#### Table 54: PMP/PTP 450b BHM Radio attributes - 5 GHz

Device Type						=
Link Mode :	Ba	ckhaul				
	© M	ultipoint				
Timing Mode :	® Tir	ming Master				
	U Ti	ning Slave				
Radio Configuration						
Frequency Band :	5.7 G	Hz 🔻				
Frequency Carrier :	None	*				
Channel Bandwidth :	10 M	Hz 🔹				
Frame Period :	05.0 82.5	0 ms 5 ms				
Cyclic Prefix :	One	Sixteenth				
Color Code :	0	(0-254)				
Sector ID :	0 •	1				
Large Data Channel data Q :	© En	abled				
MAC Control Parameters						E
MIMO Rate Adapt Algorithm :	MIMC	-A/B 🔻				
Downlink Maximum Modulation Rate :	8x *					
Uplink Maximum Modulation Rate :	8x *					
Minimum Modulation Rate :	tx • settin	Bridging will b g	e disabled if the t	transmit mod	tulation rate is	s below this
Frame Configuration						
Downlink Data :	75	% (Range: 18	5 — 85 %)			
Power Control						B
Transmit Power :	16	dBm (Rang	e: -30 - +27 dB	m) (13 dBm)	V / 13 dBm H	0
External Gain Fixed :	16 dE	31		7.00		7
Advanced						E
Receive Quality Debug :	0 Er	abled				
	® Da	sabled				
	OFF	•				
	Choose Legacy Mode setting from the table below based on colocated radio's software revision and sync source:					
Frame Alignment Legacy Mode :	Sync	Src.\ SW Rev.	13.4.1 or higher	12.0 to 13.4 (DFS on)	12.0 to 13.4 (DFS off)	below 12.0
	Timir	ng Port	OFF	OFF	OFF	OFF
	Powe	er Port	OFF	OFF	ON (Mode 1	)OFF

Attribute	Meaning
Link Mode	See PTP 450i BHM Radio page attributes - 5 GHz
Timing Mode	

PDF

Attribute	Meaning
Frequency Band	See PMP 450m Series – configuring radio
Frequency Carrier	
Channel Bandwidth	
Frame Period	
Cyclic Prefix	
Color Code	
Sector ID	
Large Data Channel data Q	
MIMO Rate Adapt Algorithm	
Downlink Maximum Modulation Rate	
Uplink Maximum Modulation Rate	
Minimum Modulation Rate	
Nomadic Mode	
Downlink Data	
Transmitter Power	See PTP 450i BHM Radio page attributes - 5 GHz
External Gain Fixed	This value represents the fixed antenna gain. The fixed antenna gain for Mid-Gain is 16 dBi and High Gain is 23 dBi.
	For ODUs with integrated antenna, this is set at the correct value in the factory.
	For Connectorized ODUs with external antenna, the user must set this value to the overall antenna gain, including any RF cable loss between the ODU and the antenna.
Receive Quality Debug	See PTP 450i BHM Radio page attributes - 5 GHz
Frame Alignment Legacy Mode	See PMP/PTP 450i Series - Configuring Radio

# Radio page - PMP/PTP 450b Mid-Gain/High Gain BHS 5 GHz

The Radio page of PMP 450b BHS is explained in the below table.

Table 55: PMP/PTP 450b BHS Radio attributes - 5 GHz

Device Type							
Link Mode :	# Backhaul						
	© Multipoint						
Timing Mode .	* Timing stayer						
5 A 40 A 4		CTOTAL COLOR					
Radio Configuration							
	100 010	2					
	4.9 GR	2					
	No custom	frequencie	s present.				
	5104	*					
	D. I CAL	*					
	0.5152.5	2.0155.0	# 0157.0	× 5168.0	M 2162.5	10160.0	C \$167.5
	# 5170.0	# 5172.5	# 5175.0	# 5177 5	# 5180 Q	# 5182.5	# 5185.0
	# 5187.5	₹5190.0	# 5192.0	₹ 5195.0	# 5197.5	# 5200.0	# 5202.5
	# 5205.0	# 5207.5	# 5210.0	# 5212.5	# 5215.0	# 5217:5	# 5220.0
	# 5222 5	# 5725.0	₩ 5227.5	# 5230 0	1. 5232 5	1,5235.0	+ 5237 E
	₹ 5240.0	# 5242.5	2.5245.0	# 5247.5			
	12225						
	5.2 GH	ž.					
	1 5252.5	₹.5255.Q	₹ 9257.0	2 5260.0	8.5282.5	1 0265.0	1 5267 5
	in 5270.0	# 5272.5	# 5275.0	# 5277.5	W 5260.0	in 5282.5	# 5285.0
	# 5287.5	# 5290.0	# 5292.8	# 5295 0	₹ 5297.5	# 5300.0	₹ 5302.5
	# 5305.0	# 5307.5	# 5310.0	# 5312.5	W 5315.0	# 5317.5	# 5320.0
	# 5322.5	# 5325.0	₹ 5327.5	₹ 5330.0	2.5332.5	5335.0	+ 5837 5
	1.5340.0	# 6342.5	× 5345.0	1 5547.5			
	5.4 GH	z					
	1 5472.5	+ 5475.0	# 5477.5	2 5400.0	2 8482 5	2.5489.0	1.5487.5
	@ 5490.0	# 5482.5	H 5495.0	# 0497.5	¥ 5560.0	# 5502.5	¥ 5505.0
	# 5507.5	W.5510.0	# 5512.5	# 5515.0	# 5517.5	W 5520.0	# 5522.5
	# 5525.0	# 5527.5	₹ 5530.0	₹ 5532.5	# 5535.0	# 5537.5	# 5540.0
	@ 5542.5	# 5545,0	₹ 5547.5	₹ 5550 0	# 0002.5	0.5555.0	₹ 5557.5
	# 5560.0	# 5562.5	# 5555.0	# 5567.5	# 5570.0	if 5572.5	# 5575.0
	# 5577.5	# 5580.0	# 5582.8	# 5585 0	₹ 5587,5	# 5590.0	# 5592.8
Custom Radio Frequency Scan Selection List	# 5595.0	# 5897.5	# 5600.0	# 5602.5	# 5605.0	W 5607.5	# 5610.0
	# 5612.6	# 5615.0	₹ 5617.5	₹ 5620 0	# 5622.5	# 5625.0	₩ 5627.5
	# 5630.0	# 5632.5	# 5635.0	# 5637.5	₹ 5640.0	# 5542.5	# 5645.0
	in 5647,5	H 5650.0	# 5652.5	# 5655.0	# 5657.5	W 5660.0	H 5662.5
	# 5665.0	# 5667.5	# 5670.0	# 5672.8	# 8675.0	# 5677.5	# 5680.0
	# 5682.5	₹ 5685 0	# 5687.5	# 5690.0	# 5682 5	₩ 5695.0	# 5697.5
	# 5700.0	# 5702.5	# 5705.0	1.5707.5	1 2710.0	10712.0	1 3715 0
	# 5717.5	1 5720.0	# 5722.5				

5.7 GHz						
# 5727 E (# 5730.0) # 5732 5 (# 5735.0) / 5737.5 (# 5740.0) / 5742.5						
#5745.0 #5747.5 #5750.0 #5752.5 #5755.0 #5757.5 #5760.0						
#57625 #57650 #57675 #57700 #57728 #57750 #5777						
# 5780.0 # 5782.5 # 5785.0 # 5787.5 # 5790.0 # 5792.5 # 5795.0						
#57975 #5800.0 #58025 #58050 #58075 #5810.0 #58125						
#5815.0 #5817.5 #5620.0 #5822.5 #5825.0 #5627.5 #5830.0						
# 5832.5 # 5835.0 # 5637.5 # 5840.0 # 5842.5 # 5845.0 # 5847.5						
# 5850.0 # 5852.5 # 5855.0 # 5857.5 # 5860.0 # 5862.5 # 5865.0						
#3867.5 #5870.0 #5872.5 #5675.0 #5877.5 #5880.0 #5882.5						
# 5885.0 # 5887.5 # 5890.0 # 5892.5 # 5895.0 # 5897.5 # 5900.0						
# 5902 5 # 5905 0 # 5907 5 # 5910 0 # 5912 5 # 5915 0 # 5917 5						
# 5920.0 # 5922.5						
S ANTE OFF						
Select All [Select All 4.9.] Bellect All 5.1.] Select All 5.2.] Select All 5.2.						
Beloct Wr.B.7   Diaar AA   Heotore						
# 5 MIC						
# 30 MH2						
# 20 MHz						
# 30 MHz						
# 40 MHz						
One Sideenth						
Chie Divertentit						
(0→254)						

MAC Control Parameters		E Contraction of the second
MIMO Rate Adapt Algorithm :	MIMO-A	VB •
Downlink Maximum Modulation Rate :	8x =	
Uplink Maximum Modulation Rate :	8x =	
Minimum Modulation Rate :	tx • B setting	kridging will be disabled if the transmit modulation rate is below this
Power Control		
Transmit Power :	16	dBm (Range: -30 +27 dBm) (13 dBm V / 13 dBm H)
External Gain Fixed :	16 dBi	
LOI Reference EVM		
Reference Downlink EVM :	0.0	dB
Current Downlink EVM :	-33.9 d	8
Reference Uplink EVM :	0.0	d8
Current Uplink EVM :	-34.1 d	B
Access Point MAC Address :	None	
Channel Frequency :	None	
Channel Bandwidth :	None	
		Populate EVM
Advanced		
Receive Quality Debug :	⊖ Enal ⊛ Disa	bled bled

Attribute	Meaning
Link Mode	See PTP 450i BHM Radio page attributes - 5 GHz
Timing Mode	

Attribute	Meaning	
Custom Radio Frequency Scan Selection List		
Channel Bandwidth Scan		
Cyclic Prefix		
Color Code		
Large Data Channel data Q		
MIMO Rate Adapt Algorithm		
Downlink Maximum Modulation Rate	See PMP 450i SM Radio attributes - 5 GHz	
Uplink Maximum Modulation Rate		
Minimum Modulation rate		
Nomadic Mode		
Transmit Power		
External Gain Fixed	This value represents the fixed antenna gain. The fixed antenna gain for Mid- Gain is 16 dBi and High Gain is 23 dBi.	
	For ODUs with integrated antenna, this is set at the correct value in the factory.	
	For Connectorized ODUs with external antenna, the user must set this value to the overall antenna gain, including any RF cable loss between the ODU and the antenna.	
Reference Downlink EVM		
Current Downlink EVM		
Reference Uplink EVM		
Current Uplink EVM	Refer PMP 450i SM Radio attributes - 5 GHz.	
Access Point MAC Address		
Channel Frequency		
Channel Bandwidth		
Receive Quality Debug		



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.

# PMP/PTP 450 Series - configuring radio

### Radio page - PMP 450 AP 5 GHz

#### The Radio tab of the AP for 5 GHz is as shown in below table.

Table 56: PMP 450 AP Radio attributes - 5 GHz

Device Type			
Device Setting :	* AP		
	© SM		
Radio Configuration	Contract of the second s		
Frequency Band	5.4 OH2 •		
Frequency Cartier	Nore •		
Channel Bandwidth	10 M9-Q *		
Frame Period	© 5.0 ms # 2.5 ms		
Cyclic Prefix :	One Soteenth		
Color Code	0 (0254)		
Subscriber Color Code Rescan (When not on a Primary Color Code)	0 Minutes (0 43200)		
Subscriber Color Code Wait Period for Idle	II Minutes (0 60)		
Installation Color Code	© Enabled		
Sector ID :	1.		
(III) A STATE OF A STA			
MAG Control Parameters (	DIMENT OF		
Downlaw Maximum Modulation Data	No. Contraction of the second se		
Lipins Maximum Modulator Rale	No. Colored States and State		
linmatic Unite	* Enabled		
Contractor moves -	CDisabled		
Frame Configuration			
Max Range	2 miles • (Range 1-40 miles / 64 km)		
Downlink Data	75 % (Range: 15 85 %)		
Contention Slots	3 (Range 1 15)		
Auto Contention	- Enabled		
	# Disabled		
Broadcast Repeat Count :	2 (Range 0 - 2)		
Power Control			
Transmit Power	16 dBm (Range -30+22 dBm) (13 dBm V ) 13 dBm H)		
External Gain	0 dBi (Range: 0 - +40 dBi)		
Stil Receive Target Level	-52 dBm (Range -7737 dBm) combined power		
Address of the second Palances	* Enabled		
Adjacent Checkel Support :	© Disabled		
Mullicast Data Crietral			
Multicast Data Channes	Dualitie •		
Multicast Receat Count	Ranne 0 - 2)		
Multicast Downlink CIR	(kbos) (Banos: 0 - 12182 kbos)		
THE REPORT OF A DESCRIPTION OF A DESCRIP	Contrast Contrasting of the section and the		

Advanced				
SN Registration Limit	238 (Range: 1 - 230)			
Receive Quality Debug :	Enabled     Tisabled			
Frame Alignment Legacy Mode :	Choose Legacy Mode setting from the table below based on colocated rade software revision and sync source Sync Src \ SW Rev 13.4 t or righer 12.0 to 13.4 12.0 to 12.4 Delow 12.0			
	Trauna Port OFF OFF OFF			
	Power Port OFF OFF ON (Mode 1) OFF			
SM Link Test Mode Restriction ;	Enabled .			

Attribute	Meaning	
See PMP 45 450i AP Radio attributes - 5 GHz for all parameters details.		



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 3.65 GHz

#### Figure 37: PMP 450 AP Radio attributes - 3.65 GHz

Device Type			
Device Setting	* AP		
Control County -	© SM		
Padio Configuration	-		
Frequency Carrier :	None	1	
Channel Bandwidth	10 MH	7 •	
	95.0	ms	
Frame Period	# 2.5	ms	
Cyclic Prefix :	One S	lixteenth	
Color Code :	0	(0-254)	
Subscriber Color Code Rescan (When not on a Primary Color Code) :	0	Minutes (0 — 43200)	
Subscriber Color Code Wait Period for Idle :	0	Minutes (0 - 60)	
Installation Color Code	En:	abled abled	
Sector ID	0 .		
MAC Control Parameters	Paral de la		
MIMO Rate Adapt Algorithm	(MMO-4		
Downlink Maximum Modulation Rate	6X V		
uplink Maximum Woddiation Hate	Enal	Ned	
Nomadic Mode :	O Disa	bied	
Frame Configuration	_		
Max Range	1	miles V (Range: 1 - 40 miles / 64 km)	
Downlink Data	75	% (Range: 15 — 85 %)	
Contention Slots :	4	(Range: 1 - 15)	
Auto Contention	OEna	bled	
Auto Comenson .	Disa	bled	
Broadcast Repeat Count	2	(Range: 0 — 2 )	
Co-located Frame Configuration Option	Disable	<u> </u>	
Power Control			
Transmit Power	15	dBm (Range: -30 - +25 dBm) (13 dBm B / 13 dBm A)	
External Gain :	0	dBI (Range: 0 +70 dBi)	
SM Receive Target Level	-52	dBm (Range: -7737 dBm) combined power	
Adjacent Channel Suncort	© Eni	abled	
Ladaceut augurate and barr	@ Dis	abled	
Multicast Data Castrol	-		
Multicast Data Channel	Dischi		
Mullicast Casest Count	Lisable *		
municasi Repeat Count	0	0 (Kange 0 – 2)	
Municast Downlink CIR	0	(Kops) (Range: 0 - 12187 Kbps)	

Advanced	Ξ.				
SM Registration Limit :	238 (Range: 1 - 238)				
Receive Quality Debug :	Enabled     Bisabled				
Frame Alignment Legacy Mode :	Choose Legacy Mode setting from the table below based on colocated radio's software revision and sync source: Sync Src.\ SW Rev. 13.4.1 or higher 12.0 to 13.4 (DFS off) below 12.0				
	Timing Port OFF OFF OFF OFF				
	Power Port OFF OFF ON (Mode 1) OFF				
SM Link Test Mode Restriction :	© Enabled ® Disabled				

Attribute	Meaning
Device Setting	Refer PMP 450m Series - configuring radiofor parameter details
Frequency Band	
Frequency Carrier	
Channel Bandwidth	
Frame Period	
Cyclic Prefix	
Color Code	
Subscriber Color Code Rescan (When not on a Primary Color Code)	
Subscriber Color Code Wait Period for Idle	
Installation Color Code	
Sector ID	
MIMO Rate Adapt Algorithm	
Downlink Maximum Modulation Rate	
Uplink Maximum Modulation Rate	
Nomadic Mode	
Max Range	
Downlink Data	
Contention Slots (a.k.a. Control Slots)	
Auto Contention	
Broadcast Repeat Count	
Co-located Frame Configuration Option	If this 3 GHz sector is operating near other LTE sectors or other 5G- NR sectors on the same channel, it is important to enable this co- location option. This will time shift the PMP frame start to in alignment with the LTE or 5G-NR sector operating in the area. The particular LTE or 5G-NR configurations that Cambium can co-locate with are as follows: • For 2.5 ms PMP frame sizes, colocation with 5G-NR
	configuration DDDSU is possible

Attribute	Meaning
	<ul> <li>For 5 ms PMP frame sizes, colocation with 5G-NR configuration DDDSUUDDDD is possible (shown on the GUI selection as DDDDDDDSUU). The proper number of RF-NR Guard Symbols needs to be selected then also.</li> </ul>
	<ul> <li>For 5 ms PMP frame sizes, colocation with LTE frame configurations 0, 1, and 2 is possible. The special subframe and cyclic prefix configurations need to be selected as well.</li> </ul>
	Note that when an operator decides to disable the <b>Enabled</b> parameter, they may need to adjust the <b>Downlink Data</b> parameter as well, considering its complexity. In situations where 5G-NR is chosen but then quickly disabled, it is advisable to utilize the <b>Undo Unit-Wide Saved Changes</b> option instead.
	<ul> <li>Two more detailed technical documents describing co- location between Cambium Networks PMP sectors, LTE, and 5G-NR sectors can be found here:</li> </ul>
	https://support.cambiumnetworks.com/files/colocationtool/
Transmit Power	Refer PMP 450m Series - configuring radiofor parameter details
External Gain	
SM Receive Target Level	
Adjacent Channel Support	
Multicast Data Channel	
Multicast Repeat Count	
Multicast Downlink CIR	
SM Registration Limit	
Receive Quality Debug	
Frame Alignment Legacy Mode	
SM Link Test Mode Restriction	



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



#### 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.

# P

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

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



### Note

Note

APs that were already configured for co-location prior to System Release 22.0 upgrade see their cyclic prefix defaulted to **Normal** and the **S Frame Configuration** defaulted to 7. This should be checked and changed as needed. Note that there is also a slight possibility that the downlink data percentage might be auto-adjusted based on this SSF value of 7 to an undesired value. This should also be checked and adjusted as needed. These corrections can be done directly on the AP. If a large number of sectors need to be adjusted, a small configuration template can be pushed from cnMaestro. A zip file containing 4 sample templates can be found on the Cambium Networks support site:

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

This zip file contains, in addition to a template that corrects just the special subframe after the upgrade, a template to enable co-location and set the special subframe configuration after the upgrade, a template to enable co-location prior to the upgrade, and a template to disable/backout co-location.

# Radio page - PMP 450 AP 3.5 GHz

Device Type

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

Device Setting :	* AP					
	V SM					
Radio Configuration						
Frequency Carrier	None	•]				
Channel Bandwidth :	10 MHz •					
Frame Period :	© 5.0 ms					
	# 2.5 ms					
Cyclic Prefix	One S	ixteenth				
ubercher Celer Cede Desers (When not an a	0	(0-254)				
Primary Color Code ):	0	Minutes (	0 — 43200)			
Subscriber Color Code Wait Period for Idle	0	Minutes (0 -	- 60)			
nstallation Color Code :	<ul> <li>Ena</li> <li>Dis</li> </ul>	abled				
iector ID	0 -					
IAC Control Darameters					_	
MMO Rate Adapt Alograthm :	(MMA-A					
Jownlink Maximum Modulation Rate	(Br V					
Jplink Maximum Modulation Rate	bv					
formatic Mode	· Enat	bled				
	Disa	bled				
rame Configuration	_					_
ax Rance	1	I mias VI (Ran	ge 1 - 40 miles /	64 km)		
ownink Data	78	% (Ranne 15-	- 85 %)	a contra		
entention State	10	(Ranne 1 - 1	51			
ontention Slote.	()Eeo	hind	"			
uto Contention	Disa	ibied				
roadcast Repeat Count	2 (Rance, 0 - 2)					
o-located Frame Configuration Option	(Onable V)					
Power Control						
ransmit Power :	16	dBm (Rang	e: -30 - +25 dB	im) (13 dBn	1 B / 13 dBm A	
External Gain :	0	dBi (Range	0 - +70 dBi)			
M Receive Target Level	-52	dBm (Rand	ae -7737 dB	m) combine	d power	
diacant Channel Support	0 End	abled				
Aufavent Granner Support.	* Disabled					
Multicast Data Control						
Julticast Data Channel	Dates					
Auticast Repeat Count	10	(Range 0 -	2)			
Authorst Rownlink CID	10	(realing). 0	(Panne 0 _ 12	197 khnci		
Inditicase Downline CIR	10	(woha)	(Malige 0 - 12	tor kopsi		
dvanced						
M Registration Limit	238	(Range 1 -	- 238)			
Leceive Quality Debug	D Ena	ibled				
	* DIS:	abled				
	OFF					
	Choos	e Legacy Mod	le setting from th	ie table belo	w based on co	olocated radio
rame Allonment Legacy Mode	Soliwa	re revision an	a sync source.	12.0 to 13	4 12.0 to 13.4	Sector and a
rame ragiment Legacy Mode .	Sync	Src. I SW Rev	13.4 1 or higher	(DFS on)	(DFS off)	below 12 0
	Timing	Port	OFF	OFF	OFF	OFF
	Power	Port	OFF	OFF	ON (Mode 1	OFF
		100000				
M Link Test Mode Restriction	Enabled					
an ener rest moder to strong the	Disabled					

# AP

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

Device Type				
Device Setting	# AP			
and a start of	0 SM			
Radio Configuration	100 C			
Erequency Carrier	None +			
Channel Bandwidth	10 MHz •			
Frame Period	0 5.0 ms # 2.5 ms			
Cyclic Prefix :	One Sixteenth			
Color Code	(0254)			
Subscriber Color Code Rescan (When not on a Primary Color Code) :	Minutes (0	+3200)		
Subscriber Color Code Wait Period for Idle	Minutes (0 - 6	2)		
Installation Color Code	Enabled Disabled			
Sector ID	2. •			
MAC Control Parameters				
MIMO Rate Adapt Algorithm	WMOAE V			
Downlink Maximum Modulation Rate	(V)			
Uplink Maximum Modulation Rate	L V			
Nomadic Mode :	* Enabled O Duabled			
Frame Configuration				
Max Range	mins . (Rano	r 1 40 miles / 64 km)		
Downlink Data	5 % (Range: 15 -	- 85 %)		
Contention Stats	(Range: 1 - 15	)		
Auto Contention	Enabled			
Broadcast Repeat Count	(Range 0 - 2)			
Power Control				
Transmt Power	8 dBm (Range)	-30 +22 dBmi (13 dBm B / 13 dBm A)		
External Gain :	dBi (Range: 0	+40 dBh		
SM Receive Targel Level	52 dBm (Range	-7737 dBm) combined power		
Multicast Data Control				
Multicast Data Channel	Disatile +			
Mutticast Repeat Count	(Bange 0 - 2)			
Multicast Downlink CIR	(khos) (R	apper 0 - 12187 kbps1		
and a standard a standard and a	(under) (u			

Advanced					
SM Registration Limit :	238 (Range: 1 - 238)				
Receive Quality Debug :	Enabled     Bisabled				
Frame Alignment Legacy Mode :	Choose Legacy Mode setting from the table below based on colocated radio's software revision and sync source:				
	Timing Port	OFF	(DFS on)	(DFS off)	OFF
	Power Port	OFF	OFF	ON (Mode 1)	OFF
SM Link Test Mode Restriction :	© Enabled ® Disabled				

Attribute	Meaning
See PMP/PTP 450i Series - Configuring Radio for al	l parameters details.



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

Radio Configuration							1	
	5.4 GH	z						
	- 8.173 A	8.478 D		- 5400 D	- A483 K		¥ 8487 8	
	2 5 100 0	₩ 5.400 K.	25/55/1	A SART S	# 8800.0	# 65/10 A	# 5505 /S	
	2 5557 5	2 5510.0	W 6612 5	# 5515 D	2 5517 5	2 6520.0	2 5522 5	
	0.2022 5	# 6577 6	# 5530 O	2 5599 5	# 6535 B	E 5537 5	# 5540 0	
	2 6542 5	# 5545 G	£ 5547 5	₩ 5555 O	3 C555 %	R AAAA O	2 5557 S	
	R 5560 D	¥ 5562 5	₹ 5555.0	W 5557 5	# 5570-0	8.5572.5	# 8575 G	
	# 5577.5	¥ 5580.0	¥ 5582 5	₹ 5585.0	# 5587.5	0.0655.%	₹ 5592.5	
	0 2622 N	W 5597.6	# 5500.0	# 5502 5	# 5605.0	R 5607 5	# 5510.0	
	# 5612.5	W 5615.0	# 5517.5	₹ 5520.0	# 5622.5	# 5625.0	# 5627.5	
	¥ 5630 0	₩ 5632 5	# 0535.0	H 5537.5	# \$640.0	# 5642.5	9 5545.0	
	# 5647.5	¥ 5650.0	H 5652 5	# 5555.0	# 5657.5	₹ 5660.0	9.5662.8	
	¥ 5665.0	# 5667 6	# 5670.0	# 5672.5	# 5675.0	# 5677.5	# 5680.0	
	# 5682.5	¥ 5685.0	# 5587.5	# 5690.0	# 5692 5	€ 5695.0	# 5697.5	
	# 5700 C	₹ 5702.5	# 5705 0	- 5707.5	F-5710 0	+ 5712.5	2 5715.0	
	8717.5	5720.0	6722.5					
Custom Radio Frequency Scan Selection List	5.7 GHz							
	5727.6	5730.0	5732 5	× 5735-0	- 6717 5	+ 5740 0	+ 5742 S	
	# 5745.0	# 5747.5	¥-5750.0	# 5752.5	# 5755.0	# 5757.5	# 5760.0	
	# 5762.5	# 5765.0	# 5767.5	# 5770.0	# 5772.5	₹ 5775.0	# 5777.5	
	# 5780.0	# 5782.5	# 5785.0	# 5787.5	# 5790.0	# 5792.5	# 5795.0	
	# 5797.5	₩ 5800.0	# 5802.5	₹ 5805.0	# 5807.5	# 5810.0	₹ 5812.5	
	# 5815.0	# 5817.5	¥ 5820.0	# 5822.5	# 5825.0	K 5827.5	# 5830.0	
	# 5832.5	# 5835.0	# 5537.5	# 5840.0	# 5842.5	₹ 5845.0	# 5847.8	
	W 5850.0	# 5852.5	# 5555.0	# 5857.5	# 5860.0	# 5862.5	# 5865.0	
	₩ 5867.5	₹ 5870.0	# 5872.5	₹ 5675.0	# 5877.5	₩ 5880.0	1.5882.5	
	/ 5665-0	# 5887.5	2.5890.0	5892.5	5695.0	5897 5		
	S MHC say in 10 MHC w15 MHC w29 MHC w39 MHC Hist gratistic	n Bas negari						
	Select All	Select Al 1	A Select	457 Cies	AL Ret	00		
Channer Bandwidth Scan	<ul> <li>Ø 5 MHZ</li> <li>№ 10 MHZ</li> <li>№ 15 MHZ</li> </ul>	1						
	# 20 MHz							
	# 40 MHz	5						

Cyclic Prefix	One Soleenth
AP Selection Method	* Power Level
Color Code 1	Optimize for throughput     (0-254) / Priority Imming +
Installation Color Code	* Enabled © Disatied
Large Data Channel data Q	<ul> <li>Enabled</li> <li>Disabled</li> </ul>
Additional Color Codes	
Color Code :	0 (0-254) / Prionity Frimary • AddModity Color Code   Renova Color Code
Additional Color Codes Table No additional color codes configure	d
MAC Cantrol Parameters	
MIMO Fulle Adapt Algorithm	(MICAT Y)
Downlink Maximum Modulation Rate	
Uplask Maximum Modulation Rate	(h ¥)
tiomatic Mode	Exabled () Dissbled
Power Control	
External Gain !	.0 dBi (Rahoe, 0 +40 dBi)
Enable Max Tx Power :	Enable     Disable
LOI Reference EVM	
Reference Downlink EVM	60 0B
Current Downlink EVM :	-29.3 dB
Reference Uptrix EVM	0.0 05
Current Uplinik EV94	-34.8 dB
Access Point MAC Address	None
Channel Frequency	None
Channel Bandwidth	None Populae EVM
Advanced	
	© Enabled

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			



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.

# Radio page - PMP 450 SM 3.65 GHz

Table 59: PMP 450 SM Radio attributes - 3.65 GHz

Radio Configuration	
	+ 2402 5 + 2405 0 + 2407 5 + 2410 0 + 2412 5 + 2415 0 + 2417 5
	# 2420 0 # 2422 5 # 2425 0 # 2427 5 # 2430 0 # 2432 5 # 2435 0
	#24375 #2440.0 #24425 #24450 #24475 #24500 #24525
	# 2455.0 # 2457.5 # 2450.0 # 2452.5 # 2465.0 # 2467.5 2 2470.0
	124725 124750 124775 124800
Custom Radio Frequency Scan Selection List :	
	S Mett weig
	ex 10 LD C
	and the horizontal second seco
	Red available in this region
	Select All Clear All Restore
	# 6 MHz
Channel Bandwidth Scon	et 10 MHz
Cistoria Strandin Scan	# 10 MHZ
	# 10 MHz
Cyclic Prefix	One Sixteenth
AP Selection Method	(i) Power Level
	* Optimize for Throughput
Color Code 1	0 (0-254) / Phoney Primary *
Installation Color Code	# Enabled
WATER CONTRACTOR	© Enabled
Large Data Channel data Q	# Disabled
Additional Color Codes	and the second
Color Code	0 (0254) / Priority Poinary •
Adv	dModity Color Code Remove Color Cade
Additional Color Codes Table	
No additional color codes configured	
MAC Control Parameters	
MBMO Rate Adapt Algorithm	(BH023 V)
Opvinink Maximum Modulation Rale	
Upinit Maximum Modulation Rate	
Nomadic Mode	Endbied
	The second second
Power Control	
External Gain	0 dBi (Range: 0 +40 dBi)
Enable Max Tx Provel	© Enable
Printer and the second	* Disable
LQI Reference EVM	
Reference Downlink EVM :	0.0 dB
Current Downlink EVM :	-32.8 dB
Reference Uplink EVM :	0.0 dB
Current Uplink EVM :	-29.1 dB
Access Point MAC Address :	None
Channel Frequency :	None
Channel Bandwidth :	None
	Populate EVM
Advanced	
WYBRCOV	© Enabled
Receive Quality Debug :	Disabled

Attribute	Meaning		
Custom Radio Frequency Scan Selection List	Check the frequencies that SM has to scan for AP transmissions. See Radio Frequency Scan Selection List		
See PMP 450i SM Radio attributes - 5 GHz			



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.

## Radio page - PMP 450 SM 3.5 GHz

Table 60: PMP 450 SM Radio attributes - 3.5 GHz

Radio Configuration	- HILL CONTRACTOR AND A CONTRACTOR OF A DESCRIPTION OF A DESCRIPANTE A DESCRIPANTE A DESCRIPANTE A DESCRIPTI					
A 140.000 M 140000	✓ 3305.000					
	₹ 3330.000 ₹ 3335.000 ₹ 3340.000 ₹ 3345.000 ₹ 3350.000					
	# 3355.000 # 3360.000 # 3365.000 # 3370.000 # 3375.000					
	₹ 3380.000 € 3385.000 € 3390.000 € 3396.000 € 3400.000					
	₹ 3405.000 ₹ 3410.000 ₹ 3415.000 ₹ 3420.000 ₹ 3425.000					
	₹3430.000 ₹3435.000 ₹3440.000 ₹3445.000 ₹3450.000					
	# 3455.000 # 3460.000 # 3465.000 # 3470.000 # 3475.000					
	# 3480,000 # 3485.000 # 3490,000 # 3496,000 # 3500.000					
	₹ 3505.000 ₹ 3510.000 ₹ 3515.000 ₹ 3525.000					
Custom Radio Frequency Scan Selection List :	₹3530.000 ₹3535.000 ₹3540.000 ₹3545.000 ₹3550.000					
	# 3555.000 # 3560.000 # 3565.000 # 3570.000 # 3575.000					
	¥ 3580 000 2 3566 000 2 3590 000 2 3590 000					
	STARLE UNIV 447 Marc 415 Marc 415 Marc 425					
Channel Bandwidth Scan :	# 5 MHz # 7 MHz # 10 MHz # 15 MHz # 20 MHz # 30 MHz # 40 MHz					
Cyclic Prefix :	One Sixteenth					
AP Selection Method	© Power Level					
Color Code 1	Optimize for (histograps)     (0-254) / Priority / Penany +					
Installation Color Code	* Enabled					
Large Data Channel data Q	© Enabled					
Additional Color Codes						
Color Code :	a (0-254) / Priority Primary •					

LELIC Side Adard American	MMOLE V				
Descript Macamen Mohalster Date	(In w)				
Update Maximum Modulation Rate	(For				
	# Enabled				
Titimpolic Mode	Constant.				
Power Control					
External Gain :	0 dBi (Range: 0 +70 dBi)				
Enable Max Tx Power	Enable				
Charles and the Control	* Disable				
EQI Reference EVM					
Reference Downlink EVM	00 dB				
Current Downlink EVM	NA				
Reference Uptink EVM	B0 dB				
Current Uplink EVM	NA				
Access Point MAC Address	None				
Channel Frequency	None				
Channel Bandwidth	None				
	Populate EVM				
Advanced					
Bereive Quality Debury	III Enabled				
Receive Quality Debug	* Disabled				

Attribute	Meaning		
Custom Radio Frequency Scan Selection List	Check the frequencies that SM has to scan for AP transmissions. See Radio Frequency Scan Selection List		
See PMP 450i SM Radio attributes - 5 GHz			



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.

# Radio page - PMP 450 SM 2.4 GHz

Table 61: PMP 450 SM Radio attributes - 2.4 GHz

the second s						
	# 2402.5 # 2405.0 # 2407.5 # 2410.0 # 2412.5 # 2415.0 # 2417.5					
	#2420.0 #2422.5 #24250 #2427.5 #2430.0 #2432.5 #2435.0					
	#2437.5 #2440.0 #2442.5 #2448.0 #2447.5 #2450.0 #2452.5					
	#24550 #24575 #24600 #24625 #24650 #24675 #24700					
	24725 #24750 #24775 #24800					
Custom Radio Frequency Scan Selection List.						
	S kärta pelji					
	++ 10 JUPLE					
	fact available in the region					
	Belect All Clear A3 Restore					
	H 5 MHZ					
The second Review Company of Second	# 10 MHz					
Channel banovion scan	W 15 MHz					
	# 30 MHz					
Cyclic Pretix	One Sixteenth					
aD Celection Method	Power Level					
AL SERVICE HENDY	* Optimize for Throughput					
Color Code 1	0 (0-254) / Phonty Primary *					
Installation Color Code	# Enabled					
	P Disacled					
Large Data Channel data Q :	* Dradsed					
Additional Color Codes						
Color Code	(0-254) / Priority Primary *					
Ad	SWindify Color Code Remove Color Code					
MAG Gastral Parameters						
Develop Material Materials						
Uplink Maximum Modulation Rate						
Alexandra dalaria	The first					
	· E19840					
THE THERE WAS TO D	Clisatived					
Provide Control	Charler					
Rower Control	Chabled					
Rower Control External Gain	Giussied     Giussied     G     GBI (Range: 0 +40 dBi)     Enable					
Rower Control External Gain : Enable Max Tx Power	Obasted      Obseted      Obseted					
Rower Control External Gain : Enable Max Tx Power	Obiatived       Obiatived					
Rower Coulmi External Gain : Enable Max Tx Power	Obiabled      Obiabled      Obiabled      Obiabled      Obiable      Obiable					
Rower Control External Gain : Enable Max Tx Power Ol Reference EVM	Obiabled      Obiabled      Obiabled      Obiable      Obiable					
Reference Downlink EVM :	Obiabled      Obiabled      Obiable      Obiable					
Content Downlink EVM :	Obiabled      Obiabled      Obiable      Obiable					
Content Downlink EVM : Current Downlink EVM						
Control Control Enable Max Tx Power  Control Control  Control						
Control Gail:  Control Gail:  Enable Max Tx Power  Control Gail:  Control Gail:  Current Downlink EVM :  Current Uplink EVM :  Curr						
Content of the second						
Content of the second						
Average average  Average average  Average average  Average average average average  Average average average average  Average average average average average  Average average average average average average  Average averag						
Consistent week in the second						
Average week						

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			

# Radio page - PMP 450 SM 900 MHz

Table 62: PMP 450 SM Radio attributes -900 MHz

Radio Configuration						
	904.50 905.00 4 905.50 4 906.00 4 905.50 4 907.00 4 907.50					
	2 908 00 2 908 50 2 909 00 4 909 50 4 910 00 4 910 50 4 911 00					
	#911.50 #912.00 #912.50 #913.00 #913.50 #914.00 #914.50					
	#915.00 #915.50 #916.00 #916.50 #917.00 #917.50 #918.00					
	# 915.50 # 919.00 # 919.50 # 920.00 # 920.50 # 921.00 # 921.10					
	₹ 922.00 ₹ 972.00 ₹ 923.00 ₹ 923.50 ₹ 974.00 ₹ 924.50 934.75					
Custom Radio Frequency Scan Selection List	925.00 925.55					
	State set					
	and the second					
	Fail available in this region					
	Select All Clear All Restrice					
	# 6 MHz					
Channel Bandwidth Scatt	W - 7 MHZ					
delegance: and minister in sector in	R 15 MHz					
Monable Carl	# 20 MHz					
Cyclic Prinfix	Qite Sikteenth					
AP Belection Method	© Power Level					
Color Code 1	0 (0-204) (Priority Plenary +)					
installation Color Code :	* Enabled					
	U Disabled					
Large Data Channel data Q	* Disabled					
Additional Color Codes						
Color Code :	8 (0-254) / Priority Primary •					
Aot	SModity Craw Code   Remove Color Code					
Additional Color Codes Table						
No additional color codes configurest						
MAC Central Parameters	(International Control of Control					
MMAG Rate Adapt Algorithm	UNICAL (V)					
Downers Navionate Modulation Falls						
Water Manager Policies of Park	* Extend					
Internation (1996)	Official					
Power Control	The second se					
External Gain	8 dBi (Range: 0 +40 dBi)					
Enable Max Tx Fower	· Enable					
	T UIDAGHT					

LQI Reference EVM					
Reference Downlink EVM :	0.0 dB				
Current Downlink EVM :	-27.0 dB				
Reference Uplink EVM :	0.0 dB				
Current Uplink EVM :	-34.6 dB				
Access Point MAC Address :	None				
Channel Frequency :	None				
Channel Bandwidth :	None				
	Populate E	EVM			
Advanced					
Receive Quality Debug :	Enabled				
	Disabled				

Attribute	Meaning				
Custom Radio Frequency Scan Selection List					
Channel Bandwidth Scan					
Cyclic Prefix					
AP Selection Method					
Color Code 1					
Installation Color Code					
Large Data Channel data Q					
Color Code					
MIMO Rate Adapt Algorithm					
Downlink Maximum Modulation Rate					
Uplink Maximum Modulation Rate	See PMP 450i SM Radio attributes - 5 GHz.				
Nomadic Mode					
External Gain					
Enable Max Tx Power					
Reference Downlink EVM					
Current Downlink EVM					
Reference Uplink EVM					
Current Uplink EVM					
Access Point MAC Address					
Channel Frequency					
Channel Bandwidth					
Receive Quality Debug					

# Radio page - PTP 450 BHM 5 GHz

Table 63: PTP 450 BHM Radio attributes -5 GHz

Timing Mode :  Radio Configuration  Frequency Band :  Frequency Carrier :  Channel Bandwidth :  Frame Period :  Cyclic Prefix	Timing Master Timing Slave  5.7 GHz   None  5.7 GHz   5.7 GHz  5.7 GHz   5.						
Radio Configuration         Frequency Band :         Frequency Carrier :         Channel Bandwidth :         Frame Period :         Cyclic Prefix :         Optimized (Configuration)	Timing Slave  5.7 GHz ▼  None ▼  10 MHz ▼  5.0 ms  2.5 ms  De Sixteenth						
Radio Configuration         Frequency Band :         Frequency Carrier :         Channel Bandwidth :         Frame Period :         Cyclic Prefix :         Optimized (Configuration)	5.7 GHz						
Frequency Band : Frequency Carrier : Channel Bandwidth : Frame Period : Cyclic Prefix : Cyclic Prefix :	5.7 GHz  None  10 MHz  6.0 ms  2.5 ms  De Sixteenth						
Frequency Carrier : Channel Bandwidth : Frame Period : Cyclic Prefix :	None    None						
Channel Bandwidth : Frame Period : Cyclic Prefix :	10 MHz * © 5.0 ms © 2.5 ms Des Sixteenth						
Frame Period : Cyclic Prefix :	© 5.0 ms # 2.5 ms Des Sixteenth						
Cyclic Prefix : 0	One Sivteenth						
Parla Parla	JHE SIMIEEIIUI						
Color Code :	0 (0-254)						
Sector ID :	0 •						
Large Data Channel data Q :	Enabled     Bisabled						
MAC Control Parameters							
MIMO Rate Adapt Algorithm :	MIMO-A/B V						
Downlink Maximum Modulation Rate :	\$X.*						
Oplink Maximum Modulation Rate :	(3) T						
Minimum Modulation Rate :	1x • Bridging will be disabled if the transmit modulation rate is below this setting						
Frame Cantinuration							
Prame Configuration	The N (Denne) All DE N)						
Downlink Data :	75 (Range: 15 - 85 %)						
Power Control	8						
Transmit Power	16 dBm (Range: -30 - +22 dBm) (13 dBm V / 13 dBm H)						
External Gain :	dBi (Range: 00 - +40 dBi)						
exema our .	obi (Nangel o — 146 dbi)						
Advanced	E,						
Receive Quality Debug :	© Enabled						
Necerre Goony Debug .	* Disabled						
	OFF *						
	Chonse Lenson Mode setting from the table below based on colorated radials						
	software revision and sync source:						
Frame Alignment Legacy Mode :	Sync Src.\ SW Rev. 13.4.1 or higher 12.0 to 13.4 12.0 to 13.4 below 12.0 (DES off)						
	Timing Port OFF OFF OFF						
	Power Port OFF OFF ON (Mode 1) OFF						

Attribute	Meaning
Refer PTP 450i BHM Radio page attributes - 5 GHz	for all parameters details.

# Radio page - PTP 450 BHS 5 GHz

Table 64: PTP 450 BHS Radio attributes -5 GHz

Device Type		380.55					12
Timing Mode	Timing	Master					
	# Timing	Slave					
Radio Configuration							
Padalo Companyation	(1) (1) (1) (1)						
	5.4 GH	z					
	0.0000000000000000000000000000000000000						
	# 5472.5	\$ 5475.0	# 5477.5	\$ 5480.0		5 3485.0	2 5487.5
	¥ 5490.0	# 5492.5	₹ 5495 0	# 5497.5	₹ 5500	0 \$5502.5	₩ 5505.0
	# 5507.5	W 5510.0	€ 5512.5	K 5515.0	₹ 5517	5 8 6520.0	¥ 6522.5
	₹ 5525.0	M 5527.5	# 5530.0	₩ 5532.5	₹ 5535.	0 # 5537.5	₹ 5540.0
	# 5542.5	# 5545.0	# 5547.5	₹ 5550.0	# 5552	5 # 5555.0	₹ 5557.5
	# 5560.0	# 5562.5	# 5565.0	₩ 5567.5	# 5570	0 # 5572.5	# 5575.0
	# 5577.5	# 5580.0	# 5582.5	₩ 5585.0	# 5587	5 ≥ 5590.0	# 5592.5
	× 5595.0	¥ 5597.5	¥ 5500.0	# 5602.5	# 5605	0 # 5607.5	# 5610.0
	₹ 5612.5	₹ 5615.0	₹ 5517.5	# 5620.0	₹ 5622	5 ₹ 5625.0	# 5627.5
	# 5630.0	# 5632.5	₹ 5535.0	R 5637.5	₹ 5640	0 2 5642 5	₹ 5645.0
	# 5647.5	# 5650.0	# 5652.5	₩ 5655.0	₹ 5657.	5 # 5660.0	W 5662.5
	# 5665.0	# 5667.5	# 5670.0	₹ 5672.5	# 5675	0 # 5677.5	# 5680.0
	# 5682.5	# 5685.0	₹ 5587.5	₹ 5690.0	₹ 5692	5 \$ 5695.0	# 5697 5
	₹ 5700.0	# 5702.5	# 5705.0	5707.5	× 5710	0 - 5712.5	1.5715.0
	# 5717.5	2 5720.0	* 5722.5				
Custom Radio Frequency Scan Selection List :	5.7 GH	z					
	# 8727.5	< 5730.0	₹ 5732.5	< 5735.0	₹ 5737	5 4 5740.0	1 5742.5
	# 5745.0	# 5747.5	₹ 5750.0	# 5752.5	# 5755.	0 \$5757.5	₩ 5760.0
	# 5762.5	H 5765.0	# 5767.5	# 5770.0	# 5772.	5 # 5775.0	# 5777.5
	# 5780.0	# 5782.5	# 5785.0	₹ 5787.5	₹ 5790	0 ₹5792.5	₹ 5795.0
	# 5797.5	# 5800.0	# 5802.5	# 5805.0	₹ 5807.	5 # 5810.0	# 5812.5
	# 5815.0	₹ 5817.5	# 5820.0	₩ 5822.5	₹ 5825.	0 # 5827.5	₹ 5830.0
	₹ 5832.5	₹ 5835.0	# 5837.5	€ 5840.0	₹ 5842	5 1 5845.0	≥ 5847.5
	# 5850.0	# 5852.5	# 5855.0	# 5857.5	¥ 5860	0 25862.5	≤ 5865.0
	¥ 5867.5	¥ 5870.0	₹ 5872.5	€ 5875.0	₹ 5877.	5 16880.0	Y 5882.5
	r 5885 0	2 5887.5	₹ 5890.0	# 5892.5	₹ 5895	0 1 5897.5	7
	5 MHz one in 10 MHz (~15 MHz =20 MHz =30 MHz						
	list available	in Ris ragion					
	Select Alt	Select All 5	4 Select A	a 5.7 Ciec	e All Ro	etore	

LQI Reference EVM	
Power Control Transmit Power : External Gain :	16         dBm (Range: -30 — +22 dBm) (13 dBm V / 13 dBm H)           0         dBi (Range: 0 — +40 dBi)
MAC Control Parameters MIMO Rate Adapt Algorithm : Downlink Maximum Modulation Rate : Uplink Maximum Modulation Rate : Minimum Modulation Rate :	MIMO-A/B   MIMO-A/B  K  K  K  K  K  K  K  K  K  K  K  K  K
Cyclic Prefix : Color Code : Large Data Channel data Q :	One Sixteenth 0 (0254) © Enabled ® Disabled
Channel Bandwidth Scan :	# 5 MHz # 10 MHz # 15 MHz # 20 MHz # 30 MHz # 40 MHz

Refer PTP 450i BHS Radio attributes - 5 GHz 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 Frequency Scan Selection List**

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

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

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

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

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

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

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

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

### **Dedicated Multicast Data Channel**

A Multicast Data Channel allows to configure multicast packets to be transmitted over a dedicated channel at a configurable rate of 2X, 3X, 4X, 5X or 6X. This feature is available only for the PMP 450 and PMP 450i and is not backward compatible with PMP 430 series of radios.

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

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

# P

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

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



### Note

Note

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

Table 65: Example for mix of multicast and unicast traffic scenarios

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

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

#### Figure 39: Data Channel statistics

and the second second in	and and the second	indound Districts			Outpoond Statistics					-Gueue -	14(27			
Contraction of the	Subscripe) [100] Charnel Pounty	Committee of	0,00000	COURSE (MIL	recent pins	(mcash)	(errors)	- potenti	ucanit pide	incar pre	discard)		Overflow Curry	
9/1-10 110 222 10	007	Low	2331271	12968	44	0	0 1	66206853	12664	0	0	0	0	2830
CONTRACTOR OF STREET,	003	Low	617.9975	3957	83.	0	4	214436	2150	0	0	ā.	g	83
2/0-10 110 212 12	004	Low.	487028	2618	81	0	0	233167	1922	0	0	0	0 1	794
Ferro-10 (10 221 U	E-005-1	Low.	7670	4		0	0	171136	1358	0	0	a	0	172
2010/10/110 233 11	005	Medium	0	0.1	0	0	4	0	0. 3	0	0	0 · · ·	0	0
1010-10-000 000 001	008	High	0	18	B	11	0	0	0	0	4	a	0	D
Letro 10 110 213 12	1.00%	stea High:	221880	2878	81	1	0.1	00(30	62/9	0	0.	0	8	626
visition and	261	14A .	NA.	544	NUM	NA.	NA I	0	0	0	0	0.	745.	TAA
Excashion)	258	144	FAA.	564	NA .	944	NA I	1720190	0	11383	0	0	544	104

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

Figure 40: Multicast scheduler statistics

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

# **Custom Frequencies page**

Note

In addition to the Radio tab, AP/SM/BH has another tab called Custom Frequencies as shown in 450 Platform Family AP/SM/BH Custom Frequencies page - 5 GHz.

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



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

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

Custom Frequencies Configurat	ion 📃
Custom Frequency Configuration	4950.000 MHz ( Range: 4902.500 - 4997.500 MHz )
Add Frequency R	temove Frequency Add Default Frequencies Remove All Custom Frequencies
Custom Frequencies	E
Number of Custom Frequencies :	12
4905.000 MHz	
4910.000 MHz	
4915.000 MHz	
4920.000 MHz	
4925.000 MHz	
4930.000 MHz	
4935.000 MHz	
4940.000 MHz	
4945.000 MHz	
4950.000 MHz	
4980.000 MHz	
4990.001 MHz	

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

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

Custom Frequencie	es Configuration			
Custom Frequency	Configuration :	000.000	MHz ( Range: 3552.500	) — 3797.500 MHz )
l	Add Frequency	Remove Free	quency Default Frequencies	
Custom Frequencie	es			
Number of Custom	Frequencies :	27		
3552.500 MHz				
3554.500 MHz				
3555.000 MHz				
3564.100 MHz				
3564.200 MHz				
3564.500 MHz				
3652.500 MHz				
3655.000 MHz				
3657.500 MHz				
3660.000 MHz				
3662.500 MHz				
3665.000 MHz				
3667.500 MHz				
3670.000 MHz				
3672.500 MHz				
3675.000 MHz				
3677.500 MHz				
3680.000 MHz				
3682.500 MHz				
3685.000 MHz				
3687.500 MHz				
3690.000 MHz				
3692.500 MHz				
3695.000 MHz				
3697.500 MHz				
3700.000 MHz				
(3750.000 MHZ				

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

Table 68: PMP/PTF	450 SM/BH Custo	om Frequencies pag	e - 3.5 GHz
-------------------	-----------------	--------------------	-------------

Custom Frequencies Configuration
Custom Frequency Configuration : D000.000 MHz (Range: 3302.500 — 3597.500 MHz )
Add Frequency Remove Frequency Default Frequencies
Custom Frequencies
Number of Custom Frequencies : 66
3302.500 MHz
3302.501 MHz
3302.555 MHz
3302.600 MHz
3302.655 MHz
3305.000 MHz
3310.000 MHz
3315.000 MHz
3320.000 MHz
3325.000 MHz
3330.000 MHz
3335.000 MHz
3340.000 MHz
3345.000 MHz
3350.000 MHz
3355.000 MHz
3360.000 MHZ
3355.000 MHZ
3370.000 MHZ
3375.000 MHZ
3380.000 MHZ
2200.000 MHz
2205.000 MHz
2410 000 MHz
5410.000 WI12

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

# **DFS for 5 GHz Radios**

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

- Country Code
- Primary Frequency

- Alternate 1 and Alternate 2 Frequencies
- External Antenna Gain

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

Figure 41: AP DFS Status

Current DFS Status		
Primary RF Carrier Frequency :	Active, 5485 Mhz, Normal Transmit	
Alternate RF Carrier Frequency 1 :	Standby, 5570 Mhz, Available for use	
Alternate RF Carrier Frequency 2 :	Standby, 5585 Mhz, Available for use	
DFS Detections :	0	
DES Event History		
DFS Evenic History		

Time: 01/01/2011 : 04:39:52 UTC Event: Channel Availability Check, Freq: 5485 MHz Time: 01/01/2011 : 04:40:58 UTC Event: Start Transmit, Freq: 5485 MHz

## **DFS operation**

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

The details of DFS operation for each Country Code, including whether DFS is active on the AP, SM, and which DFS regulations apply is shown in Country & Bands DFS setting.

# **Contention slots**

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

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



Figure 42: Frame structure

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

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

#### **Random access**

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

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

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

Table 69: Throughput penalty per modulation

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

### Selection of contention slots parameter

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

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

The System Release 16.1 introduces Auto Contention Slots that usually eliminates the need to configure optimal number of contention slots. When this feature is enabled, AP dynamically adjusts the number of contention slots resulting in improved uplink performance.

However, if using Nomadic Mode, in some cases it might be desirable to disable the Auto contention feature to increase the number of contention slots in use. The Nomadic Mode feature is introduced with System Release 21.0 and is supported for all AP/BHM types except 450m.



Auto Contention Slots feature is not currently supported on PMP 450m AP.



### Note

Note

Contention Slots configuration parameter is used to determine the number of Downlink/Uplink+Contention slots in a Frame. Therefore, there is no need to change Contention Slots parameter, unless AP's Tx/Rx configuration is changed which should be consistent for the entire site for co-location.

### Number of SMs in a sector

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

Table 70: Contention slot settings

Number of SMs	Controls Slots recommendation	Control Slots Recommendation
	2.5 ms	5.0 ms
1 to 10	3	3
11 to 50	4	8
51 to 150	6	12
151 and above	8	15



### Note

The above table has been updated with the System Release 22.0 documentation release to suggest the higher number of contention slots for 5.0 ms frame configurations. This documentation revision is not because of any software changes, but due to a more careful analysis of recent field and test data.

## Type of traffic in a sector

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

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

### **Recommendation on Contention Slots number selection**

- 1. Calculate the number of active SMs in the sector.
- 2. Evaluate the traffic mix that is expected in the sector, more specifically the expected percentage of real-time traffic (ex. VoIP, gaming, video conferencing, and video surveillance).
- 3. If the expected amount of real-time traffic is small, select the number of contention slots according to Contention slot settings.
- 4. If the expected amount of real-time traffic is large, select a number of contention slots larger than the number in Contention slot settings.
- 5. Monitor latency in your system. If the percentage of real-time traffic increases and the sector experiences increasing latency and SM-servicing issues, increase the number of contention slots from the current setting.

This is the reason why the maximum number of contention slots is 15, even if Table 2 shows 8 contention slots for more than 150 data channels. If the number of data channels is more than 150 and a significant portion of the traffic is real-time, the frequency with which bandwidth request messages are transmitted requires a higher number of contention slots, potentially as high as 15. A sector with a high number of video surveillance cameras would also require a larger number of contention slots to reduce the probability of collision between requests.

6. Monitor the percentage of BW requests successfully received and the UL frame utilization: if the frame utilization is high (close to 100%), then it is not recommended to change the number of contention slots, even if the percentage success rate of BW requests is low. However, if the percentage success rate of BW requests is low and the frame utilization is also low, then increasing the number of contention slots is recommended.

## **Cluster of APs**

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



Note

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

### Frame calculator for co-location

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

#### **Basic rules**

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

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

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

#### **Steps for co-location**

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

- 1. Obtain all configuration settings for the APs that do not change parameters (duty cycle, contention slots, max distance)
- 2. Input these configuration parameters into the OFDM Frame Calculator tool found under "Tools".
- 3. Click "Calculate"
- 4. Note the following values from the results:
  - AP Antenna Receive Start: \_\_\_\_\_\_
  - AP Antenna Transmit End: \_\_\_\_\_\_
- 5. Access the AP that needs to have a different contention slots setting and use the frame calculator tool found under "Tools"
- 6. Input the configuration parameters for this AP (same duty cycle and max distance as the other APs, different contention slots)
- 7. Click "Calculate"
- 8. Note the following values from the results:
  - AP Antenna Receive Start: \_\_\_\_\_\_
  - AP Antenna Transmit End: \_\_\_\_\_\_
- 9. Check that the two following equations are both true:
  - AP2 Receive Start > AP1 Transmit End
  - AP1 Receive Start > AP2 Transmit End
- 10. If one or both equations are not true, adjust the duty cycle until they become true (or the max distance if possible).

#### **Example**

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

AP1:

Max range: 2 miles

Contention slots: 3

DL duty cycle = 75%

AP2:

Max range: 2 miles

Contention slots: 3

DL duty cycle = 80%

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

#### **Cambium co-location tool**

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

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

		Rel	case 15.1.1		
Devic	a 1 Configuration		Device	2 Configuration	
Active	PMP		Made	PMP	10
Darred Baschvidth (MHz)	20	A CONTRACTOR OF	Channel Bandwelth (MIN)	20	1
Max Range (mil	1		Maxi flarge (mil	1	
		101010			
		Cont.			6 40
Sowiek Data	75%		Duer/Wit Date	80%	1000
Contantien stats	3		Contention Bots		-
name Parrost (ms)	2.5	And and a second se	Franter Period (mt)	2.5	and the second
		and the second se	in the second se		and the other
Device 1 Timing	1000	PROFESSION .	Device 3 Timing ()	(ms)	100001
M. mail	2.644		OL end	1.741	And and
A start	1.797		LTL istant	1.694	
DL/UL symbols	61/30		DL/UL symbols	65/16	
U.A.I./Total Throogenst (Mbps)	98.3/31.1/129.4		DL/UL/Tutal Throughput (Mhph)	104.9/24.8/129.5	

### **MIMO-A** mode of operation

450 Platform Family supports MIMO-B mode using the following modulation levels: QPSK, 8-QAM, 16-QAM, 32-QAM, 64-QAM, 128-QAM and 256-QAM. System Release 13.2 introduces MIMO-A mode of operation using the same modulation levels as the MIMO-B mode. With MIMO-B, the radio sends different streams of data over the two antennas whereas with MIMO-A, the radio uses a scheme that tries to optimize coverage by transmitting the same data over both antennas. This redundancy improves the signal to noise ratio at the receiver making it more robust, at the cost of throughput.

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

Table	71.	150	Diatform	Eamily	Modulation	lovola
Iane	7.6.5	+50	Flation	ranny	riouulation	IEVEI3

Rate	MIMO-B	MIMO-A
QPSK	2X MIMO-B	1X MIMO-A
8-QAM	3X MIMO-B	
16-QAM	4X MIMO-B	2X MIMO-A
32-QAM	5XMIMO-B	

Rate	MIMO-B	MIMO-A
64-QAM	6X MIMO-B	3X MIMO-A
128-QAM	7X MIMO-B	
256-QAM	8X MIMO-B	4X MIMO-A

#### **System Performance**

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

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

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

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

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

Table 72: Co-channel Interference per (CCI) modulation level

Modulation of Victim	Modulation of Interferer	Channel BW (MHz)	CCI
1X (QPSK MIMO-A)	6X (64-QAM MIMO-B)	5, 7, 10, 15, 20, 30, or 40	7 dB
2X (16-QAM MIMO-A)	6X (64-QAM MIMO-B)	5, 7, 10, 15, 20, 30, or 40	14 dB
3X (64-QAM MIMO-A)	6X (64-QAM MIMO-B)	5, 7, 10, 15, 20, 30, or 40	22 dB
4X (256-QAM MIMO-A)	6X (64-QAM MIMO-B)	5, 7, 10, 15, 20, 30, or 40	30 dB
2X (QPSK MIMO-B)	6X (64-QAM MIMO-B)	5, 7, 10, 15, 20, 30, or 40	10 dB
3X (8-QAM MIMO-B)	6X (64-QAM MIMO-B)	5, 7, 10, 15, 20, 30, or 40	13 dB
4X (16-QAM MIMO-B)	6X (64-QAM MIMO-B)	5, 7, 10, 15, 20, 30, or 40	17 dB
5X (32-QAM MIMO-B)	6X (64-QAM MIMO-B)	5, 7, 10, 15, 20, 30, or 40	21 dB
6X (64-QAM MIMO-B)	6X (64-QAM MIMO-B)	5, 7, 10, 15, 20, 30, or 40	25 dB
7X (128-QAM MIMO-B)	6X (64-QAM MIMO-B)	5, 7, 10, 15, 20, 30, or 40	29 dB
8X (256-QAM MIMO-B)	6X (64-QAM MIMO-B)	5, 7, 10, 15, 20, 30, or 40	33 dB

Table 73: Adjacent Channel Interference (ACI) per modulation level

Modulation of Victim	Modulation of Interferer	Channel BW (MHz)	ACI	Guard Band
1X (QPSK MIMO-A)	6X (64-QAM MIMO-B)	5, 7, 10, 15, 20, 30, or 40	-16 dB	None
2X (QPSK MIMO-B)	6X (64-QAM MIMO-B)	5, 7, 10, 15, 20, 30, or 40	-16 dB	None
3X (8-QAM MIMO-B)	6X (64-QAM MIMO-B)	5, 7, 10, 15, 20, 30, or 40	-16 dB	None
4X (16-QAM MIMO-B)	6X (64-QAM MIMO-B)	5, 7, 10, 15, 20, 30, or 40	-16 dB	None
5X (32-QAM MIMO-B)	6X (64-QAM MIMO-B)	5, 7, 10, 15, 20, 30, or 40	-16 dB	None

Modulation of Victim	Modulation of Interferer	Channel BW (MHz)	ACI	Guard Band
6X (64-QAM MIMO-B)	6X (64-QAM MIMO-B)	5, 7, 10, 15, 20, 30, or 40	-16 dB	None
7X (128-QAM MIMO-B)	6X (64-QAM MIMO-B)	5, 7, 10, 15, 20, 30, or 40	-13 dB	None
8X (256-QAM MIMO-B)	6X (64-QAM MIMO-B)	5, 7, 10, 15, 20, 30, or 40	-10 dB	None

#### **Guard Band**

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

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

Adjacent	Channel	Support :
0.0000110101		

0	Enabled
	Disabled

### Improved PPS performance of 450 Platform Family

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

Through hardware and software enhancements, the PPS performance of the PMP 450i Series AP and PMP 450b SM has been improved to more than 100,000 packets/second, measured through a standard RFC2544 test using 64 bytes packets. With this enhancement, operators are able to provide higher bandwidth including better VoIP and video services to end customers using existing SM deployments.

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

# Setting up SNMP agent

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

- SNMPv2c
- SNMPv3

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

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

Table 74: LAN1 Network Interface Configuration tab of IP page attributes

LAN1 Network Interface Configuration	
IP Address :	169.254.1.1
Network Accessibility :	Public
	Eccal     Eccal
Subnet Mask :	255.255.255.0
Gateway IP Address :	169.254.0.0
DHCP state :	Enabled
	Oisabled     O
DHCP DNS IP Address	Obtain Automatically
	Set Manually
Preferred DNS Server :	10.120.10.12
Alternate DNS Server :	10.120.10.13
Domain Name :	example.com

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

Attribute	Meaning
DNS IP Address	Canopy devices allow for configuration of a preferred and alternate DNS server IP address either automatically or manually. Devices must set DNS server IP address manually when DHCP is disabled for the management interface of the device. The default DNS IP addresses are 0.0.0.0 when configured manually.
Preferred DNS Server	The first address used for DNS resolution.
Alternate DNS Server	If the Preferred DNS server cannot be reached, the Alternate DNS Server is used.
Domain Name	The operator's management domain name may be configured for DNS. The domain name configuration can be used for configuration of the servers in the operator's network. The default domain name is example.com, and is only used if configured as such.

# **Configuring SNMP**

Note

The SNMP page configuration is explained below.



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

### SNMP page - AP/SM/BHM/BHS

The SNMP page is explained in below table.

Table 75: SNMP page attributes

SNMPv2c Settings		E
SNMP Community String 1 :	Canopy	
ONNO Community String 1 Dominstoos	Read Only	
Share Community String T Permissions .	Read / Write	
SNMP Community String 2 (Read Only) :	Canopyro	

Engine ID  Engin Engine ID  Engine ID  Engine ID  Engine ID  Engine ID  Engin	SNMPv3 Settings		
SIMIPV3 Security Level:       auth.priv         SIMIPV3 Authentication Protocol       nd5 *         SIMIPV3 Read-Only User       Usemame Canocyco         SIMIPV3 Read-Only User       Authorization Key         Privacy Key       Privacy Key         SIMIPV3 User1       Usemame         Vername       Enable R/W User         Usemame       Onsable R/W User         SIMIPV3 Read/Write User       Usemame         Vername       Disable R/W User         Usemame       Disable R/W User         Vername       Usemame         Vername       Enable R/W User         Vername       Enable R/W User         Vername       Enable R/W User         Vername       Enable User         Vername       Enable User         Vername       Enable User         Read/Write User       Read/Write User         Read/Write User       Enable User         Vername       Enable User         Vername       Enable User         Read/Write User       Enable User         Additional SIM/Pv3 User3 :       Authorization Key         Privacy Key       Read/Write User         Read/Write User       Enable User         Read/Write User       Ena	Engine (D	890000a1030a003e4586f9	
SMMPV3 Authentication Protocol       nd5 •         SMMPV3 Authentication Protocol       do: des •         SMMPV3 Read-Only User       Authorization Key •         SMMPV3 Read-Only User       Privacy Key •         SMMPV3 Read-Wirtle User       ® Enable R/W User         SMMPV3 Read/Wirtle User       ® Enable R/W User         SMMPV3 Read/Wirtle User       © Enable R/W User         SMMPV3 Read/Wirtle User       © Enable R/W User         SMMPV3 Read/Wirtle User       Username         Username       © Enable User         Additional SMMPV3 User1       Authorization Key         Additional SMMPV3 User2       Read/Wirte User         @ Enable User       © Enable User         @ ReadOnly User       © Enable User         Additional SMMPV3 User2       Privacy Key         Read/Wirte User       © Enable User         @ ReadOnly User       © Enable User         Additional SMMPV3 User3       Authorization Key         Privacy Key       Read/Wirte User         @ Enable User       Read/Wirte User         @ Enable User       © Enable User         Additional SNMPV3 User3       Privacy Key         Read/Wirte User       © Enable User         @ Read/Wirte User       © Enable User         <	Engine to 2	Use Default Engine ID	
SINUPV3 Authentication Protocol     mds •       SINUPV3 Privacy Protocol     dbcdss •       SINUPV3 Read-Only User     Usemame Cincopyco       Privacy Key     Privacy Key ••••••••••••••••••••••••••••••••••	SNMPv3 Security Level	auth,priv 💌	
SIMIPv3 Protocol dc-der • Usemame Canapye SIMIPv3 Read-Only User Privacy Key •••••••• SIMIPv3 Read/Write User Privacy Key ••••••••• Additional SIMIPv3 User1 Additional SIMIPv3 User2 Additional SIMIPv3 User3 Additional SIMIPv3 User3	SNMPv3 Authentication Protocol	nd5 🔹	
SNMPv3 Read-Only User     Username Gnooyeo       Privacy Key     Privacy Key       Privacy Key     Disable RW User       Disable RW User     Username Gnooy       Authorization Key     Privacy Key       Privacy Key     Privacy Key       Privacy Key     Privacy Key       Additional SNMPv3 User1     Username       Privacy Key     Privacy Key       BeadWrite User     Beadonic User       Additional SNMPv3 User1     Authorization Key       Privacy Key     Privacy Key       ReadWrite User     ReadWrite User       Brable User     ReadWrite User       Brable User     ReadWrite User       Privacy Key     Privacy Key       ReadWrite User     ReadWrite User       ReadWrite User     ReadWrite User       ReadWrite User     ReadWrite User	SNMPv3 Privacy Protocol	cbc-des 💌	
SNMPv3 Read-Only User       Authorization Key         Privacy Key <ul> <li>Enable RW User</li> <li>Disable RW User</li> <li>Disable RW User</li> <li>Disable RW User</li> <li>Disable RW User</li> <li>Username</li> <li>Enable User</li> <li>Authorization Key</li> <li>Enable User</li> <li>Additional SNMPv3 User1</li> <li>Authorization Key</li> <li>Read/Write User</li> <li>Brable User</li> <li>Disable User</li> <li>Disable User</li> <li>Disable User</li> <li>Disable User</li> <li>Disable User</li> <li>Disable User</li> <li>Brable User</li> <li>Brable User</li> <li>Brable User</li> <li>Brable User</li> <li>Disable User</li> <li>ReadWrite User</li> <li>Brable User</li> <li>ReadWrite User</li> <li>Brabled User</li> <li>Brable</li></ul>		Usemame Canopyro	
Pinkty Key         ShMPy3 Read/Write User         Disable R/W User         Disable R/W User         Username         Pinkty Key         Additional ShMPv3 User1         Additional ShMPv3 User2         Vermane         Enable User         Read/Write User         Pinkacy Key         Read/Write User         Beable User         Additional ShMPv3 User2         Additional ShMPv3 User3         Additional ShMPv3 User3         Additional ShMPv3 User3	SNMPv3 Read-Only User	Authorization Key	
		Privacy Key ++++++++++++++++++++++++++++++++++	
SNMPv3 Read/Write User User Userame Gnoov Authorization Key Privacy Key Usemame Enable User Boable User Doable User Doable User Bead/Write User Bead/Write User Bead/Write User Bead/Write User Boable User Doable User Doable User Doable User Doable User Doable User Bead/Write User		Enable R/W User	
SNMPv3 Read/Write User     Username Conoy Authorization Key       Privacy Key     Privacy Key       Additional SNMPv3 User1     Username       Additional SNMPv3 User1     Authorization Key       Additional SNMPv3 User1     Privacy Key       Read/Write User     Read/Write User       Bread/Only User     Disable User       Additional SNMPv3 User2     Username       Enable User     Disable User       Additional SNMPv3 User2     Authorization Key       Privacy Key     Read/Write User       Bread/Only User     Username       Enable User     Disable User       Additional SNMPv3 User2     Authorization Key       Privacy Key     Read/Write User       Bread/Only User     Username       Enable User     Read/Write User       Bread/Only User     Username       Privacy Key     Read/Write User       Bread/Only User     Disable User       Additional SNMPv3 User3     Authorization Key       Privacy Key     Read/Write User       Bread/Only User     Privacy Key       Privacy Key     Read/Write User       Bread/Only User     Privacy Key       Privacy Key     Read/Write User       Bread/Write User     Read/Write User       Bread/Write User     Read/Write User		C Disable R/W User	
Additional SNMPv3 User1 Additional SNMPv3 User2 Additional SNMPv3 User3 Additi	SNMPv3 Read/Write User :	Username Canopy	
Privacy Key       Username         Username       Enable User         Daable User       Daable User         Additional SNMPv3 User1       Authorization Key         ReadWrite User       ReadWrite User         ReadWrite User       ReadWrite User         Daable User       Daable User         Additional SNMPv3 User2       Username         Privacy Key       Privacy Key         ReadWrite User       ReadWrite User         ReadWrite User       Daable User         Daable User       Daable User         Daable User       Daable User         Daable User       Daable User         Daable User       Privacy Key         ReadWrite User       ReadWrite User         ReadWrite User       ReadWrite User         ReadWrite User       ReadWrite User         ReadWrite User       ReadWrite User         ReadWrite		Authorization Key +++++++	
Additional SNMPv3 User1  Additional SNMPv3 User1  Additional SNMPv3 User1  Additional SNMPv3 User2  Additional SNMPv3 User2  Additional SNMPv3 User3  Additional SNMPv3 Use		Privacy Key	
Additional SNMPv3 User1 Authorization Key Privacy Key ReadOnly User Additional SNMPv3 User2 Authorization Key Privacy Key ReadOnly User Additional SNMPv3 User2 Authorization Key Privacy Key ReadOnly User Username Enable User ReadOnly User		Usemanie	
Additional SNMPv3 User1 Additional SNMPv3 User1 Additional SNMPv3 User1 Additional SNMPv3 User2 Additional SNMPv3 User2 Additional SNMPv3 User3 Additi		CEnable User	
Additional SNMPv3 User1 Authorization Key Privacy Key Privacy Key ReadWrite User ReadOnly User Usemame Enable User Disable User Additional SNMPv3 User2 Authorization Key Privacy Key ReadWrite User ReadOnly User Usemame Enable User Disable User ReadOnly User Usemame ReadOnly User Disable User ReadOnly User Usemame ReadOnly User Disable User ReadOnly User Disable User ReadOnly User Disable User ReadWrite User ReadOnly User Privacy Key ReadWrite User ReadOnly User ReadWrite User ReadOnly User Disable User ReadWrite User ReadWrite User ReadWrite User ReadWrite User ReadWrite User ReadWrite User ReadOnly User		Disable User	
Privacy Key         Read/Write User         @ Read/Only User         Username         @ Enable User         Additional SNMPv3 User2         Additional SNMPv3 User3         Additional SNMPv3 User3         Additional SNMPv3 User3         Read/Write User         @ Disable User         Additional SNMPv3 User3         Authorization Key         Privacy Key         @ Read/Write User	Additional SNMPv3 User1	Authorization Key	
ReadWrite User         @ ReadOnly User         Usemame         @ Enable User         Additional SNMPv3 User2         Additional SNMPv3 User3         Additional SNMPv3 User3         Additional SNMPv3 User3         Additional SNMPv3 User3         ReadWrite User         @ ReadOnly User         Usemame         @ ReadOnly User         Disable User         @ Disable User         Additional SNMPv3 User3         Additional SNMPv3 User3         Authorization Key         Privacy Key         @ ReadWrite User         @ Disable User         Authorization Key         Privacy Key         @ ReadWrite User		Privacy Key	
Image: Construction of Construction       Image: Construction         Image: Construction       Image:		ReadWrite User	
Additional SNMPv3 User3 Additi		ReadOnly User	
Additional SNMPv3 User2 Authorization Key Privacy Key ReadWrite User ReadOnly User Usemane Usemane Disable User Disable User Disable User ReadVirte User		Usemame	
Additional SNMPv3 User2 Authorization Key Privacy Key ReadWrite User ReadOnly User Usemane Enable User Disable User Disable User Disable User ReadOnly User Enable User ReadOnly User ReadOnly User ReadOnly User		C Enable User	
Additional SNMPv3 User2 Authorization Key Privacy Key Privacy Key ReadWrite User ReadOnly User Username Enable User Disable User Disable User Disable User Disable User Privacy Key ReadWrite User ReadOnly User ReadOnly User		Disable User	
Additional SNMPv3 User3 : Authorization Key Privacy Key Privacy Key Privacy Key Privacy Key Privacy Key ReadOnly User	Additional SNMPv3 User2	Authorization Key	
Additional SNMPv3 User3 : Authorization Key Privacy Key ReadOnly User		Privacy Key	
		ReadWrite User	
Additional SNMPv3 User3 : Useration Key Privacy Key ReadOnly User		ReadOnly User	
Additional SNMPv3 User3 Disable User Additional SNMPv3 User3 Authorization Key Privacy Key Read/Write User BeadOnly User		Usemane	
Additional SNMPv3 User3 Authorization Key Privacy Key ReadWrite User BreadOnly User		Enable User	
Additional SNMPv3 User3 : Authorization Key Privacy Key ReadWrite User		Disable User	
Privacy Key ReadWrite User ReadOnly User	Additional SNMPv3 User3	Authorization Key	
Read/inte User     Bead/only User		Privacy Key	
BeadOnly User		ReadWrite User	
Distance Constantion Destant		ReadOnly User	
priverso inspiration . Dispire (*)	SNMPv3 Trap Configuration :	Disabled ·	

SNMP Accessing Addresses			2
Accessing IP / Subnet Mask 1	0.0.0.0	/ 0	
Accessing IP / Subnet Mask 2	0.0.0.0	/ 0	
Accessing IP / Subnet Mask 3	0.0.0.0	/ 0	
Accessing IP / Subnet Mask 4 :	0.0.6.0	/ 0	
Accessing IP / Subnet Mask 5	0.0.0.0	/ 0	
Accessing IP / Subnet Mask 6	0.0.0.0	1 0	
Accessing IP / Subnet Mask 7 :	0.0.0.0	/ 0	
Accessing IP / Subnet Mask 8	0.0.0.0	/ 0	
Accessing IP / Subnet Mask 9 :	0.0.0.0	/ 0	
Accessing IP / Subnet Mask 10	0.0.0.0	10	
Accessing IP / Subnet Mask 6 Accessing IP / Subnet Mask 7 Accessing IP / Subnet Mask 8 Accessing IP / Subnet Mask 9 Accessing IP / Subnet Mask 10	0.0.0.0	/ 0 / 0 / 0 / 0 / 0	

Trap Addresses		
SNMP Trap Server DNS Usage	<ul> <li>Append DNS Domain Name</li> <li>Disable DNS Domain Name</li> </ul>	
Trap Address 1	0.0.0.0	
Trap Address 2	0.0.0.0	
Trap Address 3	0.0.0.0	
Trap Address 4	0.0.0.0	
Trap Address 5	0.0.0,0	1
Trap Address 6	0.0.0.0	
Trap Address 7	0.0.0.0	
Trap Address 8	0.0.0.0	1
Trap Address 9	0.0.0.0	
Trap Address 10	0.0.0.0	

Trap Enable		
Sync Status :	Enabled Disabled	
Session Status	Enabled Obsabled	

LQI Traps	
LQI Traps :	Enabled Disabled
LQI threshold to raise trap (delta from reference LQI value) :	30
LQI threshold to clear trap (delta from reference LQI value) :	25
Minimum observation period :	1 Minutes (Range : 1 — 15 Minutes)

Site Information	
Site Information Viewable to Guest Users	Enabled
1	Disabled
Site Name :	sucessful
Site Contact :	No Site Contact
Site Location :	No Site Location

Attribute	Meaning
SNMP Community String 1	Specify a control string that can allow a Network Management Station (NMS) to access SNMP information. No spaces are allowed in this string. The default string is Canopy.
SNMP Community String 1 Permissions	You can designate the SNMP Community String 1 to be the password for WM, for example, to have Read / Write access to the module via SNMP or for all SNMP access to the module to be Read Only.
SNMP Community String 2 (Read Only)	Specify an additional control string that can allow a Network Management Station (NMS) to read SNMP information. No spaces are allowed in this string. The default string is Canopyro. This password will never authenticate a user or an NMS to read/write access.

Attribute	Meaning
	The Community String value is clear text and is readable by a packet monitor. Additional security derives from the configuration of the Accessing Subnet, Trap Address, and Permission parameters.
Engine ID	The Engine ID may be between 5 and 32 hex characters. The hex character input is driven by RFC 3411 recommendations on the Engine ID. The default Engine ID is the MAC address of the device
SNMPv3 Security Level	Specify security model where users are defined and authenticated before granting access to any SNMP service. Each device can configure the security level of SNMPv3 to No authentication/No privacy, Authentication/No privacy, or Authentication/Privacy.
SNMPv3 Authentication Protocol	<ul><li>The SNMPv3 authentication protocol is supported with:</li><li>MD5</li><li>SHA-1</li></ul>
	• SHA-256
SNMPv3 Privacy	The SNMPv3 privacy protocol is supported with:
Protocol	<ul><li>CBC-DES</li><li>CFB-AES</li></ul>
SNMPv3 Read- Only User	This field allows for a read-only user per devices. The default values for the Read- Only users is:
	Username = Canopyro
	<ul> <li>Authentication Password = authCanopyro</li> <li>Privacy Password = privacyCanopyro</li> </ul>
SNMPv3 Read/Write	Read-write user by default is disabled. The default values for the Read/Write users is:
User	Username = Canopy
	Authentication Password = authCanopy
Additional SNMP v3 User 1	• Privacy Password – privacy canopy This field allows to configure the Additional SNMP v3 User 1. The configurations include:
	<ul> <li>Enable/Disable User: These fields allow to enable or disable the user using the Enable User or Disable User radio buttons.</li> </ul>
	<ul> <li>Authorizaton Key: This field allows to configure an authorization key for the user.</li> </ul>
	• Privacy Key: This field allows to configure a privacy key for the user.
	Note Set SNMP v3 Security Level field to: auth, priv to enable the Authorization Key and Privacy Key fields.

Attribute	Meaning	
	Enabled User can be set with following privacy settings:	
	ReadWrite User	
	ReadOnly User	
Additional	This field allows to configure the Additional SNMP v3 User 2.	
SIMP VS User 2	The configurations include:	
	<ul> <li>Enable/Disable User: These fields allow to enable or disable the user using the Enable User or Disable User radio buttons.</li> </ul>	
	<ul> <li>Authorizaton Key: This field allows to configure an authorization key for the user.</li> </ul>	
	• Privacy Key: This field allows to configure a privacy key for the user.	
	Note	
	Set SNMP v3 Security Level field to: auth, priv to enable the Authorization Key and Privacy Key fields.	
	Enabled User can be set with following Privacy settings:	
	ReadWrite User	
	ReadOnly User	
Additional	This field allows to configure the Additional SNMP v3 User 3.	
SIMP V3 User 3	The configurations include:	
	<ul> <li>Enable/Disable User: These fields allow to enable or disable the user using the Enable User or Disable User radio buttons.</li> </ul>	
	<ul> <li>Authorizaton Key: This field allows to configure an authorization key for the user.</li> </ul>	
	• Privacy Key: This field allows to configure a privacy key for the user.	
	Note	
	Set SNMP v3 Security Level field to: auth, priv to enable the Authorization Key and Privacy Key fields.	
	Enabled User can be set with following Privacy settings:	
	<ul><li>ReadWrite User</li><li>ReadOnly User</li></ul>	
SNMPv3 Trap Configuration	When enabling transmission of SNMPv3 traps the read-only or read-write user credentials must be used and selected properly in order for the SNMP manager to correctly interpret the traps. By default transmission of SNMPv3 traps is disabled and all traps sent from the radios are in SNMPv2c format.	
Accessing IP / Subnet Mask 1 to 10	Specify the addresses that are allowed to send SNMP requests to this AP. The NMS has an address that is among these addresses (this subnet). You must enter both	
	The network IP address in the form xxx.xxx.xxx.xxx	

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

Attribute	Meaning
LQI threshold to clear trap (delta from reference LQI value)	It is configured in percentage. The LQI trap is cleared if the LQI values goes above the configured threshold to clear trap from reference LQI. For example, if the LQI threshold to clear trap is set as 25, the LQI trap will be clear once the LQI goes above 75% (100-25).
Minimum observation period	It is minimum observation period to raise and clear the traps after LQI threshold. It can be configured between 1 to 15 minutes.
Site Information Viewable to Guest Users	Operators can enable or disable site information from appearing when a user is in GUEST account mode.
Site Name	Specify a string to associate with the physical module. This parameter is written into the sysName SNMP MIB-II object and can be polled by Wireless Manager or an NMS. The buffer size for this field is 128 characters.
Site Contact	Enter contact information for the module administrator. This parameter is written into the sysContact SNMP MIB-II object and can be polled by Wireless Manager or an NMS. The buffer size for this field is 128 characters.
Site Location	Enter information about the physical location of the module. This parameter is written into the sysLocation SNMP MIB-II object and can be polled by Wireless Manager or an NMS. The buffer size for this field is 128 characters.

# **Configuring syslog**

450 Platform Family includes:

- Syslog event logging
- Configuring system logging

# Syslog event logging

Following events are logged in syslog as explained in below table.

Table 76: Syslog parameters

Attribute	Meaning
Timestamp	All syslog messages captured from the radio have a timestamp.
Configuration Changes	This includes any device setting that has changed and includes the old or new parameter value, including the device reboots.
User Login and Logout	Syslog records each user login and logout, with username.
Add or Delete of user accounts through GUI and SNMP	Syslog captures any user accounts that are added or deleted.
Spectrum Analysis	Syslog records a message every time Spectrum Analysis runs.

Attribute	Meaning	
	(P	Note Since the AP/BHM must be set to a SM/BHS for Spectrum Analysis, syslog messages are not reported from the radio until the scan is done and the radio mode is switched back to AP/BHM.
Link Test	Syslog recor	rds a message every time a Link Test is run.
Clear Statistics	Syslog sends individually f	s a message when Statistics are cleared. This is done for each statistics page that is cleared.
SM Register or De-register	Syslog recor	ds a message when a SM registers or deregisters.
BHS Connect or Disconnect	Syslog recor	ds a message when a BHS connects or disconnects.

### **Configuring system logging**

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

### Syslog page of AP/BHM

The Syslog Configuration page for AP/BHM is shown in below table.

Table 77: Syslog Configuration attributes - AP

Syslog Server Configuration		8
Syslog DNS Server Usage :	Append DNS Domain Name     Spisable DNS Domain Name	
Syslog Server :	0.0.0	
Syslog Server Port :	514 Default port number is 514	
		_
Syslog Transmission		=
AP Syslog Transmit :	<ul> <li>○ Enabled</li> <li>❀ Disabled</li> </ul>	
SM Syslog Transmit :	<ul> <li>○ Enabled</li> <li>❀ Disabled</li> </ul>	
		_
Syslog Level		
Syslog Minimum Level :	info 🗸	

Attribute	Meaning
Syslog DNS Server Usage	To configure the AP/BHM to append or not append the DNS server name to the syslog server name.
Syslog Server	The dotted decimal or DNS name of the syslog server address.
Syslog Server Port	The syslog server port (default 514) to which syslog messaging is sent.
AP Syslog Transmit	When enabled, syslog messages are sent from the AP/BHM.
Or BHM Syslog Transmit	

Attribute	Meaning
SM Syslog Transmit	When enabled, syslog messages are sent from all the registered SMs/BHS, unless they are individually set to override this.
Or BHS Syslog Transmit	
Syslog Minimum Level	This provides a selection for the minimum syslog message severity that is sent to the syslog server. Values range from fatal (highest severity and least verbose) to info (lowest severity, maximum verbosity).
	For example: If the Syslog Minimum Level is set to notice, then only messages with severity notice and above are sent.

# Syslog page of SM

To configure system logging, select the menu option Configuration > Syslog. The Syslog Configuration page is shown in below table.

Figure 43: Syslog Configuration attributes - SM

AP preferred, use local when AP configuration unavailable Local only
<ul> <li>Append DNS Domain Name</li> <li>Disable DNS Domain Name</li> </ul>
0.0.0.0
514 Default port number is 514

Syslog	Transmission
Syslog	Transmission :

Obtain from AP, default disabled 🔻

Syslog Level	
Syslog Minimum Level Source :	<ul> <li>AP preferred, use local when AP configuration unavailable</li> <li>Local only</li> </ul>
Syslog Minimum Level :	info 🔻

Attribute	Meaning
Syslog Configuration Source	This control determines whether the SM will attempt to use the syslog server definition from the AP, or whether it will use a local server definition.
	When set to AP preferred, use local when AP configuration unavailable, and if the SM can register with an AP, then it uses the syslog server defined on that AP. If the SM cannot register then it will syslog to its locally defined syslog server through its wired connection, if any.
	When set to Local only the SM ignores the AP's definition of the syslog server and allows the syslog server to be configured individually for each SM.
Syslog DNS Server Usage	To configure the SM to append or not the DNS server name to the syslog server name.

Attribute	Meaning
Syslog Server	The dotted decimal or DNS name of the syslog server address.
Syslog Server Port	The syslog server port (default 514) to which syslog messaging is sent.
Syslog Transmission	Controls the SMs ability to transmit syslog messages. When set to "Learn from AP" the AP will control whether this SM transmits syslog messages. When set to "enable" or "disable" the SM will control whether it sends syslog messages. This allows an operator to override the AP settings for individual SMs in a sector.
Syslog Minimum Level Source	This control determines whether the SM attempts to use the minimum syslog level defined by the AP, or whether it uses a local defined value using the "Syslog Minimum Level" parameter.
	When set to "AP preferred, use local when AP configuration unavailable", and if the SM can register with an AP, then it uses the Syslog Minimum Level defined on that AP. If the SM cannot register then it uses its own Syslog Minimum Level setting.
	When set to "Local only" the SM will always use its own Syslog Minimum Level setting and ignores the AP's setting.
Syslog Minimum Level	This provides a selection for the minimum syslog message severity that is sent to the syslog server. Values range from fatal (highest severity and least verbose) to info (lowest severity, maximum verbosity).
	For example: If the Syslog Minimum Level is set to notice, then only messages with severity notice and above are sent.

# Syslog page of BHS

The Syslog Configuration page is shown in below table.

Table 78: Syslog Configuration attributes - BHS

Syslog Server Configuration		E
Syslog Configuration Source :	BHM preferred, use local when BHM configuration unavailable Local only	
Syslog DNS Server Usage :	<ul> <li>Append DNS Domain Name</li> <li>Disable DNS Domain Name</li> </ul>	
Syslog Server :	0.0.0.0	
Syslog Server Port :	514 Default port number is 514	
Syslog Transmission Syslog Transmission :	obtain-from-BHM-default-disabled	B
Syslog Level		E)

Sysiog Level		
Syslog Minimum Level Source :	BHM preferred, use local when BHM configuration unavailable Local only	
Syslog Minimum Level :	info 🔻	J

Attribute	Meaning
Syslog Configuration Source	This control determines whether the BHS will attempt to use the syslog server definition from the BHM, or whether it will use a local server definition.
	<ul> <li>When set to BHM preferred, use local when BHM configuration unavailable, and if the BHS can register with a BHM, then it uses the syslog server defined on that BHM. If the BHS cannot register then it will syslog to its locally defined syslog server through its wired connection, if any.</li> <li>When set to Local only the BHS ignores the BHM's definition of the syslog server and allows the syslog server to be configured individually for each BHS.</li> </ul>
Syslog DNS Server Usage	To configure the BHS to append or not to append the DNS server name to the syslog server name.
Syslog Server	The dotted decimal or DNS name of the syslog server address.
Syslog Server Port	The syslog server port (default 514) to which syslog messaging is sent.
Syslog Transmission	Controls the BHSs ability to transmit syslog messages. When set to Learn from BHM the BHM will control whether this BHS transmits syslog messages. When set to enable or disable the BHS will control whether it sends syslog messages. This allows an operator to override the BHM settings for individual BHSs in a sector.
Syslog Minimum Level Source	This control determines whether the BHS attempts to use the minimum syslog level defined by the BHM, or whether it uses a local defined value using the Syslog Minimum Level parameter.
	• When set to BHM preferred, use local when BHM configuration unavailable, and if the BHS can register with a BHM, then it uses the Syslog Minimum Level defined on that BHM. If the BHS cannot register then it uses its own Syslog Minimum Level setting.
	When set to Local only the BHS will always use its own Syslog Minimum Level setting and ignores the BHM's setting.
Syslog Minimum Level	This provides a selection for the minimum syslog message severity that is sent to the syslog server. Values range from fatal (highest severity and least verbose) to info (lowest severity, maximum verbosity).
	For example: If the Syslog Minimum Level is set to notice, then only messages with severity notice and above are sent.

# **Configuring remote access**

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

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

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

Figure 44: AP Session Status page

General Status	Session Status	Remote Subscr	ibers Event Log Ne	twork Interface Layer 2 Neighbors	
	Home → Session Status				
	5.4GHz MIN	IO OFDM	- Access Point - 0a	-00-3e-a1-35-75	
Session Statu Show Idle Ses	us Configuration	* E 0 [	Enabled Disabled		
Session List Tools       Last Session Counter Reset :     None       Reset Session Counters       Last Time Idle SMs Removed :     None       Remove Idle SMs					
Session Statu Data :	us List <u>Session</u> vice Session	Status.xml Po	wer Configuration		
LUID: 002 - No Site Nar	Subscriber [0a-00-3e-a0-a0-66] ne	Hardware PMP 450	Software Version CANOPY 14.1.1	n FPGA Version 110615 (DES, Sched, US/ETSI) P	

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

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

Figure 45: AP Remote Subscribers page

#### Home → Remote Subscribers

5.4GHz MIMO OFDM - Access Point - 0a-00-3e-bb-00-fb

Rer	mote Subscriber Modules	E
01	1. <u>Site Name - [0a-00-3e-bb-01-04] - LUID: 002</u>	

# Monitoring the Link

### Link monitoring procedure

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

To monitor the link for performance, follow these instructions:

Procedure 14 Monitoring the AP-SM link

1	Access the web interface of the AP/BHM			
2	In the left-side menu of the AP/BHM interface, select Home.			
3	Click the Session Status Figure 46: Session Statu	tab. Js page		
	Session Status Configuration Show Idle Sessons	* Enabled © Disabled		=
	Sestion List Tools Last Session Counter Reset Last Time Idle SMit Removed	Norm Reset Sessed C Norm Retract Mark	urters	
	Session Status Lint Data Device Beauer	SessionStatus and Power Conlegation		=
	Subscriber	Harttware Software Version	FPGA Vintion	State
	LUID_002 - [0a-00-3e-b2-c6-an] SM_01	PMP 450 CANOPY 15.0	061716 (DES, Sched, US/ETSI) P11	(Encrypt Disabled)
	LUID: 003 - 104-00-36-ti2-ch-00 SM_04	PMP 450 CANOPY 15.0	001716 (DES, Scheit, US/ETSI) P11	(Encrypt-Disabled)
	LUID_004-30-00-30-02-(5-11) 5M_05	PMP-450 CANOPY 15.0	061710 (DES, Sched, US/ETSI) P11	IN SESSION (Encrypt Disabled)
	LUID.005-10a-00-39.02-62-64 SNL02	PMP 450 CANOPY 15.0	061710 (DES, Scheid, US/ETSI) P11	(Encrypt Dnabled)
	LUID_006 [0w 00.3e.b2.60.fb] SM_12	PMP 450 CANOPY 15 D	061710 (DES, Schwid, US/ETSI) P11	IN SESSION (Encrypt Disabled)
	LUID 007 [0:00.3e-b2<7.14] SM_12	PMP 450 CANOPY 15.0	061716 (DES, Sched, US/ETSI) PT1	IN SESSION (Encrypt Disabled)
4	The Device tab of Sessic Hardware, Software Ver Click Session Count tab Re-Reg Count.	on Status List display all d sion, FPGA Version and S of Session Status List to o	isplayed SMs - MAC address itate display values for Session Cc	;, PMP/PTP ount, Reg Count, and
	<ul> <li>Session Count: Th AP/BHM. Typicall internal calculatic</li> <li>Reg Count: When session database SM/BHS is not cu request incremen</li> <li>Re-Reg Count: W session database SM/BHS is curren</li> </ul>	his field displays how mar by, this is the sum of Reg ( on may display here as a v a SM/BHS makes a Regi to see whether it was reg rrently in session databas ts the value of this field. hen a SM/BHS makes a R to see whether it was reg tly in session database, th	by sessions the SM/BHS has I Count and Re-Reg Count. Ho ralue that slightly differs from stration Request, the AP/BH gistered earlier. If the AP/BH be and it is valid Registration registration Request, the AP/ gistered earlier. If the AP/BH men the request increments t	had with the owever, the result of n the sum. M checks its local M concludes that the Request, then the /BHM checks its local M concludes that the the value of this field.

	Typically, a Re-Reg is the case where both
	• SM/BHS attempts to reregister for having lost communication with the AP/BHM.
	• AP/BHM has not yet observed the link to the SM/BHS as being down.
	See Session tab.
6	Click Power tab of Session Status list to display Downlink Rate, AP Rx Power (dBm), Signal Strength Radio (dB) for Uplink and Signal to Noise Radio (dB) for Uplink.
	See Power tab.
7	<ul> <li>Click Configuration tab of Session Status list to get QoS configuration details:</li> <li>Sustained Data Rate (kbps)</li> <li>Burst Allocation (kbit)</li> <li>Max Burst Rate (kbit)</li> <li>Low Priority CIR (kbps)</li> </ul>
8	Briefly monitor these values, occasionally refreshing this page by clicking another tab and then the Session Status tab again.
9	If these values are low (for example, 1, 1, and 0, respectively, meaning that the SM/BHS registered and started a stable session once) and are not changing:
	Consider the installation successful.
	<ul> <li>Monitor these values from the network office over the next several hours and days.</li> </ul>
	If these values are greater than 1, 1, and 0, or they increase while you are monitoring them, troubleshoot the link. (For example, Use Receive Power Level for aiming and then use Link Tests to confirm alignment).

Refer Viewing Session Status on page 1 for more details.

# Exporting Session Status page of AP/BHM

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

sta	SemicriStatus and			
Device	filmet Car	tyridle: Lift Ge	any .	
. Subscriber	ELLICE Harthoan	Software Western	FPGA Version State	Arrest Security
letro-16 110 221 13 (0e 00 3e 58-00 3e	005 PWP 4508	CANCIPY 20.0	101520 P16 04 58 SSROP	ACS-129 [intel to AP)
5M1-10 110 230 10 IDe 00 3e 85-00 ft/	1002 Pt/#P 450x	CANCPY 20.0	101620 PT3 01 SESSION	ALS-CID Invited by AP)
5MD-10 THO 200 TH (20-00 So 70-29 will	000 PWP-4508	CANCIPY 20.0	T01520 P1E IN SESSION	AUS-128 (Invited by AP)
THE REPORT OF THE PARTY OF THE	1004 PMP 450	CANOPY 20 0	101520 PT1 IN SESSION	AUS-128 (Involution by AP)

Figure 47: Exporting Session Status page of PMP 450m AP

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

#### **Export from command line**

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

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

# Configuring quality of service

### **Maximum Information Rate (MIR) Parameters**

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

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

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



You can refer below whitepaper for 450 Platform Family Max Burst MIR: http://www.cambiumnetworks.com/resources/pmp-450-maxburst/

### **Token Bucket Algorithm**

Note

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

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

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

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

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

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

### **MIR Data Entry Checking**

Note

Uplink and downlink MIR is enforced as shown in below figure.



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

Figure 48: Uplink and downlink rate caps adjusted to apply aggregate cap

uplink cap onformed -	uplink entry x aggregate cap for the SM
upinkcap enforced -	uplink entry + downlink entry
downlink can enformed =	downlink entry x aggregate cap for the SM
downinkcap enloiced -	uplink entry + downlink entry

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

Figure 49: Uplink and downlink rate cap adjustment example



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

### **Committed Information Rate (CIR)**

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



#### Note

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

CIR parameters may be configured in the following ways:

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

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

### Bandwidth from the SM Perspective

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

### Interaction of Burst Allocation and Sustained Data Rate Settings

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

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

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

### **SM Prioritization**

Note



This feature is not supported on PMP 450m.

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

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

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

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Attribute	Meaning
Sustained Uplink Data	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
Rate	<ul> <li>Interaction of Burst Allocation and Sustained Data Rate Settings</li> </ul>
	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
	<ul> <li>Interaction of Burst Allocation and Sustained Data Rate Settings</li> </ul>
	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
	<ul> <li>Interaction of Burst Allocation and Sustained Data Rate Settings</li> </ul>
	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
	<ul> <li>Interaction of Burst Allocation and Sustained Data Rate Settings</li> </ul>
	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).

Attribute	Meaning
	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.
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.
Ultra High Priority Channel	This parameter allows the operator to enable or disable one of the data channels with the highest priority bandwidth.
Downlink Plan	This parameter allows the operator to configure the default downlink plan. The value range for this parameter is 1 - 310000 kbps.
Uplink Plan	This parameter allows the operator to configure the default uplink plan. The value range for this parameter is 1 - 310000 kbps.
Weight	This parameter ranges from 0.1 to 9.9 to prioritize SM services. This is a scaling factor to be applied to the Downlink and Uplink plan.
	Note: There is only one weight used for a plan in both directions. The default value for this parameter is 1.0.
User Lock	This parameter contains the following three modes.
Modulation	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.

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

Priority Settings			
Priority Precedence :	802 1p Then Diff	Serv 🖌	
PPPoE Control Message Priority :	<ul> <li>High</li> <li>Normal</li> </ul>		
Prioritize TCP ACK :	Enabled Obisabled		
Management Data Priority Level :	high 🛩		
Speed Test Prioritization			5
Speed Test Server IP :	50.50.50.3	Set 0.0.0.0 to disable	

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

Data Channel Priority Settings		
Number of Data Channels :	mber of Data Channels : 4 - Low, Medium, High, Ultra High 🗸	
Low Priority Channel Configuration	:	
Low Priority Channel :	🗹 En	abled
Low Priority Downlink CIR :	0	(kbps) (Range: 0- 65534 kbps)
Low Priority Uplink CIR :	0	(kbps) (Range: 0— 65534 kbps)
Medium Priority Channel Configurat	ion :	
Medium Priority Channel :	🗹 En	abled
Medium Priority Downlink CIR :	0	(kbps) (Range: 0- 65534 kbps)
Medium Priority Uplink CIR :	0	(kbps) (Range: 0- 65534 kbps)
High Priority Channel Configuration	:	
High Priority Channel :	🖾 En	abled
High Priority Downlink CIR :	0	(kbps) (Range: 0— 65534 kbps)
High Priority Uplink CIR :	0	(kbps) (Range: 0- 65534 kbps)
Ultra High Priority Channel Configur	ration	
:		
Ultra High Priority Channel :	🗹 En	abled
Ultra High Priority Downlink CIR :	0	(kbps) (Range: 0- 65534 kbps)
Ultra High Priority Uplink CIR :	0	(kbps) (Range: 0- 65534 kbps)
Priority Settings		
Priority Proceedence :	Diffe	as Theo 200 to as

Phoney Octaings		
Priority Precedence :	DiffServ Then 802.1p 🗸	
PPPoE Control Message Priority :	⊖ High ● Normal	
Prioritize TCP ACK :	Enabled     Disabled	

# Prioritized Speed Test Servers 50.50.50.3

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	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).
Downlink CIR	Committed Information Rate (CIR)
	Note: CIR values are not applicable for proportional scheduler.
Medium Priority Uplink	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).
CIR	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

Card goldenty	
Chints Broefland Rate Service :	· Linday
1.00 Linut	Disc
Reduction in Concession Process	* District
Neotra de Crémies d'el dester Crange	CiDealas
Alientate Channel Selection	C Disable
Change Counter & Only Sills are benefited	* Total Ar
	CDudle
6M Percenage Threshold to Charge Charge	W Scharge, No Mill
Codemic composition (season)	a have by a - at
Dedution	
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Carcobiese Parameters	
Operation to Sector O	Service and the service and th
Coercelence Spectrum Nause (D)	
and the second s	
Contract of the second second second	
CPI Eliciuled Deta	· · · · · · · · · · · · · · · · · · ·
	(Notes (Philips)) [ Notes (Philips)
CPI Deg Nature	Date in vite
Lauden	
Lature	et2 10000 Decimar Degree
Longitude :	-188.800000 Decimie Degree
The gen	40
Herizonta Amurany	2 Views
Vertical Associately	3 Views
Address Parameters	
Almulti	14E Capites
Gearth	1 Degree
Gen	
Reamailte :	80 Chapter
(ERPCADER)	40 CB/
Certifical Productional Installer Profile	
0P(-0)	2000x50x5040x40x743250344xx555x714
CPI Nerre	day factorized

Attribute	Meaning
Citizen Broadband Radio Service	Enable/Disable the CBRS operation until the device is valid.
Log Level	<ul> <li>Log level can be increased to Debug or decreased to Error level accordingly and logs will appear.</li> <li>Debug: Logs used to help in debugging.</li> <li>Info:Logs the message correspond to normal applicationbehavior.</li> <li>Error:Logs the issues thataffect the usage orperformance of the system.</li> </ul>
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 <b>Reboot for Channel Bandwidth Change</b> 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 <b>SM Percentage Threshold for Channel Change</b> 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	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.
Threshold for Channel Change	Note that the <b>Alternate Channel Selection</b> feature must also be enabled for the AP to hunt for a new channel due to the <b>Change Channel if SMs are Impacted</b> feature. If an operator elects to run with <b>Alternate Channel Selection</b> enabled but <b>Change Channel if</b> <b>SMs are impacted</b> 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 <b>Alternate Channel Selection</b> feature is disabled, but the <b>Change Channel if SMs</b> <b>are Impacted</b> 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	<ul> <li>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.</li> <li>Delete CPI Data: CPI data can be deleted by selecting the Delete CPI Data.</li> <li>Restore CPI Data: CPI data can be restored by selecting the Restore CPI Data.</li> </ul>
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:
	<ul><li>AGL height is measured relative to the ground level.</li><li>AMSL height is measured relative to the mean sea level.</li></ul>
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

Certified Professional Installer Data			
CPI Encoded Data			
	Detete CPI Data   Heatsile CPI Date		
CIPI Data Statos	Data in Use		
Leader			
Lattude	+66 174214 Decimal Degree		
Longitude	-158 227442 Decimal Degree		
Height	10 Mintaris		
Height Type	AMSL		
Horizonial Accuracy	D Meters		
Vertical Accuracy	0 Metera		
Arthmin Parameters			
Atimuth	180 Degree		
Downtill:	0 Degree		
Gen	20.49		
Enertwidth	20 Degree		
EIRP Capability	45 dBm		
Certified Protectional Installer Profile			
CPIID:	2018/04/14/14/00/00/01/01/01/14/11/14		
CPI Name :	Amount Craft		
Initial Contification Tatas	12(13/2019 15/23:00 CST		
Attribute	Meaning		
----------------------------	--		
CPI Encoded Data	Refer table PMP 450Series AP/BHM - CBRS		
CPI Data Status	Configuration for parameter descriptions		
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

Radio Configuration	
Frequency Band	5.4 GHz *
Frequency Carrier	5490.0 •
Channel Bandwidth :	10 MHz 🔻
Cyclic Prefix	Che Sixteenth. •
Frame Period :	© 5.0 ms * 2.5 ms
Color Code	254 (0254)
Subscriber Color Code Rescan (When not on a Primary Color Code)	0 Minutes (0 — 43200)
Subscriber Color Code Wait Period for Idle	p Minutes (0 - 60)
Installation Color Code :	<ul> <li>Enabled</li> <li>Disabled</li> </ul>

# 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 "rebootlfRequired" 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 <a href="https://www.jsoneditoronline.org/">https://www.jsoneditoronline.org/</a>.

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 (<u>http://winmerge.org/</u>) 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 "rebootlfRequired" 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": {
  "rebootlfRequired": 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": {
```

```
"rebootlfRequired": 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".	

및 CHCP 은 및 unKitpepdhap01.	General [Advanced]	
E Brd Some (10.125.103) Address Pool Address Pool Reservations Server Optionn E Fitnes E Pod	Analidde Options DIST Window System Deplay DIST Window System Deplay DIST Window System Deplay DIST Doot Servers RE Dist Doot Server Hast Name e T Date entry Skring value: Per //10.120.103.250/carveplicitg	Descention =: Army of X-M The name of A lat of the If The boot i =: 
•		Cancel Auply

### **Supported URL Formats**

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

- <u>ftp://10.120.163.253/canopy.cfg</u>
- <a>ftp://admin:admin123@10.120.163.253/canopy.cfg</a> (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.
	<pre># Frame 1007: 377 bytes on whre (2016 bits), 377 bytes cantured COOKs bits) on Interface 0 # Ethernet II, arc: Wewarm.msibe(co (00:50:56:as(bits).cos(), costs produces( (ff)f).ff).ff).ff).ff); # Intermet Produce(), Src Pert: boots: (%), Bat Pert: houts: (50) # User Datagram Protocol, Src Pert: boots: (%), Bat Pert: houts: (50) # message Type: Boot Heoly (7) # ardware syst: Ethernet (0x01) # mardware syst: Ethernet (0x01) # ardware syst: Ethernet # ardware syst: Eth</pre>

# 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

Download Configuration File		
Configuration File	Da003ea0007d.cfg	
Upload and Apply Configuration Fik		
File Choose File No file chosen Uptoad		
	Apply Configuration File	

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").</mac></mac>
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 $\rightarrow$ 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 "rebootlfRequired" 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,
"rebootlfRequired":true,
\*
}

# Configuring cnMaestro<sup>TM</sup> Connectivity

450 Platform Family network can be onboarded, configured and managed using cnMaestro<sup>™</sup> 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

Configuration		E
Remote Management :	<ul> <li>Enable</li> <li>Disable</li> </ul>	
cnMaestro URL :		
Connection Status :	Cambium-ID Not Configured	

Credentials	E
Cambium ID :	
Onboarding Key :	
AccountID :	

2.54

### Device Agent Information Device Agent Version :

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
   <a href="http://support.cambiumnetworks.com">http://support.cambiumnetworks.com</a> 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™

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Software images		
inter of their longer densities (normalised from Cardinar Gagest		
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Per-ett (in	142.1 (569110)	A 8
sur-appr	142.1.9cmt in	A 8
PTT 405	HALL BURKELED	A 8
Add Suffmare Image File		
R Insettit		

- 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<sup>™</sup> 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

Home Configuration	Line Carac As Sent Scorethan Available Beauty DNS Test	mate Spectrum Analyzes ) ( OFSM Frame Calculator ) ( Subscriber Configuration ) ( Sub-State
Statistics Tools		Tools → DNS Test
Accounts Casek Start Copyright		5.7GHz MIMO OFDM - Access Point Ga-00-3e-bb-01-9b
Contraction of the second s	DNS Test Settings	and the second
Account admin Level ADMINISTRATOR	Fully Qualified Domain Name	Perform DNS (Justing
Level ADMINISTRATOR Mode Read Write	Fully Guarried Doctato Harrier	Perform DNS Losson

- 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-Optionsfor-cnMaestro-On/m-p/55187#U55187

## **Order of Device Onboarding**

The device discovery order is as follows in On Permises cnMaestro<sup>™</sup> 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<sup>™</sup> 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 crucial 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<sup>™</sup>, facilitating further analysis by Cambium support.





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00/12/0204 - 00:44:09 UTC : Carlier 3 EIRP applaned by APU mark 23 Other to 34 other	

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

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	4417 conc 42, 100mm
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For more detailed information about AFC logs and their operation, please refer to the AFC Operation for Cambium PMP products document.

## **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

Logs - CBRS Log           PMP 458         3.65Hz MMO OFOM - Access Print (20:00-0-45:51:1+42           Status Mod OFOM - Access Print (20:00-0-45:51:1+42         Imm Damps   films            Imm Damps   films          Imm Damps   films            Outrier (20:00         PMP 50: 0-0-0-65:1:1+42           Damme (20:00         PMP 50: 0-0-0-65:1:1+42           Outrier (20:00         PMP 50: 0-0-0:1:0:1:1           Damme (20:00         PMP 50: 0-0-0:1:0:0:1:1           Damme (20:00         PMP 50: 0-0-0:0:0:0:0:0:0:0:0:0:0:0:0:0:0:0:0			of Subscriptions Time Market	ALL	And and Address of the	e Malve Lug 2 (200	and the second second second	Balanting Constants	CERTLag	
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# Monitoring Tools for PMP Devices on cnMaestro™

cnMaestro<sup>™</sup> 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<sup>™</sup> screenshot

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O Up	in Usi 🌲 G	0		· Up	
Full Duples			0.01 Km	Throughput	DL : 4.05 Kbps

### 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<sup>™</sup> using one of several ways detailed above under the Onboarding section. Once the AP is onboarded to cnMaestro<sup>™</sup> Cloud or On premises cnMaestro<sup>™</sup>server, the SMs under the AP will automatically onboard to cnMaestro<sup>™</sup> 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<sup>™</sup> 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 BAMonly 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

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Allowed Source IP 2 :	0.0.0.0	1 32	Network Mask (set to 32 to disable)
Allowed Source IP 3 :	0.0.0	/ 32	Network Mask (set to 32 to disable)
Security Mode			a la companya da companya d
Web Access :	HTTP Only	•	
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Attribute	Meaning
Authentication	Operators may use this field to select the following authentication modes:
Mode	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
Authentication Server 2	"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 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 OxFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF
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:
	<ul> <li>HTTP Only – provides non-secured web access. The radio to be accessed via http://<ip of="" radio="">.</ip></li> </ul>
	<ul> <li>HTTPS Only – provides a secured web access. The radio to be accessed via https://<ip of="" radio="">.</ip></li> </ul>
	<ul> <li>HTTP and HTTPS – If enabled, the radio can be accessed via bothHTTP and HTTPS</li> </ul>
SNMP	This option allows to configure SNMP agent protocol version. It can be selected from drop-down list :

Attribute	Meaning
	<ul> <li>Disable SNMP - To disable SNMP agent.</li> <li>SNMPv2c Only - Enables SNMP v2c protocol.</li> <li>SNMPv3 Only - Enables SNMP v3 protocol. It is secured communication protocol.</li> <li>SNMPv2c and SNMPv3 - It enables both the protocols.</li> </ul>
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

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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 OxFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF
Select Key	This option allows operators to choose which authentication key is used:
	Use Key above means that the key specified in Authentication Key is used for authentication
	Use Default Key means that a default key (based off of the SM's MAC address) is used for authentication
Enforce Authentication	The SM may enforce authentication types of AAA and AP Pre-sharedKey. The SM will not finish the registration process if the AP is not using the configured authentication method (and the SM locks out the AP for 15 minutes). Enforce Authentication default setting is Disable.
Phase 1	The protocols supported for the Phase 1 (Outside Identity) phase of authentication are EAPTTLS (Extensible Authentication Protocol Tunneled Transport Layer Security) or MSCHAPv2 (Microsoft Challenge-Handshake Authentication Protocol version 2).
Phase 2	Select the desired Phase 2 (Inside Identity) authentication protocol from the Phase 2 options of PAP (Password Authentication Protocol), CHAP (Challenge Handshake Authentication Protocol), and MSCHAP (Microsoft's version of CHAP, version 2 is used). The protocol must be consistent with the authentication protocol configured on the RADIUS server.
Identity/Realm	If Realms are being used, select Enable Realm and configure an outer identity in the Identity field and a Realm in the Realm field. These must match the Phase 1/Outer Identity and Realm configured in the RADIUS server. The default Identity is "anonymous". The Identity can be up to 128 non-special (no diacritical markings) alphanumeric characters. The default Realm is "canopy.net". The Realm can also be up to 128 non-special alphanumeric characters.
	Configure an outer Identity in the Username field. This must match the Phase 1/Outer Identity username configured in the RADIUS server. The default Phase 1/Outer Identity Username is "anonymous". The Username can be up to 128 non-special (no diacritical markings) alphanumeric characters.
Username	Enter a Username for the SM. This must match the username configured for the SM on the RADIUS server. The default Username is the SM's MAC address. The Username can be up to 128 non-special (no diacritical markings) alphanumeric characters.
Password Confirm Password	Enter the desired password for the SM in the Password and Confirm Password fields. The Password must match the password configured for the SM on the RADIUS server. The default Password is "password". The Password can be up to 128 non- special (no diacritical markings) alphanumeric characters.

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					
Allowed Source IP 2	three.					
Allowed Source IP 3	If you selected IP Access Filtering Disabled for the IP Access Control parameter, then no entries in this parameter are read, and access from all IP addresses is permitted.					
Web Access	The Radio supports secured and non-secured web access protocols. Select suitable web access from drop-down list:					
	<ul> <li>HTTP Only – provides non-secured web access. The radio to be accessed via http://<ip of="" radio="">.</ip></li> </ul>					
	<ul> <li>HTTPS Only – provides a secured web access. The radio to be accessed via https://<ip of="" radio="">.</ip></li> </ul>					
	<ul> <li>HTTP and HTTPS – If enabled, the radio can be accessed via both HTTP and HTTPS.</li> </ul>					
SNMP	This option allows to configure SNMP agent protocol version. It can be selected from drop-down list :					
	<ul> <li>Disable SNMP - To disable SNMP agent.</li> </ul>					
	<ul> <li>SNMPv2c Only – Enables SNMP v2c protocol.</li> </ul>					
	<ul> <li>SNMPv3 Only – Enables SNMP v3 protocol. It is secured communication protocol.</li> </ul>					
	<ul> <li>SNMPv2c and SNMPv3 - It enables both the protocols.</li> </ul>					
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

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# **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: <a href="https://support.cambiumnetworks.com/files/pmp450">https://support.cambiumnetworks.com/files/pmp450</a> 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	Туре	Required	Value	
Cambium-Canopy- LPULCIR	26.161.1	integer	Ν	0-65535 kbps	
Configuration > Quality c	of Service > L	ow Priority	Uplink CIR	0 kbps	32 bits
Cambium-Canopy- LPDLCIR	26.161.2	integer	Ν	0-65535 kbps	
Configuration > Quality c CIR	of Service > L	ow Priority	Downlink	0 kbps	32 bits
Cambium-Canopy- HPULCIR	26.161.3	integer	Ν	0-65535 kbps	
Configuration > Quality o	of Service > H	ligh Priority	/ Uplink CIR	0 kbps	32 bits
Cambium-Canopy- HPDLCIR	26.161.4	integer	Ν	0-65535 kbps	
Configuration > Quality c CIR	of Service > H	y Downlink	0 kbps	32 bits	
Cambium-Canopy- HPENABLE	26.161.5	integer	Ν	0-disable, 1-enable	
Configuration > Quality o Enable/Disable	of Service > H	0	32 bits		
Cambium-Canopy- ULBR	26.161.6	integer	N	0-100000 kbps	

Name	Number	Туре	Required	Value	
Configuration > Quality of Rate	of Service > S	dependent on radio feature set	32 bits		
Cambium-Canopy- ULBL	26.161.7	integer	N	0-2500000 kbps	
Configuration > Quality c	of Service > L	Jplink Burst	t Allocation	dependent on radio feature set	32 bits
Cambium-Canopy- DLBR	26.161.8	integer	N	0-100000 kbps	
Configuration > Quality of Rate	of Service > S	ustained D	ownlink Data	dependent on radio feature set	32 bits
Cambium-Canopy- DLBL	26.161.9	integer	N	0-2500000 kbps	
Configuration > Quality of Allocation	of Service > [	Downlink Bu	urst	dependent on radio feature set	32 bits
Cambium-Canopy- VLLEARNEN	26.161.14	integer	N	O-disable, 1-enable	
Configuration > VLAN >	Dynamic Lea	irning		1	32 bits
Cambium-Canopy- VLFRAMES	26.161.15	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 M	embership			0	32 bits
Cambium-Canopy- VLAGETO	26.161.20	integer	N	5 - 1440 minutes	
Configuration > VLAN >	VLAN Aging	25 mins	32 bits		
Cambium-Canopy- VLIGVID	26.161.21	integer	N	1 - 4094	
Configuration > VLAN >	Default Port	1	32 bits		
Cambium-Canopy- VLMGVID	26.161.22	integer	N	1 - 4094	
Configuration > VLAN >	Management	1	32 bits		

Name	Number	Туре	Required	Value	
Cambium-Canopy- VLSMMGPASS	26.161.23	integer	N	0-disable, 1-enable	
Configuration > VLAN > 3	SM Managen	1	32 bits		
Cambium-Canopy- BCASTMIR	26.161.24	integer	N	0-100000 kbps, 0=disabled	
Configuration > Quality c Uplink Data Rate	of Service > E	Broadcast/I	Multicast	dependent on radio feature set	32 bits
Cambium-Canopy- Gateway	26.161.25	ipaddr	N	-	
Configuration > IP > Gate	way IP Addr	ess	•	0.0.0.0	-
Cambium-Canopy- ULMB	26.161.26	integer	N	0-100000 kbps	
Configuration > Quality c Rate	of Service > N	1ax Burst U	Iplink Data	0	32 bits
Cambium-Canopy- DLMB	26.161.27	integer	N	0-100000 kbps	
Configuration > Quality c Data Rate	of Service > N	ownlink	0	32 bits	
Cambium-Canopy- 26.161.28 integer N BCASTMIRUNITS					
Configuration > QoS > Br	roadcast Dov	wnlink CIR		0	32 bits
Cambium-Canopy- ConfigFileImportUrI	26.161.29	string	N		
Configuration > Unit Sett	ings			0	32 bits
Cambium-Canopy- ConfigFileExportUrl	26.161.30	string	N		
Configuration > Unit Sett	ings	0	32 bits		
Cambium-Canopy- DHCP-State	26.161.31	integer	N	1-Enable	
Configuration > IP > DHC	P state	1	32 bits		
Cambium-Canopy- SMPrioritizationGroup	26.161.32	integer	N	0-Low, 1-High	32 bits

Name	Number	Туре	Required	Value	
Configuration > Quality of	of Service > F	0			
Cambium-Canopy- DATACHANCOUNT	26.161.35	integer	Ν	1 - 4	
Configuration > Quality of Channels	of Service > N	1	32 bits		
Cambium-Canopy- MPULCIR	26.161.36	integer	N	0 - 65534 Kbps	
Configuration > Quality c CIR	of Service > N	1edium Prio	ority Uplink	0	32 bits
Cambium-Canopy- MPDLCIR	26.161.37	integer	N	0 - 65534 Kbps	
Configuration > Quality of Downlink CIR	of Service > N	1edium Prio	ority	0	32 bits
Cambium-Canopy- UHPULCIR	26.161.39	integer	N	0 - 65534 Kbps	
Configuration > Quality c CIR	of Service > L	Jltra High P	riority Uplink	0	32 bits
Cambium-Canopy- UHPDLCIR	26.161.40	integer	N	0 - 65534 Kbps	
Configuration > Quality of Downlink CIR	of Service > L	Jltra High P	riority	0	32 bits
Cambium-Canopy- UserLevel	26.161.50	integer	N	1-Technician, 2-Installer, 3- Administrator	
Account > Add User > Le	evel			0	32 bits
Cambium-Canopy- UserMode	26.161.51	integer	N	1=Read-Only 0=Read-Write	
Account > Add User > U	ser Mode		0	32 bits	
Cambium-Canopy- PortMap-Priority	26.161.52	integer	N	0 - 7	
Configuration > VLAN > Priority	Port VID MA	0	32 bits		
Cambium-Canopy- PortMap-VLANID	26.161.53	integer	N	1 - 4094	32 bits
Configuration > VLAN > VID	Port VID MA	1			

Name	Number	Туре	Required	Value	
Cambium-Canopy- PortMap-MacAddr	26.161.54	string	N	12 - 17	
Configuration > VLAN > MAC Address	Port VID MA	00-00-00-00-00	-		
Cambium-Canopy- RatePlan-DL	26.161.55	integer	N	1 — 310000 kbps	
Configuration > Quality c	of Service > D	ownlink Pl	an	0	32 bits
Cambium-Canopy- RatePlan-UL	26.161.56	integer	N	1 — 310000 kbps	
Configuration > Quality c	of Service > L	Jplink Plan		0	32 bits
Cambium-Canopy- RatePlan-Weight	26.161.57	integer	Ν	0.1 - 9.9	
Configuration > Quality c	of Service > V	Veight		0	32 bits
Cambium-Canopy- RatePlan-UserLckMod	26.161.58	Ν	O-Disabled, 1-Enabled, 2-Enable below threshold		
Configuration > Quality c	of Service > L	Jser Lock M	10dulation	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 c	of Service > L	ocked Moo	dulation	8	32 bits
Cambium-Canopy- RatePlan-ThreMod	26.161.60	integer	Ν	8=8x,6=6x,4=4x,3=3x,2=2x	
Configuration > Quality c	of Service > T	hreshold M	1odulation	8	32 bits
Cambium-Canopy- SMVIan8021pSupport	26.161.61	integer	N	O-disable, 1-enable	
Configuration > VLAN > 2	Support 802	(VID 0)	0	32 bits	
Cambium-Canopy- UserLevel-AP	26.161.62	integer	Ν	1-Technician, 2-Installer, 3- Administrator	
Account > Add User > Le	evel		0	32 bits	
Cambium-Canopy- UserMode-AP	26.161.63	integer	N	1=Read-Only 0=Read- Write	

Name	Number	Туре	Required	Value	
Account > Add User > Us	ser Mode	25 mins	32 bits		
Cambium-Canopy- UserLevel-SM	26.161.64	integer	N	1-Technician, 2-Installer, 3- Administrator	
Account > Add User > Le	evel			1	32 bits
Cambium-Canopy- User Mode-SM	26.161.65	integer	N	1=Read-Only 0=Read- Write	
Account > Add User > Us	ser 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/



# 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.			
	<ul> <li>Local: The local SM is checked for accounts. No centralized RADIUS accounting (access control) is performed.</li> </ul>			
	• 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

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	5.7GHz MIMO OFDM - Access Point 0a-00-3e-b0-05-8f	
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iser Authentication Method :	EAD HEAD ANSING A	
linv Local Login after Reject from AAA :	and department of the	
Jeer Authentication Server 1:	Shared Secret	
her Authentication Server 2 :	Shared Secret 0.000	
Joor Authentication Server 3	Ehared Secret	
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	Anyword Carribleader	
	Live Defeat Liettfrates	
	This will delete all current certificane	
	This will delete all carrier certificane	
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Jeer Authentication Centricate 1	Une Unhalt Certificates This will defete all correct certificates	
Iter Authentication Centrolate 1	Une Unhuit Certificates This will delete all correct certificates	
leer Authentication Centrules 1 2 +US 5 +Binole	This will defete all current certificane	_
Terre Automoticalion Censicales C +US 5 +Elingia D +Muterola SoluSona, Inc.	The will delete all current certificane	_
Iser Authentication Centrals I C +US 5 +tilisola D shotevola Solutions, Inc. Di +Careopy Weeksa Broatbarrd Di +Careopy Weeksa Broatbarrd	This will delete all current certificane	
Jeer Authentication Centrates 1 C +US = *Einole > #Autoecks Solutions, Inc. Ol +Canopy Weekss Broadband CN +Canopy Weekss Broadband CN =Canopy AAA Server Dems CA = #echologist Assocraft Server Dems CA	This will delete all current certificane	
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Attribute	Meaning
User Authentication	<ul> <li>Local: The local SM is checked for accounts. No centralized RADIUS accounting (access control) is performed.</li> </ul>
mode	<ul> <li>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.</li> </ul>
	<ul> <li>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.</li> </ul>
User	The user authentication method employed by the radios:
Authentication Method	<ul><li>EAP-MD5</li><li>EAP-PEAP-MSCHAPv2</li></ul>
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	Import Cetificate - browse and select the file to be uploaded and click on "Import Certificate" to import a new certificate.
Settings	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

user Authent (at in	
Remote Login is enabled only when Si back-end AAA server. The SM will only of configuration settings on this page. Curren: State: CCSERVICE	V is Registered with an AP and the system is operating with a do Local Login until these preconditions are met regardless
User Authent (abon Volie	1111 •
Allow local logination Reject from ARA	Cienatied Riblindon
Access (rackin), Uchhaurat (n	E
wittunbng Vessagest	cial la 🗾
Actoum Status	E

#### Table 90: SM User Authentication and Access Tracking attributes

ser A. them ist in Remote Login is enabled only when SM is Registered with an AP and the system is operating with a back-end AAA server. The SM will only do Local Login until these preconditions are met regardless of configuration settings on this page. Current State: CCSERVICE				
User Authent (stion Volie	1131 -			
Allow local logination Reyear from AAA	C ±nati¥d © D refere			
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wittunbhg Vessages :	cialla -			
Coro process	E)			

Attribute	Meaning			
User Authentication Mode	<ul> <li>Local: The local SM is checked for accounts. No centralized RADIUS accounting (access control) is performed.</li> <li>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.</li> <li>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.</li> </ul>			
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".         Image: Comparison of the term of the term of the term of term of term of term of term of term of the term of the term of t			
Accounting Messages	<ul> <li>disable - no accounting messages are sent to the RADIUS server</li> <li>deviceccess - accounting messages are sent to the RADIUS server regarding device access (see Device data accounting RADIUS attributes).</li> </ul>			

# **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.

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	

Table 91: Device data accounting RADIUS attributes

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

🗛 se a Tracking Configuration 👘		E.
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RV Rosaulten pation i terval	- 59,	/minutes/0=1488/tied/min

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

Authentication Server Settings					
Authentication Mode :	RADIUS AA	8			
Authentication Server DNS Usage	<ul> <li>Append</li> <li>Disable</li> </ul>	DNS Domain Name DNS Domain Name			
Authentication Server 1		<ul> <li>Shared Secret</li> </ul>			
Authentication Server 1	0000				
Authentication Requer 2		Shared Secret			
Authentication Server 2	0000				
Authoritzation Convertit	24110100	Shared Secret			
Aumenacation Server 3	0000				
Authentication Server 4 (BAM ONLY)	0000				
Authentication Server 5 (BAM ONLY)	0000				
Radius Port :	1812	Default port number is	1812		
Authentication Key	Chillion and	Charles was recently a not serve	(Using All 0xFF's Key)		
Select Key :	Use Key Use Def	/ above ault Key			
Dynamic Authorization Extensions for RADIUS	Enable CoA and Disconnect Message     Disable CoA and Disconnect Message				
Disable Authentication for SM connected via ICC :	<ul> <li>Enabled</li> <li>Enabled</li> <li>Disabled</li> </ul>	1 3			

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

AAA Authentication Settings	
Enforce Authentication :	AAA 🔻
Phase 1 :	eapttis 🔹
Phase 2 :	eapttis
	eapMSChapV2
I de actite (De actor e	eappeap

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 <u>registry file</u> 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

		and the second second	
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SANDBOX\		linet :	
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User cannut chan Passent reve Store passent	enge password enge password v expirez	e ned logon d le encryption	
Account expires			
(E Never			
O End of	Failey	Nie/ 22,2015	101

# **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

	1.0	nuchap Properties		L
Overview   Conditione   Caroli	savis Settings			
Configure the entirge for the Economic and constraints of	ndownik policy witch the connection request a	ni itu pika garit kanan, milingi an m	sites	
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C Standed	Abituale harve Vender Specific			US devis. See
Helwook Access Post	Searchy retry ork, access as	iv <del>a</del> verdal		
1955, Entitionament	C Selector ld	RADUE Standard	- 21	
Handley and Remain	· Enter Vendor Code	181	187	-
Allocation Protocol P Filess Encoption P Settings	You I certaine     You I certaine     Certaine Anticipe	06. De	en ter	
	Configure 1	/SA (RFC Compliant)		
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	Altitude format		ΩK.	Corost Acres
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		OK Gros		

# 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

<ul> <li>Ally Withinspace</li> </ul>	Habeurt 1	Neesances - Natural	Design and AAA D	Sertie .		
• Princhelick Revisions	Heter	NR Devices				
<ul> <li>Network Device Groups Location</li> </ul>	Filer	1	V Matth #	Ŷ	· ·	
Device Type	0	Name +	IP Address	Oescription	NOG Location	NDG Device Type
Default Network Device		5.7 P9 AP	10 110 61 14/32		All Locations	At Device Types
External Proxy Servers OCSP Services	O.	5.x PMP.452.AP	10.110.01.2/32		All Locations	All Device Types

# **Creating Users**

Figure 80: Creating users

CISCO EVAL(Days left 87)	ACS
My Workspace	Users and Identity Stores + Internal Identity Stores + Users
BI Network Resources	Internal Users
· 🖀 Louis and alcolity Spens	Filter Vilatch it V
Internal identity Stores	Status User Name + Identity Group Description
	0 0a-00-3e-a0-60-50 All Groups PMP 450 5 x SM
External Identity Stores	0a-00-0e-te-01-55 At Groups P9 SM
LDAP	administration     Al Groups

## **Creating RADIUS instance**

Figure 81: Creating RADIUS instance

<ul> <li>My Workspace</li> </ul>	Policy Elementa > Authorization and Permissions > Network Access = Authorization Profiles					
Network Resources	Authorization Profiles					
Users and Identity Stores						
Policy Elements						

# **RADIUS protocols**

#### Figure 82: RADIUS protocols



#### **Service selection**

Figure 83: Service selection



## **Adding Trusted CA**

Figure 84: Adding Trusted CA

cisco Evergenet an	AC8			
+ S Wy Wonepate	Users and Aserts Stones - Certificate Author	to		
+ Gr Netwon Resistors	Certificate Autorities			
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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

cisco Cisco Secure A	92				
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# **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	Туре	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	1	14	Unsigned Integer 32	BOTH	false
Cambium-Canopy-VLMGVID		22	Unsigned Integer 32	BOTH	true
Cambium-Canopy-VLSMMGPAS	<u>ss</u>	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

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3. Click **Create** from the screen you get following screen

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Chose some name and then move to RADIUS Attributes tab

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

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Common Tasks Athl	utes			
Altribute	1	Type	Value	
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Add A Ent	V Replace n Del	ehe		
Distances To a	RADIUS-Motorola			
C RADIUS Attribute	Cambium-Canopy-Usi	erMode	Select	
	Unsigned Integer 32			
d Attribute Type:	deres Brieger and Brieger and			
Attribute Type. Attribute Value:	Static		5 <b>9</b> 2	
<ul> <li>Attribute Type: Attribute Value:</li> </ul>	Static 계		· • 2	



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.

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		The lines (M. 199)	

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

<b>7</b>
Cabled
0.0.00
300 Seconds (Range: 30086400)
3 (Range: 1-100)

Seve Changes

Reboot

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.



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

Rec	spectrum Anal eiver Channel System firme a	ysis not perfo Bandwidth: at start of and	ormed. 40.0 MHz alvsis
Site Name: 450iAP-	10.110.233.9	Location: Ba	angalore Contact Smruti
Nsplay Data Path :	Both 👻		
bata :	File does	not exist.	
Display :	<ul> <li>Instant</li> <li>Average</li> </ul>	aneous aing	
in And Max Fragilancias			
In and Max Frequencies in kHz :	5500000	5800000	(Valid Range in kHz: 4900000 - 5925000)
Set Min And Max Tr	Ful Scan 50	t Min And Max	To Center Soan +/-40MHz
ccess Point Stats			
Registered SM Count :	4 (16 Data	a Channeis)	
Aximum Count of Registered SMs :	4	- 11-1-1-2-AM	
pectrum Analyzer Options			
Construction of the second s	5.0 MHz	~	
canning bandwidth :			
canning bandwidth :			
imed Spectrum Analyzer			
imed Spectrum Analyzer Juration :	10	Seconds (10	—1000)
canning Bandwidth : imed Spectrum Analyzer Juration : ferform Spectrum Analysis on Boot Up for C ican :	10 Ine O Enable Disable	Seconds (10 I	
imed Spactrum Analyzer Juration : Perform Spectrum Analysis on Boot Up for C Ican :	10 Ine C Enable Disable Start Timed Sect	Seconds (10 r e tor Spectrum Ar	

Note: Continuous Spectrum Analysis has a max of 24 hours and afterwards	will automatically resume transmitting
---	--

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 $\pm$ 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	This field allows selecting scanning bandwidth for AP and all the registered SMs.
Bandwidth	<b>Note</b> : 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	<b>Start Continuous Spectrum</b> 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 <b>Tools &gt; Spectrum Analyzer</b> 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

Results	
R Site Name: 450b L0	Spectrum Analysis not performed. eceiver Channel Bandwidth: 5.0 MHz. System time at start of analysis: 3 Location: No Site Location Contact: No Site Contact
Display Data Path :	Both 💌
Data :	File does not exist.
Display :	Instantaneous     Averaging
Nin And Max Francescies	Stop Spectrum Anabsis
Min and Max Frequencies in KHz :	5400000 5900000 (Valid Range in KHz: 4900000 - 5925000) Set Min And Max To Full Scan
Subscriber Module Stats	
Session Status :	REGISTERED VC 18 Rate 8X/6X MIMO-8 VC 255 Rate 8X/4X MIMO-8
Registered AP :	0a-00-3e-bb-01-77 450i AP-133
Spectrum Analyzer Options	
Scanning Bandwidth :	5.0 MHz 👻
Timed Spectrum Analyzer	
Duration :	10 Seconds (10-1000)
Perform Spectrum Analysis on Boot Up for One Scan :	Enable     Disable
Power Up Mode With No 802.3 Link :	Power up in Aim Mode     Power up in Operational Mode
	Start Timed Spectrum Analysis

Start Continuous Spectrum Analysis

Note: Continuous Spectrum Analysis has a max of 24 hours and afterwards will automatically resume scanning for APs.

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

(include)	ato an Aran	unic pot port	ormod
Receive	er Channe	Bandwidth:	20.0 MHz
Sys	stem time a	at start of ana	alysis:
Site Name: 450iMASTER-	10.110.233	3.16 Location	n: Bangalore Contact: Smruti
Display Data Path :	Both v		
Data :	File does	not exist,	
Display :	Instantaneous		
	- Maradula		
	101-10.1-1		
Min And Max Frequencies			
Min and Max Frequencies in kHz :	4900000	5925000	(Valid Range in kHz: 4900000 - 5925000)
Set Min And Max To Fu	I Scan Se	et Min And Max	To Center Scan +/-40MHz
Backhaul Stats			
Timing Slave Status :	Connecte	hd	
Searthum Analyzar Ontions	-	-	
Scanning Bandwidth :	40.0 MHz	•	
	1.12.0.111.0		
Timed Spectrum Analyzer			
Duration :	10	Seconds (10	
Perform Spectrum Analysis on Boot Up for One	O Enable		
Scan :	Disabl	0	
Star	Timed Sec	for Spectrum Ar	natytes
Note: BHM scans for extra 30 seconds		_	
Conditional Departments I and a series	_		
Continuous Spectrum Analyzer	of Continues	e Enectant An	alacia
Note: Continuous Construm Applications	of 24 h	an oppication Ap	angles all as descentioned, and the barrow of the

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

Results	
	Spectrum Analysis not performed.
	System time at start of analysis:
Sile Name: N	to Site Name Location: No Site Location Contact: No Site Contact
Display Data Path :	Both 💌
Data :	File does not exist.
Display :	Cinstantaneous
Display .	Averaging
	Stop Spectrum Analysis
Min And Max Frequencies	
Min and Max Frequencies in KHz :	5470000 5925000 (Valid Range in KHz: 4900000 - 5925000)
	Set Min And Max To Full Scan
Backhaul Stats	
Timing Slave Status :	Connected
Timing Slave Stats	
Session Status :	REGISTERED VC 18 Rate 8X/1X MIMO-A VC 255 Rate 8X/8X MIMO-B
Registered Backhaul :	0a-00-3e-bb-b0-c1
Spectrum Analyzer Options	
Scanning Bandwidth :	5.0 MHz 💌
Timed Spectrum Analyzer	
Duration :	10 Seconds (10-1000)
Perform Spectrum Analysis on Boot Up for One	Scan : Enable Disable
Power Up Mode With No 802.3 Link :	Power up in Aim Mode
	Power up in Operational Mode
	Start Timed Spectrum Analysis

#### Continuous Spectrum Analyzer

Start Continuous Spectrum Analysis

Note: Continuous Spectrum Analysis has a max of 24 hours and afterwards will automatically resume scanning for BHMs.

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.

 Receive Signal Quality
 -35.0 dB (-42.0 dB V / -36.0 dB H)

 Receive Power :
 -35.0 dB (-42.0 dB V / -36.0 dB H)

 Maximum Receive Power :
 -29.4 dB (-38.0 dB V / -30.0 dB H)

 Signal Strength Ratio :
 -6.0 dB V-H

 Beacons :
 100 %

 Receive Fragments Modulation ;
 Path V.QPSK: 100%

 Path H.n/a
 Path H.n/a

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

Receive Signal Quality	
Receive Power :	-72.9 dB (-77.0 dB V / -75.0 dB H)
Maximum Receive Power :	-70 2 dB (-75 0 dB V / -72 0 dB H)
Signal Strength Ratio :	-2.0 dB V-H
Beacons	100 %
Receive Fragments Modulation :	Path V QPSK 51% 16-QAM 33% 64-QAM 16% Path H QPSK 91% 16-QAM 9%

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

Receive Signal Quality	
	-81.2 dB (-52 0 dB V / -89.0 dB H)
Receive Power :	Greater than -70 🛄 Between -70 and -80 🛄 Below -80
Maximum Receive Power	-50.5 dB (-82.0 dB V / -84.4 dB H)
Signal Strength Ratio	7.0 dB V-H
Beacons	100 %
Receive Fragments Modulation :	Path V:QPSK:59% 16-QAM:33% 64-QAM:7% Path H:QPSK:88% 16-QAM:11%

## 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.



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

Note

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.

### Tools → Aiming

#### 5.4/5.7GHz MIMO OFDM - Subscriber Module - 0a-00-3e-a0-a0-66

#### Alignment mode

Aiming Configuration	
Aiming Mode :	<ul> <li>Single Frequency Only</li> <li>Normal Frequency Scan List</li> <li>Note: No beacon information is decoded for 'Single Frequency Only' mode</li> </ul>
Single Frequency :	None *
	Enable Aiming Mode Disable Aiming Mode
	Aiming Mode will be enabled for 15 minutes or until disabled.
Aiming Status	
Current Status : SM is in Alignment Mode for selected frequencies	

Aiming Results Current entry: Frequency: 5745.000 MHz Power: -31.9 (-50.0 V / -32.0 H) dBm Users: 1 ESN: 0a-00-3e-a1-35-75 Color Code: 0 Multipoint

Other entries: Frequency: 5680.000 MHz Power: -36.5 (-42.0 V / -38.0 H) dBm ESN: 0a-00-3e-a0-aa-9a Color Code: Backhaul

Frequency: 5740.000 MHz Power: -77.8 (-91.0 V / -78.0 H) dBm Users: 2 ESN: 0a-00-3e-a0-08-08 Color Code: 0 Multipoint

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

#### Alignment mode

-

Aiming Configuration		
Aiming Mode :	<ul> <li>Single Frequency Only</li> <li>Normal Frequency Scan List</li> <li>Note: No beacon information is decoded for 'Single Frequency Only' mode</li> </ul>	
Single Frequency :	None *	
	Enable Aiming Mode Disable Aiming Mode	
Ain	ing Mode will be enabled for 15 minutes or until disabled.	
Aiming Status	E	
Current Status :	BHS is in Alignment Mode for selected frequencies	
Aiming Results		
No Backhauls available and vis	ble which match current configuration.	
Other entries:		
Prequency: 5080.000 MHZ		
Users: 0		
ESN: 0a-00-3e-a0-aa-9a		
Color Code: 5		
Deekhaul		

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

ten fini Langemunt	
All Service	Los Techni Sonta (1991)
Lev Solide Man two Internet	the billion who there are any other to be and the the second to be and the second to be and the second to be an
Manager .	1 and 1
Area (articul (in	- Claime - Claime
their fields there are field	<ul> <li>East App 2x46</li> <li>East App 2x46</li> </ul>
7 States and Stat	
List for George	
(40) pm .	THE R. P. LEWIS CO., MICH.
Delite	2000 B ( 1 - 10)
Difference in the second secon	James of J
Purca stratus	2 11 March 44, 2001 Star March 44, 61 March 47 March 4
Patient and	1.1. BORTHAL - TTERMEN

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

Link Test	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	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.		
	<ul> <li>Current Subscriber Module: select the LUID to perform the link test with</li> <li>LUID list: select a list or range of LUIDs to include in the link test with multiple LUIDs</li> </ul>		
	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

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

### Figure 97: Link Test without Bridging

init Toya Configurations	And the second
Link Test Mode :	Set Set attacking *)
Signal to Noice Ratio Colouiston during Link Test	* Endbled = Disablet
Link Test with AD Available Data Channels	In All Available Data Channels In Lew Priority Channel snity Note: All Available Data Channels option requires that the SM ansaty has at least one additional data channel enabled.
ink Text Settings	
Current Subscriber Medule	344_11 De070e04009 Lue 2 *
Duration	12 Seconds (2 10)
Direction	A statistical and the statistical statisticae statisticae statisti
Number of Packets	(i) — 64) Zero will flood the limit far duration of test
Pacied Langth	rft+ Bytes (64 1774 bytes) Dart See

#### Figure 98: Link Test with Bridging and MIR

Unik Test Cariliguations	
Live. Text Mude	Loss Test with Bridging and 1648 • 1
Signal to Noise Ratio Calculation during Link Test	Eratied     Doubled
Link Test with Ail Available Data Channels	M Available Cata Channels + Low Proofs Channel only Note: All Available Cata Channels option resumes that the GM already has at least one additional data channel enabled
ink Tast Settings	A AN ANALYSIN AND A AN A
Current Subscriber Module	Style 21 (SebStandsSt)
Duration	10 Seconds (2 - 10)
Direction	Relational *
Number of Packets	<ol> <li>(0 64) Zerb will fixed the init for duration of test</li> </ol>
Pachel Length	1714 Bytes (54 1714 bytes) (Bart New )

Refer Link Test with Multiple LUIDs for Link Test procedure.

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

Data	-	El.	alees of		440.00000		Packet Transmit		Packet Receive
Phonty	Downink	1.34	gank.	1.1.1	Aggre	gane		Actual	Arhiai
LOW	22.70 Mbp	s 24 !	51 Mbps	47.21	Mbps	3841 pp	8 923	2 (1846 pps)	9977 (1995 pps)
Efficienc	¥								
Participation and	Down	WW.	-	1		Up	irik :	10	
	Fragm	eents	-			Fragm	ents	Constant law	
Efficience	cour	W.,	Signal Noise R	nin Em	:kency	cou	nt	Signal to Noise Ratio	
eouver nie	Actual	Miseed	11000001110		10000	Actual	Missed	and the second s	
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	1000000		20.001					399 042 15	
Link Qua	irty								
Downlini		-					-		
RF Path	Modulation	Fragm	ints Per	tuiition tentage	Avera	ge Correc It Errors	Dek3		
V	QPSK	27701	25	6	0.37	8.	_		
V	16-QAM	27702	25	6	0.61	3			
V	64-QAM	27701	25	6	0.94	1			
V	256-QAM	27700	25	5	0.51	9			
н	QPSK	27697	25	¥	1.71	9.:	_		
н	16-QAM	27694	25	6. B	2.48	7			
H	64-QAM	27675	25	6	3.28	2			
H.	256-QAM	27695	25	6	1.89	5			
Uplink				111					
RF Path	Modutation	Fragme	ents No.	tutation centage	Avera	ge Correc M Errors	ted		
Y.	256-QAM	11832	4 10	)%	3.56	9			
н	256-QAM	11978	8 10	2%	0.75	3.			

## 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

Link Test Configurations	E,			
Link Test Mode :	Link Test with Bridging and MIR 👻			
Signal to Noise Ratio Calculation during Link	Enabled			
Test :	Disabled			
SM Link Test Mode Destriction	Enabled			
SM LINK TEST MODE RESULTION .	Ink Test with Bridging and MIR   Enabled Disabled Enabled All Available Data Channels Low Priority Channel only ote: All Available Data Channels option requires that the SM ready has at least one additional data channel enabled. Enabled Disabled Enabled Disabled Disabled			
	All Available Data Channels			
Link Test with All Available Data Channels :	Low Priority Channel only			
	Note: All Available Data Channels option requires that the SM already has at least one additional data channel enabled.			
MU MINO :	Enabled			
MO-MINO .	Disabled			
Display results for untested Data Chappels :	Enabled			
bisplay results for unrested bata channels .	Disabled			
Innore Configured CIP	Enabled			
ignore comgarea onc.	Disabled			

Link Test Settings	E				
Current Subscriber Module :	Idle [0a003ebb41d2] Luid: 2 🔹				
LUID List :	(eg. 2 — 22,24,32) Empty field or 0 will flood all registered LUIDs for duration of test				
Duration :	2 Seconds (2 - 10)				
Direction :	Bi-directional 🔻				
Number of Packets :	0 (0 — 64) Zero will flood the link for duration of test				
Packet Length :	1714 Bytes (64 — 1714 bytes)				
	Start Test				

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

Link Test Configurations						
Link Test Mode :	Link Test without Bridging 💌					
Signal to Noise Ratio Calculation during Link Test	Enabled Disabled All Available Data Channels Low Priority Channel only					
	Disabled					
Link Test with All Available Data Channels :	All Available Data Channels     Cow Priority Channel only     Note: All Available Data Channels option requires that the SM already has at least     one additional data channel enabled.					
Link Test Settings	E					
Duration :	2 Seconds (2 - 10)					

I	uration :		Seconds (2 - 10)				
	Direction :	Bi-din	ectional 🔻				
Number of Packets : Packet Length :		0	0 — 64) Zero will flood the link for duration of test				
		1714	Bytes (64 — 1714 bytes)				
l			Start Test				

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

AP List AP Selection Method used: Optimize for Throughput Current entry index: 0 Session Status: REGISTERED (via Primary Color Code 181) \* Index: 0 Frequency: 3657,500 MHz Channel Bandwidth: 20.0 MHz Cyclic Prefix: 1/16 ESN: 0a-00-3e-45-11-f2 Region: Other Beacon Receive Power: -52.5 (-55.0 V / -56.0 H) dBm Beacon Count: 9 FECEn: 1 Type: Multipoint Avail: 1 Age: 0 Scans Seen: 1 Lockout: 0 RegFail 0 Range: 0 feet MaxRange: 2 miles TxBER: 1 EBcast 0 AES256Rdy: 0 Session Count: 1 NoLUIDS: 0 OutOfRange: 0 AuthFall: 0 EncryptFall: 0 Rescan Reg: 0 SMLimitReached: 0 NoVC's 0 VCRsv/430smFail 0 VCActFail 0 UnsupportedULMap 0 Air Delay 0 AP Gain: 25 dBm AP RcvT -55 dBm Color Code: 181 BeaconVersion: 1 SectorUserCount: 0 SyncSrc: 0 NumULSlots: 41 NumDLSlots: 40 NumULContSlots: 3 WhiteSched 0 ICC: 0 Authentication Disabled SM PPPoE Supported AckBeforeMap Enabled Frame Period 2.5 ms Rescan APs

Last Registered Primary Color Code AP MAC Address: 0a-00-3e-45-11-f2 Frequency: 3657.500 MHz Channel Bandwidth: 20.0 MHz Color Code: 181 Air Delay: 0 Receive Power:-33.5 (-37.0 V / -36.0 H) dBm

### Scan Statistics Scan Cycle Count : 1

Beacon Statistics			E
Unsupported Feature Beacon Received :	0		
Unknown Feature Beacon Received	0		
Old Version Beacon Received :	0		
Wrong Frequency Beacon Received :	0		
Non Lite Beacon Received	0		

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		
Туре	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

#### BHM List

Current entry index: 0 Session Status: REGISTERED (via Primary Color Code 254)

\*\*\*\*\*\*\*\*\*\*\*

Index: 0 Frequency: 5490.000 MHz Channel Bandwidth: 10.0 MHz Cyclic Prefix: 1/16 ESN: 0a-00-3e-bb-00-fb Region: Other Beacon Receive Power: -44.5 (-47.0 V / -48.0 H) dBm Beacon Count: 13 FECEn: 1 Type: Point-to-Point Avail: 1 Age: 0 Lockout: 0 RegFail 0 Range: 0 feet MaxRange: 0 miles TxBER: 1 EBcast: 0 Session Count: 1 NoLUIDS: 0 OutOfRange: 0 AuthFail: 0 EncryptFail: 0 Rescan Req: 1 SMLimitReached: 0 NoVC's: 0 VCRsv/430smFail: 0 VCActFail: 0 AP Gain: -10 dBm Color Code: 254 BeaconVersion: 1 SectorUserCount: N/A NumULSlots: 10 NumDLSlots: 29 NumULContSlots: 0 WhiteSched: 0 ICC: 0 Authentication: Disabled PToP VLAN: Supported Frame Period:2.5 ms

Update Display

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		
Туре	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

Link Mada -	OPo	int-To-Point Link		
Link Mode :	🖷 Mu	Multipoint Link		
Platform Type AP/BHM :	PMP/	PTP 450/450/450m 🗸		
Platform Type SM/BHS :	PMP/	PTP 450/4506/4501 🗸		
Channel Bandwidth :	5 0 M	12 ¥		
Cyclic Prefix :	One S	One Sideenth 🗸		
Eramo Pariod :	.00	5.0 ms		
Frame Period .	02.5	ms		
Max Range :	1	(km 😺 (Range: 1 — 40 miles / 64 km)		
Downlink Data :	67	%		
Contention Slots :	3	(Range: 0 - 15)		
SM/BHS One Way Air Delay :	0	ns		
		Calculate		
Calculated Frame Results				
CANOPY 20.0 AP				

Modulation:OFDM Total Frame Bits : 50000 Frame Period : 5.0 ms AP Details : Data Slots (Down/Up) : 26 /13

#### Maximum Spectral Efficiency (user data bits per second per hertz) and Throughput

Frags Per	Slot Spectral Efficiency(Total)	Throughput(Total)	Spectral Efficiency(DL)	Throughput(DL)	Spectral Efficiency(UL)	Throughput(UL)
8X	6.38	31.94 Mbps	4.25	21.29 Mbps	2.12	10.64 Mbps
7X	5.59	27.95 Mbps	3.72	18.63 Mbps	1.86	9.31 Mbps
6X	4.79	23.95 Mbps	3.19	15.97 Mbps	1.59	7.98 Mbps
5X	3.99	19.96 Mbps	2.66	13.31 Mbps	1.33	6.65 Mbps
4X	3.19	15.96 Mbps	2.12	10.64 Mbps	1.06	5.32 Mbps
3X	2.39	11.97 Mbps	1.59	7.98 Mbps	0.79	3.99 Mbps
2X	1.59	7.98 Mbps	1.06	5.32 Mbps	0.53	2.66 Mbps
1X	0.79	3.99 Mbps	0.53	2.66 Mbps	0.26	1.33 Mbps

Contention Slots: 3 Air Delay for Max Range: 5400 ns, 54 bits Approximate distance for Max Range: 1617 meters AP Antenna Transmit End : 29859, 2.985973 ms AP Antenna Receive Start : 31622, 3.152205 ms AP Antenna Receive End : 49103 SM Details : SM Receive End : 30388 SM Transmit Start : 30640 SM One Way Air Delay : 0 ns SM Approximate distance : 0 meters

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

Select Subscriber	
Current Subscriber Module :	No Site Name (0a003ebb0104) Luid: 2 •
Subscriber Configuration Informati	on (
LUID: 002 - [0a-00-3e-bb-01-04] St Site Name : No Site Name Software Version : SVM, 14 SV Software Boot Version : CANO FPGA Version : 080715 (DES, Sustained Uplink Data Rate(SM Rate (SM): 65000 Downlink Burst A Sustained Broadcast Data Rate (SI Max Burst Uplink Rate (SM): 0 (kbl Max Burst Downlink CIR (SM): 0 (kbl HiPriChan(SM): 0 VCChannel: Low Priority Uplink CIR (SM): 0 (kbl Low Priority Uplink CIR (SM): 0 (kbl Low Priority Uplink CIR (SM): 3 Low Priority (SM): 5 APBerLevel(AP): 2 Level HiPri AllowVLANLearning(SM): 1 Allo SMManageVIDDis(SM): 0 IngressVID(SM): 1 ManageVID MemberSet(SM): Empty Set	ate: IN SESSION (Encrypt Disabled) (m.0.SVB,25.SVW,F.IT;SOC110.SVT;01:58.SVD;08/20/2015. PYBOOT 1.0 Sched, US/ETSI) P13 1) 65000 Uplink Burst Allocation(SM): 2500000 Sustained Downlink Data (location (SM): 2500000 (kbit) W): 0, units: (SM): kbps () kbit) 2 Low Priority Downlink CIR (SM): 0 High Priority Uplink CIR (SM): 0 High () Downlink Priority (SM): 3 High Uplink Priority (SM): 5 High Downlink TCPAck(AP): 1 pwVLANFrameType(SM): 0 VLANAgeTmout(SM): 25 (SM): 1

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:

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

Table 105: Color code versus uplink/downlink rate column

## 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

Maria Contractor	d againt sine Dos In Millar	n faal, Downlos S murte Acculation 2-ASISO 18	Extinica will pe I avery Septer AMO-E-AX MEA	le das sepalarias 1. Receive Qu 114/3150 2X	al at many alty Delta	every E ea providitie o to B SK W	rubied NO Artic	ie si 🖂 🖬	10-010 WWC-4550-4K							
			See.	CA SHORE				-	1448	Switkle						
Shorte	UMD	Brenst-N. Received Curriller, Leptine	日本の	Topsai to Topsai Turbi (182)	1000	a dada Takat Manasari y	fine .	Han Line Hyper Strength Rahn 198 P.	Tragments History	Dignat in Roba Rate (40)	Average Excel 1001	ion Taur (Brinny	lun .	101 Paulo	Hag	Table
	181	100100100100	420748.0 V:-86.8 HLD 8	38.873M H	-38.V/ -28.m	NA.	PODY MUC-	-348.106.0 91.40.8 93.8	Fub V DPMC YIS: N. DAM 25% K4-DAM 25% 2%-DAM 15% Fwh m DPSK 39% DF DAM 25% S4-DAM 25% 218-DAM 25%	35 ¥ / 37 10	:#W	NA.	INC.	a popularior	*	

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

Attribute	Meaning							
	(L	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 dis registers to number to t then regains	splays the LUID (logical unit ID) of the SM/BHS. As each SM or BHS the AP/BHM, the system assigns an LUID of 2 or a higher unique he SM/BHS. If a SM/BHS loses registration with the AP/BHS and s registration, the SM/BHS will retain the same LUID.						
	(P	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	<ul> <li>s - This field displays a count of beacons and maps received by the S percentage. SMs operating on System Release 20.2.1 or later will s lower of the map and beacon percentages and that will be display</li> <li>g SMs operating on System Release 20.2 or earlier will always send beacon percentage.</li> </ul>							
	This stat is recommended to be between 99-100%. If it is lower than indicates a problematic link as beacons and maps are sent in the low 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/BH							
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 dis	splays the average EVM statistics that measures RF signal quality.						
Downlink Statistics - Link Test Efficiency	This field dis the radio do	splays the efficiency of the radio link, expressed as a percentage, for ownlink.						
Downlink Statistics -	The SU-MIM	O rate applies to all AP platforms.						
SU-MIMO Rate	For 450m, t particular V	his field indicates the rate being used for symbols where this C 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 -	The SU-MIMO rate applies to all AP platforms.					
SU-MIMO Rate	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 ( $1 \times 10^{-4}$ ) 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

	Automotion Network	insel, Operative Star canal michaelans of p x 18. Calendary	anta anta a	A De sel	Chemit of the Chemity Co Industry Co Industry Co	at an ang P Second sa ta	9025098	unica isa			Line range	_		_			
-	1.000	Bancon Mary S. Recentl Carthly Suppose	1343555	191919	2.0 ()	Losi Seal Chinasy	340		FREE BEE	100000	Tertilien,	1-115	192	1 miles	1	-	-
No. of the local division of the local divis	192	-	-#53 143 GV/ 489 P	494) 494	No. 2	5.	121.051.	4.000000-00	121 43.8 5.86.941 48.9 46.93 46.93 46.93 48.9 48.9 48.9 48.9 48.9 48.9 48.9 48.9	Mail V Griek (Mic all GRIECTIN BAL GRIECTIN BAL GRIECTIN Date A GRIEK (Chi ba GRIECTIN GRIECTIN GRIECTIN GRIECTIN	Math. V GPNK (CRIMINAL SAMP CARANA SAMP CARANA SAMP SAMP CARANA SAMP CARANA SAMPA SAMPA SAMP SAMP SAMP SAMP SAMP SAMPA SAMP SAMPA S	48 V) 49 H		-	100	1	

Attribute	Meaning				
Subscriber	This field displays the MAC address and Site Name of the SM.				
	P	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 di registers to number to t then regains	splays the LUID (logical unit ID) of the SM/BHS. As each SM or BHS the AP/BHM, the system assigns an LUID of 2 or a higher unique the SM/BHS. If a SM/BHS loses registration with the AP/BHS and s registration, the SM/BHS will retain the same LUID.			
	₽ P	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							
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 ( $1 \times 10^{-4}$ ) 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							
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)	
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

Driverierik Status		
Recitive Prever	-54.41-57.9.B (-57.9.A) dBm	
Puth Info	Path A 1, 45' Path B 1, 44'	
Signal Strength Rates	1.5d) F - A	
Signal to Nume Rate	34.0 / 33.6 dt	
EVM	1 mini: Wangt 247 BT -256 A Ang 272 (261 B) + 27 A). Byot: 281 B1 -216 A mt 5 mini: Wangt 246 B1 -256 A Ang 273 (261 B) - 27 A). Bant 291 B1 -286 A mt 14 mini: Wonst 256 B1 -256 A Ang 272 (251 B) -27 A), Bund 256 B1 -295 A mt 14 mini: Wonst 256 B1 -256 A Ang 272 (251 B) -27 A), Bund 256 B1 -295 A mt	
Beausine / Mape:	15 ani: 150% imm/augiman) 1 min: 150% imm/augiman) 15 min: 95%150% (metargaman)	
Receive Fregments Modulation	Plan B GPSK 15% 16 GAM 33% \$4 GAM 36% 256 GAM 16% Plan A GPSK 15% 15 GAM 37% \$4 GAM 35% 256 GAM 17%	
Latest Remittle Link Test Efficiency Percentage:	NA %	
BER Tetel Aug Remain	E 0/0100x=00	
And and a second s		
Algara States		
Dignamit Poser	2 (2) (2)	
Mas Transmit Power	23 dan	
Pomar Level	-43.0 ( 47.0 % ( -47.0 Å) dBw	
Signal Storigth Ratio	E 0:00 E - A	
Signal to Sinker Ratio.	55 - 48 - 43 - 45 - 45 - 45 - 45 - 45 - 45 - 45	
EVM	1 min: Workt25 II / -33 A, Avg13 U (-32 B) -35 A), Beat40 B / -38 A min 5 min: Workt26 B / -33 A, Avg13 T / -32 B / -36 A), Beat40 B / -40 A min 16 min: Workt32 B / -33 A, Avg33 C / -22 B / -36 A, Beat46 B / -40 A, 40	
Latest Remote Link Taul Efficiency Percentage	NA S	
Local Status		
Sessian Status	REGISTERED BUIK MIMO-E	
Spatial Frequency	11	
Link County Indicates		
10	105%	
Downlive LOF	100%	
Reatton / Man Ociality Indian	107%	
Maleix LOI	100%	
Research attest Quality Index	102%	
Revegistration Courts		
Refrequences LOI		
Reference Downleik Quality Index	Taofre	
Reference Uplinit Quality Index	74cme	
Access Palet MAC Address	Taone	

Ludest Local Link Test Re-	100		
No test results available	_		

Serie Ser

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 Indicat	or					
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

Diversitile Datase		
Recalled Present 1		
Heating Power Cartor 11		
Receive Power Castler 2 ;	-01.21.00.0 V / -06.8 Ht start	
Ognal Strength Pate	-32.000 V + H	
Signal to Hasse Rate:	(3人)(43)(1)	
esw,	T. Yunin, Wanara, 204. V J. 204. PL, Aug. 282, 5 (20). V 1-20, Per, Berlan, 207. V 1-27, PL 40, Biranin, Wanara, 204. V 1-204. PL, Aug. 282, 5 (2019. V 1-204. PL, Berlan, 207. V 1-27, PL 400, V 0, Yunin, Wanara, 203. V 1-204. PL, Aug. 255, 8 (203. V 1-204. PL, Berlan, 207. V 1-27, PL 400).	
Eletiscome ( Magie )	100% (miniary)maxi	
Beacome / Maps (Ereprese)	100%	
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	Pado HI DUDOS (CAPOK)	
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Hendrice, Exageneeria Altanziation	Party or GPUER (1995) 18-CERE 2116 BALCARE 2116 (2004) 2016 (2004) 1815 Party of GPUER 2016 (1964) 2016 (BALCARE 2116) (2016) 2016	
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REN Tala Aug Henriti	Comparised Career 1: 0.000000+00 Comparised Carebra 2: 0.000001e-00	_
Lipink Sintar		
Signand Power	B pBes / 10 dBe;	
Man Transmit Power	. 28 other	
Power Level :	-04.9-1-07.0 V / -00.0 Ht 480x	
Signat Strength Halls	42 0488 V + H	
Rignal In Note Ralia:	38/48 V / 44 59 H	
finder (	1 mm; Humit 1 V / EHG Aug - 11-3 (-18 V / - 10 H); Best -35 V / - 36 H (45)	
EXM.	10 March 19 (2010) 1 (2010) 10 (2010) 2 (2010) 2 (2010) 2 (2010) 10 (2010	
I must likened into Tool O'Bring on Decembers	AND NO.	

Local Data			
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Les Overs Industry			
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Parlemente L CA			
National Diversity County makes	105		
Retrievency uplots Quality Index :	700 %		
Autorio Point MAC Addreso :	00-04-06-00-01-fe		
Lanual Local Date: Taket Hansada			
No test weather available.			
	Platter for		

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	Indicates 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.	
Beacons/Maps (Engineer)	Shows the percentage of received beacons for engineering purposes. A value of 100% suggests optimal reception.	
Link Quality Beacon Engineering	Displays the quality assessment of beacon signals, intended for engineering analysis. Quality values are shown for both Vertical (V) and Horizontal (H) paths, with modulation types specified.	
Link Quality Data Engineering	Shows an evaluation of data transmission signal quality, tailored for engineering purposes. Quality values are presented for various modulation types (QPSK, 16-QAM, 64-QAM, 256-QAM) on both Vertical (V) and Horizontal (H) paths.	
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.	
Stuck Session Count	Indicates the number of times the SM has encountered a stuck session, where it fails to establish or maintain a connection.	
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.
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%.
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

Receive BER Results	E
Current Receive BER modulation: QPSK	
Total bits received : 3161354664	
B: QPSK: Bit Errors: 0 Bit Error Rate: 0.000000e+00 A: QPSK: Bit Errors: 0 Bit Error Rate: 0.000000e+00	
Combined BER: 0.000000e+00	
L	Clear BER Results
Receive BER Power	B
Receive BER Power Level :	-24.0 dB (-27.0 dB B / -27.0 dB A)

# 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

Lito: Succoncer Session		E,
outert Suternier Midue	tu Fielstone (10013au1014a) Luit 2 💌	
l	DrictSeenedFesting EngliAl ConertSetsure	

# 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

PING Test Settings		
IPv4 Address/Fully Qualified Domain Name : www.google.com		
Perform Ping Test		
PING Test Results	E	
Pinging www.google.com		
[216.58.197.68]		
Sent to 216 58 197 68: hytes=64 seg=0		
Reply from 216.58.197.68: bytes=64 seq=0 time=70ms		
Sent to 216.58.197.68: bytes=64 seq=1		
Reply from 216.58.197.68: bytes=64 seq=1 time=110ms		
Sent to 216.58.197.68: bytes=64 seq=2		
Reply from 216.58.197.68: bytes=64 seq=2 time=110ms		
Ping statistics for 216.58.197.68: Paskets: Sent = 2. Reseived = 2. Lest = 0.(0% less)		
Approximate round trip times in milli-seconds: Minimum = 70ms, Maximum = 110ms, Average = 96ms		

#### Note

When a domain name (for example, <u>www.google.com</u>) 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

Contequantion	Link Dassels Test Generation Andreas (Black Detts Test   Page Test   Formware Upgrad	nan Spectrers Andycer   CHCM France Caduater   (Subscriber Configuration   Cark Status   Second *
Reference ogin voccordin Sauch Slavit Separight ogiofi		Tools+ Firmware Upgrade PMP 450i 5.7GHz MIMO OFDM - Access Point
Account edmin Lavel CMMESTRATOR Rode: Fourt Write Authoritication Histhod: Local	Integer Oxforms Upgrade File to Uploant upgrade ing or	Save Changes   Nation   r
Contraction (Contraction)	Upload and Update New Firmware In	iigo
CANOPY	File   Dyname File   No Tie shoreen   Uymad	
	-	Rard Inage There Teams
	Status of Image Update	
	Update Property	0



#### 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

Image details	
Upgrade File to Upload: 5x_20_cf200.img	

Figure 109: Firmware upgrade page for PMP 450 SM

Image details	
Upgrade File to Upload: 5x_cat120.img	

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

Device information		
Device Type :	SAGHz NU-MMO OFDM - Access Pvint - 0a-00-3e-00-e4-b	
(Nuwit Type :	#14	
Preduct Type :	PMP 450m	
Software Version	CANOPY 22:2 (Build DEV-12) AP	
Beethauter Version	BOOTLOADER 21.1/102.2022-08-27 13:13:18-0800	
CPU Usage:	24%	
Board MBN	MENCERIKMACIWE	
Board Model	COSOD45A111A	
Upper -	34, 18, 16, 33	
Southers Time	06.40.58 01/16/2024 CDT	
Main Etherveri kristiane	1000Base T Full Durbes	
Acce Ethannat Interface	Disatiest (PoE Disatiest)	
Basine Costa	Other	
Berndatory	Passed	
Channel Employee	5500.0 Miler	
Channel Boodwalth	20 0 MHz	
Cardin Broke	1746	
Enterna Present	10 to	
Concerning of Marine	111.449.00	
Ciperation dealer ;	Canadia of APR, 128 in a conditioned in Koney	
Electropicso ;	Endberge of MEDIA rise and coundrient of Moule	
CONF COME .	15	
Muo Honge :	2 Allen	
Chail.	32 dbm	
Terripistatione	37 10110 9	
Access Point State		
Registered BM Crasti	8-(21 Data-Charmels)	
Even: Pulse Solution	Generating Band	
Sync Pulse Bource	Self Generate	
Wastiman Count of Regulated SMs :		

Frame Configuration Information		
Data Bide Down	- 40	
Chuba Hildra Upi :	41	
Casterdan Buts	1	
cnMaeutro Connection State		-
Convection Status:	Connected (10, 120, 221, 248)	
Accust0 :	erroambo_ini jicorikae	
Site Information		
Sits Name	10.120.347.101 - PMP 450:: AP	
Sile-Contact	jie .	
File Location	lappade rack	
Feature Key Information		
MULANING Model	Trial Modo Inactive - 30 strye remaining	
Interterance Cancellation Milde	Trial Mode Active - 20 days remaining	
AES-256 Enclyption Keyed :	False	
Time Lipdated and Location Code :	01/12/2024 17-20 33 + INTL	

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.
	<ul> <li>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.</li> </ul>
	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	<ul> <li>This field displays a value from 0 to 254 indicating the AP's configured color code.</li> <li>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.</li> <li>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).</li> </ul>			
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 inc on the Cour	This field indicates the combined power level at which the AP will transmit, based on the Country Code.		
Temperature	This field ind	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 <b>CBRS Consolidated Procedurs</b> 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 S outside sou	ync indicates that the module is set to receive a sync pulse from an rce 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		
	Ú	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:			
	<ul> <li>Searching indicates that the unit is searching for a GPS fix</li> <li>Timing Port/UGPS indicates that the module is receiving sync via the timing AUX/SYNC timing port</li> <li>Power Port indicates that the module is receiving sync via the power port (Ethernet port).</li> <li>On-board GPS indicates that the module is receiving sync via the unit's internal GPS module</li> </ul>			

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 <b>MU-MIMO</b> (Multi User - MIMO); otherwise, it displays <b>SU-MIMO</b> (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 <b>Supported</b> . 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 <b>Configuration</b> -> <b>General</b> on the AP GUI.		
AES-256	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	ja (
Device Type 1	5 7GHz MMO OFDM - Access Point - 0a-00-8c-b1-2a-78
Board Type :	P12
Product Type .	PMP 450
Software Version .	CANOPY 15.2 AP
CPU Usage 1	Curr/Max: 93/95%
Board MSN.	6069QU0F0C
LPGA Version .	062618
PLD Version 1	20
Uptime :	03:44:81
System line .	09.11.33 07/12/2018 UTC
Mam Ethernet Interface .	100Base TX Full Duplex
Region Code :	Other
Regulatory :	Passed
Antenna Type .	External
Channel Frequency .	5050.0 MHz
Channel Bandwidth 1	20.0 MHz
Cyclic Profix 1	1/16
Frame Period .	2.5 ms
Encryption .	Capable of ALS_120 but configured to None
Color Code 1	171
Max Range 1	3 Mies
Transmit Power .	0 dBm
Iotal Antenna Gain .	0 dDr
Temperature	29 °C / 85 °F
	E)
Access Foll Shis	E
Registered Six Count :	1 (Tibata Channels)
Sync Pulse Status . Suite Bidea Status :	Generating Sync
Sync Puise Source 1	ser Generate
waximum count of logistered sws -	1
Frame Configuration Information	
Data Slots Down .	40
Data Slots Up 1	41
Contention Slots :	3
onMaestro Connection Stats	E
Connection Status .	Connected (cloud.cambrumnetworks.com)
AccountID 1	GRE001
Site Information	ET ET
Site Name .	No Sile Name
Site Contact .	No Sile Contact
Site Location 1	No Site Location
L	· · · · · · · · · · · · · · · · · · ·

Feature Key Information

AES-256 Encryption Keyed : Time Updated and Location Code . False 05/09/2017 06:23:21 INTE

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

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

Device Information	E.
Device Type .	5.4GHz MIMO OF DM - Access Point - Oa 00 Ge bb 01 77
Board Type :	P13
Product Type 1	PMP 450
Software Version .	CANOPY 15.1.5 AP None
CPU Usage .	2%
Board MSN 1	PMPM50IM8N
Board Model 1	C050045A010A
LPGA Version .	020110
Uptime .	2d, 07.56.57
System Time 1	17:58:46 01/03/2016 UTC
Man Ethernet Interface .	100Base TX Full Duplex
Aux Ethernet Interface :	Disabled (PoL Disabled)
Region Code :	Other
Regulatory	Passed
DES.	lde
Antenna Type :	Laternal
Channel Erequency :	5705 0 MHz
Channel Bandwidth 1	40.0 MHz
Cyclic Prefix .	1/16
Frame Period .	2.5 ms
Color Code 1	133
Max Range :	2 Mics
Transmit Power .	27 dBm
Iotal Antenna Gain .	40 dBr
Temperature 1	35 °C / 97 °F

Access Point Stats		E
Registered SM Count .	F (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 .	I	

Access Point Stats		
Registered SM Count :	1 (1 Data VCs)	
Sync Pulse Status :	Generating Sync	
Sync Pulse Source :	Self Generate	
Maximum Count of Registered SMs :	1	
Frame Configuration Information		E
Data Slots Down :	129	
Data Slots Up :	43	
Contention Slots :	3	
cnMaestro Connection Stats		E
Connection Status :	Cambium-ID Not Configured	
AccountID :		

Site Information	
Site Name :	450i AP-133
Site Contact :	No Site Contact
Site Location :	No Site Location

#### Feature Key Information

Time Updated and Location Code :

11/01/2017 13:21:54 - INTL

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	Con Conevel Status as as of AD for datails
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 MMID OFDM - Access Point - 03-04-06-00-01-0e
Buard Type :	P19
Product Type	PSP 455v 4z4
Solbarare Version	CANOPY 24.0 (Build SIT-15-BLENZ) AP
CONTRACT	2366
Dennel Miller	Large States and State
poors with .	NACHILL OWNERS
Board Medel	CONCOLSANDA 450YGCH2Enable
FFGA Variant	041924 FPGA Compiled Info Low Cost, Wireless-only, RF, Patha-2, Component Camera-3, AP, only
Uptime	06.07.11
System Time :	03.66.02 05/07/0924 CSV
March Ethannal Industries	100/Hores T Full Durches
Ann Etherned Mide Body	Parameter (Ref. Parameter)
with Diseline supervises	
Heliou mode	Crues some
Regulatory :	Paulod
Astennia Type :	Extense
	.5880.0 MHz (Component Carrier 1, Carrier 1)
Contraction of the second s	6666.0 MHz (Component Carrier 2, Carrier 2)
Charines Prequency.	
	Carrier 1 Fring SDBD J MHg
ADVO DOVALON AND TO	Casting 2 Find opportunity (1994)
Charged Bandwillty	40.0 MHz (20 + 20)
Gyttic Profix 1	1/16
Frame Period .	2.5 mi
Excreditori	Capable of AES-128 fact convergence to Norma
Calley Castle	140
Adapt Theorem 1	2 Miles
Putter Francisco I	a series
Elege :	10 dom a 10 dom
Transmit Power .	10.0pm/10.0pm
Total Anterna Gaix	5 dBi
Temperature	45 10 / 114 17
Allows Point Stata	
Becinternet BM Court	1(2 Data (Dervers))
Republication Bilation	Designing there (0) 270, Base online mentall (1909, the Dilat method orthog
Bine Boles for one	An entry of the sector of the provide the sector is a function of the sector of the se
Sync Fune Source	Watch own some transporte share) (successing to share)
Matemater Court of Registered SMs	
Franke Clarifiquation Information	
Data Stats Down	81
Data Blots Up	20
Contraction State	3
cristaestro Consection Stats.	
Connection Status :	Connected my direct cambiometrowiks card
Assessed	5 b b x Cacillo Declaression
Siler askermalism	
Site Name	propi Carrapy v
Site Contant	No She Contact
Site Location	No Sile Location
CARA STORY COMPANY AND	(100mm/0300)
APR 200 Exercises Present	1 day
TOD & CHUYPEN NET COM	Table State in the Second
LCC ACCERT ID & CHIS (UNIT-9) (UNIT-1)	True (Crighteening Kay Crientine)
Time Lipdated and Location Code	10/13/2823 13:48:17 - 0415

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 Monwation	
Device Type:	5.1-7.DGHz MBMO CFDM - Bubsenber Module - 02-04-50-00-d1-P1
Fishert Type:	Ptil
Provide and Transa	Philip and and
EnBassin Unrelief	Category 14.0 (Build BETS S) BM
and and a second s	Contrast and Dama and Long) and
CPU Usage	340 Pe
Buart MSN	MARA COVER TATH
Board Model	CD00045C401A
and the second	400 VECENCIARA
FPEAA Wershon :	DETIGS FPGA Compared Into Ltw_Cole, SM-only, Weinste-prov, HF_Pathan2, Component Camerana)
Lipteres (	06,15/28
Syldarei Tietar ii	00.08-07 05/03/2024 CST
Main Ethernet Intertace :	1000Base-T Pull Duales
802 tx Btabai	Department
Receiptors Cooler	Living States
DES	10m
Anderson Turker	Esternal
Francis Transfer	Automatic State St
Franker Freihou.	2.000
Encyglion :	Pacrose
Eirop	fighter / 10 affer
Transmit Pitwer	6 dBm / 10 dBm
Total Antenna Gaes	0.485
Teriperature	344 YC / 102 YF
Subscriber Module Stats	
Research River of	Recurst entry of
Contractor Granus	CODE DATES AND
Surveyory Lindows	64.45.26
Berlinsed AT	AN AL REPORT AN AD STRAID CONTRACT OF AD
Historica M.	Development of the second as a carried a view
Registered AP Software Version	CANCEY 24.0 (Build SE 14-5)
Cietor Ciede	THE ( Permany )
Sector ID	0
	19880.0 MHz (Companyint Carriar 1, Carriar 1)
	6000.0 NEtz (Component Center 2, Center 2)
Chernial Freiguardy	Contract Process and Contract
	Carter 1 File Deci V Min
Consult Provide land	Later and a final state of the second state of
Create Dark (Well)	and a second sec
CACIET LUMBE	100
An Childy :	75 mill approximately (LODE mans (38 heat)
Receive Power:	CC1: -40.5 mm
	10C22-401.8 (Bee
Signal Strength Ralac:	+1.0dB V + H
Signal to Notes Flatin	3/2 Y / 45 H 40
Beecons / Maps	100% (minimuginee)
AP Friend Utilization	Drawniank, 100% Uplink (100% (awar menute)
Line Churche Date Contraction	Path V OPSK 0.000 18-OAA10.000 64-OAMI0.000 255-OAMI0.000
Fair Creasily there Fuidureausid	Path H OP9K 0.024 18-GAM 0.000 84-OAM 0.000 258-OAM 0.000

Advanced Subscriber Matule Slats	
LUD:	2
RF Private 3P Acktrons	192.568 101.2
Registration Grant Status	Normal
Frequency Adjustment	1788.78900036
Bicktworest Upfink Data Rate	#19000
Uplink Bunt Allocation	4250007
Sustained Downlink Data Rate :	620000
Drawnick Hurst Alocation	4255000
Mae Burst Uplink Rate	8
Max Burst Downink Rate	8
Maltzait Data Channel Receive Rate	Disation
Frame Configuration Information	
Dwa Sints Down	RT
Data Sints Up :	20
Contention State	3
Report Specific Information	10x.12x2x2
Region Code	Livital Rates
on Manestro Connection Shifts	AND STATES AND STREET, AND STR
Connection Status :	Please welly retweek settings. Not able to establish connection with onlineation server. (15:120/207-200- From ATL
Autourit(D)	(Market)
Sile Information	
Elle Name	BM1 + Canopy V Bebar 4
Bile Contact )	BAN
Take Locaters 1	Canego// Setup 1
	(Yest the
Feeture Key Information	
Maamute Throughput	Unlimited
FOC Special Temporary Authority UNII-3 Band Extension 9850 MHz :	1+3805 Tites
Access to 6 GHz (FCC UNI-6, FCC UNI-7)	Test
Time Updated and Location Code :	02/29/2024 02:19:03 + IWTL

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.

Attribute	Meaning		
802.1x Status	Indicates th	Indicates the current status of IEEE 802.1X authentication protocol.	
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 ind	dicates the current Frame Period setting of the radio in ms.	
Encryption	This field ind	dicates the capability and the encryption configuration of the device.	
EIRP	Indicates th	e Effective Isotropic Radiated Power (EIRP) of the device.	
Transmit Power	This field lis	ts the current combined transmit power level, in dBm.	
		The red SM message "target power exceeded maximum" does not necessarily indicate a problem. <b>7 dBm (target power [24 dBm] exceeded maximum)</b> 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 cumulative gain of all antennas connected to the device, measured in decibels relative to isotropic (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 ind	icates that this SM currently attempts to receive sync.	
	Registering and has not	indicates that this SM has sent a registration request message to the AP yet received a response.	
	Registered indicates that this SM is both:		
	<ul> <li>regis</li> </ul>	tered to an AP.	
	• ready	y to transmit and receive data packets.	

Attribute	Meaning
Session Uptime	This field displays the duration of the current link. The syntax of the displayed time is hh:mm:ss.
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 for every 16 bits of throughput data transmitted, an additional bit is used.
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.
Link Quality	Provides detailed data on link quality for both vertical (V) and horizontal (H) paths,

Attribute	Meaning	
Data Engineering	including modulation types and associated quality percentages.	
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.	
Frequency Adjustment	Provides information about frequency adjustment values, potentially used for fine- tuning radio frequency settings.	
Sustained Uplink Data Rate	Indicates the sustained data rate for uplink transmission.	
Uplink Burst Allocation	Specifies the burst allocation for uplink transmission, potentially used for allocating additional bandwidth for bursts of data.	
Sustained Downlink Data Rate	Indicates the sustained data rate for downlink transmission.	
Downlink Burst Allocation	Specifies the burst allocation for downlink transmission, potentially used for allocating additional bandwidth for bursts of data.	
Max Burst Uplink Rate	Indicates the maximum burst rate allowed for uplink transmission.	
Max Burst Downlink Rate	Indicates the maximum burst rate allowed for downlink transmission.	
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.	
Contention Slots	This field indicates the number of (reserved) Contention Slots configured by the operator.	
Region Code	Represents multiple fixed selections, each automatically implementing frequency band range for the selected region. Units shipped to regions other than 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.	

Attribute	Meaning
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.
FCC Special Temporary Authority UNII- 3 Band Extension 5850 - 5895 MHz	Indicates whether the device is operating under the special temporary authority granted by the FCC for extension of the UNII-3 band, allowing operation in the frequency range of 5850 to 5895 MHz.
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 Info (under Subscriber Module Stats) which displays polarization path(A & B) information.

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Classifier	9000MHz - Calendaria Charles Calendaria (1980
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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	a) – – – – – – – – – – – – – – – – – – –
Device type	5 7GHz MMO OFDM - Dackload - Timing Naster - Dx-R0-Deh0-b0-c1
Board Type :	P13
Product type	P1P450
Software Version :	CANOPY 15.1.5 EHUL450 None
СРОПаяры	2%
Board NSN :	N9TJ1 C92CCJH
Hoard Model	CUMONSIDOTA
FPCA Version :	020118
Uptime	01.01.51
System Time :	23:19:08 01/02/2016 UTC
Nam I themel Interface	100Base-1X1 of Doples
Aux Ethernet Interface :	Disabled (PoE Disabled)
Region Code	Oher
Regulatory:	Passed
Adenus type	l stemat
Channel Frequency:	6760.0 MHz
Channel Banderdh	40.0.607
Ceclic Prefx:	1/16
Frame Ferrod	50 ms
Color Code :	38
Inanami Poeer	1K d Im
Total Antenna Cain :	0 dBl
Temperature	31.107.00.1
802.3at Type 2 PoE Status :	Not Present (gnored)
Backhard Stats	a de la companya de l
Lummu Slave Status	Connected
Sync Pulse Status :	Ceneraling Sync
Sync Pulse Source	Sell Generale
Frame Configuration Information	a' a'
Data Stota Down	191
Data Slois Up :	192
onMaestor Connection Stats	a
Connection Status	Remote management using chilaeatro is disabled
AccountID:	
Site Internation	
Site Name :	
Sile Contact	No Sile Contact
Site Location :	No Ste Location
<	
Feature Key Information	a
Time Updated and Location Code	0 MC92010 05 58003 - 1 XGD

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 :	4.9/5.9CHz NINO OFDM_Backhaul_Timing Slave_0a.00 3e bb ac 1b
Board Type	1213
Product Type :	PTP 4501
Sallware Version	CANOPY 15 1.5 DEDUCTORED IS
OPU Usage:	2%
Down HON	MATTERI GMSI
Board Model :	C0500458001A
LINGA Version	1120/110
Uplime :	01:00:23
System time	23/22 DE 01/02/2018 01/1
Hain Ethernet Interface :	No Link
Aug I themet luterlace	Disabled (Pol. Disabled)
Region Code :	Other
10.5	ldi=
Antenna Type :	External
Losme Period	5.0 ms
Temperature :	27 °C /81 °F
102 Gal Type 2 Poll (Status	Not Prevent (Ignored)
Timing State Stats	
Session Status :	RECISTERED VC 18 Rate \$301X MINO A VC 255 Rate \$308X MINO B
Season Uptime	10.58 53
Registered Backhaul:	0a 00 3e bb b0 c1
Channel Frequence	5/50 0 M L/
Channel Bandwidin :	40.0 MHz
Cyclic Preix	1/16
Alr Delay:	100 ns, approximately 0.009 miles (49 feet)
Receive Power	-129 dBu
Signal Strength Ratio:	2.0dBV H
Signal to Norse Ratio	403 W74011 dtt
Transmit Power:	16 dBm
Total Ademos Gam	
Beacons :	100 %
Linne Centeursten Internation	
Data Story Down :	151
Data Stole Down.	107
Loss - may by	
Region Specific Information	
Region Code :	Other
enViaestro Connection Stats	
Connection Status :	Device Not Claimed (cloud.camblumnetworks.com   Default Cloud URL)
AccountD	
Sta húreating	

Site Name	No Sile Name	
Sile Contact:	No Site Contact	
Sile Location	No Sile Location	
Feature Key Information		-
Time Updated and Location Code	01/03/2010/05/11/06 -11/04	

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	1
Site Location	1
Time Updated and Location Code	1

## **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

Seasting Statut List Sola				Jermell	214.415										
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an by (+= >+) (->	-	Advent	878	1000	1.25/21/28	1147	Sale C	34	19105001 101031	1.02	1.00				
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NATE OF BRIDE AND	0	Aireand	1016	3049.70	38/28/28	1 11	2145	2136	CONSTRUCTION OF	0	10				
11.571 Republication	in	100 Automat 1/8		1010.08	and a	nie.	3147	- 67 - 2136	Unable: 14.0629	1.1	10				
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the life to man it had		Autorini	.s/A	100-001 40	25-(2272)	24	2141	2134	10110103 143438 CDT	11	10				
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NUL ST2 AGAIN 25-FLTB AN	100	A landstate S/A		1003530	15/195-28	147	Sur	318	1249-0400 4408-26 CS/F	1.1	12				
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Herri Bille Rie Hille All ta H	1 100	Admitted	10.0	10-02-04	minim.	2742	1147	2128	18485020 44.00.27	10	10				
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paint (In Treated in Darys	Cherry I	*		9.2											
ttribute	Mear	ning													
ubscriber	This SM/I	This field displays the LUID (logical unit ID), MAC address and Site Name of the SM/BHS.													
	Note depe yield	: The M ending c s a blan	AC is a on netv k web	a hot lin vork ac page. I	k to oper tivity and f this occ	the in netwo urs, ref	terfac ork de <sup>F</sup> resh y	e to tl sign, t /our b	ne SM/BHS. In his route to th rowser view.	some i e inter	nstan face				
	Site Conf	Name ir iguratic	idicate n web	es the na page c	ame of th of the SM/	e SM/I /BHS. 1	ЗНS. С Гhis in	Chang forma	e this name on tion is also set	the into tł	ne				

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.
	<b>Note</b> : 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
	<ul> <li>IN SESSION to indicate that the SM/BHS is currently registered to the AP/BHM.</li> </ul>
	<ul> <li>IDLE to indicate that the SM/BHS was registered to the AP/BHM at one time, but now is not.</li> </ul>
	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	<b>Req:</b> EIRP requested in the Grant Request.
Req/Auth/In Use	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 <b>same day</b> 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						
	<b>In Use</b> : For SMs, this value is the smaller of the <b>granted EIRP</b> and the <b>Max EIRP</b> 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 <b>In Use</b> 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 <b>In Use</b> 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.						
	<b>Skipped:</b> 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 <b>Perform Religuish/Deregister</b> button to relinquish this grant. Keep checked to prevent the device to request the same grant.						
De-Register	Check and click the <b>Perform Religuish/Deregister</b> 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 <b>Number of idle SMs</b> <b>which are considered active</b> 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 <b>Channel Change When Only SMs are</b> <b>Impacted</b> 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 <b>Threshold for</b> <b>Channel Change</b> configuration item is left at its default value of 10%, then this statistic has a value of 1. Changing the <b>Threshold for Channel Change</b> 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

Date:	Property and the second			_	Second	Status and							
thinp	hin momaton				Encryption	on is deadlined in	on the rade						
1	-Dense B	ession	- News	Certiger		Lot Gualty							
	Reporting .	mber LUD state		Uptime Se	Session Registration	Re	00	Ar Deay		PPPoE	120		
1	- Starker to be			(Opantime)	Could	Requests	Requests	Priority	Distance	m	to fa	ittato	1 mente
110 5	He Name (0a-00-3e- 9-4d)	822	IN SESSION	02 38 38	1	1	0	Primary	0.000 miles (0 feet)	0	0	TGA	n

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
	<ul> <li>AP/BHM has not yet observed the link to the SM/BHS as being down.</li> </ul>
	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. O indicates that no limit is imposed.

### Power tab

Table 120: Power tab attributes

ta : cripti	ton information		Power	Contamine	Late Challey		SectionStatus or Encryption is disc	ni Ibied on t	his rade		
				Deserre	im Rata	Lipin	t: Rate	神影	Signal	Granut to Notes	
. Butticriber		CUID	Hardware	BU-WMD	MU-MINO	SU-MMO	MU-MMO	offirm	Rate (dl)	Fatio (dB)	
UD	010-108-00-38-50-12-90	010	NA.	NA.	NA	NLA.	NA .	NA I	NA	NA	
ΠĎ	Citer Cost States	011	NA I	NA.	NA .	[ NA .	MA	NA	NA	NA	
×D	1010-00400-0404-0400	013	14A	NA	NA .	74A	NA .	NA I	NA.	NA	
11	51a-00-3e-b4-d2-c9	012	PMP 450	BX/8X MIMO-B	BX/BX MIMO-E	EK/EX MIMO-B	SX/SX MIMO-B	-53.0	0.0dB V - H	35 V/38 H	
11	110/12/00/25/25/25/25/00	003	FWP 450	BK6X MINO-E	SX/SX MIMO-E	BX:BX:MIMO-B	SX/1X MIMO-A	-51.2	0.5dB V - H	35 V/38 H	
42	12 (0+-05-2+-04-24-28)	008	PWP 450	EXEX MIND-II	GX:8X MINED-8	BODK MINO-B	B-OMIM XB/XB	-50.0	0.0481 12-14	34 V/38 H	
11	13 (0e-00-3e-04-(0-e0)	007	PMP 450	4X/4X MINO-E	ADCVDX MINIO-B	4X/4X MMO-B	4X/4X/MMO-B	-50.5	1.0d8 V - H	20 V/20 H	
44	21100-01-04-01-05	602	PMP 450 8	4X/4X MINO-E	4X/2X MIMO-A	4X/4X M MO-B	48/4X MIND B	-55.4.	H V Bbb B	20 V / 20 H	
45	24 (0#-319-3#-04-d2-0)	005	PWP 450 1	BX/BX MIMO-B	EXCILX MIMO-B	EKAX MINO-B	BX/6X MIMO-B	-80.5	1.000 V-H	27 V/ 22 H	
11	2210a-0(-Se-04-d2-ff)	009	PWP 450	BUDY MIND-E	BX/8X MIMO-E	B-CMIM KRX8	8X/KX MIMO-B	-51.0	0.04E V - H	26 V / 33 H	
π	21 04-05 34.04 (2.53	004	PWP 450 1	SX/SK MIMO-B	BX-8X MIMO B	EXEX M MO-B	BX BX M MO B	-618	0.8dB V - H	26 V/33 H	
MI	28 04-05-34-64-62-65	008	PMP 450 1	EXEX MINO-8	BCIX MIND-B	E BOOK MINICI-B	B-OMM MIMO-B	-51.1	-0.700 V - H	32 V / 30 H	

Attribute	Meaning
Subscriber	See Device tab attributes
LUID	
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

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tao Jidar Maran	002	11pine	4000	4000(AAA)	2900(AAA)	5000(AAA)	0(0)	NA .	0(0)	NA.	1000010	1000	SM on	10.115.207.101
104-00-361	-	Doenes		1000(AAA)	2900(AAA)	3000(AAA)	0(11)	34	O(D)	365			10.110.207.101	

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 fallback. 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.

Session Status Configuration	
Show Idle Sessions	Enabled
Show fale Sessions .	O Disabled
Link Quality Update Interval :	1 minute 🔻
Link Quality Metric :	EVM V
	Rate
	EVM

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

la clypb	on information		Second Dielas and Encryption is disabled on this radio											
Dense Second Press Configuration Link Quality														
	Subscriper	LUID	Leni Quetty milcator	Dyanty Index	Actual Average Rate	Expected Rate	Beacon Guality Inder	Bearum Th	Quality Index	Actual Aswrage Rate	Expected	Re-F Guality Index	Court	Uptime
SM15 12-09	12#-00.3#:2#	012	105	100%	800	-8X	100%	100%	100%	8X	ax.	100%	0	02:38:48
141	11.10#30-34-64	803	100	100%	8X	31	100%	100%	103%	8X	8X.	100%	0	02,38 13
1M2 4-01	12 04-00-18-04-	908	100	100%	800	3X	100%	100%	1025	3X	8X	109%	0	02:38:13
141	1100005004	607	100	100%	43.	48	190%	100%	100%	48	40,	10295	0	02.38.17
114	21 100-06-50-04-	902	100	102%	41	4X	100%	100%	100%	48	40.	100%	0	02:38:17
0-fel	24108-05-38-64	005	100	100%	DK .	81	100%	100%	300%	6K	63	100%	6	02:38:15
2.0	22.084.905344.94	809	100	100%	105	AX.	100%	150%	103%	ax	tax.	100%	0	02:38:15
M7.	23,106:92:36:94:	004	100	100%	SX	8X	100%	100%	100%	61	ØX.	100%	8	02:38:17
INI.	20.10±91-3±9±	005	100	100%	800	ax	100%	100%	100%	80	SK	103%	0	02:38:15

#### Link Quality Metric: EVM

Data Encryption Information					Encryption in	a ani o disabled e	t this radio	:					
Dente	Selate		Press:	Century	Link	Quality					_		
<ul> <li>Subsorber</li> </ul>	1.10	Link Guality Indicator	Guality Indee	Actual Average EVM	Expectent EVM	Beacon Quality Index	Guacon Ng.	Gundity Index	Actual Actual Average EVM	Espected (EVM	Guarty Judes	eg. Court	tipeon
VSM Kia 00-3e-45-11	002	89	9945	-28.1	-79.0	100%	100%	100%	.27.1	25.0	100%	D	3 days.

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 110: Remote Subscribers page of AP

#### Remote Subscriber Modules

01	72 SM 5.7 MIMO P11 -	[0a-00-3e-a0-00-79] - LUID: 005
1 million 1		

02 76 SM 57 SISO P11 - [0a-00-3e-39-35-4f] - LUID 006

03 77 SM 5.7 SISO P11 - [0a-00-3e-39-35-91] - LUID: 007

04 81 450i SM 4 9/5 9 MIMO - [0a-00-3e-bb-00-d7] - LUID 010

05 82 SM 450i 4.9/5.9 MIMO - [0a-00-3e-bb-01-03] - LUID 002 06 83 450i SM 4.9/5.9 MIMO - [0a-00-3e-bb-00-ae] - LUID 004

07. 84 450i SM 4.9/5.9 MIMO - [0a-00-3e-a2-c3-d8] - LUID, 009

08. 86 SM 450 P11 5 4/5 7 MIMO - [0a-00-3e-a0-00-71] - LUID: 008

09 No Site Name - (0a-00-3e-a2-c2-79) - LUID: 003

### 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 111: Event log data

 System Event Log

 01/01/2011 : 00:00:15 UTC : :user=admin; \*System Log Cleared\*;

 01/01/2011 : 00:00:00 UTC : :

 01/01/2011 : 00:00:00 UTC : :Time Set

 01/01/2011 : 00:00:00 UTC : :Time Set

 System Reset Exception -- Power-On Reset

 Software Version : CANOPY 14.1.1 AP-DES

 Board Type : P12

 Device Setting : 5.4GHz MIMO OFDM - Access Point - 0a-00-3e-a1-35-75 - 5480.0 MHz - 20.0

 MHz - 1/16 - CC 5 - 2.5 ms

 FPGA Version : 110615

 FPGA Features : DES, Sched, US/ETSI;

### **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.

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.

Table 125: Event Log messages for normal events

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 112: 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 113: 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.

# Layer 2 Neighbors Log

MAC address: 0a-00-3e-a0-01-75 IP address: 192.168.2.6 Site Name: No Site Name

# **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	曰: [1]
Transmit Unicast Data Count	6715
Transmit Broadcast Data Count :	804747
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
Ovenun Count	0
Underrun Count :	0
Receive Corrupt Data Count	0
Receive Corrupt Control Data Count :	0
Receive Bad Broadcast Control Count	0
Rev L1 Start :	3
Rev IT Start HS	5
Rev LT Result :	5
Xnt IT Result	0
Trame Too Big :	0
Bad RCV Fragment	0
Bad RCV I ragment Length :	0
VC Clear Frior Count	0
Rx No Buffer Count :	D
Scheduler Error	90
Transmit Ring Error :	D
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	ast 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. W radio initiates a link test, the remote radio will send its results to this radio 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 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 mor of these will cause the session to drop and be re-established. That static should 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 couto 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

Norradie Mode	
	Fishied Si/s 0
Kenado Statistica :	Maned Responses (R)
	Percent Received: 12%
	Header Service

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	t 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

Nemetic Male Nonacie Statistiks : Updale Responses Sent:12745		
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

Registration Failures Statistics	E,
Number of Registration Grant Failures 1	
Most Recent Registration Failure List	EŶ
MAC : 0a 00 3e 04 a7 26 AAA Session Retry 12/31/2010 : 19:23:30 CST : Status : 17 Hag : 0	

Attribute	Meaning
Status 17 Flag O	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

Registration Failures Statistics Number of Registration Grant Failures

Most Recent Registration Failure List

MAC : 0a-00-3e-04-a7-26 AAA Session Retry 12/31/2010 : 19:23:30 CST : Status : 17 Flag : 0

1

Attribute	Meaning
Status 17 Flag O	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 115: Bridging Table page

# Statistics → Bridging Table

### 5.4GHz MIMO OFDM - Access Point - 0a-00-3e-bb-00-fb

Bridging Table				
Physical Address	Dest LUID	Age	Hash	<b>⊜Ent</b>
0A003EBB00FB	258	-1	0576	02
0A003EBB0104	002	-1	0959	02
1A003EBB00FB	259	-1	0576	02
1A003EBB0104	002	-1	0959	02
Used: 4 BridgeFree	4092 Bridge	FullEn	r 0	

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 116: Translation Table page of SM

ransiston latie 🗖
Ma: 0022/0894581 pAdtress:182.108 2.1 Atte 0
Map 00, FS 3450879 (p5dorber, 162), 86 2 7 Age 0
Mat 3021555/83E31tAt dress 192198.3.2 Agetu
Mac 000P43783603 loApdress - 92,160,2,4,5gc 0
Mat AC81128BUU MItAt dress 192-198.26 Agetu
Mad 0004206DA056 loApdives: 102.160.2.0 Ago 0
Mat 1020501/A92B/pAdtress(132/103/27) Atjevi
Mad 6021550706E6 loApdress   73-150 6-168 Ago 86
Mat VCLALM818AZ - pAdtresst 192.166 2.6 Alte Vu
Vac 00 FSB450679 p5dorce: 161 - 66 50 107 Ago 16

### **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

Ethemet Statistics		
Link Desected	3	
Link Speed :	100Base-TX Full Duplex	
PIN ID.	Micrel KSZ8041 P12 (0x00221510)	
Link Uptime :	1 day, 1h:14m28s	
Link Lost :	2	
Undersized Toss Count :	0	
inoctets Court	1020927	
inucastplits Count	10906	
Innucastokis Count :	4792	
indiscards Count	0	
inerrors Count	0	
munknownprotos Count :	0	
getociets Count :	703480	
outucastpkteCount :	3	
putrucastpicts Count .	8190	
outdisclards Count :	0	
outerrors Count	0	
CRC Error :	0	
RevFifeNaBul .	0	
Late Collision :	0	
Excessive Collision :	0	
Tx Underrun :	0	
Carrier Sense Lost	0	
No Carrier	0	
Large Frame :	0	
Runt Frame :	0	
Excessive Defenses :	0	
Jabliers :	0	
RX Pause Frames Discarded	0	
RX Ethernet Bounce :	0	
TX Ethemet Source :	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

Re- Control Efficies Statistics	E Contraction of the second
nicters wount:	957572789
hutestpits upunt:	42?0?6
nnucast : kts Count	25010015
httiscards ulturt:	
herors Courc	
hunknewneretos weinte	
cutorcets Count	167721214
:utucast:ktsCount	401826
tutrucastikts Count	16765
cutdiscence Count	· 2
iute filirs Giunti:	

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

Colorestar	in an	Constal Francisco	Stimuth (Dessare)	Dov	undezde :	-Up	Ink
ODJECHUTE	100	share cadvair's	Crammin in all carrie	Sounding State	MU-MIMO Rate	Sounding State	MU-MIMO Rate
SM4_21 F9a-00-34-64-d3-361	002	879	-59.7, -9.1, 41.6	TRACKING	4X/2X MIMO-A	TRACKING	4X/4X MIMO-8
SM1 11 (0a-00-3e-64-24-1a)	003	2	-50.6.0.1.50.7	TRACKING	BX/8X MIMO-B	TRACKING	BX/1X MIMO-A
3M7 23 (0a-00-3e-04-c2-5c	004	879	-59791,41.6	TRACKING	6X/6X MIMO-B	TRACKING	8X/6X MIMO-8
SM5 24 F0g-06-3e-b4-d2-tel	005	879	-597 -91 41.6	TRACKING	SX/SX MIMO-B	TRACKING	8X/6X MIMO-B
SM8 2610e-00-3e-64-c2-65	008	879	-59.7, -9.1, 41.6	TRACKING	EX/8X MIMO-E	TRACKING	BX/6X MIMO-B
SM3 53 F0a-00-3e-b4-d2-e01	007	2	-50 6, 0.1, 50.7	TRACKING	4304X MIMO-B	TRACKING	4X/4X MIMO-8
SM2 12 10a-00-3e-b4-24-081	800	2	-50.6, 0.1, 50.7	TRACKING	SX/SX MIMO-B	TRACKING	BX/SX MIMO-E
SMS 22108-00-3e-04-02-11	009	879	-59.79.1.41.6	TRACKING	6X/6X MMO-B	TRACKING	8X/6X MIMO-B
SM15 (0a-00-3e-04-d2-c9)	012	2	-50 6 0 1 50 7	TRACKING	BX/8X MIMO-B	TRACKING	8X/8X MIMO-8

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
	<ul> <li>UNKNOWN: SM has recently registered to the AP but not registered with the channel manager yet.</li> </ul>
	<ul> <li>NEW: SM has been registered with the channel manager and will soon transition to ASSESSING.</li> </ul>
	<ul> <li>ASSESSING: AP will instruct SM to take the channel measurements. Channel estimates and spatial frequencies will be calculated.</li> </ul>
	<ul> <li>TRACKING: Valid measurements resulted in good channel estimates and spatial frequency. This SM can now be used for MU-MIMO.</li> </ul>
	<ul> <li>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.</li> </ul>
	<ul> <li>NOT ELIGIBLE: Due to poor RF link conditions, the RF link as rate adapted down to SU-MIMO transmissions.</li> </ul>
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

VLAN Statistics Configuration :	1	(Range : 1 - 4094 or 0 for Priority-tagged)
VLAN Statistics		
VID : VID Stats Frames Received : 1823 Bytes Received : 586624 Frames Transmitted : 1640 Bytes Transmitted : 585735	1	

No Ingress Filtered Frames

Ingress : Total Frames Filtered : 0 Total Bytes Filtered : 0

Egress : Total Frames Filtered : 0 Total Bytes Filtered : 0

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

Samonier LUC	hack	D Chairesi Pinaity	Introved Statistics					Chiltopund Blatston				Distan	High	
	LUC		octette	VCAIL DATE	revolution and a	Uncarity	01013	echete	Lincast picts	WALKET DRTD.	decards	errors	Overfax	Dunty
M4.21	002	Los	35471406	1	11742	0	0	78002904	6011	45568	0 )	0	0	100
MA.21	002	Mechuint	107730	0	(1)	0.	0	107738	0	83	0	0	0	0
MI 21	002	Figt	387730	0	60	0.	0	107730	0	-63	0	0	0	0
MA.21	007	Uitra High	1038574	6678	100	0	0	152828	158	311	0	4	0	3006
AIS U	003	Low	1958	4	2	0.	0	99422	117	0	0	0	0	241
Art It	003-	Medium	1	0	0	4	2	4	0	0	0	4	0	0
MIV 11	003	High	0	0	0	4	1	4	0	0.	0	4	5	0
MIL IT	103	Uitra High	648533	3950	36	4	2	41899	158	198	0	4	2	396
NT 23	1004	Low	10098383	E.	6375	0	0	96431	£11	t	0	0	0	292
NO-23	D04-1	Medum	8	0	6	0.	0	0	8	0 5	0	0.1	0	0
247.21	D04	High		0	6	0	0	0	0	D	0	0	0	0
M7.23	004	Utra High	636037	4008	37	0	0	45099	150	248	0	0	0	401
NIS 24	005	Los	10093173	5	6372	0	0	86204	764	1. 1	0	0.1	0	254
M5.24	005	Medury	8	0	0	0	0	0	0	D	0	0 .	0	0
M5.24	005	Nigh.	5	0	6	0	0	0	0	D I	0	0	0	0
M5.24	005	Lifts High	671A35	4291	37	0	2	45089	158	248	2	0	2	406
A81.25	008	Low	14407593	5	\$474	÷.	ð .	95000	742	1.	0	0	0	224
41.3	003	Medium	3	0	8		\$		0	0	8	4	8	0
18.3	000	High	8	0	6	8	ð	1	0	0	6	4	0	0
41.15	006	Uitra High	761670	4625	36	4	8	45057	157	148	0	4	0	405
NO 12	607	Low	12903055	£.	7600	0.	0	89789	670	1 1	0	0	0	154
40.12	007	Medium		0	0	4	0	4	0	0	0	0	0	0
U_08	007	High	8	0	0	0.	0 :	4	0	0	0 1	0	0	Ô.
MO 10	007	Utia High	636026	3998	38	0	0 1	45000	-150	240	0 1	0	0	401
M2 12	000	Low	21802973	5	12752	0.	0	\$4194	720	1. 1	0	0	0	2.20
M2 12	008	Meduri	9	0	0	0.	0 1	4	0	0.	0 1	4	0	0
M2 12	008	High.	8	0	0	0	0	0	0	0 1	0 1	0	0	0
M2 32	000	Litra High	6.37607	3931	36	4	0	45099	150	240	0	0	0	404
148.22	009	Law	10000563	8	6301	0	0	100175	001	.1.	0	0	0	275
AND 22	0.09	Medum	3	0	8	4	0	8	0	8	0	0	0	0
All5 22	009	High	8	0	0	0.	0	a	0	8	ġ i	6	0	0
ANS 22 1	609	Uttra High	696681	4521	38	0.	5	45099	150	240	0	4	6	404
MILS .	012	Low	22323535	3924	12741	a	0	142215	3445	250	0	6	ð	675
Autoast	252	NA	NA	NA	NA	14	hA.	36504	0	415	0	4	NA.	PAA
tespace.	155	NA.	144	NA.	NA.	AA .	NA	1006314	18	15912	0	0	NA	NA.

#### Data Channel Statistics

Subscriber	LUID	SM Ptt	Channel Priority	Inbound Statistics					Outbound Statistics					
				actets	ucast pkts	nocast pkts	discards	errors	nctets	ucast pits	nucast pkts	discards	еприз	
Broadcast	255	NA	NA	NA	NA.	NA	NA	NA	5527765	399	25160	0	D	
Multicast	252	NA.	NA	NA	NA	NA	NA	NA	0	0	0	0	0	
No Site Name	002	Low	Low	1948	4	1	a	0	2618	7	0	0	0	
No Site Name	002	Low	High	8112944	49563	396	0	0	6033604	40613	4010	0	0	

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

a secondora	dia any	Rec	Retransmitted				
<ul> <li>buoschber</li> </ul>	LOD	OPSK	16-GAM	64-QAM	256-QAM	Fragmenta	
No Site Name	002	44171 256	43626 221	43594 173	231 99	0	