryption :	None
EIRP :	12 dBm / 11 dBm
Transmit Power :	12 dBm / 11 dBm
Total Antenna Gain :	0 dBi
Temperature :	45 °C / 112 °F

Subscriber Module Stats	
Session Status :	REGISTERED CC1: 8X/8X MIMO-B CC2: 8X/8X MIMO-B
Session Uptime :	04:41:00
Registered AP :	02-04-56-00-01-fe Setup 4 - Canopy V AP
Registered AP Software Version :	CANOPY 24.0 (Build BETA-6)
Color Code :	180 (Primary)
Sector ID :	0
Channel Frequency :	5870.0 MHz (Component Carrier 1, Carrier 1) 6840.0 MHz (Component Carrier 2, Carrier 2)
Channel Bandwidth :	80.0 MHz (40 + 40)
Cyclic Prefix :	1/16
Air Delay :	0 ns, approximately 0.000 miles (0 feet)
Receive Power :	CC1: -52.0 dBm CC2: -52.2 dBm
Signal Strength Ratio :	0.0dB V - H
Signal to Noise Ratio :	43 V / 42 H dB
Beacons / Maps :	15 sec: 99% 1 min: 99/99/100% (min/avg/max) 15 min: 99/99/100% (min/avg/max)
AP Frame Utilization :	Downlink:100% Uplink:100% (last minute)



Attribute	Meaning
Device Type	This field indicates the type of the module. Values include the frequency band of the SM, its module type and its MAC address.
Board Type	This field indicates the series of hardware.
Product Type	This indicates model of the device.
Software Version	This field indicates the system release, the time and date of the release. If you request technical support, provide the information from this field.
CPU Usage	This field indicates the current CPU utilization of the device.
Board MSN	This field indicates the Manufacturer’s Serial number. A unique serial number assigned to each radio at the factory for inventory and quality control.
Board Model	This field indicates the Manufacturer’s Model number.
FPGA Version	This field indicates the version of the field-programmable gate array (FPGA) on the module. When you request technical support, provide the information from this field.
Uptime	This field indicates how long the module has operated since power was applied.
System Time	This field provides the current time. Any SM that registers to an AP inherits the system time, which is displayed in this field as GMT (Greenwich Mean Time).
Main Ethernet Interface	This field indicates the speed and duplex state of Ethernet interface to the SM.
802.1x Status	Indicates the current status of IEEE 802.1X authentication protocol.

Attribute	Meaning
Regional Code	A parameter that offers multiple fixed selections, each of which automatically implements frequency band range restrictions for the selected region. Units shipped to regions other than the United States must be configured with the corresponding Country Code to comply with local regulatory requirements.
DFS	This field indicates that DFS operation is enabled based on the configured region code, if applicable.
Antenna Type	The current antenna type that has been selected.
Frame Period	This field indicates the current Frame Period setting of the radio in ms.
Encryption	This field indicates the capability and the encryption configuration of the device.
EIRP	Indicates the Effective Isotropic Radiated Power (EIRP) of the device. If more than one number is shown, then this is the EIRP for each of the CCs.
Transmit Power	This field lists the current combined transmit power level, in dBm. **Note** The red SM message “target power exceeded maximum” does not necessarily indicate a problem.  In this case, the AP is requesting the SM to transmit at a higher power level, but the SM is restricted due to EIRP limits or hardware capabilities. This message can be an indication that the SM is deployed further from the AP than optimal, causing the AP to adjust the SM to maximum transmit power.
Total Antenna Gain	Specifies the antenna gain of the device, measured in dBi.
Temperature	The current operating temperature of the board.
Session Status	This field displays the following information about the current session: Scanning indicates that this SM currently cycles through the radio frequencies that are selected in the Radio tab of the Configuration page. Syncing indicates that this SM currently attempts to receive sync. Registering indicates that this SM has sent a registration request message to the AP and has not yet received a response. Registered indicates that this SM is both: • registered to an AP. • ready to transmit and receive data packets.
Session Uptime	This field displays the duration of the current link. The syntax of the displayed time is hh:mm:ss.

Attribute	Meaning
Registered AP	Displays the MAC address and site name of the AP to which the SM is registered to. This parameter provides click-through proxy access to the AP's management interface.
Registered AP Software Version	Displays the software version of the registered AP.
Color Code	This field displays a value from 0 to 254 indicating the SM's configured color code. For registration to occur, the color code of the SM and the AP must match. Color code is not a security feature. Instead, color code is a management feature, typically for assigning each sector a different color code. Color code allows you to force a SM to register to only a specific AP, even where the SM can communicate with multiple APs. 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	Indicates the unique identifier assigned to the sector.
Channel Frequency	This field lists the current operating frequency of the radio.
Channel Bandwidth	The size in MHz of the operating channel.
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 a copy of the last 1/16 of the symbol is appended at the beginning of the symbol.
Air Delay	This field displays the current air delay in nanoseconds between this SM and the AP, and the distance that computes to. The distances reported as less than 200 feet (61 meters) are unreliable. If the Nomadic Mode feature is enabled, this field will also include minimum and maximum air delays measured for this SM since this air interface connection was established.
Receive Power	This field lists the current combined receive power level, in dBm.
Signal Strength Ratio	This field displays the difference of the Vertical path received signal power to the Horizontal path received signal power.
Signal to Noise Ratio	This field lists the current signal-to-noise level, an indication of the separation of the received power level vs. noise floor.
Beacons/ Maps	Displays a count of beacons received by the SM in percentage. This value must be typically between 99-100%. If lower than 99%, it indicates a problematic link. This statistic is updated every 16 seconds.
AP Frame Utilization	Displays the utilization of frames by the AP for downlink and uplink traffic over the last minute.
LUID	Indicates the Logical Unit ID (LUID) assigned to the device.
RF Private IP Address	Specifies the private IP address assigned to the device for RF communication.
Registration Grant Status	Indicates the current status of registration grant, typically used in network registration processes.

Attribute	Meaning
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 • Interaction of Burst Allocation and Sustained Data Rate Settings • Configuration Source
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: • Interaction of Burst Allocation and Sustained Data Rate Settings • Configuration Source
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: • Interaction of Burst Allocation and Sustained Data Rate Settings. • Configuration Source
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 • Interaction of Burst Allocation and Sustained Data Rate Settings • Configuration Source
Max Burst Uplink 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.
Max Burst Downlink 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.
Multicast Data Channel Receive Rate	Indicates the receive rate for multicast data channels, with an option to enable or disable reception.
Data Slots Down	This field lists the number of slots used for downlink data transmission.
Data Slots Up	This field lists the number of slots used for uplink data transmission.

Attribute	Meaning
Contention Slots	This field indicates the number of (reserved) Contention Slots configured by the operator.
Region Code	A parameter that offers multiple fixed selections, each of which automatically implements frequency band range for the selected region. Units shipped to regions other than restrictions the United States must be configured with the corresponding Region Code to comply with local regulatory requirements.
Connection Status	This field indicates the device connectivity to cnMaestro (Cambium's cloud-based network management system).
AccountID	This field shows Account ID which is registered with Cambium Networks and it allows operator to manage devices using cnMaestro.
Site Name	This field indicates the name of the physical module. You can assign or change this name in the SNMP tab of the SM Configuration page. This information is also set into the sysName SNMP MIB-II object and can be polled by an SNMP management server.
Site Contact	This field indicates contact information for the physical module. You can provide or change this information in the SNMP tab of the SM Configuration page. This information is also set into the sysName SNMP MIB-II object and can be polled by an SNMP management server.
Site Location	This field indicates site information for the physical module. You can provide or change this information in the SNMP tab of the SM Configuration page.
Maximum Throughput	This field indicates the limit of aggregate throughput for the SM and is based on the default (factory) limit of the SM and any floating license that is currently assigned to it.
Access to 6 GHz (FCC UNII-5, FCC UNII-7)	Indicates whether the device has access to the 6 GHz frequency band, specifically FCC UNII-5 and FCC UNII-7 bands.
Time Updated and Location Code	This field displays information about the keying of the radio.

Note

For PMP 450 SM 900 MHz, there is additional parameter Path Informatio (Table 115, under Subscriber Module Stats) which displays polarization path (A & B) information.

Figure 110: *General Status page - 900 MHz SM*

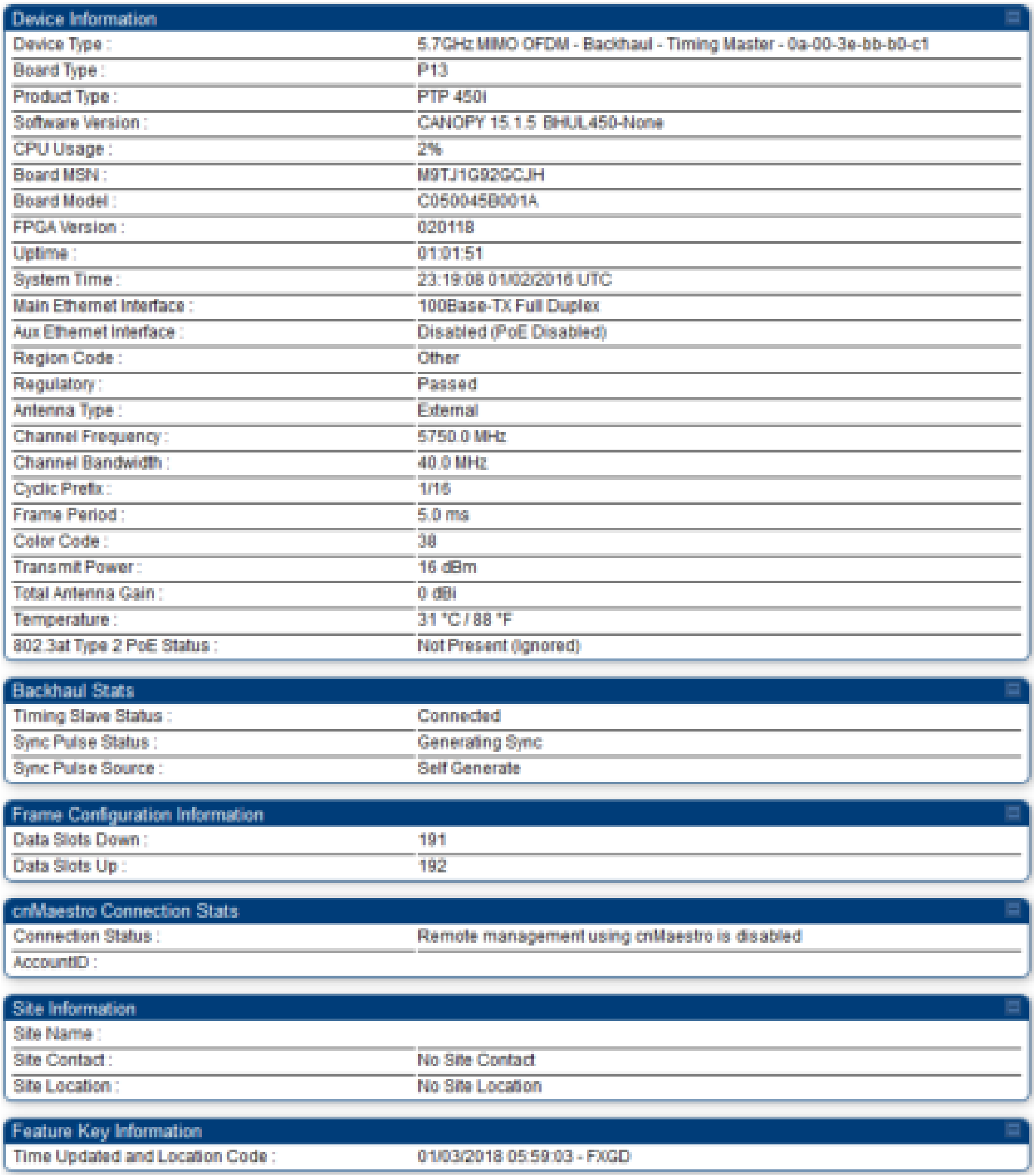
Device Information	
Device Type :	900MHz - Subscriber Module - 0a-00-3e-45-fc-36
Board Type :	P11 C120
Software Version :	CANOPY 14.2 (Build 12) SM-DES
Board MSN :	6069RU0TYJ
Board Model :	C009045C001A
FPGA Version :	040716
Uptime :	00:30:16
System Time :	02:36:06 02/13/2011 IST
Main Ethernet Interface :	No Link
Region Code :	Other
Antenna Type :	External
Frame Period :	5.0 ms
Temperature :	78 °C / 172 °F

Subscriber Module Stats	
Session Status :	REGISTERED VC 18 Rate 8X/6X MIMO-B
Session Uptime :	00:26:35
Registered AP :	0a-00-3e-45-86-f0 SIT-waterfall
Color Code :	86 (Primary)
Channel Frequency :	912.00 MHz
Channel Bandwidth :	10.0 MHz
Cyclic Prefix :	1/16
Air Delay :	175 ns, approximately 0.016 miles (86 feet)
Receive Power :	-71.9 dBm
Signal Strength Ratio :	3.0dB B - A
Signal to Noise Ratio :	28 B / 28 A dB
Path Info :	Path A = -45° Path B = +45°
Beacons :	100 %
Transmit Power :	25 dBm
Total Antenna Gain :	0 dBi (0 dBi external + 0 dBi internal)

General Status page of BHM

The BHM's General Status page is explained in below table.

Table 116: General Status page attributes - BHM



Device Information	
Device Type :	5.7GHz MIMO OFDM - Backhaul - Timing Master - 0a-00-3e-bb-b0-c1
Board Type :	P13
Product Type :	PTP 450i
Software Version :	CANOPY 15.1.5 BHUL450-None
CPU Usage :	2%
Board MSN :	M9TJ1G92GCJH
Board Model :	C050045B001A
FPGA Version :	020118
Uptime :	01:01:51
System Time :	23:19:08 01/02/2018 UTC
Main Ethernet Interface :	100Base-TX Full Duplex
Aux Ethernet Interface :	Disabled (PoE Disabled)
Region Code :	Other
Regulatory :	Passed
Antenna Type :	External
Channel Frequency :	5750.0 MHz
Channel Bandwidth :	40.0 MHz
Cyclic Prefix :	1/16
Frame Period :	5.0 ms
Color Code :	38
Transmit Power :	16 dBm
Total Antenna Gain :	0 dBi
Temperature :	31 °C / 88 °F
802.3at Type 2 PoE Status :	Not Present (Ignored)

Backhaul Stats	
Timing Slave Status :	Connected
Sync Pulse Status :	Generating Sync
Sync Pulse Source :	Self Generate

Frame Configuration Information	
Data Slots Down :	191
Data Slots Up :	192

cnMaestro Connection Stats	
Connection Status :	Remote management using cnMaestro is disabled
AccountID :	

Site Information	
Site Name :	
Site Contact :	No Site Contact
Site Location :	No Site Location

Feature Key Information	
Time Updated and Location Code :	01/03/2018 05:59:03 - FXGD

Attribute	Meaning
Device Type	This field indicates the type of the module. Values include the frequency band of the BHM, its module type and its MAC address.
Board Type	This field indicates the series of hardware.
Product Type	This indicates model of the device.
Software Version	This field indicates the system release, the time and date of the release. If you request technical support, provide the information from this field.

Attribute	Meaning
CPU Usage	This field indicates the current CPU utilization of the device.
Board MSN	This field indicates the Manufacture's Serial number. A unique serial number assigned to each radio at the factory for inventory and quality control.
Board Model	This field indicates the Manufacturer's Model number.
FPGA Version	This field indicates the version of the field-programmable gate array (FPGA) on the module. When you request technical support, provide the information from this field.
Uptime	This field indicates how long the module has operated since power was applied.
System Time	This field provides the current time. Any BHS that registers to a BHM inherits the system time, which is displayed in this field as GMT (Greenwich Mean Time).
Ethernet Interface	This field indicates the speed and duplex state of Ethernet interface to the BHM.
Antenna Type	The current antenna type that has been selected.
Temperature	The current operating temperature of the board.
Session Status	This field displays the following information about the current session: Scanning indicates that this BHS currently cycles through the radio frequencies that are selected in the Radio tab of the Configuration page. Syncing indicates that this BHM currently attempts to receive sync. Registering indicates that this BHM has sent a registration request message to the BHM and has not yet received a response. Registered indicates that this BHM is both: • Registered to a BHM. • Ready to transmit and receive data packets.
Session Uptime	This field displays the duration of the current link. The syntax of the displayed time is hh:mm:ss.
Registered Backhaul	Displays the MAC address and site name of the BHM to which the BHS is registered to. This parameter provides click-through proxy access to the BHM's management interface.
Channel Frequency	This field lists the current operating frequency of the radio.
Receive Power	This field lists the current combined receive power level, in dBm.
Signal Strength Ratio	This field displays the difference of the Vertical path received signal power to the Horizontal path received signal power.
Transmit Power	This field lists the current combined transmit power level, in dBm.

Attribute	Meaning
Signal to Noise Ratio	This field lists the current signal-to-noise level, an indication of the separation of the received power level vs. noise floor.
Beacons	Displays a count of beacons received by the BHM in percentage. This value must be typically between 99-100%. If lower than 99%, it indicates a problematic link. This statistic is updated every 16 seconds.
Air Delay	This field displays the distance in feet between this BHS and the BHM. To derive the distance in meters, multiply the value of this parameter by 0.3048. Distances reported as less than 200 feet (61 meters) are unreliable.
Data Slots Down	This field lists the number of slots used for downlink data transmission.
Data Slots Up	This field lists the number of slots used for uplink data transmission.
Regional Code	A parameter that offers multiple fixed selections, each of which automatically implements frequency band range restrictions for the selected region. Units shipped to regions other than the United States must be configured with the corresponding Country Code to comply with local regulatory requirements.
Site Name	This field indicates the name of the physical module. Assign or change this name in the Configuration > SNMP page. This information is also set into the sysName SNMP MIB-II object and can be polled by an SNMP management server.
Time Updated and Location Code	This field displays information about the keying of the radio.

General Status page of BHS

The BHS's General Status page is explained in below table.

Table 117: General Status page attributes - BHS

Device Information	
Device Type :	4.9/5.9GHz MIMO OFDM - Backhaul - Timing Slave - 0a-00-3e-bb-ae-1b
Board Type :	P13
Product Type :	PTP 450i
Software Version :	CANOPY 15.1.5 BHUL450-DES
CPU Usage :	2%
Board MSN :	M9TJ1DRLGM5L
Board Model :	C050045B001A
FPGA Version :	020118
Uptime :	01:00:23
System Time :	23:22:08 01/02/2016 UTC
Main Ethernet Interface :	No Link
Aux Ethernet Interface :	Disabled (PoE Disabled)
Region Code :	Other
DFS :	Idle
Antenna Type :	External
Frame Period :	5.0 ms
Temperature :	27 °C / 81 °F
802.3at Type 2 PoE Status :	Not Present (Ignored)

Timing Slave Stats	
Session Status :	REGISTERED VC 18 Rate 8X/1X MIMO-A VC 255 Rate 8X/8X MIMO-B
Session Uptime :	00:59:53
Registered Backhaul :	0a-00-3e-bb-b0-c1
Channel Frequency :	5750.0 MHz
Channel Bandwidth :	40.0 MHz
Cyclic Prefix :	1/16
Air Delay :	100 ns, approximately 0.009 miles (49 feet)
Receive Power :	-42.9 dBm
Signal Strength Ratio :	2.0dB V - H
Signal to Noise Ratio :	43 V / 43 H dB
Transmit Power :	16 dBm
Total Antenna Gain :	0 dBi
Beacons :	100 %

Frame Configuration Information	
Data Slots Down :	191
Data Slots Up :	192

Region Specific Information	
Region Code :	Other

cnMaestro Connection Stats	
Connection Status :	Device Not Claimed (cloud.cambiumnetworks.com - Default Cloud URL)
AccountID :	

Site Information	
Site Name :	No Site Name
Site Contact :	No Site Contact
Site Location :	No Site Location

Feature Key Information	
Time Updated and Location Code :	01/03/2018 06:11:06 - HJDJ

Attribute	Meaning
Device Type	See General Status page of BHS
Board Type	
Software Version	
CPU Usage	
Board MSN	
Board Model	
FPGA Version	
Uptime	
System Time	
Ethernet Interface	
Antenna Type	
Temperature	
Session Status	
Session Uptime	
Registered Backhaul	
Channel Frequency	
Receive Power	
Signal Strength Ratio	
Transmit Power	
Signal to Noise Ratio	
Beacons	
Air Delay	
Data Slots Down	
Data Slots Up	
Regional Code	
Site Name	See General Status page of BHS
Site Contact	
Site Location	
Time Updated and Location Code	

Viewing Session Status

The Session Status page in the Home page provides information about each SM or BHS that has registered to the AP or BHM. This information is useful for managing and troubleshooting a system. This page also includes the current active values on each SM or BHS for MIR and VLAN, as well as the source of these values, representing the SM/BHS itself, Authentication Server, or the Authentication Server and SM/BHS.

Note
For accurate power level readings to be displayed, traffic must be present on the radio link.

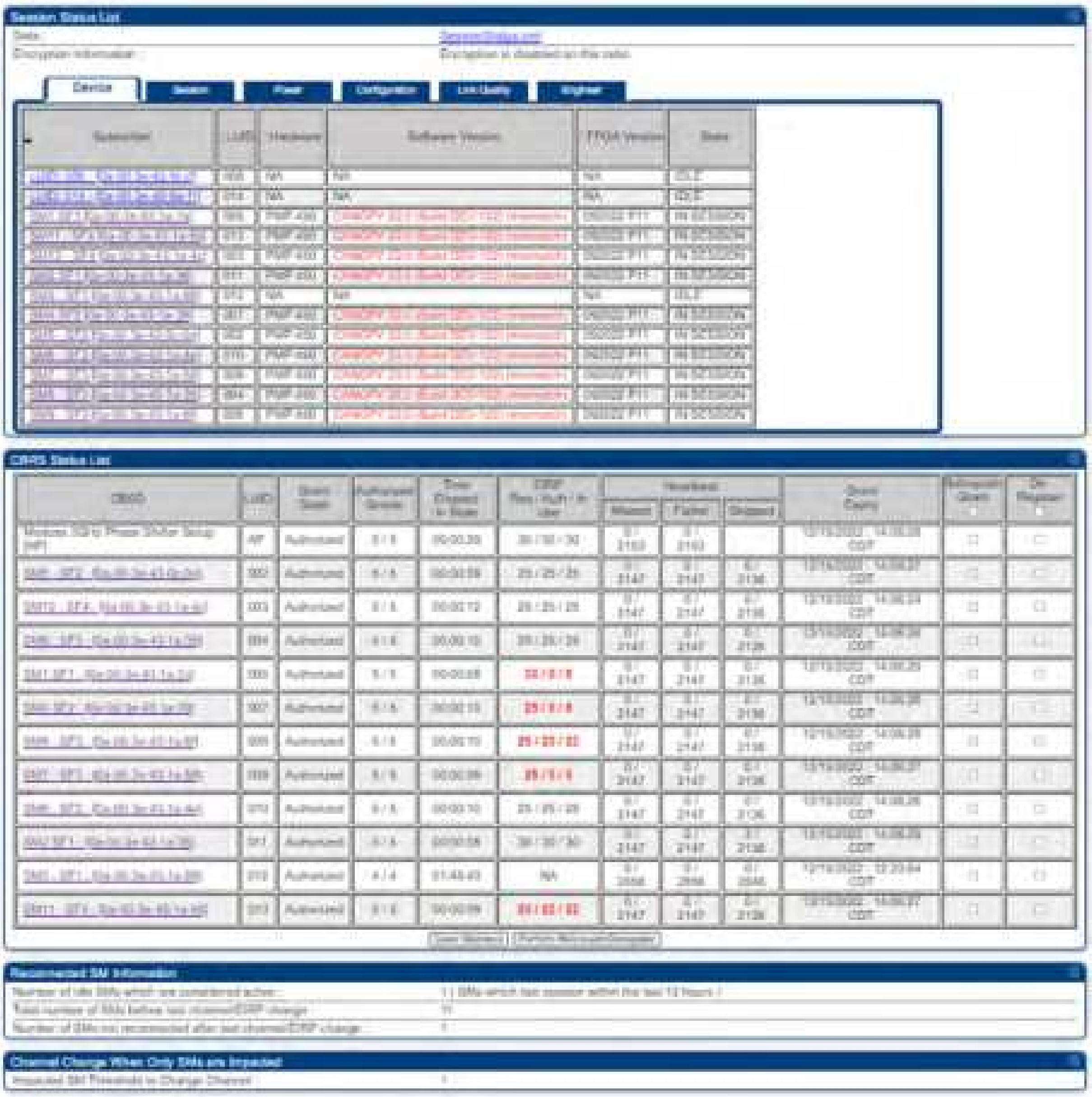
The Session Status List has four tabs: Device, Session, Power, Configuration, and Link Quality.

The Session Status .xml hyper link allows user to export session status page from web management interface of AP or BHM. The session status page will be exported in xml file.

Device tab

The Device tab provides information on the Subscriber's LUID and MAC, Hardware, Software, FPGA versions and the state of the SM/BHS (Registered and/or encrypted).

Table 118: Device tab attributes



Attribute	Meaning
Subscriber	This field displays the LUID (logical unit ID), MAC address and Site Name of the SM/BHS. **Note**: The MAC is a hot link to open the interface to the SM/BHS. In some instances, depending on network activity and network design, this route to the interface yields a blank web page. If this occurs, refresh your browser view. Site Name indicates the name of the SM/BHS. Change this name on the Configuration web page of the SM/BHS. This information is also set into the sysName SNMP MIB-II object and can be polled by an SNMP management server.

Attribute	Meaning
LUID	This field displays the LUID (logical unit ID) of the SM/BHS. As each SM or BHS registers to the AP/BHM, the system assigns an LUID of 2 or a higher unique number to the SM/BHS. If a SM/BHS loses registration with the AP/BHS and then regains registration, the SM/BHS will retain the same LUID. **Note**: Both the LUID and the MAC are hot links to open the interface to the SM/BHS. In some instances, depending on network activity and network design, this route to the interface yields a blank web page. If this occurs, refresh your browser view.
Hardware	This field displays the SMs or BHS hardware type.
Software Version	This field displays the software release that operates on the SM/BHS, the release date and time of the software.
FPGA Version	This field displays the version of FPGA that runs on the SM/BHS
State	This field displays the current status of the SM/BHS as either • IN SESSION to indicate that the SM/BHS is currently registered to the AP/BHM. • IDLE to indicate that the SM/BHS was registered to the AP/BHM at one time, but now is not. This field also indicates whether the encryption scheme in the module is enabled.
Airlink Security	Attribute is available if AP security setting is AES. Will be missing if security setting is NONE. Possible values are AES-128 and AES-256.
Grant State	This field displays the current Grant State such as Registered, Granted, Suspended, Authorized and Unregistered.
Authorized Grants	The field indicates the total number of AUTHORIZED grants for this device, followed by the total number of grants for this device. If the Multigrant feature is disabled, there will never be more than 1 grant per device.
Time Elapsed In State	Displays the time since the last state change.
EIRP Req/Auth/In Use	**Req:** EIRP requested in the Grant Request. **Auth:** EIRP allowed by the SAS in the grant response. CBRS operators using Federated Wireless SAS might also see a TMP flag in this field. This indicates that the Authorized grant value is a **same day** grant value - a temporary value while the SAS does more precise calculations on what a final value could be. This TMP flag would be cleared in less than 24 hours - at the next CBRS CPAs interval, at which time the final EIRP value, which can be more, less, or equal to the TMP value, would be granted.

Attribute	Meaning
	In Use: For SMs, this value is the smaller of the **granted EIRP** and the **Max EIRP** configured on the SM. It represents the largest EIRP value the SM can power control up to. A cnMaestro obtained grant value larger than the SMs configured Max EIRP is 1 scenario where this **In Use** value is lower than the Authorized value. A runtime edit of the SM's Max EIRP to a value lower than the authorized value is another example, although in this case the **In Use** value does not reflect the edit until the next SM or AP reboot.
Heartbeat	**Missed:** The heartbeat request was sent but no response was received. **Failed:** The heartbeat response was received with a failure code. **Skipped:** The AP did not include this SM in the HB exchange (For SM only).
Grant Expiry	Displays the Day/Time grant expires.
Relinguish Grant	Check and click **Perform Religuish/Deregister** button to relinquish this grant. Keep checked to prevent the device to request the same grant.
De-Register	Check and click the **Perform Religuish/Deregister** button to de-register this device (and relinquish associated grants). Keep checked to prevent the device from de-registering.
Number of idle SMs which are considered active	This is a count of the number of SMs that, after a channel/EIRP change, are currently in IDLE state and are being tracked and expected to reconnect to compute the percentage used in the SM Reconnection Percentage alarm feature. SMs that were IDLE just before a channel/EIRP change, but had a connected state at any time in the 12 hours before the channel/EIRP are counted. Additionally, if the AP rebooted 12 hours before the channel/EIRP change, all IDLE SMs are counted.
Total number of SMs before last channel/EIRP change	This is the total number of SMs that were connected before the most recent change and the number of SMs that were idle just before the channel/EIRP change but are being considered active per the definition described in the **Number of idle SMs which are considered active** above.
Number of SMs not reconnected after last channel/EIRP change	This is a count of the number of SMs that are expected to reconnect, but have not reconnected to the air interface since the last channel/EIRP change.
Channel Change When Only SMs are Impacted	This statistic is a computation of the number of active SMs that need to experience a termination or suspension before the **Channel Change When Only SMs are Impacted** feature is invoked, moving the sector's channel, based only on CBRS SM terminations or suspensions while the AP is authorized. Only currently active SMs factor into this statistic. For example, if four SMs are active and the **Threshold for Channel Change** configuration item is left at its default value of 10%, then this statistic has a value of 1. Changing the **Threshold for Channel Change** configuration value from 10% to 26% changes this statistic to a value of 2.

Note

Reconnected SM Information table of counters is not normally visible – it's not visible after an AP upgrade or reboot. The table will appear and begin updating when a channel/EIRP change has been made.

Session tab

The Session tab provides information on the SMs or BHS Session Count, Reg Count, Re-Reg Count, Uptime, Air delay, PPPoE State and Timeouts.

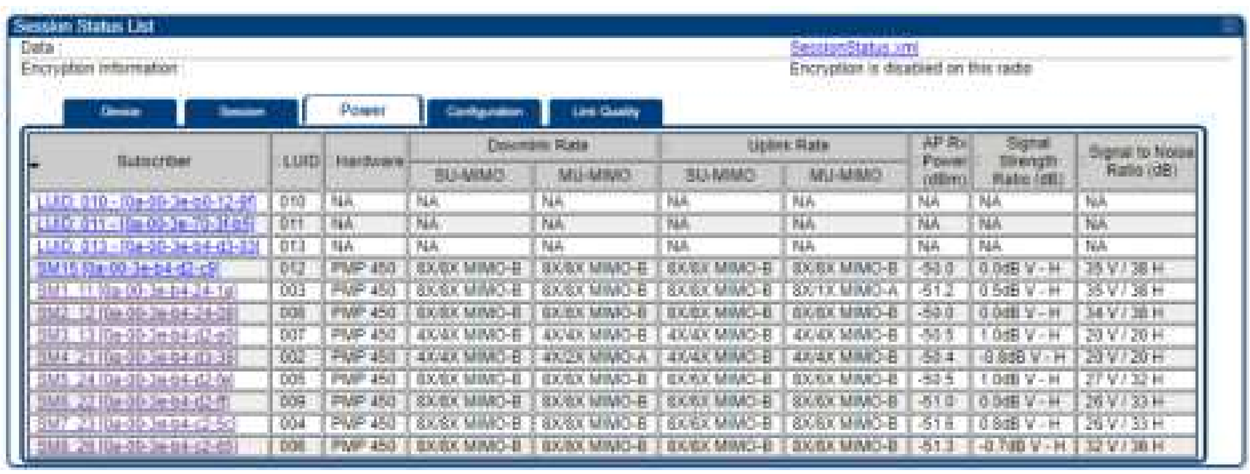
Table 119: Session tab attributes

Attribute	Meaning
Subscriber	See Device tab attributes
LUID	See Device tab attributes
State	This filed displays the status of the registered SM.
Uptime (Downtime)	Once a SM/BHS successfully registers to an AP/BHM, this timer is started. If a session drops or is interrupted, this timer is reactivated once re-registration is complete.
Session Count	This field displays how many sessions the SM/BHS has had with the AP/BHM. Typically, this is the sum of Registration Requests and Re-Registration Requests. However, the result of internal calculation may display here as a value that slightly differs from the sum. If the number of sessions is significantly greater than the number for other SMs or BHS, then this may indicate a link problem or an interference problem.
Registration Requests	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. In ideal situation, the Registration Requests indicates total number of connected SMs to an AP. **Note** The user can clear Registration Requests by dropping all current sessions of SM (or BHS) from Configuration > Tools > Sessions menu.
Re-Registration Requests	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-Registration Requests is the case where both: • SM/BHS attempts to reregister for having lost communication with the AP/BHM.

Attribute	Meaning
	• AP/BHM has not yet observed the link to the SM/BHS as being down. It is possible for a small period of time if there is no downlink traffic and AP/BHM still assumes the session is up, but the SM/BHS, loses session and quickly re-connects before the AP/BHM knew the session had dropped. This is how a re-registration happens. If the number of sessions is significantly greater than the number for other SMs or BHS, then this may indicate a link problem (check mounting, alignment, receive power levels) or an interference problem (conduct a spectrum scan).
CC Priority	The field displays Color Code Priority (ICC, Primary, Secondary or Tertiary) of all connected SM.
AirDelay	This field displays the distance of the SM/BHS from the AP/BHM in meters, nanoseconds and bits. At close distances, the value in this field is unreliable.
PPPoE state	This field displays the current PPPoE state (whether configured) of the SM/BHS.
Timeout	This field displays the timeout in seconds for management sessions via HTTP, ftp access to the SM/BHS. 0 indicates that no limit is imposed.

Power tab

Table 120: Power tab attributes



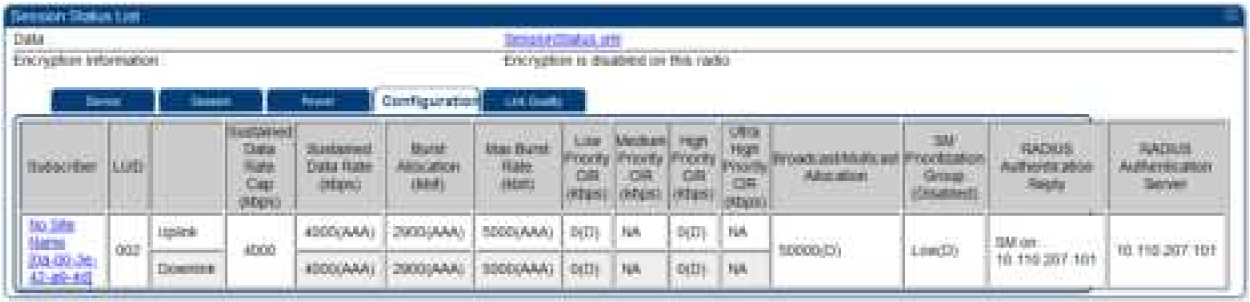
Attribute	Meaning
Subscriber	See Device tab attributes
LUID	See Device tab attributes
Hardware	This field displays the SMs or BHS hardware type.
Downlink Rate SU-MIMO	This field displays whether the high-priority channel is enabled in the SM/BHS and the status of rate adapt. For example, if “8X/4X” is listed, the radio is capable of operating at 8X but is currently operating at 4X, due to RF conditions.

Attribute	Meaning
	This field also states whether it is MIMO-A or MIMO-B radio e.g. “8X/8X MIMO-B” indicates MIMO-B and “8X/4X MIMO-A” indicates MIMO-A. A data channel starts at its lowest modulation and slowly rate adapts up, as traffic is successfully transmitted over the data channel. From system release 15.2, all data channels in a single SM will have the same modulation rates. Note: The SU-MIMO rate applies to all AP platforms. For 450m, this field indicates the rate being used for symbols where this particular VC is not being MU-MIMO grouped with other SMs.
Downlink Rate MU-MIMO	This field indicates the modulation rate used for symbols where the low or medium priority data channels are MU-MIMO scheduled by grouping it in the same slot with other low or Medium priority data channels from other SM's.
Uplink Rate SU-MIMO	This field the status of rate adapt. For example, if “8X/4X” is listed, the radio is capable of operating at 8X but is currently operating at 4X, due to RF conditions. This field also states whether it is MIMO-A or MIMO-B radio e.g. “8X/8X MIMO-B” indicates MIMO-B and “8X/4X MIMO-A” indicates MIMO-A. A data channel starts at its lowest modulation and slowly rate adapts up, as traffic is successfully transmitted over the data channel. From system release 15.2, all data channels in a single SM will have the same modulation rates. Note: The SU-MIMO rate applies to all AP platforms. For 450m, this field indicates the rate being used for symbols where this particular VC is not being MU-MIMO grouped with other SMs.
Uplink Rate MU-MIMO	This field indicates the modulation rate used for symbols where the MUMIMO groupable data channels are MU-MIMO scheduled by grouping it in the same slot with other MU-MIMO groupable data channels from other SM's.
AP Rx Power (dBm)	This field indicates the AP’s or BHM’s combined receive power level for the listed SM/BHS.
Signal Strength Ratio (dB)	This field displays the ratio of the Vertical path received signal power to the Horizontal path received signal power. This ratio can be useful for determining multipathing conditions (high vertical to horizontal ratio) for Uplink.
Signal to Noise Ratio (dB)	This field lists the current signal-to-noise level, an indication of the separation of the received power level vs. noise floor. In other words, it indicates signal to noise ratio for Uplink.

Configuration tab

The Configuration tab provides information on the SMs or BHS Uplink or Downlink (UL/DL) Sustained Data Rate, UL/DL Burst Allocation, UL/DL Burst Rate, UL/DL Low Priority CIR, UL/DL Medium Priority CIR UL/DL High Priority CIR, UL/DL Ultra High Priority CIR, the UL/DL Broadcast or Multicast Allocation, SM Prioritization Group, RADIUS Authentication Reply, and RADIUS Authentication Server. This data is refreshed based on the Web Page Auto Update setting on the AP’s or BHS’s General Configuration page.

Table 121: Configuration tab attributes



Attribute	Meaning
Subscriber	See Device tab attributes
LUID	
Sustained Data Rate Cap (kbps)	This field specifies the maximum sustained data rate between SM/BHS and AP/BHM. If this field displays “Uncapped”, then there is no limit set for data rate. If this field displays 4000, then the maximum sustained data rate between SM/BHS and AP/BHM is limited to 4000 kbps.
Sustained Data Rate (kbps) - Uplink	This field displays the value that is currently in effect for the SM/BHS, with the source of that value in parentheses. This is the specified rate at which each SM/BHS registered to this AP/BHM is replenished with credits for transmission. The configuration source of the value is indicated in parentheses. See Maximum Information Rate (MIR) Parameters on page 1.
Sustained Data Rate (kbps) - Downlink	This field displays the value that is currently in effect for the SM/BHS, with the source of that value in parentheses. This is the specified the rate at which the AP/BHM should be replenished with credits (tokens) for transmission to each of the SMs/BHS’s in its sector. The configuration source of the value is indicated in parentheses. See Maximum Information Rate (MIR) Parameters.
Burst Allocation (kbit) - Uplink	This field displays the value that is currently in effect for the SM/BHS, with the source of that value in parentheses. This is the specified maximum amount of data that each SM/BHS is allowed to transmit before being recharged at the Sustained Uplink Data Rate with credits to transmit more. The configuration source of the value is indicated in parentheses. See Interaction of Burst Allocation and Sustained Data Rate Settings.
Burst Allocation (kbit) - Downlink	This field displays the value that is currently in effect for the SM/BHS, with the source of that value in parentheses. This is the specified the rate at which the AP/BHM should be replenished with credits (tokens) for transmission to each of the SMs/BHS’s in its sector. The configuration source of the value is indicated in parentheses. See Interaction of Burst Allocation and Sustained Data Rate Settings.
Max Burst Rate (kbit) - Uplink	The data rate at which an SM/BHS is allowed to burst (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.

Attribute	Meaning
	See Interaction of Burst Allocation and Sustained Data Rate Settings.
Max Burst Rate (kbit) - Downlink	The data rate at which an SM/BHS is allowed to burst (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. See Interaction of Burst Allocation and Sustained Data Rate Settings.
Low Priority CIR	This field indicates the minimum rate at which low priority traffic is sent over the uplink and downlink (unless CIR is oversubscribed or RF link quality is degraded).
Medium Priority CIR	This field indicates the minimum rate at which medium priority traffic is sent over the uplink and downlink (unless CIR is oversubscribed or RF link quality is degraded).
High Priority CIR	This field indicates the minimum rate at which high priority traffic is sent over the uplink and downlink (unless CIR is oversubscribed or RF link quality is degraded).
Ultra High Priority CIR	This field indicates the minimum rate at which ultra high priority traffic is sent over the uplink and downlink (unless CIR is oversubscribed or RF link quality is degraded).
Broadcast/Multicast Allocation	This field displays the data rate at which Broadcast and Multicast traffic is sent via the radio link.
SM Prioritization Group	This field displays the priority level configured on the SM under SM Prioritization Group.
RADIUS Authentication Reply	This field displays whether RADIUS server is reachable or not.
RADIUS Authentication Server	This field displays the associated RADIUS Authentication Server for each SM where it was authenticated. This information is useful when there are multiple RADIUS servers (maximum three servers supported by Cambium). If one server is not reachable, other configured servers are tried in sequential order as a fall-back. In this scenario, the Session Status is useful to identify associate RADIUS Authentication Server for all connected SMs.

Table 122: Session Status > Configuration CIR configuration denotations

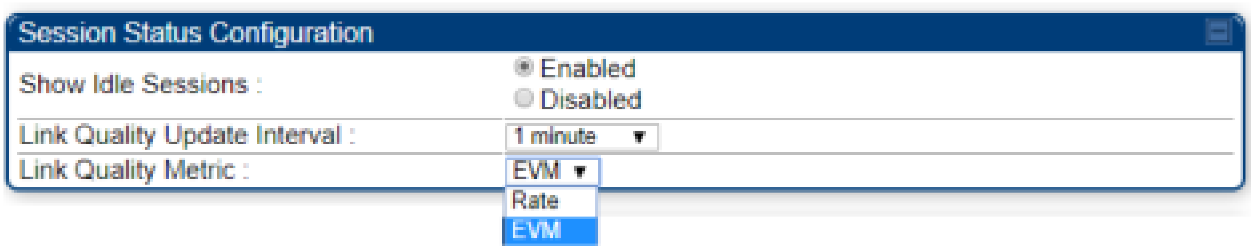
Attribute	Meaning
(SM)	QoS/VLAN parameters are derived from the SM's/BHS's settings
(APCAP)	QoS/VLAN parameters are derived from the AP's settings, including any keyed capping (for radios capped at 4 Mbps, 10 Mbps, or 20 Mbps)
(D)	QoS/VLAN parameters are retrieved from the device, due to failed retrieval from the AAA or WM server.
(AAA)	QoS/VLAN parameters are retrieved from the RADIUS server
(BAM)	QoS/VLAN parameters are retrieved from a WM BAM server

Link Quality tab

The Link Quality tab provides information on the Subscriber's UID, Link quality, Downlink, Uplink, Beacon, ReReg, and the Uptime.

This data is refreshed based on the Link Quality Update Interval parameter configuration under the Sessions Status page.

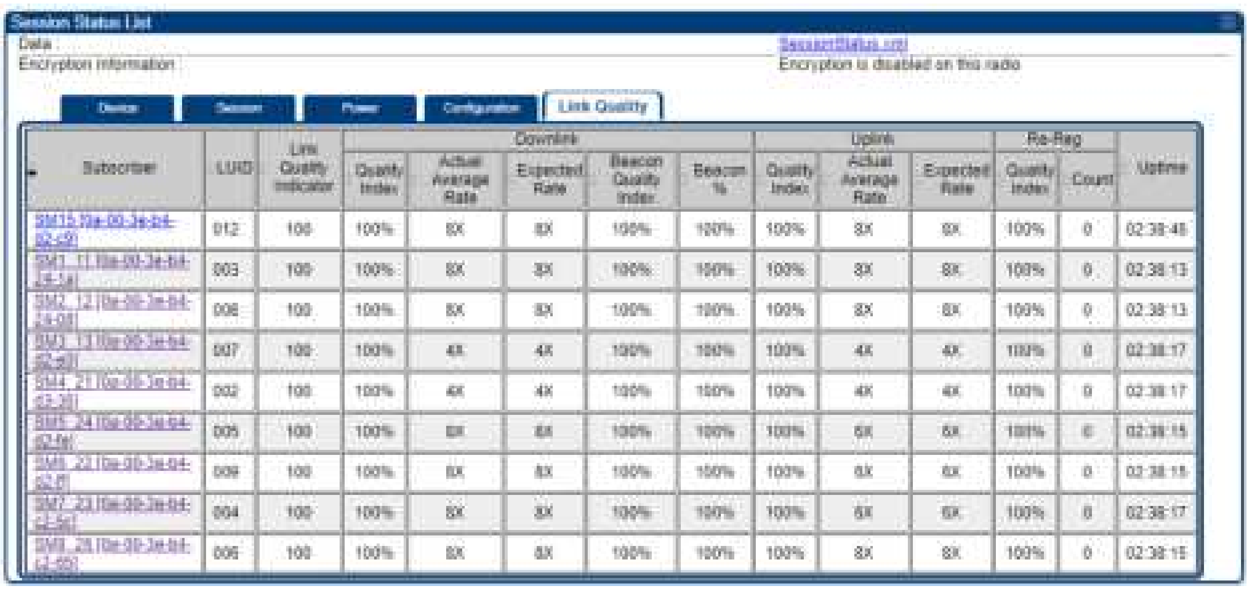
Link Quality Metric parameter offers an option to choose either EVM or Rate based LQI calculation.



The Link Quality tab displays the calculated Link Quality Indicator (LQI) for the configured interval (Link Quality Update Interval parameter).

Table 123: Link Quality tab attributes

Link Quality Metric: Rate



Subscriber	LUID	Link Quality Indicator	Downlink Quality Index	Downlink Actual Average Rate	Downlink Expected Rate	Downlink Beacon Quality Index	Downlink Beacon %	Uplink Quality Index	Uplink Actual Average Rate	Uplink Expected Rate	Re-Reg Quality Index	Re-Reg Count	Uptime
SM15 [illegible]	012	100	100%	8X	8X	100%	100%	100%	8X	8X	100%	0	02:38:45
SM1_11 [illegible]	003	100	100%	8X	8X	100%	100%	100%	8X	8X	100%	0	02:38:13
SM2_12 [illegible]	008	100	100%	8X	8X	100%	100%	100%	8X	8X	100%	0	02:38:13
SM3_13 [illegible]	007	100	100%	4X	4X	100%	100%	100%	4X	4X	100%	0	02:38:17
SM4_21 [illegible]	002	100	100%	4X	4X	100%	100%	100%	4X	4X	100%	0	02:38:17
SM5_24 [illegible]	005	100	100%	8X	8X	100%	100%	100%	6X	6X	100%	0	02:38:15
SM6_22 [illegible]	009	100	100%	8X	8X	100%	100%	100%	6X	6X	100%	0	02:38:15
SM7_23 [illegible]	004	100	100%	8X	8X	100%	100%	100%	6X	6X	100%	0	02:38:17
SM8_28 [illegible]	006	100	100%	8X	8X	100%	100%	100%	8X	8X	100%	0	02:38:15

Link Quality Metric: EVM

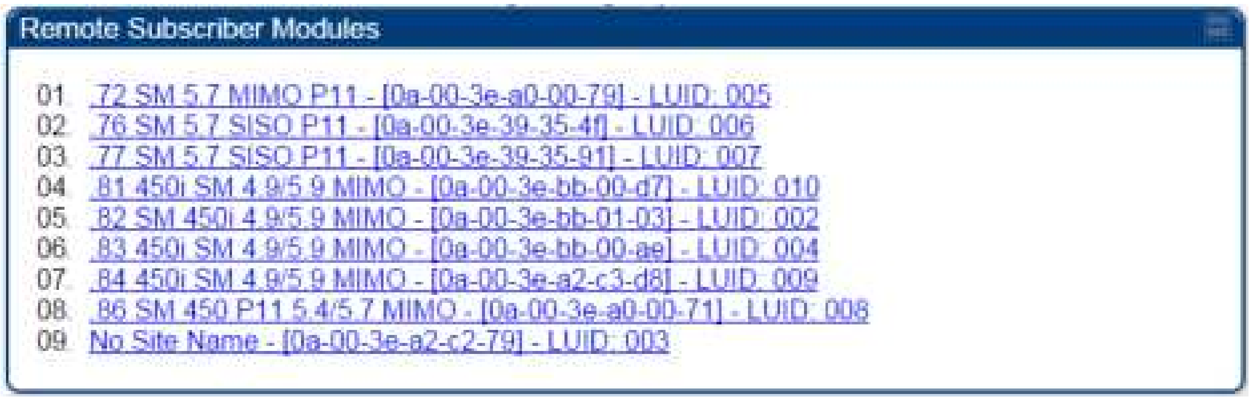
Subscriber	LUID	Link Quality Indicator	Downlink Quality Index	Downlink Actual Average EVM	Downlink Expected EVM	Downlink Beacon Quality Index	Downlink Beacon %	Uplink Quality Index	Uplink Actual Average EVM	Uplink Expected EVM	Re-Reg Quality Index	Re-Reg Count	Uptime
vSM [illegible]	002	99	99%	-28.1	-29.0	100%	100%	100%	-27.1	-25.0	100%	0	3 days, 18:18:17

Attribute	Meaning
Subscriber	See Device tab attributes
LUID	
Link Quality Indicator	This field displays quality of the link. It is calculated based on receive power, modulation rate, re-registrations and beacon percentage.
Downlink - Quality Index	This field displays the downlink quality in percentage. It is calculated based on Downlink receiver power, modulation rate, and beacon percentage.
Downlink - Actual Average Rate	This field displays the average Downlink modulation rate. For 450m, this field specifies the SU-MIMO Modulation Rate. When Rate based LQI is selected, only actual rate and expected rate will be displayed.
Downlink - Actual Average EVM	This field displays the average Downlink EVM rate.
Downlink - Expected Rate	This field displays the expected modulation rate based on receive power in Downlink. When EVM based LQI is selected, only actual EVM and expected EVM will be displayed.
Downlink - Beacon Quality Index	This field displays the beacon quality index. It is calculated based on beacon percentage.
Downlink - Beacon %	This field displays the received beacon percentage.
Uplink - Quality Index	This field displays the uplink quality in percentage. It is calculated based on Uplink receiver power and modulation rate.
Uplink -Actual Average Rate	This field displays the average Uplink modulation rate.
Uplink -Actual Average EVM	This field displays the average Uplink EVM rate.
Uplink - Expected Rate	This field displays the expected modulation rate based on receive power in Uplink.
Re-Reg - Quality Index	This field displays the re-registration quality. It is calculated based on the re-registration count.
Re-Reg Count	This field displays the number of re-registrations.
Uptime	This field displays the uptime of the device.

Viewing Remote Subscribers

This page allows to view the web pages of registered SMs or BHS over the RF link. To view the pages for a selected SM/BHS, click its link. The General Status page of the SM opens.

Figure 111: *Remote Subscribers page of AP*



Interpreting messages in the Event Log

Each line in the Event Log of a module Home page begins with a time and date stamp. However, some of these lines wrap as a combined result of window width, browser preferences and line length. You may find this tab easiest to use if you expand the window till all lines are shown beginning with time and date stamp.

Time and Date Stamp

The time and date stamp reflect one of the following:

- GPS time and date directly or indirectly received from the CMM4.
- NTP time and date from a NTP server (CMM4 may serve as an NTP server)
- The running time and date that you have set in the Time & Date web page.

Note

In the Time & Date web page, if you have left any time field or date field unset and clicked the Set Time and Date button, then the time and date default to **00:00:00 UT: 01/01/00**.

A reboot causes the preset time to pause or, in some cases, to run in reverse. Additionally, a power cycle resets the running time and date to the default **00:00:00 UT: 01/01/00**. Thus, whenever either a reboot or a power cycle has occurred, must reset the time and date in the Time & Date web page of any module that is not set to receive sync.

Event Log Data Collection

The collection of event data continues through reboots and power cycles. When the buffer allowance for event log data is reached, the system adds new data into the log and discards an identical amount of the oldest data.

Each line that contains the expression WatchDog flags an event that was both:

- considered by the system software to have been an exception
- recorded in the preceding line.

Conversely, a Fatal Error () message flags an event that is recorded in the next line. Some exceptions and fatal errors may be significant and require either operator action or technical support.

Figure 112: *Event log data*

Messages that Flag Abnormal Events

The messages listed below flag abnormal events and, case by case, may signal the need for corrective action or technical support.

Table 124: Event Log messages for abnormal events

Event Message	Meaning
FatalError ()	The event recorded on the line immediately beneath this message triggered the Fatal Error ().
Loss of GPS Sync Pulse	Module has lost GPS sync signal.
Machine Check Exception	This is a symptom of a possible hardware failure. If this is a recurring message, begin the RMA process for the module.
System Reset Exception External Hard Reset	The unit lost power or was power cycled.
System Reset Exception External Hard Reset WatchDog	The event recorded on the preceding line triggered this WatchDog message.

Messages that Flag Normal Events

The messages listed below record normal events and typically do not signal a need for any corrective action or technical support.

Table 125: Event Log messages for normal events

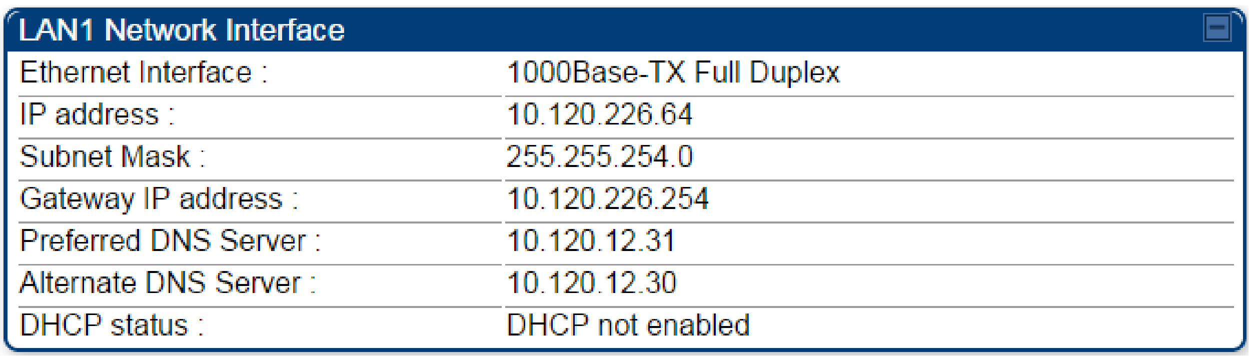
Event Message	Meaning
Acquired GPS Sync Pulse.	Module has acquired GPS sync signal.
FPGA Features	Type of encryption.
FPGA Version	FPGA (JBC) version in the module.

Event Message	Meaning
GPS Date/Time Set	Module is now on GPS time.
Reboot from Webpage	Module was rebooted from management interface.
Software Boot Version	Boot version in the module.
Software Version	The software release and authentication method for the unit.
System Log Cleared	Event log was manually cleared.

Viewing the Network Interface

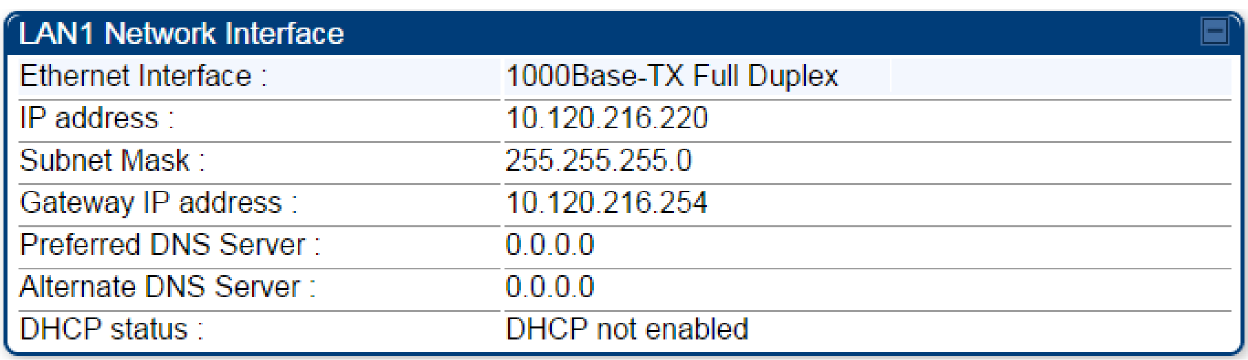
In any module, the LAN1 Network Interface section of this tab displays the defined Internet Protocol scheme for the Ethernet interface to the module. In SM/BHS devices, this page also provides an RF Public Network Interface section, which displays the Internet Protocol scheme defined for network access through the master device (AP/BHM).

Figure 113: *Network Interface tab of the AP*



LAN1 Network Interface	
Ethernet Interface :	1000Base-TX Full Duplex
IP address :	10.120.226.64
Subnet Mask :	255.255.254.0
Gateway IP address :	10.120.226.254
Preferred DNS Server :	10.120.12.31
Alternate DNS Server :	10.120.12.30
DHCP status :	DHCP not enabled

Figure 114: *Network Interface tab of the SM*

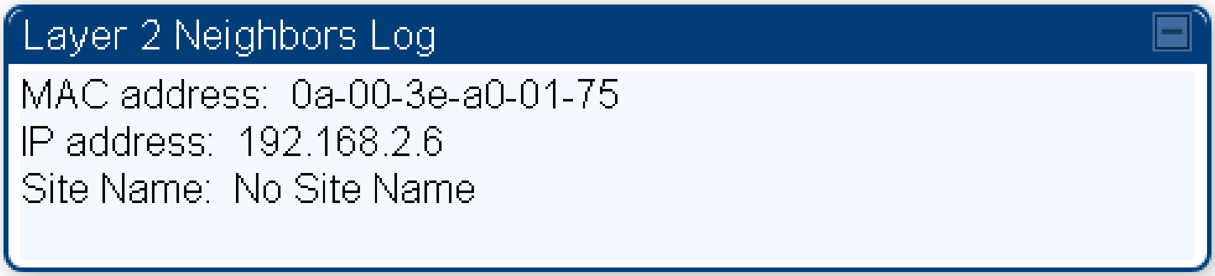


LAN1 Network Interface	
Ethernet Interface :	1000Base-TX Full Duplex
IP address :	10.120.216.220
Subnet Mask :	255.255.255.0
Gateway IP address :	10.120.216.254
Preferred DNS Server :	0.0.0.0
Alternate DNS Server :	0.0.0.0
DHCP status :	DHCP not enabled

Viewing the Layer 2 Neighbors

In the Layer 2 Neighbors tab, a module reports any device from which it has received a message in Link Layer Discovery Protocol within the previous two minutes. Given the frequency of LLDP messaging, this means that the connected device will appear in this tab 30 seconds after it is booted and remain until two minutes after its shutdown.

Figure 115: *Layer 2 Neighbors page*



System statistics

This section describes how to use the system statistics pages to manage the performance of the PMP/PTP 450 Platform Family link.

Viewing the Scheduler Statistics

The **Statistics -> Scheduler** page is applicable for all modules (AP/SM/BHM/BHS) and the parameters are displayed as shown below:

Table 126: Radio Statistics attributes for (AP/SM/BHM/BHS)

Radio Statistics	
Transmit Unicast Data Count :	6715
Transmit Broadcast Data Count :	904747
Transmit Multicast Data Count :	0
Receive Unicast Data Count :	1328470
Receive Broadcast Data Count :	57683
Receive Multicast Data Count :	0
Transmit Control Count :	98
Receive Control Count :	177
In Sync Count :	0
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
Rcv LT Start :	3
Rcv LT Start HS :	5
Rcv LT Result :	5
Xmt LT Result :	0
Frame Too Big :	0
Bad RCV Fragment :	0
Bad RCV Fragment Length :	0
VC Clear Error Count :	0
Rx No Buffer Count :	0
Scheduler Error :	90
Transmit Ring Error :	0
TDD Slips :	0

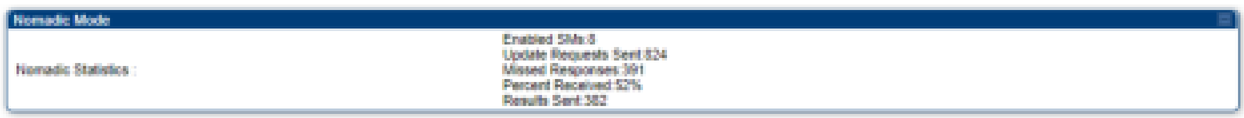
Attribute	Meaning
Transmit Unicast Data Count	Total amount of unicast packets transmitted from the radio
Transmit Broadcast Data Count	Total amount of broadcast packets transmitted from the radio
Transmit Multicast Data Count	Total amount of multicast packets transmitted by the radio
Receive Unicast Data Count	Total amount of unicast packets received by the radio
Receive Broadcast Data Count	Total amount of broadcast packets received by the radio

Attribute	Meaning
Receive Multicast Data Count	Total amount of multicast packets received by the radio
Transmit Control Count	Amount of radio control type messages transmitted (registration requests and grants, etc.)
Receive Control Count	Amount of radio control type messages received (registration requests and grants, etc.)
In Sync Count	Number of times the radio has acquired sync. When GPS synchronization is used it is number of times GPS sync acquired. For the SM, it is the number of times the SM successfully obtained sync with an AP.
Out of Sync Count	Number of times the radio lost same sync lock
Overrun Count	Number of times FPGA frame has overrun its TX Frame
Underrun Count	Number of times FPGAs TX Frame aborted prematurely
Receive Corrupt Data Count	Number of times a corrupt packet has been received at the FPGA.
Receive Corrupt Control Data Count	Number of times a corrupt control data packet has been received at the FPGA.
Receive Bad Broadcast Control Count	Number of times the radio has received an invalid control message via broadcast (SM only).
Rcv LT Start	Number of Link Test Start messages received. A remote radio has requested that this radio start a link test to it.
Rcv LT Start HS	Number of Link Test Start Handshake messages received. This radio requested that a remote radio start a link test and the remote radio has sent a handshake back acknowledging the start.
Rcv LT Result	This radio received Link Test results from the remote radio under test. When this radio initiates a link test, the remote radio will send its results to this radio for display.
Xmt LT Result	This radio transmitted its link test results to the remote radio under test. When the remote radio initiates a link test, this radio must send its results to the remote radio for display there.
Frame Too Big	This statistic indicates the number of packets received and processed by the radios which were greater than max packet size 1700 bytes.
Bad Acknowledgment	This statistic indicates the number of packets received as bad acknowledgment. It is for engineering use only.
Bad Fragment	This statistic indicates number of fragments tagged internally as bad. It is for engineering use only.
VC Clear Error Count	This statistic indicates number of times VC clear failed.

Attribute	Meaning
Rx No Buffer Count	Currently unused
Scheduler Error	This error is incremented when the scheduler cannot send or get scheduled to send a packet. It is also called as “VC Error”.
Transmit Ring Error	This is a state that records when Canopy’s MAC Transmit Ring Error. One or more of these will cause the session to drop and be re-established. That static should be zero. If you are seeing this statistic increment, please contact Cambium support.
TDD Slips	TDD Slips indicate that the 450m AP processer is heavily loaded and could lead to buffer discards.

The **Nomadic Mode** table is applicable for all modules (AP/SM) and the parameters are displayed as shown below:

Table 127: Nomadic mode for AP

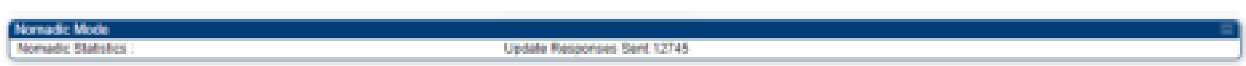


Attribute	Meaning
Enabled SMs	The number of registered SMs in this sector that have the Nomadic Mode feature enabled.
Update Requests Sent	Nomadic mode ranging updates are a 3 step exchange. The first step is an update request sent to the SM from the AP. This statistic counts the total number of these update requests sent to all the nomadic mode enabled SMs in the sector since the stats were last cleared.
Missed Responses	The second step in the 3 step ranging update exchange is an update response sent from the SM to the AP. Because these responses use the sector's contention space, missed responses will be common.
Percent Received	This is simply the percentage of responses that were not missed.
Results sent	The third step in the 3 steps ranging from update exchange is a Nomadic Mode result sent to the SM. Note that not received update responses will be valid, so it's common that the Results Sent/Update Requests Sent rate may be less than the Percent Received.

Note

The Nomadic Mode feature is not supported on PMP 450m and in PTP modes.

Table 128: Nomadic mode for SM



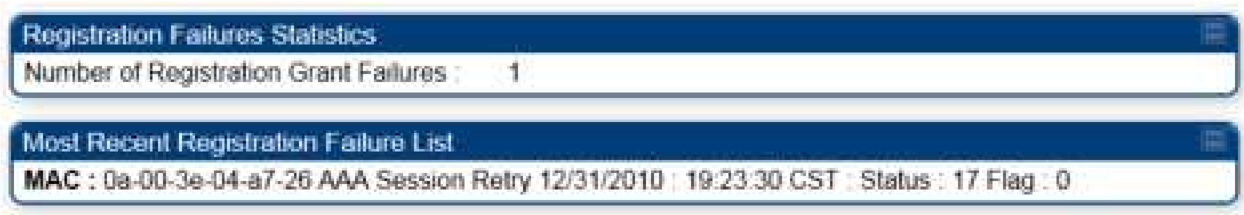
Attribute	Meaning
Update Responses Sent	The number of Nomadic Mode update responses sent to the AP.

Viewing list of Registration Failures statistics

SM Registration Failures page of AP

The SM Registration Failures tab identifies SMs that have recently attempted and failed to register to this AP. With its time stamps, these instances may suggest that a new or transient source of interference exists.

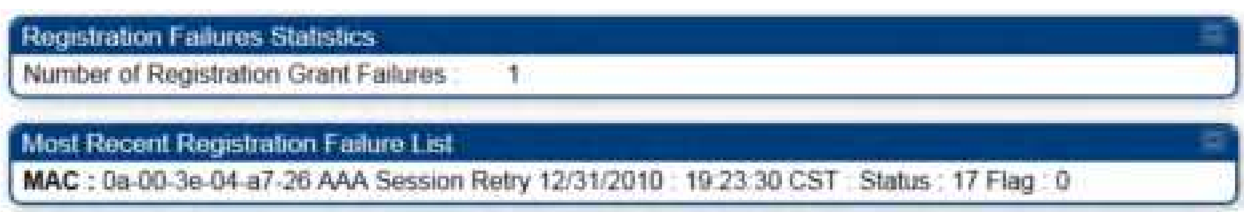
Table 129: SM Registration Failures page attributes - AP



Attribute	Meaning
Status 17 Flag 0	No response was received from the AAA server and hence SM is trying to send a session request again.

BHS Registration Failures page of BHM

Table 130: BHS Registration Failures page attributes - BHM



Attribute	Meaning
Status 17 Flag 0	No response was received from the AAA server and hence BHS is trying to send a session request again.

There is a list of flags from 0 to 20 as shown in Flags status and the "Flags" can be ignored.

Table 131: Flags status

Flag	Meaning	Flag	Meaning
0	Normal	11	AP Lite Limit Reached
1	Out of Range	12	Only Ver 9.5+ Allowed
2	No Luids	13	Temporary Data VC for AAA
3	BH ReRange	14	AAA Authentication Failure

Flag	Meaning	Flag	Meaning
4	Auth Fail	15	Registration Grant Reject
5	Encrypt Fail	16	Blank
6	Power Adjust	17	AAA Session Retry
7	No VCs	18	AAA Reauth Failure
8	Reserve VC Fail	19	RegReq at zero power
9	Activate VC Fail	20	RegReq no time ref
10	Hi VC Setup Fail	-	-

Interpreting Bridging Table statistics

If NAT (network address translation) is not active on the SM/BHS, then the Bridging Table page provides the MAC address of all devices that are attached to registered SMs/BHS (identified by LUIDs).

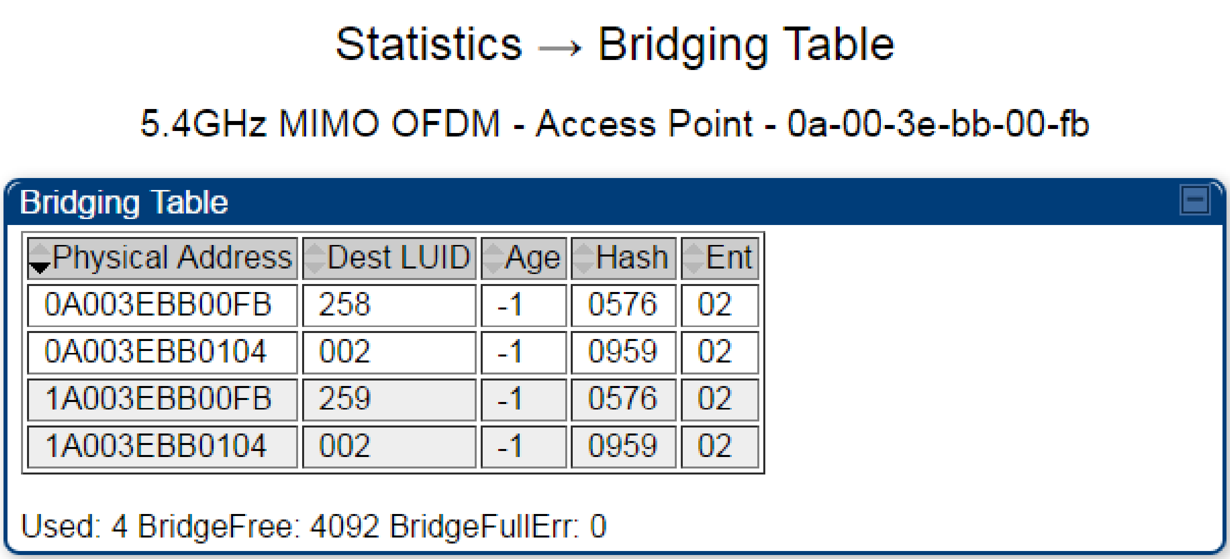
The SM/BHS management MAC addresses are also added in bridge table upon SMs/BHS registration. These entries will be remove automically from the table once SMs/BHS is de-registered. This alleviates the arp cache > bridge cache timeout problems.

The bridging table allows data to be sent to the correct module as follows:

- For the AP/BHM, the uplink is from RF to Ethernet. Thus, when a packet arrives in the RF interface to the AP/BHM, the AP/BHM reads the MAC address from the inbound packet and creates a bridging table entry of the source MAC address on the other end of the RF interface.

- For the SM/BHS, the uplink is from Ethernet to RF. Thus, when a packet arrives in the Ethernet interface to one of these modules, the module reads the MAC address from the inbound packet and creates a bridging table entry of the source MAC address on the other end of the Ethernet interface.

Figure 116: *Bridging Table page*



The Bridging Table supports up to 4096 entries.

Interpreting Translation Table statistics

When Translation Bridging is enabled in the AP, each SM keeps a table mapping MAC addresses of devices attached to the AP to IP addresses, as otherwise the mapping of end-user MAC addresses to IP addresses is lost. (When Translation Bridging is enabled, an AP modifies all uplink traffic originating from registered SMs such that the source MAC address of every packet is changed to that of the SM which bridged the packet in the uplink direction.)

Figure 117: *Translation Table page of SM*

Translation Table

Mac:002275394384 IpAddress:192.168.2.1 Age:0
Mac:001F3B4AC679 IpAddress:192.168.2.7 Age:0
Mac:902155C788E8 IpAddress:192.168.2.2 Age:0
Mac:000D4B76388B IpAddress:192.168.2.4 Age:0
Mac:AC81128BCCF4 IpAddress:192.168.2.3 Age:0
Mac:0004236DA056 IpAddress:192.168.2.8 Age:3
Mac:00265507A92B IpAddress:192.168.2.5 Age:4
Mac:902155C788E8 IpAddress:173.158.9.186 Age:68
Mac:5CDAD4818A2F IpAddress:192.168.2.9 Age:50
Mac:001F3B4AC679 IpAddress:192.168.50.137 Age:26

Interpreting Ethernet statistics

The Statistics > Ethernet page reports TCP throughput and error information for the Ethernet connection of the module. This page is applicable for all modules (AP/SM/BHM/BHS).

The Ethernet page displays the following fields.

Table 132: Ethernet tab attributes

Ethernet Statistics	
Link Detected :	3
Link Speed :	100Base-TX Full Duplex
PHY ID :	Micrel KSZ8041 P12 (0x00221510)
Link Uptime :	1 day, 1h:14m:28s
Link Lost :	2
Undersized Toss Count :	0
inoctets Count :	1028927
inucastpkts Count :	10908
Innucastpkts Count :	4792
indiscards Count :	0
inerrors Count :	0
inunknownprotos Count :	0
outoctets Count :	703480
outucastpktsCount :	3
outnucastpkts Count :	8180
outdiscards Count :	0
outerrors Count :	0
CRC Error :	0
RcvFifoNoBuf :	0
Late Collision :	0
Excessive Collision :	0
Tx Underrun :	0
Carrier Sense Lost :	0
No Carrier :	0
Large Frame :	0
Runt Frame :	0
Excessive Deferrals :	0
Jabbers :	0
RX Pause Frames Discarded :	0
RX Ethernet Bounce :	0
TX Ethernet Bounce :	0

Attribute	Meaning
Link Detected	3 indicates that an Ethernet link is established to the radio, 0 indicates that no Ethernet link is established.
Link Speed	This field indicates the speed of the link set of negotiated.
PHY ID	This field indicates the identifier of the Ethernet PHY chip on the PCB.
Link Uptime	This field indicates how long the Ethernet link has been up.
Link Lost	This field indicates a count of how many times the Ethernet link was lost.
Undersized Toss Count	This field indicates the number of packets that were too small to process and hence discarded.
inoctets Count	This field displays how many octets were received on the interface, including those that deliver framing information.
inucastpkts Count	This field displays how many inbound subnetwork-unicast packets were delivered to a higher-layer protocol.
Innucastpkts Count	This field displays how many inbound non-unicast (subnetwork-broadcast or subnetwork-multicast) packets were delivered to a higher-layer protocol.
indiscards Count	This field displays how many inbound packets were discarded without errors that would have prevented their delivery to a higher-layer protocol. (Some of these packets may have been discarded to increase buffer space.)
inerrors Count	This field displays how many inbound packets contained errors that prevented their delivery to a higher-layer protocol.
inunknownprotos Count	This field displays how many inbound packets were discarded because of an unknown or unsupported protocol.
outoctets Count	This field displays how many octets were transmitted out of the interface, including those that deliver framing information.
outucastpkts Count	This field displays how many packets for which the higher-level protocols requested transmission to a subnetwork-unicast address. The number includes those that were discarded or not sent.
outnucastpkts Count	This field displays how many packets for which the higher-level protocols requested transmission to a non-unicast (subnetwork-broadcast or subnetwork-multicast) address. The number includes those that were discarded or not sent.
outdiscards Count	This field displays how many outbound packets were discarded without errors that would have prevented their transmission. (Some of these packets may have been discarded to increase buffer space.)
outerrrors Count	This field displays how many outbound packets contained errors that prevented their transmission.
RxBabErr	This field displays how many receiver babble errors occurred.
RcvFifoNoBuf	This field displays the number of times no FIFO buffer space was able to be allocated.

Attribute	Meaning
	Note: PMP 450 AP running in Gigabit Ethernet Mode displays error “RcfFifoNoBuf” which indicates packet loss. For 450 AP platforms, if ethernet auto-negotation is set to Gigabit, then it is a known limitation that “RcfFifoNoBuf” error will be seen. This issue is not seen if autonegotation is set to 100Mbps or lower, and the issue is not seen on 450i or 450m AP's.
RxOverrun	This field displays how many receiver overrun errors occurred on the Ethernet controller.
Late Collision	This field displays how many late collisions occurred on the Ethernet controller. A normal collision occurs during the first 512 bits of the frame transmission. A collision that occurs after the first 512 bits is considered a late collision. **Caution** A late collision is a serious network problem because the frame being transmitted is discarded. A late collision is most commonly caused by a mismatch between duplex configurations at the ends of a link segment.
Excessive Collisions	This field displays the number of packets whose retransmission limit expired.
TxUnderrun	This field displays how many transmission-underrun errors occurred on the Ethernet controller.
Carrier Sense Lost	This field displays how many carrier sense lost errors occurred on the Ethernet controller.
No Carrier	This field displays how many no carrier errors occurred on the Ethernet controller.
Large Frame	An ethernet packet that has been recieved that is greater than the board MTU, or a segmented frame.
Excessive Deferrals	The number of frames that are not sent after the time exceeds the maximum-packet time.
Jabbers	A count of the number of attempts to send a packet > 2048 bytes.
RX Pause Frames Discarded	A count of the number of Ethernet pause frames discarded.
RX Ethernet Bounce	Number of times ethernet link has been bounced due to not receiving any ethernet packets over the configured ethernet bounce timeout interval.
TX Ethernet Bounce	Number of times ethernet link has been bounced due to not transmitting any ethernet packets over the configured ethernet bounce timeout interval.

Interpreting RF Control Block statistics

The Statistics > Radio page is applicable for all module (AP/SM/BHM/BHS). The Radio page of the Statistics page displays the following fields.

Table 133: Radio (Statistics) page attributes – RF Control Block

RF Control Block Statistics	
inoctets Count :	653532396
inucastpkts Count :	423096
Innucastpkts Count :	35848043
indiscards Count :	0
inerrors Count :	0
inunknownprotos Count :	0
outoctets Count :	138721214
outucastpktsCount :	401826
outnucastpkts Count :	13855
outdiscards Count :	120
outerrors Count :	0

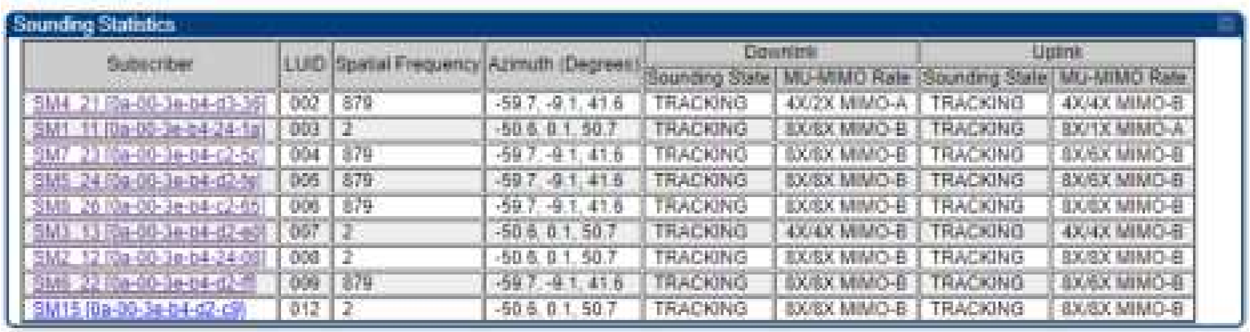
Attribute	Meaning
inoctets Count	This field displays how many octets were received on the interface, including those that deliver framing information.
inucastpkts Count	This field displays how many inbound subnetwork-unicast packets were delivered to a higher-layer protocol.
Innucastpkts Count	This field displays how many inbound non-unicast (subnetwork-broadcast or subnetwork-multicast) packets were delivered to a higher-layer protocol.
indiscards Count	This field displays how many inbound packets were discarded without errors that would have prevented their delivery to a higher-layer protocol. This stat is pegged whenever corrupt data is received by software or whenever the RF Software Bridge queue is full. Corrupt data is a very unusual event because all packets are CRC checked by hardware before being passed into software. The likely case for indiscards is if the RF bridge queue is full. If this is the case the radio is most likely PPS limited due to excessive small packet traffic or a problem at the Ethernet interface. If there is a problem at the Ethernet interface there is likely to be discards at the Ethernet as well.
inerrors Count	This field displays how many inbound packets contained errors that prevented their delivery to a higher-layer protocol.
inunknownprotos Count	This field displays how many inbound packets were discarded because of an unknown or unsupported protocol.
outoctets Count	This field displays how many octets were transmitted out of the interface, including those that deliver framing information.
outucastpkts Count	This field displays how many packets for which the higher-level protocols requested transmission to a subnetwork-unicast address. The number includes those that were discarded or not sent.

Attribute	Meaning
outnucastpkts Count	This field displays how many packets for which the higher-level protocols requested transmission to a non-unicast (subnetwork-broadcast or subnetwork-multicast) address. The number includes those that were discarded or not sent.
outdiscards Count	This field displays how many outbound packets were discarded without errors that would have prevented their transmission. (Some of these packets may have been discarded to increase buffer space.)
outerrrors Count	This field displays how many outbound packets contained errors that prevented their transmission.

Interpreting Sounding statistics for AP

In the 450m AP GUI, sounding statistics can be found under Statistics > Sounding Statistics.

Table 134: Sounding Statistics - 450m AP page attributes



Sounding Statistics

Subscriber	LUID	Spatial Frequency	Azimuth (Degrees)	Downlink		Uplink	
				Sounding State	MU-MIMO Rate	Sounding State	MU-MIMO Rate
SM4_21 [0a-00-3e-b4-d3-38]	002	879	-59.7, -9.1, 41.6	TRACKING	4X/2X MIMO-A	TRACKING	4X/4X MIMO-B
SM1_11 [0a-00-3e-b4-24-1a]	003	2	-50.6, 0.1, 50.7	TRACKING	8X/8X MIMO-B	TRACKING	8X/1X MIMO-A
SM7_23 [0a-00-3e-b4-c2-5c	004	879	-59.7, -9.1, 41.6	TRACKING	8X/8X MIMO-B	TRACKING	8X/6X MIMO-B
SM5_24 [0a-00-3e-b4-d2-fe	005	879	-59.7, -9.1, 41.6	TRACKING	8X/8X MIMO-B	TRACKING	8X/6X MIMO-B
SM8_26 [0a-00-3e-b4-c2-65]	006	879	-59.7, -9.1, 41.6	TRACKING	8X/8X MIMO-B	TRACKING	8X/6X MIMO-B
SM3_13 [0a-00-3e-b4-d2-a6]	007	2	-50.6, 0.1, 50.7	TRACKING	4X/4X MIMO-B	TRACKING	4X/4X MIMO-B
SM2_12 [0a-00-3e-b4-24-08]	008	2	-50.6, 0.1, 50.7	TRACKING	8X/8X MIMO-B	TRACKING	8X/8X MIMO-B
SM6_22 [0a-00-3e-b4-d2-f	009	879	-59.7, -9.1, 41.6	TRACKING	8X/8X MIMO-B	TRACKING	8X/6X MIMO-B
SM15 [0a-00-3e-b4-d2-c9]	012	2	-50.6, 0.1, 50.7	TRACKING	8X/8X MIMO-B	TRACKING	8X/8X MIMO-B

Attribute	Meaning
Subscriber	This field displays the MAC address and Site Name of the SM/BHS. As each SM or BHS registers to the AP/BHM.
LUID	This field displays the LUID (logical unit ID) of the SM/BHS. As each SM or BHS registers to the AP/BHM, the system assigns an LUID of 2 or a higher unique number to the SM/BHS. If a SM/BHS loses registration with the AP/BHS and then regains registration, the SM/BHS will retain the same LUID.
Spatial Frequency	This field displays the spatial frequency value of the LUID or SM. Values 0 to 1023 are valid and value 2048 is considered as invalid.
Azimuth	This field displays the Azimuth range in degrees corresponding to the spatial frequencies of the bin. The zero-degree azimuth is boresight. **Note** Some SF ranges correspond to multiple azimuth ranges. This is because for some spatial frequencies the AP generates beams in multiple azimuth directions. The SM can be physically located in any of the azimuth ranges.
Downlink - Sounding State	Different types of Sounding states are:

Attribute	Meaning
	• UNKNOWN: SM has recently registered to the AP but not registered with the channel manager yet. • NEW: SM has been registered with the channel manager and will soon transition to ASSESSING. • ASSESSING: AP will instruct SM to take the channel measurements. Channel estimates and spatial frequencies will be calculated. • TRACKING: Valid measurements resulted in good channel estimates and spatial frequency. This SM can now be used for MU-MIMO. • INVALID: Inconsistent measurements resulting in no channel estimate or spatial frequency. This SM cannot be used for MU-MIMO and it will ultimately be re-assessed. • NOT ELIGIBLE: Due to poor RF link conditions, the RF link as rate adapted down to SU-MIMO transmissions.
Downlink - MU-MIMO Rate	This field indicates the modulation rate used for symbols where this particular LUID is MU-MIMO scheduled by grouping it in the same slot with other LUIDs.
Uplink - Sounding State	This field indicates the status of uplink sounding.
Uplink - MU-MIMO Rate	This field indicates the modulation rate used for symbols where the MU-MIMO groupable data channels are MU-MIMO scheduled by grouping it in the same slot with other MU-MIMO groupable data channels from other SM's.

Interpreting VLAN statistics

The Statistics > VLAN page provides a list of the most recent packets that were filtered because of VLAN membership violations. It is applicable for all modules (AP/SM/BHM/BHS).

Table 135: VLAN page attributes

Attribute	Meaning
Unknown	This must not occur. Contact Technical Support.
Only Tagged	The packet was filtered because the configuration is set to accept only packets that have an 802.1Q header and this packet did not.
Ingress	When the packet entered through the wired Ethernet interface, the packet was filtered because it indicated an incorrect VLAN membership.
Local Ingress	When the packet was received from the local TCP/IP stack, the packet was filtered because it indicated an incorrect VLAN membership. This must not occur. Contact Technical Support.
Egress	When the packet attempted to leave through the wired Ethernet interface, the packet was filtered because it indicated an incorrect VLAN membership.
Local Egress	When the packet attempted to reach the local TCP/IP stack, the packet was filtered because it indicated an incorrect VLAN membership.

Interpreting Data Channels statistics

The Statistics > Data Channels page displays information about data channels used in data communications. This page is applicable for all modules (AP/SM/BHM/BHS).

The Data VC tab displays the fields as explained in Data Channel page attributes.

Table 136: Data Channel page attributes

Data Channel Statistics

Subscriber	LUID	Channel Priority	Inbound Statistics: octets	ucast pkts	nucast pkts	discards	errors	Outbound Statistics: octets	ucast pkts	nucast pkts	discards	errors	Queue Overflow	High Priority Queue
SM4_21	002	Low	38471486	0	51742	0	0	78002604	681	45569	0	0	0	193
SM4_21	002	Medium	107730	0	63	0	0	107730	0	63	0	0	0	0
SM4_21	002	High	107730	0	63	0	0	107730	0	63	0	0	0	0
SM4_21	002	Ultra High	1038574	6878	100	0	0	152829	158	311	0	0	0	406
SM1_11	003	Low	1959	4	2	0	0	99422	777	0	0	0	0	241
SM1_11	003	Medium	0	0	0	0	0	0	0	0	0	0	0	0
SM1_11	003	High	0	0	0	0	0	0	0	0	0	0	0	0
SM1_11	003	Ultra High	648533	3960	36	0	0	41699	158	198	0	0	0	396
SM7_24	004	Low	10698383	5	6375	0	0	98431	811	1	0	0	0	292
SM7_23	004	Medium	0	0	6	0	0	0	0	0	0	0	0	0
SM7_23	004	High	0	0	0	0	0	0	0	0	0	0	0	0
SM7_23	004	Ultra High	636097	4008	37	0	0	45099	158	248	0	0	0	406
SM5_24	005	Low	10693173	5	6372	0	0	88204	764	1	0	0	0	234
SM5_24	005	Medium	0	0	6	0	0	0	0	0	0	0	0	0
SM5_24	005	High	0	0	0	0	0	0	0	0	0	0	0	0
SM5_24	005	Ultra High	671488	4291	37	0	0	45099	158	248	0	0	0	406
SM8_25	006	Low	14407593	5	8474	0	0	95689	742	1	0	0	0	224
SM8_25	006	Medium	0	0	0	0	0	0	0	0	0	0	0	0
SM8_25	006	High	0	0	0	0	0	0	0	0	0	0	0	0
SM8_25	006	Ultra High	751670	4825	36	0	0	45057	157	248	0	0	0	405
SM3_11	007	Low	12993053	5	7600	0	0	89789	670	1	0	0	0	154
SM3_11	007	Medium	0	0	0	0	0	0	0	0	0	0	0	0
SM3_11	007	High	0	0	0	0	0	0	0	0	0	0	0	0
SM3_11	007	Ultra High	636026	3968	38	0	0	45099	158	248	0	0	0	406
SM2_12	008	Low	21802973	5	12752	0	0	94194	739	1	0	0	0	220
SM2_12	008	Medium	0	0	0	0	0	0	0	0	0	0	0	0
SM2_12	008	High	0	0	0	0	0	0	0	0	0	0	0	0
SM2_12	008	Ultra High	637607	3881	38	0	0	45099	158	248	0	0	0	406
SM6_22	009	Low	10900583	5	6301	0	0	100175	801	1	0	0	0	275
SM6_22	009	Medium	0	0	0	0	0	0	0	0	0	0	0	0
SM6_22	009	High	0	0	0	0	0	0	0	0	0	0	0	0
SM6_22	009	Ultra High	696681	4521	36	0	0	45099	158	248	0	0	0	406
SM15	012	Low	22323136	3824	12741	0	0	142215	940	250	0	0	0	675
Multicast	252	NA	NA	NA	NA	NA	NA	88504	0	415	0	0	NA	NA
Broadcast	255	NA	NA	NA	NA	NA	NA	1006314	18	15912	0	0	NA	NA

Data Channel Statistics

Subscriber	LUID	SM Pri	Channel Priority	Inbound Statistics: octets	ucast pkts	nucast pkts	discards	errors	Outbound Statistics: octets	ucast pkts	nucast pkts	discards	errors
Broadcast	255	NA	NA	NA	NA	NA	NA	NA	5527765	399	25160	0	0
Multicast	252	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0
No Site Name	002	Low	Low	1948	4	1	0	0	2618	7	0	0	0
No Site Name	002	Low	High	8112944	49563	396	0	0	6033604	46813	4010	0	0

Fragments Modulation

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

Subscriber	LUID	Receive Fragments Modulation: QPSK	16-QAM	64-QAM	256-QAM	Retransmitted Fragments
No Site Name	002	44171 256	43626 221	43594 173	231 99	0

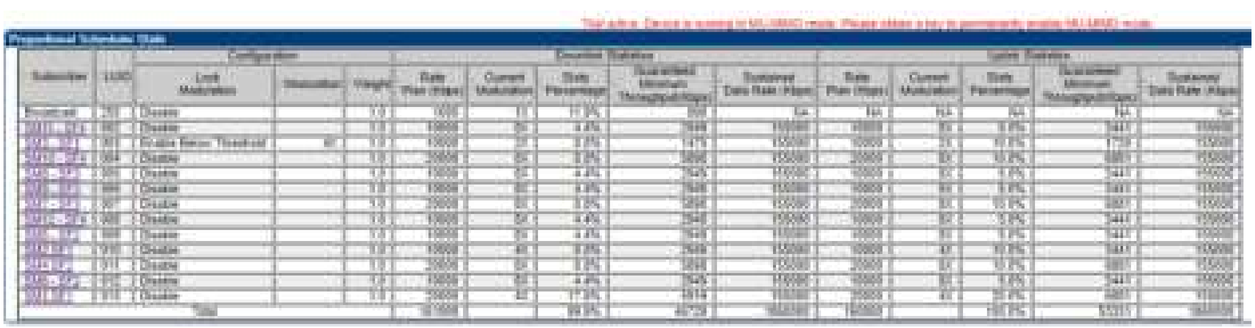
Attribute	Meaning
Subscriber	This field displays the MAC address and Site Name of the SM/BHS.
LUID	This field displays the LUID (logical unit ID) of the SM/BHS. As each SM or BHS registers to the AP/BHM, the system assigns an LUID of 2 or a higher unique number to the SM/BHS. If a SM/BHS loses registration with the AP/BHS and then regains registration, the SM/BHS will retain the same LUID. **Note** Both the LUID and the MAC are hot links to open the interface to the SM/BHS. In some instances, depending on network activity and network design, this route to the interface yields a blank web page. If this occurs, refresh your browser view.
Channel Priority	This field displays the channel priority for the virtual channel. The values supported are Low, Medium, High, and Ultra High.
Inbound Statistics, octets	This field displays how many octets were received on the interface, including those that deliver framing information.
Inbound Statistics, ucastpkts	This field displays how many inbound subnetwork-unicast packets were delivered to a higher-layer protocol.
Inbound Statistics, nucastpkts	This field displays how many inbound non-unicast (subnetwork-broadcast or subnetwork-multicast) packets were delivered to a higher-layer protocol.
Inbound Statistics, discards	This field displays how many inbound packets were discarded without errors that would have prevented their delivery to a higher-layer protocol. Inbound discard statistics are incremented similar to the indiscards stat on the RF control block stats page. The sum of all data VC indiscards must be close to the RF control block in discards. If indiscards are evenly distributed across SMs, then the radio is PPS limited due to either excessive small packet transmissions, or a problem at the Ethernet link. If indiscards are contained to one or a few SMs, then there is likely a problem at or underneath the SM which is incrementing the count.
Outbound Statistics, octets	This field displays how many octets were transmitted out of the interface, including those that deliver framing information.
Outbound Statistics, ucastpkts	This field displays how many packets for which the higher-level protocols requested transmission to a subnetwork-unicast address. The number includes those that were discarded or not sent.
Outbound Statistics, nucastpkts	This field displays how many packets for which the higher-level protocols requested transmission to a non-unicast (subnetwork-broadcast or subnetwork-multicast) address. The number includes those that were discarded or not sent.

Attribute	Meaning
Outbound Statistics, discards	This field displays how many outbound packets were discarded without errors that would have prevented their transmission. Outbound discard statistics are incremented if a VC is not active when a packet is ready to send. This is a rare condition.
Outbound Statistics, errors	This field displays how many outbound packets contained errors that prevented their transmission.
Queue Overflow	This is a count of packets that were discarded because the queue for the VC was already full. If Queue Overflows are being seen across most or all SMs, then there is either an interferer local to the AP or the APs RF link is at capacity. If Queue Overflows are being seen at one or only a few SMs, then it is likely that there is a problem with those specific links whether it is insufficient signal strength, interferer, or a problem with the actual SM hardware.
High Priority Queue	This is a count of packets that were received on high priority queue.
Fragments Modulation - Receive Fragments Modulation	
QPSK	This field displays how many inbound fragments were received via the QPSK modulation scheme.
16-QAM	This field displays how many inbound fragments were received via the 16-QAM modulation scheme.
64-QAM	This field displays how many inbound fragments were received via the 64-QAM modulation scheme.
256-QAM	This field displays how many inbound fragments were received via the 256-QAM modulation scheme.
Retransmitted Fragments	This field displays how many outbound fragments were retransmitted.

Interpreting Proportional Scheduler

The Statistics > Proportional Scheduler page displays information:

Table 137: MIR/Burst page attributes for AP



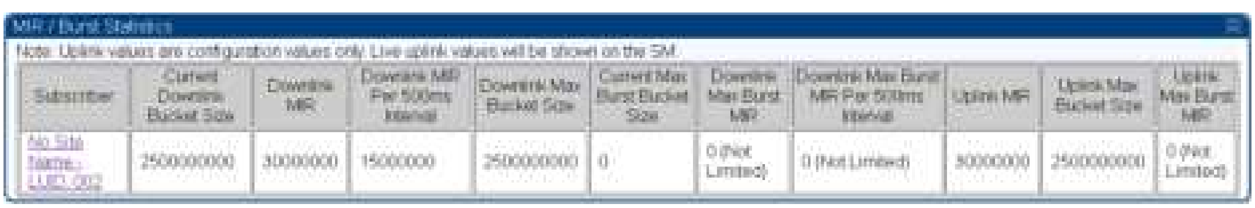
Attribute	Meaning
Subscriber	See Device tab attributes
LUID	
Lock Modulation	This field displays the Lock Modulation mode of all registered SMs.
Modulation	The database configured Lock Modulation value if lock modulation is set to Enable below threshold or Enabled.
Weight	This field displays the weight of each registered SM. For more information about Weight, See QoS page attributes - AP.
Downlink Statistics	This field displays the Dowlink statistics of every registered SM.
Uplink Statistics	This field displays the Uplink statistics of every registered SM.
Rate Plan	This field displays the rate plan associated with each SM.
Current Modulation	The currently operating modulation of this SM.
Slots Percentage	This field displays the percentage of slot used by each SM.
Guaranteed minimum throughput	Guaranteed minimum throughput based on the SM's Rate Plan configuration, it's current modulation rate, and any Lock Modulation settings. For 450m AP's the maximum possible Throughput shown here assumes all SUMIMO scheduling. MUMIMO scheduling will result in higher TPUT.
Sustained Data Rate	This field displays the preset rate limit of data transfer for every SM.

Interpreting MIR/Burst statistics

The Statistics > MIR/Burst page displays information about MIR/Burst. This page is applicable for all modules (AP/SM).

The MIR/Burst tab displays the fields as explained in MIR/Burst page attributes for AP and MIR/Burst page attributes for SM.

Table 138: MIR/Burst page attributes for AP

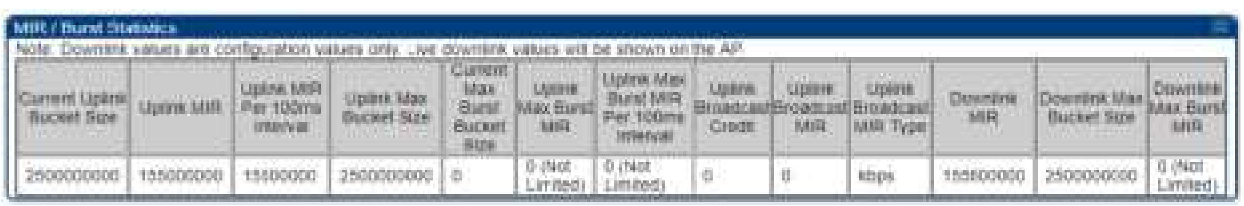

MIR / Burst Statistics

Note: Uplink values are configuration values only. Live uplink values will be shown on the SM.

Subscriber	Current Downlink Bucket Size	Downlink MIR	Downlink MIR Per 500ms Interval	Downlink Max Bucket Size	Current Max Burst Bucket Size	Downlink Max Burst MIR	Downlink Max Burst MIR Per 500ms Interval	Uplink MIR	Uplink Max Bucket Size	Uplink Max Burst MIR
No Site Name - LUID: 002	2500000000	30000000	15000000	2500000000	0	0 (Not Limited)	0 (Not Limited)	30000000	2500000000	0 (Not Limited)

Attribute	Meaning
Subscriber	This field displays the LUID (logical unit ID), MAC address and Site Name of the SM/BHS. As each SM or BHS registers to the AP/BHM, the system assigns an LUID of 2 or a higher unique number to the SM/BHS. As of release 15.2, if an SM/BHS loses registration with the AP/BHM and then regains registration, the SM/BHS retains the same LUID.
Current Downlink Bucket Size	This field displays the number of bits in the bucket to be potentially consumed at above-MIR rates, up to Max Burst MIR rate.
Downlink MIR	This field displays the active configured MIR rate per second. This is the rate that the bucket is filled with bits.
Downlink MIR Per 500ms Interval	This field displays the rate that the bucket is filled with bits at every 500 ms interval.
Downlink Max Bucket Size	This field displays the configured maximum bucket size, which is the maximum number of bits that can be in the bucket. The bucket fills at MIR rate and can hold this number of bits, which is a configuration value.
Current Max Burst Bucket Size	If Max Burst is enabled, there is a secondary “bucket” that controls the maximum rate of bit consumption. If Max Burst is not enabled (which means not limited), this will be 0 as the bucket is not used.
Downlink Max Burst MIR	This field displays the configured value of the Max Burst rate. This is the maximum rate at which bits can be consumed above MIR. Once excess (> MIR) bits have been consumed, the link will be throttled to MIR.
Downlink Max Burst MIR Per 500ms Interval	This field displays the configured value of the Max Burst rate at every 500 ms interval.
Uplink MIR	This field displays the active configured MIR rate per second in the SM.
Uplink Max Bucket Size	This field displays the configured maximum bucket size of the SM, which is the maximum number of bits that can be in the bucket. The bucket fills at MIR rate and can hold this number of bits, which is a configuration value.
Uplink Max Burst MIR	This field displays the configured value of the MaxBurst rate of the SM. This is the maximum rate at which bits can be consumed above MIR. Once excess (> MIR) bits have been consumed, the link will be throttled to MIR.

Table 139: MIR/Burst page attributes for SM


MIR / Burst Statistics

Note: Downlink values are configuration values only. Live downlink values will be shown on the AP.

Current Uplink Bucket Size	Uplink MIR	Uplink MIR Per 100ms Interval	Uplink Max Bucket Size	Current Max Burst Bucket Size	Uplink Max Burst MIR	Uplink Max Burst MIR Per 100ms Interval	Uplink Broadcast Credit	Uplink Broadcast MIR	Uplink Broadcast MIR Type	Downlink MIR	Downlink Max Bucket Size	Downlink Max Burst MIR
2500000000	155000000	15500000	2500000000	0	0 (Not Limited)	0 (Not Limited)	0	0	kbps	155000000	2500000000	0 (Not Limited)

Attribute	Meaning
Current Uplink Bucket Size	This field displays the number of bits in the bucket to be potentially consumed at above-MIR rates, up to Max Burst MIR rate.
Uplink MIR	This field displays the active MIR rate per second. This is the rate that the bucket is filled with bits.
Uplink MIR Per 100ms Interval	This field displays the rate that the bucket is filled with bits at every 100 ms interval.
Uplink Max Bucket Size	This field displays the maximum bucket size, which is the maximum number of bits that can be in the bucket. The bucket fills at MIR rate and can hold this number of bits, which is a configuration value.
Current Max Burst Bucket Size	If Max Burst is enabled, there is a secondary "bucket" that controls the maximum rate of bit consumption. If Max Burst is not enabled (which means not limited), this will be 0 as the bucket is not used.
Uplink Max Burst MIR	This field displays the configured value of the Max Burst rate. This is the maximum rate at which bits can be consumed above MIR. Once excess (> MIR) bits have been consumed, the link will be throttled to MIR.
Uplink Max Burst MIR per 100ms Interval	This field displays the configured value of the Max Burst rate at every 100 ms interval.
Uplink Broadcast Credit	This field displays the broadcast credit.
Uplink Broadcast MIR	This field displays the broadcast MIR rate per second.
Uplink Broadcast MIR Type	This field displays the type of the broadcast MIR.
Downlink MIR	This field displays the active configured MIR rate per second. This is the rate that the bucket is filled with bits.
Downlink Max Bucket Size	This field displays the configured maximum bucket size, which is the maximum number of bits that can be in the bucket. The bucket fills at MIR rate and can hold this number of bits, which is a configuration value.
Downlink Max Burst MIR	This field displays the configured value of the Max Burst rate. This is the maximum rate at which bits can be consumed above MIR. Once excess (> MIR) bits have been consumed, the link will be throttled to MIR.

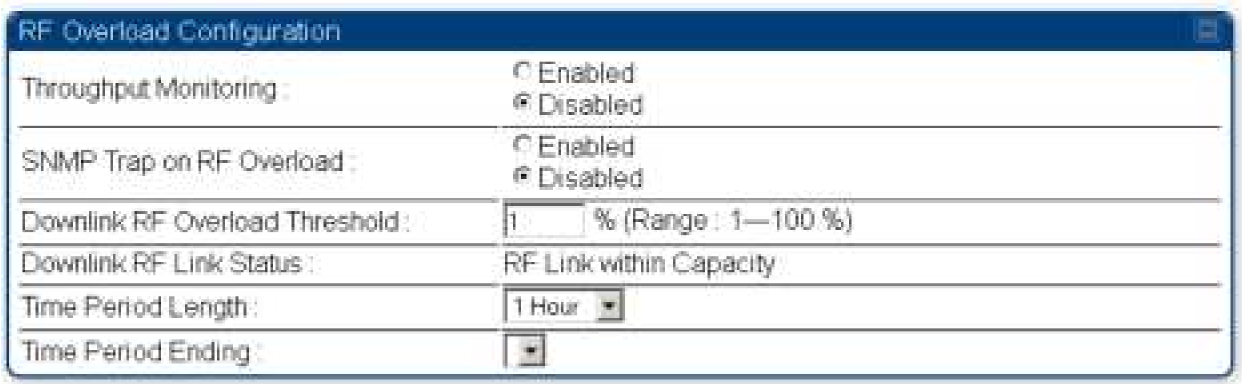
Interpreting Throughput statistics

The 450 Platform Family has a Statistics > Throughput page which shows historical information about sector or backhaul throughput and packet discards. This page is applicable for AP and BHM modules. This information can be useful to identify an overloaded sector or heavy bandwidth users. This page also shows the user throughput in terms of data rate (kbps) and packet rate (packets per second, or PPS), as well as the average packet size during the sample period.

Operators may set the AP/BHM to send an SNMP trap when it detects an RF overload condition based on a configurable threshold.

The following configuration parameters are available on the Throughput tab GUI pane and a radio reboot is not required when configuring these parameters:

Table 140: RF overload Configuration attributes – AP/BHM



Attribute	Meaning
Throughput Monitoring	This enables or disables the monitoring of sector throughput and packet discards. This parameter is disabled by default.
SNMP Trap on RF Overload	This enables or disables the sending of an SNMP trap when an AP/BHM overload condition is reached (based on Downlink RF Overload Threshold).
Downlink RF Overload Threshold	This parameter determines the overload threshold in percent of packets discarded that triggers the generation of an SNMP trap.
Downlink RF Link Status	This field displays the status of the capacity of the RF link.
Time Period Length Time Period Ending	These two configuration parameters determine what set of collection samples to show on the GUI display. The Time Period Length can be set from one to three hours. Time Period Ending allows the operator to set the end time for the set of collection samples to display.

Following configuration settings are three tables that display the statistics that are collected.

Board Performance statistics

This table contains a row that corresponds to each 1 minute statistics collection interval. Each row contains the following data aggregated for the entire AP/BHM:

- Ethernet Throughput - Statistics collected at the Ethernet port:
    - kbps in – average throughput over the collection interval in Kbps into the AP/BHM on the Ethernet Interface
    - kbps out – average throughput over the collection interval in Kbps out of the AP/BHM on the Ethernet Interface

- PPS in – average packets per second over the collection interval into the AP/BHM on the Ethernet Interface
- PPS out – average packets per second over the collection interval out of the AP/BHM on the Ethernet Interface

- RF Throughput - Statistics collected at the RF Interface:
    - kbps in – average throughput over the collection interval in Kbps into the AP/BHM on the RF Interface
    - kbps out – average throughput over the collection interval in Kbps out of the AP/BHM on the RF Interface
    - PPS in – average packets per second over the collection interval into the AP/BHM on the RF Interface
    - PPS out – average packets per second over the collection interval out of the AP/BHM on the RF Interface
- Aggregate Through Board – Sum of bidirectional data transferred through (not originating or terminating at) the AP/BHM:
    - kbps – average bidirectional throughput over the collection interval in Kbps
    - PPS – average bidirectional packets per second over the collection interval
    - Ave Pkt Size – Average Packet size over the collection interval of bidirectional data transferred

Board Throughput statistics

This table contains a row that corresponds to each one minute statistics collection interval. This table may be used to determine if there are problems with any of the interfaces. For example, if the Ethernet in packets is much higher than the RF out packets it could indicate a denial of service (DoS) attack on the AP/BHM. Each row contains the following data aggregated for the entire AP/BHM:

- Ethernet Statistics- Statistics collected at the Ethernet port:
    - inOctets – Number of octets (bytes) received by the AP/BHM at the Ethernet Interface over the collection interval
    - outOctets – Number of octets (bytes) sent by the AP/BHM at the Ethernet Interface over the collection interval
    - inPkts – Number of packets received by the AP/BHM at the Ethernet Interface over the collection interval
    - outPkts – Number of packets sent by the AP/BHM at the Ethernet Interface over the collection interval
    - Discards (in/out) – Number of packets that had to be discarded by the AP/BHM at the respective Ethernet Interface Queue

- RF Statistics - Statistics collected at the RF Interface:
    - inOctets – Number of octets (bytes) received by the AP/BHM at the RF Interface over the collection interval
    - outOctets – Number of octets (bytes) sent by the AP/BHM at the RF Interface over the collection interval
    - inPkts – Number of packets received by the AP/BHM at the RF Interface over the collection interval
    - outPkts – Number of packets sent by the AP/BHM at the RF Interface over the collection interval
    - Discards (in/out) – Number of packets that had to be discarded by the AP/BHM at the respective RF Interface Queue during the collection interval
    - Discards % (in/out) – Percent of the total packets received / transmitted that had to be discarded during the collection interval

LUID RF Throughput statistics

This table contains a row that corresponds to each active LUID served by the AP/BHM. Note that an LUID may be assigned 1 or 2 VCs. If the LUID is assigned 2 VCs, then the data in the table is the sum of the activity for both VCs. This table may be used to determine which LUIDs are experiencing overload so that corrective action can be taken (i.e. fixing a poor RF link or moving a heavily loaded link to a less congested AP/BHM). Each row contains counters and statistics related to the RF Interface that are updated once per minute:

- Inbound Statistics - Statistics collected at the RF Interface for the Uplink:
- octets – Number of octets (bytes) received by the AP/BHM at the RF Interface for this LUID over the collection interval
- pkts – Number of packets received by the AP/BHM at the RF Interface for this LUID over the collection interval
- Ave Pkt Size – Average size of the packets received by the AP/BHM at the RF Interface for this LUID over the collection interval
- discards – Number of packets received by the AP/BHM at the RF Interface for this LUID over the collection interval that had to be discarded because the RF In Queue was full
- discards % – Percent of the total packets received by the AP/BHM at the RF Interface for this LUID over the collection interval that had to be discarded because the RF In Queue was full
- Outbound Statistics - Statistics collected at the RF Interface for the Downlink:
- octets – Number of octets (bytes) transmitted by the AP/BHM at the RF Interface for this LUID over the collection interval
- pkts – Number of packets transmitted by the AP/BHM at the RF Interface for this LUID over the collection interval

- Ave Pkt Size – Average size of the packets transmitted by the AP/BHM at the RF Interface for this LUID over the collection interval
- discards – Number of packets to be transmitted by the AP/BHM at the RF Interface for this LUID over the collection interval that had to be discarded because the RF Out Queue was full
- discards % – Percent of the total packets to be transmitted by the AP/BHM at the RF Interface for this LUID over the collection interval that had to be discarded because the RF Out Queue was full.

Interpreting Overload statistics

The Statistics > Overload page displays statistics on packet overload and resultant packet discards. Unlike the other fields, the Total Packets Overload Count is expressed in only this page. It is not a count of how many packets have been lost, but rather of how many discard events (packet loss bursts) have been detected due to overload condition.

This statistics page is applicable for all modules (AP/SM/BHM/BHS) and explained in below table.

Table 141: Overload page attributes – AP/SM/BHM/BHS

Packet Overload Statistics	
Total Packets Overload Count :	0
Ethernet In Discards (Statistics=>Ethernet=>indiscards Count + Various Other Sources) :	0
Ethernet Out Discards (Statistics=>Ethernet=>outdiscards Count) :	0
RF In Discards (Sum of all Data Channels of: Statistics=>Data Channel=>indiscards Count) :	0
RF Out Discards (Statistics=>Radio=>outdiscards Count) :	0

Attribute	Meaning
Total Packets Overload Count	This field represents the sum of all RF and Ethernet in/out discards.
Ethernet In Discards	This field represents the number of packets tossed due to the Ethernet queue being full. If a climb in this stat accompanies a climb in RF Out Discards stat, then most likely the board is at RF capacity either due to traffic exceeding the RF pipe, or interference temporarily limiting the RF throughput. If this stat climbs without the RF Out Discards stat climbing, then the radio is most likely PPS limited.
Ethernet Out Discards	This field represents the number of packets tossed due to an Ethernet out overload. This stat must not climb in normal operation because the Ethernet link is much higher capacity than the RF link. If this stat is incrementing, then either the Ethernet link is established at a low speed (i.e. 10Mbps – half duplex), or there is a problem with cabling/Ethernet hardware.

Attribute	Meaning
RF In Discards	This field indicates the number of packets tossed due to no resources available within the radio to process them. This stat also must not be increasing because the system is designed to shed packets on the RF Out interface. If this stat is incrementing the board, it is most likely congested due to high PPS rate in combination with an Ethernet Out problem, which limits packet flow off the device.
RF Out Discards	This field indicates the number of packets tossed due to RF link at capacity. This stat will increase whenever the RF link is at capacity. When the internal FPGA RF input queue overflows, this stat is incremented. If this stat is seen to be incrementing at the AP, then the sector is congested. If seen at the SM, the number of Contention Slots must be looked at to ensure that enough Contention Slots are allocated to allow for bandwidth requests to be seen at the AP.

Note

PMP 450m overload:

The 450m Series AP is designed to handle high load in terms of high throughput and high PPS. In terms of throughput, PMP 450m is designed to achieve 3x or more throughput improvement over PMP 450 and PMP 450i Series products. In terms of packets per second (PPS), PMP 450m is designed to handle more than 100k PPS.

Overload occurs when the offered load exceeds the above limits. When overload occurs, PMP 450m will start discarding packets and TCP throughput will degrade due to packet loss.

It’s worth noting that Frame Utilization statistics (Statistics > Frame Utilization tab: Frame Utilization: Downlink and Uplink) are not necessarily indicative of overload condition. They show how much the TDD frame is utilized. High frame utilization depends on:

- High traffic during busy periods: those statistics will be close to 100% and almost all slots will be utilized. In this case if the Overload statistics show that packets are discarded then this is an indication of overload condition.
- High percentage of VCs with low modulation with moderate traffic. Those VCs will require more slots to service them (due to low modulation) and the frame utilization will be high. In this case the TDD frame is fully utilized but the system is at low capacity and is not in an overload condition.

PMP 450m has higher PPS than PMP 450 and PMP 450i and supports higher throughput through spatial multiplexing, therefore when a PMP 450m replaces an overloaded PMP 450 or PMP 450i AP the PMP 450m will not be overloaded under the same conditions but the frame utilization may still show close to 100%; this should not alarm the customer. The overload statistics shall be monitored on PMP 450m to see if it is overloaded or not.

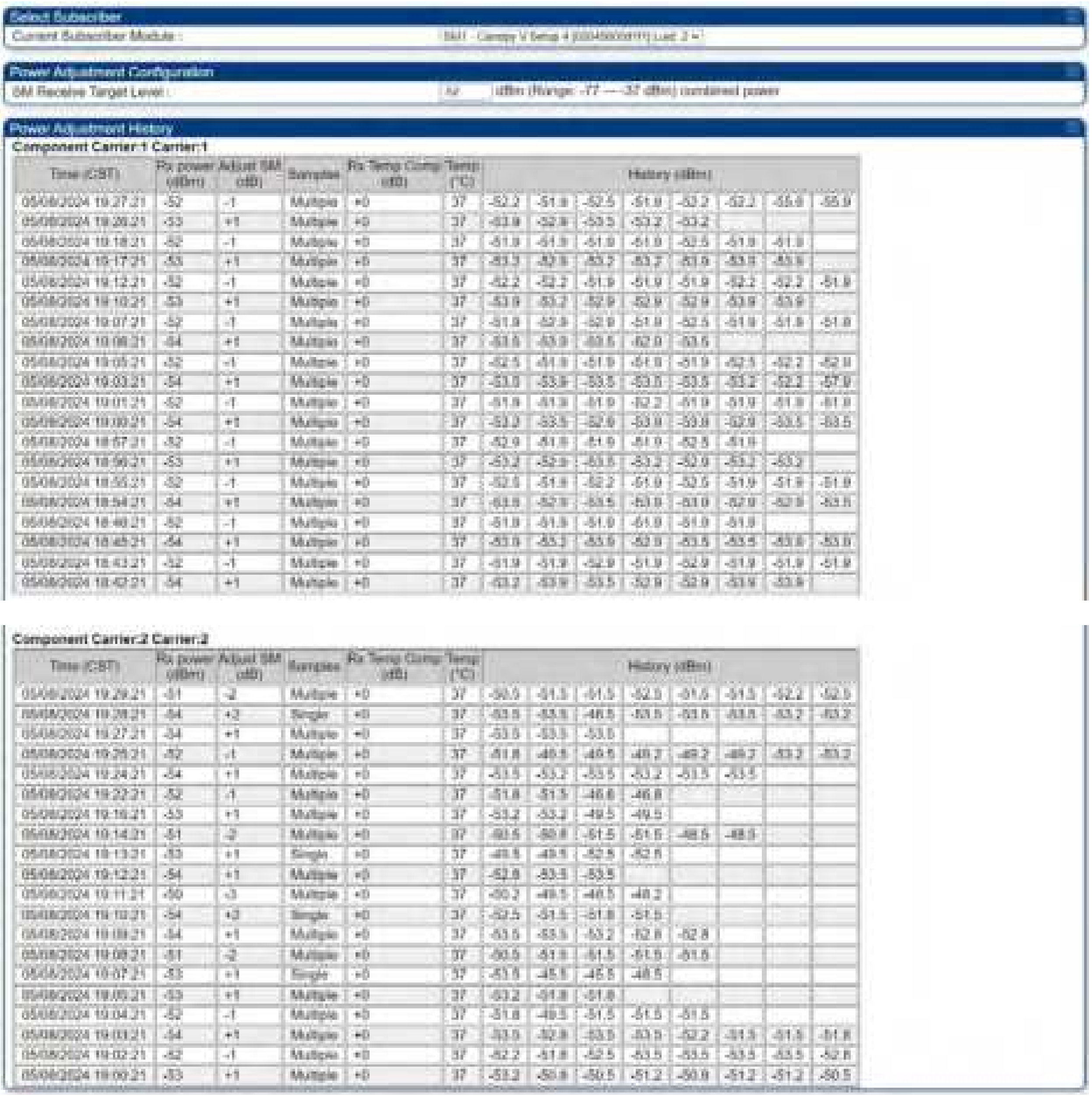
Interpreting Power Adjust History

The **Statistics > Power Adjust History** tab provides a chronological record of power adjustment events for the selected SM. It logs changes in received power levels (Rx power) over time, detailing adjustments made to the module's power settings. Each entry includes timestamps, received power levels, adjustment values, number of samples, receiver temperature compensation, temperature readings, and historical power values. Adjustments are segmented by component carrier, with separate entries for each carrier.

This feature facilitates monitoring and analysis of system-driven power adjustments to optimize performance.

This statistics page is applicable for all modules (AP/SM/BHM/BHS) and explained in below table.

Table 142: Power Adjust History page attributes – AP/SM/BHM/BHS



Select Subscriber

Current Subscriber Module :

Power Adjustment Configuration

SM Receive Target Level : dBm (Range: -77 — -37 dBm) combined power

Power Adjustment History

Component Carrier:1 Carrier:1

Time (CST)	Rx power (dBm)	Adjust SM (dB)	Samples	Rx Temp Comp (dB)	Temp (°C)	History (dBm)							
05/08/2024 19:27:21	-52	-1	Multiple	+0	37	-52.2	-51.9	-52.5	-51.9	-52.2	-52.2	-55.9	-55.9
05/08/2024 19:20:21	-53	+1	Multiple	+0	37	-53.9	-52.9	-53.5	-53.2	-53.2			
05/08/2024 19:18:21	-52	-1	Multiple	+0	37	-51.9	-51.9	-51.9	-51.9	-52.5	-51.9	-51.9	
05/08/2024 19:17:21	-53	+1	Multiple	+0	37	-53.3	-52.6	-53.2	-53.2	-53.6	-53.9	-53.9	
05/08/2024 19:12:21	-52	-1	Multiple	+0	37	-52.2	-52.2	-51.9	-51.9	-51.9	-52.2	-52.2	-51.9
05/08/2024 19:10:21	-53	+1	Multiple	+0	37	-53.9	-53.2	-52.9	-52.9	-52.9	-53.9	-53.9	
05/08/2024 19:07:21	-52	-1	Multiple	+0	37	-51.9	-52.9	-52.9	-51.9	-52.5	-51.9	-51.9	-51.9
05/08/2024 19:06:21	-54	+1	Multiple	+0	37	-53.5	-53.9	-53.5	-52.9	-53.5			
05/08/2024 19:05:21	-52	-1	Multiple	+0	37	-52.5	-51.9	-51.9	-51.9	-51.9	-52.5	-52.2	-52.9
05/08/2024 19:03:21	-54	+1	Multiple	+0	37	-53.5	-53.9	-53.5	-53.5	-53.5	-53.2	-52.2	-57.9
05/08/2024 19:01:21	-52	-1	Multiple	+0	37	-51.9	-51.9	-51.9	-52.2	-51.9	-51.9	-51.9	-51.9
05/08/2024 19:00:21	-54	+1	Multiple	+0	37	-53.2	-53.5	-52.9	-53.9	-53.9	-52.9	-53.5	-53.5
05/08/2024 18:57:21	-52	-1	Multiple	+0	37	-52.9	-51.9	-51.9	-51.9	-52.5	-51.9		
05/08/2024 18:56:21	-53	+1	Multiple	+0	37	-53.2	-52.9	-53.5	-53.2	-52.9	-53.2	-53.2	
05/08/2024 18:55:21	-52	-1	Multiple	+0	37	-52.5	-51.9	-52.2	-51.9	-52.5	-51.9	-51.9	-51.9
05/08/2024 18:54:21	-54	+1	Multiple	+0	37	-53.9	-52.9	-53.5	-53.9	-53.9	-52.9	-52.9	-53.5
05/08/2024 18:48:21	-52	-1	Multiple	+0	37	-51.9	-51.9	-51.9	-51.9	-51.9	-51.9		
05/08/2024 18:45:21	-54	+1	Multiple	+0	37	-53.9	-53.2	-53.9	-52.9	-53.5	-53.5	-53.9	-53.9
05/08/2024 18:43:21	-52	-1	Multiple	+0	37	-51.9	-51.9	-52.9	-51.9	-52.9	-51.9	-51.9	-51.9
05/08/2024 18:42:21	-54	+1	Multiple	+0	37	-53.2	-53.9	-53.5	-52.9	-52.9	-53.9	-53.9	

Component Carrier:2 Carrier:2

Time (CST)	Rx power (dBm)	Adjust SM (dB)	Samples	Rx Temp Comp (dB)	Temp (°C)	History (dBm)							
05/08/2024 19:29:21	-51	-2	Multiple	+0	37	-50.5	-51.5	-51.5	-52.5	-51.5	-51.5	-52.2	-52.5
05/08/2024 19:28:21	-54	+2	Single	+0	37	-53.5	-53.5	-48.5	-53.5	-53.5	-53.5	-53.2	-53.2
05/08/2024 19:27:21	-54	+1	Multiple	+0	37	-53.5	-53.5	-53.5					
05/08/2024 19:25:21	-52	-1	Multiple	+0	37	-51.8	-49.5	-49.5	-49.2	-49.2	-49.2	-53.2	-53.2
05/08/2024 19:24:21	-54	+1	Multiple	+0	37	-53.5	-53.2	-53.5	-53.2	-53.5	-53.5		
05/08/2024 19:22:21	-52	-1	Multiple	+0	37	-51.8	-51.5	-46.8	-46.8				
05/08/2024 19:16:21	-53	+1	Multiple	+0	37	-53.2	-53.2	-49.5	-49.5				
05/08/2024 19:14:21	-51	-2	Multiple	+0	37	-50.5	-50.8	-51.5	-51.5	-48.5	-48.5		
05/08/2024 19:13:21	-53	+1	Single	+0	37	-49.5	-49.5	-52.5	-52.5				
05/08/2024 19:12:21	-54	+1	Multiple	+0	37	-52.8	-53.5	-53.5					
05/08/2024 19:11:21	-50	-3	Multiple	+0	37	-50.2	-49.5	-46.5	-48.2				
05/08/2024 19:10:21	-54	+3	Single	+0	37	-52.5	-51.5	-51.8	-57.5				
05/08/2024 19:09:21	-54	+1	Multiple	+0	37	-53.5	-53.5	-53.2	-52.8	-52.8			
05/08/2024 19:08:21	-51	-2	Multiple	+0	37	-50.5	-51.5	-51.5	-51.5	-51.5			
05/08/2024 19:07:21	-53	+1	Single	+0	37	-51.5	-45.5	-45.5	-48.5				
05/08/2024 19:05:21	-53	+1	Multiple	+0	37	-53.2	-51.8	-51.8					
05/08/2024 19:04:21	-52	-1	Multiple	+0	37	-51.8	-49.5	-51.5	-51.5	-51.5			
05/08/2024 19:03:21	-54	+1	Multiple	+0	37	-53.5	-52.8	-53.5	-53.5	-52.2	-51.5	-51.5	-51.8
05/08/2024 19:02:21	-52	-1	Multiple	+0	37	-52.2	-51.8	-52.5	-53.5	-53.5	-53.5	-53.5	-52.8
05/08/2024 19:00:21	-53	+1	Multiple	+0	37	-53.2	-50.8	-50.5	-51.2	-50.8	-51.2	-51.2	-50.5

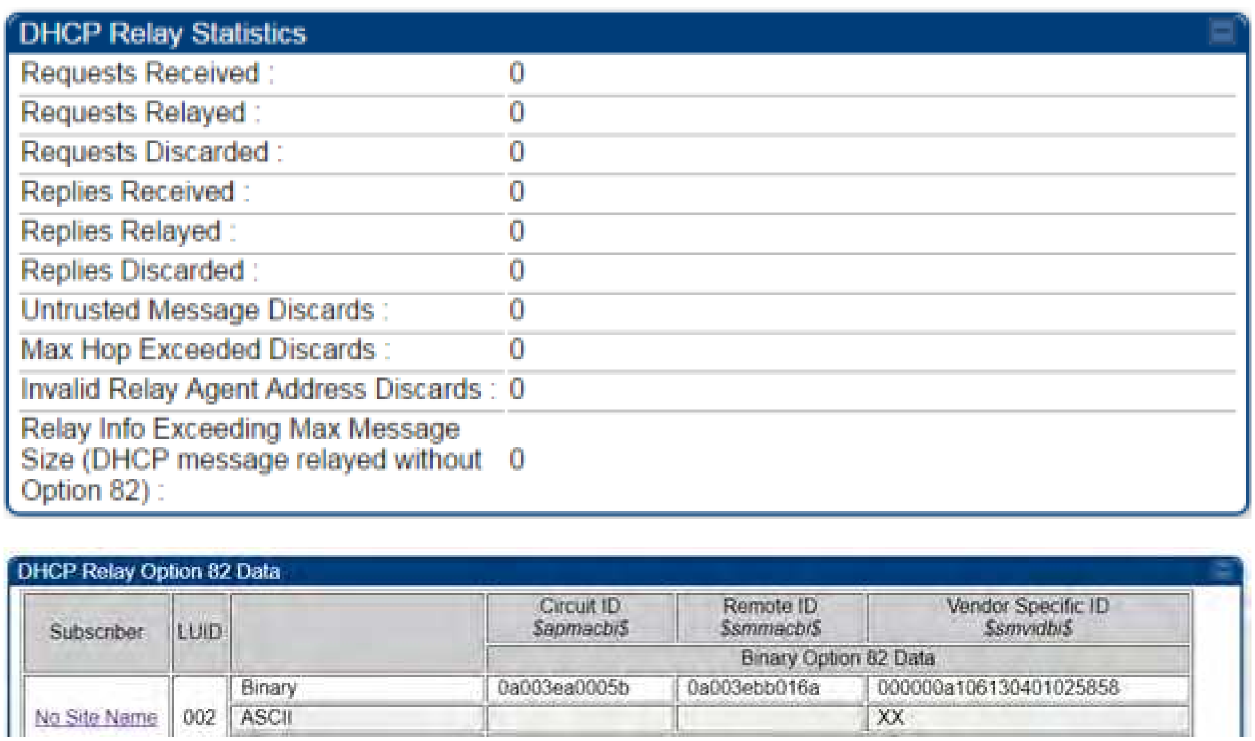
Attribute	Meaning
Current Subscriber Module	Identifies the subscriber module that is currently active and being observed.
SM Receive Target Level	Shows the desired level for receiving signals, indicating the ideal strength of the incoming signals.

Attribute	Meaning
Time (CST)	Displays the current time in Central Standard Time (CST) for each recorded event.
Rx power (dBm)	Shows the strength of the received signal at the subscriber module, measured in decibels (dB).
Adjust SM (dB)	Indicates the adjustment made to the subscriber module's power settings, measured in decibels (dB).
Samples	Displays the number of samples taken to calculate the received signal strength and adjustments.
Rx Temp Comp (dB)	Shows the adjustment made to the received signal strength to account for changes in temperature, measured in decibels (dB).
Temp (°C)	Displays the current temperature recorded by the subscriber module in degrees Celsius (°C).
History (dBm)	Provides a record of past signal strengths at the subscriber module, aiding in understanding signal fluctuations over time.

Interpreting DHCP Relay statistics

The Statistics > DHCP Relay page displays requests and replies received, relayed and discarded when the AP is configured as a DHCP relay. Typically, in a working DHCP relay configuration a one-to-one ratio is established between requests and replies that are received and relayed. This statistics page is only applicable for PMP (AP and SM modules) and it is explained in below figure.

Figure 118: *DHCP Relay page attributes – AP/SM*



Attribute	Meaning
Requests Received	This field represents the number of DHCP relay requests received by the AP.
Requests Relayed	This field represents the number of DHCP relay requests relayed by the AP.
Requests Discarded	This field represents the number of DHCP relay requests discarded by the AP due to errors in the request.
Replies Received	This field represents the number of DHCP relay replies received by the AP.
Replies Relayed	This field represents the number of DHCP relay replies relayed by the AP.
Replies Discarded	This field represents the number of DHCP relay replies discarded by the AP due to errors in the reply.
Untrusted Message Discards	This field indicates messages that were discarded because the message already contained Option 82 information with no Relay Agent specified.
Max Hop Exceeded Discards	This field indicates messages that have been relayed too many times, exceeding the max hop count (16).
Invalid Relay Agent Address Discards	This field indicates messages that have been discarded because the message relay agent address is already in place (relay agent address does not equal address of the AP).
Relay Info Exceeding Max Message Size (DHCP message relayed without Option 82)	This field indicates DHCP messages too large to fit Option 82 data. These messages are sent on without Option 82 information.
Subscriber	See Device tab attributes
LUID	
Circuit ID	This field displays the option 82 data of the SM in binary and ASCII formats.
Remote ID	
Vendor Specific ID	

Interpreting Filter statistics

The Statistics > Filter page displays statistics on packets that have been filtered (dropped) due to the filters set on the Protocol Filtering page. The filter page of SM is explained in below table.

Table 143: Filter page attributes - SM

Packet Filter Statistics	
PPPoE Count :	0
All IPv4 Count :	0
All Other IPv4 Count :	0
SMB Count :	0
SNMP Count :	0
Bootp Client Count :	0
Bootp Server Count :	0
IPv4 Multicast Count :	0
All IPv6 Count :	0
All Other IPv6 Count :	0
IPv6 SMB Count :	0
IPv6 SNMP Count :	0
IPv6 Bootp Client Count :	0
IPv6 Bootp Server Count :	0
IPv6 Multicast Count :	0
ARP Count :	0
All Others Count :	0
User Defined Port1 Count :	0
User Defined Port2 Count :	0
User Defined Port3 Count :	0

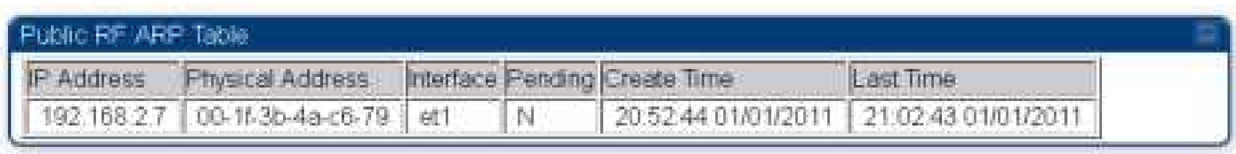
Attribute	Meaning
PPPoE Count	Number of PPPoE packets filtered.
All IPv4 Count	Number of IPv4 packets filtered.
All Other IPv4 Count	Any IPv4 message that was not SMB, SNMP, Bootp, Multicast or one of the user defined filters, that was filtered out.
SMB Count	Number of IPv4 Server Message Block (file sharing) packets filtered.
SNMP Count	Number of IPv4 SNMP packets filtered.
Bootp Client Count	Total number of IPv4 DHCP requests filtered.
Bootp Server Count	Total number of IPv4 DHCP replies filtered.
IPv4 Multicast Count	Number of IPv4 Multicast messages filtered.
All IPv6 Count	Number of IPv6 messages filtered.
All Other IPv6 Count	Any IPv6 message that was not SMB, SNMP, Bootp, Multicast or one of the user defined filters, that was filtered out.
IPv6 SMB Count	Number of IPv6 Server Message Block (file sharing) packets filtered
IPv6 SNMP Count	Number of IPv6 SNMP messages filtered
IPv6 Bootp Client Count	Total number of IPv6 DHCP replies filtered
IPv6 Bootp Server Count	Total number of IPv6 DHCP replies filtered

Attribute	Meaning
IPv6 Multicast Count	Number of IPv6 Multicast messages filtered
ARP Count	Total number of ARP packets filtered.
All other Count	The count of any messages that did not fit above that were filtered out
User Defined Port1 Count	Number of packets defined by the user port1 that were filtered.
User Defined Port2 Count	Number of packets defined by the user port2 that were filtered.
User Defined Port3 Count	Number of packets defined by the user port3 that were filtered.

Viewing ARP statistics

The Statistics > ARP page in a SM module correlated the IP address of the Ethernet-connected device to its MAC address and provides data about the connection.

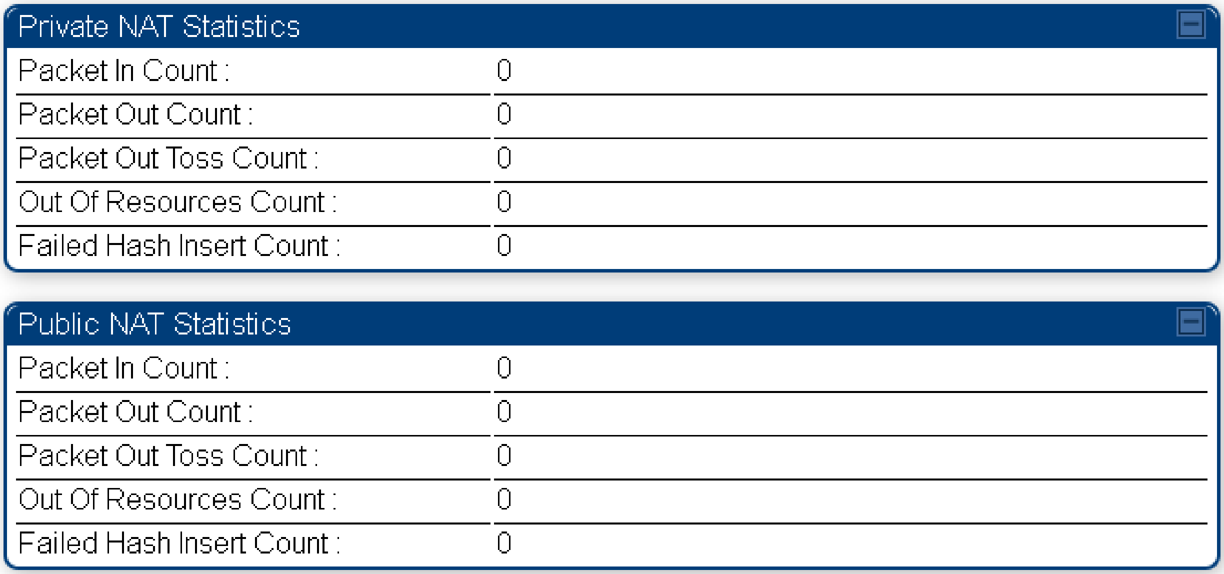
Figure 119: *ARP page of the SM*



Viewing NAT statistics

When NAT is enabled on a SM, statistics are kept on the Public and Private (WAN and LAN) sides of the NAT and displayed on the **Statistics > NAT Stats** page. The NAT page of SM is explained in below table.

Table 144: NAT page attributes - SM



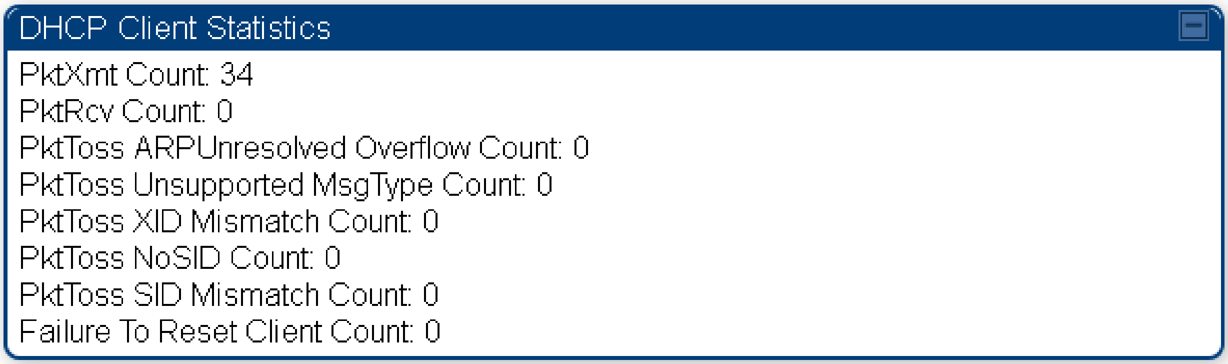
Attribute	Meaning
Private NAT Statistics, Packet In Count	This field represents the number of packets received on the SM's LAN/Ethernet interface
Private NAT Statistics, Packet Out Count	This field represents the number of packets sent from the SM's LAN/Ethernet interface
Private NAT Statistics, Packet Out Toss Count	This field represents the number of packets that we not sent from the SM's LAN/Ethernet interface due to addressing issues.
Private NAT Statistics, Out of Resources Count	This field represents the number of times the NAT table for the SM's LAN/Ethernet interfaces has been filled.
Private NAT Statistics, Failed Hash Insert Count	This field represents the number of times that the device failed to insert an address binding into the NAT hash table.
Public NAT Statistics, Packet In Count	This field represents the number of packets received on the SM's WAN/wireless interface
Public NAT Statistics, Packet Out Count	This field represents the number of packets sent from the SM's WAN/wireless interface
Public NAT Statistics, Out of Resources Count	This field represents the number of packets that we not sent from the SM's WAN/wireless interface due to addressing issues.
Public NAT Statistics, Failed Hash Insert Count	This field represents the number of times the NAT table for the SM's WAN/wireless interfaces has been filled.

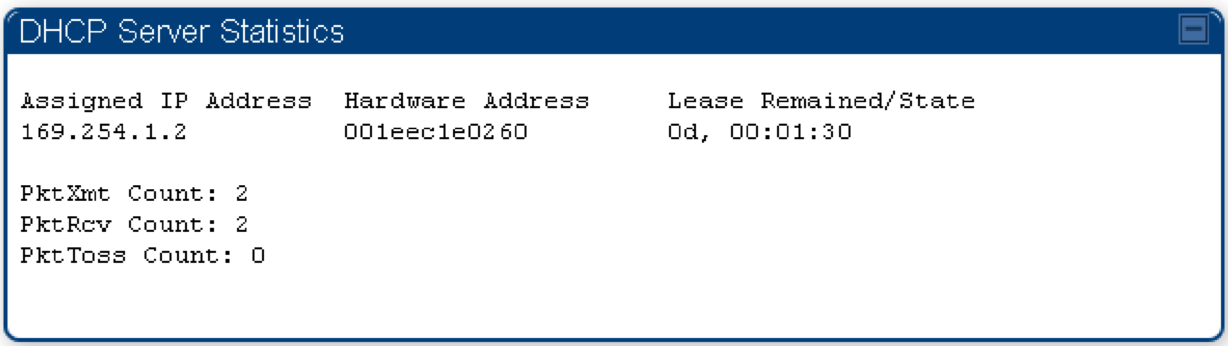
Viewing NAT DHCP Statistics

The Statistics > NAT DHCP page displays NAT enabled DHCP client statistics. This is statistics page is applicable for SM only.

When NAT is enabled on a SM with DHCP client (DHCP selected as the Connection Type of the WAN interface) and/or DHCP Server, statistics are kept for packets transmitted, received and tossed, as well as a table of lease information for the DHCP server (Assigned IP Address, Hardware Address and Lease Remained/State).

Table 145: NAT DHCP Statistics page attributes - SM





Attribute	Meaning
PktXmt Count	Represents the number of DHCP packets transmitted from the client
PktRcv Count	This field represents the number of DHCP packets received by the client
PktToss ARPUnresolved Overflow Count	This field represents the number of packets tossed due to failed attempts to resolve an IP address into a physical MAC address
PktToss Unsupported MsgType Count	This field represents the number of packets tossed due to the receipt of an unsupported message type (cannot be interpreted by DHCP client)
PktToss XID Mismatch Count	The field represents the number of packets that were tossed due to a transaction ID mismatch
PktToss NoSID Count	This field represents the number of packets that were tossed due to lack of a DHCP session ID
PktToss SID Mismatch Count	Represents the number of packets tossed due to a session ID mismatch
Failure to Reset Client Count	This field represents the number of times the DHCP client was unable to be reset (resulting in no IP address being served).

Interpreting Sync Status statistics

The Statistics > Sync Status page of AP is only displayed when the Sync Input is set to AutoSync or AutoSync+Free Run.

The Sync Status page is explained in below table.

Table 146: Sync Status page attributes - AP

Sync Status	
Sync Pulse Source :	Power Port
Sync Pulse Status :	Receiving Sync
Sync Pulse Status - Timing Port/UGPS :	No Sync
Sync Pulse Status - Power Port :	Receiving Sync
UGPS Power Status :	Power Off

Attribute	Meaning
Sync Pulse Source	This field indicates the status of the synchronization source: • Searching indicates that the unit is searching for a GPS fix • Timing Port/UGPS indicates that the module is receiving sync via the timing AUX/SYNC timing port • Power Port indicates that the module is receiving sync via the power port (Ethernet port).
Sync Pulse Status	This field indicates synchronization source pulse status.
Sync Pulse Status - Timing Port/UGPS	This field indicates synchronization pulse status over Timing Port/UGPS port.
Sync Pulse Status - Power Port	This field indicates synchronization pulse status over power port.
UGPS Power Status	This field indicates UGPS power up status (on or off).

This information may be helpful in a decision of whether to climb a tower to diagnose a perceived antenna problem.

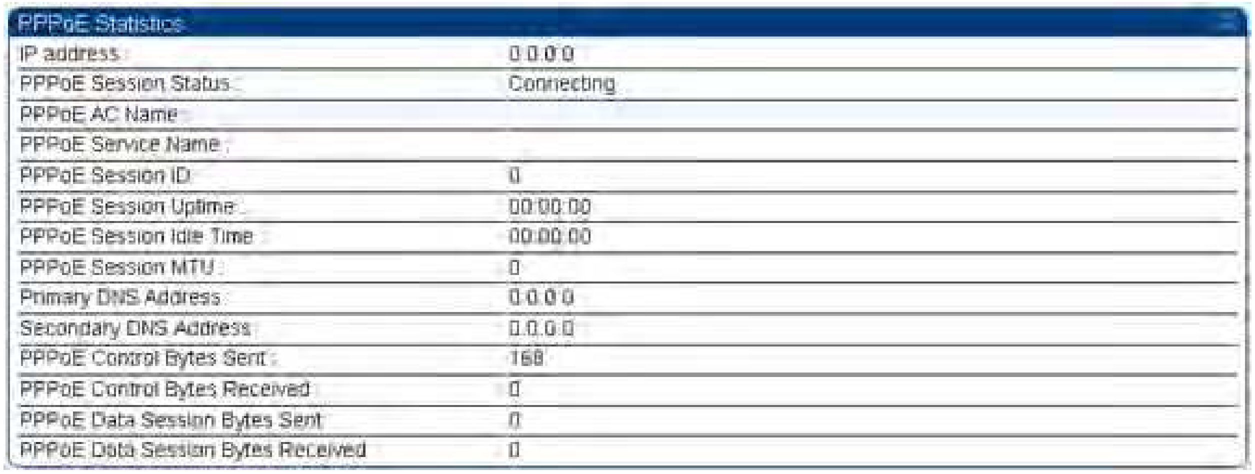
Interpreting PPPoE Statistics for Customer Activities

The page can be access under Statistics > PPPoE of SM GUI.

When the PPPoE feature is enabled on the SM, PPPoE statistics provide data about activities of the customer.

The PPPoE Statistics of SM is explained in below table.

Table 147: PPPoE Statistics page attributes - SM

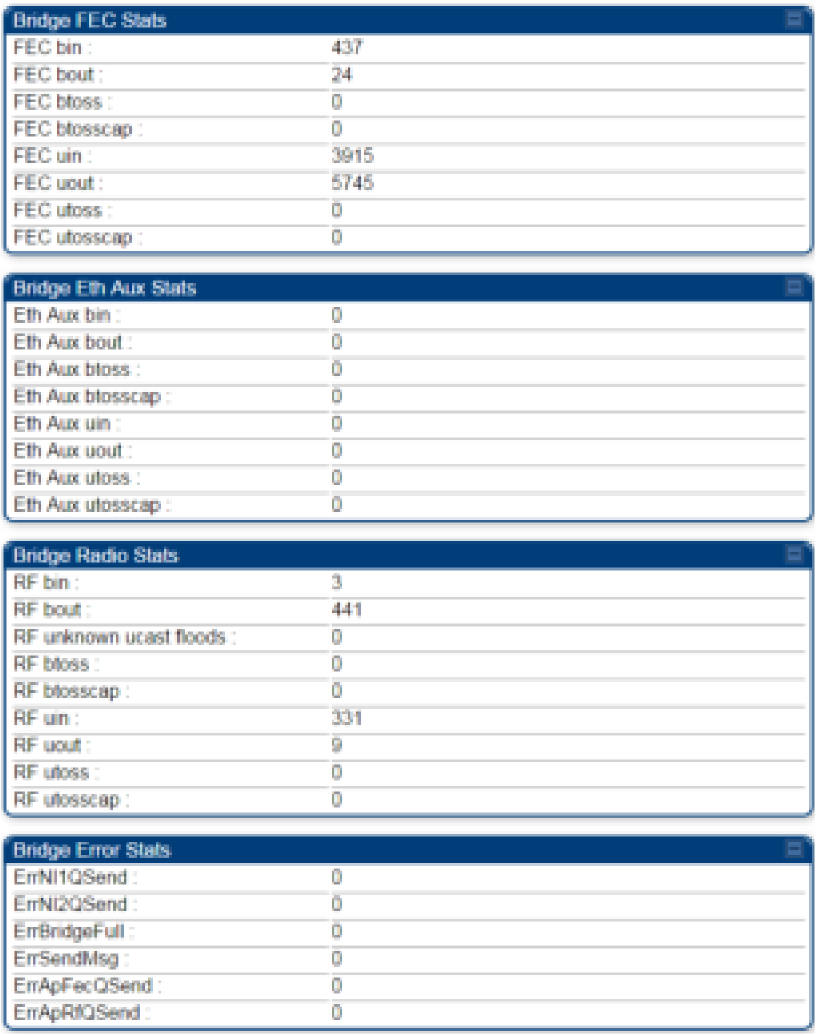


Attribute	Meaning
IP address	This field displays the IP address of the PPPoE session initiator (situated below the SM)
PPPoE Session Status	This field displays the operational status of the PPPoE Session
PPPoE AC Name	This field displays access concentrator name used in the PPPoE session
PPPoE Service Name	This field displays the PPPoE service name associated with the PPPoE server in use
PPPoE Session ID	This field displays the current PPPoE session ID
PPPoE Session Uptime	This field displays the total session uptime for the PPPoE session
PPPoE Session Idle Time	This field displays the total idle time for the PPPoE session
PPPoE Session MTU	This field displays Maximum Transmission Unit configured for the PPPoE session
Primary DNS Address	This field displays the primary DNS server used by the PPPoE session
Secondary DNS Address	This field displays the secondary DNS server used by the PPPoE session
PPPoE Control Bytes Sent	Displays the total number of PPPoE session control bytes sent from SM
PPPoE Control Bytes Received	This field displays the total number of PPPoE session control bytes received by the SM
PPPoE Data Session Bytes Sent	This field displays the total number of PPPoE data session (non-control/non-session management user data) sent by the SM
PPPoE Data Session Bytes Received	This field displays the total number of PPPoE data session (non-control/non-session management user data)

Interpreting Bridge Control Block statistics

The Statistics > Bridge Control Block page displays statistics of Bridge FEC, Bridge ratio and Bridge error. The page is applicable for all modules (AP/SM/BHM/BHS). The Bridge Control Block Statistics page is explained in below table.

Table 148: Bridge Control Block page attributes – AP/SM/BHM/BHS



Attribute	Meaning
Bridge FEC Stats	
FEC bin	This field indicates the number of broadcast packets received by the bridge control block on the Main Ethernet interface
FEC bout	This field indicates the number of broadcast packets sent by the bridge control block on the Main Ethernet interface
FEC btoss	This field indicates the number of broadcast packets tossed out by the bridge control block on the Main Ethernet interface

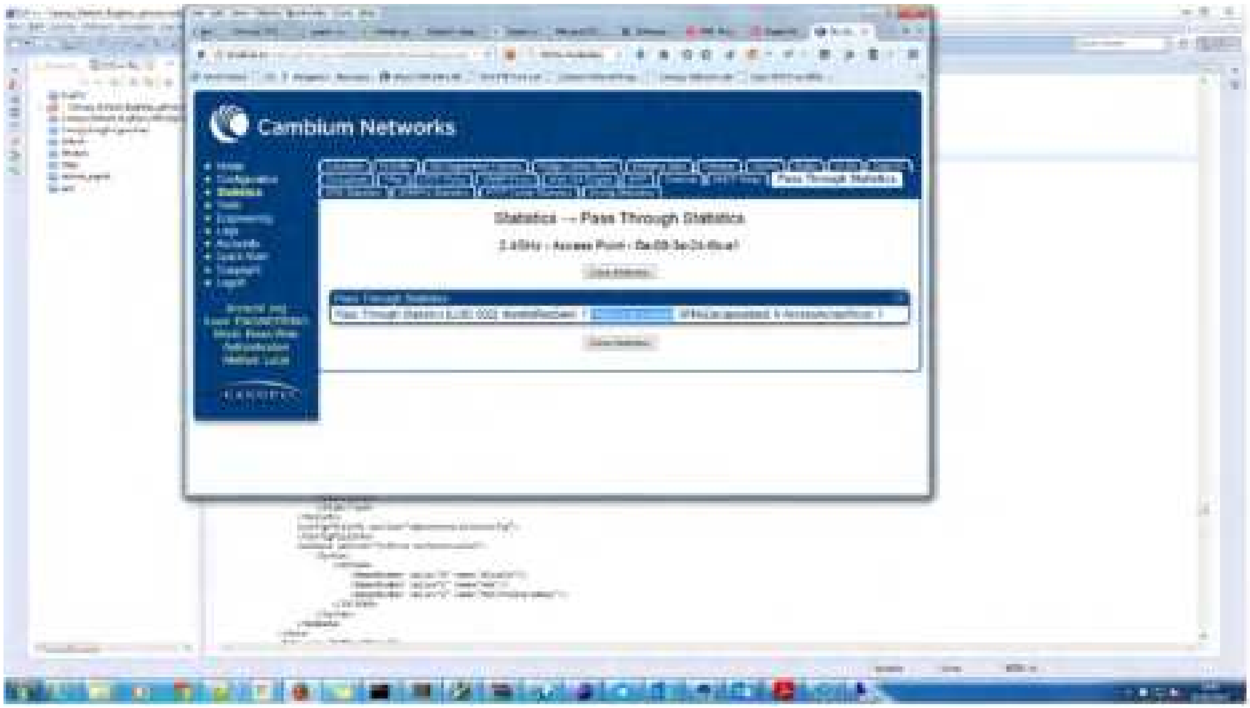
Attribute	Meaning
FEC btosscap	This field indicates the number of broadcast packets tossed out at the Main Ethernet interface due to MIR cap being exceeded.
FEC uin	This field indicates the number of unicast packets received by the bridge control block on the Main Ethernet interface
FEC uout	This field indicates the number of unicast packets sent by the bridge control block on the Main Ethernet interface
FEC utoss	This field indicates the number of unicast packets tossed by the bridge control block on the Main Ethernet interface
FEC utosscap	This field indicates the number of unicast packets tossed out at the Main Ethernet interface due to MIR cap being exceeded.
Bridge Eth Aux Stats	
FEC bin	This field indicates the number of broadcast packets received by the bridge control block on the Aux Ethernet interface
FEC bout	This field indicates the number of broadcast packets sent by the bridge control block on the Aux Ethernet interface
FEC btoss	This field indicates the number of broadcast packets tossed out by the bridge control block on the Aux Ethernet interface
FEC btosscap	This field indicates the number of broadcast packets tossed out at the Aux Ethernet interface due to MIR cap being exceeded.
FEC uin	This field indicates the number of unicast packets received by the bridge control block on the Aux Ethernet interface
FEC uout	This field indicates the number of unicast packets sent by the bridge control block on the Aux Ethernet interface
FEC utoss	This field indicates the number of unicast packets tossed by the bridge control block on the Aux Ethernet interface
FEC utosscap	This field indicates the number of unicast packets tossed out at the Aux Ethernet interface due to MIR cap being exceeded.
Bridge Radio Stats	
RF bin	This field indicates the number of broadcast packets received by the bridge control block on the radio interface
RF bout	This field indicates the number of broadcast packets sent by the bridge control block on the radio interface
RF btoss	This field indicates the number of broadcast packets tossed by the bridge control block on the radio interface
RF btosscap	This field indicates the number of broadcast packets tossed out at the radio interface due to MIR cap being exceeded.

Attribute	Meaning
RF uin	This field indicates the number of unicast packets received by the bridge control block on the radio interface
RF uout	This field indicates the number of unicast packets sent by the bridge control block on the radio interface
RF utoss	This field indicates the number of unicast packets tossed by the bridge control block on the radio interface
RF utosscap	This field indicates the number of unicast packets tossed out at the radio interface due to MIR cap being exceeded.
Bridge Error Stats	
ErrNI1QSend	This field indicates that a packet which was sourced from the radio network stack interface 1 (Ethernet interface) could not be sent because the radio bridge queue was full. The packet was tossed out.
ErrNI2QSend	This field indicates that a packet which was sourced from the radio network stack interface 2 (RF interface) could not be sent because the radio bridge queue was full. The packet was tossed out.
ErrBridgeFull	This field indicates the total number of times the bridging table was full and could not accept new entries.
ErrSendMsg	This field displays the error message from bridge core call back routine.
ErrApFecQSend	This field indicates that a packet which was received on the Ethernet interface could not be processed because the radio bridge queue was full and packet was tossed out.
ErrApRfQSend	This field indicates that a packet which was received on the RF interface could not be processed because the radio bridge queue was full. The packet was tossed out.

Interpreting Pass Through Statistics

The Statistics > Pass Through Statistics page displays radius related statistics. The page is applicable for PMP 450 Platform Family - AP only. The Pass Through Statistics page is explained in below table.

Table 149: Pass Through Statistics page attributes – AP

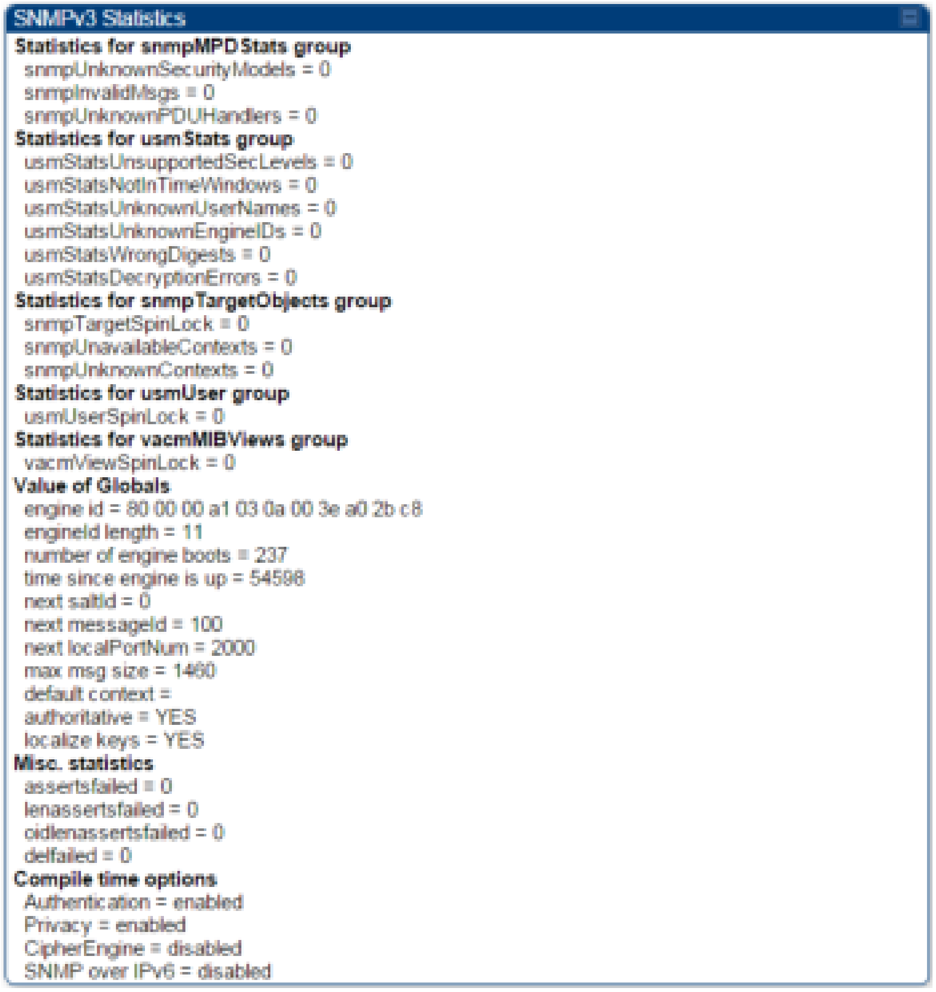


Attribute	Meaning
IdentityReqSent	This field indicates the number of EAP Identity requests sent through the AP with respect to an SM.
PktsEncapsulated	This field indicates no of packets received from the SM which are encapsulated by the AP.
PktsDecasulated	This field indicates no of packets received from the radius server and are decapsulated by the AP with respect to an SM
AccessAcceptRcvd	This field indicates no of RADIUS Access Accept message received by the AP with respect to an SM.

Interpreting SNMPv3 Statistics

The Statistics > SNMPv3 Statistics page displays all SNMPv3 related statistics. The page is applicable for all type of ODUs of PMP 450 Platform. The SNMPv3 Statistics page is explained in below table.

Table 150: SNMPv3 Statistics page attributes – AP



Attribute	Meaning
Statistics for snmpMPDStats group	SNMP Message Processing and Dispatching RFC 3412
snmpUnknownSecurityModels	The total number of packets received by the SNMP engine which were dropped because they referenced a securityModel that was not known to or supported by the SNMP engine.
snmpInvalidMsgs	The total number of packets received by the SNMP engine which were dropped because there were invalid or inconsistent components in the SNMP message.

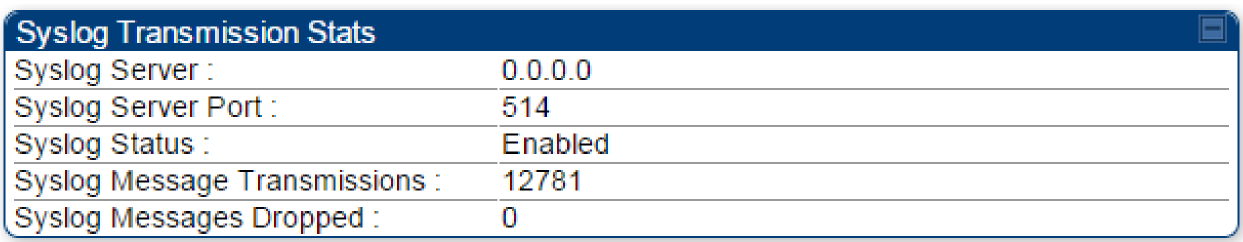
Attribute	Meaning
snmpUnknownPDUHandlers	The total number of packets received by the SNMP engine which were dropped because the PDU contained in the packet could not be passed to an application responsible for handling the pduType, e.g. no SNMP application had registered for the proper combination of the contextEngineID and the pduType.
usmStatsUnsupportedSecLevels	The total number of packets received by the SNMP engine which were dropped because they requested a securityLevel that was unknown to the SNMP engine or otherwise unavailable.
usmStatsNotInTimeWindows	The total number of packets received by the SNMP engine which were dropped because they appeared outside of the authoritative SNMP engine's window.
usmStatsUnknownUserNames	The total number of packets received by the SNMP engine which were dropped because they referenced a user that was not known to the SNMP engine.
usmStatsUnknownEngineIDs	The total number of packets received by the SNMP engine which were dropped because they referenced a snmpEngineID that was not known to the SNMP engine.
usmStatsWrongDigests	The total number of packets received by the SNMP engine which were dropped because they didn't contain the expected digest value.
usmStatsDecryptionErrors	The total number of packets received by the SNMP engine which were dropped because they could not be decrypted.
snmpTargetSpinLock	This object is used to facilitate modification of table entries in the SNMP-TARGET-MIB module by multiple managers.
snmpUnavailableContexts	The total number of packets received by the SNMP engine which were dropped because the context contained in the message was unavailable.
snmpUnknownContexts	The total number of packets received by the SNMP engine which were dropped because the context contained in the message was unknown.
usmUserSpinLock	The use of usmUserSpinlock is to avoid conflicts with another SNMP command generator application which may also be acting on the usmUserTable.

Attribute	Meaning
vacmViewSpinLock	An advisory lock used to allow cooperating SNMP Command Generator applications to coordinate their use of the Set operation in creating or modifying views.
snmpEngineBoots	It is a count of the number of times the SNMP engine has re-booted/re-initialized since snmpEngineID was last configured
snmpEngineTime time since engine is up	which is the number of seconds since the snmpEngineBoots counter was last incremented

Interpreting syslog statistics

The Statistics > Syslog Statistics page displays statistics of syslog messages. The page is applicable for all modules (AP/SM/BHM/BHS). The Syslog Statistics page is explained in below table.

Table 151: Syslog statistics page attributes – AP/SM/BH



Attribute	Meaning
Syslog Server	This displays dotted decimal or DNS name (if the DNS is enabled) of the syslog server address.
Syslog Server Port	The syslog server port (default 514) to which syslog messaging is sent.
Syslog Status	This indicates status of syslog messaging. It can be Enable or Disabled based on configuration
Syslog Message Transmissions	This field indicates the count of syslog messages sent to UDP layer.
Syslog Message Dropped	This field indicates the count of dropped syslog messages.

CBRS Statistics for AP/SM

The **Statistics > CBRS** page displays CBRS heart beat statistics and CBRS EIRP Change History. This page is visible only on the AP/BHM. Statistics for the SMs can also be seen on this page, viewed on the AP/BHM Radio. The CBRS statistics for AP/SM page is explained in Table 1.

Figure 120: *CBRS statistics for AP*

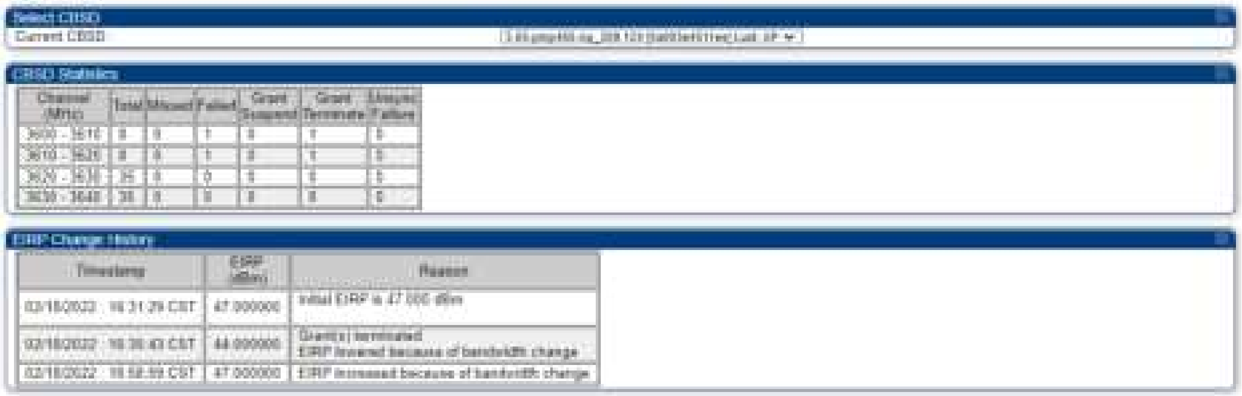


Table 152: CBRS statistics for AP

Attribute	Meaning
Select CBSD	
Current CBSD	Allows an operator to select the statistics for a particular AP/BHM.
CBSD Statistics	
Channel	The low frequency and high frequency range of a CBRS grant. Each row in the CBSD Statistics table represents a channel range for a currently active CBRS grant. Note that the statistics per row represent all the counts for all the grants in a particular channel range since the statistics were last cleared, assuming a grant is currently held for that channel range.
Total	The total count of the heartbeat requests sent, per frequency range, since the statistics were last cleared.
Missed	The AP sent a heartbeat request but did not receive a heartbeat response.
Failed	The AP received a heartbeat response with a failure code.
Grant Suspend	The total number of heartbeat responses received from the SAS, per frequency range, with reason code **suspended grant**.
Grant Terminate	The total number of heartbeat responses received from the SAS with reason code 500 – **terminated grant**. Note that as of System Release 21.0, terminated grants will immediately be removed from the table. But as mentioned previously in the **Channel** field description, the statistics show all the counts for all grants held in every channel range since the statistics were last cleared. If at any time after a grant termination, an operator moves the radio’s back to the previously terminated channel range and is successful in obtaining a new grant, these counts will include the counts for the previously terminated grant as well as the newly obtained grant.
Unsync failure	The total number of heartbeat responses received from the SAS with reason code 502 – unsync failure.
EIRP Change History	

Attribute	Meaning
Timestamps	Each row in the EIRP Change History table represents a point in the time when the total EIRP for a particular CBSD was changed. The events are listed in chronological order.
EIRP	The total transmit EIRP the CBSD moved to at this point in time.
Reason	The detailed reason for that EIRP change.

Figure 121: *CBRS Statistics for SM*

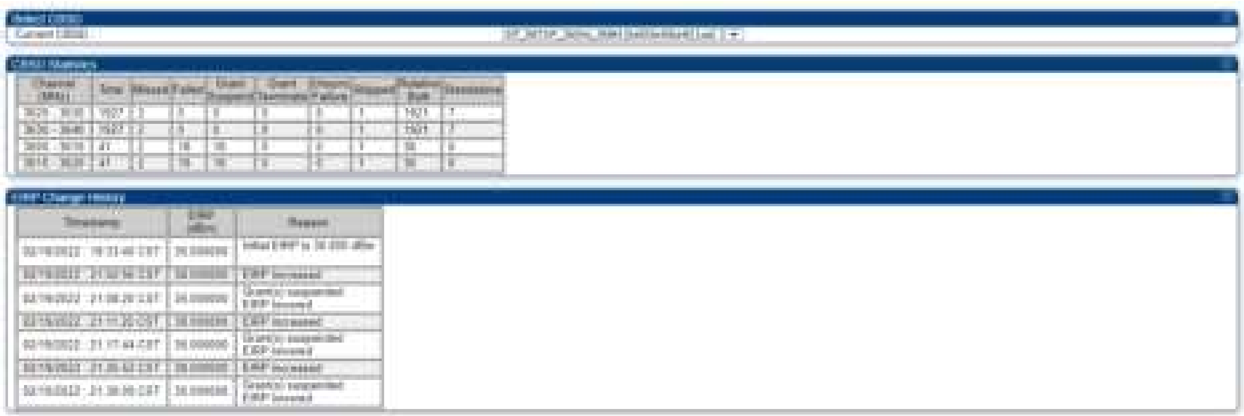


Table 153: CBRS Statistics for SM

Attribute	Meaning
Select CBSD	
Current CBSD	Allows an operator to select to view statistics for a particular SM.
CBSD Statistics	
Channel	The low frequency and high frequency range of a CBRS grant. Each row in the CBSD Statistics table represents a channel range for a currently active CBRS grant. Note that the statistics per row represent all the counts for all the grants in a particular channel range since the statistics were last cleared, assuming a grant is currently held for that channel range.
Total	The total count of the heartbeat requests sent, per frequency range, since the statistics were last cleared.
Missed	The heartbeat request was sent but no response was received.
Failed	The heartbeat response was received with a failure code.
Grant Suspend	The total number of heartbeat responses received from the SAS, per frequency range, with reason code **suspended grant**.
Grant Terminate	The total number of heartbeat responses received from the SAS with reason code 500 – **terminated grant**. Note that as of PMP System Release 21.0, terminated grants will immediately be removed from the table. But as mentioned previously in the **Channel**

Attribute	Meaning
	field description, the statistics show all the counts for all grants held in every channel range since the statistics were last cleared. If at any time after a grant termination, an operator moves the Radio's back to the previously terminated channel range and is successful in obtaining a new grant, these counts will include the counts for the previously terminated grant as well as the newly obtained grant.
Unsync failure	The total number of heartbeat responses received from the SAS with reason code 502 – unsync failure.
Skipped	The AP did not include this SM in the heartbeat exchange.
Relative bulk	The total number of heartbeat requests sent for this particular SM that was included in a bulk heartbeat request with other SMs.
Standalone	The total number of heartbeat requests sent for this particular SM that was sent standalone – not part of a bulk heartbeat request with other SMs.
EIRP Change History	
Timestamps	Each row in the EIRP Change History table represents a point in the time when the total EIRP for a particular CBSD was changed. The events are listed in chronological order.
EIRP	The total transmit EIRP the CBSD moved to at this point in time.
Reason	The detailed reason for that EIRP change. Note that an "EIRP lowered" or an "EIRP increased" reason that does not mention grants is typically a user-initiated change.

Interpreting Frame Utilization statistics

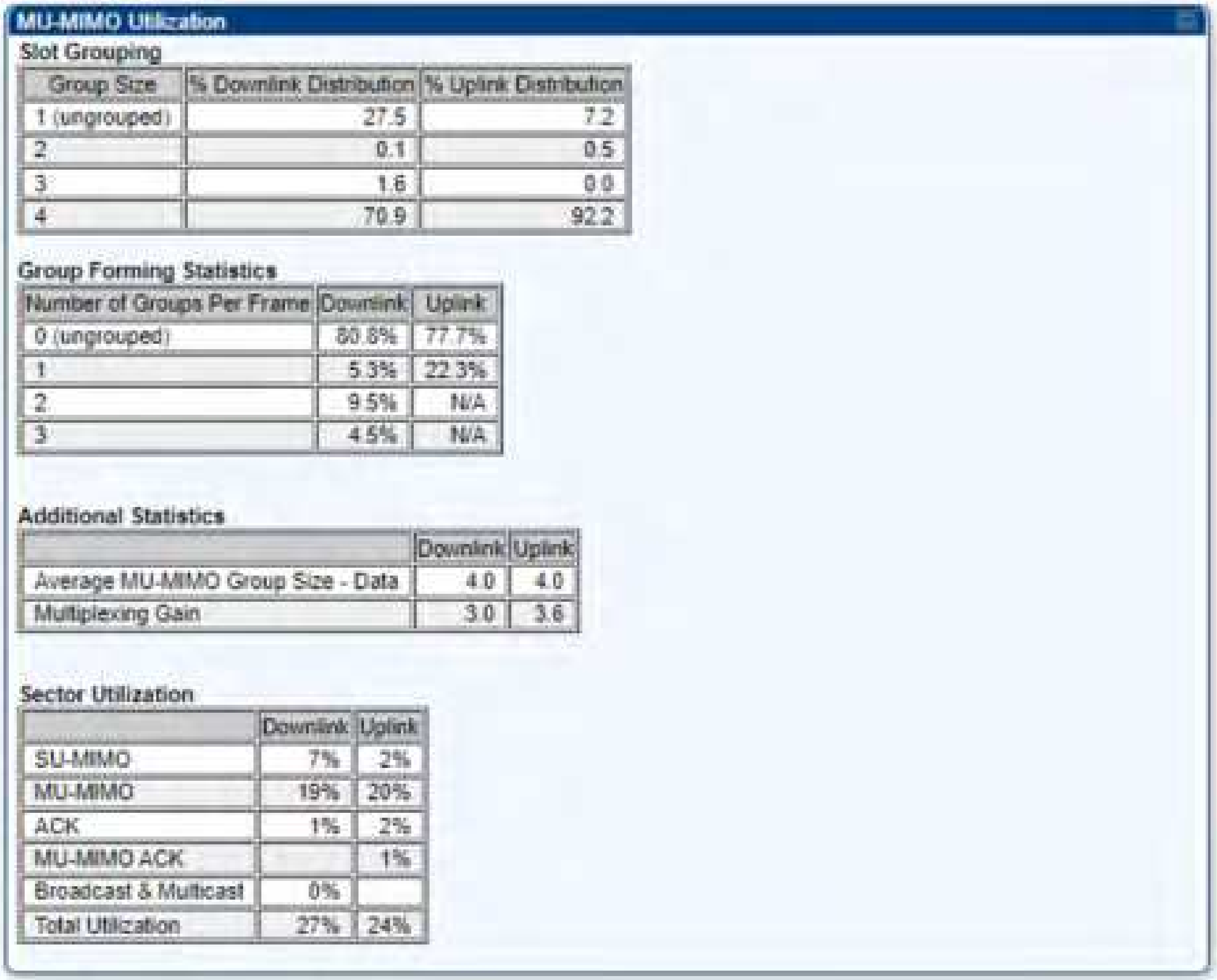
The Frame Utilization Statistics is a feature helps user to understand how effectively the RF channel is being utilized. This feature allows to check Time Division Duplex (TDD) frame utilization pattern and diagnose for any excessive usage in uplink or downlink direction.

This forms the first step of identifying the TDD frame utilization information. If the user finds excessive utilization based on these stats, the second step would be to take several actions like sectorization, tuning the uplink/downlink ratio etc. to improve RF channel utilization. Efficient use of the TDD frame will help to achieve optimum performance of link.

Note

The backhauls (BHM and BHS) contain only the downlink scheduler-based statistics.

Table 154: Frame utilization statistics for 450m



MU-MIMO Utilization

Slot Grouping

Group Size	% Downlink Distribution	% Uplink Distribution
1 (ungrouped)	27.5	7.2
2	0.1	0.5
3	1.6	0.0
4	70.9	92.2

Group Forming Statistics

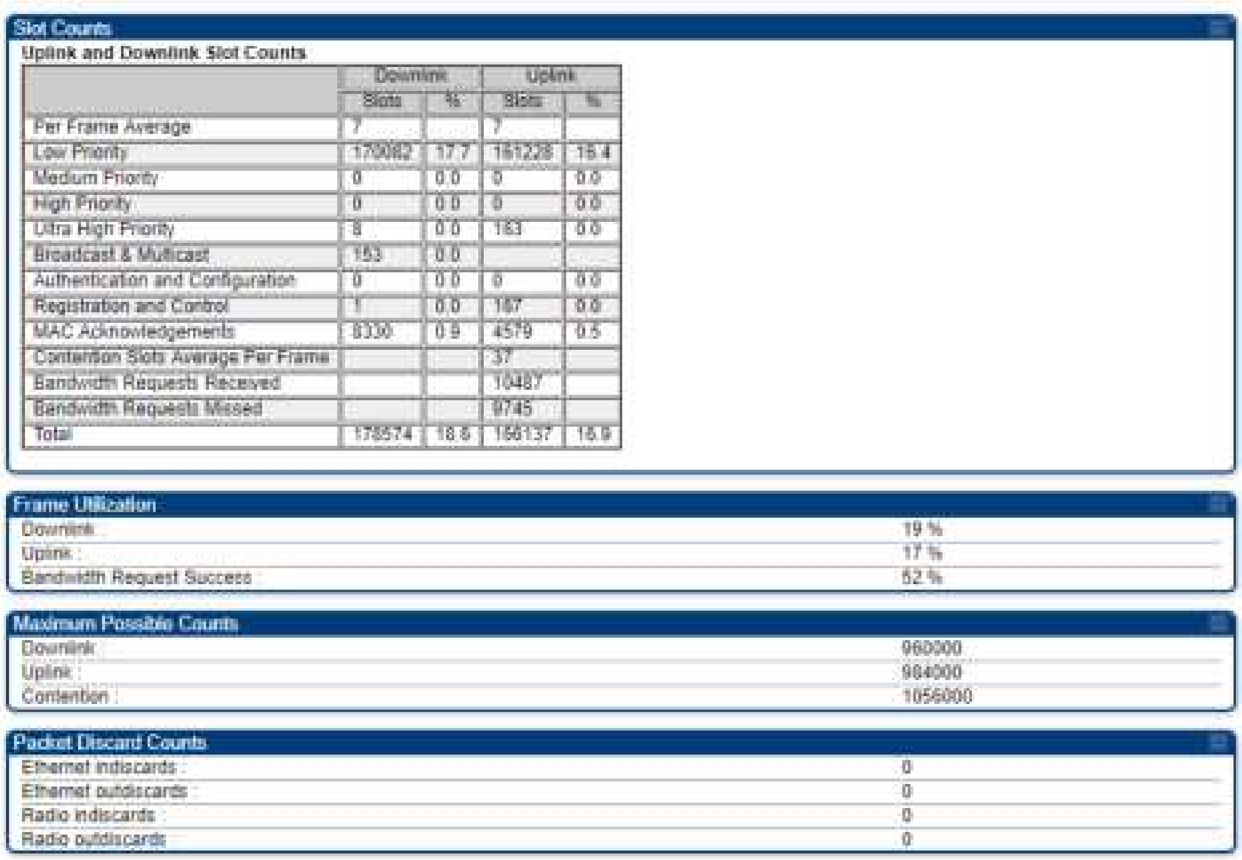
Number of Groups Per Frame	Downlink	Uplink
0 (ungrouped)	80.8%	77.7%
1	5.3%	22.3%
2	9.5%	N/A
3	4.5%	N/A

Additional Statistics

	Downlink	Uplink
Average MU-MIMO Group Size - Data	4.0	4.0
Multiplexing Gain	3.0	3.6

Sector Utilization

	Downlink	Uplink
SU-MIMO	7%	2%
MU-MIMO	19%	20%
ACK	1%	2%
MU-MIMO ACK		1%
Broadcast & Multicast	0%	
Total Utilization	27%	24%


Slot Counts

Uplink and Downlink Slot Counts

	Downlink		Uplink	
	Slots	%	Slots	%
Per Frame Average	7		7	
Low Priority	170082	17.7	151228	15.4
Medium Priority	0	0.0	0	0.0
High Priority	0	0.0	0	0.0
Ultra High Priority	8	0.0	163	0.0
Broadcast & Multicast	153	0.0		
Authentication and Configuration	0	0.0	0	0.0
Registration and Control	1	0.0	167	0.0
MAC Acknowledgements	8330	0.9	4579	0.5
Contention Slots Average Per Frame			37	
Bandwidth Requests Received			10487	
Bandwidth Requests Missed			9745	
Total	178574	18.6	166137	16.9

Frame Utilization

Downlink :	19 %
Uplink :	17 %
Bandwidth Request Success :	52 %

Maximum Possible Counts

Downlink :	960000
Uplink :	984000
Contention :	1056000

Packet Discard Counts

Ethernet indiscards :	0
Ethernet outdiscards :	0
Radio indiscards :	0
Radio outdiscards :	0

Attribute	Meaning
Frame Utilization Interval	
Statistics Display interval	This allows to configure timer interval to monitor and display the frame utilization statistics. It can be configured for 1 minute (low interval), 5 minutes (medium interval) or 15 minutes (high interval) based on requirement.
Next Update	This field displays when the next update will occur.
MU-MIMO Utilization	
Slot Grouping - Group Size	This specifies the distribution of group size for the past 1/5/15 minutes. For each group size, from 1 to 7, the table shows the percentage of slots using that group size. • A group size of 1 corresponds to beamformed transmissions. • A group size of 2 to 7 corresponds to MU-MIMO transmissions. Note that for 30 MHz and 40 MHz bandwidths, the UL group size is limited to 3 or smaller.
Group Forming Statistics	

Attribute	Meaning
Number of Groups Per Frame	Indicates what percentage of frames in this measurement window had the corresponding number of MU-MIMO groups per frame, and per direction. In the example shown, 5.3% of the frames had 3 different MU-MIMO groups formed. Note that this frame could also contain SU-MIMO scheduled data. The "0 ungrouped" shows the percentage of frames that had non-MUMIMO scheduled traffic at all. This frame would have only SU-MIMO scheduled traffic, and/or unused symbols. The "2" and "3" rows always show N/A in the Uplink direction because current PMP software only supports a single MU-MIMO group per frame in the Uplink direction.
Additional Statistics	
Average MU-MIMO Group Size - Data	This specifies the average number of users in the MU-MIMO groups formed in the last 1/5/15 minutes for data traffic only.
Total Utilization	This is a percentage of available timeslots used in the past 1/5/15 minutes.
Multiplexing Gain	This specifies the ratio between the number of logical slots and the number of physical slots used. A physical slot is an OFDM symbol. In non MU-MIMO mode, each logical slot is sent during one physical slot. In MU-MIMO mode a number of logical slots are sent during a physical slot, equal to the number of VCs in the group. A logical slot carries new information; if data is repeated in a group, because some VCs have more data to send then others, then the repeated transmissions are not counted as a logical slots. Without MU-MIMO operation, the multiplexing gain would always be equal to 1. With MU-MIMO operation, this number accounts for parallel transmissions to multiple users in the MU-MIMO group. The difference between the Average MU-MIMO Group Size and the Multiplexing Gain is that the Average MU-MIMO Group Size only considers the MU-MIMO groups, and it averages the number of VCs in the Group. The Multiplexing Gain also considers non MU-MIMO transmissions, which are counted as groups of size 1.
Sector Utilization	
SU-MIMO	This specifies the portion of the Total Utilization used for SU-MIMO transmissions.
MU-MIMO	This specifies the portion of the Total Utilization used for MU-MIMO transmissions.
ACK	This specifies the portion of the Total Utilization used for acknowledgments transmission.
MU-MIMO ACK	This specifies the portion of the Total Utilization used for acknowledgements transmissions that are MU-MIMO scheduled. Currently only the UL direction supports MU-MIMO scheduling of ACK's.

Attribute	Meaning
Broadcast & Multicast	This specifies the portion of the Total Utilization used for broadcast and multicast transmissions.
Slots Counts - Uplink and Downlink Slot Counts	
Per Frame Average	This indicates the average data per frame in the downlink traffic.
Low Priority	The number of downlink data slots used for low priority downlink traffic.
Medium Priority	The number of downlink data slots used for medium priority downlink traffic.
High Priority	The number of downlink data slots used for high priority downlink traffic.
Ultra High Priority	The number of downlink data slots used for ultra high priority downlink traffic.
Note: The above Low, Medium, High, and Ultra High Priority Counts are physical slot transmissions. For MU-MIMO scheduling, some transmissions can contain data from more than 1 data channel priority. In those cases, the highest data channel used is "counted" in these statistics, and the other data channels are not, to avoid overcounting.	
Broadcast & Multicast	The number of downlink data slots used for broadcast and multicast traffic.
Authentication and Configuration	The number of slots used for registration and control message transmissions
Registration and control	The number of slots used for Authentication and Configuration transmissions.
MAC Acknowledgements	The number of downlink data slots used as ACKs.
Contention Slots Average Per Frame	It is the average number of contention slots in a frame for the last duration. Duration is 1/5/15 mins.
Bandwidth Requests Received	This indicates the number of Bandwidth Requests received from SMs.
Bandwidth Requests Missed	This indicates how many of Bandwidth Requests are colliding.
Total	This indicates the sum of all downlink data slots used in the configured interval.
Frame Utilization	
Downlink	This indicates the percentage of downlink data slots used against the maximum number of slots possible in the configured interval.
Uplink	This indicates the percentage of uplink data slots used against the maximum number of uplink slots possible in the configured interval.

Attribute	Meaning
Bandwidth Request Success	The "Bandwidth Request Success" is a message sent from the SM to the AP asking to be scheduled for bandwidth to send in the uplink. This gets transmitted in the unscheduled portion of the uplink. Unscheduled uplink is defined as Contention Slots + unscheduled uplink slots. Since this is sent in the unscheduled portion of the uplink, it will result in collisions when SMs randomly pick the same slot. The "Bandwidth Request Missed" metrics are to add data to know how many of requests are colliding. If it is near 100%, then near all of the SM's bandwidth requests are getting through to the AP, so this a is near perfect scenario. If it is significantly less than that, you may be experiencing uplink latency as your SMs are attempting to request bandwidth and are unable to do so. Also note that if it is consistently at 100% the AP may be able to reduce its contention slots to a lower value and gain more data slots.
Maximum possible counts	
Downlink	This indicates the maximum possible downlink data slots in the configured interval. This is based on the configuration of Channel Bandwidth, Frame period, uplink/downlink allocation, contention slots and configured Statistics Display interval.
Uplink	This indicates the maximum possible uplink data slots in the configured interval. This is based on the configuration of Channel Bandwidth, Frame period, uplink/downlink allocation, contention slots and configured Statistics Display interval.
Contention	This indicates the maximum possible contention slots.
Packet Discard counts	
Ethernet indiscards	This indicates the number of Ethernet packets discarded in the IN queue.
Ethernet outdiscards	This indicates the number of Ethernet packets discarded in the OUT queue.
Radio indiscards	This indicates the number of packets discarded over radio in the IN queue.
Radio outdiscards	This indicates the number of packets discarded over radio in the OUT queue.

Table 155: Frame utilization statistics for 450, 450i

Frame Utilization Interval

Statistics Display Interval :	1 minute
Next Update :	23 seconds

Frame Utilization Summary

Utilization

Direction	Percentage
Downlink	0.4%
Uplink	0.5%

Spectral Efficiency (user data bits per second per hertz)

Direction	Extrapolated	8X Max	7X Max	6X Max	5X Max	4X Max	3X Max	2X Max	1X Max
Downlink	1.38	3.52	3.08	2.64	2.20	1.76	1.32	0.88	0.44
Uplink	1.53	3.60	3.15	2.70	2.25	1.80	1.35	0.90	0.45

Data to Overhead Percentage

Direction	Data	Overhead (Ack)
Downlink	60.5%	39.4%
Uplink	83.1%	16.8%

Data Per Modulation Percentage

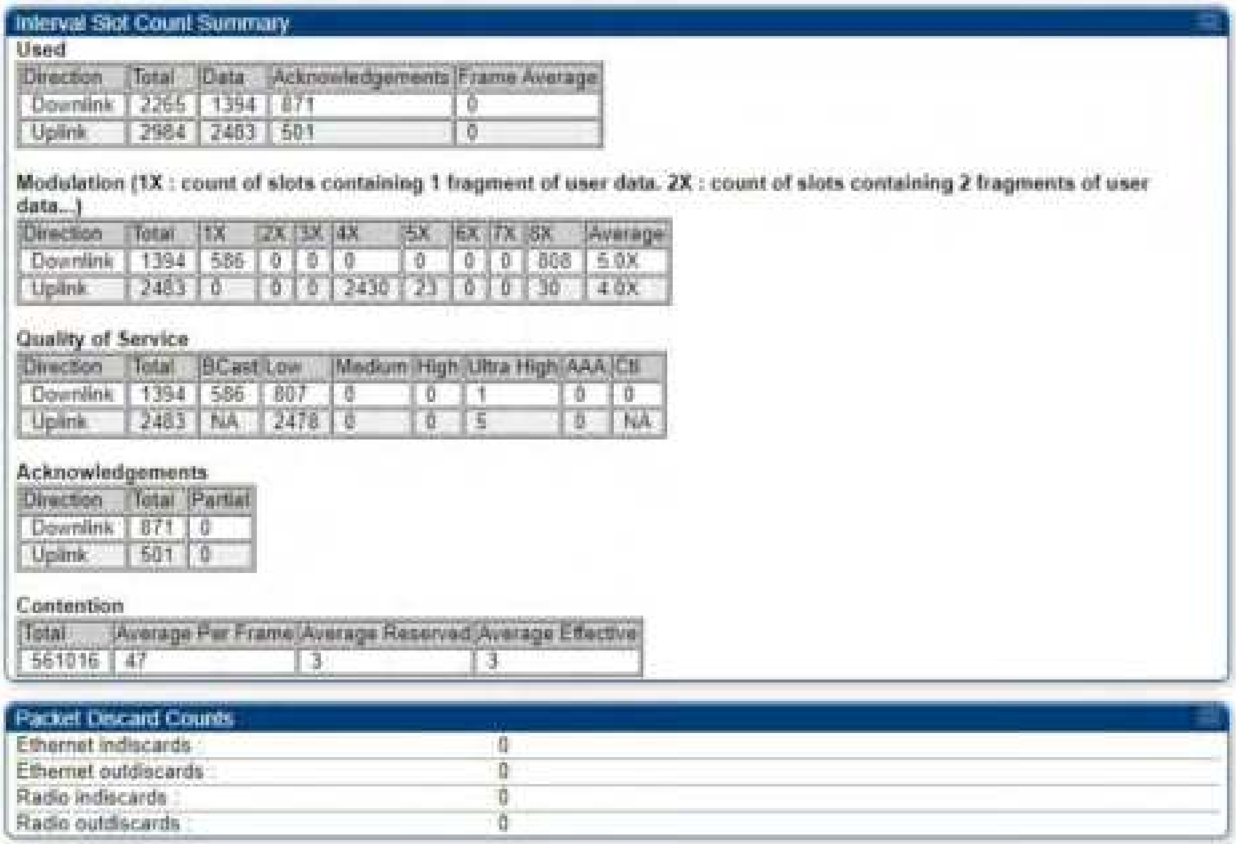
Direction	1X	2X	3X	4X	5X	6X	7X	8X
Downlink	40.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	59.1%
Uplink	0.0%	0.0%	0.0%	98.4%	0.0%	0.0%	0.0%	1.5%

Data Per QoS Percentage

Direction	BCast	Low	Medium	High	Ultra High	AAA	Ctl
Downlink	40.8%	59.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Uplink	NA	99.7%	0.0%	0.0%	0.2%	0.0%	NA

Bandwidth Request Receive Efficiency

Percentage Received	Received	Missed	Urgent
100.0%	684	0	0



Interval Slot Count Summary

Used

Direction	Total	Data	Acknowledgements	Frame Average
Downlink	2265	1394	871	0
Uplink	2984	2483	501	0

Modulation (1X : count of slots containing 1 fragment of user data. 2X : count of slots containing 2 fragments of user data...)

Direction	Total	1X	2X	3X	4X	5X	6X	7X	8X	Average
Downlink	1394	586	0	0	0	0	0	0	808	5.0X
Uplink	2483	0	0	0	2430	23	0	0	30	4.0X

Quality of Service

Direction	Total	BCast	Low	Medium	High	Ultra High	AAA	Ctl
Downlink	1394	586	807	0	0	1	0	0
Uplink	2483	NA	2478	0	0	5	0	NA

Acknowledgements

Direction	Total	Partial
Downlink	871	0
Uplink	501	0

Contention

Total	Average Per Frame	Average Reserved	Average Effective
561016	47	3	3

Packet Discard Counts

Ethernet indiscards :	0
Ethernet outdiscards :	0
Radio indiscards :	0
Radio outdiscards :	0

Attribute	Meaning
Frame Utilization Interval	
Statistics Display interval	This allows to configure timer interval to monitor and display the frame utilization statistics. It can be configured for 1 minute (low interval), 5 minutes (medium interval) or 15 minutes (high interval) based on requirement.
Next Update	This field displays when the next update will occur.
Frame Utilization Summary	
Utilization	Total percentage used in the time interval.
Spectral Effeicincy (user data bits per second per hertz)	Provides an actual measure of how many bits per hertz per second achieved for user data in the most recent frame utilization interval.
Data to Overhead Percentage	Provides a breakdown of user data to overhead data.
Data Per Modulation Percentage	Provides a breakdown of data slots used per modulation.
Data Per QoS Percentage	Provides what percentage of used slots were due to which QoS levels. Note that “AAA” QoS refers to slots used for authentication/authorization/accounting. “Ctl” QoS refers to slots used for

Attribute	Meaning
	system level messages (registration, encryption).
Bandwidth Request Receive Efficiency	How efficient the SM's Bandwidth Request messages are getting to the AP.
Interval Slot Count Summary-Used	Provides a summary of actual slot counts rather than the percentages provided in the Frame Utilization Summary.
Used	Provides a breakdown of total slots used in each direction. It further breaks down the total between data and acks. Finally, it provides an average slots used per TDD frame.
Modulation (1X : Count of slot containing 1 fragment of user data. 2X: Count of slot containing 2 fragments of user data…)	Provides a breakdown of the number of slots used at each modulation.
Quality of Service	Provides a breakdown of the number of slots used at each QoS level.
Aknowledgements	Provides the number of slots used for acks. It also provides a new count called **Partial.**
Contention	
Total	The total number of slots available for contention in this statistics time interval. This includes both slots reserved for contention and unused uplink data slots.
Average Per Frame	The average number of total slots available for contention. This includes both slots reserved for contention and unused uplink data slots. This is calculated by dividing the total count by the number of frames in the statistics time interval.
Average Reserved	The average number of slots reserved for contention per frame. These slots cannot be used for uplink data. This statistic is only applicable when auto-contention is enabled.
Average Effective	In addition to adjusting the number of slots available for contention, contention space collisions can also be controlled by adjusting the timing of when bandwidth requests can be sent by the SM. This effective statistic takes into account both the timing backoff and the number of slots reserved for contention. This statistic is only applicable when auto-contention is enabled.
Packet Discard counts	
Ethernet indiscards	This indicates the number of Ethernet packets discarded in the IN queue.
Ethernet outdiscards	This indicates the number of Ethernet packets discarded in the OUT queue.
Radio indiscards	This indicates the number of packets discarded over radio in the IN queue.
Radio outdiscards	This indicates the number of packets discarded over radio in the OUT queue.

Interpreting Channel Change History statistics

The Channel Change History statistics are available for all PMP AP and BHM products. For non-CBRS deployments, the Authorized Grants column is not be visible, and only user-triggered channel change reasons are displayed.

Figure 122: *The Channel Change History statistics for AP and BHM*

Channel Change History

Center Frequency (MHz)	Bandwidth (MHz)	Timestamp	Reason
5165.000	5.0	04/26/2024 : 11:15:25 CST	Channel change triggered by user
5167.500	5.0	04/26/2024 : 11:15:42 CST	Channel change triggered by user
5170.000	5.0	04/26/2024 : 11:15:59 CST	Channel change triggered by user
5172.500	5.0	04/26/2024 : 11:16:15 CST	Channel change triggered by user
5175.000	5.0	04/26/2024 : 11:16:33 CST	Channel change triggered by user
5177.500	5.0	04/26/2024 : 11:16:50 CST	Channel change triggered by user
5180.000	5.0	04/26/2024 : 11:17:06 CST	Channel change triggered by user
5182.500	5.0	04/26/2024 : 11:17:22 CST	Channel change triggered by user
5185.000	5.0	04/26/2024 : 11:17:40 CST	Channel change triggered by user
5187.500	5.0	04/26/2024 : 11:17:56 CST	Channel change triggered by user
5190.000	5.0	04/26/2024 : 11:18:13 CST	Channel change triggered by user
5192.500	5.0	04/26/2024 : 11:18:29 CST	Channel change triggered by user
5880.000	5.0	05/01/2024 : 15:54:23 CST	Channel change triggered by user
5880.000	20.0	05/02/2024 : 16:14:21 CST	Channel change triggered by user

Table 156: The Channel Change History statistics for AP and BHM

Attribute	Meaning
Center frequency	The center frequency of the operating channel for the sector. For example, if a CBRS AP holds four 10 MHz multigrants ranging in frequency from 3580 through 3620, the first, second, and fourth 10 MHz channels are authorized while the third channel was suspended, 3590 would be the center frequency displayed here.
Bandwidth	The bandwidth of the operating channel for the sector. For example, if a CBRS AP holds four 10 MHz multigrants ranging in frequency from 3580 through 3620, the first, second, and fourth 10 MHz channels are authorized while the third channel was suspended, 20 MHz would be the bandwidth displayed here.
Timestamp	The time that the AP/BHM switch to the Center Frequency and Bandwidth displayed in this row. The channel changes are displayed in chronological order, with the newest changes at the bottom of the table.
Reason	The particular reason for the channel change. For example, CBRS grant termination.

Interpreting Spatial Utilization statistics

Figure 123: *Spatial Utilization statistics*

Spatial Utilization

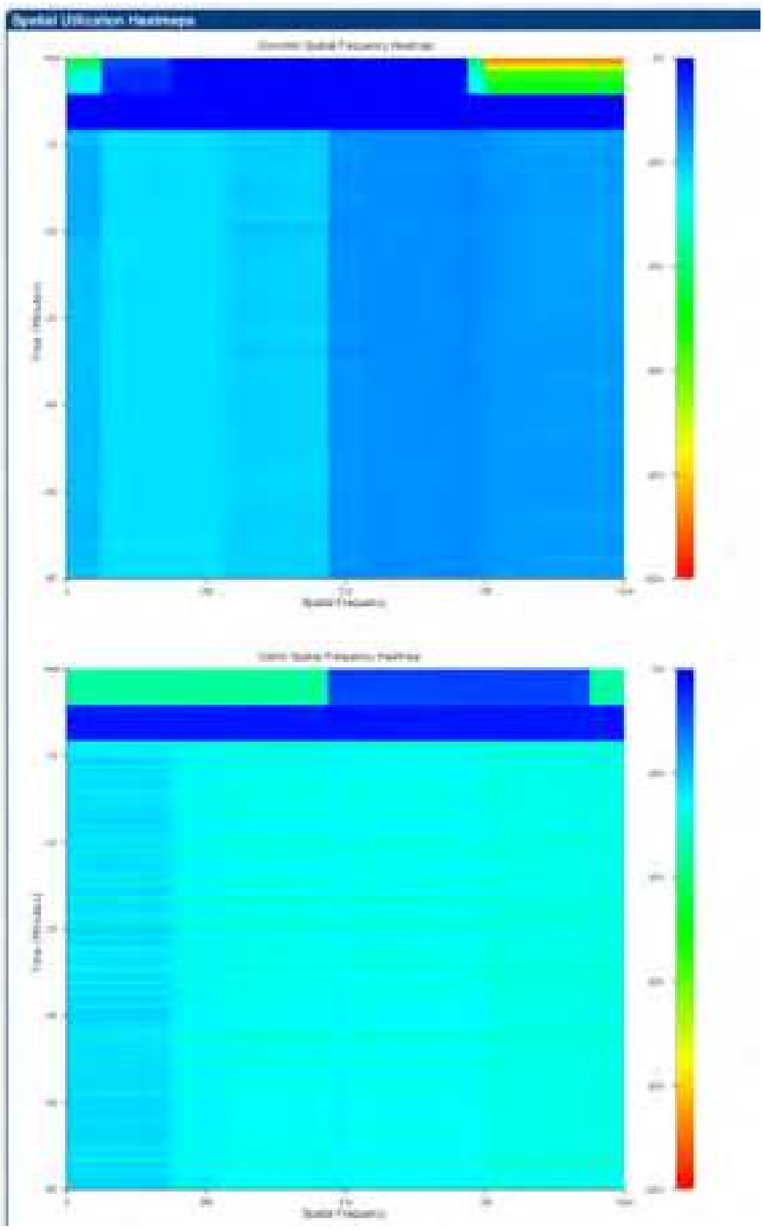
Instantaneous Distribution

Group	Downlink	
	Median Slot Count	LUIDs in Group
Top LUID	3584	19
Top 2 LUIDs	3584	18
Top 4 LUIDs	3584	15, 16
Top 8 LUIDs	3584	4, 5, 7, 9
Top 16 LUIDs	3428	2, 3, 6, 8, 10, 12, 21, 22
Top 32 LUIDs	3368	11, 13, 14, 17, 20
Top 64 LUIDs	0	
Top 128 LUIDs	0	
Top 256 LUIDs	0	

Spatial Utilization

Spatial Frequency	LUIDs in Range	Downlink				Azimuth (degrees)
		Instantaneous (%)	Total (%)	Max (%)	Min (%)	
0 - 31	2	100	100	100	99	(-50.7 - -49.3) , (0.0 - 1.4) , (50.7 - 52.0)
32 - 63	5	100	100	100	99	(-49.3 - -47.9) , (1.4 - 2.8) , (52.0 - 53.4)
64 - 95	9	100	100	100	99	(-47.9 - -46.5) , (2.8 - 4.2) , (53.4 - 54.8)
96 - 127		100	100	100	99	(-46.5 - -45.1) , (4.2 - 5.5) , (54.8 - 56.2)
128 - 159	14	100	100	100	99	(-45.1 - -43.7) , (5.5 - 6.9) , (56.2 - 57.6)
160 - 191		100	100	100	99	(-43.7 - -42.3) , (6.9 - 8.3) , (57.6 - 59.0)
192 - 223	8	100	100	100	99	(-42.3 - -40.9) , (8.3 - 9.7) , (59.0 - 60.0)
224 - 255	19	100	100	100	99	(-40.9 - -39.5) , (9.7 - 11.1)
256 - 287	11	100	100	100	99	(-39.5 - -38.1) , (11.1 - 12.6)
288 - 319		100	100	100	99	(-38.1 - -36.7) , (12.6 - 14.0)
320 - 351	22	100	100	100	99	(-36.7 - -35.2) , (14.0 - 15.4)
352 - 383	18	100	100	100	99	(-35.2 - -33.8) , (15.4 - 16.9)
384 - 415		100	100	100	99	(-33.8 - -32.3) , (16.9 - 18.3)
416 - 447	3	100	100	100	99	(-32.3 - -30.9) , (18.3 - 19.8)
448 - 479	6	100	100	100	99	(-30.9 - -29.4) , (19.8 - 21.3)
480 - 511		100	100	100	99	(-29.4 - -27.9) , (21.3 - 22.7)
512 - 543	4	100	100	100	99	(-27.9 - -26.4) , (22.7 - 24.3)
544 - 575		100	100	100	99	(-26.4 - -24.9) , (24.3 - 25.8)
576 - 607	17	100	100	100	99	(-24.9 - -23.3) , (25.8 - 27.3)
608 - 639	10	100	100	100	99	(-23.3 - -21.8) , (27.3 - 28.9)
640 - 671		100	100	100	99	(-21.8 - -20.2) , (28.9 - 30.5)
672 - 703	7	100	100	100	99	(-20.2 - -18.5) , (30.5 - 32.1)
704 - 735	20	100	100	100	99	(-18.5 - -16.9) , (32.1 - 33.8)
736 - 767		100	100	100	99	(-16.9 - -15.2) , (33.8 - 35.5)
768 - 799	12	100	100	100	99	(-15.2 - -13.5) , (35.5 - 37.2)
800 - 831		100	100	100	99	(-13.5 - -11.7) , (37.2 - 38.9)
832 - 863	16	100	100	100	99	(-11.7 - -9.9) , (38.9 - 40.7)
864 - 895	13	100	100	100	99	(-60.0 - -58.7) , (-9.9 - -8.1) , (40.7 - 42.6)
896 - 927	21	100	100	100	99	(-58.7 - -56.8) , (-8.1 - -6.2) , (42.6 - 44.5)
928 - 959		100	100	100	99	(-56.8 - -54.8) , (-6.2 - -4.2) , (44.5 - 46.5)
960 - 991	15	100	100	100	99	(-54.8 - -52.8) , (-4.2 - -2.1) , (46.5 - 48.5)
992 - 1023		100	100	100	99	(-52.8 - -50.7) , (-2.1 - 0.0) , (48.5 - 50.7)

Spatial Frequency Heatmap



Attribute	Meaning
Instantaneous Distribution	This table is updated every 500 ms and displays the following: • Group: Each row corresponds to the top (most active) 1, 2, 8, 16, 32, 64, 128 and 256 VCs. • Median Slot Count: Median value of the average number of slots scheduled for the VCs in each group in the past 500 ms.
	• LUIDs in Group: List of LUIDs belonging to each bin.

<table>
<tr><th>Attribute</th><th>Meaning</th></tr>
<tr><td>Spatial Utilization</td><td>This is a table (32 rows) that lists frame utilization for each spatial frequency (SF) range with following information:
Spatial Frequency: Range of spatial frequency for each bin. Each bin includes 32 consecutive spatial frequency values.
Azimuth (degrees): Azimuth range in degrees corresponding to the spatial frequencies of the bin. The zero-degree Azimuth is boresight.
Note
Some SF ranges correspond to multiple azimuth ranges. This is because for some spatial frequencies the AP generates beams in multiple azimuth directions. The SM can be physically located in any of the azimuth ranges.</td></tr>
<tr><td>Spatial Utilization (Contd.)</td><td>Instantaneous (%): Frame utilization for the SF bin, updated every 500 ms. The frame utilization percentage accounts for all traffic, sector mode, beamforming mode, and MU-MIMO mode.
Total (%): Average utilization in the SF bin for the past 1/5/15 minutes, as selected in the Statistics Display interval.
Max (%): Maximum instantaneous utilization in the 1/5/15 minute interval.
Min (%): Minimum instantaneous utilization in the 1/5/15 minute interval.
VCs in Range: List of VCs with spatial frequency falling in the bin.
LUIDs in Range: List of LUIDs with spatial frequency falling in the bin.
Note
The size of each SF bin is smaller than the beam generated by the AP during a MU-MIMO transmission. This means that when a VC in a bin is scheduled for a MU-MIMO transmission, the adjacent bins also receive the signal, and the transmission is counted towards their utilization as well. Bins with consistent low utilization indicate the areas of the sector where more SMs could be installed, or the cutomers that could be offered higher data plans.</td></tr>
<tr><td>Spacial Frequency Heatmap</td><td>The spatial frequency heatmap allow the operator to see how the 450m spatial frequency have been occupied (utilised) over the previous hour of operation. There are two heatmaps the first displays downlink utilisation and the lower the uplink utilisation. The heatmaps are useful when operators are identifying:
congested spatial directions
spare capacity in spatial directions
The heatmap uses a graduated colour scale to represent the percentage utilisation. The graphic to the right-hand side of the heatmap should be used as a key to interpret the GUI. Where dark blue represents zero percent utilisation and red represents 100% utilisation.</td></tr>
</table>

Radio Recovery

This section describes:

- How to recover a PMP/PTP 450i and PMP 450m Series ODUs from configuration errors or software image corruption
- How to override a PMP/PTP 450 Series ODUs from forgotten IP address and password to factory default

Radio Recovery Console– PMP/PTP 450i/450b and PMP 450m

Recovery mode allows to restore IP address and password. Also, it allows new main application software to be loaded even when the integrity of the existing main application software image has been compromised. The most likely cause of an integrity problem with the installed main application software is where the power supply has been interrupted during a software upgrade.

> **Note**
>
> When Recovery has been entered through a power on/off/on cycle, the ODU will revert to normal operation if no web access has been made to the unit within 30 seconds. This prevents the unit remaining inadvertently in recovery following a power outage.

Options in recovery mode are:

- Boot with normal operation
- Boot with default Canopy system software settings
- Load a previous SW image

The last most recent software images loaded to the board are retained. However the factory image is not retained.

Boot with default Canopy system software settings (similar to the hardware Default Plug based on 450 Platforms Family).

> **Note**
>
> The unit may enter recovery console automatically, in response to some failures.

> **Note**
>
> Once the unit has entered recovery, it will switch back to normal operation if no access has been made to the recovery web page within 30 seconds.

Use below procedure to enter in recovery console manually.

Procedure 27 Radio Recovery Console:

1	Apply power to PSU for at least 10 seconds.
2	Remove power from the PSU, and then re-apply it as soon as the power indicator light goes out (about 1 - 2 seconds).
3	When the unit is in recovery mode, access the web interface by entering the default IP address 169.254.1.1. The Recovery Image Warning page is displayed.
4	Review the Boot Selection (Recovery Options attributes).
5	Select a recovery option

Figure 124: *Recovery Options page*

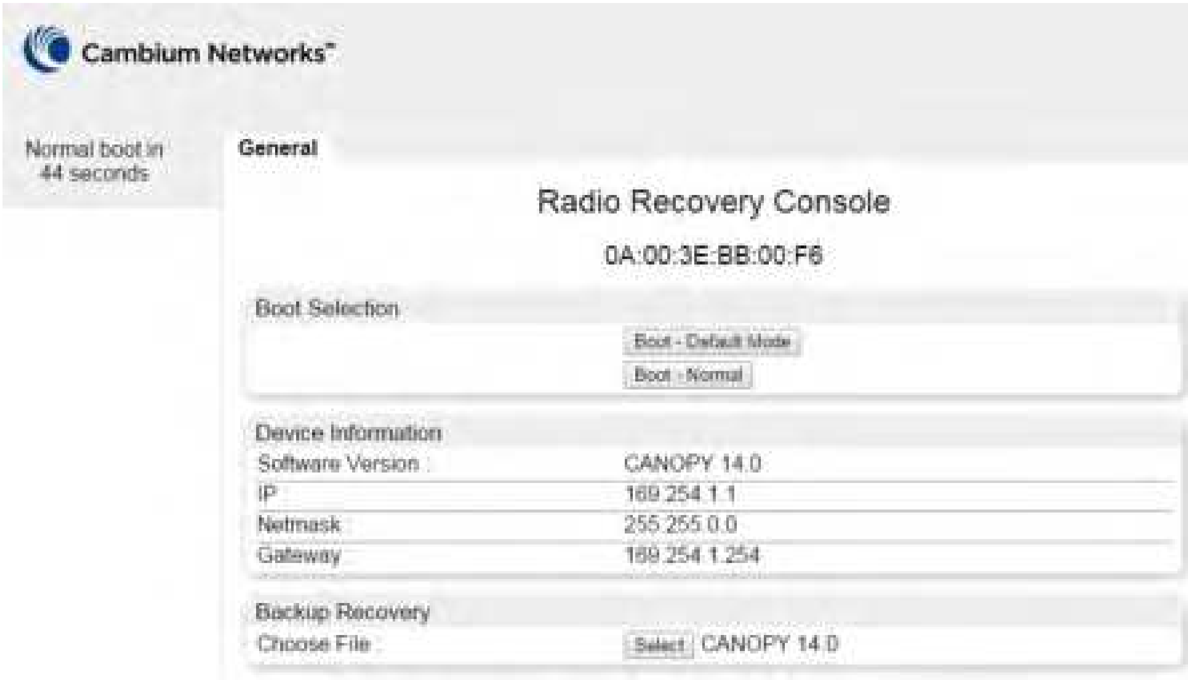


Table 157: Recovery Options attributes

Attribute	Meaning
Boot Selection	Boot – Default Mode: Use this option to temporarily set the IP and Ethernet attributes to factory defaults until the next reboot. Boot – Normal: Use this option to reboot the unit.
IP address, Netmask, Gateway	These fields display IP address, Netmask and Gateway of the radio while it is in recovery or default mode.

Note

The radio enters recovery mode when a short power cycle is used. The radio will boot normally if power has been removed for a longer period (typically 5 - 10 seconds).

Default Mode (or Default/Override Plug) - PMP/PTP 450 Series

The default mode allows to temporarily override some PMP/PTP 450 Series ODU settings and thereby regain control of the module by powering the module on with the Default Plug inserted into the unit's synchronization (RJ11) port.

This override plug is needed for access to the module in any of the following cases:

- You have forgotten either

- the IP address assigned to the ODU.
- the password that provides access to the ODU.
- The ODU has been locked by the No Remote Access feature.
- You want local access to a module that has had the 802.3 link disabled in the Configuration page.

You can configure the module such that, when it senses the override plug, it responds by either

- resetting the LAN1 IP address to 169.254.1.1, allowing access through the default configuration without changing the configuration, whereupon you will be able to view and reset any non-default values as you wish.
- resetting all configurable parameters to their factory default values.

Note

The Default Plug is available from Best-Tronics Manufacturing, Inc.
See https://btpa.com/Cambium-Products/ as Part BT-0583 (RJ-11 Default Plug).
Alternatively, you can fabricate an override plug. See Override plug cable in Planning and Installation Guide for pinout.

Using the Default/Override Plug

The following section details usage of the override plug to regain access to PMP/PTP 450 Series ODU.

Note

While the override plug is connected to a PMP/PTP 450 Series ODU, the ODU can neither register nor allow registration of another ODU.

Note

Since the 900 MHz SM is based on the 450 Series, it only supports the "Default Plug" mode of overriding.

Use below procedure to enter in default mode manually.

Procedure 28 Default mode

1	Insert the override plug into the RJ-11 GPS utility port of the module.
2	Power cycle by removing, then re-inserting, the Ethernet cable. RESULT: The module boots with the default IP address of 169.254.1.1, password fields blank, and all other configuration values as previously set.
3	Wait approximately 30 seconds for the boot to complete.
4	Remove the override plug.
5	Set passwords and IP address as desired.
6	Change configuration values if desired.
7	Click the Save Changes button.
8	Click the Reboot button.

Chapter 4: Reference information

This chapter contains reference information and regulatory notices that apply to the 450 Platform Family ODUs.

The following topics are described in this chapter:

- Equipment specifications contains specifications of the 450 Platform Family, ODU specifications including RF bands, channel width and link loss.
- Data network specifications shows the 450 Platform Family Ethernet interface specifications.
- Wireless specifications lists the safety specifications against which 450 Platform Family ODU has been tested and certified. It also describes how to keep RF exposure within safe limits.
- Country specific radio regulations describes how the 450 Platform Family complies with the radio regulations that are enforced in various countries.
- Equipment Disposal describes the Equipment Disposal system for Electronic and Electric Equipment.

Equipment specifications

This section contains specifications of the AP, SM, BHM and BHS associated supplies required for 450 Platform Family installations.

Specifications for 5/6 GHz 450v Series - AP

The 5/6 GHz 450v AP conforms to the specifications listed in below table.

Table 158: 5/6 GHz 450v Series - AP specifications

Category	Specification
Model Number	450v AP
Channel Spacing	Configurable on 2.5 MHz increments
Frequency Range	5125 to 7125 MHz
Channel Bandwidth	5, 10, 15, 20, 30, and 40 MHz
Interface	
MAC (Media Access Control) Layer	Cambium Proprietary
Physical Layer	2x2 MIMO OFDM
Ethernet Interface	100/1000BASE-T, full duplex, rate auto negotiated (802.3 compliant)
Protocols Used	IPv4, IPv6, UDP, TCP/IP, ICMP, Telnet, SNMP, HTTP, FTP
Network Management	IPv4/IPv6 (dual stack), HTTP, HTTPS, Telnet, FTP, SNMPv2c and v3, Cambium Networks cnMaestro

Category		Specification
MTU		1700 bytes
VLAN		802.1ad (DVLAN Q-inQ), 802.1Q with 802.1p priority, dynamic port VID
Sensitivity		
Nominal Receive Sensitivity (w/ FEC) @ 10 MHz Channel	5.1 GHz	1x = -89.0 dBm, 2x = -85.6 dBm, 3x = -81.0 dBm, 4x = -79.3 dBm, 5x = -76.2 dBm, 6x = -73.4 dBm, 7x = -70.0 dBm, 8x = -65.8 dBm
	5.2 GHz	1x = -89.0 dBm, 2x = -85.6 dBm, 3x = -81.0 dBm, 4x = -79.3 dBm, 5x = -76.2 dBm, 6x = -73.4 dBm, 7x = -70.0 dBm, 8x = -65.8 dBm
	5.4 GHz	1x = -89.0 dBm, 2x = -85.6 dBm, 3x = -81.0 dBm, 4x = -79.3 dBm, 5x = -76.2 dBm, 6x = -73.4 dBm, 7x = -70.0 dBm, 8x = -65.8 dBm
	5.8 GHz	1x = -89.0 dBm, 2x = -85.6 dBm, 3x = -81.0 dBm, 4x = -79.3 dBm, 5x = -76.2 dBm, 6x = -73.4 dBm, 7x = -70.0 dBm, 8x = -65.8 dBm
	U-NII-5	1x = -88.2 dBm, 2x = -85.5 dBm, 3x = -81.6 dBm, 4x = -79.0 dBm, 5x = -75.7 dBm, 6x = -72.8 dBm, 7x = -69.0 dBm, 8x = -64.0 dBm
	U-NII-7	1x = -88.3 dBm, 2x = -84.8 dBm, 3x = -80.8 dBm, 4x = -78.4 dBm, 5x = -75.1 dBm, 6x = -72.3 dBm, 7x = -69.1 dBm, 8x = -64.8 dBm
Nominal Receive Sensitivity (w/ FEC) @ 20 MHz Channel	5.1 GHz	1x = -85.0 dBm, 2x = -81.0 dBm, 3x = -76.9 dBm, 4x = -75.0 dBm, 5x = -72.3 dBm, 6x = -69.0 dBm, 7x = -66.4 dBm, 8x = -62.0 dBm
	5.2 GHz	1x = -86.0 dBm, 2x = -82.0 dBm, 3x = -77.6 dBm, 4x = -76.2 dBm, 5x = -73.0 dBm, 6x = -70.0 dBm, 7x = -67.0 dBm, 8x = -63.0 dBm
	5.4 GHz	1x = -86.5 dBm, 2x = -82.5 dBm, 3x = -78.5 dBm, 4x = -76.2 dBm, 5x = -73.1 dBm, 6x = -70.4 dBm, 7x = -66.6 dBm, 8x = -63.4 dBm
	5.8 GHz	1x = -86.5 dBm, 2x = -82.5 dBm, 3x = -78.5 dBm, 4x = -76.2 dBm, 5x = -73.1 dBm, 6x = -70.4 dBm, 7x = -66.6 dBm, 8x = -63.4 dBm
	U-NII-5	1x = -87.7 dBm, 2x = -82.5 dBm, 3x = -78.3 dBm, 4x = -75.8 dBm, 5x = -73.0 dBm, 6x = -69.7 dBm, 7x = -66.7 dBm, 8x = -62.8 dBm
	U-NII-7	1x = -86.4 dBm, 2x = -82.3 dBm, 3x = -77.6 dBm, 4x = -75.5 dBm, 5x = -72.2 dBm, 6x = -69.3 dBm, 7x = -65.4 dBm, 8x = -61.3 dBm

Category		Specification		
Nominal Receive Sensitivity (w/ FEC) @ 40 MHz Channel	5.1 GHz	1x = -82.0 dBm, 2x = -78.0 dBm, 3x = -73.6 dBm, 4x = -72.0 dBm, 5x = -69.5 dBm, 6x = -67.0 dBm, 7x = -64.0 dBm, 8x = -59.0 dBm		
	5.2 GHz	1x = -81.0 dBm, 2x = -78.0 dBm, 3x = -75.4 dBm, 4x = -73.0 dBm, 5x = -69.5 dBm, 6x = -67.0 dBm, 7x = -63.7 dBm, 8x = -59.0 dBm		
	5.4 GHz			
	5.8 GHz	1x = -81.0 dBm, 2x = -78.0 dBm, 3x = -75.4 dBm, 4x = -73.0 dBm, 5x = -69.5 dBm, 6x = -67.0 dBm, 7x = -63.7 dBm, 8x = -59.0 dBm		
	U-NII-5	1x = -82.0 dBm, 2x = -79.3 dBm, 3x = -75.2 dBm, 4x = -73.0 dBm, 5x = -69.9 dBm, 6x = -66.9 dBm, 7x = -63.4 dBm, 8x = -59.0 dBm		
	U-NII-7	1x = -82.0 dBm, 2x = -78.0 dBm, 3x = -74.6 dBm, 4x = -72.5 dBm, 5x = -68.9 dBm, 6x = -66.0 dBm, 7x = -62.8 dBm, 8x = -58.4 dBm		
Performance				
Subscriber Per Sector		Up to 238		
ARQ		Yes		
Cyclic Prefix		1/16		
Frame Period		2.5 ms, 5 ms		
Modulation Levels (Adaptive)		Modulation Levels		SNR (in dB)
		3x	QPSK	10
		3x	8-QAM	14
		4x	16-QAM	17
		5x	32-QAM	20
		6x	64-QAM	24
		7x	128-QAM	28
		8x	256-QAM	32
Latency		3-5 ms, typical		
Maximum Deployment Range		Up to 40 miles (64 km)		
GPS Synchronization		Yes, via embedded GPS, or Cambium Sync		
Quality of Service		Diffserv QoS		
Link Budget				

Category	Specification
Antenna Beam Width	90° integrated sector (Dual polarity, H+V)
Antenna Gain	+16 dBi
Maximum EIRP	+48 dBm
Physical	
Ports	• Main PoE: 1 GbE • Aux: 1 GbE • SFP optical: 10 GbE • GPS • Reset
Antenna Connection	Integrated Sector antenna
Surge Suppression (with LPU)	EN 61000-4-5: 10x700 µs, 6 kV, EN 61000-4-2: ESD 8 kV contact / 15 kV air Recommended external surge suppressor: Cambium Networks Model # C000000L033A
Mean Time Between Failure	> 40 Years
Environmental	IP66, IP67
Temperature / Humidity	-40°C to +60°C (-40°F to +140°F) 0-100% condensing
Wind Survival	200 kph (124 mph)
Weight	6.3 kg (13.9 lbs), 9.1 kg (20 lbs) with bracket
Wind Loading – Front Facing	@90 mph / 144 kph 376 N
	@110 mph /177 kph 562 N
Dimension (HxWxD)	673 x 222 x 134 mm (26.5 x 8.75 x 5.3 in.)
Power Consumption	45W Typical, 55W Max, Using Aux port PoE for another device will increase power draw
Input Voltage	48-59 VDC, 802.3bt type 4 class 8 (also accepting passive PoE)
Mounting	Pole mount with included brackets
Security	
Encryption	FIPS-197 128-bit AES and 256-bit AES Note AES-256 requires a license key.

Specifications for 5 GHz PMP 450m Series - AP

The 5 GHz PMP 450m AP conforms to the specifications listed in below table.

Table 159: 5 GHz PMP 450m Series - AP specifications

Category		Specification
Model Number		PMP 450m AP
Spectrum		
Channel Spacing		Configurable on 2.5 MHz increments
Frequency Range		4900 to 5925 MHz
Channel Bandwidth		5, 10, 15, 20, 30, and 40 MHz
Interface		
MAC (Media Access Control) Layer		Cambium Proprietary
Physical Layer		14x14 Multi-User MIMO OFDM
Ethernet Interface		100/1000BaseT, half/full duplex, rate auto negotiated (802.3 compliant)
Protocols Used		IPv4, UDP, TCP, IP, ICMP, Telnet, SNMP, HTTP, FTP
Network Management		HTTP, HTTPS, Telnet, FTP, SNMP v3
VLAN		802.1ad (DVLAN Q-in-Q), 802.1Q with 802.1p priority, dynamic port VID
Sensitivity		
Nominal Receive Sensitivity (w/ FEC) @ 5 MHz Channel	4.9 GHz	1x = -99.4 dBm, 2x = -96.9 dBm, 4x = -90.5 dBm, 6x = -84.3 dBm, 8x = -76.9 dBm
	5.1 GHz	1x = -100.6 dBm, 2x = -97 dBm, 4x = -90.5 dBm, 6x = -84 dBm, 8x = -76.3 dBm
	5.2 GHz	1x = -100.5 dBm, 2x = -96.7 dBm, 4x = -90.1 dBm, 6x = -83.7 dBm, 8x = -76.1 dBm
	5.4 GHz	1x = -101.2 dBm, 2x = -96.2 dBm, 4x = -90.3 dBm, 6x = -83.9 dBm, 8x = -76.5 dBm
	5.8 GHz	1x = -100.8 dBm, 2x = -96.5 dBm, 4x = -90.3 dBm, 6x = -84 dBm, 8x = -76.3 dBm

Category		Specification
Nominal Receive Sensitivity (w/ FEC) @ 10 MHz Channel	4.9 GHz	1x = -97.5 dBm, 2x = -94.8 dBm, 4x = -88.4 dBm, 6x = -82.3 dBm, 8x = -75.1 dBm
	5.1 GHz	1x = -97.9 dBm, 2x = -94.3 dBm, 4x = -87.8 dBm, 6x = -81.5 dBm, 8x = -74.2 dBm
	5.2 GHz	1x = -97.9 dBm, 2x = -93.9 dBm, 4x = -87.4 dBm, 6x = -81.1 dBm, 8x = -73.9 dBm
	5.4 GHz	1x = -98.1 dBm, 2x = -94.1 dBm, 4x = -87.5 dBm, 6x = -81.3 dBm, 8x = -74.2 dBm
	5.8 GHz	1x = -98.4 dBm, 2x = -94.3 dBm, 4x = -87.8 dBm, 6x = -81.5 dBm, 8x = -74.4 dBm
Nominal Receive Sensitivity (w/ FEC) @ 15 MHz Channel	4.9 GHz	1x = -96 dBm, 2x = -93.2 dBm, 4x = -86.7 dBm, 6x = -80.3 dBm, 8x = -73.5 dBm
	5.1 GHz	1x = -96.5 dBm, 2x = -92.8 dBm, 4x = -86.4 dBm, 6x = -80 dBm, 8x = -72.8 dBm
	5.2 GHz	1x = -96.4 dBm, 2x = -92.2 dBm, 4x = -85.4 dBm, 6x = -79.1 dBm, 8x = -72.2 dBm
	5.4 GHz	1x = -96.7 dBm, 2x = -92.4 dBm, 4x = -85.7 dBm, 6x = -79.4 dBm, 8x = -72.6 dBm
	5.8 GHz	1x = -97.4 dBm, 2x = -92.8 dBm, 4x = -86.2 dBm, 6x = -80 dBm, 8x = -73 dBm
Nominal Receive Sensitivity (w/ FEC) @ 20 MHz Channel	4.9 GHz	1x = -94.7 dBm, 2x = -92.1 dBm, 4x = -85.5 dBm, 6x = -79.2 dBm, 8x = -72.5 dBm
	5.1 GHz	1x = -95.2 dBm, 2x = -91.5 dBm, 4x = -85.1 dBm, 6x = -78.7 dBm, 8x = -71.7 dBm
	5.2 GHz	1x = -95.2 dBm, 2x = -91.3 dBm, 4x = -84.8 dBm, 6x = -78.5 dBm, 8x = -71.5 dBm
	5.4 GHz	1x = -95.6 dBm, 2x = -90.8 dBm, 4x = -84.8 dBm, 6x = -78.5 dBm, 8x = -71.5 dBm
	5.8 GHz	1x = -96.3 dBm, 2x = -91.3 dBm, 4x = -85.2 dBm, 6x = -78.8 dBm, 8x = -71.6 dBm

Category		Specification	
Nominal Receive Sensitivity (w/ FEC) @ 30 MHz Channel	4.9 GHz	1x = -92.6 dBm, 2x = -89.9 dBm, 4x = -83.6 dBm, 6x = -77.4 dBm, 8x = -70.9 dBm	
	5.1 GHz	1x = -93.1 dBm, 2x = -89.0 dBm, 4x = -83.0 dBm, 6x = -76.7 dBm, 8x = -69.8 dBm	
	5.2 GHz	1x = -93.1 dBm, 2x = -88.7 dBm, 4x = -82.5 dBm, 6x = -76.2 dBm, 8x = -69.4 dBm	
	5.4 GHz	1x = -93.6 dBm, 2x = -89.1 dBm, 4x = -82.9 dBm, 6x = -76.5 dBm, 8x = -69.7 dBm	
	5.8 GHz	1x = -94.1 dBm, 2x = -89.4 dBm, 4x = -83.2 dBm, 6x = -76.8 dBm, 8x = -69.9 dBm	
Nominal Receive Sensitivity (w/ FEC) @ 40 MHz Channel	4.9 GHz	1x = -91.5 dBm, 2x = -88.8 dBm, 4x = -82.5 dBm, 6x = -76.3 dBm, 8x = -69.7 dBm	
	5.1 GHz	1x = -92.1 dBm, 2x = -88.1 dBm, 4x = -82.0 dBm, 6x = -75.5 dBm, 8x = -68.2 dBm	
	5.2 GHz	1x = -92.0 dBm, 2x = -87.7 dBm, 4x = -81.7 dBm, 6x = -75.3 dBm, 8x = -67.9 dBm	
	5.4 GHz	1x = -92.7 dBm, 2x = -87.4 dBm, 4x = -81.8 dBm, 6x = -75.4 dBm, 8x = -68.2 dBm	
	5.8 GHz	1x = -93.0 dBm, 2x = -87.9 dBm, 4x = -82.1 dBm, 6x = -75.6 dBm, 8x = -68.1 dBm	
Performance			
Subscriber Per Sector		Up to 238	
ARQ		Yes	
Cyclic Prefix		1/16	
Frame Period		2.5 ms, 5 ms	
Modulation Levels (Adaptive)		Modulation Levels	SNR (in dB)
		2x QPSK	10
		4x 16-QAM	17
		6x 64-QAM	24
		8x 256-QAM	32
Latency		10 ms, typical (MU-MIMO introduces additional latency for the traffic that is MU-MIMO scheduled.)	
Maximum Deployment Range		Up to 40 miles (64 km)	
GPS Synchronization		Yes, via Autosync (UGPS)	

Category		Specification
Quality of Service		Diffserv QoS
Link Budget		
Antenna Beam Width	5 GHz	90° integrated sector (Dual polarity, H+V)
Antenna Gain		+14 dBi
Maximum EIRP		+48 dBm
Physical		
Data, Sync/AUX and SFP port	RJ45	• 1000BASE-T Ethernet Data • AUX port for UGPS or PoE out to 802.3at
Antenna Connection		Integrated Sector Array
Surge Suppression (with LPU)		EN61000-4-5: 1.2 us/50 us, 500 V voltage waveform Recommended external surge suppressor: Cambium Networks Model # C000065L007B
Mean Time Between Failure		> 40 Years
Environmental		IP66, IP67
Temperature / Humidity		-40°C to +60°C (-40°F to +140°F) 0-95% non-condensing
Weight	Integrated	Approx. 14.2 kg (31 bs)
Wind Loading – Front Facing		@90 mph / 144 kph 376 N
		@110 mph /177 kph 562 N
Dimension (HxWxD)	Integrated	52 x 65 x 11 cm (20.3” x 25.7” x 4.4”)
Power Consumption		70 W typical, 80 W peak (up to 110 W max with AUX port PoE enabled)
Input Voltage		58 V, 1.7 A
Mounting		Pole mount with included brackets
Security		
Encryption		128-bit AES and 256-bit AES Note AES-256 requires a license key.

Specifications for 3 GHz PMP 450m Series - AP

The 3 GHz PMP 450m AP conforms to the specifications listed in below table.

Table 160: 3 GHz PMP 450m Series - AP specifications

Category		Specification
Model Number		3 GHz PMP 450m AP
Spectrum		
Channel Spacing		Customizable channel selection to 50kHz raster
Frequency Range		3300 – 3980 MHz
Channel Bandwidth		5, 7, 10, 15, 20, 30 and 40MHz
Interface		
MAC (Media Access Control) Layer		Cambium Networks Proprietary
Physical Layer		8x8 Multi-User MIMO OFDM
Ethernet Interface		100/1000BaseT, full duplex, rate auto negotiated (802.3 compliant), dual SFP support for 1 Gbps optical
Protocols Used		IPv4, IPv6, UDP, TCP/IP, ICMP, Telnet, SNMP, HTTP, FTP
Network Management		IPv4/IPv6 (dual stack), HTTP, HTTPS, Telnet, FTP, SNMPv2c and v3, Cambium Networks cnMaestroTM
VLAN		802.1ad (DVLAN Q-inQ), 802.1Q with 802.1p priority, dynamic port VID
Sensitivity		
Nominal Receive Sensitivity (w/ FEC) @ 5 MHz Channel	3.5 GHz	1x = -97.6 dBm, 2x = -95 dBm, 4x = -88.7 dBm, 6x = -82.5 dBm, 8x = -75 dBm
	3.6 GHz	1x = -96.9 dBm, 2x = -94.4 dBm, 4x = -88.1 dBm, 6x = -81.7 dBm, 8x = -74 dBm
Nominal Receive Sensitivity (w/ FEC) @ 7 MHz Channel	3.5 GHz	1x = -96.1 dBm, 2x = -93.4 dBm, 4x = -87.1 dBm, 6x = -81.1 dBm, 8x = -74.7 dBm
	3.6 GHz	1x = -96 dBm, 2x = -92.9 dBm, 4x = -86.6 dBm, 6x = -80.6 dBm, 8x = -73.6 dBm
Nominal Receive Sensitivity (w/ FEC) @ 10 MHz Channel	3.5 GHz	1x = -95.2 dBm, 2x = -92.8 dBm, 4x = -86.4 dBm, 6x = -80.3 dBm, 8x = -73.2 dBm
	3.6 GHz	1x = -94.6 dBm, 2x = -92.5 dBm, 4x = -86 dBm, 6x = -79.6 dBm, 8x = -72.8 dBm

Category		Specification		
Nominal Receive Sensitivity (w/ FEC) @ 15 MHz Channel	3.5 GHz	1x = -93.6 dBm, 2x = -91.1 dBm, 4x = -84.6 dBm, 6x = -78.4 dBm, 8x = -71.8 dBm		
	3.6 GHz	1x = -92.8 dBm, 2x = -90.4 dBm, 4x = -84 dBm, 6x = -78 dBm, 8x = -71.1 dBm		
Nominal Receive Sensitivity (w/ FEC) @ 20 MHz Channel	3.5 GHz	1x = -92.3 dBm, 2x = -89.8 dBm, 4x = -83.4 dBm, 6x = -77.2 dBm, 8x = -70.7 dBm		
	3.6 GHz	1x = -91.5 dBm, 2x = -89.3 dBm, 4x = -82.9 dBm, 6x = -76.5 dBm, 8x = -70 dBm		
Nominal Receive Sensitivity (w/ FEC) @ 30 MHz Channel	3.5 GHz	1x = -89.7 dBm, 2x = -87.2 dBm, 4x = -81.1 dBm, 6x = -74.8 dBm, 8x = -68.7 dBm		
	3.6 GHz	1x = -89 dBm, 2x = -86.6 dBm, 4x = -80.7 dBm, 6x = -74.4 dBm, 8x = -68.1 dBm		
Nominal Receive Sensitivity (w/ FEC) @ 40 MHz Channel	3.5 GHz	1x = -88.7 dBm, 2x = -86.3 dBm, 4x = -80.1 dBm, 6x = -73.7 dBm, 8x = -67.4 dBm		
	3.6 GHz	1x = -88 dBm, 2x = -85.5 dBm, 4x = -79.5 dBm, 6x = -73.3 dBm, 8x = -66.7 dBm		
Performance				
Subscriber Per Sector		Up to 238		
ARQ		Yes		
Cyclic Prefix		1/16		
Frame Period		2.5 ms, 5 ms		
Modulation Levels (Adaptive)		Modulation Levels	MCS	SNR (in dB)
		2x	QPSK	10
		4x	16-QAM	17
		6x	64-QAM	24
		8x	256-QAM	32
Latency		10 ms, typical		
Maximum Deployment Range		Up to 40 miles (64 km)		
GPS Synchronization		Yes, via Autosync (UGPS, CMM5 (GPS only, no power))		
Quality of Service		Diffserv QoS		
Link Budget				
Antenna Beam Width (Azimuth)		90° integrated sector (3dB rolloff), 120° (6dB rolloff), (dual slant polarity, ±45°		

<table>
<tr><th colspan="2">Category</th><th colspan="2">Specification</th></tr>
<tr><td>Antenna Beam Width (Elevation)</td><td></td><td colspan="2">2° Electrical Downtilt, 8° Elevation (with Null Fill)</td></tr>
<tr><td>Antenna Gain</td><td></td><td colspan="2">+16 dBi</td></tr>
<tr><td>Maximum EIRP</td><td></td><td colspan="2">+58 dBm (or up to maximum allowed by regulation)</td></tr>
<tr><td colspan="4">Physical</td></tr>
<tr><td>Data ports
Main port
Aux port
SFP port 1
SFP port 2</td><td>RJ45
RJ45
SFP
SFP</td><td colspan="2">1000BASE-T Ethernet Data
100BASE-T with 802.3at PoE out; UGPS power/sync
Single channel SFP, 1 Gbps
Dual channel SFP, 1 Gbps</td></tr>
<tr><td>Power</td><td>4-pin</td><td colspan="2">DC power input</td></tr>
<tr><td>Antenna Connection</td><td></td><td colspan="2">Integrated Sector Array</td></tr>
<tr><td>Surge Suppression (with LPU)</td><td></td><td colspan="2">MAIN and AUX ports: EN61000-4-5: 10/700us, 4 kV voltage waveform. Recommended external surge suppressor: Model # C000065L007B
DC IN port: EN61000-4-5: 1.2/50us, 2 kV/4 kV. Recommended external surge suppressor: Model # C000000L114A</td></tr>
<tr><td>Mean Time Between Failure</td><td></td><td colspan="2">> 40 Years</td></tr>
<tr><td>Environmental</td><td></td><td colspan="2">IP66, IP67</td></tr>
<tr><td>Temperature / Humidity</td><td></td><td colspan="2">-40°C to +76°C (-40°F to +169°F) / 100% condensing</td></tr>
<tr><td>Weight</td><td>Integrated</td><td colspan="2">Without Mounting Brackets: 20.4 kg (45 lbs)
With Mounting Brackets: 22.6 kg (49.8 lbs)</td></tr>
<tr><td colspan="2" rowspan="3">Wind Loading – Front Facing</td><td>@90 mph / 144 kph</td><td>521 N</td></tr>
<tr><td>@110 mph /177 kph</td><td>787 N</td></tr>
<tr><td>@124 mph/ 200kph</td><td>986 N</td></tr>
<tr><td>Dimension (HxWxD)</td><td>Integrated</td><td colspan="2">69 x 61 x 17.5 cm (27.2” x 24” x 7”)</td></tr>
<tr><td>Power Consumption</td><td></td><td colspan="2">140 W typical, 150 W peak (up to 180 W max with AUX port PoE enabled)</td></tr>
<tr><td>Input Voltage</td><td></td><td colspan="2">40 - 60 V DC</td></tr>
<tr><td>Mounting</td><td></td><td colspan="2">Pole mount with included brackets (1.25″ to 4″ pole diameter)</td></tr>
</table>

Category		Specification
Security		
Encryption		FIPS-197 128-bit AES, Optional 256-bit AES Note AES-256 requires a license key.

Specifications for PMP 450i Series - AP

The PMP 450i AP conforms to the specifications listed in below table.

Table 161: PMP 450i Series - AP specifications

Category		Specification
Model Number		PMP 450i AP
Spectrum		
Channel Spacing		5, 7, 10, 15, 20, 30, and 40 MHz Channel Bandwidth Configurable on 2.5 MHz increments
Frequency Range		902 to 928 MHz
		3300 - 3900 MHz
		4900 - 5925 MHz
Channel Bandwidth	902 – 928 MHz	5, 7, 10, 15, and 20 MHz
	3300 - 3900 MHz	5, 7, 10, 15, 20, 30, and 40 MHz
	4900 – 5925 MHz	5, 10, 15, 20, 30, and 40 MHz
Interface		
MAC (Media Access Control) Layer		Cambium Proprietary
Physical Layer		2x2 MIMO OFDM
Ethernet Interface		10/100/1000BaseT, half/full duplex, rate auto negotiated (802.3 compliant)
Protocols Used		IPv4, UDP, TCP, IP, ICMP, Telnet, SNMP, HTTP, FTP
Network Management		HTTP, HTTPS, Telnet, FTP, SNMP v3
VLAN		802.1ad (DVLAN Q-in-Q), 802.1Q with 802.1p priority, dynamic port VID
Sensitivity		

Category		Specification
Nominal Receive Sensitivity (w/ FEC) @ 5 MHz Channel	900 MHz	1x = -91.9 dBm, 2x = -87.29 dBm, 3x = -83.38 dBm, 4x = -81.34 dBm, 5x = -78.41 dBm, 6x = -75.42 dBm, 7x = -72.46 dBm, 8x = -68.58 dBm
	3.5 GHz	1x = -93 dBm, 2x = -89.3 dBm, 3x = -84.9 dBm, 4x = -82.6 dBm, 5x = -79.2 dBm, 6x = -76.1 dBm, 7x = -72.3 dBm, 8x = -68.2 dBm
	3.6 GHz	1x = -92.4 dBm, 2x = -87.5 dBm, 3x = -83.6 dBm, 4x = -81.0 dBm, 5x = -78.2 dBm, 6x = -75.0 dBm, 7x = -72.0 dBm, 8x = -67.2 dBm
	4.9 GHz	1x = -91.6 dBm, 2x = -87.6 dBm, 3x = -83.0 dBm,4x = -80.4 dBm, 5x = -77.2 dBm, 6x = -74.3 dBm, 7x = -71.0 dBm, 8x = -66.3 dBm
	5.1 GHz	1x = -91.0 dBm, 2x = -87.0 dBm, 3x = -82.0 dBm, 4x = -80.3 dBm, 5x = -76.6 dBm, 6x = -73.5 dBm, 7x = -70.6 dBm, 8x = -66 dBm
	5.2 GHz	1x = -91.0 dBm, 2x = -87.0 dBm, 3x = -82.0 dBm, 4x = -80.3 dBm, 5x = -76.6 dBm, 6x = -73.5 dBm, 7x = -70.6 dBm, 8x = -66.0 dBm
	5.4 GHz	1x = -91.0 dBm, 2x = -87.0 dBm, 3x = -82.0 dBm, 4x = -80.3 dBm, 5x = -76.6 dBm, 6x = -73.5 dBm, 7x = -70.6 dBm, 8x = -66.0 dBm
	5.8 GHz	1x = -90.5 dBm, 2x = -86.0 dBm, 3x = -82.0 dBm, 4x = -80.0 dBm, 5x = -76.3 dBm, 6x = -73.6 dBm, 7x = -70.0 dBm, 8x = -66.1 dBm
Nominal Receive Sensitivity (w/ FEC) @ 7 MHz Channel	900 MHz	1x = -89.31 dBm, 2x = -85.32 dBm, 3x = -82.35 dBm, 4x = -80.35 dBm, 5x = -77.43 dBm, 6x = -74.36 dBm, 7x = -71.53 dBm, 8x = -67.47 dBm
	3.5 GHz	1x = -92.0 dBm, 2x = -87.7 dBm, 3x = -82.6 dBm, 4x = -80.4 dBm, 5x = -77.5 dBm, 6x = -74.5 dBm, 7x = -71.1 dBm, 8x = -66.2 dBm
	3.6 GHz	1x = -90.6 dBm, 2x = -87.0 dBm, 3x = -82.1 dBm, 4x = -80.0 dBm, 5x = -77.0 dBm, 6x = -73.5 dBm, 7x = -70.0 dBm, 8x = -66.0 dBm

Category		Specification
Nominal Receive Sensitivity (w/ FEC) @ 10 MHz Channel	900 MHz	1x = -89.47 dBm, 2x = -84.61 dBm, 3x = -81.71 dBm, 4x = -78.77 dBm, 5x = -75.82 dBm, 6x = -73.69 dBm, 7x = -70.78 dBm, 8x = -66.76 dBm
	3.5 GHz	1x = -90.2 dBm, 2x = -86.2 dBm, 3x = -82.0 dBm, 4x = -79.9 dBm, 5x = -76.3 dBm, 6x = -73.2 dBm, 7x = -70.0 dBm, 8x = -65.2 dBm
	3.6 GHz	1x = -90.0 dBm, 2x = -85.0 dBm, 3x = -81.0 dBm, 4x = -78.8 dBm, 5x = -75.3 dBm, 6x = -72.8 dBm, 7x = -69.0 dBm, 8x = -65.0 dBm
	4.9 GHz	1x = -88.8 dBm, 2x = -84.2 dBm, 3x = -80.0 dBm, 4x = -77.9 dBm, 5x = -74.3 dBm, 6x = -71.4 dBm, 7x = -68.3 dBm, 8x = -64.0 dBm
	5.1 GHz	1x = -88.6 dBm, 2x = -84.7 dBm, 3x = -79.7 dBm, 4x = -78.0 dBm, 5x = -74.6 dBm, 6x = -71.5 dBm, 7x = -67.6 dBm, 8x = -64.6 dBm
	5.2 GHz	1x = -88.6 dBm, 2x = -84.7 dBm, 3x = -79.7 dBm, 4x = -78.0 dBm, 5x = -74.6 dBm, 6x = -71.5 dBm, 7x = -67.6 dBm, 8x = -64.6 dBm
	5.4 GHz	1x = -88.0 dBm, 2x = -84.0 dBm, 3x = -79.6 dBm, 4x = -77.8 dBm, 5x = -74.6 dBm, 6x = -71.5 dBm, 7x = -68.0 dBm, 8x = -63.8 dBm
	5.8 GHz	1x = -88.0 dBm, 2x = -84.0 dBm, 3x = -79.6 dBm, 4x = -77.8 dBm, 5x = -74.6 dBm, 6x = -71.5 dBm, 7x = -68.0 dBm, 8x = -63.8 dBm

Category		Specification
Nominal Receive Sensitivity (w/ FEC) @ 15 MHz Channel	900 MHz	1x = -88.5 dBm, 2x = -83.56 dBm, 3x = -79.67 dBm, 4x = -75.58 dBm, 5x = -74.66 dBm, 6x = -71.57 dBm, 7x = -68.64 dBm, 8x = -65.61 dBm
	3.5 GHz	1x = -89.0 dBm, 2x = -84.4 dBm, 3x = -80.2 dBm, 4x = -78.0 dBm, 5x = -74.9 dBm, 6x = -72.0 dBm, 7x = -68.1 dBm, 8x = -63.8 dBm
	3.6 GHz	1x = -88.0 dBm, 2x = -83.6 dBm, 3x = -79.0 dBm, 4x = -77.0 dBm, 5x = -74.0 dBm, 6x = -71.1 dBm, 7x = -67.1 dBm, 8x = -63.1 dBm
	4.9 GHz	1x = -87.0 dBm, 2x = -82.6 dBm, 3x = -78.2 dBm, 4x = -76.2 dBm, 5x = -73.0 dBm, 6x = -69.6 dBm, 7x = -66.3 dBm, 8x = -62.6 dBm
	5.1 GHz	1x = -87.5 dBm, 2x = -82.9 dBm, 3x = -78.5 dBm, 4x = -76.5 dBm, 5x = -72.7 dBm, 6x = -69.5 dBm, 7x = -65.8 dBm, 8x = -62.8 dBm
	5.2 GHz	1x = -87.5 dBm, 2x = -82.9 dBm, 3x = -78.5 dBm, 4x = -76.5 dBm, 5x = -72.7 dBm, 6x = -69.5 dBm, 7x = -65.8 dBm, 8x = -62.8 dBm
	5.4 GHz	1x = -85.6 dBm, 2x = -82.4 dBm, 3x = -78.0 dBm, 4x = -76.0 dBm, 5x = -72.5 dBm, 6x = -69.5 dBm, 7x = -66.2 dBm, 8x = -62.2 dBm
	5.8 GHz	1x = -86.0 dBm, 2x = -81.5 dBm, 3x = -77.5 dBm, 4x = -75.5 dBm, 5x = -72.4 dBm, 6x = -69.2 dBm, 7x = -66.0 dBm, 8x = -62.0 dBm

Category		Specification
Nominal Receive Sensitivity (w/ FEC) @ 20 MHz Channel	900 MHz	1x = -86.51 dBm, 2x = -82.51 dBm, 3x = -78.56 dBm, 4x = -75.58 dBm, 5x = -72.61 dBm, 6x = -70.55 dBm, 7x = -67.64 dBm, 8x = -63.54 dBm
	3.5 GHz	1x = -87.4 dBm, 2x = -83.0 dBm, 3x = -78.8 dBm, 4x = -76.9 dBm, 5x = -73.2 dBm, 6x = -69.9 dBm, 7x = -66.0 dBm, 8x = -62.0 dBm
	3.6 GHz	1x = -86.8 dBm, 2x = -82.0 dBm, 3x = -78.0 dBm, 4x = -76.0 dBm, 5x = -72.7 dBm, 6x = -69.5 dBm, 7x = -65.9 dBm, 8x = -61.6 dBm
	4.9 GHz	1x = -85.5 dBm, 2x = -81.6 dBm, 3x = -77.3 dBm, 4x = -75.0 dBm, 5x = -71.8 dBm, 6x = -68.6 dBm, 7x = -64.8 dBm, 8x = -61.0 dBm
	5.1 GHz	1x = -85.5 dBm, 2x = -81.6 dBm, 3x = -77.3 dBm, 4x = -75.0 dBm, 5x = -71.8 dBm, 6x = -68.6 dBm, 7x = -64.8 dBm, 8x = -61.0 dBm
	5.2 GHz	1x = -85.5 dBm, 2x = -81.6 dBm, 3x = -77.3 dBm, 4x = -75.0 dBm, 5x = -71.8 dBm, 6x = -68.6 dBm, 7x = -64.8 dBm, 8x = -61.0 dBm
	5.4 GHz	1x = -85.5 dBm, 2x = -81.6 dBm, 3x = -77.3 dBm, 4x = -75.0 dBm, 5x = -71.8 dBm, 6x = -68.6 dBm, 7x = -64.8 dBm, 8x = -61.0 dBm
	5.8 GHz	1x = -85.8 dBm, 2x = -80.7 dBm, 3x = -77.2 dBm, 4x = -74.6 dBm, 5x = -71.5 dBm, 6x = -68.7 dBm, 7x = -64.9 dBm, 8x = -61.0 dBm

Category		Specification
Nominal Receive Sensitivity (w/ FEC) @ 30 MHz Channel	3.5 GHz	1x = -86.0 dBm, 2x = -81.4 dBm, 3x = -77.0 dBm, 4x = -74.9 dBm, 5x = -71.9 dBm, 6x = -68.0 dBm, 7x = -64.3 dBm, 8x = -60.0 dBm
	3.6 GHz	1x = -84.8 dBm, 2x = -80.5 dBm, 3x = -75.8 dBm, 4x = -73.9 dBm, 5x = -70.8 dBm, 6x = -68.0 dBm, 7x = -64.1 dBm, 8x = -60.0 dBm
	4.9 GHz	1x = -84.1 dBm, 2x = -80.0 dBm, 3x = -76.0 dBm, 4x = -73.0 dBm, 5x = -70.2 dBm, 6x = -66.4 dBm, 7x = -63.2 dBm, 8x = -59.6 dBm
	5.1 GHz	1x = -83.0 dBm, 2x = -79.6 dBm, 3x = -75.0 dBm, 4x = -73.5 dBm, 5x = -70.0 dBm, 6x = -66.6 dBm, 7x = -63.6 dBm, 8x = -59.0 dBm
	5.2 GHz	1x = -83.0 dBm, 2x = -79.6 dBm, 3x = -75.0 dBm, 4x = -73.5 dBm, 5x = -70.0 dBm, 6x = -66.6 dBm, 7x = -63.6 dBm, 8x = -59.0 dBm
	5.4 GHz	1x = -83.0 dBm, 2x = -79.6 dBm, 3x = -75.0 dBm, 4x = -73.5 dBm, 5x = -70.0 dBm, 6x = -66.6 dBm, 7x = -63.6 dBm, 8x = -59.0 dBm
	5.8 GHz	1x = -83.2 dBm, 2x = -79.2 dBm, 3x = -74.1 dBm, 4x = -73.0 dBm, 5x = -69.3 dBm, 6x = -66.2 dBm, 7x = -63.0 dBm, 8x = -59.0 dBm

Category		Specification		
Nominal Receive Sensitivity (w/ FEC) @ 40 MHz Channel	3.5 GHz	1x = -83.9 dBm, 2x = -79.5 dBm, 3x = -75.0 dBm, 4x = -73.0 dBm, 5x = -70.0 dBm, 6x = -67.0 dBm, 7x = -63.0 dBm, 8x = -58.5 dBm		
	3.6 GHz	1x = -83.4 dBm, 2x = -79.0 dBm, 3x = -74.6 dBm, 4x = -72.4 dBm, 5x = -69.0 dBm, 6x = -66.0 dBm, 7x = -63.0 dBm, 8x = -58.0 dBm		
	4.9 GHz	1x = -83.0 dBm, 2x = -78.9 dBm, 3x = -74.2 dBm, 4x = -72.0 dBm, 5x = -69.2 dBm, 6x = -66.0 dBm, 7x = -62.3 dBm, 8x = -57.0 dBm		
	5.1 GHz	1x = -82.0 dBm, 2x = -78.5 dBm, 3x = -74.0 dBm, 4x = -72.4 dBm, 5x = -68.6 dBm, 6x = -65.3 dBm, 7x = -62.3 dBm, 8x = -57.0 dBm		
	5.2 GHz	1x = -82.0 dBm, 2x = -78.5 dBm, 3x = -74.0 dBm, 4x = -72.4 dBm, 5x = -68.6 dBm, 6x = -65.3 dBm, 7x = -62.3 dBm, 8x = -57.0 dBm		
	5.4 GHz	1x = -82.0 dBm, 2x = -78.5 dBm, 3x = -74.0 dBm, 4x = -72.4 dBm, 5x = -68.6 dBm, 6x = -65.3 dBm, 7x = -62.3 dBm, 8x = -57.0 dBm		
	5.8 GHz	1x = -81.8 dBm, 2x = -78.4 dBm, 3x = -73.6 dBm, 4x = -71.6 dBm, 5x = -68.2 dBm, 6x = -65.2 dBm, 7x = -61.7 dBm, 8x = -57.0 dBm		
Performance				
ARQ		Yes		
Cyclic Prefix		1/16		
Frame Period		2.5 ms or 5.0 ms		
Modulation Levels (Adaptive)		Modulation Levels		SNR (in dB)
		2x	QPSK	10
		3x	8-QAM	14
		4x	16-QAM	17
		5x	32-QAM	21
		6x	64-QAM	24
		7x	128-QAM	28
		8x	256-QAM	32
Latency		2.5 - 5 ms		
Maximum Deployment Range		Up to 40 miles (64 km) Up to 120 miles (190 km) for 900 MHz		

Category		Specification
GPS Synchronization		Yes, via Autosync (CMM4), via UGPS
Quality of Service		Diffserv QoS
Link Budget		
Antenna Beam Width	900 MHz	65° sector antenna (Dual Slant)
	3 GHz	90° sector for integrated (Dual polarity, slant +45° and -45°)
	5 GHz	90° (3 dB roll off) sector for integrated (Dual polarity, H+V)
Antenna Gain (Does not include cable loss, ~1dB)	900 MHz	13 dBi
	3 GHz	17 dBi integrated 90° sector or external
	5 GHz	17 dBi integrated 90° sector or external
Transmit Power Range		-27 dB dynamic range (to EIRP limit by region) (1 dB step)
Maximum Transmit Power		+27 dBm combined output (for 5 GHz) +25 dBm combined output (for 3 GHz) +25 dBm combined output (for 900MHz)
Physical		
Sync/AUX port	RJ45	• 10/100/100BASE-T Ethernet Data • PoE output (planned for future release) • Sync input or output (Connection and powering of UGPS Sync input)
Antenna Connection		50 ohm, N-type (Connectorized version only)
Surge Suppression EN61000-4-5		EN61000-4-5: 1.2 us/50 us, 500 V voltage waveform Recommended external surge suppressor: Cambium Networks Model # C000000L033A
Mean Time Between Failure		> 40 Years
Environmental		IP66, IP67
Temperature / Humidity		-40°C to +60°C (-40°F to +140°F), 0-95% non-condensing
Weight	Connectorized	Approx. 2.0 kg (4.5 lbs)
	Integrated	Approx. 2.5 kg (5.5 lbs)

Category		Specification
Wind Survival	Connectorized	322 km/h (200 mi/h)
	Integrated	200 km/h (124 mi/h)
Dimension (HxWxD)	Connectorized	26.0 x 13.4 x 6.4 cm (10.3" x 5.3" x 3.3")
	Integrated	37.0 x 37.0 x 6.3 cm (14.5" x 14.5" x 3.2")
Power Consumption		15 W typical, 25 W max, 55 W max with Aux port PoE out enabled
Input Voltage		48-59 V DC, 802.3at compliant
Mounting		Wall or Pole mount with Cambium Networks Model # N000045L002A
Security		
Encryption		128-bit AES and 256-bit AES Note AES-256 requires a license key.

Specifications for PMP 450 MicroPoP - AP

The PMP 450 MicroPoP conforms to the specifications listed in below table.

Table 162: PMP 450 MicroPoP Series - AP specifications

Category	Specification
Model Number	PMP 450 MicroPoP AP
Spectrum	
Channel Spacing	5, 10, 15, 20, 30, and 40 MHz Channel Bandwidth Configurable on 2.5 MHz increments
Frequency Range	4900 – 5925 MHz
Channel Bandwidth	5, 10, 15, 20, 30, and 40 MHz
Interface	
MAC (Media Access Control) Layer	Cambium Proprietary
Physical Layer	2x2 MIMO OFDM
Ethernet Interface	10/100/1000BaseT, half/full duplex, rate auto negotiated (802.3 compliant)
Protocols Used	IPv4, IPv6, UDP, TCP, IP, ICMP, Telnet, SNMP, HTTP, FTP
Network Management	IPv4/IPv6 (dual stack), HTTP, HTTPS, Telnet, FTP, SNMPv2c and v3, Cambium Networks cnMaestro

Category		Specification
VLAN		802.1ad (DVLAN Q-in-Q), 802.1Q with 802.1p priority, dynamic port VID
Sensitivity		
Nominal Receive Sensitivity (w/ FEC) @ 5 MHz Channel	900 MHz	1x = -91.9 dBm, 2x = -87.29 dBm, 3x = -83.38 dBm, 4x = -81.34 dBm, 5x = -78.41 dBm, 6x = -75.42 dBm, 7x = -72.46 dBm, 8x = -68.58 dBm
	3.5 GHz	1x = -93 dBm, 2x = -89.3 dBm, 3x = -84.9 dBm, 4x = -82.6 dBm, 5x = -79.2 dBm, 6x = -76.1 dBm, 7x = -72.3 dBm, 8x = -68.2 dBm
	3.6 GHz	1x = -92.4 dBm, 2x = -87.5 dBm, 3x = -83.6 dBm, 4x = -81.0 dBm, 5x = -78.2 dBm, 6x = -75.0 dBm, 7x = -72.0 dBm, 8x = -67.2 dBm
	4.9 GHz	1x = -91.6 dBm, 2x = -87.6 dBm, 3x = -83.0 dBm,4x = -80.4 dBm, 5x = -77.2 dBm, 6x = -74.3 dBm, 7x = -71.0 dBm, 8x = -66.3 dBm
	5.1 GHz	1x = -91.0 dBm, 2x = -87.0 dBm, 3x = -82.0 dBm, 4x = -80.3 dBm, 5x = -76.6 dBm, 6x = -73.5 dBm, 7x = -70.6 dBm, 8x = -66 dBm
	5.2 GHz	1x = -91.0 dBm, 2x = -87.0 dBm, 3x = -82.0 dBm, 4x = -80.3 dBm, 5x = -76.6 dBm, 6x = -73.5 dBm, 7x = -70.6 dBm, 8x = -66.0 dBm
	5.4 GHz	1x = -91.0 dBm, 2x = -87.0 dBm, 3x = -82.0 dBm, 4x = -80.3 dBm, 5x = -76.6 dBm, 6x = -73.5 dBm, 7x = -70.6 dBm, 8x = -66.0 dBm
	5.8 GHz	1x = -90.5 dBm, 2x = -86.0 dBm, 3x = -82.0 dBm, 4x = -80.0 dBm, 5x = -76.3 dBm, 6x = -73.6 dBm, 7x = -70.0 dBm, 8x = -66.1 dBm

Category		Specification
Nominal Receive Sensitivity (w/ FEC) @ 10 MHz Channel	900 MHz	1x = -89.47 dBm, 2x = -84.61 dBm, 3x = -81.71 dBm, 4x = -78.77 dBm, 5x = -75.82 dBm, 6x = -73.69 dBm, 7x = -70.78 dBm, 8x = -66.76 dBm
	3.5 GHz	1x = -90.2 dBm, 2x = -86.2 dBm, 3x = -82.0 dBm, 4x = -79.9 dBm, 5x = -76.3 dBm, 6x = -73.2 dBm, 7x = -70.0 dBm, 8x = -65.2 dBm
	3.6 GHz	1x = -90.0 dBm, 2x = -85.0 dBm, 3x = -81.0 dBm, 4x = -78.8 dBm, 5x = -75.3 dBm, 6x = -72.8 dBm, 7x = -69.0 dBm, 8x = -65.0 dBm
	4.9 GHz	1x = -88.8 dBm, 2x = -84.2 dBm, 3x = -80.0 dBm, 4x = -77.9 dBm, 5x = -74.3 dBm, 6x = -71.4 dBm, 7x = -68.3 dBm, 8x = -64.0 dBm
	5.1 GHz	1x = -88.6 dBm, 2x = -84.7 dBm, 3x = -79.7 dBm, 4x = -78.0 dBm, 5x = -74.6 dBm, 6x = -71.5 dBm, 7x = -67.6 dBm, 8x = -64.6 dBm
	5.2 GHz	1x = -88.6 dBm, 2x = -84.7 dBm, 3x = -79.7 dBm, 4x = -78.0 dBm, 5x = -74.6 dBm, 6x = -71.5 dBm, 7x = -67.6 dBm, 8x = -64.6 dBm
	5.4 GHz	1x = -88.0 dBm, 2x = -84.0 dBm, 3x = -79.6 dBm, 4x = -77.8 dBm, 5x = -74.6 dBm, 6x = -71.5 dBm, 7x = -68.0 dBm, 8x = -63.8 dBm
	5.8 GHz	1x = -88.0 dBm, 2x = -84.0 dBm, 3x = -79.6 dBm, 4x = -77.8 dBm, 5x = -74.6 dBm, 6x = -71.5 dBm, 7x = -68.0 dBm, 8x = -63.8 dBm

Category		Specification
Nominal Receive Sensitivity (w/ FEC) @ 15 MHz Channel	900 MHz	1x = -88.5 dBm, 2x = -83.56 dBm, 3x = -79.67 dBm, 4x = -75.58 dBm, 5x = -74.66 dBm, 6x = -71.57 dBm, 7x = -68.64 dBm, 8x = -65.61 dBm
	3.5 GHz	1x = -89.0 dBm, 2x = -84.4 dBm, 3x = -80.2 dBm, 4x = -78.0 dBm, 5x = -74.9 dBm, 6x = -72.0 dBm, 7x = -68.1 dBm, 8x = -63.8 dBm
	3.6 GHz	1x = -88.0 dBm, 2x = -83.6 dBm, 3x = -79.0 dBm, 4x = -77.0 dBm, 5x = -74.0 dBm, 6x = -71.1 dBm, 7x = -67.1 dBm, 8x = -63.1 dBm
	4.9 GHz	1x = -87.0 dBm, 2x = -82.6 dBm, 3x = -78.2 dBm, 4x = -76.2 dBm, 5x = -73.0 dBm, 6x = -69.6 dBm, 7x = -66.3 dBm, 8x = -62.6 dBm
	5.1 GHz	1x = -87.5 dBm, 2x = -82.9 dBm, 3x = -78.5 dBm, 4x = -76.5 dBm, 5x = -72.7 dBm, 6x = -69.5 dBm, 7x = -65.8 dBm, 8x = -62.8 dBm
	5.2 GHz	1x = -87.5 dBm, 2x = -82.9 dBm, 3x = -78.5 dBm, 4x = -76.5 dBm, 5x = -72.7 dBm, 6x = -69.5 dBm, 7x = -65.8 dBm, 8x = -62.8 dBm
	5.4 GHz	1x = -85.6 dBm, 2x = -82.4 dBm, 3x = -78.0 dBm, 4x = -76.0 dBm, 5x = -72.5 dBm, 6x = -69.5 dBm, 7x = -66.2 dBm, 8x = -62.2 dBm
	5.8 GHz	1x = -86.0 dBm, 2x = -81.5 dBm, 3x = -77.5 dBm, 4x = -75.5 dBm, 5x = -72.4 dBm, 6x = -69.2 dBm, 7x = -66.0 dBm, 8x = -62.0 dBm

Category		Specification
Nominal Receive Sensitivity (w/ FEC) @ 20 MHz Channel	900 MHz	1x = -86.51 dBm, 2x = -82.51 dBm, 3x = -78.56 dBm, 4x = -75.58 dBm, 5x = -72.61 dBm, 6x = -70.55 dBm, 7x = -67.64 dBm, 8x = -63.54 dBm
	3.5 GHz	1x = -87.4 dBm, 2x = -83.0 dBm, 3x = -78.8 dBm, 4x = -76.9 dBm, 5x = -73.2 dBm, 6x = -69.9 dBm, 7x = -66.0 dBm, 8x = -62.0 dBm
	3.6 GHz	1x = -86.8 dBm, 2x = -82.0 dBm, 3x = -78.0 dBm, 4x = -76.0 dBm, 5x = -72.7 dBm, 6x = -69.5 dBm, 7x = -65.9 dBm, 8x = -61.6 dBm
	4.9 GHz	1x = -85.5 dBm, 2x = -81.6 dBm, 3x = -77.3 dBm, 4x = -75.0 dBm, 5x = -71.8 dBm, 6x = -68.6 dBm, 7x = -64.8 dBm, 8x = -61.0 dBm
	5.1 GHz	1x = -85.5 dBm, 2x = -81.6 dBm, 3x = -77.3 dBm, 4x = -75.0 dBm, 5x = -71.8 dBm, 6x = -68.6 dBm, 7x = -64.8 dBm, 8x = -61.0 dBm
	5.2 GHz	1x = -85.5 dBm, 2x = -81.6 dBm, 3x = -77.3 dBm, 4x = -75.0 dBm, 5x = -71.8 dBm, 6x = -68.6 dBm, 7x = -64.8 dBm, 8x = -61.0 dBm
	5.4 GHz	1x = -85.5 dBm, 2x = -81.6 dBm, 3x = -77.3 dBm, 4x = -75.0 dBm, 5x = -71.8 dBm, 6x = -68.6 dBm, 7x = -64.8 dBm, 8x = -61.0 dBm
	5.8 GHz	1x = -85.8 dBm, 2x = -80.7 dBm, 3x = -77.2 dBm, 4x = -74.6 dBm, 5x = -71.5 dBm, 6x = -68.7 dBm, 7x = -64.9 dBm, 8x = -61.0 dBm

Category		Specification
Nominal Receive Sensitivity (w/ FEC) @ 30 MHz Channel	3.5 GHz	1x = -86.0 dBm, 2x = -81.4 dBm, 3x = -77.0 dBm, 4x = -74.9 dBm, 5x = -71.9 dBm, 6x = -68.0 dBm, 7x = -64.3 dBm, 8x = -60.0 dBm
	3.6 GHz	1x = -84.8 dBm, 2x = -80.5 dBm, 3x = -75.8 dBm, 4x = -73.9 dBm, 5x = -70.8 dBm, 6x = -68.0 dBm, 7x = -64.1 dBm, 8x = -60.0 dBm
	4.9 GHz	1x = -84.1 dBm, 2x = -80.0 dBm, 3x = -76.0 dBm, 4x = -73.0 dBm, 5x = -70.2 dBm, 6x = -66.4 dBm, 7x = -63.2 dBm, 8x = -59.6 dBm
	5.1 GHz	1x = -83.0 dBm, 2x = -79.6 dBm, 3x = -75.0 dBm, 4x = -73.5 dBm, 5x = -70.0 dBm, 6x = -66.6 dBm, 7x = -63.6 dBm, 8x = -59.0 dBm
	5.2 GHz	1x = -83.0 dBm, 2x = -79.6 dBm, 3x = -75.0 dBm, 4x = -73.5 dBm, 5x = -70.0 dBm, 6x = -66.6 dBm, 7x = -63.6 dBm, 8x = -59.0 dBm
	5.4 GHz	1x = -83.0 dBm, 2x = -79.6 dBm, 3x = -75.0 dBm, 4x = -73.5 dBm, 5x = -70.0 dBm, 6x = -66.6 dBm, 7x = -63.6 dBm, 8x = -59.0 dBm
	5.8 GHz	1x = -83.2 dBm, 2x = -79.2 dBm, 3x = -74.1 dBm, 4x = -73.0 dBm, 5x = -69.3 dBm, 6x = -66.2 dBm, 7x = -63.0 dBm, 8x = -59.0 dBm
Nominal Receive Sensitivity (w/ FEC) @ 40 MHz Channel	3.5 GHz	1x = -83.9 dBm, 2x = -79.5 dBm, 3x = -75.0 dBm, 4x = -73.0 dBm, 5x = -70.0 dBm, 6x = -67.0 dBm, 7x = -63.0 dBm, 8x = -58.5 dBm
	3.6 GHz	1x = -83.4 dBm, 2x = -79.0 dBm, 3x = -74.6 dBm, 4x = -72.4 dBm, 5x = -69.0 dBm, 6x = -66.0 dBm, 7x = -63.0 dBm, 8x = -58.0 dBm
	4.9 GHz	1x = -83.0 dBm, 2x = -78.9 dBm, 3x = -74.2 dBm, 4x = -72.0 dBm, 5x = -69.2 dBm, 6x = -66.0 dBm, 7x = -62.3 dBm, 8x = -57.0 dBm
	5.1 GHz	1x = -82.0 dBm, 2x = -78.5 dBm, 3x = -74.0 dBm, 4x = -72.4 dBm, 5x = -68.6 dBm, 6x = -65.3 dBm, 7x = -62.3 dBm, 8x = -57.0 dBm
	5.2 GHz	1x = -82.0 dBm, 2x = -78.5 dBm, 3x = -74.0 dBm, 4x = -72.4 dBm, 5x = -68.6 dBm, 6x = -65.3 dBm, 7x = -62.3 dBm, 8x = -57.0 dBm
	5.4 GHz	1x = -82.0 dBm, 2x = -78.5 dBm, 3x = -74.0 dBm, 4x = -72.4 dBm, 5x = -68.6 dBm, 6x = -65.3 dBm, 7x = -62.3 dBm, 8x = -57.0 dBm
	5.8 GHz	1x = -81.8 dBm, 2x = -78.4 dBm, 3x = -73.6 dBm, 4x = -71.6 dBm, 5x = -68.2 dBm, 6x = -65.2 dBm, 7x = -61.7 dBm, 8x = -57.0 dBm

<table>
<tr><th colspan="2">Category</th><th colspan="3">Specification</th></tr>
<tr><td colspan="5">Performance</td></tr>
<tr><td colspan="2">ARQ</td><td colspan="3">Yes</td></tr>
<tr><td colspan="2">Cyclic Prefix</td><td colspan="3">1/16</td></tr>
<tr><td colspan="2">Frame Period</td><td colspan="3">2.5 ms or 5.0 ms</td></tr>
<tr><td colspan="2" rowspan="8">Modulation Levels (Adaptive)</td><td>Modulation Levels</td><td>MCS</td><td>SNR (in dB)</td></tr>
<tr><td>2x</td><td>QPSK</td><td>10</td></tr>
<tr><td>3x</td><td>8-QAM</td><td>14</td></tr>
<tr><td>4x</td><td>16-QAM</td><td>17</td></tr>
<tr><td>5x</td><td>32-QAM</td><td>21</td></tr>
<tr><td>6x</td><td>64-QAM</td><td>24</td></tr>
<tr><td>7x</td><td>128-QAM</td><td>28</td></tr>
<tr><td>8x</td><td>256-QAM</td><td>32</td></tr>
<tr><td colspan="2">Latency</td><td colspan="3">3-5 ms with 2.5 ms frame, 7-10 ms with 5 ms frame</td></tr>
<tr><td colspan="2">Maximum Deployment Range</td><td colspan="3">Up to 2 miles (3.2 k)
With license key up to 40 miles (64 km)</td></tr>
<tr><td colspan="2">GPS Synchronization</td><td colspan="3">Yes, via Autosync (CMM4), via UGPS</td></tr>
<tr><td colspan="2">Quality of Service</td><td colspan="3">Diffserv QoS</td></tr>
<tr><td colspan="5">Link Budget</td></tr>
<tr><td rowspan="3">Antenna Beam Width</td><td>Omni</td><td colspan="3">360-degree integrated omni (dual polarity, vertical and horizontal)</td></tr>
<tr><td>Sector</td><td colspan="3">90-degree integrated (dual polarity, vertical and horizontal)</td></tr>
<tr><td>Connectorized</td><td colspan="3">Gain of external antenna</td></tr>
<tr><td rowspan="3">Antenna Gain</td><td>Omni</td><td colspan="3">9 dBi</td></tr>
<tr><td>Sector</td><td colspan="3">13 dBi</td></tr>
<tr><td>Connectorized</td><td colspan="3">Gain of external antenna</td></tr>
<tr><td>Transmit Power Range</td><td></td><td colspan="3">54 dB dynamic range (to EIRP limit by region) (1 dB step)</td></tr>
<tr><td>Maximum Transmit Power</td><td></td><td colspan="3">+27 dBm</td></tr>
<tr><td colspan="5">Physical</td></tr>
<tr><td>Sync/AUX port</td><td>RJ45</td><td colspan="3">• 10/100/100BASE-T Ethernet Data
• PoE output (planned for future release)</td></tr>
</table>

Category		Specification
		• Sync input or output (Connection and powering of UGPS Sync input)
Surge Suppression		EN61000-4-5: 10x700us, 4kV, EN 61000-4-2: ESD 30 kV contact / 30 kV air
Mean Time Between Failure		> 40 Years
Environmental		IP67
Temperature / Humidity	Omni	-40C to +60C (-40F to +140F) 0-95% non-condensing
	Sector	-40C to +60C (-40F to +140F) 0-100% condensings
Weight	Omni	1.2 kg (includes mounting bracket)
	Sector	2 kg (includes mounting bracket)
	Connectorized	0.9 kg (includes mounting bracket)
Wind Survival	Omni	200 km/Hr
	Sector	200 km/Hr
	Connectorized	200 km/Hr
Dimension (HxWxD)	Omni	56 x 9 x 9 cm (22'' x 3.5'' x 3.5''), mount standoff 11 cm (4.3'')
	Sector	31 x 17 x 10 cm (12'' x 6.7'' x 3.7''), mount standoff 11 cm (4.3'')
	Connectorized	24 x 4 x 9 cm (9.5"x1.5"x3.5")
Power Consumption		9 W typical, 12 W peak
Input Voltage		48-59 V DC, 802.3at compatible
Mounting		Wall or Pole mount with Cambium Networks Model # N000045L002A
Security		
Encryption		128-bit AES and 256-bit AES **Note** AES-256 requires a license key.

Specifications for PMP/PTP 450b Retro - SM

The PMP/PTP 450b Retro conforms to the specifications listed in below table.

Table 163: PMP/PTP 450b Retro Series - SM specifications

Category		Specification
Model Number		PMP 450b Retro SM
Spectrum		
Channel Spacing		5, 10, 15, 20, 30, and 40 MHz Channel Bandwidth Configurable on 2.5 MHz increments
Frequency Range		4900 – 5925 MHz
Channel Bandwidth		5, 10, 15, 20, 30, and 40 MHz
Interface		
MAC (Media Access Control) Layer		Cambium Proprietary
Physical Layer		2x2 MIMO OFDM
Ethernet Interface		10/100/1000BaseT, half/full duplex, rate auto negotiated (802.3 compliant)
Protocols Used		IPv4, IPv6, UDP, TCP, IP, ICMP, Telnet, SNMP, HTTP, FTP
Network Management		IPv4/IPv6 (dual stack), HTTP, HTTPS, Telnet, FTP, SNMPv2c and v3, Cambium Networks cnMaestro
VLAN		802.1ad (DVLAN Q-in-Q), 802.1Q with 802.1p priority, dynamic port VID
Sensitivity		
Nominal Receive Sensitivity (w/ FEC) @ 5 MHz Channel	4.9 GHz	1x = -89.7 dBm, 2x = -84.8 dBm, 3x = -80.7 dBm, 4x = -78.4 dBm, 5x = -75.7 dBm, 6x = -72.0 dBm, 7x = -68.8 dBm, 8x = -64.2 dBm
	5.2 GHz	1x = -92.6 dBm, 2x = -88.5 dBm, 3x = -83.4 dBm, 4x = -80.8 dBm, 5x = -77.6 dBm, 6x = -74.2 dBm, 7x = -71.6 dBm, 8x = -67.0 dBm
	5.4 GHz	1x = -92.6 dBm, 2x = -88.5 dBm, 3x = -84.0 dBm, 4x = -82.3 dBm, 5x = -79.0 dBm, 6x = -75.9 dBm, 7x = -72.3 dBm, 8x = -68.0 dBm
	5.8 GHz	1x = -92.1 dBm, 2x = -87.9 dBm, 3x = -84.3 dBm, 4x = -82.1 dBm, 5x = -79.0 dBm, 6x = -75.4 dBm, 7x = -72.0 dBm, 8x = -68.0 dBm

Category		Specification
Nominal Receive Sensitivity (w/ FEC) @ 10 MHz Channel		
	4.9 GHz	1x = -89.7 dBm, 2x = -84.8 dBm, 3x = -80.7 dBm, 4x = -78.4 dBm, 5x = -75.7 dBm, 6x = -72.0 dBm, 7x = -68.8 dBm, 8x = -64.2 dBm
	5.1 GHz	1x = -90.0 dBm, 2x = -85.3 dBm, 3x = -80.0 dBm, 4x = -78.8 dBm, 5x = -75.2 dBm, 6x = -71.6 dBm, 7x = -69.2 dBm, 8x = -64.8 dBm
	5.2 GHz	1x = -90.0 dBm, 2x = -85.3 dBm, 3x = -80.0 dBm, 4x = -78.8 dBm, 5x = -75.2 dBm, 6x = -71.6 dBm, 7x = -69.2 dBm, 8x = -64.8 dBm
	5.4 GHz	1x = -89.6 dBm, 2x = -85.6 dBm, 3x = -81.0 dBm, 4x = -78.2 dBm, 5x = -75.9 dBm, 6x = -72.4 dBm, 7x = -69.4 dBm, 8x = -65.0 dBm
	5.8 GHz	1x = -89.6 dBm, 2x = -85.6 dBm, 3x = -81.0 dBm, 4x = -78.2 dBm, 5x = -75.9 dBm, 6x = -72.4 dBm, 7x = -69.4 dBm, 8x = -65.0 dBm
Nominal Receive Sensitivity (w/ FEC) @ 15 MHz Channel	4.9 GHz	1x = -88.0 dBm, 2x = -83.7 dBm, 3x = -78.9 dBm, 4x = -76.6 dBm, 5x = -74.0 dBm, 6x = -70.4 dBm, 7x = -67.8 dBm, 8x = -63.0 dBm
	5.1 GHz	1x = -87.8 dBm, 2x = -83.7 dBm, 3x = -78.3 dBm, 4x = -76.6 dBm, 5x = -73.5 dBm, 6x = -70.0 dBm, 7x = -67.5 dBm, 8x = -63.2 dBm
	5.2 GHz	1x = -87.8 dBm, 2x = -83.7 dBm, 3x = -78.3 dBm, 4x = -76.6 dBm, 5x = -73.5 dBm, 6x = -70.0 dBm, 7x = -67.5 dBm, 8x = -63.2 dBm
	5.4 GHz	1x = -88.0 dBm, 2x = -83.5 dBm, 3x = -79.4 dBm, 4x = -76.5 dBm, 5x = -74.0 dBm, 6x = -70.5 dBm, 7x = -67.7 dBm, 8x = -63.0 dBm
	5.8 GHz	1x = -88.0 dBm, 2x = -83.5 dBm, 3x = -79.4 dBm, 4x = -76.5 dBm, 5x = -74.0 dBm, 6x = -70.5 dBm, 7x = -67.7 dBm, 8x = -63.0 dBm

Category		Specification
Nominal Receive Sensitivity (w/ FEC) @ 20 MHz Channel	4.9 GHz	1x = -86.3 dBm, 2x = -81.3 dBm, 3x = -77.2 dBm, 4x = -75.4 dBm, 5x = -72.2 dBm, 6x = -69.0 dBm, 7x = -66.0 dBm, 8x = -61.4 dBm
	5.1 GHz	1x = -86.0 dBm, 2x = -82.2 dBm, 3x = -78.2 dBm, 4x = -75.4 dBm, 5x = -72.5 dBm, 6x = -69.3 dBm, 7x = -65.5 dBm, 8x = -61.4 dBm
	5.2 GHz	1x = -86.0 dBm, 2x = -82.2 dBm, 3x = -78.2 dBm, 4x = -75.4 dBm, 5x = -72.5 dBm, 6x = -69.3 dBm, 7x = -65.5 dBm, 8x = -61.4 dBm
	5.4 GHz	1x = -86.5 dBm, 2x = -82.0 dBm, 3x = -78.0 dBm, 4x = -75.6 dBm, 5x = -72.6 dBm, 6x = -69.1 dBm, 7x = -66.0 dBm, 8x = -62.0 dBm
	5.8 GHz	1x = -86.5 dBm, 2x = -82.2 dBm, 3x = -77.9 dBm, 4x = -75.9 dBm, 5x = -72.8 dBm, 6x = -69.2 dBm, 7x = -66.2 dBm, 8x = -62.0 dBm
Nominal Receive Sensitivity (w/ FEC) @ 30 MHz Channel	4.9 GHz	1x = -84.5 dBm, 2x = -80.0 dBm, 3x = -76.2 dBm, 4x = -74.1 dBm, 5x = -70.8 dBm, 6x = -67.7 dBm, 7x = -64.2 dBm, 8x = -59.0 dBm
	5.1 GHz	1x = -84.6 dBm, 2x = -79.8 dBm, 3x = -75.2 dBm, 4x = -73.3 dBm, 5x = -70.2 dBm, 6x = -67.4 dBm, 7x = -64.2 dBm, 8x = -59.0 dBm
	5.2 GHz	1x = -84.6 dBm, 2x = -79.8 dBm, 3x = -75.2 dBm, 4x = -73.3 dBm, 5x = -70.2 dBm, 6x = -67.4 dBm, 7x = -64.2 dBm, 8x = -59.0 dBm
	5.4 GHz	1x = -84.8 dBm, 2x = -79.8 dBm, 3x = -76.0 dBm, 4x = -73.6 dBm, 5x = -71.0 dBm, 6x = -67.5 dBm, 7x = -64.7 dBm, 8x = -59.5 dBm
	5.8 GHz	1x = -84.8 dBm, 2x = -79.8 dBm, 3x = -76.0 dBm, 4x = -73.6 dBm, 5x = -71.0 dBm, 6x = -67.5 dBm, 7x = -64.7 dBm, 8x = -59.5 dBm

Category		Specification		
Nominal Receive Sensitivity (w/ FEC) @ 40 MHz Channel	4.9 GHz	1x = -82.9 dBm, 2x = -79.0 dBm, 3x = -75.0 dBm, 4x = -72.4 dBm, 5x = -69.0 dBm, 6x = -65.9 dBm, 7x = -63.0 dBm, 8x = -56.4 dBm		
	5.1 GHz	1x = -83.2 dBm, 2x = -79.3 dBm, 3x = -74.5 dBm, 4x = -72.1 dBm, 5x = -69.0 dBm, 6x = -65.9 dBm, 7x = -62.0 dBm, 8x = -57.0 dBm		
	5.2 GHz	1x = -83.2 dBm, 2x = -79.3 dBm, 3x = -74.5 dBm, 4x = -72.1 dBm, 5x = -69.0 dBm, 6x = -65.9 dBm, 7x = -62.0 dBm, 8x = -57.0 dBm		
	5.4 GHz	1x = -83.6 dBm, 2x = -78.6 dBm, 3x = -75.4 dBm, 4x = -72.4 dBm, 5x = -69.4 dBm, 6x = -66.0 dBm, 7x = -63.5 dBm, 8x = -57.0 dBm		
	5.8 GHz	1x = -83.6 dBm, 2x = -78.6 dBm, 3x = -75.4 dBm, 4x = -72.4 dBm, 5x = -69.4 dBm, 6x = -66.0 dBm, 7x = -63.5 dBm, 8x = -57.0 dBm		
Performance				
ARQ		Yes		
Cyclic Prefix		1/16		
Frame Period		2.5 ms or 5.0 ms		
Modulation Levels (Adaptive)		Modulation Levels	MCS	SNR (in dB)
		2x	QPSK	10
		4x	16-QAM	17
		6x	64-QAM	24
		8x	256-QAM	32
Latency		3 - 5 ms		
Maximum Deployment Range		PMP mode: up to 40 miles (64 km)		
GPS Synchronization		Yes, synchronized by Access Point		
Quality of Service		Diffserv QoS		
Link Budget				
Antenna Beam Width		60 degrees		
Antenna Gain		9 dBi		
Transmit Power Range		54 dB dynamic range (to EIRP limit by region) (1 dB step)		
Maximum Transmit Power		+27 dBm		
Physical				

Category		Specification
Sync/AUX port	RJ45	• 10/100/100BASE-T Ethernet Data • PoE output (planned for future release) • Sync input or output (Connection and powering of UGPS Sync input)
Surge Suppression		EN61000-4-5: 10x700us, 4kV, EN 61000-4-2: ESD 30 kV contact / 30 kV air
Mean Time Between Failure		> 40 Years
Environmental		IP55
Temperature / Humidity		-40C to +60C (-40F to +140F) 0-95% non-condensing
Weight		0.4 kg (1 lb.) (includes mounting bracket)
Wind Survival		200 km/hour (124 mi/hour)
Dimension (HxWxD)		28.6 x 8.9 x 8.9 cm (11.25'' x 3.5'' x 3.5'')
Power Consumption		9 W typical, 12 W peak
Input Voltage		48-59 V DC, 802.3at compatible
Mounting		Wall or Pole mount with Cambium Networks Model # N000045L002A
Security		
Encryption		128-bit AES and 256-bit AES Note AES-256 requires a license key.

Specifications for 450v Series - SM

The 450v SM conforms to the specifications listed in below table.

Table 164: 450v Series - SM specifications

Category	Specification
Model Number	450v SM
Spectrum	
Channel Spacing	Configurable on 2.5 MHz increments
Frequency Range	5.150 GHz - 7.125 GHz
Channel Bandwidth	5, 10, 15, 20, 30, and 40 MHz
Interface	

<table>
<tr><th colspan="2">Category</th><th>Specification</th></tr>
<tr><td colspan="2">MAC (Media Access Control) Layer</td><td>Cambium Proprietary</td></tr>
<tr><td colspan="2">Physical Layer</td><td>2x2 MIMO OFDM</td></tr>
<tr><td colspan="2">Ethernet Interface</td><td>100/1000BASE-T, full duplex, rate auto negotiated (802.3 compliant)</td></tr>
<tr><td colspan="2">Protocols Used</td><td>IPv4, IPv6, UDP, TCP/IP, ICMP, Telnet, SNMP, HTTP, FTP</td></tr>
<tr><td colspan="2">Network Management</td><td>IPv4/IPv6 (dual stack), HTTP, HTTPS, Telnet, FTP, SNMPv2c and v3, Cambium Networks cnMaestro</td></tr>
<tr><td colspan="2">MTU</td><td>1700 bytes</td></tr>
<tr><td colspan="2">VLAN</td><td>802.1ad (DVLAN Q-inQ), 802.1Q with 802.1p priority, dynamic port VID</td></tr>
<tr><td colspan="3">Sensitivity</td></tr>
<tr><td rowspan="6">Nominal Receive Sensitivity (w/FEC) @ 10 MHz Channel</td><td>5.1 GHz</td><td>1x = -89.0 dBm, 2x = -85.6 dBm, 3x = -81.0 dBm, 4x = -79.3 dBm, 5x = -76.2 dBm, 6x = -73.4 dBm, 7x = -70.0 dBm, 8x = -65.8 dBm</td></tr>
<tr><td>5.2 GHz</td><td>1x = -89.0 dBm, 2x = -85.6 dBm, 3x = -81.0 dBm, 4x = -79.3 dBm, 5x = -76.2 dBm, 6x = -73.4 dBm, 7x = -70.0 dBm, 8x = -65.8 dBm</td></tr>
<tr><td>5.4 GHz</td><td>1x = -89.0 dBm, 2x = -85.6 dBm, 3x = -81.0 dBm, 4x = -79.3 dBm, 5x = -76.2 dBm, 6x = -73.4 dBm, 7x = -70.0 dBm, 8x = -65.8 dBm</td></tr>
<tr><td>5.8 GHz</td><td>1x = -89.0 dBm, 2x = -85.6 dBm, 3x = -81.0 dBm, 4x = -79.3 dBm, 5x = -76.2 dBm, 6x = -73.4 dBm, 7x = -70.0 dBm, 8x = -65.8 dBm</td></tr>
<tr><td>U-NII-5</td><td>1x = -87.0 dBm, 2x = -85.9 dBm, 3x = -81.7 dBm, 4x = -79.0 dBm, 5x = -75.9 dBm, 6x = -72.8 dBm, 7x = -69.8 dBm, 8x = -64.8 dBm</td></tr>
<tr><td>U-NII-7</td><td>1x = -87.7 dBm, 2x = -84.8 dBm, 3x = -80.7 dBm, 4x = -78.5 dBm, 5x = -75.0 dBm, 6x = -72.0 dBm, 7x = -68.5 dBm, 8x = -64.0 dBm</td></tr>
<tr><td rowspan="6">Nominal Receive Sensitivity (w/FEC) @ 20 MHz Channel</td><td>5.1 GHz</td><td>1x = -86.0 dBm, 2x = -82.0 dBm, 3x = -77.0 dBm, 4x = -75.6 dBm, 5x = -72.6 dBm, 6x = -69.5 dBm, 7x = -66.6 dBm, 8x = -62.6 dBm</td></tr>
<tr><td>5.2 GHz</td><td>1x = -86.0 dBm, 2x = -82.0 dBm, 3x = -77.0 dBm, 4x = -76.1 dBm, 5x = -73.0 dBm, 6x = -69.7 dBm, 7x = -66.8 dBm, 8x = -63.0 dBm</td></tr>
<tr><td>5.4 GHz</td><td>1x = -86.0 dBm, 2x = -82.0 dBm, 3x = -78.0 dBm, 4x = -76.4 dBm, 5x = -73.3 dBm, 6x = -70.0 dBm, 7x = -66.7 dBm, 8x = -63.5 dBm</td></tr>
<tr><td>5.8 GHz</td><td>1x = -86.0 dBm, 2x = -82.0 dBm, 3x = -77.0 dBm, 4x = -75.6 dBm, 5x = -72.6 dBm, 6x = -69.5 dBm, 7x = -66.6 dBm, 8x = -62.6 dBm</td></tr>
<tr><td>U-NII-5</td><td>1x = -87.1 dBm, 2x = -82.4 dBm, 3x = -78.1 dBm, 4x = -76.0 dBm, 5x = -73.0 dBm, 6x = -70.0 dBm, 7x = -66.9 dBm, 8x = -62.0 dBm</td></tr>
<tr><td>U-NII-7</td><td>1x = -86.9 dBm, 2x = -82.1 dBm, 3x = -78.0 dBm, 4x = -75.6 dBm, 5x = -72.4 dBm, 6x = -69.7 dBm, 7x = -66.0 dBm, 8x = -61.4 dBm</td></tr>
</table>

Category		Specification		
Nominal Receive Sensitivity (w/ FEC) @ 40 MHz Channel	5.1 GHz	1x = -82.0 dBm, 2x = -78.0 dBm, 3x = -74.0 dBm, 4x = -72.6 dBm, 5x = -69.6 dBm, 6x = -66.5 dBm, 7x = -63.6 dBm, 8x = -59.6 dBm		
	5.2 GHz	1x = -82.0 dBm, 2x = -78.7 dBm, 3x = -75.6 dBm, 4x = -72.4 dBm, 5x = -69.6 dBm, 6x = -66.7 dBm, 7x = -63.5 dBm, 8x = -59.5 dBm		
	5.4 GHz			
	5.8 GHz	1x = -82.0 dBm, 2x = -78.7 dBm, 3x = -75.6 dBm, 4x = -72.4 dBm, 5x = -69.6 dBm, 6x = -66.7 dBm, 7x = -63.5 dBm, 8x = -59.5 dBm		
	U-NII-5	1x = -82.0 dBm, 2x = -78.3 dBm, 3x = -75.1 dBm, 4x = -72.5 dBm, 5x = -69.7 dBm, 6x = -66.5 dBm, 7x = -62.5 dBm, 8x = -58.0 dBm		
	U-NII-7	1x = -82.5 dBm, 2x = -77.8 dBm, 3x = -74.8 dBm, 4x = -72.4 dBm, 5x = -69.2 dBm, 6x = -66.2 dBm, 7x = -62.7 dBm, 8x = -58.0 dBm		
Performance				
ARQ		Yes		
Frame Period		2.5 ms or 5.0 ms		
Modulation Levels (Adaptive)		Modulation Levels	MCS	SNR (in dB)
		2x	QPSK	10
		3x	8-QAM	13
		4x	16-QAM	17
		5x	32-QAM	21
		6x	64-QAM	24
		7x	128-QAM	28
		8x	256-QAM	32
Latency		3-5 ms, typical		
Maximum Deployment Range		Up to 40 miles (64 km), in PMP mode, up to 124 miles (200 km) in PTP mode		
GPS Synchronization		Yes, via embedded GPS		
Quality of Service		Diffserv QoS		
Link Budget				
Antenna Beam Width		7° azimuth		
Antenna Gain	5 GHz	+22 dBi H+V, integrated		
	6 GHz	+24 dBi H+V, integrated		
Transmit Power Range		55 dB dynamic range (to EIRP limit by region) (1 dB step)		

Category		Specification
Maximum Transmit Power	5 GHz	+28 dBm combined output
	6 GHz	+20 dBm combined output
Physical		
Ports		• Main PoE: 1 GbE • SFP optical: 10 GbE • Audio jack • SMA connector: for GPS antenna
Antenna Connection		N/A - Integrated Dish antenna
Surge Suppression EN61000-4-5		EN 61000-4-5: 10x700 µs, 6 kV, EN 61000-4-2: ESD 8 kV contact / 15 kV air Recommended external surge suppressor: Cambium Networks Model # C000000L033A
Mean Time Between Failure		> 40 Years
Dust and Water Ingress Protection Rating		IP66, IP67
Temperature / Humidity		-40°C to +60°C (-40°F to +140°F), 0-100% condensing
Weight		4.5 kg (9.9 lbs), 6.5 kg (14.3 lbs) with bracket
Wind Survival		200 kph (124 mph)
Vibration		NEMA TS2 Section 2.1.9 and Section 2.2.3
Shock		NEMA TS2 Section 2.1.10 and Section 2.2.4
External Icing		NEMA 250-2003 Section 5.6
Dimensions (Dia x Depth)		462 mm (diameter) x 264 mm (18.1" diameter x 10.4" depth)
Power Consumption		45W Typical, 55W Maximum
Input Voltage		48-59 VDC, 802.3bt type 4 class 8 (also accepting passive PoE)
Mounting		Pole mount with brackets
Security		
Encryption		FIPS-197 128-bit AES, and 256-bit AES **Note** AES-256 requires a license key.

Specifications for PMP 450i Series - SM

The PMP 450i SM conforms to the specifications listed in below table.

Table 165: PMP 450i Series - SM specifications

Category		Specification
Model Number		PMP 450i SM
Spectrum		
Channel Spacing		5, 7, 10, 15, 20, 30, and 40 Channel Bandwidth Configurable on 2.5 MHz increments
Frequency Range		3300 – 3900 MHz
		4900 - 5925 MHz
Channel Bandwidth	3300 – 3900 MHz	5, 7, 10, 15, 20, 30, and 40 MHz
	4900 – 5925 MHz	5, 10, 15, 20, 30, and 40 MHz
Interface		
MAC (Media Access Control) Layer		Cambium Proprietary
Physical Layer		2x2 MIMO OFDM
Ethernet Interface		10/100/1000BaseT, half/full duplex, rate auto negotiated (802.3 compliant)
Protocols Used		IPv4, UDP, TCP, IP, ICMP, Telnet, SNMP, HTTP, FTP
Network Management		HTTP, HTTPS, Telnet, FTP, SNMP v2c and v3
VLAN		802.1ad (DVLAN Q-in-Q), 802.1Q with 802.1p priority, dynamic port VID
Sensitivity		

Category		Specification
Nominal Receive Sensitivity (w/ FEC) @ 5 MHz Channel	3.5 GHz	1x = -93.0 dBm, 2x = -89.2 dBm, 3x = -85.3 dBm, 4x = -82.9 dBm, 5x = -79.4 dBm, 6x = -76.2 dBm, 7x = -72.4 dBm, 8x = -68.5 dBm
	3.6 GHz	1x = -92.0 dBm, 2x = -88.0 dBm, 3x = -84.0 dBm, 4x = -82.0 dBm, 5x = -78.6 dBm, 6x = -75.6 dBm, 7x = -71.7 dBm, 8x = -68.6 dBm
	4.9 GHz	1x = -92.5 dBm, 2x = -88.3 dBm, 3x = -83.8 dBm, 4x = -81.4 dBm, 5x = -78.4 dBm, 6x = -75.4 dBm, 7x = -71.4 dBm, 8x = -67.0 dBm
	5.1 GHz	1x = -92.0 dBm, 2x = -87.5 dBm, 3x = -83.0 dBm, 4x = -81.0 dBm, 5x = -78.0 dBm, 6x = -75.0 dBm, 7x = -72.0 dBm, 8x = -67.4 dBm
	5.2 GHz	1x = -92.0 dBm, 2x = -87.5 dBm, 3x = -83.0 dBm, 4x = -81.0 dBm, 5x = -78.0 dBm, 6x = -75.0 dBm, 7x = -72.0 dBm, 8x = -67.4 dBm
	5.4 GHz	1x = -92.0 dBm, 2x = -87.5 dBm, 3x = -83.0 dBm, 4x = -81.0 dBm, 5x = -78.0 dBm, 6x = -75.0 dBm, 7x = -72.0 dBm, 8x = -67.4 dBm
	5.8 GHz	1x = -91.3 dBm, 2x = -87.3 dBm, 3x = -83.3 dBm, 4x = -81.3 dBm, 5x = -78.0 dBm, 6x = -75.0 dBm, 7x = -71.0 dBm, 8x = -67.0 dBm
Nominal Receive Sensitivity (w/ FEC) @ 7 MHz Channel	3.5 GHz	1x = -92.3 dBm, 2x = -87.9 dBm, 3x = -83.0 dBm, 4x = -81.0 dBm, 5x = -78.8 dBm, 6x = -75.0 dBm, 7x = -71.0 dBm, 8x = -67.8 dBm
	3.6 GHz	1x = -91.0 dBm, 2x = -87.9 dBm, 3x = -82.6 dBm, 4x = -81.4 dBm, 5x = -76.7 dBm, 6x = -73.7 dBm, 7x = -70.3 dBm, 8x = -67.8 dBm
Nominal Receive Sensitivity (w/ FEC) @ 10 MHz Channel	3.5 GHz	1x = -90.3 dBm, 2x = -86.3 dBm, 3x = -81.8 dBm, 4x = -80.2 dBm, 5x = -76.4 dBm, 6x = -73.5 dBm, 7x = -69.8 dBm, 8x = -66.3 dBm
	3.6 GHz	1x = -89.6 dBm, 2x = -85.4 dBm, 3x = -80.9 dBm, 4x = -78.6 dBm, 5x = -75.7 dBm, 6x = -72.7 dBm, 7x = -69.1 dBm, 8x = -65.8 dBm
	4.9 GHz	1x = -89.6 dBm, 2x = -84.9 dBm, 3x = -81.0 dBm, 4x = -78.8 dBm, 5x = -75.0 dBm, 6x = -72.0 dBm, 7x = -69.0 dBm, 8x = -64.5 dBm
	5.1 GHz	1x = -89.8 dBm, 2x = -85.5 dBm, 3x = -80.6 dBm, 4x = -79.0 dBm, 5x = -75.4 dBm, 6x = -71.8 dBm, 7x = -69.7 dBm, 8x = -64.5 dBm
	5.2 GHz	1x = -89.8 dBm, 2x = -85.5 dBm, 3x = -80.6 dBm, 4x = -79.0 dBm, 5x = -75.4 dBm, 6x = -71.8 dBm, 7x = -69.7 dBm, 8x = -64.5 dBm
	5.4 GHz	1x = -89.0 dBm, 2x = -84.7 dBm, 3x = -80.7 dBm, 4x = -78.7 dBm, 5x = -75.6 dBm, 6x = -72.2 dBm, 7x = -68.7 dBm, 8x = -64.8 dBm
	5.8 GHz	1x = -88.0 dBm, 2x = -84.7 dBm, 3x = -80.7 dBm, 4x = -78.7 dBm, 5x = -75.6 dBm, 6x = -72.2 dBm, 7x = -68.7 dBm, 8x = -64.8 dBm

Category		Specification
Nominal Receive Sensitivity (w/ FEC) @ 15 MHz Channel	3.5 GHz	1x = -89.0 dBm, 2x = -84.5 dBm, 3x = -80.2 dBm, 4x = -77.9 dBm, 5x = -74.5 dBm, 6x = -71.5 dBm, 7x = -68.4 dBm, 8x = -64.8 dBm
	3.6 GHz	1x = -88.3 dBm, 2x = -83.8 dBm, 3x = -79.5 dBm, 4x = -76.8 dBm, 5x = -73.7 dBm, 6x = -70.4 dBm, 7x = -67.7 dBm, 8x = -64.4 dBm
	4.9 GHz	1x = -87.8 dBm, 2x = -83.1 dBm, 3x = 79.0 dBm, 4x = -76.9 dBm, 5x = -74.0 dBm, 6x = -70.4 dBm, 7x = -67.0 dBm, 8x = -62.3 dBm
	5.1 GHz	1x = -88.6 dBm, 2x = -83.6 dBm, 3x = -79.7 dBm, 4x = -77.5 dBm, 5x = -73.7 dBm, 6x = -70.2 dBm, 7x = -67.7 dBm, 8x = -62.9 dBm
	5.2 GHz	1x = -88.6 dBm, 2x = -83.6 dBm, 3x = -79.7 dBm, 4x = -77.5 dBm, 5x = -73.7 dBm, 6x = -70.2 dBm, 7x = -67.7 dBm, 8x = -62.9 dBm
	5.4 GHz	1x = -87.0 dBm, 2x = -83.5 dBm, 3x = -78.8 dBm, 4x = -76.6 dBm, 5x = -73.7 dBm, 6x = -70.4 dBm, 7x = -66.7 dBm, 8x = -62.6 dBm
	5.8 GHz	1x = -86.9 dBm, 2x = -82.9 dBm, 3x = -78.0 dBm, 4x = -76.0 dBm, 5x = -73.0 dBm, 6x = -70.0 dBm, 7x = -67.1 dBm, 8x = -62.3 dBm
Nominal Receive Sensitivity (w/ FEC) @ 20 MHz Channel	3.5 GHz	1x = -87.0 dBm, 2x = -83.5 dBm, 3x = -78.8 dBm, 4x = -76.3 dBm, 5x = -73.1 dBm, 6x = -70.3 dBm, 7x = -67.0 dBm, 8x = -63.2 dBm
	3.6 GHz	1x = -86.7 dBm, 2x = -82.0 dBm, 3x = -78.0 dBm, 4x = -75.7 dBm, 5x = -72.6 dBm, 6x = -69.8 dBm, 7x = -65.8 dBm, 8x = -62.8 dBm
	4.9 GHz	1x = -87.0 dBm, 2x = -82.6 dBm, 3x = -77.9 dBm, 4x = -75.4 dBm, 5x = -72.9 dBm, 6x = -69.1 dBm, 7x = -65.9 dBm, 8x = -61.8 dBm
	5.1 GHz	1x = -87.0 dBm, 2x = -82.6 dBm, 3x = -77.9 dBm, 4x = -75.4 dBm, 5x = -72.9 dBm, 6x = -69.1 dBm, 7x = -65.9 dBm, 8x = -61.8 dBm
	5.2 GHz	1x = -87.0 dBm, 2x = -82.6 dBm, 3x = -77.9 dBm, 4x = -75.4 dBm, 5x = -72.9 dBm, 6x = -69.1 dBm, 7x = -65.9 dBm, 8x = -61.8 dBm
	5.4 GHz	1x = -87.0 dBm, 2x = -82.6 dBm, 3x = -77.9 dBm, 4x = -75.4 dBm, 5x = -72.9 dBm, 6x = -69.1 dBm, 7x = -65.9 dBm, 8x = -61.8 dBm
	5.8 GHz	1x = -85.9 dBm, 2x = -81.5 dBm, 3x = -77.9 dBm, 4x = -74.8 dBm, 5x = -72.1 dBm, 6x = -68.7 dBm, 7x = -65.2 dBm, 8x = -61.2 dBm

Category		Specification
Nominal Receive Sensitivity (w/ FEC) @ 30 MHz Channel	3.5 GHz	1x = -85.5 dBm, 2x = -81.2 dBm, 3x = -76.7 dBm, 4x = -74.6 dBm, 5x = -71.3 dBm, 6x = -68.8 dBm, 7x = -65.3 dBm, 8x = -61.1 dBm
	3.6 GHz	1x = -85.0 dBm, 2x = -80.4 dBm, 3x = -76.2 dBm, 4x = -73.6 dBm, 5x = -70.7 dBm, 6x = -67.5 dBm, 7x = -64.4 dBm, 8x = -61.0 dBm
	4.9 GHz	1x = -84.9 dBm, 2x = -80.9 dBm, 3x = -75.8 dBm, 4x = -73.2 dBm, 5x = -70.8 dBm, 6x = -66.4 dBm, 7x = -63.2 dBm, 8x = -59.6 dBm
	5.1 GHz	1x = -84.6 dBm, 2x = -80.2 dBm, 3x = -75.4 dBm, 4x = -73.8 dBm, 5x = -70.6 dBm, 6x = -67.0 dBm, 7x = -63.6 dBm, 8x = -59.6 dBm
	5.2 GHz	1x = -84.6 dBm, 2x = -80.2 dBm, 3x = -75.4 dBm, 4x = -73.8 dBm, 5x = -70.6 dBm, 6x = -67.0 dBm, 7x = -63.6 dBm, 8x = -59.6 dBm
	5.4 GHz	1x = -84.6 dBm, 2x = -80.2 dBm, 3x = -75.4 dBm, 4x = -73.8 dBm, 5x = -70.6 dBm, 6x = -67.0 dBm, 7x = -63.6 dBm, 8x = -59.6 dBm
	5.8 GHz	1x = -84.0 dBm, 2x = -80.0 dBm, 3x = -74.8 dBm, 4x = -73.9 dBm, 5x = -69.9 dBm, 6x = -66.8 dBm, 7x = -63.8 dBm, 8x = -59.1 dBm
Nominal Receive Sensitivity (w/ FEC) @ 40 MHz Channel	3.5 GHz	1x = -83.5 dBm, 2x = -79.6 dBm, 3x = -75.0 dBm, 4x = -73.0 dBm, 5x = -70.0 dBm, 6x = -67.0 dBm, 7x = -64.0 dBm, 8x = -60.0 dBm
	3.6 GHz	1x = -82.9 dBm, 2x = -78.9 dBm, 3x = -74.0 dBm, 4x = -72.0 dBm, 5x = -69.1 dBm, 6x = -66.0 dBm, 7x = -62.9 dBm, 8x = -59.0 dBm
	4.9 GHz	1x = -83.7 dBm, 2x = -79.6 dBm, 3x = -74.7 dBm, 4x = -72.7 dBm, 5x = -69.7 dBm, 6x = -66.0 dBm, 7x = -62.7 dBm, 8x = -56.8 dBm
	5.1 GHz	1x = -83.6 dBm, 2x = -79.1 dBm, 3x = -74.5 dBm, 4x = -72.5 dBm, 5x = -69.5 dBm, 6x = -66.0 dBm, 7x = -62.4 dBm, 8x = -56.9 dBm
	5.2 GHz	1x = -83.6 dBm, 2x = -79.1 dBm, 3x = -74.5 dBm, 4x = -72.5 dBm, 5x = -69.5 dBm, 6x = -66.0 dBm, 7x = -62.4 dBm, 8x = -56.9 dBm
	5.4 GHz	1x = -83.6 dBm, 2x = -79.1 dBm, 3x = -74.5 dBm, 4x = -72.5 dBm, 5x = -69.5 dBm, 6x = -66.0 dBm, 7x = -62.4 dBm, 8x = -56.9 dBm
	5.8 GHz	1x = -82.7 dBm, 2x = -78.7 dBm, 3x = -74.0 dBm, 4x = -72.7 dBm, 5x = -68.6 dBm, 6x = -65.6 dBm, 7x = -61.7 dBm, 8x = -56.3 dBm
Performance		
ARQ		Yes
Cyclic Prefix		1/16
Frame Period		2.5 ms or 5.0 ms

Category		Specification		
Modulation Levels (Adaptive)		Modulation Levels	MCS	SNR (in dB)
		2x	QPSK	10
		3x	8-QAM	14
		4x	16-QAM	17
		5x	32-QAM	21
		6x	64-QAM	24
		7x	128-QAM	28
		8x	256-QAM	32
Latency		3 - 5 ms		
Maximum Deployment Range		Up to 40 miles (64 km)		
GPS Synchronization		Yes, via Autosync (CMM4)		
Quality of Service		Diffserv QoS		
Link Budget				
Antenna Beam Width		10° azimuth for 23 dBi integrated antenna		
Antenna Gain (Does not include cable loss, ~1dB)	5 GHz	+23 dBi H+V, integrated or external		
	3 GHz	+19 dBi dual slant, integrated or external		
Transmit Power Range		40 dB dynamic range (to EIRP limit by region) (1 dB step)		
Maximum Transmit Power		+27 dBm combined output (for 5 GHz)		
		+25 dBm combined output (for 3 GHz)		
Physical				
Sync/AUX port	RJ45	10/100/1000BASE-T Ethernet Data PoE output (planned for future release) Sync input or output (Connection and powering of UGPS Sync input)		
Antenna Connection		50 ohm, N-type (Connectorized version only)		
Surge Suppression EN61000-4-5		EN61000-4-5: 1.2us/50us, 500 V voltage waveform Recommended external surge suppressor: Cambium Networks Model # C000000L033A		

Category		Specification
Mean Time Between Failure		> 40 Years
Environmental		IP66, IP67
Temperature / Humidity		-40°C to +60°C (-40°F to +140°F), 0-95% non-condensing
Weight	Connectorized	Approx. 2.0 kg (4.5 lbs)
	Integrated	Approx. 2.5 kg (5.5 lbs)
Wind Survival	Connectorized	322 km/h (200 mi/h)
	Integrated	200 km/h (124 mi/h)
Dimension (HxWxD)	Connectorized	26.0 x 13.4 x 6.4 cm (10.3” x 5.3” x 3.3”)
	Integrated	31.0 x 31.0 x 6.4 cm (12” x 12” x 2.5”)
Power Consumption		15 W typical, 25 W max, 55 W max with Aux port PoE out enabled
Input Voltage		48-59 V DC, 802.3at compliant
Mounting		Wall or Pole mount with Cambium Networks Model # N000045L002A
Security		
Encryption		128-bit AES and 256-bit AES Note AES-256 requires a license key.

Specifications for PTP 450i Series - BH

The PTP 450i BH conforms to the specifications listed in below table.

Table 166: PTP 450i Series - BH specifications

Category		Specification
Model Number		PTP 450i BH
Spectrum		
Channel Spacing		5, 7, 10, 15, 20, 30, and 40 MHz Channel Bandwidth Configurable on 2.5 MHz increments
Frequency Range		4900 - 5925 MHz
Channel Bandwidth	4900 – 5925 MHz	5, 10, 15, 20, 30, and 40 MHz

Category		Specification
Interface		
MAC (Media Access Control) Layer		Cambium Proprietary
Physical Layer		2x2 MIMO OFDM
Ethernet Interface		10/100/1000BaseT, half/full duplex, rate auto negotiated (802.3 compliant)
Protocols Used		IPv4, UDP, TCP, IP, ICMP, Telnet, SNMP, HTTP, FTP
Network Management		HTTP, HTTPS, Telnet, FTP, SNMP v2c and v3
VLAN		802.1ad (DVLAN Q-in-Q), 802.1Q with 802.1p priority, dynamic port VID
Sensitivity		
Nominal Receive Sensitivity (w/ FEC) @ 5 MHz Channel	3.5 GHz	1x = -93.0 dBm, 2x = -89.3 dBm, 3x = -85.0 dBm, 4x = -82.2 dBm, 5x = -79.2 dBm, 6x = -76.3 dBm, 7x = -72.6 dBm, 8x = -69.1 dBm
	3.6 GHz	1x = -93.0 dBm, 2x = -88.1 dBm, 3x = -84.0 dBm, 4x = -82.3 dBm, 5x = -78.8 dBm, 6x = -75.9 dBm, 7x = -72.1 dBm, 8x = -68.6 dBm
	4.9 GHz	1x = -92.6 dBm, 2x = -88.3 dBm, 3x = -84.0 dBm, 4x = -81.6 dBm, 5x = -78.4 dBm, 6x = -75.4 dBm, 7x = -72.3 dBm, 8x = -68.0 dBm
	5.1 GHz	1x = -93.0 dBm, 2x = -88.5 dBm, 3x = -84.3 dBm, 4x = -82.0 dBm, 5x = -78.3 dBm, 6x = -75.1 dBm, 7x = -72.4 dBm, 8x = -68.0 dBm
	5.2 GHz	1x = -93.0 dBm, 2x = -88.5 dBm, 3x = -84.3 dBm, 4x = -82.0 dBm, 5x = -78.3 dBm, 6x = -75.1 dBm, 7x = -72.4 dBm, 8x = -68.0 dBm
	5.4 GHz	1x = -93.0 dBm, 2x = -88.6 dBm, 3x = -84.2 dBm, 4x = -81.3 dBm, 5x = -78.8 dBm, 6x = -75.0 dBm, 7x = -72.2 dBm, 8x = -68.0 dBm
	5.8 GHz	1x = -92.4 dBm, 2x = -88.4 dBm, 3x = -82.6 dBm, 4x = -81.2 dBm, 5x = -78.0 dBm, 6x = -75.1 dBm, 7x = -71.4 dBm, 8x = -67.2 dBm
Nominal Receive Sensitivity (w/ FEC) @ 7 MHz Channel	3.5 GHz	1x = -92.0 dBm, 2x = -87.9 dBm, 3x = -83.0 dBm, 4x = -81.2 dBm, 5x = -77.8 dBm, 6x = -75.0 dBm, 7x = -71.0 dBm, 8x = -68.1 dBm
	3.6 GHz	1x = -91.0 dBm, 2x = -86.9 dBm, 3x = -82.0 dBm, 4x = -80.8 dBm, 5x = -76.2 dBm, 6x = -73.8 dBm, 7x = -70.4 dBm, 8x = -67.3 dBm

Category		Specification
Nominal Receive Sensitivity (w/ FEC) @ 10 MHz Channel	3.5 GHz	1x = -90.3 dBm, 2x = -86.5 dBm, 3x = -81.6 dBm, 4x = -79.4 dBm, 5x = -76.5 dBm, 6x = -73.4 dBm, 7x = -70.0 dBm, 8x = -66.3 dBm
	3.6 GHz	1x = -89.8 dBm, 2x = -86.0 dBm, 3x = -80.5 dBm, 4x = -78.9 dBm, 5x = -75.7 dBm, 6x = -72.5 dBm, 7x = -69.0 dBm, 8x = -66.0 dBm
	4.9 GHz	1x = 90.0 dBm, 2x = -85.6 dBm, 3x = -81.2 dBm, 4x = -78.8 dBm, 5x = -76.0 dBm, 6x = -72.8 dBm, 7x = -69.0 dBm, 8x = -65.0 dBm
	5.1 GHz	1x = 90.0 dBm, 2x = -85.6 dBm, 3x = -81.2 dBm, 4x = -78.8 dBm, 5x = -76.0 dBm, 6x = -72.8 dBm, 7x = -69.0 dBm, 8x = -65.0 dBm
	5.2 GHz	1x = 90.0 dBm, 2x = -85.6 dBm, 3x = -81.5 dBm, 4x = -78.4 dBm, 5x = -75.9 dBm, 6x = -72.2 dBm, 7x = -68.9 dBm, 8x = -65.0 dBm
	5.4 GHz	1x = 89.6 dBm, 2x = -85.2 dBm, 3x = -81.2 dBm, 4x = -78.6 dBm, 5x = -75.5 dBm, 6x = -72.4 dBm, 7x = -69.2 dBm, 8x = -64.7 dBm
	5.8 GHz	1x = 89.6 dBm, 2x = -84.8 dBm, 3x = -80.0 dBm, 4x = -78.5 dBm, 5x = -74.8 dBm, 6x = -71.6 dBm, 7x = -68.7 dBm, 8x = -64.3 dBm

Category		Specification
Nominal Receive Sensitivity (w/ FEC) @ 15 MHz Channel	3.5 GHz	1x = 88.6 dBm, 2x = -84.5 dBm, 3x = -79.8 dBm, 4x = -77.6 dBm, 5x = -74.7 dBm, 6x = -71.6 dBm, 7x = -68.5 dBm, 8x = -65.2 dBm
	3.6 GHz	1x = 88.0 dBm, 2x = -83.6 dBm, 3x = -78.9 dBm, 4x = -76.7 dBm, 5x = -73.9 dBm, 6x = -70.8 dBm, 7x = -67.8 dBm, 8x = -64.0 dBm
	4.9 GHz	1x = 88.0 dBm, 2x = -83.6 dBm, 3x = -79.2 dBm, 4x = -77.0 dBm, 5x = -74.0 dBm, 6x = -71.0 dBm, 7x = -67.2 dBm, 8x = -63.1 dBm
	5.1 GHz	1x = 88.0 dBm, 2x = -83.6 dBm, 3x = -79.2 dBm, 4x = -77.0 dBm, 5x = -74.0 dBm, 6x = -71.0 dBm, 7x = -67.2 dBm, 8x = -63.1 dBm
	5.2 GHz	1x = 88.1 dBm, 2x = -83.9 dBm, 3x = -79.5 dBm, 4x = -76.6 dBm, 5x = -74.0 dBm, 6x = -70.4 dBm, 7x = -67.7 dBm, 8x = -62.8 dBm
	5.4 GHz	1x = 88.0 dBm, 2x = -83.9 dBm, 3x = -79.3 dBm, 4x = -77.1 dBm, 5x = -73.6 dBm, 6x = -70.7 dBm, 7x = -67.4 dBm, 8x = -63.4 dBm
	5.8 GHz	1x = 87.9 dBm, 2x = -83.0 dBm, 3x = -78.4 dBm, 4x = -76.7 dBm, 5x = -73.4 dBm, 6x = -70.0 dBm, 7x = -66.7 dBm, 8x = -62.5 dBm

Category		Specification
Nominal Receive Sensitivity (w/ FEC) @ 20 MHz Channel’	3.5 GHz	1x = 87.0 dBm, 2x = -82.6 dBm, 3x = -78.4 dBm, 4x = -76.6 dBm, 5x = -73.2 dBm, 6x = -70.2 dBm, 7x = -67.3 dBm, 8x = -63.2 dBm
	3.6 GHz	1x = 87.0 dBm, 2x = -82.4 dBm, 3x = -77.8 dBm, 4x = -75.8 dBm, 5x = -72.6 dBm, 6x = -69.0 dBm, 7x = -66.0 dBm, 8x = -63.2 dBm
	4.9 GHz	1x = 87.0 dBm, 2x = -82.4 dBm, 3x = -78.0 dBm, 4x = -76.0 dBm, 5x = -72.9 dBm, 6x = -69.5 dBm, 7x = -66.1 dBm, 8x = -62.4 dBm
	5.1 GHz	1x = 87.0 dBm, 2x = -82.4 dBm, 3x = -78.0 dBm, 4x = -76.0 dBm, 5x = -72.9 dBm, 6x = -69.5 dBm, 7x = -66.1 dBm, 8x = -62.4 dBm
	5.2 GHz	1x = 87.0 dBm, 2x = -82.5 dBm, 3x = -77.7 dBm, 4x = -76.0 dBm, 5x = -72.8 dBm, 6x = -69.5 dBm, 7x = -66.8 dBm, 8x = -61.9 dBm
	5.4 GHz	1x = 86.7 dBm, 2x = -82.8 dBm, 3x = -78.0 dBm, 4x = -75.7 dBm, 5x = -72.4 dBm, 6x = -69.6 dBm, 7x = -66.2 dBm, 8x = -61.3 dBm
	5.8 GHz	1x = 85.9 dBm, 2x = -81.6 dBm, 3x = -77.6 dBm, 4x = -75.5 dBm, 5x = -71.7 dBm, 6x = -68.6 dBm, 7x = -65.8 dBm, 8x = -60.8 dBm

Category		Specification
Nominal Receive Sensitivity (w/ FEC) @ 30 MHz Channel	3.5 GHz	1x = 86.0 dBm, 2x = -81.0 dBm, 3x = -76.0 dBm, 4x = -75.0 dBm, 5x = -71.3 dBm, 6x = -68.2 dBm, 7x = -65.3 dBm, 8x = -61.1 dBm
	3.6 GHz	1x = 85.2 dBm, 2x = -80.5 dBm, 3x = -76.0 dBm, 4x = -74.0 dBm, 5x = -70.4 dBm, 6x = -67.5 dBm, 7x = -64.6 dBm, 8x = -61.0 dBm
	4.9 GHz	1x = -84.9 dBm, 2x= -80.5 dBm, 3x = -76.0 dBm, 4x = -74.0 dBm, 5x = -71.0 dBm, 6x = -68.0 dBm, 7x = -63.9 dBm, 8x = -59.8 dBm
	5.1 GHz	1x = -84.9 dBm, 2x= -80.5 dBm, 3x = -76.0 dBm, 4x = -74.0 dBm, 5x = -71.0 dBm, 6x = -68.0 dBm, 7x = -63.9 dBm, 8x = -59.8 dBm
	5.2 GHz	1x = 85.0 dBm, 2x = -80.5 dBm, 3x = -75.9 dBm, 4x = -74.2 dBm, 5x = -71.0 dBm, 6x = -67.9 dBm, 7x = -64.9 dBm, 8x = -59.4 dBm
	5.4 GHz	1x = 85.0 dBm, 2x = -80.4 dBm, 3x = -76.0 dBm, 4x = -74.2 dBm, 5x = -71.0 dBm, 6x = -67.6 dBm, 7x = -64.2 dBm, 8x = -60.0 dBm
	5.8 GHz	1x = 84.7 dBm, 2x = -79.9 dBm, 3x = -75.5 dBm, 4x = -73.3 dBm, 5x = -70.5 dBm, 6x = -66.4 dBm, 7x = -63.8 dBm, 8x = -59.0 dBm

Category		Specification		
Nominal Receive Sensitivity (w/ FEC) @ 40 MHz Channel	3.5 GHz	1x = 84.0 dBm, 2x = -79.0 dBm, 3x = -75.0 dBm, 4x = -73.4 dBm, 5x = -70.0 dBm, 6x = -67.0 dBm, 7x = -64.0 dBm, 8x = -59.0 dBm		
	3.6 GHz	1x = 84.0 dBm, 2x = -79.0 dBm, 3x = -74.0 dBm, 4x = -72.0 dBm, 5x = -69.0 dBm, 6x = -65.5 dBm, 7x = -63.1 dBm, 8x = -58.9 dBm		
	4.9 GHz	1x = 83.6 dBm, 2x = -79.5 dBm, 3x = -74.6 dBm, 4x = -72.0 dBm, 5x = -69.4 dBm, 6x = -66.4 dBm, 7x = -63.7 dBm, 8x = -58.7 dBm		
	5.1 GHz	1x = 83.6 dBm, 2x = -79.5 dBm, 3x = -74.6 dBm, 4x = -72.0 dBm, 5x = -69.4 dBm, 6x = -66.4 dBm, 7x = -63.7 dBm, 8x = -58.7 dBm		
	5.2 GHz	1x = 83.7 dBm, 2x = -79.5 dBm, 3x = -74.9 dBm, 4x = -72.6 dBm, 5x = -69.5 dBm, 6x = -66.4 dBm, 7x = -63.6 dBm, 8x = -58.6 dBm		
	5.4 GHz	1x = 83.6 dBm, 2x = -79.1 dBm, 3x = -75.0 dBm, 4x = -72.8 dBm, 5x = -69.4 dBm, 6x = -66.9 dBm, 7x = -62.8 dBm, 8x = -58.4 dBm		
	5.8 GHz	1x = 83.3 dBm, 2x = -78.5 dBm, 3x = -74.2 dBm, 4x = -72.7 dBm, 5x = -69.0 dBm, 6x = -66.0 dBm, 7x = -62.3 dBm, 8x = -58.0 dBm		
Performance				
ARQ		Yes		
Cyclic Prefix		1/16		
Frame Period		2.5 ms or 5.0 ms		
Modulation Levels (Adaptive)		Modulation Levels		SNR (in dB)
		2x	QPSK	10
		3x	8-QAM	14
		4x	16-QAM	17
		5x	32-QAM	21
		6x	64-QAM	24
		7x	128-QAM	28
		8x	256-QAM	32
Latency		3 - 5 ms		

Category		Specification
Maximum Deployment Range		Up to 40 miles (64 km)
GPS Synchronization		Yes, via Autosync (CMM4)
Quality of Service		Diffserv QoS
Link Budget		
Antenna Beam Width	900 MHz	37° azimuth for 12 dBi Yagi antenna
	5 GHz	10° azimuth for 23 dBi integrated antenna
Antenna Gain (Does not include cable loss, ~1dB)	900 MHz	12 dBi Yagi antenna
	5 GHz	+23 dBi H+V, integrated or external
Transmit Power Range		40 dB dynamic range (to EIRP limit by region) (1 dB step)
Maximum Transmit Power		+27 dBm combined output
Physical		
Sync/AUX port	RJ45	• 10/100/1000BASE-T Ethernet Data • PoE output • Sync input or output (Connection and powering of UGPS Sync input)
Antenna Connection		50 ohm, N-type (Connectorized version only)
Surge Suppression EN61000-4-5		EN61000-4-5: 1.2 us/50us, 500 V voltage waveform Recommended external surge suppressor: Cambium Networks Model # C000000L033A
Mean Time Between Failure		> 40 Years
Environmental		IP66, IP67
Temperature / Humidity		-40°C to +60°C (-40°F to +140°F), 0-95% non-condensing
Weight	Connectorized	Approx. 2.0 kg (4.5 lbs)
	Integrated	Approx. 2.5 kg (5.5 lbs)
Wind Survival	Connectorized	322 km/h (200 mi/h)
	Integrated	200 km/h (124 mi/h)
Dimension (HxWxD)	Connectorized	26.0 x 13.4 x 6.4 cm (10.25” x 5.25” x 3.25”)
	Integrated	31.0 x 31.0 x 6.4 cm (12” x 12” x 2.5”)

Category		Specification
Power Consumption		15 W typical, 25 W max, 55 W max with Aux port PoE out enabled
Input Voltage		48-59 V DC, 802.3at compliant
Mounting		Wall or Pole mount with Cambium Networks Model #N000045L002A
Security		
Encryption		128-bit AES and 256-bit AES Note AES-256 requires a license key.

Specifications for PMP 450b 5 GHz Mid-Gain Series - SM

The PMP 450b 5 GHz Mid-Gain conforms to the specifications listed in below table.

Table 167: PMP 450b 5 GHz Mid-Gain Series - SM specifications

Category	Specification
Model Number	5 GHz PMP 450b Mid-Gain
Spectrum	
Channel Spacing	Configurable in 2.5 MHz increments
Frequency Range	4900 - 5925 MHz
Channel Bandwidth	5, 10, 15, 20, 30, and 40 MHz
Interface	
MAC (Media Access Control) Layer	Cambium Proprietary
Physical Layer	2x2 MIMO OFDM
Ethernet Interface	100/1000BaseT, half/full duplex, rate auto negotiated (802.3 compliant)
Protocols Used	IPv4, UDP, TCP, IP, ICMP, Telnet, SNMP, HTTP, FTP
Network Management	HTTP, HTTPS, Telnet, FTP, SNMP v2c and v3
VLAN	802.1ad (DVLAN Q-in-Q), 802.1Q with 802.1p priority, dynamic port VID
Sensitivity	

Category		Specification
Nominal Receive Sensitivity (w/ FEC) @ 5 MHz Channel	4.9 GHz	1x = -92.0 dBm, 2x = -88.0 dBm, 3x = -84.0 dBm, 4x = -82.0 dBm, 5x = -78.0 dBm, 6x = -75.1 dBm, 7x = -72.5 dBm, 8x = -68.0 dBm
	5.1 GHz	1x = -92.6 dBm, 2x = -88.5 dBm, 3x = -82.6 dBm, 4x = -80.8 dBm, 5x = -77.6 dBm, 6x = -74.2 dBm, 7x = -71.6 dBm, 8x = -66.8 dBm
	5.2 GHz	1x = -92.6 dBm, 2x = -88.5 dBm, 3x = -83.4 dBm, 4x = -80.8 dBm, 5x = -77.6 dBm, 6x = -74.2 dBm, 7x = -71.6 dBm, 8x = -67.0 dBm
	5.4 GHz	1x = -92.6 dBm, 2x = -88.5 dBm, 3x = -84.0 dBm, 4x = -82.3 dBm, 5x = -79.0 dBm, 6x = -75.9 dBm, 7x = -72.3 dBm, 8x = -68.0 dBm
	5.8 GHz	1x = -92.1 dBm, 2x = -87.9 dBm, 3x = -84.3 dBm, 4x = -82.1 dBm, 5x = -79.0 dBm, 6x = -75.4 dBm, 7x = -72.0 dBm, 8x = -68.0 dBm
Nominal Receive Sensitivity (w/ FEC) @ 10 MHz Channel	4.9 GHz	1x = -89.7 dBm, 2x = -84.8 dBm, 3x = -80.7 dBm, 4x = -78.4 dBm, 5x = -75.7 dBm, 6x = -72.0 dBm, 7x = -68.8 dBm, 8x = -64.2 dBm
	5.1 GHz	1x = -90.0 dBm, 2x = -85.3 dBm, 3x = -80.0 dBm, 4x = -78.8 dBm, 5x = -75.2 dBm, 6x = -71.6 dBm, 7x = -69.2 dBm, 8x = -64.8 dBm
	5.2 GHz	1x = -90.0 dBm, 2x = -85.3 dBm, 3x = -80.0 dBm, 4x = -78.8 dBm, 5x = -75.2 dBm, 6x = -71.6 dBm, 7x = -69.2 dBm, 8x = -64.8 dBm
	5.4 GHz	1x = -89.6 dBm, 2x = -85.6 dBm, 3x = -81.0 dBm, 4x = -78.2 dBm, 5x = -75.9 dBm, 6x = -72.4 dBm, 7x = -69.4 dBm, 8x = -65.0 dBm
	5.8 GHz	1x = -89.6 dBm, 2x = -85.6 dBm, 3x = -81.0 dBm, 4x = -78.2 dBm, 5x = -75.9 dBm, 6x = -72.4 dBm, 7x = -69.4 dBm, 8x = -65.0 dBm

Category		Specification
Nominal Receive Sensitivity (w/ FEC) @ 15 MHz Channel	4.9 GHz	1x = -88.0 dBm, 2x = -83.7 dBm, 3x = -78.9 dBm, 4x = -76.6 dBm, 5x = -74.0 dBm, 6x = -70.4 dBm, 7x = -67.8 dBm, 8x = -63.0 dBm
	5.1 GHz	1x = -87.8 dBm, 2x = -83.7 dBm, 3x = -78.3 dBm, 4x = -76.6 dBm, 5x = -73.5 dBm, 6x = -70.0 dBm, 7x = -67.5 dBm, 8x = -63.2 dBm
	5.2 GHz	1x = -87.8 dBm, 2x = -83.7 dBm, 3x = -78.3 dBm, 4x = -76.6 dBm, 5x = -73.5 dBm, 6x = -70.0 dBm, 7x = -67.5 dBm, 8x = -63.2 dBm
	5.4 GHz	1x = -88.0 dBm, 2x = -83.5 dBm, 3x = -79.4 dBm, 4x = -76.5 dBm, 5x = -74.0 dBm, 6x = -70.5 dBm, 7x = -67.7 dBm, 8x = -63.0 dBm
	5.8 GHz	1x = -88.0 dBm, 2x = -83.5 dBm, 3x = -79.4 dBm, 4x = -76.5 dBm, 5x = -74.0 dBm, 6x = -70.5 dBm, 7x = -67.7 dBm, 8x = -63.0 dBm
Nominal Receive Sensitivity (w/ FEC) @ 20 MHz Channel	4.9 GHz	1x = -86.3 dBm, 2x = -81.3 dBm, 3x = -77.2 dBm, 4x = -75.4 dBm, 5x = -72.2 dBm, 6x = -69.0 dBm, 7x = -66.0 dBm, 8x = -61.4 dBm
	5.1 GHz	1x = -86.0 dBm, 2x = -82.2 dBm, 3x = -78.2 dBm, 4x = -75.4 dBm, 5x = -72.5 dBm, 6x = -69.3 dBm, 7x = -65.5 dBm, 8x = -61.4 dBm
	5.2 GHz	1x = -86.0 dBm, 2x = -82.2 dBm, 3x = -78.2 dBm, 4x = -75.4 dBm, 5x = -72.5 dBm, 6x = -69.3 dBm, 7x = -65.5 dBm, 8x = -61.4 dBm
	5.4 GHz	1x = -86.5 dBm, 2x = -82.0 dBm, 3x = -78.0 dBm, 4x = -75.6 dBm, 5x = -72.6 dBm, 6x = -69.1 dBm, 7x = -66.0 dBm, 8x = -62.0 dBm
	5.8 GHz	1x = -86.5 dBm, 2x = -82.2 dBm, 3x = -77.9 dBm, 4x = -75.9 dBm, 5x = -72.8 dBm, 6x = -69.2 dBm, 7x = -66.2 dBm, 8x = -62.0 dBm

Category		Specification
Nominal Receive Sensitivity (w/ FEC) @ 30 MHz Channel	4.9 GHz	1x = -84.5 dBm, 2x = -80.0 dBm, 3x = -76.2 dBm, 4x = -74.1 dBm, 5x = -70.8 dBm, 6x = -67.7 dBm, 7x = -64.2 dBm, 8x = -59.0 dBm
	5.1 GHz	1x = -84.6 dBm, 2x = -79.8 dBm, 3x = -75.2 dBm, 4x = -73.3 dBm, 5x = -70.2 dBm, 6x = -67.4 dBm, 7x = -64.2 dBm, 8x = -59.0 dBm
	5.2 GHz	1x = -84.6 dBm, 2x = -79.8 dBm, 3x = -75.2 dBm, 4x = -73.3 dBm, 5x = -70.2 dBm, 6x = -67.4 dBm, 7x = -64.2 dBm, 8x = -59.0 dBm
	5.4 GHz	1x = -84.8 dBm, 2x = -79.8 dBm, 3x = -76.0 dBm, 4x = -73.6 dBm, 5x = -71.0 dBm, 6x = -67.5 dBm, 7x = -64.7 dBm, 8x = -59.5 dBm
	5.8 GHz	1x = -84.8 dBm, 2x = -79.8 dBm, 3x = -76.0 dBm, 4x = -73.6 dBm, 5x = -71.0 dBm, 6x = -67.5 dBm, 7x = -64.7 dBm, 8x = -59.5 dBm
Nominal Receive Sensitivity (w/ FEC) @40 MHz Channel	4.9 GHz	1x = -82.9 dBm, 2x = -79.0 dBm, 3x = -75.0 dBm, 4x = -72.4 dBm, 5x = -69.0 dBm, 6x = -65.9 dBm, 7x = -63.0 dBm, 8x = -56.4 dBm
	5.1 GHz	1x = -83.2 dBm, 2x = -79.3 dBm, 3x = -74.5 dBm, 4x = -72.1 dBm, 5x = -69.0 dBm, 6x = -65.9 dBm, 7x = -62.0 dBm, 8x = -57.0 dBm
	5.2 GHz	1x = -83.2 dBm, 2x = -79.3 dBm, 3x = -74.5 dBm, 4x = -72.1 dBm, 5x = -69.0 dBm, 6x = -65.9 dBm, 7x = -62.0 dBm, 8x = -57.0 dBm
	5.4 GHz	1x = -83.6 dBm, 2x = -78.6 dBm, 3x = -75.4 dBm, 4x = -72.4 dBm, 5x = -69.4 dBm, 6x = -66.0 dBm, 7x = -63.5 dBm, 8x = -57.0 dBm
	5.8 GHz	1x = -83.6 dBm, 2x = -78.6 dBm, 3x = -75.4 dBm, 4x = -72.4 dBm, 5x = -69.4 dBm, 6x = -66.0 dBm, 7x = -63.5 dBm, 8x = -57.0 dBm
Performance		
ARQ		Yes
Cyclic Prefix		1/16
Frame Period		2.5 ms or 5.0 ms

Category		Specification		
Modulation Levels (Adaptive)		Modulation Levels		SNR (in dB)
		2x	QPSK	10
		3x	8-QAM	14
		4x	16-QAM	17
		5x	32-QAM	21
		6x	64-QAM	24
		7x	128-QAM	28
		8x	256-QAM	32
Latency		3 - 5 ms		
Maximum Deployment Range		Up to 40 miles (64 km)		
GPS Synchronization		Yes, via Autosync (CMM4)		
Quality of Service		Diffserv QoS		
Link Budget				
Antenna Beam Width		15° azimuth for 16 dBi integrated antenna 30° elevation for 16 dBi integrated antenna		
Antenna Gain	5 GHz	+16 dBi H+V, integrated		
Transmit Power Range		40 dB dynamic range (to EIRP limit by region) (1 dB step)		
Maximum Transmit Power		+27 dBm combined output		
Physical				
Sync/AUX port	RJ45	• 100/1000BASE-T Ethernet Data • PoE output (planned for future release) • Sync input or output (Connection and powering of UGPS Sync input)		
Antenna Connection		50 ohm, N-type (Connectorized version only)		
Surge Suppression EN61000-4-5		EN61000-4-5: 10us/700us, Level 4, 4kV voltage waveform Recommended surge suppressor: Cambium Networks Model # C000000L065A		
Mean Time Between Failure		> 40 Years		
Environmental		IP55		
Temperature / Humidity		-40°C to +60°C (-40°F to +140°F), 0-95% non-condensing		

Category		Specification
Weight	Integrated	Approx. 0.5 kg (1.1 lb. including mounting bracket)
Wind Survival	Integrated	190 km/h (118 mi/h)
Dimension (HxWxD)	Integrated	12.4 x 25.1 x 11.9 cm (4.9" x 9.9" x 4.7")
Power Consumption		9 W nominal, 12 W peak
Input Voltage		20 - 32 V DC,
Mounting		Wall or Pole mount
Security		
Encryption		128-bit AES and 256-bit AES Note AES-256 requires a license key.

Specifications for PMP 450b 5 GHz High Gain Series – SM

The PMP 450b High Gain SM conforms to the specifications listed in below table.

Table 168: PMP 450b High Gain Series – SM specifications

Category		Specification
Model Number		PMP 450b High Gain SM
Spectrum		
Channel Spacing		Configurable in 2.5 MHz increments
Frequency Range		4900 - 5925 MHz
Channel Bandwidth		5, 10, 15, 20, 30, and 40 MHz
Interface		
MAC (Media Access Control) Layer		Cambium Proprietary
Physical Layer		2x2 MIMO OFDM
Ethernet Interface		100/1000BaseT, half/full duplex, rate auto negotiated (802.3 compliant)
Protocols Used		IPv4, UDP, TCP, IP, ICMP, Telnet, SNMP, HTTP, FTP
Network Management		HTTP, HTTPS, Telnet, FTP, SNMP v2c and v3
VLAN		802.1ad (DVLAN Q-in-Q), 802.1Q with 802.1p priority, dynamic port VID

Category		Specification
Sensitivity		
Nominal Receive Sensitivity (w/ FEC) @ 5 MHz Channel	4.9 GHz	1x = -92.0 dBm, 2x = -88.0 dBm, 3x = -84.0 dBm, 4x = -82.0 dBm, 5x = -78.0 dBm, 6x = -75.1 dBm, 7x = -72.5 dBm, 8x = -68.0 dBm
	5.1 GHz	1x = -92.6 dBm, 2x = -88.5 dBm, 3x = -82.6 dBm, 4x = -80.8 dBm, 5x = -77.6 dBm, 6x = -74.2 dBm, 7x = -71.6 dBm, 8x = -66.8 dBm
	5.2 GHz	1x = -92.6 dBm, 2x = -88.5 dBm, 3x = -83.4 dBm, 4x = -80.8 dBm, 5x = -77.6 dBm, 6x = -74.2 dBm, 7x = -71.6 dBm, 8x = -67.0 dBm
	5.4 GHz	1x = -92.6 dBm, 2x = -88.5 dBm, 3x = -84.0 dBm, 4x = -82.3 dBm, 5x = -79.0 dBm, 6x = -75.9 dBm, 7x = -72.3 dBm, 8x = -68.0 dBm
	5.8 GHz	1x = -92.1 dBm, 2x = -87.9 dBm, 3x = -84.3 dBm, 4x = -82.1 dBm, 5x = -79.0 dBm, 6x = -75.4 dBm, 7x = -72.0 dBm, 8x = -68.0 dBm
Nominal Receive Sensitivity (w/ FEC) @ 10 MHz Channel	4.9 GHz	1x = -89.7 dBm, 2x = -84.8 dBm, 3x = -80.7 dBm, 4x = -78.4 dBm, 5x = -75.7 dBm, 6x = -72.0 dBm, 7x = -68.8 dBm, 8x = -64.2 dBm
	5.1 GHz	1x = -90.0 dBm, 2x = -85.3 dBm, 3x = -80.0 dBm, 4x = -78.8 dBm, 5x = -75.2 dBm, 6x = -71.6 dBm, 7x = -69.2 dBm, 8x = -64.8 dBm
	5.2 GHz	1x = -90.0 dBm, 2x = -85.3 dBm, 3x = -80.0 dBm, 4x = -78.8 dBm, 5x = -75.2 dBm, 6x = -71.6 dBm, 7x = -69.2 dBm, 8x = -64.8 dBm
	5.4 GHz	1x = -89.6 dBm, 2x = -85.6 dBm, 3x = -81.0 dBm, 4x = -78.2 dBm, 5x = -75.9 dBm, 6x = -72.4 dBm, 7x = -69.4 dBm, 8x = -65.0 dBm
	5.8 GHz	1x = -89.6 dBm, 2x = -85.6 dBm, 3x = -81.0 dBm, 4x = -78.2 dBm, 5x = -75.9 dBm, 6x = -72.4 dBm, 7x = -69.4 dBm, 8x = -65.0 dBm
Nominal Receive Sensitivity (w/ FEC) @ 15 MHz Channel	4.9 GHz	1x = -88.0 dBm, 2x = -83.7 dBm, 3x = -78.9 dBm, 4x = -76.6 dBm, 5x = -74.0 dBm, 6x = -70.4 dBm, 7x = -67.8 dBm, 8x = -63.0 dBm
	5.1 GHz	1x = -87.8 dBm, 2x = -83.7 dBm, 3x = -78.3 dBm, 4x = -76.6 dBm, 5x = -73.5 dBm, 6x = -70.0 dBm, 7x = -67.5 dBm, 8x = -63.2 dBm
	5.2 GHz	1x = -87.8 dBm, 2x = -83.7 dBm, 3x = -78.3 dBm, 4x = -76.6 dBm, 5x = -73.5 dBm, 6x = -70.0 dBm, 7x = -67.5 dBm, 8x = -63.2 dBm
	5.4 GHz	1x = -88.0 dBm, 2x = -83.5 dBm, 3x = -79.4 dBm, 4x = -76.5 dBm, 5x = -74.0 dBm, 6x = -70.5 dBm, 7x = -67.7 dBm, 8x = -63.0 dBm
	5.8 GHz	1x = -88.0 dBm, 2x = -83.5 dBm, 3x = -79.4 dBm, 4x = -76.5 dBm, 5x = -74.0 dBm, 6x = -70.5 dBm, 7x = -67.7 dBm, 8x = -63.0 dBm

Category		Specification
Nominal Receive Sensitivity (w/ FEC) @ 20 MHz Channel	4.9 GHz	1x = -86.3 dBm, 2x = -81.3 dBm, 3x = -77.2 dBm, 4x = -75.4 dBm, 5x = -72.2 dBm, 6x = -69.0 dBm, 7x = -66.0 dBm, 8x = -61.4 dBm
	5.1 GHz	1x = -86.0 dBm, 2x = -82.2 dBm, 3x = -78.2 dBm, 4x = -75.4 dBm, 5x = -72.5 dBm, 6x = -69.3 dBm, 7x = -65.5 dBm, 8x = -61.4 dBm
	5.2 GHz	1x = -86.0 dBm, 2x = -82.2 dBm, 3x = -78.2 dBm, 4x = -75.4 dBm, 5x = -72.5 dBm, 6x = -69.3 dBm, 7x = -65.5 dBm, 8x = -61.4 dBm
	5.4 GHz	1x = -86.5 dBm, 2x = -82.0 dBm, 3x = -78.0 dBm, 4x = -75.6 dBm, 5x = -72.6 dBm, 6x = -69.1 dBm, 7x = -66.0 dBm, 8x = -62.0 dBm
	5.8 GHz	1x = -86.5 dBm, 2x = -82.2 dBm, 3x = -77.9 dBm, 4x = -75.9 dBm, 5x = -72.8 dBm, 6x = -69.2 dBm, 7x = -66.2 dBm, 8x = -62.0 dBm
Nominal Receive Sensitivity (w/ FEC) @ 30 MHz Channel	4.9 GHz	1x = -84.5 dBm, 2x = -80.0 dBm, 3x = -76.2 dBm, 4x = -74.1 dBm, 5x = -70.8 dBm, 6x = -67.7 dBm, 7x = -64.2 dBm, 8x = -59.0 dBm
	5.1 GHz	1x = -84.6 dBm, 2x = -79.8 dBm, 3x = -75.2 dBm, 4x = -73.3 dBm, 5x = -70.2 dBm, 6x = -67.4 dBm, 7x = -64.2 dBm, 8x = -59.0 dBm
	5.2 GHz	1x = -84.6 dBm, 2x = -79.8 dBm, 3x = -75.2 dBm, 4x = -73.3 dBm, 5x = -70.2 dBm, 6x = -67.4 dBm, 7x = -64.2 dBm, 8x = -59.0 dBm
	5.4 GHz	1x = -84.8 dBm, 2x = -79.8 dBm, 3x = -76.0 dBm, 4x = -73.6 dBm, 5x = -71.0 dBm, 6x = -67.5 dBm, 7x = -64.7 dBm, 8x = -59.5 dBm
	5.8 GHz	1x = -84.8 dBm, 2x = -79.8 dBm, 3x = -76.0 dBm, 4x = -73.6 dBm, 5x = -71.0 dBm, 6x = -67.5 dBm, 7x = -64.7 dBm, 8x = -59.5 dBm
Nominal Receive Sensitivity (w/ FEC) @ 40 MHz Channel	4.9 GHz	1x = -82.9 dBm, 2x = -79.0 dBm, 3x = -75.0 dBm, 4x = -72.4 dBm, 5x = -69.0 dBm, 6x = -65.9 dBm, 7x = -63.0 dBm, 8x = -56.4 dBm
	5.1 GHz	1x = -83.2 dBm, 2x = -79.3 dBm, 3x = -74.5 dBm, 4x = -72.1 dBm, 5x = -69.0 dBm, 6x = -65.9 dBm, 7x = -62.0 dBm, 8x = -57.0 dBm
	5.2 GHz	1x = -83.2 dBm, 2x = -79.3 dBm, 3x = -74.5 dBm, 4x = -72.1 dBm, 5x = -69.0 dBm, 6x = -65.9 dBm, 7x = -62.0 dBm, 8x = -57.0 dBm
	5.4 GHz	1x = -83.6 dBm, 2x = -78.6 dBm, 3x = -75.4 dBm, 4x = -72.4 dBm, 5x = -69.4 dBm, 6x = -66.0 dBm, 7x = -63.5 dBm, 8x = -57.0 dBm
	5.8 GHz	1x = -83.6 dBm, 2x = -78.6 dBm, 3x = -75.4 dBm, 4x = -72.4 dBm, 5x = -69.4 dBm, 6x = -66.0 dBm, 7x = -63.5 dBm, 8x = -57.0 dBm
Performance		
ARQ		Yes
Cyclic Prefix		1/16
Frame Period		2.5 ms or 5.0 ms

Category		Specification		
Modulation Levels (Adaptive)		Modulation Levels	MCS	SNR (in dB)
		2x	QPSK	10
		3x	8-QAM	14
		4x	16-QAM	17
		5x	32-QAM	21
		6x	64-QAM	24
		7x	128-QAM	28
		8x	256-QAM	32
Latency		3 - 5 ms		
Maximum Deployment Range		Up to 40 miles (64 km)		
GPS Synchronization		Yes, via Autosync (CMM4)		
Quality of Service		Diffserv QoS		
Link Budget				
Antenna Beam Width		7° azimuth for 23 dBi integrated antenna 7° elevation for 23 dBi integrated antenna		
Antenna Gain	5 GHz	+23 dBi H+V, integrated		
Transmit Power Range		22 dB dynamic range (to EIRP limit by region) (1 dB step)		
Maximum Transmit Power		+27 dBm combined output (+22 dBm @ 256QAM)		
Physical				
Sync/AUX port	RJ45	• 100/1000BASE-T Ethernet Data • PoE output (planned for future release) • Sync input or output (Connection and powering of UGPS Sync input)		
Antenna Connection		50 ohm, N-type (Connectorized version only)		
Surge Suppression EN61000-4-5		EN61000-4-5: 10us/700us, Level 4, 4kV voltage waveform Recommended surge suppressor: Cambium Networks Model # C000000L065A		
Mean Time Between Failure		> 40 Years		
Environmental		IP67		

Category		Specification
Temperature / Humidity		-40°C to +60°C (-40°F to +140°F), 0-95% non-condensing
Weight	Integrated	Approx. 3.1 kg (7 lb. including mounting bracket)
Wind Survival	Integrated	145 km/h (90 mi/h)
Dimension (HxWxD)	Integrated	47 cm diameter x 28 cm (18.5” diameter x 11.2”)
Power Consumption		9 W nominal, 12 W peak
Input Voltage		20 - 32 V DC,
Mounting		Wall or Pole mount
Security		
Encryption		128-bit AES and 256-bit AES Note AES-256 requires a license key.

Specifications for PMP/PTP 450b 3 GHz High Gain Series – SM/BHS

The PMP/PTP 450b 3 GHz High Gain – SM/BHS conforms to the specifications listed in below table.

Table 169: PMP/PTP 450b 3 GHz High Gain Series specifications

Category		Specification
Model Number		PMP/PTP 450b 3 GHz High Gain – SM/BHS
Spectrum		
Channel Spacing		Customizable channel selection to 50 kHz raster
Frequency Range		3300 – 3980 MHz
Channel Bandwidth		5, 7, 10, 15, 20, 30, and 40 MHz
Interface		
MAC (Media Access Control) Layer		Cambium Networks Proprietary
Physical Layer		2x2 MIMO OFDM
Ethernet Interface		100/1000BaseT, half/full duplex, rate auto negotiated (802.3 compliant)
Protocols Used		IPv4, UDP, TCP, IP, ICMP, Telnet, SNMP, HTTP, FTP
Network Management		HTTP, HTTPS, Telnet, FTP, SNMP v2c and v3

Category		Specification
VLAN		802.1ad (DVLAN Q-in-Q), 802.1Q with 802.1p priority, dynamic port VID
Sensitivity		
Nominal Receive Sensitivity (w/ FEC) @ 5 MHz Channel	3.5 GHz	1x = -93.0 dBm, 2x = -90.1 dBm, 3x = -86.2 dBm, 4x = -83.8 dBm, 5x = -80.3 dBm, 6x = -77.6 dBm, 7x = -73.9 dBm, 8x = -70.1 dBm
	3.6 GHz	1x = -93.0 dBm, 2x = -89.7 dBm, 3x = -85.6 dBm, 4x = -83.0 dBm, 5x = -80.0 dBm, 6x = -76.8 dBm, 7x = -73.0 dBm, 8x = -69.9 dBm
Nominal Receive Sensitivity (w/ FEC) @ 7 MHz Channel	3.5 GHz	1x = -92.0 dBm, 2x = -88.2 dBm, 3x = -84.5 dBm, 4x = -82.2 dBm, 5x = -79.4 dBm, 6x = -76.0 dBm, 7x = -73.0 dBm, 8x = -68.4 dBm
	3.6 GHz	1x = -92.0 dBm, 2x = -87.9 dBm, 3x = -83.6 dBm, 4x = -81.4 dBm, 5x = -78.2 dBm, 6x = -75.4 dBm, 7x = -71.6 dBm, 8x = -67.8 dBm
Nominal Receive Sensitivity (w/ FEC) @ 10 MHz Channel	3.5 GHz	1x = -91.0 dBm, 2x = -87.0 dBm, 3x = -83.0 dBm, 4x = -80.4 dBm, 5x = -77.6 dBm, 6x = -74.4 dBm, 7x = -71.2 dBm, 8x = -67.4 dBm
	3.6 GHz	1x = -90.0 dBm, 2x = -86.0 dBm, 3x = -82.1 dBm, 4x = -80.0 dBm, 5x = -77.0 dBm, 6x = -74.0 dBm, 7x = -70.8 dBm, 8x = -66.7 dBm
Nominal Receive Sensitivity (w/ FEC) @ 15 MHz Channel	3.5 GHz	1x = -89.0 dBm, 2x = -85.1 dBm, 3x = -81.0 dBm, 4x = -79.0 dBm, 5x = -75.6 dBm, 6x = -72.7 dBm, 7x = -69.4 dBm, 8x = -65.9 dBm
	3.6 GHz	1x = -89.0 dBm, 2x = -84.9 dBm, 3x = -80.2 dBm, 4x = -78.1 dBm, 5x = -75.0 dBm, 6x = -71.9 dBm, 7x = -69.0 dBm, 8x = -64.9 dBm
Nominal Receive Sensitivity (w/ FEC) @ 20 MHz Channel	3.5 GHz	1x = -88.0 dBm, 2x = -84.0 dBm, 3x = -80.0 dBm, 4x = -77.8 dBm, 5x = -74.6 dBm, 6x = -71.6 dBm, 7x = -68.5 dBm, 8x = -64.5 dBm
	3.6 GHz	1x = -87.9 dBm, 2x = -83.0 dBm, 3x = -79.0 dBm, 4x = -76.8 dBm, 5x = -74.0 dBm, 6x = -70.2 dBm, 7x = -67.5 dBm, 8x = -63.9 dBm
Nominal Receive Sensitivity (w/ FEC) @ 30 MHz Channel	3.5 GHz	1x = -86.5 dBm, 2x = -82.0 dBm, 3x = -78.2 dBm, 4x = -75.8 dBm, 5x = -72.7 dBm, 6x = -69.6 dBm, 7x = -66.4 dBm, 8x = -62.0 dBm
	3.6 GHz	1x = -86.0 dBm, 2x = -80.8 dBm, 3x = -77.6 dBm, 4x = -74.7 dBm, 5x = -72.0 dBm, 6x = -68.5 dBm, 7x = -65.9 dBm, 8x = -61.5 dBm
Nominal Receive Sensitivity (w/ FEC) @ 40 MHz Channel	3.5 GHz	1x = -85.0 dBm, 2x = -80.7 dBm, 3x = -76.4 dBm, 4x = -74.4 dBm, 5x = -71.6 dBm, 6x = -68.0 dBm, 7x = -65.4 dBm, 8x = -60.0 dBm
	3.6 GHz	1x = -84.2 dBm, 2x = -80.2 dBm, 3x = -76.2 dBm, 4x = -73.4 dBm, 5x = -70.4 dBm, 6x = -67.5 dBm, 7x = -64.5 dBm, 8x = -60.0 dBm
Performance		
ARQ		Yes
Cyclic Prefix		1/16
Frame Period		2.5 ms or 5.0 ms

Category		Specification		
Modulation Levels (Adaptive)		Modulation Levels		SNR (in dB)
		2x	QPSK	10
		3x	8-QAM	14
		4x	16-QAM	17
		5x	32-QAM	21
		6x	64-QAM	24
		7x	128-QAM	28
		8x	256-QAM	32
Latency		3 - 5 ms		
Maximum Deployment Range		Up to 40 miles (64 km)		
GPS Synchronization		Yes, via Autosync (CMM4)		
Quality of Service		Diffserv QoS		
Link Budget				
Antenna Beam Width		12° azimuth for 20 dBi integrated antenna 12° elevation for 20 dBi integrated antenna		
Antenna Gain		+20 dBi H+V, integrated		
Transmit Power Range		40 dB dynamic range (to EIRP limit by region) (1 dB step)		
Maximum Transmit Power		29 dBm combined output (23 dBm @ 256-QAM)		
Physical				
Sync/AUX port	RJ45	• 100/1000BASE-T Ethernet Data • PoE output (planned for future release) • Sync input or output (Connection and powering of UGPS Sync input)		
Antenna Connection		50 ohm, N-type (Connectorized version only)		
Surge Suppression EN61000-4-5		EN61000-4-5: 1.2us/50us, 500 V voltage waveform		
Mean Time Between Failure		> 40 Years		
Environmental		IP67		

Category		Specification
Temperature / Humidity		-40°C to +60°C (-40°F to +140°F), 0-95% non-condensing
Weight	Integrated	Approx. 3.1 kg (7 lb. including mounting bracket)
Wind Survival	Integrated	145 km/h (90 mi/h)
Dimension (HxWxD)	Integrated	47 cm diameter x 28 cm (18.5” diameter x 11.2”)
Power Consumption		9 W nominal, 12 W peak
Input Voltage		20 - 32 V DC,
Mounting		Wall or Pole mount
Security		
Encryption		128-bit AES and 256-bit AES Note AES-256 requires a license key.

Specifications for PMP 450 Series - AP

The PMP 450 AP conforms to the specifications listed in below table.

Table 170: PMP 450 Series - AP specifications

Category		Specification
Model Number		PMP 450 AP
Spectrum		
Channel Spacing		5, 7, 10, 15, 20 and 30 MHz Channel Bandwidth Configurable on 2.5 MHz increments
Frequency Range	2.4 GHz	2400 – 2483.5 MHz
	3.5 GHz	3300 – 3600 MHz
	3.65 GHz	3500 – 3850 MHz
	5 GHz	5470 – 5875 MHz
Channel Bandwidth	3.5 and 3.65 GHz	5, 7, 10, 15, 20 and 30 MHz
	2.4 and 5 GHz	5, 10, 15, 20 and 30 MHz
OFDM Subcarriers		512 FFT
Interface		
MAC (Media Access Control) Layer		Cambium Proprietary

Category		Specification
Physical Layer		2x2 MIMO OFDM
Ethernet Interface		10/100/1000BaseT, half/full duplex, rate auto negotiated (802.3 compliant)
Protocols Used		IPv4, UDP, TCP, IP, ICMP, Telnet, SNMP, HTTP, FTP, TFTP, RADIUS
Network Management		HTTP, HTTPS, Telnet, FTP, SNMP v3, TFTP, Syslog
VLAN		802.1ad (DVLAN Q-in-Q), 802.1Q with 802.1p priority, dynamic port VID
Sensitivity		
Nominal Receive Sensitivity (w/ FEC) @ 5 MHz Channel	900 GHz	1x = -91.9 dBm, 2x = -87.29 dBm, 3x = -83.38 dBm, 4x = -81.34 dBm, 5x = -78.41 dBm, 6x = -75.42 dBm, 7x = -72.46 dBm, 8x = -68.58 dBm
	2.4 GHz	1x = -88.7 dBm, 2x = -85.62 dBm, 3x = -81.14 dBm, 4x = -78.87 dBm, 5x = -75.71 dBm, 6x = -72.71 dBm, 7x = -69.0 dBm, 8x = -65.02 dBm
	3.5 GHz	1x = -91.0 dBm, 2x = -87.0 dBm, 3x = -82.3 dBm, 4x = -79.7 dBm, 5x = -76.7 dBm, 6x = -73.3 dBm, 7x = -70.0 dBm, 8x = -65.8 dBm
	3.65 GHz	1x = -91.0 dBm, 2x = -86.1 dBm, 3x = -82.0 dBm, 4x = -80.0 dBm, 5x = -75.2 dBm, 6x = -72.0 dBm, 7x = -68.8 dBm, 8x = -65.0 dBm
	5.4 GHz	1x = -88.7 dBm, 2x = -84.0 dBm, 3x = -79.0 dBm, 4x = -77.0 dBm, 5x = -74.0 dBm, 6x = -70.9 dBm, 7x = -67.0 dBm, 8x = -63.0 dBm
	5.8 GHz	1x = -88.5 dBm, 2x = -84.0 dBm, 3x = -78.7 dBm, 4x = -76.6 dBm, 5x = -73.7 dBm, 6x = -69.7 dBm, 7x = -66.7 dBm, 8x = -63.0 dBm
Nominal Receive Sensitivity (w/ FEC) @ 7 MHz Channel	900 GHz	1x = -89.31 dBm, 2x = -85.32 dBm, 3x = -82.35 dBm, 4x = -80.35 dBm, 5x = -77.43 dBm, 6x = -74.36 dBm, 7x = -71.53 dBm, 8x = -67.47 dBm
	3.5 GHz	1x = -89.0 dBm, 2x = -86.0 dBm, 3x = -80.8 dBm, 4x = -78.8 dBm, 5x = -75.4 dBm, 6x = -72.0 dBm, 7x = -68.6 dBm, 8x = -64.3 dBm
	3.65 GHz	1x = -89.0 dBm, 2x = -85.0 dBm, 3x = -80.0 dBm, 4x = -78.0 dBm, 5x = -74.5 dBm, 6x = -71.0 dBm, 7x = -67.5 dBm, 8x = -64.0 dBm
Nominal Receive Sensitivity (w/ FEC) @ 10 MHz Channel	900 GHz	1x = -89.47 dBm, 2x = -84.61 dBm, 3x = -81.71 dBm, 4x = -78.77dBm, 5x = -75.82 dBm, 6x = -73.69 dBm, 7x = -70.78 dBm, 8x = -66.76 dBm

Category		Specification
	2.4 GHz	1x = -87.27 dBm, 2x = -83.62 dBm, 3x = -80.36 dBm, 4x = -77.81dBm, 5x = -74.76 dBm, 6x = -71.73 dBm, 7x = -68.79 dBm, 8x = -64.82 dBm
	3.5 GHz	1x = -88.0 dBm, 2x = -84.0 dBm, 3x = -79.8 dBm, 4x = -77.8 dBm, 5x = -74.4 dBm, 6x = -71.0 dBm, 7x = -67.4 dBm, 8x = -63.2 dBm
	3.65 GHz	1x = -88.0 dBm, 2x = -84.0 dBm, 3x = -79.0 dBm, 4x = -77.0 dBm, 5x = -72.8 dBm, 6x = -69.8 dBm, 7x = -66.4 dBm, 8x = -62.0 dBm
	5.4 GHz	1x = -86.1 dBm, 2x = -82.2 dBm, 3x = -76.3 dBm, 4x = -74.6 dBm, 5x = -71.3 dBm, 6x = -68.0 dBm, 7x = -64.3 dBm, 8x = -60.5 dBm
	5.8 GHz	1x = -86.0 dBm, 2x = -82.2 dBm, 3x = -76.0 dBm, 4x = -74.6 dBm, 5x = -71.0 dBm, 6x = -68.0 dBm, 7x = -64.0 dBm, 8x = -60.0 dBm
Nominal Receive Sensitivity (w/ FEC) @ 15 MHz Channel	900 GHz	1x = -88.5 dBm, 2x = -83.56 dBm, 3x = -79.67 dBm, 4x = -75.58 dBm, 5x = -74.66 dBm, 6x = -71.57 dBm, 7x = -68.64 dBm, 8x = -65.61 dBm
	2.4 GHz	1x = -85.39 dBm, 2x = -82.86 dBm, 3x = -77.91 dBm, 4x = -74.87 dBm, 5x = -72.9 dBm, 6x = -69.81 dBm, 7x = -66.94 dBm, 8x = -63.67 dBm
	3.5 GHz	1x = -87.0 dBm, 2x = -82.8 dBm, 3x = -78.7 dBm, 4x = -76.3 dBm, 5x = -72.7 dBm, 6x = -69.8 dBm, 7x = -66.5 dBm, 8x = -62.6 dBm
	3.65 GHz	1x = -86.4 dBm, 2x = -82.6 dBm, 3x = -77.0 dBm, 4x = -76.0 dBm, 5x = -71.5 dBm, 6x = -68.9 dBm, 7x = -65.5 dBm, 8x = -61.5 dBm
	5.4 GHz	1x = -84.2 dBm, 2x = -80.2 dBm, 3x = -75.0 dBm, 4x = -72.9 dBm, 5x = -69.9 dBm, 6x = -66.9 dBm, 7x = -62.9 dBm, 8x = -59.0 dBm
	5.8 GHz	1x = -85.0 dBm, 2x = -80.0 dBm, 3x = -74.6 dBm, 4x = -73.0 dBm, 5x = -69.1 dBm, 6x = -66.4 dBm, 7x = -62.1 dBm, 8x = -58.0 dBm
Nominal Receive Sensitivity (w/ FEC) @ 20 MHz Channel	900 GHz	1x = -86.51 dBm, 2x = -82.51 dBm, 3x = -78.56 dBm, 4x = -75.58 dBm, 5x = -72.61 dBm, 6x = -70.55 dBm, 7x = -67.64 dBm, 8x = -63.54 dBm
	2.4 GHz	1x = -84.22 dBm, 2x = -81.27 dBm, 3x = -77.27 dBm, 4x = -74.73 dBm, 5x = -71.3 dBm, 6x = -68.86 dBm, 7x = -65.29 dBm, 8x = -62.2 dBm
	3.5 GHz	1x = -85.8 dBm, 2x = -81.8 dBm, 3x = -77.4 dBm, 4x = -75.0 dBm, 5x = -71.8 dBm, 6x = -68.8 dBm, 7x = -65.5

Category		Specification
		dBm, 8x = -61.2 dBm
	3.65 GHz	1x = -85.0 dBm, 2x = -81.5 dBm, 3x = -76.9 dBm, 4x = -75.2 dBm, 5x = -70.5 dBm, 6x = -67.0 dBm, 7x = -64.0 dBm, 8x = -61.2 dBm
	5.4 GHz	1x = -83.1 dBm, 2x = -78.9 dBm, 3x = -74.0 dBm, 4x = -72.0 dBm, 5x = -68.7 dBm, 6x = -66.0 dBm, 7x = -62.0 dBm, 8x = -56.8 dBm
	5.8 GHz	1x = -83.0 dBm, 2x = -78.8 dBm, 3x = -73.7 dBm, 4x = -71.8 dBm, 5x = -67.8 dBm, 6x = -64.7 dBm, 7x = -62.8 dBm, 8x = -56.0 dBm
Nominal Receive Sensitivity (w/ FEC) @ 30 MHz Channel	2.4 GHz	1x = -82.16 dBm, 2x = -79.77 dBm, 3x = -75.72 dBm, 4x = -73.31 dBm, 5x = -70.31 dBm, 6x = -67.29 dBm, 7x = -64.31 dBm, 8x = -59.18 dBm
	3.5 GHz	1x = -85.0 dBm, 2x = -80.0 dBm, 3x = -75.8 dBm, 4x = -73.6 dBm, 5x = -69.8 dBm, 6x = -67.0 dBm, 7x = -63.6 dBm, 8x = -59.4 dBm
	3.65 GHz	1x = -83.7 dBm, 2x = -79.5 dBm, 3x = -75.0 dBm, 4x = -73.0 dBm, 5x = -69.0 dBm, 6x = -65.9 dBm, 7x = -62.5 dBm, 8x = -58.0 dBm
	5.4 GHz	1x = -81.0 dBm, 2x = -76.9 dBm, 3x = -72.0 dBm, 4x = -70.1 dBm, 5x = -66.1 dBm, 6x = -64.0 dBm, 7x = -60.1 dBm, 8x = -55.8 dBm
	5.8 GHz	1x = -80.9 dBm, 2x = -76.8 dBm, 3x = -71.8 dBm, 4x = -69.7 dBm, 5x = -66.0 dBm, 6x = -63.5 dBm, 7x = -59.0 dBm, 8x = -55.0 dBm
Performance		
Subscribers Per Sector		Up to 238
ARQ		Yes
Cyclic Prefix		1/16
Frame Period		2.5 ms or 5.0 ms

Category		Specification		
Modulation Levels (Adaptive)		Modulation Levels		SNR (in dB)
		2x	QPSK	10
		3x	8QAM	14
		4x	16QAM	17
		5x	32QAM	21
		6x	64QAM	24
		7x	128QAM	28
		8x	256QAM	32
Latency		3 - 5 ms for 2.5 ms Frame Period 6-10 ms for 5.0 ms Frame Period		
Maximum Deployment Range		Up to 40 miles (64 km)		
Packets Per Second		12,500		
GPS Synchronization		Yes, via CMM3, CMM4 or UGPS		
Quality of Service		Diffserv QoS		
Link Budget				
Antenna Gain (Does not include cable loss, ~1dB)	2.4 GHz	18 dBi Dual Slant		
	3.5 GHz	16 dBi Dual Slant		
	3.65 GHz	16 dBi Dual Slant		
	5 GHz	17 dBi Horizontal and Vertical		
Combined Transmit Power		-30 to +22 dBm (to EIRP limit by region) in 1 dB-configurable intervals (2.4 GHz, 5 GHz) -30 to +25 dBm (to EIRP limit by region) in 1 dB-configurable intervals (3.5 GHz) -30 to +25 dBm (to EIRP limit by region and channel bandwidth) in 1 dB-configurable intervals (3.6 GHz)		
Maximum Transmit Power		• 22 dBm combined OFDM (2.4 GHz, 5 GHz) (dependent upon Region Code setting) • 25 dBm combined OFDM (3.5 GHz, 3.6 GHz), (dependent upon Region Code setting)		
Physical				
Wind Survival		200 mph (322 kph)		
Antenna Connection		50 ohm, N-type (Connectorized version only)		

Category		Specification
Surge Suppression EN61000-4-5		EN61000-4-5: 10us/700us, Level 4, 4kV voltage waveform Recommended surge suppressor: Cambium Networks Model # C000000L065A
Environmental		IP66, IP67
Temperature / Humidity		-40°C to +60°C (-40°F to +140°F) / 0-95% non-condensing
Weight	2.4 GHz	15 kg (33 lbs) with antenna 2.5 kg (5.5 lbs) without antenna
	3.5 GHz	15 kg (33 lbs) with antenna 2.5 kg (5.5 lbs) without antenna
	3.6 GHz	15 kg (33 lbs) with antenna 2.5 kg (5.5 lbs) without antenna
	5 GHz	5.9 kg (13 lbs) with antenna 2.5 kg (5.5 lbs) without antenna
Dimension (HxWxD)	2.4 GHz	Radio: 27 x 21 x 7 cm (10.6” x 8.3” x 2.8”) Antenna: 112.2 x 24.5 x 11.7 cm (44.2” x 9.6” x 4.6”)
	3.5 GHz	Radio: 27 x 21 x 7 cm (10.6” x 8.3” x 2.8”)
	3.6 GHz	Radio: 27 x 21 x 7 cm (10.6” x 8.3” x 2.8”)
	5 GHz	Radio: 27 x 21 x 7 cm (10.6” x 8.3” x 2.8”) Antenna: 51 x 13 x 7.3 cm (20.2” x 5.1” x 2.9”)
Power Consumption		14 W
Input Voltage		22 to 32 VDC
Security		
Encryption		128-bit AES and 256-bit AES Note AES-256 requires a license key.

Specifications for PMP 450 Series - SM

The PMP 450 SM conforms to the specifications listed in below table.

Table 171: PMP 450 Series - SM specifications

Category		Specification
Model Number		PMP 450 SM
Spectrum		
Channel Spacing		5, 7, 10, 15, 20, 30, and 40 MHz Channel Bandwidth Configurable on 2.5 MHz increments
Frequency Range	900 MHz	902 – 928 MHz
	2.4 GHz	2400 – 2483.5 MHz
	3.5 GHz	3300 – 3600 MHz
	3.65 GHz	3500 – 3850 MHz
	5 GHz	5470 – 5875 MHz
Channel Bandwidth	900 MHz,	5, 7, 10, 15, and 20 MHz
	2.4 GHz, 3.5 GHz, 3.65 GHz and 5 GHz	5, 10, 15, 20, 30, and 40 MHz Note: 2.4 GHz band does not support 40 MHz.
OFDM Subcarriers		512 FFT
Interface		
MAC (Media Access Control) Layer		Cambium Proprietary
Physical Layer		2x2 MIMO OFDM
Ethernet Interface		10/100 BaseT, half/full duplex, rate auto negotiated (802.3 compliant)
Protocols Used		IPv4, UDP, TCP, IP, ICMP, Telnet, SNMP, HTTP, FTP
Network Management		HTTP, HTTPS, Telnet, FTP, SNMP v3
VLAN		802.1ad (DVLAN Q-in-Q), 802.1Q with 802.1p priority, dynamic port VID
Sensitivity		