Cambium 450 Platform User Guide

System Release 14.1.1

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About This User Guide

This guide describes the planning, installation, configuration and operation of the Cambium point-to-point and point-to-multipoint wireless Ethernet bridges. It covers PMP/PTP 450, 450i and 450d platform Series. It is intended for use by the system designer, system installer and system administrator.

For radio network design, refer to the following chapters:

- Chapter 1: Product description
- Chapter 2: System hardware
- Chapter 3: System planning
- Chapter 4: Legal and regulatory information
- Chapter 5: Preparing for installation
- Chapter 6: Installation

For system configuration, tools and troubleshooting, refer to the following chapters:

- Chapter 7: Configuration
- Chapter 8: Tools
- Chapter 9: Operation
- Chapter 10: Reference Information
- Chapter 11: Troubleshooting

Contacting Cambium Networks

Support website:	http://www.cambiumnetworks.com/support
Main website:	http://www.cambiumnetworks.com
Sales enquiries:	solutions@cambiumnetworks.com
Support enquiries:	support@cambiumnetworks.com
Repair enquiries:	rma@cambiumnetworks.com
Telephone number list:	http://www.cambiumnetworks.com/contact
Address:	Cambium Networks Limited, Global Headquarters, 3800 Golf Road, Suite 360, Rolling Meadows, IL 60008 USA

Purpose

Cambium Networks Point-to-Multi-Point (PMP)/Point-To-Point (PTP) 450 documents are intended to instruct and assist personnel in the operation, installation and maintenance of the Cambium PMP/PTP equipment and ancillary devices of 450 platforms. It is recommended that all personnel engaged in such activities be properly trained.

Cambium disclaims all liability whatsoever, implied or express, for any risk of damage, loss or reduction in system performance arising directly or indirectly out of the failure of the customer, or anyone acting on the customer's behalf, to abide by the instructions, system parameters, or recommendations made in this document.

Cross references

References to external publications are shown in italics. Other cross references, emphasized in blue text in electronic versions, are active links to the references.

This document is divided into numbered chapters that are divided into sections. Sections are not numbered, but are individually named at the top of each page, and are listed in the table of contents.

Feedback

We appreciate feedback from the users of our documents. This includes feedback on the structure, content, accuracy, or completeness of our documents. Send feedback to support@cambiumnetworks.com.

Important regulatory information

The 450 platfrom products are certified as an unlicensed device in frequency bands where it is not allowed to cause interference to licensed services (called primary users of the bands).

Application firmware

Download the latest 450 platform firmware and install it in the Outdoor Units (ODUs) before deploying the equipment. Instructions for installing firmware are provided in Upgrading the software version and using CNUT on page 7-67.

USA specific information

Caution

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

- This device may not cause harmful interference, and
- This device must accept any interference received, including interference that may cause undesired operation

The USA Federal Communications Commission (FCC) requires manufacturers to implement special features to prevent interference to weather radar systems that operate in the band 5600 MHz to 5650 MHz. These features must be implemented in all products able to operate outdoors in the band 5470 MHz to 5725 MHz.

Manufacturers must ensure that such radio products cannot be configured to operate outside of FCC rules; specifically it must not be possible to disable or modify the radar protection functions that have been demonstrated to the FCC.

Cambium supplies variants of the PMP/PTP 450i specifically for operation in the USA in order to comply with FCC requirements (KDB 905462 D02 UNII DFS Compliance Procedures New Rules v01r02). These variants are only allowed to operate with license keys that comply with FCC rules.

Similarly, Cambium supplies variants of the PMP/PTP 450 specifically for operation in the USA in order to comply with FCC requirements (KDB 443999 D01 Approval of DFS UNII Devices v01r04). These variants are only allowed to operate with license keys that comply with FCC rules. To ensure compliance when using PMP 450 and PTP 450, follow the recommendation in Avoidance of weather radars (USA only).

External antennas

When using a connectorized version of the product, the conducted transmit power may need to be reduced to ensure the regulatory limit on transmitter EIRP is not exceeded. The installer must have an understanding of how to compute the effective antenna gain from the actual antenna gain and the feeder cable losses.

The range of permissible values for maximum antenna gain and feeder cable losses are included in this user guide together with a sample calculation. The product GUI automatically applies the correct conducted power limit to ensure that it is not possible for the installation to exceed the EIRP limit, when the appropriate values for antenna gain and feeder cable losses are entered into the GUI.

Avoidance of weather radars (USA only)

To comply with FCC rules (KDB 443999: Interim Plans to Approve UNII Devices Operating in the 5470 - 5725 MHz Band with Radar Detection and DFS Capabilities), units which are installed within 35 km (22 miles) of a Terminal Doppler Weather Radar (TDWR) system (or have a line of sight propagation path to such a system) must be configured to avoid any frequency within +30 MHz or –30 MHz of the frequency of the TDWR device. This requirement applies even if the master is outside the 35 km (22 miles) radius but communicates with outdoor clients which may be within the 35 km (22 miles) radius of the TDWRs. If interference is not eliminated, a distance limitation based on line-of-sight from TDWR will need to be used. Devices with bandwidths greater than 20 MHz may require greater frequency separation.

When planning a link in the USA, visit http://spectrumbridge.com/udia/home.aspx, enter the location of the planned link and search for TDWR radars. If a TDWR system is located within 35 km (22 miles) or has line of sight propagation to the PTP device, perform the following tasks:

- Register the installation on http://spectrumbridge.com/udia/home.aspx.
- Make a list of channel center frequencies that must be barred, that is, those falling within +30 MHz or –30 MHz of the frequency of the TDWR radars.

The PMP 450 platform AP must be configured to not operate on the affected channels.

Canada specific information

Caution

This device complies with Industry Canada's license-exempt RSSs. Operation is subject to the following two conditions:

(1) This device may not cause interference; and

(2) This device must accept any interference, including interference that may cause undesired operation of the device.

Industry Canada requires manufacturers to implement special features to prevent interference to weather radar systems that operate in the band 5600 MHz to 5650 MHz. These features must be implemented in all products able to operate outdoors in the band 5470 MHz to 5725 MHz.

Manufacturers must ensure that such radio products cannot be configured to operate outside of IC rules; specifically it must not be possible to disable or modify the radar protection functions that have been demonstrated to IC.

In order to comply with these IC requirements, Cambium supplies variants of the PMP/PTP 450 platform for operation in Canada. These variants are only allowed to operate with license keys that comply with IC rules. In particular, operation of radio channels overlapping the band 5600 MHz to 5650 MHz is not allowed and these channels are permanently barred.

In addition, other channels may also need to be barred when operating close to weather radar installations.

Other variants of the PMP/PTP 450 platform are available for use in the rest of the world, but these variants are not supplied to Canada except under strict controls, when they are needed for export and deployment outside Canada.

Renseignements specifiques au Canada

Attention

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes :

(1) l'appareil ne doit pas produire de brouillage, et

(2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Industry Canada (IC) a demandé aux fabricants de mettre en œuvre des mécanismes spécifiques pour éviter d'interférer avec des systèmes radar fonctionnant dans la bande 5600 MHz à 5650 MHz. Ces mécanismes doivent être mis en œuvre dans tous les produits capables de fonctionner à l'extérieur dans la bande 5470 MHz à 5725 MHz.

Les fabricants doivent s'assurer que les produits de radiocommunications ne peuvent pas être configurés pour fonctionner en dehors des règles IC, en particulier, il ne doit pas être possible de désactiver ou modifier les fonctions de protection des radars qui ont été démontrés à IC.

Afin de se conformer à ces exigences de IC, Cambium fournit des variantes du PMP/PTP 450 platform exclusivement pour le Canada. Ces variantes ne permettent pas à l'équipement de fonctionner en dehors des règles de IC. En particulier, le fonctionnement des canaux de radio qui chevauchent la bande 5600-5650 MHz est interdite et ces canaux sont définitivement exclus.

IC Approved Antennas

The list of antennas used to obtain IC approvals is provided in section Country specific radio regulations, Industry Canada (IC) , Table 244.

Antennas externes

Lorsque vous utilisez une version du produit sans antenne intégrée, il peut être nécessaire de réduire la puissance d'émission pour garantir que la limite réglementaire de puissance isotrope rayonnée équivalente (PIRE) n'est pas dépassée. L'installateur doit avoir une bonne compréhension de la façon de calculer le gain de l'antenne réelle et les pertes dans les câbles de connections.

La plage de valeurs admissibles pour un gain maximal de l'antenne et des pertes de câbles de connections sont inclus dans ce guide d'utilisation avec un exemple de calcul. L'interface utilisateur du produit applique automatiquement la limite de puissance menée correct afin de s'assurer qu'il ne soit pas possible pour l'installation de dépasser la limite PIRE, lorsque les valeurs appropriées pour le gain d'antenne et les pertes de câbles d'alimentation sont entrées dans l'interface utilisateur.

Antennes approuvées par IC

La liste des antennas approveés pour l'operation au Canada est founie dans le chapitre Country specific radio regulations, Industry Canada (IC) tableaux Table 244.

EU Declaration of Conformity

Hereby, Cambium Networks declares that the Cambium PMP/PTP 450i, 450d and 450 Series Wireless Ethernet Bridge complies with the essential requirements and other relevant provisions of Directive 1999/5/EC. The declaration of conformity may be consulted at:

http://www.cambiumnetworks.com/support/ec-doc

Specific expertise and training for professional installers

To ensure that the PMP/PTP 450 platform equipment is installed and configured in compliance with the requirements of Industry Canada and the FCC, installers must have the radio engineering skills and training described in this section.

The Cambium Networks technical training program details can be accessed from below link:

http://www.cambiumnetworks.com/training/category/technical-training/

Ethernet networking skills

The installer must have the ability to configure IP addressing on a PC and to set up and control products using a web browser interface.

Lightning protection

To protect outdoor radio installations from the impact of lightning strikes, the installer must be familiar with the normal procedures for site selection, bonding and grounding. Installation guidelines for the 450 platform can be found in Chapter 2: System hardware and Chapter 3: System planning.

Training

The installer needs to have basic competence in radio and IP network installation. The specific requirements applicable to the 450 platform should be gained by reading Chapter 5: Preparing for installation, Chapter 6: Installation, Chapter 7: Configuration, Chapter 8: Tools and Chapter 9: Operation; and by performing sample set ups at base workshop before live deployments.

The Cambium Networks technical training program details can be accessed from below link:

http://www.cambiumnetworks.com/training/category/technical-training/

Problems and warranty

Reporting problems

If any problems are encountered when installing or operating this equipment, follow this procedure to investigate and report:

1. Search this document and the software release notes of supported releases.
2. Visit the support website.
3. Ask for assistance from the Cambium product supplier.
4. Gather information from affected units, such as any available diagnostic downloads.
5. Escalate the problem by emailing or telephoning support.

Repair and service

If unit failure is suspected, obtain details of the Return Material Authorization (RMA) process from the support website (http://www.cambiumnetworks.com/support).

Hardware warranty

Cambium's standard hardware warranty is for one (1) year from date of shipment from Cambium Networks or a Cambium distributor. Cambium Networks warrants that hardware will conform to the relevant published specifications and will be free from material defects in material and workmanship under normal use and service. Cambium shall within this time, at its own option, either repair or replace the defective product within thirty (30) days of receipt of the defective product. Repaired or replaced product will be subject to the original warranty period but not less than thirty (30) days.

To register PMP and PTP products or activate warranties, visit the support website. For warranty assistance, contact the reseller or distributor. The removal of the tamper-evident seal will void the warranty.

Caution

Using non-Cambium parts for repair could damage the equipment or void warranty. Contact Cambium for service and repair instructions.

Portions of Cambium equipment may be damaged from exposure to electrostatic discharge. Use precautions to prevent damage.

Security advice

Cambium Networks systems and equipment provide security parameters that can be configured by the operator based on their particular operating environment. Cambium recommends setting and using these parameters following industry recognized security practices. Security aspects to be considered are protecting the confidentiality, integrity, and availability of information and assets. Assets include the ability to communicate, information about the nature of the communications, and information about the parties involved.

In certain instances Cambium makes specific recommendations regarding security practices, however the implementation of these recommendations and final responsibility for the security of the system lies with the operator of the system.

Warnings, cautions, and notes

The following describes how warnings and cautions are used in this document and in all documents of the Cambium Networks document set.

Warnings

Warnings precede instructions that contain potentially hazardous situations. Warnings are used to alert the reader to possible hazards that could cause loss of life or physical injury. A warning has the following format:

Warning

Warning text and consequence for not following the instructions in the warning.

Cautions

Cautions precede instructions and are used when there is a possibility of damage to systems, software, or individual items of equipment within a system. However, this damage presents no danger to personnel. A caution has the following format:

Caution

Caution text and consequence for not following the instructions in the caution.

Notes

A note means that there is a possibility of an undesirable situation or provides additional information to help the reader understand a topic or concept. A note has the following format:

Note

Note text.

Caring for the environment

The following information describes national or regional requirements for the disposal of Cambium Networks supplied equipment and for the approved disposal of surplus packaging.

In EU countries

The following information is provided to enable regulatory compliance with the European Union (EU) directives identified and any amendments made to these directives when using Cambium equipment in EU countries.

Disposal of Cambium equipment

European Union (EU) Directive 2002/96/EC Waste Electrical and Electronic Equipment (WEEE)

Do not dispose of Cambium equipment in landfill sites. For disposal instructions, refer to http://www.cambiumnetworks.com/support/weee-compliance

Disposal of surplus packaging

Do not dispose of surplus packaging in landfill sites. In the EU, it is the individual recipient's responsibility to ensure that packaging materials are collected and recycled according to the requirements of EU environmental law.

In non-EU countries

In non-EU countries, dispose of Cambium equipment and all surplus packaging in accordance with national and regional regulations.

Chapter 1: Product description

This chapter provides a high level description of 450 platform Series products. It describes in general terms the function of the product, the main product variants and the main hardware components. The following topics are described in this chapter:

- Overview of the PMP/PTP 450 platform on page 1-2 introduces the key features, typical uses, product variants and components of the PMP/PTP 450i and 450 series platform.
- Wireless operation on page 1-12 describes how the PMP/PTP 450 platform wireless link is operated, including modulation modes and spectrum management.
- System management on page 1-16 introduces the PMP/PTP 450 platform management system, including the web interface, configuration, security, alerts and recovery.

Overview of the PMP/PTP 450 platform

This section introduces the key features, typical uses, product variants and components of the PMP/PTP 450 platform.

Purpose

Cambium PMP/PTP 450 platform Series products are designed for Ethernet bridging over point-to-point and point-to-multipoint microwave links in unlicensed and lightly-licensed frequency bands 900MHz, 2.4 GHz, 3.5/3.65 GHz and 4.9 to 5.925 GHz.

Users must ensure that the 450 platform Series complies with local operating regulations.

The 450 platform Series acts as a transparent bridge between two or more segments of the operator's network. In this sense, it can be treated as a virtual wired connection among points. The 450 platform Series forwards 802.3 Ethernet frames destined for the other part of the network and filters frames it does not need to forward. The system is transparent to higher-level protocols such as VLANs.

PMP/PTP 450 platform Series

The 450 platform supports following series:

- PMP/PTP 450i Series
- PMP/PTP 450 Series
- PMP 450d Series
- PMP 430 Series

PMP/PTP 450i Series

The PMP/PTP 450i is a high performance wireless bridge for Ethernet traffic. It is capable of operating in line-of-sight (LOS), near-LOS and non-LOS propagation condition. It supports 900 MHz and 4.9 to 5.925 GHz frequency band.

Key features

The PMP/PTP 450i Series has extensive quality of service (QoS) classification capability.

The Cambium PMP/PTP 450i Series offers the following benefits:

- Cambium's highest performing point-to-multipoint solution, with up to 150 Mbps usable throughput for PMP and PTP
- State-of-the-art MIMO (Multi-In Multi-Out) technology
- Upto 6.5 bps/Hz spectral efficiency
- Increased Packet Processing rate

- Efficient GPS synchronized, scheduled TDD operation for easy AP/BHM site deployment and performance that is consistent regardless of SM/BHS loading
- A range of cost-effective subscriber device solutions to meet the business case of any network application
- MIMO Matrix B: This technique provides for the ability to double the throughput of a radio transmission under proper RF conditions. Different data streams are transmitted simultaneously on two different antennas
- MIMO-A mode: This mode of operation has same modulation levels as the MIMO-B mode, namely: QPSK, 16-QAM, 64-QAM and 256-QAM. This mode increases system reliability in the links.
- Timing synchronization via CMM4 or uGPS

Table 1 gives a summary of the main PMP/PTP 450i characteristics.

Table 1 Main characteristics of the PMP/PTP 450i Series

Characteristic	Value
Topology	PMP/PTP
Wireless link condition	LOS, near LOS or non-LOS
Range	PTP Up to 186 mi (or 299 km) depending on configuration for all bands PMP: Up to 40 mi (or 64 km) for 5.x GHz band PMP: Up to 120 mi (or 193 km) for 900 MHz band
Duplexing	TDD (symmetric and asymmetric)
Connectivity	1000Base-T Ethernet Main port with PoE input
Operating frequencies	902 to 928 MHz 4.9 to 5.925 GHz
Tx Power	max 27 dBm (5 GHz) max 25 dBm (900 MHz)
Channel bandwidth	5, 7, 10 and 20 MHz
High spectral efficiency	Up to 6.5 bps/Hz
Timing synchronization	CMM4 or uGPS
Data rate	Up to 150 Mbps (20 MHz channel BW) for PMP/PTP

Frequency bands

The PMP/PTP 450i ODU can operate in the following bands:

- 900 MHz band: 902 to 928 MHz (PMP only)
- 5 GHz band: 4900 to 5925 MHz
  - 5.1 GHz band: 5150 to 5250 MHz
  - 5.2 GHz band: 5250 to 5350 MHz
  - 5.4 GHz band: 5470 to 5725 MHz
  - 5.8 GHz band: 5725 to 5925 MHz

Note

900 MHz band requires different hardware.

Hardware components

The ODU (Outdoor unit) is a self-contained transceiver unit that houses both radio and networking electronics. The main hardware components of the PMP/PTP 450i are as follows:

- PMP 450i AP
- PMP 450i SM
- PTP 450i BH (BHM/BHS)

The **PMP/PTP 450i** is supplied in the following configurations:

Table 2 PMP/PTP 450i Series hardware configurations

ODU	Frequency	ODU type	
PMP 450i AP	902 to 928 MHz	Connectorized	Use with an external antenna
	4.9 to 5.925 GHz (support 4.9, 5.1, 5.2, 5.4 and 5.8 GHz)	Integrated	16 dBi, 90° sector antenna
		Connectorized	Use with an external antenna
PMP 450i SM	4.9 to 5.925 GHz (support 4.9, 5.1, 5.2, 5.4 and 5.8 GHz)	Integrated	23 dBi flat panel antenna
		Connectorized	Use with an external antenna
PTP 450i BH	4.9 to 5.925 GHz	Integrated	23 dBi flat panel antenna
		Connectorized	Use with an external antenna

Note

The BH ODU can be configured as a BHM or a BHS in PTP mode

Warning

The PMP 450i AP 16 dBi, 90° sector antenna does not support frequency reuse between collocated APs because of poor F/B ratio.

To achieve frequency re-use between collocated APs, please use the PMP 450i AP Connectorized and external antennas.

For details on frequency planning, please see Radio Frequency planning on page 3-15.

PMP/PTP 450 Series

Cambium PMP/PTP 450 Series networks are designed for wireless point-to-multipoint and point-to-point links in the unlicensed/licensed 2.4 GHz, 3.5 GHz, 3.65 GHz, 5.4 GHz and 5.8 GHz bands. Users must ensure that the PMP/PTP 450 Series complies with local operating regulations.

The PMP/PTP 450 Series adds dramatically increased network throughput and capacity. The PMP/PTP 450 Series enables network operators to grow their business by offering more capacity for data, voice and video applications.

Key features

The Cambium PMP/PTP 450 Series offers the following benefits:

- Cambium's highest performing point-to-multipoint solution, with up to 150 Mbps usable throughput
- State-of-the-art MIMO (Multi-In Multi-Out) technology
- Better spectral efficiency than other MIMO alternatives
- Efficient GPS synchronized, scheduled TDD operation for easy Access Point site deployment and performance that is consistent regardless of subscriber loading
- A range of cost-effective subscriber device solutions to meet the business case of any network application
- MIMO Matrix B: This technique provides for the ability to double the throughput of a radio transmission under proper RF conditions. Different data streams are transmitted simultaneously on two different antennas.
- MIMO-A mode: This mode of operation using the same modulation levels as the MIMO-B mode, namely: QPSK, 16-QAM, 64-QAM and 256-QAM.

Table 3 gives a summary of the main PMP/PTP 450 characteristics.

Table 3 Main characteristics of the PMP/PTP 450 Series

Characteristic	Value
Topology	PMP/PTP
Wireless link condition	LOS, near LOS or non-LOS
Range	PTP: Up to 186 mi (or 299 km) depending on configuration for all bands PMP: Up to 40 mi (or 64 km) for 5.x GHz band PMP: Up to 120 mi (or 193 km) for 900 MHz band
Duplexing	TDD (symmetric and asymmetric)
Connectivity	100Base-T Ethernet Main port with PoE input
Operating frequencies	900 MHz, 2.4 GHz, 3.5 GHz, 3.65 GHz and 5 GHz
Tx Power	max 27 dBm (2.4 GHz and 5 GHz) max 25 dBm (3.5 GHz and 3.65 GHz max 25 dBm (900 MHz - PMP 450 SM only)
Channel bandwidth	5, 7, 10 and 20 MHz
High spectral efficiency	Up to 6.5 bps/Hz
Data rate	Up to 150 Mbps (20 MHz channel BW) for PMP/PTP

Frequency bands

The PMP/PTP 450 Series ODU can operate in the following bands:

- 900 MHz band: 902 to 928 MHz (SM only)
- 2.4 GHz band: 2400 to 2483 MHz
- 3.5 GHz band: 3300 to 3600 MHz
- 3.65 GHz band: 3500 to 3850 MHz
- 5.4 GHz band: 5470 to 5725 MHz
- 5.8 GHz band: 5725 to 5875 MHz

Note

The 900 MHz, 2.4 GHz, 3.5 GHz, 3.65 GHz and 5 GHz bands require different hardware. The 5 GHz band (either 5.4 or 5.8 GHz) can be configured on same hardware.

Hardware components

The main hardware components of the PMP/PTP 450 are as follows:

- PMP 450 AP
- PMP 450 SM
- PTP 450 BH (BHM/BHS)

The **PMP/PTP 450** is supplied in the following configurations:

Table 4 PMP/PTP 450 Series hardware configurations

ODU	Frequency	ODU type	
PMP 450 AP	2.4 GHz	Connectorized	Use with an external antenna
		Integrated	18 dBi Dual Slant
	3.5/3.65 GHz	Connectorized	Use with an external antenna
		Integrated	16 dBi Dual Slant
	5 GHz (5.4 and 5.8 GHz)	Connectorized	Use with an external antenna
		Integrated	17 dBi Dual Slant
PMP 450 SM	900 MHz	Connectorized	Use with an external antenna
	2.4 GHz	Connectorized	Use with an external antenna
		Integrated	7 dBi Dual Slant, integrated patch
	3.5/3.65 GHz	Connectorized	Use with an external antenna
		Integrated	8 dBi Dual Slant, integrated patch
	5 GHz (5.4 and 5.8 GHz)	Connectorized	Use with an external antenna
		Integrated	9 dBi H+V, integrated patch
PTP 450 BH	3.5/3.65 GHz	Connectorized	Use with an external antenna
		Integrated	16 dBi Dual Slant
	5 GHz (5.4 and 5.8 GHz)	Connectorized	Use with an external antenna
		Integrated	17 dBi Dual Slant

Note

The BH ODU can be configured as a BHM or a BHS in PTP mode

Supported interoperability for 450i/450/430 platforms

The supported interoperability among various 450i/450/430 hardware platforms are listed below:

Table 5 Supported Interoperability for PMP

Band	AP platform	SM platform
4.9, 5.1, 5.2 and 5.9 GHz	PMP 450i AP	PMP 450i SM (Greenfield)
5.4 and 5.8 GHz	PMP 450i AP	PMP 450i SM, PMP 450 SM, PMP 450d SM and PMP 430 SM
	PMP 450 AP	
2.4, 3.5 and 3.65 GHz	PMP 450 AP	PMP 450 SM
900 MHz	PMP 450i AP	PMP 450 SM

Table 6 Supported Interoperability for PTP

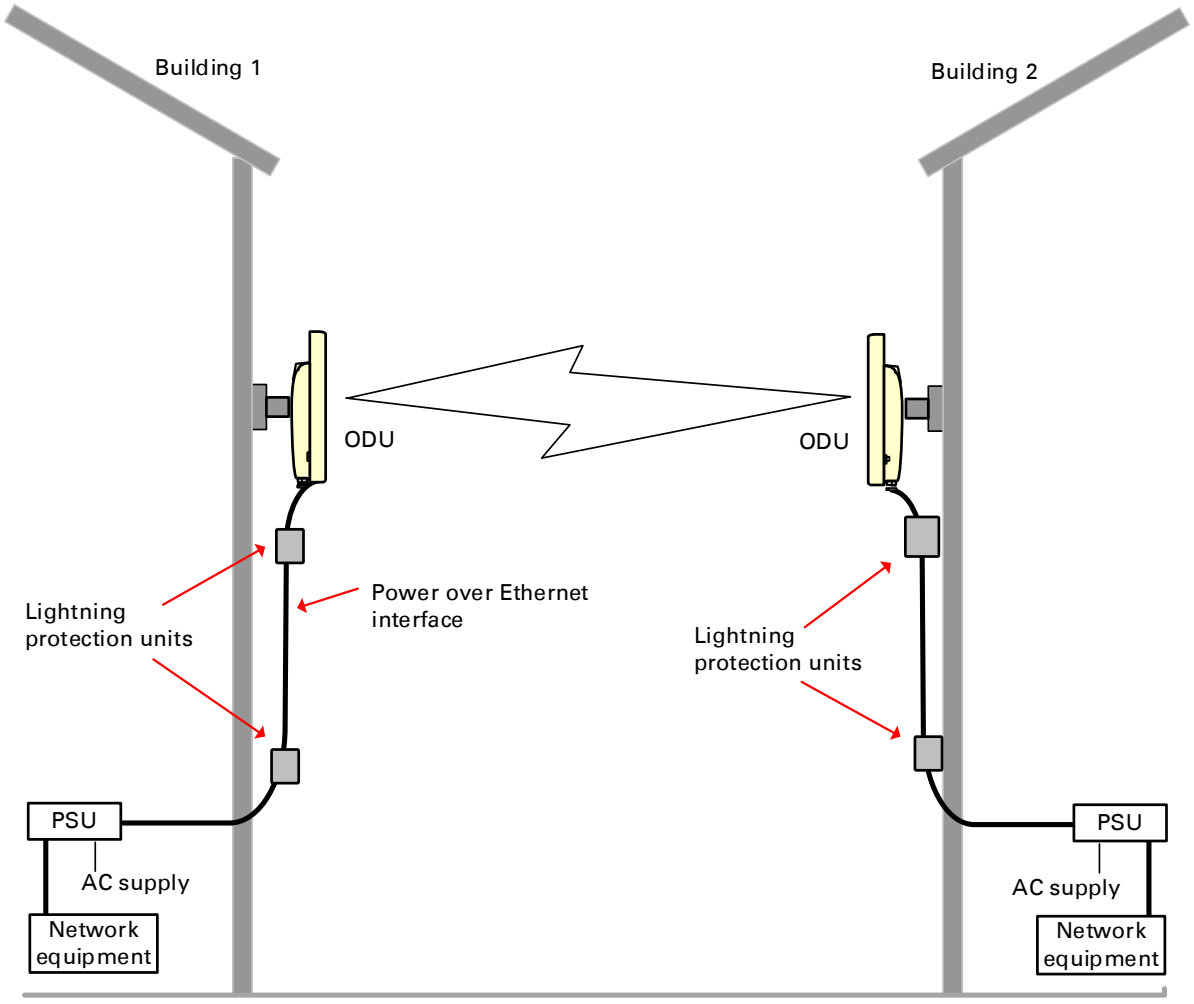
Band	BH platform
4.9, 5.1, 5.2, 5.4 and 5.8 GHz	PMP 450i BHM and BHS
5.4 and 5.8 GHz	PMP 450 BHM and BHS
3.5 and 3.65 GHz	PMP 450 BHM and BHS

Typical deployment

The 450 platform is an "all outdoor" solution consisting of a wireless bridge across sites. Each site installation consists of an Integrated or Connectorized outdoor unit (ODU) and a power supply (PSU) (see Figure 1). The ODU provides the following interfaces:

- Ethernet port: This provides proprietary power over Ethernet and connection to the management and/or data networks.

Figure 1 PMP/PTP 450 platform typical bridge deployment



Point-to-Multipoint

The PMP 450 platform Series consists of Access Point (AP) and Subscriber Module (SM) ODU. The radio link operates on a single frequency channel in each direction using Time Division Duplex (TDD).

Applications for the PMP Series include:

- High throughput enterprise applications
- nLOS video surveillance in metro areas
- Urban area network extension
- Network extension into areas with foliage

Point-to-Point (Backhaul)

The PTP 450 platform Series consists of two BH (Backhaul) ODUs. The customer can decide, via software configuration, if this unit is a BHM (Backhaul Master) or a BHS (Backhaul Slave). The radio link operates on a single frequency channel using Time Division Duplex (TDD).

Applications for the PTP Series include:

- Enterprise Access
- nLOS video surveillance
- Leased line replacements and backup solutions
- Network extension

Product variants

The PMP 450 platform Series is available in the following product variants:

- The ODU is supplied in the following regional variants:
  - FCC, intended for deployment in the USA
  - EU, intended for deployment in countries of the European Union or other countries following ETSI regulations
  - Rest of the World (RoW), intended for deployment in countries other than USA and EU countries.
  - IC, intended for deployment in Canada
- An indoor power supply module providing Power-over-Ethernet (PoE) supply to ODU (AP/SM/BH)
- Antennas and antenna cabling: Connectorized ODUs require external antennas connected using RF cable
- Ethernet cabling: All configurations require a copper Ethernet Cat5e connection from the ODU (Ethernet port) to the PoE
- Lightning protection unit (LPU): LPUs are installed in the ports copper drop cables to provide transient voltage surge suppression
- Surge Suppression: The 600SS and 1000SS Surge Suppressor provides a path to ground (Protective Earth) that protects connected radio equipment from near-miss lightning strikes.
- Ground cables: ODU, LPUs and outdoor copper Ethernet cables are bonded to the site grounding system using ground cables.

For more information about these components, including interfaces, specifications and Cambium part numbers, refer to Chapter 2: System hardware.

Wireless operation

This section describes how the PMP/PTP 450 platform wireless link is operated, including modulation modes, power control and security.

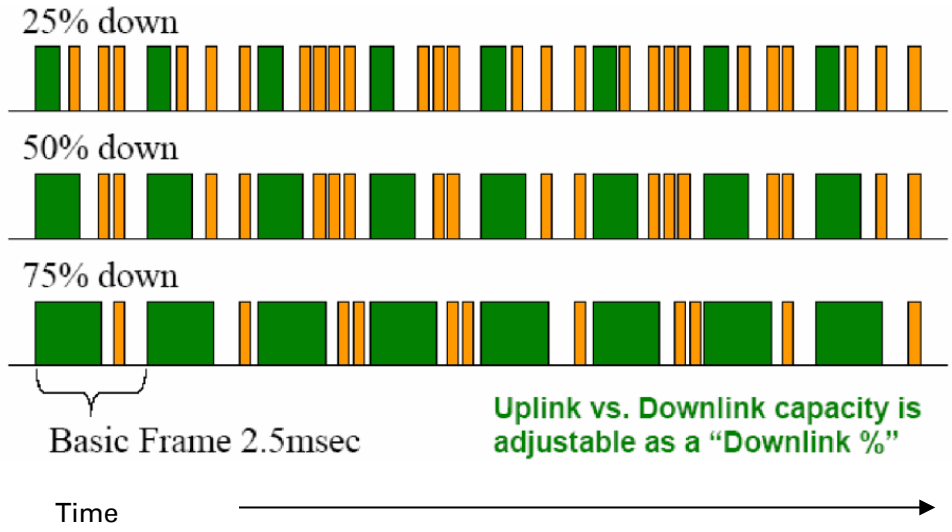
Time division duplexing

The system uses Time Division Duplexing (TDD) – one channel alternately transmits and receives rather than using one channel for transmitting and a second channel for receiving. To accomplish TDD, the AP/BHM must provide sync to its BHS. Furthermore, collocated APs/BHMs must be synced together – an unsynchronized AP/BHM that transmits during the receive cycle of a collocated AP/BHM can prevent a second AP/BHM from being able to decode the signals from its APs/BHSs. In addition, across a geographical area, APs/BHMs that can "hear" each other benefit from using a common sync to further reduce self-interference within the network.

Modules use TDD on a common frequency to divide frames for uplink (orange) and downlink (green) usage, as shown in the figure below.

For more information on synchronization configuration options, see GPS synchronization on page 2-37.

Figure 2 TDD frame division



TDD frame parameters

The TDD burst duration varies depending on the following:

- Channel Bandwidth
- Cyclic Prefix
- Frame Period
- Frame configuration - Downlink Data
- Link operation – Dynamic Rate Adaptation

OFDM and channel bandwidth

The PMP/PTP 450 platform Series transmits using Orthogonal Frequency Division Multiplexing (OFDM). This wideband signal consists of many equally spaced sub-carriers. Although each sub carrier is modulated at a low rate using conventional modulation schemes, the resultant data rate from the sub-carriers is high. OFDM works exceptionally over a Non-Line-of-Sight (NLoS) channel.

The channel bandwidth of the OFDM signal is configurable to one of the following values: 5, 7, 10 and 20 MHz. Higher bandwidths provide greater link capacity at the expense of using more bandwidth. Systems configured for a narrower channel bandwidth provide better receiver sensitivity and can also be an appropriate choice in deployments where the amount of free spectrum is limited.

Note

The channel bandwidth must be configured to the same value at both ends of the link. Not all channel bandwidths are available in all regulatory bands.

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 (slot) 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. For your convenience, the 450 and 450i products have been locked to a 1/16 CP.

Frame Period

The frame period or frame duration is the time between the beginning of a frame and the end of the frame. The PMP/PTP 450 platform Series supports two frame periods: 2.5 ms and 5 ms.

The 5ms frame period configuration provides higher throughput as a result of reduced frame overhead during transmission. In turn, the 2.5 ms frame period configuration affords reduced latency in the system, half of that introduced by the 5 ms frame configuration.

Frame configuration - Downlink Data

The percentage of frame assigned to transport downlink data. The downlink data specifies the percentage of the aggregate throughput for the downlink (frames transmitted from the AP/BHM to the subscriber). The configurable range is 15 to 85 percent.

Link operation – Dynamic Rate Adapt

PMP/PTP 450 platform Series products offer eight levels or speeds of operation – 2X MIMO-B and 1X MIMO-A (QPSK), 4X MIMO-B and 2X MIMO-A (16-QAM), 6x MIMO-B and 3X MIMO-A (64-QAM) and 8X MIMO-B and 4X MIMO-A (265-QAM). If received power is less due to distance between the AP/BHM and the SM/BHS or due to obstructions, or if interference affects the RF environment, the system automatically and dynamically adjusts the links to the best operation level.

The system chooses its modulation rate dynamically, based on an internal ARQ (Automatic Repeat reQuest) error control method. With ARQ, every data slot of every frame sent over the air (except downlink broadcast) is expected to be acknowledged by the receiver, and if acknowledgement is not received, the data is resent. The sending unit monitors these re-sends and adjusts the modulation rate accordingly. It is normal to have links that change levels of operation as the RF environment changes. Furthermore, the uplink or downlink portions of TDD duty cycle operate independently; normal operation can have a downlink running at 6x while the uplink RF environment only supports 2x.

The various modulation levels used by the PMP/PTP 450 platform are shown in Table 7.

Table 7 Modulation levels

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

Note

MIMO-A achieves half the throughput of MIMO-B but adds a combining diversity (gain) which enhances the link budget or availability.

MIMO

Multiple-Input Multiple-Output (MIMO) techniques provide protection against fading and increase the probability that the receiver decodes a usable signal. When the effects of MIMO are combined with those of OFDM techniques and a high link budget, there is a high probability of a robust connection over a non-line-of-sight path.

The sub-features that comprises the MIMO techniques utilized in the PMP/PTP 450 platform product are:

- Matrix A: This technique enables the 450 platform radio to use a scheme that optimizes 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.
- Matrix B: This technique provides for the ability to double the throughput of a radio transmission under proper RF conditions. Different data streams are transmitted simultaneously on two different antennas.

Encryption

The Cambium 450 platform Series supports optional encryption for data transmitted over the wireless link. The PTP 450 platform Series supports the following forms of encryption for security of the wireless link:

- **DES (Data Encryption Standard)**: An over-the-air link encryption option that uses secret 56-bit keys and 8 parity bits. DES performs a series of bit permutations, substitutions, and recombination operations on blocks of data. DES encryption does not affect the performance or throughput of the system.
- **AES (Advanced Encryption Standard):** An over-the-air link encryption option that uses the Rijndael algorithm and 128-bit keys and 256-bit key size to establish a higher level of security than DES. AES products are certified as compliant with the Federal Information Processing Standards (FIPS 197) in the U.S.A.

The default setting on an AP is "Disabled".

System management

This section introduces the PMP/PTP 450 platform management system, including the web interface, installation, configuration, alerts and upgrades.

Management agent

PMP/PTP 450 platform equipment is managed through an embedded management agent.

Management workstations, network management systems or PCs can be connected to this agent using the module's Ethernet port or over-the air (SM/BHS)

The management agent supports the following interfaces:

- Hypertext transfer protocol (HTTP)
- Hypertext transfer protocol secure (HTTPS)
- RADIUS authentication
- Simple network management protocol (SNMP) – v2c and v3
- Network time protocol (NTP)
- System logging (Syslog)
- Wireless Manager (WM) software
- Canopy Network Updater Tool (CNUT) software

Web server

The PMP/PTP 450 platform management agent contains a web server. The web server supports access via the HTTP/HTTPS interface.

Web-based management offers a convenient way to manage the PMP/PTP 450 platform equipment from a locally connected computer or from a network management workstation connected through a management network, without requiring any special management software. The web and SNMP are the interfaces supported for installation of 450 platform equipment and for the majority of configuration management tasks.

Web pages

The web-based management interfaces provide comprehensive web-based fault, configuration, performance and security management functions organized into the following groups:

Access Point or Backhaul Master:

- Home
- Configuration
- Statistics
- Tools
- Logs
- Accounts
- Quick Start
- Copyright

Subscriber Module or Backhaul Slave

- Home
- Configuration
- Statistics
- Tools
- Logs
- Accounts
- PDA
- Copyright

Identity-based user accounts

- When identity-based user accounts are configured, a security officer can define from one to four user accounts, each of which may have one of the four possible roles:
- ADMINISTRATOR, who has full read and write permissions. This is the level of the root and admin users, as well as any other administrator accounts that one of them creates.
- INSTALLER, who has permissions identical to those of ADMINISTRATOR except that the installer cannot add or delete users or change the password of any other user.
- TECHNICIAN, who has permissions to modify basic radio parameters and view informational web pages
- GUEST, who has no write permissions and only a limited view of General Status tab
- Admin, Installer and Tech accounts can be configured as READ-ONLY. This will allow the account to only see the items.

See Managing module access by passwords for detailed information on account permissions.

Remote Authentication Dial-in User Service (RADIUS)

The PMP 450 platform system includes support for RADIUS (Remote Authentication Dial In User Service) protocol functionality including:

- 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 not used for APs.
- SM Configuration: Configures authenticated SMs with MIR (Maximum Information Rate), High Priority, and VLAN (Virtual LAN) parameters from the RADIUS server when a SM registers to an AP.
- 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 and Read-Only) 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 Wireless Manager. This accounting is not the ability to perform accounting functions on the subscriber/end user/customer account.
- Framed-IP-Address: Operators may use a RADIUS server to assign management IP addressing to SM modules.

SNMP

The management agent supports fault and performance management by means of an SNMP interface. The management agent is compatible with SNMP v2c and SNMP v3 using Management Information Base (MIB) files which are available for download from the Cambium Networks Support website:

https://support.cambiumnetworks.com/files/ptp450

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

Network Time Protocol (NTP)

The clock supplies accurate date and time information to the system. It can be set to run with or without a connection to a network time server (NTP). It can be configured to display local time by setting the time zone and daylight saving in the Time web page.

If an NTP server connection is available, the clock can be set to synchronize with the server time at regular intervals. PMP/PTP 450 platform devices may receive NTP data from a CMM4 module or an NTP server configured in the system's management network.

The Time Zone option is configurable on the AP's/BHM's Time Configuration page, and may be used to offset the received NTP time to match the operator's local time zone. When set on the AP/BHM, the offset is set for the entire sector (AP/BHSs is notified of the current Time Zone upon initial registration). If a Time Zone change is applied, the AP/BHSs are notified of the change in a best effort fashion, meaning some AP/BHSs may not pick up the change until the next re-registration. Time Zone changes are noted in the Event Log.

An AP/BHM which is receiving NTP date and time information from an NTP server or from a GPS synchronization source may be used as an NTP server. Any client which has IP connectivity to the BHM may request NTP date and time information from the AP/BHM. No additional configuration (other than the AP/BHM receiving valid NTP data) is required to use the AP/BHM as an NTP server.

Wireless Manager (WM)

Cambium Networks Wireless Manager 4.0 is recommended for managing PMP/PTP 450 platform networks. You can achieve better uptime through better visibility of your network with the Cambium Wireless Manager. This network management software tool offers breakthrough map-based visualization capabilities using embedded Google maps, and combined with advanced configuration, provisioning, alerting and reporting features you can control your entire outdoor wireless network including Point-to-Multipoint and Point-to-Point solutions as well as other SNMP enabled devices. With its powerful user interface you can not only be able to control your network's access, distribution and backhaul layers, but can also have visibility to WLAN sites and be able to quickly launch indoor network management systems. Some key features of Wireless Manager are:

- **Template-Based Configuration**: With Wireless Manager's user-defined templates you can accelerate the process for the configuration of the devices you add to your network resulting in quicker and easier deployments. The template-based functionality provides an automated way to configure large numbers of network devices with just a few mouse clicks, and can be scheduled to occur at any time via Wireless Manager's Task Scheduler.
- **Ultralight Thin Client**: With the growing mobile workforce it is important to have access to the status of your network at any time. With Wireless Manager you can view the status and performance of your entire wireless network via a compact web interface accessible by your smart phone.
- **Map-Based Visualization**: Wireless Manager overlays sophisticated real-time information about your network elements onto building layouts and dynamic Google maps. Visuals can be scaled to view an entire city or building or a specific area, floor or link.
- **High Availability Architecture Support**: Wireless Manager offers a high availability option, providing a highly reliable and redundant network management solution that ensures you always have management access to your network.
- **High Scalability**: The enhanced Wireless Manager offers you server scalability with support for up to 10,000 nodes as well as support for distributed server architecture.

Cambium's Wireless Manager 4.0 available for download at:
http://www.cambiumnetworks.com/support/management-tools/wireless-manager/

Canopy Network Updater Tool (CNUT)

CNUT (Canopy Network Updater Tool) is the stand-alone software update tool for 450 platform Series products. The CNUT 4.9.12 or greater should be used for 450 platform radios.

The Canopy Network Updater Tool has the following features:

- Automatically discovers all network elements
- HTTP and HTTPS
- Executes UDP command that initiates and terminates the Auto-update mode within APs/BHMs. This command is both secure and convenient:
  - For security, the AP/BHM accepts this command from only the IP address that specified in the Configuration page of ODU.
  - For convenience, Network Updater automatically sets this Configuration parameter in the AP/BHM to the IP address of the Network Updater server when the server performs any of the update commands.
- Allows you to choose among updating:
  - Entire network.
  - Only elements that you select.
  - Only network branches that you select.
- Provides a Script Engine that you can use with any script which:
  - The user can define.
  - Cambium supplies.

CNUT is available at:

http://www.cambiumnetworks.com/support/management-tools/cnut/

Radio recovery mode – Radio Recovery Console / Default Mode (fka Default Plug)

PMP/PTP 450i Series

The PMP/PTP 450i recovery mode provides a means to recover from serious configuration errors including lost or forgotten passwords and unknown IP addresses.

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

The recovery mode supports a single IPv4 interface, with IP address 169.254.1.1, and with default link settings.

Note

When Recovery has been entered through a power on/off/on cycle, the ODU will revert to normal operation if no web access has been made to the unit within 30 seconds.

This prevents the unit remaining inadvertently in recovery following a power outage.

Recovery mode options

Options in recovery mode (IPv4 only) are as follows:

- Load a previous SW image
- Boot with default Canopy system software settings (similar to the hardware default plug on previous Canopy-based PMP platforms)

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

Boot with default Canopy system software settings (similar to the hardware default plug on previous Canopy-based PMP platforms).

See Radio Recovery on page 9-59.

PMP/PTP 450 Series

A default plug (sometimes called an override plug) is available to provide access to a module whose password and/or IP address have been forgotten. This plug allows the PMP 450 AP, PMP 450 SM, or PTP 450 BH to be accessed using IP address 169.254.1.1 and no password. During the override session, you can assign any new IP address and set either or both user passwords (display-only and/or full access) as well as make other parameter changes.

This plug is available from Best-Tronics Manufacturing, Inc.
See http://www.best-tronics.com/cambium.htm as Part BT-0583 (RJ-11 Default Plug). Alternatively, you can fabricate an override plug. See Override plug cable on page 5-14 for pinout.

Note

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

Chapter 2: System hardware

This chapter describes the hardware components of a PMP/PTP 450 platform link.

The following topics are described in this chapter:

- System Components on page 2-2 describes system components of PTP and PMP including its accessories
- Cabling and lightning protection on page 2-26 describes various cable and lightning protection
- Antennas and antenna cabling on page 2-34 describes supported antennas and its accessories
- GPS synchronization on page 2-37 describes UGPS and CMM4.
- Ordering the components on page 2-46 specifies Cambium part numbers for PMP/PTP 450 platform components

System Components

Point-to-Multipoint (PMP)

The PMP radio is a transceiver device. It is a connectorized or radiated outdoor unit containing all the radio, networking, and surge suppression electronics. It can be purchased as:

- Access Point Module (AP)
- Subscriber Module (SM)

PMP 450 platform Integrated or Connectorized ODU

The PMP 450i and PMP 450 ODUs are supplied in Integrated or Connectorized configurations.

See Table 2 PMP/PTP 450i Series hardware configurations on page 1-4

See Table 4 PMP/PTP 450 Series hardware configurations on page 1-7

Product variants

Table 8 PMP 450i variants

Variant	Region	Antenna	Frequency Range	Channel Bandwidth	Max Tx Power	Notes
900 MHz PMP 450i AP	FCC	Connectorized	902 - 928 MHz	5, 7, 10, 20 MHz	25 dBm	Transmit power limited based on regional setting
5 GHz PMP 450i AP	FCC	Connectorized	4900 – 5925 MHz	5, 10, 20 MHz	27 dBm	Transmit power limited based on regional setting
		Integrated 16 dBi 90 degree				
	RoW	Connectorized				
		Integrated 23 dBi				
	Canada	Connectorized				
		Integrated 23 dBi				
	RoW DES	Connectorized				
		Integrated 23 dBi				
5 GHz PMP 450i SM	FCC	Connectorized	4900 – 5925 MHz	5, 10, 20 MHz	27 dBm	Transmit power limited based on regional setting
		Integrated 23 dBi				
	RoW	Connectorized				
		Integrated 23 dBi				
	Canada	Connectorized				
		Integrated 23 dBi				
	RoW DES	Connectorized				
		Integrated 23 dBi				

Table 9 PMP 450 variants

Variant	Region	Antenna	Frequency Range	Channel Bandwidth	Max Tx Power	Notes
2.4 GHz PMP 450 AP	FCC ISM	Connectorized Integrated 18 dBi	2400 – 2483.5 MHz	5, 10, 20 MHz	27 dBm	Transmit power limited based on regional setting
3.5 GHz PMP 450 AP	FCC ISM	Connectorized Integrated 16 dBi	3300 – 3600 MHz	5, 7, 10, 20 MHz	27 dBm	Transmit power limited based on regional setting
3.65 GHz PMP 450 AP	FCC ISM	Connectorized Integrated 16 dBi	3500 – 3850 MHz	5, 7, 10, 20 MHz	27 dBm	Transmit power limited based on regional setting
5.4/5.8 GHz PMP 450 AP	FCC	Connectorized Integrated 17 dBi	5470 – 5875 MHz	10, 20 MHz (5 MHz not available in DFS regions)	27 dBm	Transmit power limited based on regional setting
	RoW	Connectorized Integrated 17 dBi				
	Canada	Connectorized Integrated 17 dBi				
	RoW DES	Connectorized Integrated 23 dBi				
900 MHz PMP 450 SM	FCC	Connectorized	902 - 928 MHz	5, 7, 10, 20 MHz	25 dBm	Transmit power limited based on regional setting

Backhaul (PTP)

The Backhaul radio is a transceiver device. It is a connectorized or integrated outdoor unit containing all the radio, networking, and surge suppression electronics. It can be configured as:

- Backhaul Master (BHM)
- Backhaul Slave (BHS)

PTP 450 platform Integrated or Connectorized ODU

See Table 2 PMP/PTP 450i Series hardware configurations on page 1-4

See Table 4 PMP/PTP 450 Series hardware configurations on page 1-7

Product variants

Table 10 PTP 450i variants

Variant	Region	Antenna	Frequency Range	Channel Bandwidth	Max Tx Power	Notes
5 GHz PTP 450i	FCC	Connectorized	4900 – 5925 MHz	5, 10, 20 MHz	27 dBm	Transmit power limited based on regional setting
		Integrated 23 dBi				
	RoW	Connectorized				
		Integrated 23 dBi				
	Canada	Connectorized				
		Integrated 23 dBi				
	RoW DES	Connectorized				
		Integrated 23 dBi				

Table 11 PTP 450 variants

Variant	Region	Antenna	Frequency Range	Channel Bandwidth	Max Tx Power	Notes
3.5 GHz PTP 450 BH	ROW	Connectorized	3300 – 3600 MHz	5, 7, 10, 20 MHz	27 dBm	Transmit power limited based on regional setting
		Integrated 16 dBi				
3.65 GHz PTP 450 BH	ROW	Connectorized	3500 – 3850 MHz	5, 7, 10, 20 MHz	27 dBm	Transmit power limited based on regional setting
		Integrated 16 dBi				
5.4/5.8 GHZ PTP 450 BH	FCC	Connectorized	5470 – 5875 MHz	5, 10, 20 MHz	27 dBm	Transmit power limited based on regional setting
		Integrated 17 dBi				
5 GHz PTP 450 BH	FCC	Connectorized	4900 – 5875 MHz	5, 10, 20 MHz	27 dBm	Transmit power limited based on regional setting
		Integrated 23 dBi				
	RoW	Connectorized				
		Integrated 23 dBi				
	Canada	Connectorized				
		Integrated 23 dBi				
	RoW DES	Connectorized				
		Integrated 23 dBi				

PMP/PTP 450 platform interfaces

PMP/PTP 450i interfaces – AP/SM/BH

The AP/SM/BH interfaces are illustrated below.

Figure 5 PMP/PTP 450i interfaces

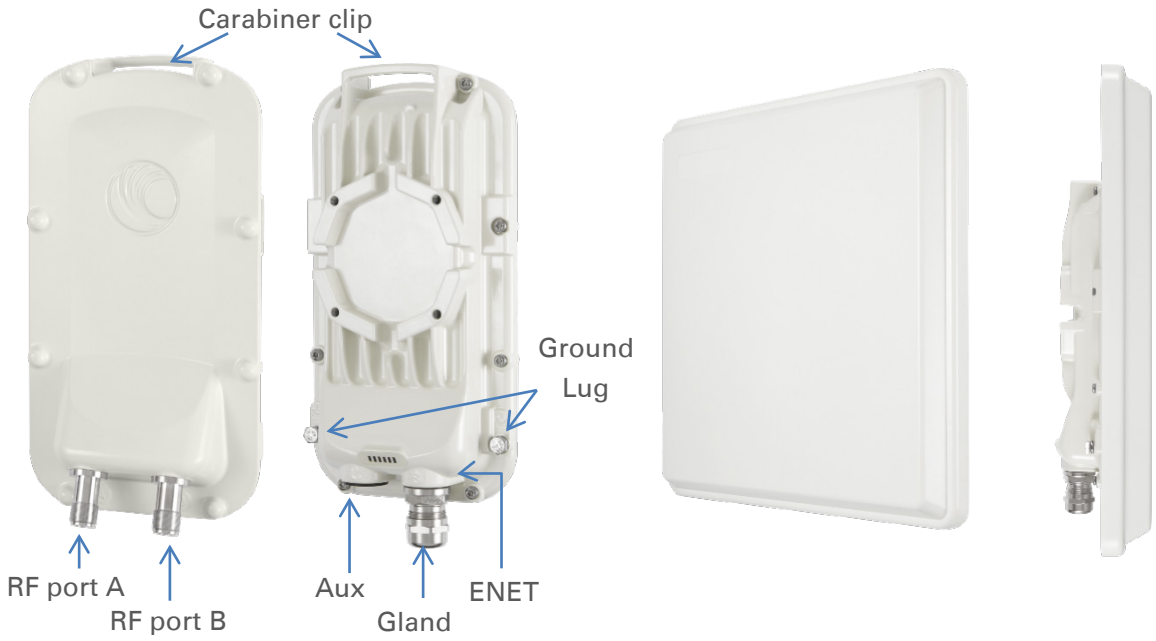


Table 12 AP/SM/BH interface descriptions and cabling

Interface	Function	Cabling
PSU/Ethernet	Power-over-Ethernet, Ethernet communications (management and data), CMM sync-over-power synchronization input	RJ45 Cable See Table 65 on page 5-11
Aux/Sync	GPS synchronization input and output, UGPS power output	RJ 45 Cable See Table 66 on page 5-11
	Audio tones	
	Data	
RF Port A	Vertical RF connection to antenna	50 ohm RF cable, N-type
RF Port B	Horizontal RF connection to antenna	50 ohm RF cable, N-type
Ground Lugs	For grounding the unit	10 AWG copper wire

Note

If the Aux port will be used, a second ethernet Gland will need to be ordered (Part Number: N000065L033A).

PMP/PTP 450 interfaces - AP

The **PMP 450 AP** interfaces are illustrated below.

Figure 3 PMP/PTP 450 interfaces - AP

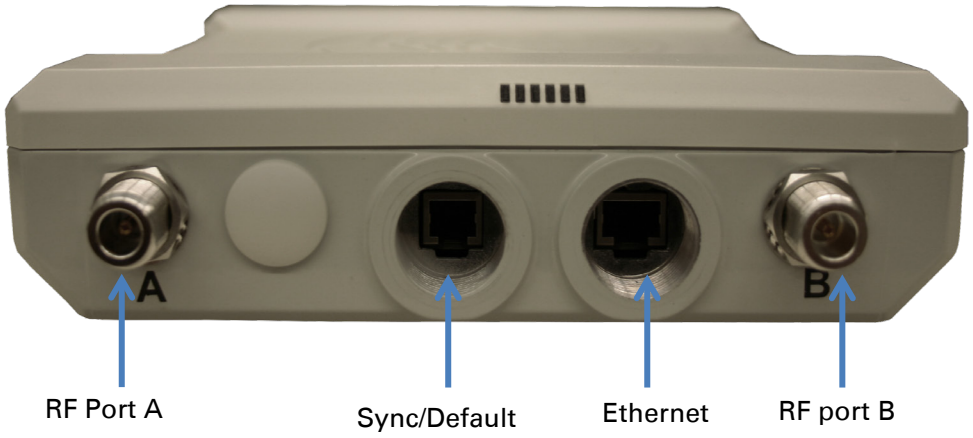


Table 13 AP interface descriptions and cabling – 2.4 GHz, 5 GHz

Interface		Function	Cabling
PSU/Ethernet		Power-over-Ethernet, Ethernet communications (management and data)	RJ45 Cable
Sync/Default		GPS synchronization signaling, provides power to UGPS module. Default plug port.	RJ11 cable, default plug.
RF Port A	2.4 GHz	-45 degree RF connection to AP antenna	50 ohm RF cable, N-type
	5 GHz	Vertical RF connection to AP antenna	
RF Port B	2.4 GHz	+45 degree RF connection to AP antenna	50 ohm RF cable, N-type
	5 GHz	Horizontal RF connection to AP antenna	
Ground Lugs		For grounding the unit	10 AWG copper wire

PMP/PTP 450 interfaces – SM/BH

The **PMP 450 SM/BH** interfaces are illustrated below.

Figure 4 PMP/PTP 450 interfaces – SM/BH

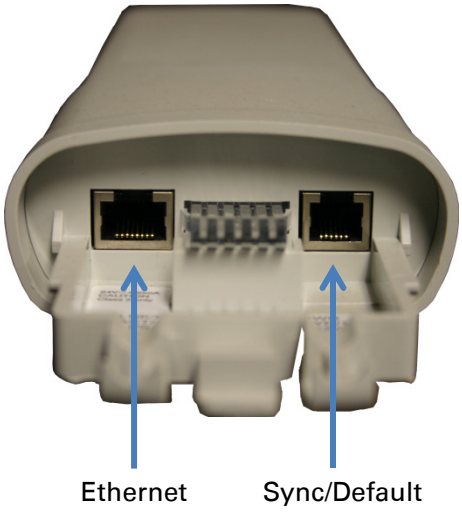


Figure 5 PMP/PTP 450 interfaces – SM/BH Connectorized

Note

As per UL guidelines, the Ground Lug on the radiated SM is not required.

Figure 6 PMP 450d SM - Integrated Dish

Figure 7 PTP 450 Series – BHM/BHS

Diagnostic LEDs

The diagnostic LEDs of PMP/PTP 450 platform Series are as shown below.

Note

The LED color helps distinguish the position of LED. The LED color does not indicate any status.

AP/BHM LEDs

The diagnostic LEDs report the information about the status of the AP/BHM.

Figure 8 AP/BHM diagnostic LEDs, viewed from unit front

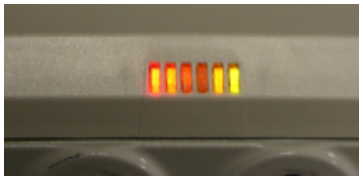
ODU LED Display	LED Labels
PMP 450i AP/BHM	
	LNK/5 ACT/4 GPS/3 SES/2 SYN/1 PWR
PMP 450 AP/BHM	
	LNK/5 ACT/4 GPS/3 SES/2 SYN/1 PWR

Table 14 AP/BHM LED descriptions

LED	Color when active	Status information provided	Notes
PWR	Red	DC power	Always lit after 10-20 seconds of power on.
SYN/1	Yellow	Presence of sync	-
SES/2	Green	Unused	-
GPS/3	Red	Pulse of sync	Lit when the AP/BHM is getting a sync pulse from a GPS source goes along with SYN/1
ACT/4	Yellow	Presence of data activity on the Ethernet link	Flashes during data transfer. Frequency of flash is not a diagnostic indication.
LNK/5	**For PMP/PTP 450i** Red/ Green/Orange (bi-colored for 10/100/1000)	Ethernet link Ethernet link	Continuously lit when link is present. 10Base-T : Red 100Base-T : Green 1000Base-T : Orange
	For PMP/PTP 450 Green		Continuously lit when link is present.

SM/BHS LEDs

The SM/BHS LEDs provide different status of radio based on the operating modes. A SM/BHS in "operating" mode registers and passes traffic normally. A SM/BHS in "aiming" mode does not register or pass the traffic, but displays (via LED panel) the strength of received radio signals (based on radio channel selected via **Tools -> Alignment**).

Figure 9 AP/BH diagnostic LEDs, viewed from unit front

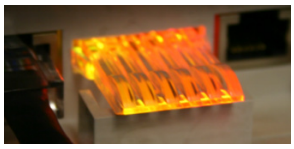
ODU LED Display	LED Labels					
PMP 450i SM/BHS						
						
	LNK/5	ACT/4	GPS/3	SES/2	SYN/1	PWR
PMP 450 SM/BHS						
						
	LNK/5	ACT/4	GPS/3	SES/2	SYN/1	PWR

Table 15 SM/BHS LED descriptions

		Status information provided		
LED	**Color when active**	**SM / BHS in "Operating"Mode**	**SM / BHS in "Aiming" Mode**	**Notes**
PWR	Red	DC power		Always lit after 10-20 seconds of power on.
SYN/1	Yellow	Presence of sync	These five LEDs act as a bar graph to indicate the relative quality of alignment. As power level improves during alignment, more of these LEDs are lit.	Lit when SM/BHS is in sync with an AP/BHM.
SES/2	Green	Session Indicator		Lit when SM/BHS is in session.
GPS/3	Red	Unused		On - high interference. Blinking - medium interference. Off - low interference.
ACT/4	Yellow	Presence of data activity on the Ethernet link		Flashes during data transfer. Frequency of flash is not a diagnostic indication.
LNK/5	**For PMP/PTP 450i** Red/ Green/ Orange (bi-colored for 10/100/1000)	Ethernet link		Continuously lit when link is present. 10Base-T : Red 100Base-T : Green 1000Base-T : Orange
	For PMP/PTP 450 Green	Ethernet link		Continuously lit when link is present.

Operating Mode

- Scanning: If the SM/BHS is not registered to AP/BHM, then these three LEDs cycle on and off from left to right (SYN/1, SES/2 and GPS/3).
- Ethernet Link: The LNK/5 LED lit continuously when link is present.
- Data Transfer: The ACT/4 LED lit on the presence of data activity on the Ethernet link.

Aiming Mode

The 5 LEDs (SYN/1, SES/2, GPS/3, ACT/4 and LNK/5) are turned into a 5-position bar graph. The more LEDs that are lit, the better the received power the module is seeing. The colors of the LEDS have no particular meaning other than to assist is distinguishing one position from the next.

ODU part numbers

Order PMP/PTP 450i and PMP/PTP 450 Series products from Cambium Networks.

PMP 450i

Table 16 PMP 450i ODU part numbers

Cambium description	Cambium part number
PMP 450i AP (Access Point)	
900 MHz PMP 450i Connectorized Access Point	C009045A001A
5 GHz PMP 450i Connectorized Access Point (RoW)	C050045A001A
5 GHz PMP 450i Connectorized Access Point (FCC)	C050045A002A
5 GHz PMP 450i Connectorized Access Point (EU)	C050045A003A
5 GHz PMP 450i Connectorized Access Point (DES Only)	C050045A004A
5 GHz PMP 450i Connectorized Access Point (IC)	C050045A015A
5 GHz PMP 450i AP, Integrated 90°sector antenna (RoW)	C050045A005A
5 GHz PMP 450i AP, Integrated 90°sector antenna (FCC)	C050045A006A
5 GHz PMP 450i Integrated Access Point, 90 degree (EU)	C050045A007A
5 GHz PMP 450i AP, Integrated 90°sector antenna (DES only)	C050045A008A
5 GHz PMP 450i AP, Integrated 90°sector antenna (IC)	C050045A016A
PMP 450i SM (Subscriber Module)	
5 GHz PMP 450i Connectorized Subscriber Module	C050045C001A
5 GHz PMP 450i SM, Integrated High Gain Antenna	C050045C002A

Cambium description	Cambium part number
Note The 450i SM does not have license keys.	

PTP 450i

Table 17 PTP 450i ODU part numbers

Cambium description	Cambium part number
5 GHz PTP 450i END, Connectorized (RoW)	C050045B001A
5 GHz PTP 450i END, Integrated High Gain Antenna (RoW)	C050045B002A
5 GHz PTP 450i END, Connectorized (FCC)	C050045B003A
5 GHz PTP 450i END, Connectorized (EU)	C050045B005A
5 GHz PTP 450i END, Connectorized (DES only)	C050045B007A
5 GHz PTP 450i END, Connectorized (IC)	C050045B015A
5 GHz PTP 450i END, Integrated High Gain Antenna (FCC)	C050045B004A
5 GHz PTP 450i END, Integrated High Gain Antenna (EU)	C050045B006A
5 GHz PTP 450i END, Integrated High Gain Antenna (DES only)	C050045B008A
5 GHz PTP 450i END, Integrated High Gain Antenna (IC)	C050045B016A
Ethernet cable adapter for CMM4	N000045L001A

PMP 450

Table 18 PMP 450 ODU part numbers

Cambium description	Cambium part number
PMP 450 AP (Access Point)	
2.4 GHz PMP 450 Connectorized Access Point	C024045A001A
2.4 GHz PMP 450 Connectorized Access Point (DES)	C024045A003A
3.5 GHz PMP 450 Connectorized Access Point	C035045A001A
3.5 GHz PMP 450 Connectorized Access Point (DES)	C035045A003A
3.6 GHz PMP 450 Connectorized Access Point	C036045A001A
3.6 GHz PMP 450 Connectorized Access Point (DES)	C036045A003A
5 GHz PMP 450 Connectorized Access Point	C054045A001A

Cambium description	Cambium part number
5 GHz PMP 450 Connectorized Access Point (US only)	C054045A002A
5 GHz PMP 450 Connectorized Access Point (DES)	C054045A003A
PMP 450 AP Lite	
2.4 GHz PMP 450 Connectorized Access Point - Lite	C024045A011A
3.3-3.6 GHz PMP 450 Connectorized Access Point - Lite	C035045A011A
3.55-3.8 GHz PMP 450 Connectorized Access Point - Lite	C036045A011A
5 GHz PMP 450 Connectorized Access Point - Lite	C054045A011A
5 GHz PMP 450 Connectorized Access Point (FCC) - Lite	C054045A012A
PMP 450 SM (Subscriber Module)	
900 MHz PMP 450 Connectorized Subscriber Module	C009045C001A
2.4 GHz PMP 450 Subscriber Module, 4 Mbps	C024045C001A
2.4 GHz PMP 450 Subscriber Module, 10 Mbps	C024045C002A
2.4 GHz PMP 450 Subscriber Module, 20 Mbps	C024045C003A
2.4 GHz PMP 450 Subscriber Module, Uncapped	C024045C004A
2.4 GHz PMP 450 Connectorized Subscriber Module, 4 Mbps	C024045C005A
2.4 GHz PMP 450 Connectorized Subscriber Module, 10 Mbps	C024045C006A
2.4 GHz PMP 450 Connectorized Subscriber Module, 20 Mbps	C024045C007A
2.4 GHz PMP 450 Connectorized Subscriber Module, Uncapped	C024045C008A
3.5 GHz PMP 450 Subscriber Module, 4 Mbps	C035045C001A
3.5 GHz PMP 450 Subscriber Module, 10 Mbps	C035045C002A
3.5 GHz PMP 450 Subscriber Module, 20 Mbps	C035045C003A
3.5 GHz PMP 450 Subscriber Module, Uncapped	C035045C004A
3.5 GHz PMP 450 Connectorized Subscriber Module, 4 Mbps	C035045C005A
3.5 GHz PMP 450 Connectorized Subscriber Module, 10 Mbps	C035045C006A
3.5 GHz PMP 450 Connectorized Subscriber Module, 20 Mbps	C035045C007A
3.5 GHz PMP 450 Connectorized Subscriber Module, Uncapped	C035045C008A
3.6 GHz PMP 450 Subscriber Module, 4 Mbps	C036045C001A
3.6 GHz PMP 450 Subscriber Module, 10 Mbps	C036045C002A
3.6 GHz PMP 450 Subscriber Module, 20 Mbps	C036045C003A
3.6 GHz PMP 450 Subscriber Module, Uncapped	C036045C004A

Cambium description	Cambium part number
3.6 GHz PMP 450 Connectorized Subscriber Module, 4 Mbps	C036045C005A
3.6 GHz PMP 450 Connectorized Subscriber Module, 10 Mbps	C036045C006A
3.6 GHz PMP 450 Connectorized Subscriber Module, 20 Mbps	C036045C007A
3.6 GHz PMP 450 Connectorized Subscriber Module, Uncapped	C036045C008A
5 GHz PMP 450 Connectorized Subscriber Module, 4 Mbps	C054045C005A
5 GHz PMP 450 Connectorized Subscriber Module, 10 Mbps	C054045C006A
5 GHz PMP 450 Connectorized Subscriber Module, 20 Mbps	C054045C007A
5 GHz PMP 450 Connectorized Subscriber Module, Uncapped	C054045C008A
5 GHz PMP 450 Integrated Subscriber Module, 4 Mbps	C054045C001B
5 GHz PMP 450 Integrated Subscriber Module, 10 Mbps	C054045C002B
5 GHz PMP 450 Integrated Subscriber Module, 20 Mbps	C054045C003B
5 GHz PMP 450 Integrated Subscriber Module, Uncapped	C054045C004B
5 GHz PMP 450 Connectorized Subscriber Module, 4 Mbps	C054045C005B
5 GHz PMP 450 Connectorized Subscriber Module, 10 Mbps	C054045C006B
5 GHz PMP 450 Connectorized Subscriber Module, 20 Mbps	C054045C007B
5 GHz PMP 450 Connectorized Subscriber Module, Uncapped	C054045C008B
5 GHz PMP 450d Subscriber Module, 20 Mbps – PMP 450d Radio Only	C054045C013B
5 GHz PMP 450d Subscriber Module, Uncapped – PMP 450d Radio Only	C054045C014B
5 GHz PMP 450d Subscriber Module, 20 Mbps – PMP 450d	C054045H013B
5 GHz PMP 450d Subscriber Module, Uncapped – PMP 450d	C054045H014B

PTP 450

Table 19 PTP 450 ODU part numbers

Cambium description	Cambium part number
3.5 GHz PTP 450 BH Unit	C035045A001A
3.5 GHz PTP 450 BH Unit, DES only	C035045A003A
PTP 450 3.5 GHz END – Integrated	C035045B001A
PTP 450 3.5 GHz END – Connectorized	C035045B002A

Cambium description	Cambium part number
PTP 450 3.5 GHz END – Integrated – DES Only	C035045B003A
PTP 450 3.5 GHz END – Connectorized – DES Only	C035045B004A
3.6 GHz PTP 450 BH Unit	C036045A001A
3.6 GHz PTP 450 BH Unit, DES only	C036045A003A
PTP 450 3.65 GHz END – Integrated	C036045B001A
PTP 450 3.65 GHz END – Connectorized	C036045B002A
PTP 450 3.65 GHz END – Integrated – DES Only	C036045B003A
PTP 450 3.65 GHz END – Connectorized – DES Only	C036045B004A
5 GHz PTP 450 BH Unit	C054045A001A
5 GHz PTP 450 BH Unit, US only	C054045A002A
5 GHz PTP 450 BH Unit, DES only	C054045A003A
PTP 450 5 GHz END – Integrated (ROW)	C054045B001A
PTP 450 5 GHz END – Connectorized (ROW)	C054045B002A
PTP 450 5 GHz END – Integrated (ROW) – DES Only	C054045B003A
PTP 450 5 GHz END – Connectorized (ROW) – DES Only	C054045B004A
PTP 450 5 GHz END – Integrated (FCC)	C054045B005A
PTP 450 5 GHz END – Connectorized (FCC)	C054045B006A

PMP/PTP 450/450i Accessories

Cambium description	Cambium part number
PMP 450 AP Antenna Options	
5 GHz Antenna for 90 Degree Sector	85009324001
5 GHz Antenna for 60 Degree Sector	85009325001
2.4 GHz Dual Slant Antenna for 60 Degree Sector	C024045D601A
3.5 GHz and 3.6 GHz Dual Slant Antenna for 90 Degree Sector	C030045D901A
N-type to N-type cable (16 inch length)	30009406002
PMP 450i AP Antenna Options	
900 MHz 65 degree Sector Antenna (Dual Slant)	N009045D001A
900 MHz 12 dBi gain directional antenna (Dual Slant)	N009045D003A

Cambium description	Cambium part number
AP Optional Equipment	
Gigabit Enet Capable Power Supply - 30VDC, 15W	N000900L001A
Cable, UL Power Supply Cord Set, US	N000900L007A
Cable, UL Power Supply Cord Set, EU	N000900L008A
Cable, UL Power Supply Cord Set, UK	N000900L009A
Power Supply,120W 30VDC AT 60C 100-240VAC EL5	ACPS120WA
Surge Protector	600SSH
Universal Mounting Bracket	SMMB2A
CMM MICRO (Outdoor Enclosure)	1070CKHH
CMM4 W/RUGGEDIZED Switch and GPS	1090CKHH
CMM4 NO Switch	1091HH
CMM4 Rack Mount Assembly	1092HH
Universal GPS Module	1096H
RJ-45 Gland Spare – PG16 style (QTY 10)	N000065L033A
PTP 650 Series Blanking Plug Pack (Qty 10)	N000065L036A
Ethernet cable adapter for CMM4	N000045L001A
SM Optional Equipment	
Gigabit Enet Capable Power Supply - 30VDC, 15W	N000900L001A
Power Supply, 30W, 56V – Gbps support	N000000L034A
Cable, UL Power Supply Cord Set, US	N000900L007A
Cable, UL Power Supply Cord Set, EU	N000900L008A
Cable, UL Power Supply Cord Set, UK	N000900L009A
53CM Offset, Reflector Dish Kit, 4PK	HK2022A
Universal Mounting Kit	SMMB1A
Surge Protector	600SSH
Upgrade Keys	
PMP 450 4 To 10 Mbps Upgrade Key	C000045K002A
PMP 450 4 To 20 Mbps Upgrade Key	C000045K003A
PMP 450 4 To Uncapped Upgrade Key	C000045K004A
PMP 450 10 To 20 Mbps Upgrade Key	C000045K005A

Cambium description	Cambium part number
PMP 450 10 To Uncapped MBPS Upgrade Key	C000045K006A
PMP 450 20 To Uncapped MBPS Upgrade Key	C000045K007A
PMP 450 Lite AP to Full AP Upgrade Key	C000045K008A
Extended Warranty	
PMP450 AP Extended Warranty, 1 Additional Year	SG00TS4009A
PMP450 AP Extended Warranty, 2 Additional Years	SG00TS4017A
PMP450 AP Extended Warranty, 4 Additional Years	SG00TS4025A
PMP450 SM Extended Warranty, 1 Additional Year	SG00TS4010A
PMP450 SM Extended Warranty, 2 Additional Years	SG00TS4018A
PMP450 SM Extended Warranty, 4 Additional Years	SG00TS4026A

Power supply options

The PMP/PTP 450/450i is powered over its Main Ethernet cable using Power Over Ethernet (POE). The power injector is connected to the ODU and network terminating equipment using Cat5e cable with RJ45 connectors.

Power supply – PMP/PTP 450i

The PMP/PTP 450i support powering from the following powering sources:

- Power Suppy, 60 W, 56 V with Gbps support
- AC+DC Enhanced Power Injector
- Power over Ethernet midspan, 60 W, -48 VDC Input
- CMM4 with external 56 V power supply
- CMM4 to 450i cable (Dongle)
- IEEE802.3at power injector

Note

The 900 MHz SM is based off the 450 platform, please see Power supply – PMP/PTP 450 on page 2-23.

Please refer to Ethernet standards and cable lengths on Page 2-27 for details on maximum cable lengths between power injector and PMP/PTP 450i.

PSU part numbers

Table 20 PSU part numbers for PMP/PTP 450i

Cambium description	Cambium part number
Power supply, 60 W, 56 V with Gbps support	N000065L001B
AC+DC Enhanced Power Injector	C000065L002A
Power over Ethernet midspan, 60 W, -48 VDC Input	N000000L036A

AC Power Injector

The AC Power Injector interfaces are shown in Figure 10 and described in Table 21.

Figure 10 AC Power Injector interfaces

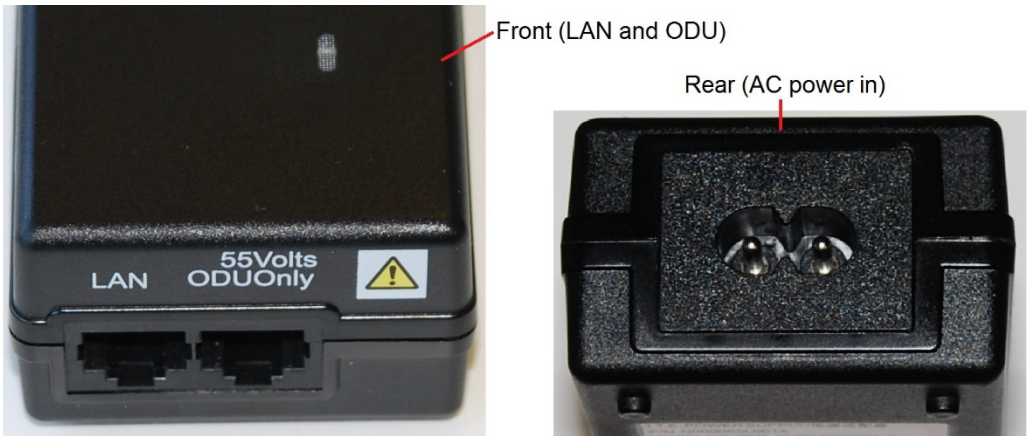


Table 21 AC Power Injector interface functions

Interface	Function
AC power in	AC power input (main supply)
ODU	RJ45 socket for connecting Cat5e cable to ODU
LAN	RJ45 socket for connecting Cat5e cable to network
Power (green) LED	Power supply detection

AC+DC Enhanced Power Injector

The AC+DC Enhanced Power Injector interfaces are shown in Figure 11 and described in Table 22.

Figure 11 AC+DC Enhanced Power Injector interfaces

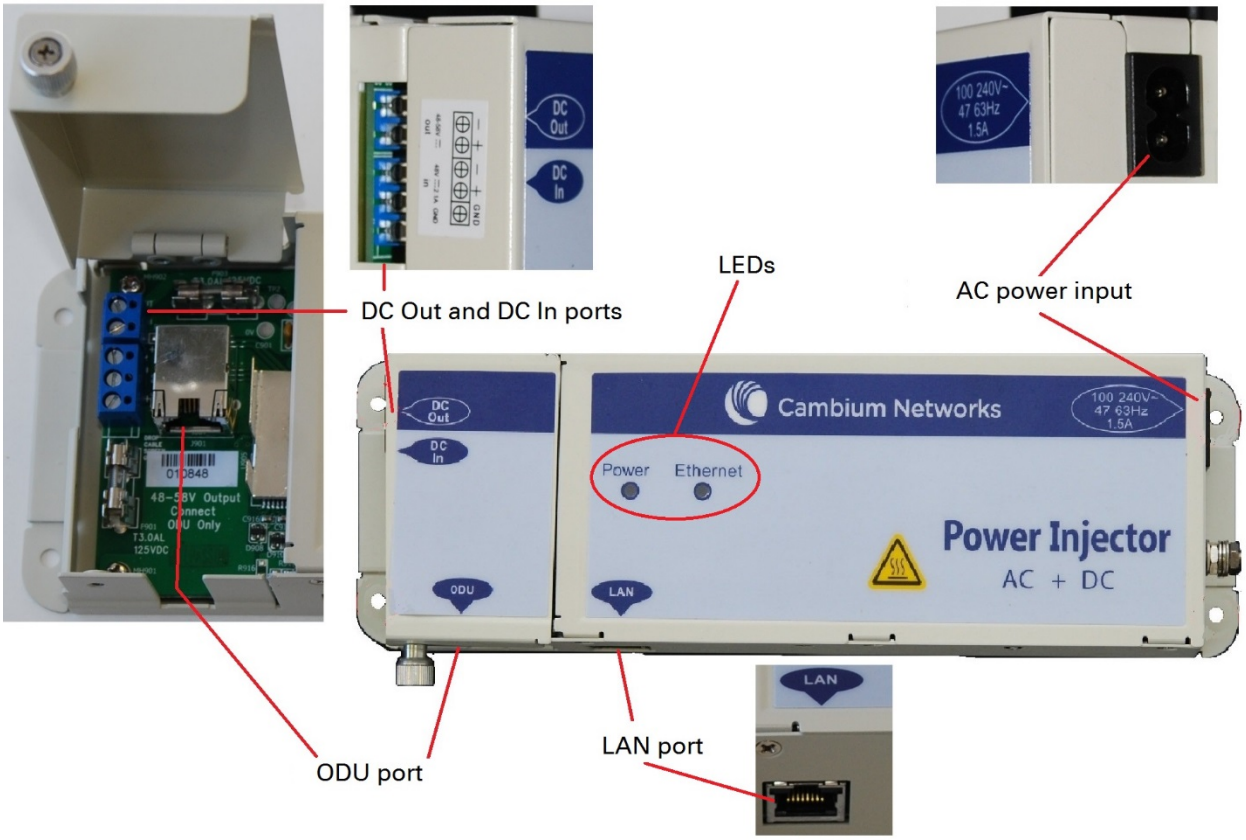


Table 22 AC+DC Enhanced Power Injector interface functions

Interface	Function
100-240V 47-63Hz 1.5A	AC power input (main supply)
DC In	Alternative DC power supply input
DC Out	DC power output to a second PSU (for power supply redundancy) or to a NIDU
ODU	RJ45 socket for connecting Cat5e cable to ODU
LAN	RJ45 socket for connecting Cat5e cable to network
Power (green) LED	Power supply detection
Ethernet (yellow) LED	Ethernet traffic detection

-48 V DC Power Injector

The DC Power Injector interfaces are shown in Figure 12 and described in Table 23.

Figure 12 -48 V DC Power Injector interfaces

Table 23 -48V DC Power Injector interfaces

Interface	Function
DC input	36 to 60V, 2A
RJ 45 Sockets	Two (Data In and Data & Power Out)
LEDs	Two (AC and Port)

Power supply – PMP/PTP 450

The PMP/PTP 450 support powering from the following powering sources:

- Gigabit Enet Capable Power Supply - 30VDC, 15W
- Power Supply,120W 30VDC AT 60C 100-240VAC EL5

PSU part numbers

Table 24 PSU part numbers for PMP/PTP 450

Cambium description	Cambium part number
Gigabit Enet Capable Power Supply - 30VDC, 15W	N000900L001A
Power Supply,120W 30VDC AT 60C 100-240VAC EL5	ACPS120WA

Gigabit Enet Capable Power Supply

The Gigabit Enet Capable power supply interfaces are described in Table 25.

Table 25 –Gigabit Enet Capable power supply

Interface	Function
AC Input	90-264 VAC, 0.5A rms @120VAC/ 0.25A rms @240VAC, 47 to 63 Hz
DC Output	30.0 Vdc +/-5%, 15W, 500 mA max
RJ 45 Sockets	Two (Data In and Data & Power Out)
LEDs	Green, :LED Intensity determined by Level 5 efficiency

Power Supply -120 W/30 VDC

The power supply 120W/30VDC interfaces are described in Table 26.

Table 26 -120 W/30 VDC power supply

Interface	Function
AC Input	90-264 VAC, 3A rms @115VAC/ 1.5A rms @230VAC, 47 to 63 Hz
DC Output	30.0 Vdc +/-5%, 120W, 4 A max
RJ 45 Sockets	Two (Data In and Data & Power Out)

ODU mounting brackets & accessories

The list of supported brackets is provided in Table 27.

- The "Tilt bracket assembly" is the recommended bracket for the AP, SM or BH integrated units.
- The "Mounting Bracket (Connectorized)" can be used where a low profile and ease of assembly of Connectorized AP, SM or BH is required.
- The "Mounting Bracket (Integrated)" provide a wider range of adjustment for AP, SM and BH integrated devices.

Table 27 Accessories part numbers

Cambium description	Cambium part number
Mounting brackets	
Tilt Bracket Assembly	N000045L002A
Mounting Bracket (Integrated)	N000065L031A
Mounting Bracket (Connectorized)	N000065L032A
Miscellaneous	
Ethernet cable adapter for CMM4 (Dongle)	N000045L001A
RJ-45 Gland Spare – PG16 style (QTY 10)	N000065L033A
Blanking Plug Pack (Qty 10)	N000065L036A

Lightning protection

The PMP/PTP 450i Series supports the lightning protection units listed in Table 28.

The LPU offers the highest level of protection and is the recommended device. Where low cost deployment is essential, for example for SM in residential application, the Gigabit Surge Suppressor may be used instead.

Table 28 Lightning protection part numbers

Cambium description	Cambium part number
LPU and Grounding Kit (1 kit per ODU)	C000065L007A
Gigabit Surge Suppressor (56V)	C000000L033A
Surge Protector	600SSH

Cabling and lightning protection

ODU interfaces – PMP/PTP 450i

The Ethernet and Sync/AUX ports are on the rear of the integrated and connectorized ODUs (Figure 13). These interfaces are described in Table 29.

Figure 13 ODU rear interfaces

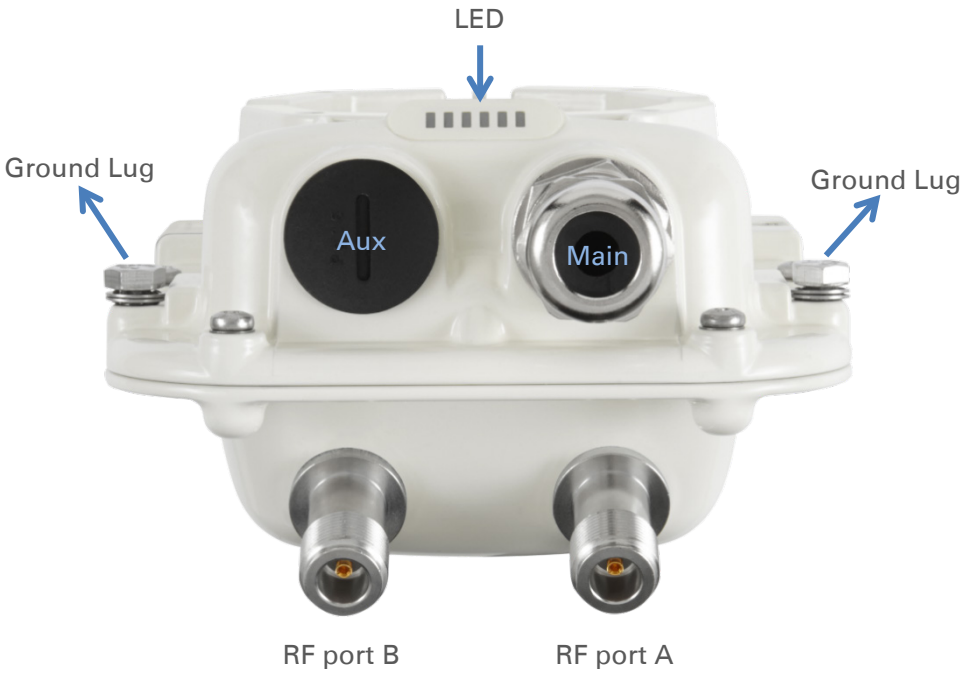


Table 29 ODU rear interfaces

Port name	Connector	Interface	Description
Main PSU	RJ45	PoE input	Power over Ethernet (PoE).
		10/100/1000BASE-T Ethernet	Data
Sync/AUX	RJ45	10/100/100BASE-T Ethernet	Data (see Note below)
		PoE output	Standard IEEE802.3at PoE. (see Note below)
		Sync input/output	Connection and powering of UGPS Sync input

Note

The Sync/AUX port Data and PoE output capability are not supported in this firmware release 14.1.1.

The front of the connectorized ODU (Figure 14 Connectorized ODU antenna interfaces) provides N type female connectors for RF cable interfaces to antennas with ports A and B for vertical and horizontal polarization respectively.

Figure 14 Connectorized ODU antenna interfaces

Ethernet standards and cable lengths

All configurations require a copper Ethernet connection from the ODU (Ethernet port) to the PoE. Table 30 specifies, for each type of PSU and configuration, the maximum permitted PSU drop cable length.

Table 30 PSU drop cable length restrictions

System configuration		Maximum cable length (m/ft)	
Power supply	**PoE powered device on AUX/SYNC port (see Note below)**	**From power supply to ODU**	**From ODU to PoE device on AUX/SYNC port (see Note below)**
AC Power Injector (60W)	None	100 m	N/A
	IEEE 802.3at Type 2	100 m in total	
AC+DC enhanced Power Injector (90W)	None	100 m	N/A
	IEEE 802.3at Type 2	100 m in total	
-48 V DC power injector	None	100 m	N/A
	IEEE 802.3at Type 2	100 m in total	
CMM4 with 56 V supply	None	100 m	N/A
	IEEE 802.3at Type 2	Not supported	
IEEE802.3at compliant supply	None	100 m	N/A
	IEEE 802.3at Type 2	Not supported	

Note

The Ethernet functionality and associated PoE output capability are not supported in this firmware release.

The Ethernet connectivity for CMM4 requires the part “Ethernet cable adapter for CMM4 – N000045L001A”.

Outdoor copper Cat5e Ethernet cable

Outdoor Cat5e cable is used for all connections that terminate outside the building. For example, connections between the ODU, surge suppressors (if installed), UGPS receivers (if installed) and the power supply injector. This is known as a "drop cable" (Figure 15).

The following practices are essential to the reliability and longevity of cabled connections:

- Use only shielded cables and connectors to resist interference and corrosion.
- For vertical runs, provide cable support and strain relief.
- Include a 2 ft (0.6 m) service loop on each end of the cable to allow for thermal expansion and contraction and to facilitate terminating the cable again when needed.
- Include a drip loop to shed water so that most of the water does not reach the connector at the device.
- Properly crimp all connectors.
- Use dielectric grease on all connectors to resist corrosion.

Order Superior Essex type BBDGe cable from Cambium Networks (Table 31). Other lengths of this cable are available from Superior Essex.

Figure 15 Outdoor drop cable

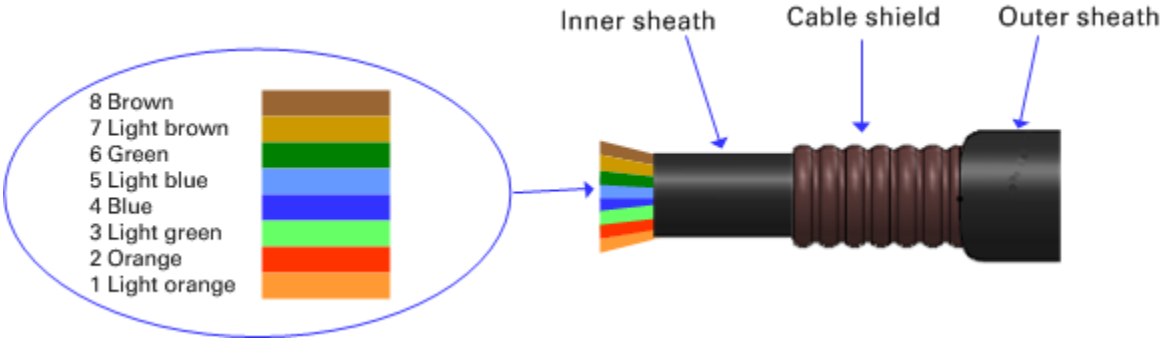


Table 31 Drop cable part numbers

Cambium description	Cambium part number
1000 ft Reel Outdoor Copper Clad CAT5E	WB3175
328 ft (100 m) Reel Outdoor Copper Clad CAT5E	WB3176

Main Ethernet port

The PoE cable pinout diagram for Main port is given below.

Table 32 Main port PoE cable pinout

RJ45 pin	Interface	Ethernet description	PoE input description
1	1000 BaseT Ethernet with PoE In	+TxRx0	+Ve or -Ve
2		–TxRx0	
3		+TxRx1	+Ve or –Ve
6		–TxRx1	
5		–TxRx2	+Ve or –Ve
4		+TxRx2	
7		+TxRx3	+Ve or –Ve
8		–TxRx3	

Note

The PoE input on the Main port accepts any polarity as long as there is at least one pair at +Ve and at least one at –Ve.

Aux port

Table 33 Aux port PoE cable pinout

RJ45 pin	Interface	Signal description	PoE output description
1	100 BaseT Ethernet with PoE Out (see note below)	+TxRx0	-Ve
2		–TxRx0	
3		+TxRx1	+Ve
6		–TxRx1	
5	GPS and alignment tone	GPS power out, Alignment tone out, GPS data out	N/A
4		GPS data in	
7		GPS 0v	
8		GPS Sync in	

Note

Only alignment and sync functionalities are supported on the Aux port in current release 14.1.1.

Aux port to alignment tone headset wiring

A standard 32 ohms stereo headset can be connected to the AUX port to use the audio alignment tool. The diagram of the adapter is provided in Figure 16. The recommended values for both resistors are 220 ohm, 0.25W. Different resistor value can be used to optimize the level of the audio signal depending on the headset characteristics and the level of ambient noise

Figure 16 Alignment Tone Cable

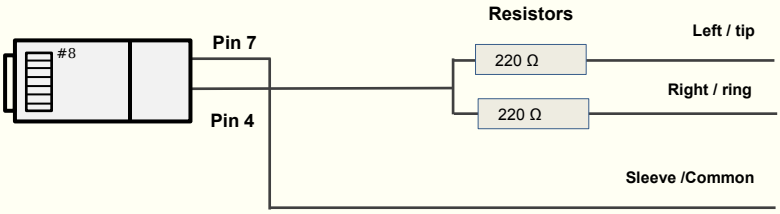


Table 34 Aux port PoE cable pinout

RJ45 pin (AUX port)	Signal description	Serial component	Jack socket (to jack plug of headset)
5	Alignment tone out	220 ohms resistor	Ring
		220 ohm resistor	Tip
7	GPS 0v	None	Sleeve

Alternatively, a readymade headset adapter can be ordered from Best-Tronics (http://btpa.com/Cambium-Products/) with the following part number:

Table 35 Alignment tone adapter third party product details

Reference	Product description
BT-1277	Headset alignment cable for the Cambium Networks PMP450i and PTP450i product lines

Cable grounding kit

Copper drop cable shields must be bonded to the grounding system in order to prevent lightning-strike arcing (resulting in fire risk and damage to equipment).

One grounding kit (Figure 17) is required for each grounding point on the PSU. Order cable grounding kits from Cambium Networks (Table 36).

Caution

To provide adequate protection, all grounding cables must be a minimum size of 10 mm^2 csa (8AWG), preferably 16 mm^2 csa (6AWG), or 25 mm^2 csa (4AWG).

Figure 17 Cable grounding kit

Table 36 Cable grounding kit part numbers

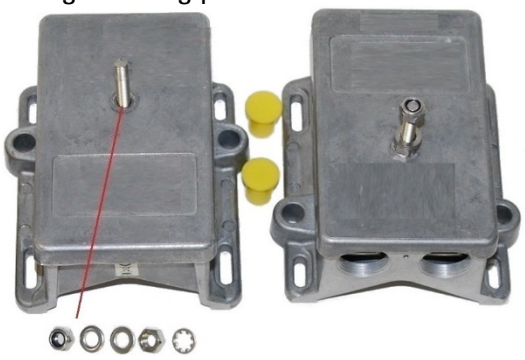
Cambium description	Cambium part number
Cable Grounding Kits For 1/4" And 3/8" Cable	01010419001

Lightning protection unit (LPU) and grounding kit

PMP/PTP 450i LPUs provide transient voltage surge suppression for ODU installations. Each PSU requires two LPUs, one near the ODU and the other near the linked device, usually at the building entry point (Table 37).

Table 37 LPU and grounding kit contents

Lightning protection units (LPUs)
LPU grounding point nuts and washers



ODU to top LPU drop cable (600 mm)
EMC strain relief cable glands

U-bolts, nuts and washers for mounting LPUs

ODU to top LPU ground cable (M6-M6)

Bottom LPU ground cable (M6-M10)

ODU to ground cable (M6-M10

One LPU and grounding kit (Table 37) is required for the PSU drop cable connection to the ODU. If the ODU is to be connected to an auxiliary device, one additional LPU and grounding kit is required for the Aux drop cable. Order the kits from Cambium Networks (Table 38).

Table 38 LPU and grounding kit part number

Cambium description	Cambium part number
PMP/PTP 450i LPU and Grounding Kit (One Kit Per End)	C000065L007

Antennas and antenna cabling

Antenna requirements

Each connectorized ODU requires one external antenna (normally dual-polar).

For connectorized units operating in the USA or Canada 900 MHz, 4.9 GHz, 5.1 GHz, 5.2 GHz, 5.4 GHz or 5.8 GHz bands, choose external antennas which are recommended by Cambium Networks. Do not install any other antennas.

Supported external AP antennas

The recommended AP external antennas are listed in Table 39.

Table 39 List of AP external antennas

Cambium description	Cambium part number
900 MHz 13 dBi 65 degree Sector Antenna (Dual Slant)	N009045D001A
5 GHz Horizontal and Vertical Polarization Antenna for 90 Degree Sector	85009324001
5 GHz Horizontal and Vertical Polarization Antenna for 60 Degree Sector	85009325001

Note

LINKPlanner, Cambium Networks planning tool, contains an up-to-date, exhaustive list of antennas that can be used with Cambium Products.

Supported external SM antennas

The recommended PMP 450/450i SM external antennas is listed in Table 40.

Table 40 PMP 450/450i SM antenna

Cambium description	Cambium part number
900 MHz 12 dBi gain directional antenna (Dual Slant)	N009045D003A

RF cable and connectors

RF cable of generic type LMR-400 is required for connecting the ODU to the antenna. N type male connectors are required for connecting the RF cables to the connectorized ODU. Two connectors are required per ODU. Use weatherproof connectors, preferably ones that are supplied with adhesive lined heat shrink sleeves that are fitted over the interface between the cable and connector. Order CNT-400 RF cable and N type male connectors from Cambium Networks (Table 41).

Table 41 RF cable and connector part numbers

Cambium description	Cambium part number
50 Ohm Braided Coaxial Cable - 75 meter	30010194001
50 Ohm Braided Coaxial Cable - 500 meter	30010195001
RF Connector, N, Male, Straight for CNT-400 Cable	09010091001

Antenna accessories

Connectorized ODUs require the following additional components:

- Cable grounding kits: Order one cable grounding kit for each grounding point on the antenna cables. Refer to Lightning protection unit (LPU) and grounding kit on 2-32
- Self-amalgamating and PVC tape: Order these items to weatherproof the RF connectors
- Lightning arrestors: When the connectorized ODU is mounted indoors, lightning arrestors (not LPUs) are required for protecting the antenna RF cables at building entry. One arrestor is required per antenna cable. One example of a compatible lightning arrestor is the Polyphaser LSXL-ME or LSXL (not supplied by Cambium Networks).

RJ45 connectors and spare glands

RJ45 connectors are required for plugging Cat5e cables into ODUs, LPUs, PoEs and other devices. Order RJ45 connectors and crimp tool from Cambium Networks (Table 42).

The ODU is supplied with one environmental sealing gland for the drop cable.

Figure 18 Cable gland (part number #N000065L033)

Table 42 RJ45 connector and spare gland part numbers

Cambium description	Cambium part number
Tyco/AMP, Mod Plug RJ45, 100 pack	WB3177
Tyco/AMP Crimp Tool	WB3211
RJ-45 Spare Grounding Gland - PG16 size (Qty. 10)	N000065L033

GPS synchronization

GPS synchronization description

Cambium offers GPS synchronization to limit the network's own self-interference. The Cluster Management CMM provides Global Positioning System (GPS) synchronization to the Access Point (AP) and all associated Subscriber Modules (SM). Network operators have a choice of UGPS and CMM solutions to select the option that works best for the environment.

Universal GPS (uGPS)

The uGPS provides network synchronization for smaller networks where a CMM may not be cost effective. The uGPS provides synchronization for one or two modules so that even remote areas at the edge of the network can operate with synchronization for improved performance. The uGPS works with all Cambium PMP radios. The uGPS has a small footprint and is easy to deploy.

Figure 19 uGPS

Note

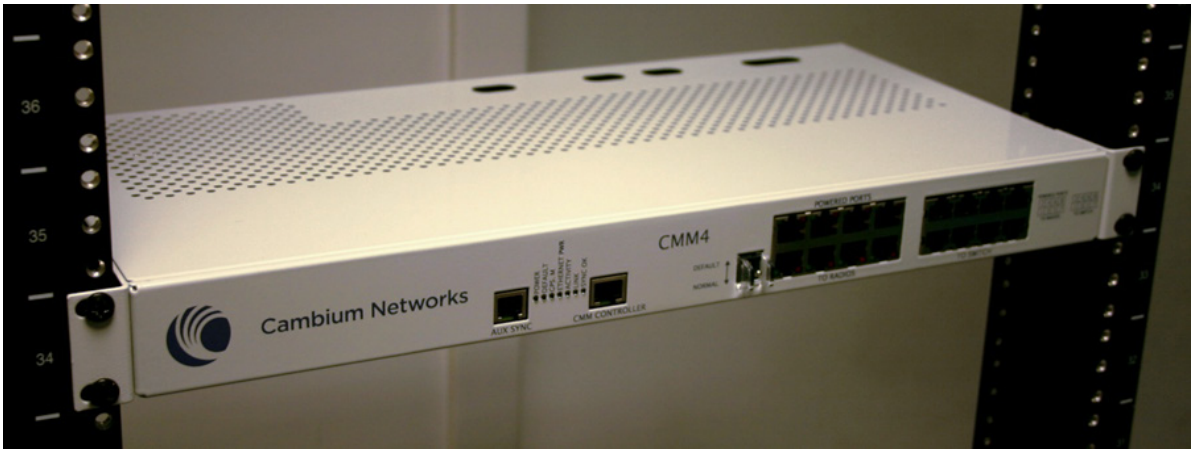
PMP 450 and 450i APs can power up a uGPS via the Aux/Timing port.

CMM4 (Rack Mount)

The Cluster Management Module (CMM) is the heart of the Cambium system's synchronization capability, which allows network operators to reuse frequencies and add capacity while ensuring consistency in the quality of service to customers.

For operators who prefer indoor CMM mounting, Cambium offers the Rack-Mounted Cluster Management Module 4. The unit is designed to be mounted onto a standard 19-inch telecommunications rack and to allow the Cambium CMM4 to be co-located with other telecommunications equipment.

Figure 20 CMM4 (Rack Mount)



The CMM4 has two DC power inputs, one 29 V and one 56V. It can be used to power and synchronize both 29V legacy products such as the PMP 450 and 56V products such as the PMP 450i simultaneously.

If the 29V legacy products are connected to the CMM4, a 29V power supply needs to be connected.

If PMP/PTP 450/450i are connected to the CMM4, a 56V power supply needs to be connected.. The CMM4 supports having two of the 56V and two of the 24V supplies for redundancy.

Warning

PMP 450i requires different wiring between the CMM4 and device. If a PMP450 is replaced by a PMP 450i and the existing drop cable needs to be re-used, the adapter "CMM4 56V power adapter, #N000045L001A" must be used between the CMM4 and the existing drop cable.

Note

If only a 56V supply is used, it can not power up 29V radios.

Figure 21 CMM4 56V power adapter (dongle)

CMM4 56V power adapter cable pinout

Figure 22 CMM4 power adapter cabling diagram

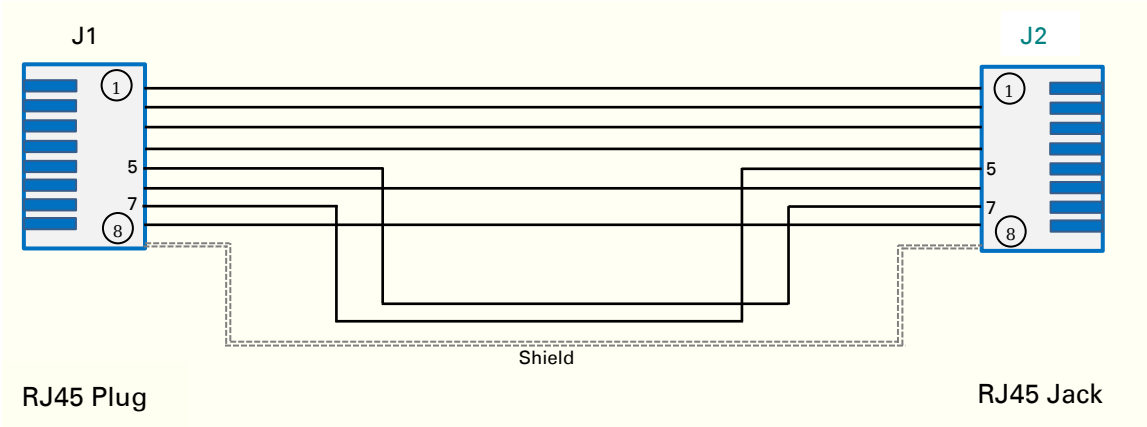


Table 43 CMM4 power adapter cable pinout

Plug J1 pin	Jack J2 pin
1	1
2	2
3	3
4	4
5	7
6	6
7	5
8	8
Screen	Screen

Note

Pins 5 and 7 are flipped.

CMM4 (Cabinet with switch)

Designed to deliver consistent and reliable wireless broadband service, the PMP/PTP system gracefully scales to support large deployments. The cluster management module is the heart of the system's synchronization capability which allows network operators to re-use frequencies and add capacity while ensuring consistency in the quality of service to customers. As a result, subscribers can experience carrier-grade service even at the outer edge of the network.

Figure 23 CMM4 (Cabinet with switch)

CMM4 (Cabinet without switch)

This CMM includes all of the functionality listed above but there is no switch. This provides the network operator the flexibility to use the switch of their choice with the power and synchronization capabilities of the CMM4.

CMM3/CMMmicro

The CMM3 or CMMmicro (Cluster Management Module micro) provides power, GPS timing, and networking connections for an AP cluster. The CMM3 is configurable through a web interface.

The CMM3 contains an 8-port managed switch that supports Power over Ethernet (PoE[1]) on each port and connects any combination of APs, BHMs, BHSs, or Ethernet feed. The Cambium fixed wireless broadband IP networks PoE *differs from* IEEE Standard 803.3af PoE, and the two should not be intermixed. The CMM3 can auto-negotiate speed to match inputs that are either 100Base-TX or 10Base-T, and either full duplex or half duplex, where the connected device is set to auto-negotiate. Alternatively, these parameters are settable.

A CMM3 requires only one cable, terminating in an RJ-45 connector, for each connected module to distribute

- Ethernet signaling.
- power to as many as 8 co-located modules—APs, BHMs, or BHSs. Through a browser interface to the managed switch, ports can be powered or not.
- sync to APs and BHMs. The CMM3 receives 1-pulse per second timing information from Global Positioning System (GPS) satellites through an antenna (included) and passes the timing pulse embedded in the 24-V power to the connected modules.

GPS status information is available at the CMM3, however

- CMM3 provides time and date information to BHMs and APs if both the CMMmicro is operating on CMMmicro Release 2.1 or later and the AP/BHM is operating on System Release 4.2 or later. See Configuring time settings on Page 7-18.
- CMM3 *does not* provide time and date information to BHMs and APs if either the CMM3 is operating on a release earlier than CMMmicro Release 2.1 or the AP/BHM is operating on a release earlier than System Release 4.2.

A CMM3/CMMicro is shown in Figure 24 and Figure 25.

Figure 24 CMM3

Figure 25 Pole mounted CMM3

Note

A CMM3 can not be used to power up a 450i radio.

[1] This is cambium PoE, not the standard PoE.

Installing a GPS receiver

To install a GPS receiver as the timing reference source, use the following procedures:

- Mounting the GPS receiver on page 2-44
- Cabling the GPS Antenna on page 2-45
- Installing and connecting the GPS LPU on page 2-45

Caution

Prior to power-up of equipment, ensure that all cables are connected to the correct interfaces of the CMM4 unit and the UGPS receiver module. Failure to do so may result in damage to the equipment.

GPS receiver location

Mount the GPS receiver at a location that meets the following requirements:

- It must be possible to protect the installation as described in Grounding and lightning protection on page 3-8.
- It must have an un-interrupted view of at least half of the southern (resp. northern) sky in the northern (resp. southern) hemisphere. For a receiver mounted on a wall there must be no other significant obstructions in the view of the sky.
- It must be mounted at least 1 m (3 ft), preferably 2 m (6 ft), away from other GPS receiving equipment.
- It must not be sited in the field of radiation of co-located radio communications equipment and should be positioned at a distance of at least 3 m (10 ft) away.

Mount the UGPS receiver on the wall of the equipment building if there is a suitable location on the wall that can meet these requirements.

Mounting the GPS receiver module on the equipment building

If mounting the GPS receiver on the equipment building (Figure 30), select a position on the wall that meets the following requirements:

- It must be below the roof height of the equipment building or below the height of any roof-mounted equipment (such as air conditioning plant).
- It must be below the lightning air terminals.
- It must not project more than 600mm (24 inches) from the wall of the building.

If these requirements cannot all be met, then the module must be mounted on a metal tower or mast.

Mounting the GPS receiver module on a metal tower or mast

If mounting the GPS receiver module on a metal tower or mast (Figure 31), select a position that meets the following requirements:

- It must not be mounted any higher than is necessary to receive an adequate signal from four GPS satellites.
- It must be protected by a nearby lightning air terminal that projects farther out from the tower than the GPS receiver module.

Mounting the GPS receiver

Mount the UGPS receiver (following manufacturer's instructions) upon either an external wall (Figure 30) or a metal tower or mast (Figure 31).

Figure 26 GPS antenna mounting

Procedure 1 Mounting the GPS receiver

1. Ensure that the mounting position
   - has an unobstructed view of the sky to 20° above the horizon.
   - is not the highest object at the site. (The GPS antenna does not need to be particularly high on a site, which would give it more exposure to lightning. It just needs to have an unobstructed view of the sky.)
   - is not further than 100 feet (30.4 meters) of cable from the CMM.
2. Select a pole that has an outside diameter of 1.25 to 1.5 inches (3 to 4 cm) to which the GPS antenna bracket can be mounted.
3. Place the U-bolts (provided) around the pole as shown in Figure 28..
4. Slide the GPS antenna bracket onto the U-bolts.
5. Slide the ring washers (provided) onto the U-bolts.
6. Slide the lock washers (provided) onto the U-bolts.
7. Use the nuts (provided) to securely fasten the bracket to the U-bolts.

Please refer to the *PMP Synchronization Solutions User Guide* located on the Cambium website (http://www.cambiumnetworks.com/resources/pmp-synchronization-solutions).

Cabling the GPS Antenna

Connect the GPS coax cable to the female N-connector on the GPS antenna. Please refer to the *PMP Synchronization Solutions User Guide* located on the Cambium website (http://www.cambiumnetworks.com/resources/pmp-synchronization-solutions).

Installing and connecting the GPS LPU

Install and ground the GPS drop cable LPU at the building (or cabinet) entry point, as described in Install the bottom LPU on page 6-19.

Ordering the components

This section describes how to select components for PMP/PTP 450 and 450i Greenfield network or PMP/PTP 450i network migration. It specifies Cambium part numbers for PMP/PTP 450 platformcomponents.

Table 44 PMP/PTP 450 platform components

Cambium description	Cambium part number
PMP 450i AP	
5 GHz PMP 450i Connectorized Access Point (ROW)	C050045A001A
5 GHz PMP 450i Connectorized Access Point (FCC)	C050045A002A
5 GHz PMP 450i Connectorized Access Point (EU)	C050045A003A
5 GHz PMP 450i Connectorized Access Point (DES Only)	C050045A004A
5 GHz PMP 450i Connectorized Access Point (IC)	C050045A015A
5 GHz PMP 450i Integrated Access Point, 90 degree (ROW)	C050045A005A
5 GHz PMP 450i Integrated Access Point, 90 degree (FCC)	C050045A006A
5 GHz PMP 450i Integrated Access Point, 90 degree (EU)	C050045A007A
5 GHz PMP 450i Integrated Access Point, 90 degree (DES Only)	C050045A008A
5 GHz PMP 450i Integrated Access Point, 90°sector antenna (IC)	C050045A016A
900 MHz PMP 450i Connectorized Access Point	C009045A001A
PMP 450i SM	
5 GHz PMP 450i Connectorized Subscriber Module	C050045C001A
5 GHz PMP 450i SM, Integrated High Gain Antenna	C050045C002A
PTP 450i	
5 GHz PTP 450i END, Connectorized (ROW)	C050045B001A
5 GHz PTP 450i END, Integrated High Gain Antenna (ROW)	C050045B002A
5 GHz PTP 450i END, Connectorized (FCC)	C050045B003A
5 GHz PTP 450i END, Integrated High Gain Antenna (FCC)	C050045B004A
5 GHz PTP 450i END, Connectorized (EU)	C050045B005A
5 GHz PTP 450i END, Integrated High Gain Antenna (EU)	C050045B006A
5 GHz PTP 450i END, Connectorized (DES Only)	C050045B007A
5 GHz PTP 450i END, Integrated High Gain Antenna (DES only)	C050045B008A

PMP 450	
900 MHz PMP 450 Connectorized Subscriber Module	C009045C001A
Power supplies	
Power supply, 60 W, 56 V with Gbps support	N000065L001B
AC+DC Enhanced Power Injector	C000065L002B
Ethernet cable adapter for CMM4	N000045L001A
Power over Ethernet midspan, 60 W, -48 VDC Input	N000000L036A
Accessories	
Gigabit Surge Suppressor (56V)	C000000L033A
LPU and Grounding Kit (1 kit per ODU)	C000065L007A
Mounting brackets	
Tilt Bracket Assembly	N000045L002A
Mounting Bracket (Integrated)	N000065L031A
Mounting Bracket (Connectorized)	N000065L032A
Accessories	
900 MHz 13 dBi 65 degree Sector Antenna (Dual Slant)	N009045D001A
900 MHz 12 dBi gain directional antenna (Dual Slant)	N009045D003A
5 GHz Horizontal and Vertical Polarization Antenna for 90 Degree Sector	85009324001
5 GHz Horizontal and Vertical Polarization Antenna for 60 Degree Sector	85009325001
50 Ohm Braided Coaxial Cable - 75 meter	30010194001
50 Ohm Braided Coaxial Cable - 500 meter	30010195001
RF Connector, N, Male, Straight for CNT-400 Cable	09010091001
Blanking Plug Pack (Qty 10)	N000065L036A
RJ-45 Spare Grounding Gland - PG16 size (Qty. 10)	N000065L033
Extended Warranty	
PMP 450 AP Extended Warranty, 1 Additional Year	SG00TS4009A
PMP 450 AP Extended Warranty, 2 Additional Years	SG00TS4017A
PMP 450 AP Extended Warranty, 4 Additional Years	SG00TS4025A
PMP 450 SM Extended Warranty, 1 Additional Year	SG00TS4010A
PMP 450 SM Extended Warranty, 2 Additional Years	SG00TS4018A

PMP 450 SM Extended Warranty, 4 Additional Years	SG00TS4026A

Chapter 3: System planning

This chapter provides information to help the user to plan a PMP/PTP 450 platform link.

The following topics are described in this chapter:

- Typical deployment on page 3-2 contains diagrams illustrating typical PMP/PTP 450 platform site deployments.
- Site planning on page 3-7 describes factors to be considered when planning the proposed link end sites, including grounding, lightning protection and equipment location.
- Radio Frequency planning on page 3-15 describes how to plan PMP/PTP 450 platform links to conform to the regulatory restrictions that apply in the country of operation.
- Link planning on page 3-6 describes factors to be taken into account when planning links, such as range, path loss and throughput.
- Planning for connectorized units on page 3-9 describes factors to be taken into account when planning to use connectorized ODUs with external antennas in PMP/PTP 450 platform links.
- Data network planning on page 3-11 describes factors to be considered when planning PMP/PTP 450 platform data networks.
- Network management planning on page 3-19 describes how to plan for PMP/PTP 450 platform links to be managed remotely using SNMP.
- Security planning on page 3-20 describes how to plan for PMP/PTP 450 platform links to operate in secure mode.

Typical deployment

This section contains diagrams illustrating typical PMP/PTP 450 platform site deployments.

ODU with PoE interface to PSU

In the basic configuration, there is only one Ethernet interface, a copper Cat5e power over Ethernet (POE) from the PSU to the ODU (PSU port), as shown in the following diagrams: mast or tower installation (Figure 27), wall installation (Figure 28) and roof installation (Figure 29).

Figure 27 Mast or tower installation

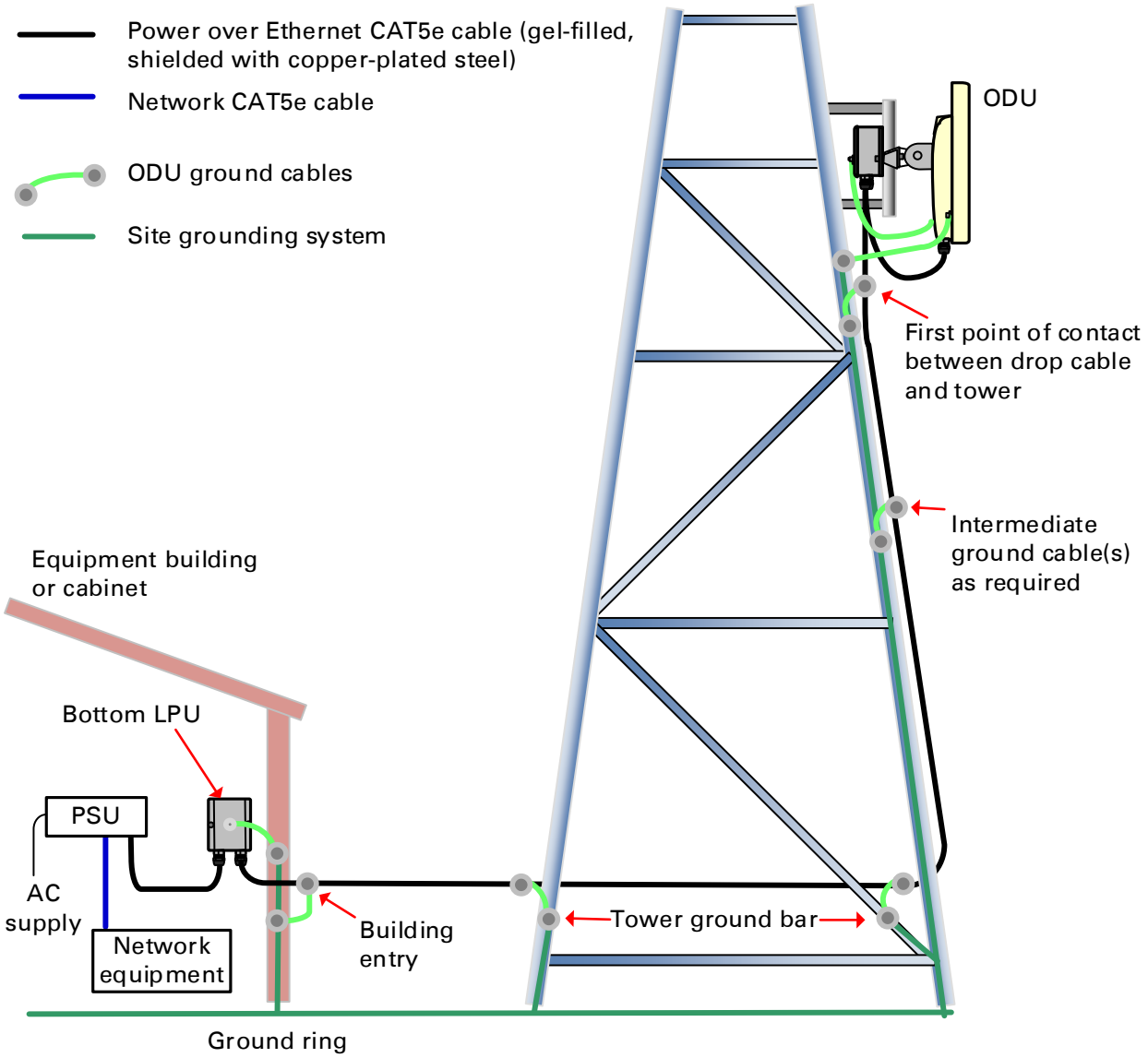


Figure 28 Wall installation

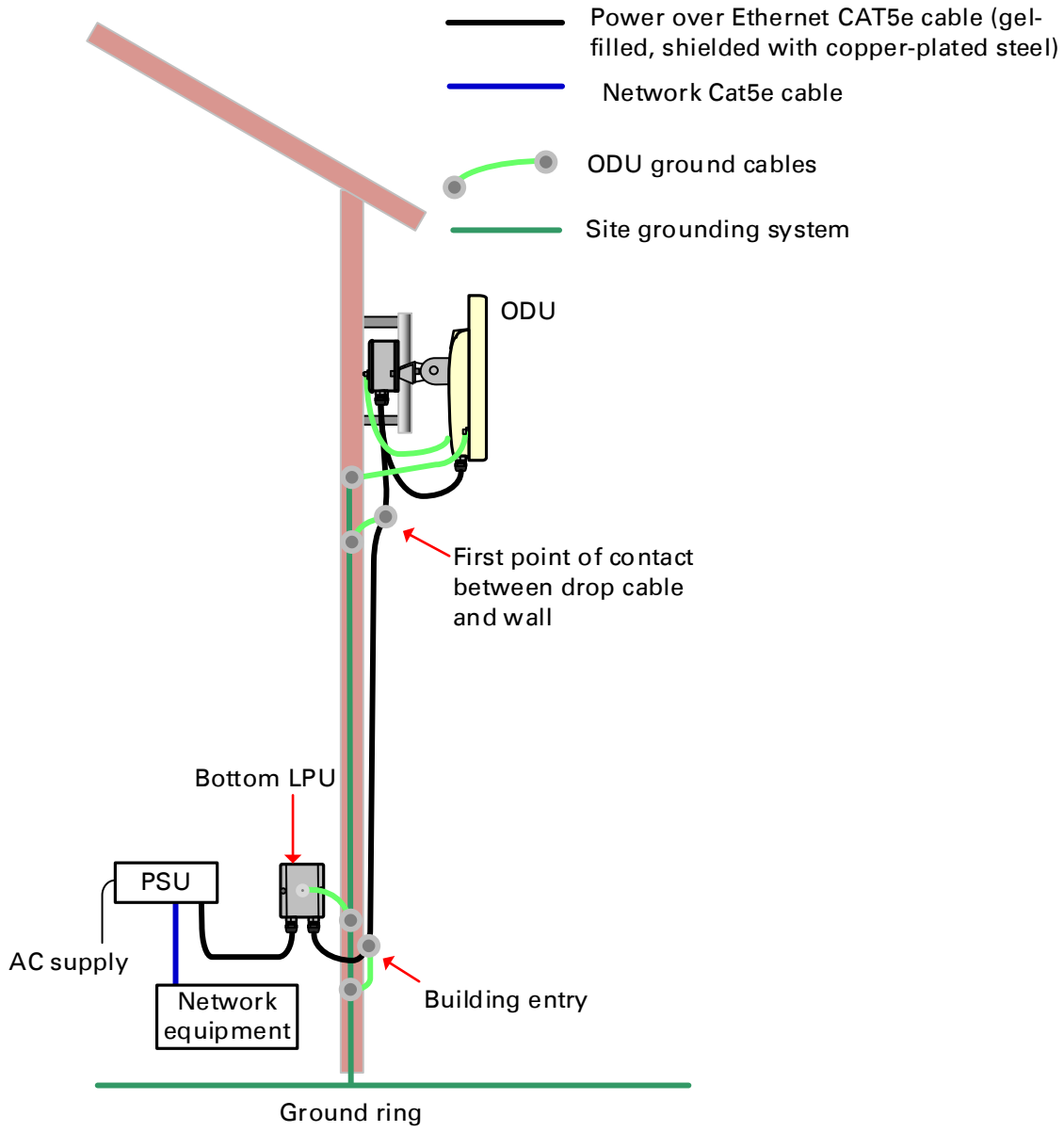


Figure 29 Roof installation

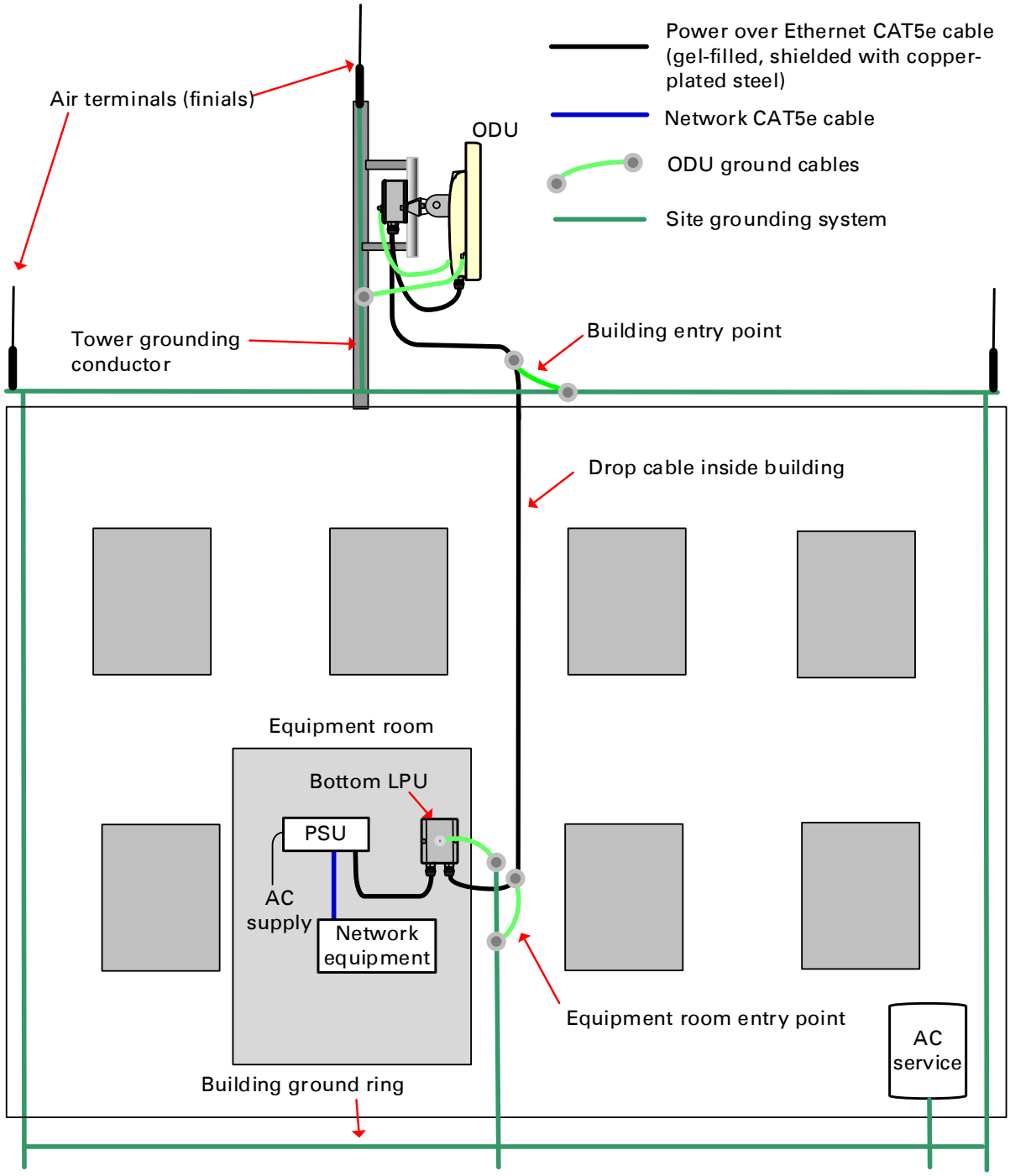
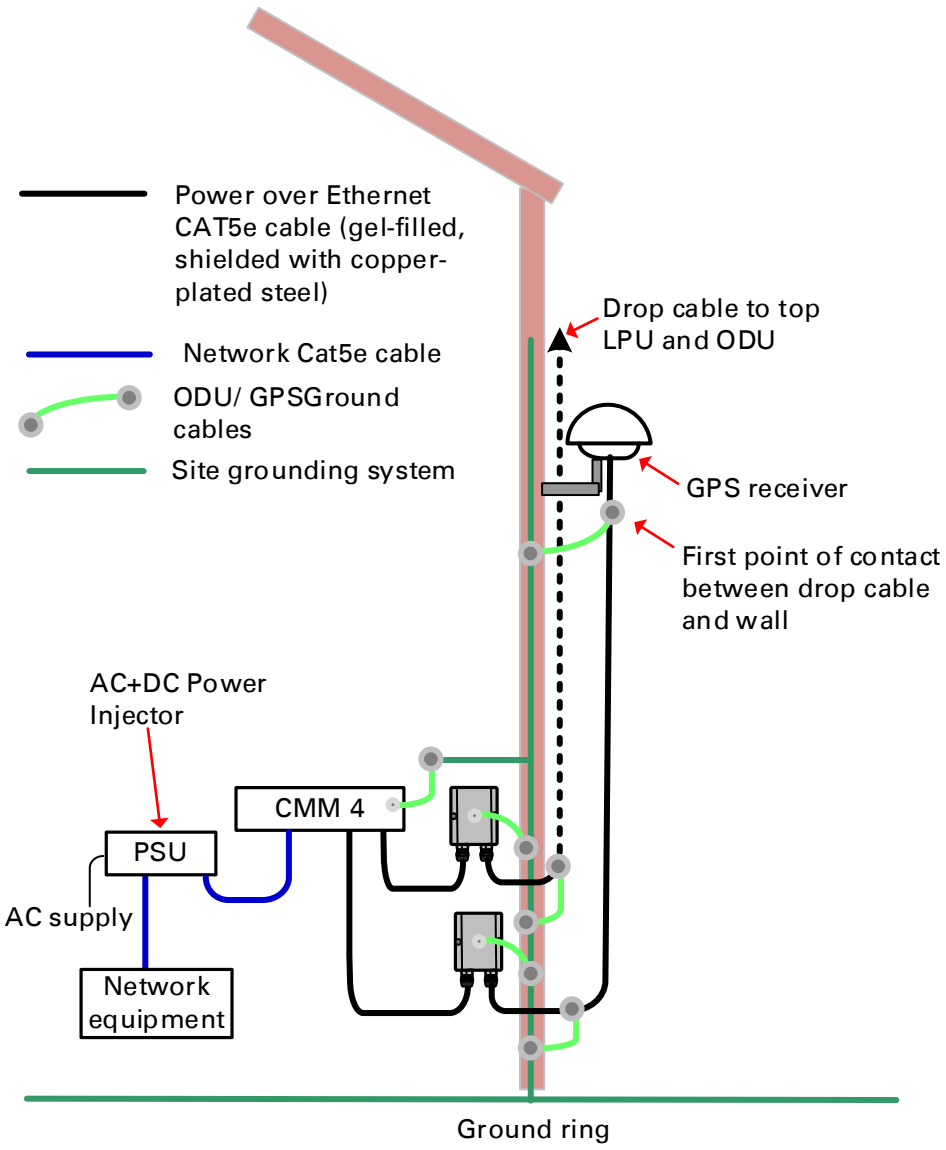


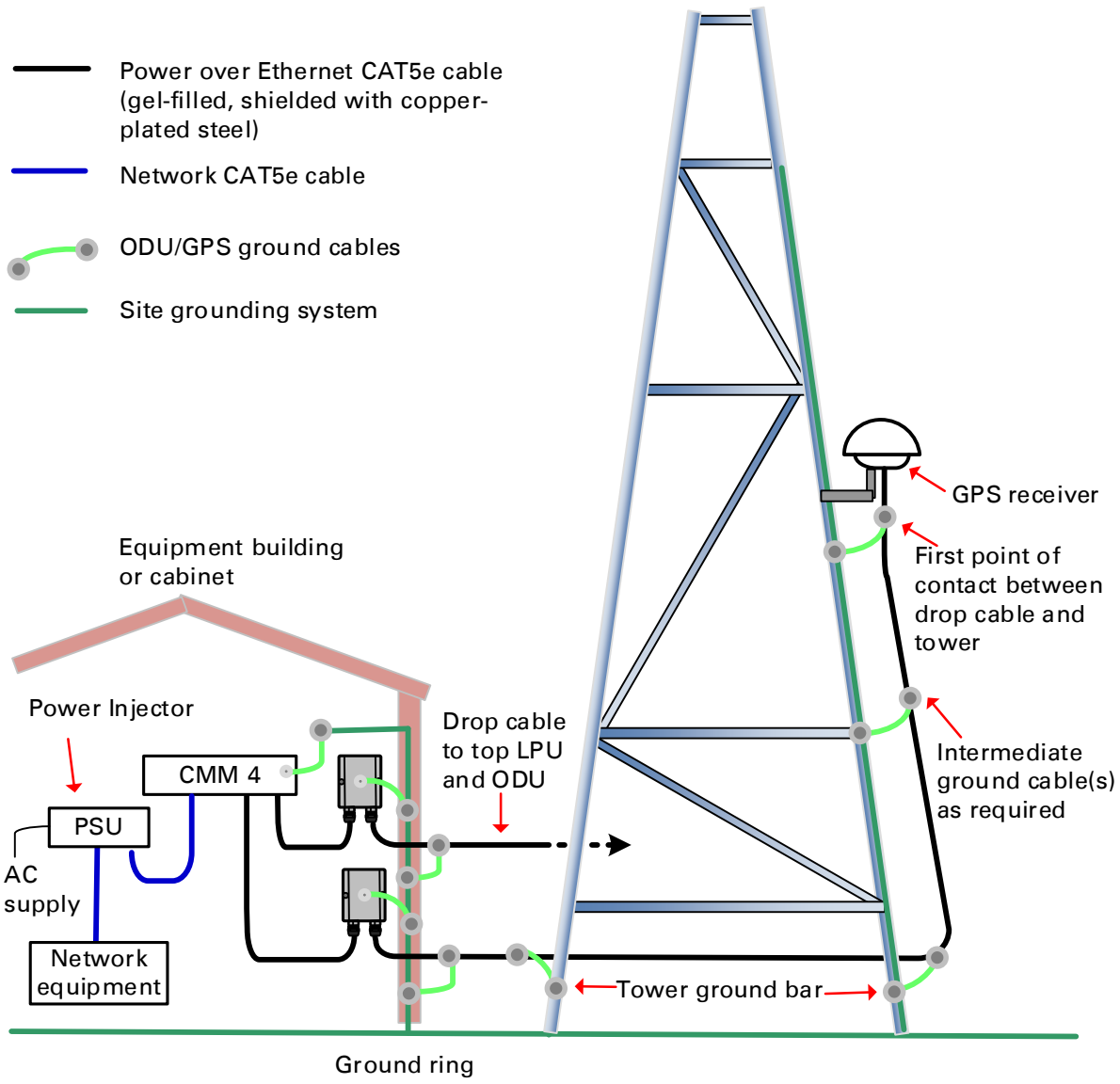
Figure 30 GPS receiver wall installation



Note

The CMM3 or CMM4 can be used for PMP/PTP 450 platform.

Figure 31 GPS receiver tower or mast installation



Note

The CMM3 or CMM4 can be used for PMP/PTP 450 platform.

Site planning

This section describes factors to be considered when choosing sites for PMP or PTP radios, power supplies, CMM4 (if applicable) and UGPS (if applicable).

Site selection for PMP/PTP radios

When selecting a site for the ODU, consider the following factors:

- Height and location to ensure that people are kept away from the antenna; see Calculated distances and power compliance margins on page 4-24.
- Height and location to achieve the best radio path.
- Indoor location where power supply LED indicators accessible and cable length should not exceed maximum recommended length; see Power supply site selection
- Ability to meet the requirements specified in Grounding and lightning protection on page 3-8.
- Aesthetics and planning permission issues.
- Cable lengths; see ODU interfaces on page 2-26.
- The effect of strong winds on the installation; see ODU wind loading on page 3-11.

Calculated distances and power compliance margin

The calculated minimum separation distances, recommended distances and resulting margins for each frequency band and antenna combination. These are conservative distances that include compliance margins. At these and greater separation distances, the power density from the RF field is below generally accepted limits for the general population.

PMP/PTP 450 platform equipment adheres to all applicable EIRP limits for transmit power when operating in MIMO mode. Separation distances and compliance margins include compensation for both transmitters.

Power supply site selection

When selecting a site for the ODU power supply, consider the following factors:

- Indoor location with no possibility of condensation, flooding or high humidity.
- Availability of a mains electricity supply.
- Located in an environment where it is not likely to exceed its operational temperature rating, allowing for natural convection cooling.
- Accessibility for viewing status indicator LED and connecting Ethernet cables.
- Cable lengths; see ODU interfaces on page 2-26.

Maximum cable lengths

When installing PMP/PTP 450i Series ODU, the maximum permitted length of the shielded copper Ethernet interface cable is 330 feet (100m) from AP/BHM/SM/BHS to their associated power supplies or CMM4.

Grounding and lightning protection

Warning

Electro-magnetic discharge (lightning) damage is not covered under warranty. The recommendations in this guide, when followed correctly, give the user the best protection from the harmful effects of EMD. However 100% protection is neither implied nor possible.

Structures, equipment and people must be protected against power surges (typically caused by lightning) by conducting the surge current to ground via a separate preferential solid path. The actual degree of protection required depends on local conditions and applicable local regulations. To adequately protect a PMP/PTP 450 platform installation, both ground bonding and transient voltage surge suppression are required.

Full details of lightning protection methods and requirements can be found in the international standards IEC 61024-1 and IEC 61312-1, the U.S. National Electric Code ANSI/NFPA No. 70-1984 or section 54 of the Canadian Electric Code.

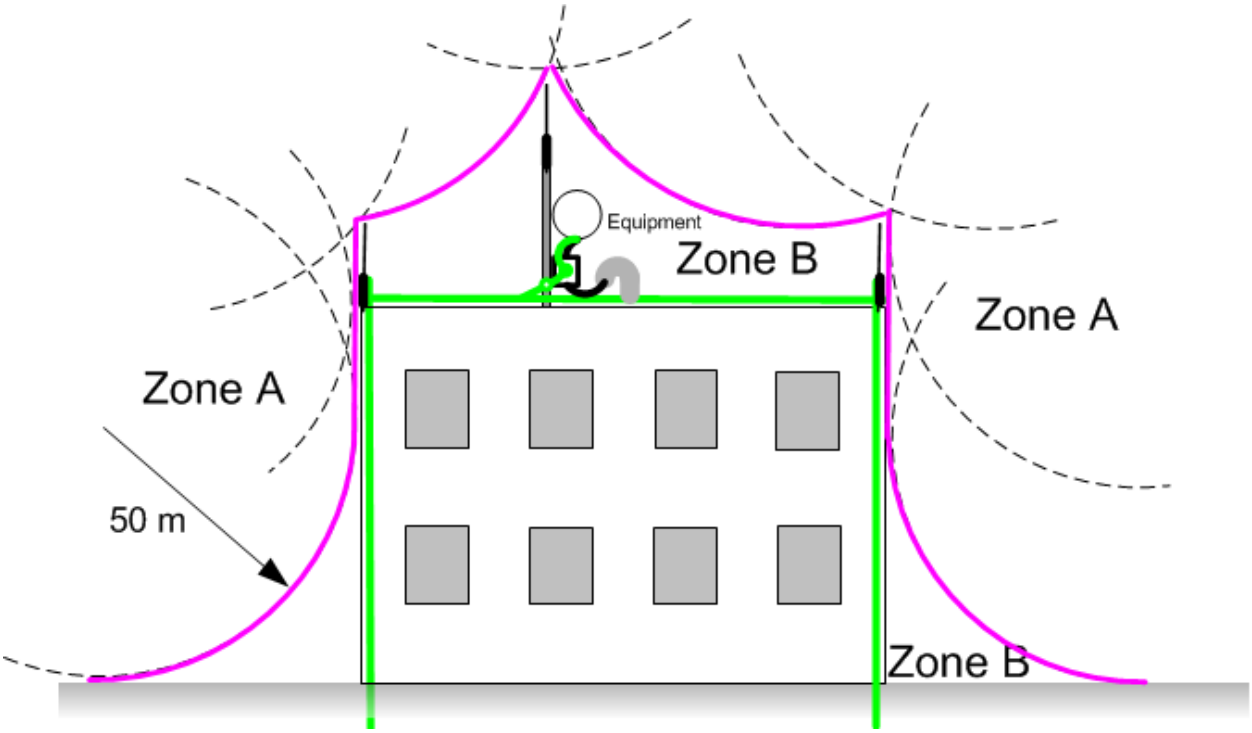
Warning

International and national standards take precedence over the requirements in this guide.

Lightning protection zones

Use the rolling sphere method (Figure 32) to determine where it is safe to mount equipment. An imaginary sphere, typically 50 meters in radius, is rolled over the structure. Where the sphere rests against the ground and a strike termination device (such as a finial or ground bar), all the space under the sphere is considered to be in the zone of protection (Zone B). Similarly, where the sphere rests on two finials, the space under the sphere is considered to be in the zone of protection.

Figure 32 Rolling sphere method to determine the lightning protection zones



Zone A: In this zone a direct lightning strike is possible. Do not mount equipment in this zone.

Zone B: In this zone, direct EMD (lightning) effects are still possible, but mounting in this zone significantly reduces the possibility of a direct strike. Mount equipment in this zone.

Warning

Never mount equipment in Zone A. Mounting in Zone A may put equipment, structures and life at risk.

Site grounding system

Confirm that the site has a correctly installed grounding system on a common ground ring with access points for grounding PMP/PTP 450 platform equipment.

If the outdoor equipment is to be installed on the roof of a high building (Figure 29), confirm that the following additional requirements are met:

- A grounding conductor is installed around the roof perimeter to form the main roof perimeter lightning protection ring.
- Air terminals are installed along the length of the main roof perimeter lightning protection ring, typically every 6.1m (20ft).
- The main roof perimeter lightning protection ring contains at least two down conductors connected to the grounding electrode system. The down conductors should be physically separated from one another, as far as practical.

ODU and external antenna location

Find a location for the ODU (and external antenna for connectorized units) that meets the following requirements:

- The equipment is high enough to achieve the best radio path.
- People can be kept a safe distance away from the equipment when it is radiating. The safe separation distances are defined in Calculated distances and power compliance margins on page 4-24.
- The equipment is lower than the top of the supporting structure (tower, mast or building) or its lightning air terminal.
- If the ODU is connectorized, select a mounting position that gives it maximum protection from the elements, but still allows easy access for connecting and weatherproofing the cables. To minimize cable losses, select a position where the antenna cable lengths can be minimized. If diverse or two external antennas are being deployed, it is not necessary to mount the ODU at the midpoint of the antennas.

ODU ambient temperature limits

Select a location where the ODU can operate within safe ambient temperature limits. The following points need to be considered while selecting a location for the ODU:

- The ODU must be mounted in a Restricted Access Location (as defined in EN 60950-1) if the operating ambient temperature may exceed 40°C, including solar radiation.
- If the ambient temperature never exceeds 40°C, the temperature of the external metal case parts of the ODU will not exceed the touch temperature limit of 70°C.
- If the ambient temperature never exceeds 60°C, the temperature of the external metal case parts of the ODU will not exceed the touch temperature limit of 90°C.

Note

A restricted access location is defined (in EN 60950-1) as one where access may only be gained by use of a tool or lock and key, or other means of security, and access is controlled by the authority responsible for the location. Access must only be gained by persons who have been instructed about the reasons for the restrictions applied to the location and about any precautions that must be taken. Examples of permissible restricted access locations are a lockable equipment room or a lockable cabinet.

ODU wind loading

Ensure that the ODU and the structure on which it is mounted are capable of withstanding the prevalent wind speeds at a proposed PMP/PTP 450i site. Wind speed statistics are available from national meteorological offices.

The ODU and its mounting bracket are capable of withstanding wind speeds of up to 323 kph (200 mph).

Wind blowing on the ODU will subject the mounting structure to significant lateral force. The magnitude of the force depends on both wind strength and surface area of the ODU. Wind loading is estimated using the following formulae:

- Force (in kilogrammes) = $0.1045aV^2$
  where:
  - "a" is the surface area in square meters, and
  - "V" is the wind speed in meters per second.
- Force (in pounds) = $0.0042Av^2$
  where:
  - "A" is the surface area in square feet, and
  - "v" is the wind speed in miles per hour.

Applying these formulae to the 450 platformat different wind speeds, the resulting wind loadings are shown in below tables.

Table 45 PMP/PTP 450i wind loading (Newton)

Type of ODU	Max surface area (square meters)	Wind speed (kilometer per hour)				
		160	170	180	190	200
Connectorized	0.035	59	66	74	83	92
Directional antenna – 5.x GHz	0.093	156	176	197	220	243
Integrated 90° sector antenna -5.x GHz	0.126	211	238	267	298	330
Directional Yagi antenna - 900 MHz	0.025	44	50	56	62	69
External 65° sector antenna – 900 MHz	0.253	430	486	545	607	672

Table 46 PMP/PTP 450i wind loading (lb force)

Type of ODU	Max surface area (square feet)	Wind speed (miles per hour)				
		100	105	110	115	120
Connectorized	0.377	13	15	16	18	19
Directional antenna – 5.x GHz	1.001	35	39	43	47	51
Integrated 90° sector antenna -5.x GHz	1.356	48	53	58	64	69
Directional Yagi antenna - 900 MHz	0.27	10	11	13	14	16
External 65° sector antenna – 900 MHz	2.72	97	109	123	137	151

For a connectorized ODU, add the wind loading of the external antenna to that of the ODU. The antenna manufacturer should be able to quote wind loading.

Table 47 PMP/PTP 450 wind loading (Newton)

Type of ODU	Max surface area (square meters)	Wind speed (kilometer per hour)				
		30	40	50	60	70

External 60° sector antenna – 2.4 GHz AP	0.27	25	45	71	102	138
External 60° sector antenna – 5 GHz AP	0.066	6	11	17	25	34
External 90° sector antenna – 5 GHz AP	0.083	8	14	22	31	43
SM	0.29	0.25	0.45	0.7	1	1.4

Table 48 PMP/PTP 450 wind loading (lb force)

Type of ODU	Max surface area (square feet)	Wind speed (miles per hour)				
		80	100	120	140	150
External 60° sector antenna – 2.4 GHz AP	2.9	78	122	175	239	274
External 60° sector antenna – 5 GHz AP	0.71	19	30	43	58	67
External 90° sector antenna – 5 GHz AP	0.89	24	37	54	73	84
SM	0.29	7.8	12	18	23	27

Drop cable grounding points

To estimate how many grounding kits are required for each drop cable, refer to the site installation diagrams (Figure 27 , Figure 28 and Figure 29) and use the following criteria:

- The drop cable shield must be grounded near the ODU at the first point of contact between the drop cable and the mast, tower or building.
- The drop cable shield must be grounded at the building entry point.

For mast or tower installations (Figure 27), use the following additional criteria:

- The drop cable shield must be grounded at the bottom of the tower, near the vertical to horizontal transition point. This ground cable must be bonded to the tower or tower ground bus bar (TGB), if installed.
- If the tower is greater than 61 m (200 ft) in height, the drop cable shield must be grounded at the tower midpoint, and at additional points as necessary to reduce the distance between ground cables to 61 m (200 ft) or less.

- In high lightning-prone geographical areas, the drop cable shield must be grounded at spacing between 15 to 22 m (50 to 75 ft). This is especially important on towers taller than 45 m (150 ft).

For roof installations (Figure 29), use the following additional criteria:

- The drop cable shield must be bonded to the building grounding system at its top entry point (usually on the roof).
- The drop cable shield must be bonded to the building grounding system at the entry point to the equipment room.

Lightning Protection Unit(LPU) location

Find a location for the bottom LPU that meets the following requirements:

- The bottom LPU can be connected to the drop cable from the ODU.
- The bottom LPU is within 600 mm (24 in) of the point at which the drop cable enters the building, enclosure or equipment room within a larger building.
- The bottom LPU can be bonded to the grounding system.

Radio Frequency planning

This section describes how to plan PMP/PTP 450 platform links to conform to analysis of spectrum and the regulatory restrictions that apply in the country of operation.

Regulatory limits

Many countries impose EIRP limits (Allowed EIRP) on products operating in the bands used by the PMP/PTP 450 platform Series.

Refer to Equipment Disposal

Waste (Disposal) of Electronic and Electric Equipment

Waste (Disposal) of Electronic and Electric Equipment

Please do not dispose of Electronic and Electric Equipment or Electronic and Electric Accessories with your household waste. In some countries or regions, collection systems have been set up to handle waste of electrical and electronic equipment. In European Union countries, please contact your local equipment supplier representative or service center for information about the waste collection system in your country.

Country specific maximum transmit power

(Chapter 10: Reference Information) on page 10-35 to determine what the maximum transmitted power and EIRP for PMP/PTP 450/450i Series that can be used in each of countries and frequency band.

Caution

It is the responsibility of the user to ensure that the PMP/PTP product is operated in accordance with local regulatory limits.

Note

Contact the applicable radio regulator to find out whether or not registration of the PMP/PTP 450/450i link is required.

Conforming to the limits

Ensure the link is configured to conform to local regulatory requirements by configuring the PMP 450/450i AP or PTP 450/450iBHM for the correct country. In the following situations, this does not prevent operation outside the regulations:

- When using connectorized ODUs with external antennas, the regulations may require the maximum transmit power to be reduced.

Available spectrum

The available spectrum for operation depends on the regulatory band. When configured appropriately, the unit will only allow operation on those channels which are permitted by the regulations.

Certain regulations have allocated certain channels as unavailable for use:

- FCC has allocated part of the 5.1 & 5.2 GHz
- ETSI has allocated part of the 5.4 GHz band to weather radar.
- UK and some other European countries have allocated part of the 5.8 GHz band to Road Transport and Traffic Telematics (RTTT) systems.

The number and identity of channels barred in a given regulatory band is dependent on the channel bandwidth and channel raster selected.

Analyzing the RF Environment

An essential element in RF network planning is the analysis of spectrum usage and the strength of the signals that occupy the spectrum. Regardless of how these parameters are measured and log or chart the results (through the Spectrum Analyzer feature or by using a spectrum analyzer), ensure measurements are performed:

- At various times of day.
- On various days of the week.
- Periodically into the future.

As new RF neighbors move in or consumer devices proliferate in currently used spectrum, this keeps the user aware of the dynamic possibilities for interference within the network.

Channel bandwidth

Select the required channel bandwidth for the link. The selection depends upon the regulatory band selected.

The wider the channel bandwidth, the greater the capacity. As narrower channel bandwidths take up less spectrum, selecting a narrow channel bandwidth may be a better choice when operating in locations where the spectrum is very busy.

Both ends of the link must be configured to operate on the same channel bandwidth.

Anticipating Reflection of Radio Waves

In the signal path, any object that is larger than the wavelength of the signal can reflect the signal. Such an object can even be the surface of the earth or of a river, bay or lake. The wavelength of the signal is approximately

- 2 inches (or 5 cm) for 5.4 GHz and 5.8 GHz signals.
- 12 inches for 900 MHz signals

A reflected signal can arrive at the antenna of the receiver later than the non-reflected signal arrives. These two or more signals cause the condition known as multipath. Multipath may increase or decrease the signal level, resulting in overall attenuation that may be higher or lower than that caused by the link distance. This is problematic at the margin of the link budget, where the standard operating margin (fade margin) may be compromised.

Obstructions in the Fresnel Zone

The Fresnel (pronounced fre·NEL) Zone is a three-dimensional volume around the line of sight of an antenna transmission. Objects that penetrate this area can cause the received strength of the transmitted signal to fade. Out-of-phase reflections and absorption of the signal result in signal cancellation.

The foliage of trees and plants in the Fresnel Zone can cause signal loss. Seasonal density, moisture content of the foliage, and other factors such as wind may change the amount of loss. Plan to perform frequent and regular link tests if you must transmit through foliage.

Planning for co-location

The first step to avoid interference in wireless systems is to set all AP/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 AP/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/BHM transmits, which could overpower that signal.

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

- Downlink Data percentage
- (reserved) Contention slots

If OFDM (PMP/PTP 450 platform, PMP/PTP 230) and FSK (PMP/PTP 1x0) APs/BHMs of the same frequency band are in proximity, or if you want BHMs set to different parameters then you must use the Frame Calculator to identify compatible settings for APs/BHMs.

The co-location is also supported for 900 MHz PMP 450i APs (OFDM) and PMP 100 APs (FSK).

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

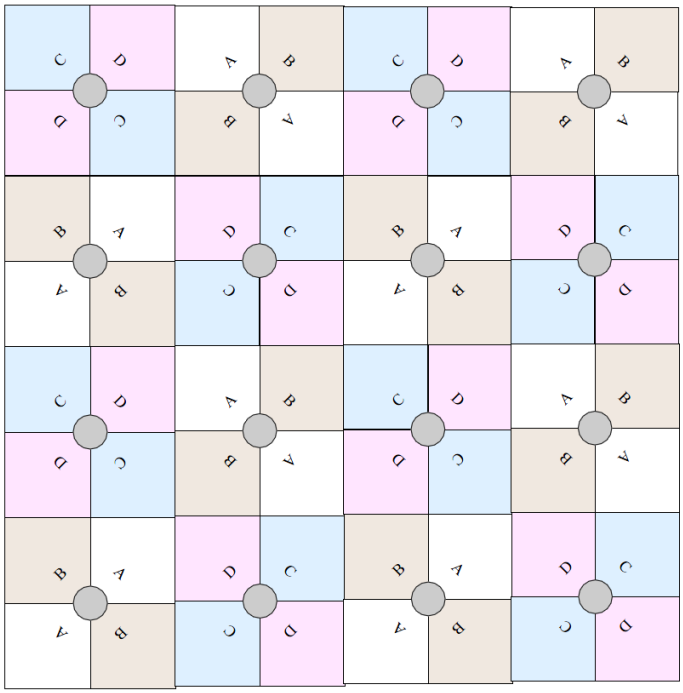
For more information on PMP/PTP 450 platform co-location, see

http://www.cambiumnetworks.com/solution-papers

Multiple OFDM Access Point Clusters

When deploying multiple AP clusters in a dense area, consider aligning the clusters as shown below. However, this is only a recommendation. An installation may dictate a different pattern of channel assignments.

Figure 33 Example layout of 16 Access Point sectors (ABCD), 90 degree sectors

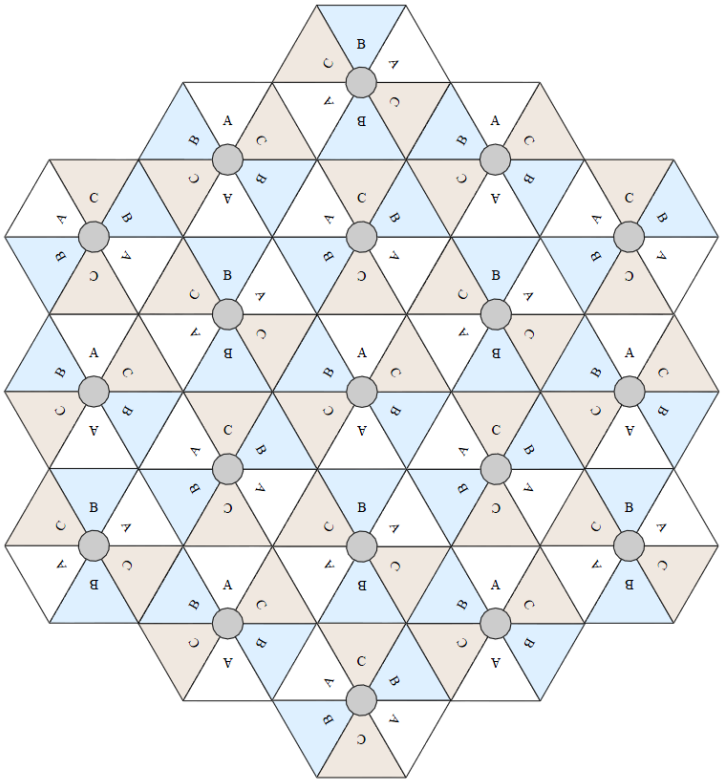


An example for assignment of frequency channels is provided in the following table.

Table 49 Example 5.8 GHz 4-channel assignment by access site

Symbol	Frequency
A	5.740 GHz
B	5.760 GHz
C	5.780 GHz
D	5.800 GHz

Figure 34 Example layout of 6 Access Point sectors (ABC), 60 degree sectors



An example for assignment of frequency channels and sector IDs is provided in the following table.

Table 50 Example 5.8 GHz 3-channel assignment by access site

Symbol	Frequency
A	5.740 GHz
B	5.760 GHz
C	5.780 GHz

Link planning

This section describes factors to be taken into account when planning links, such as range, obstacles path loss and throughput. LINKPlanner is recommended.

Range and obstacles

Calculate the range of the link and identify any obstacles that may affect radio performance.

Perform a survey to identify all the obstructions (such as trees or buildings) in the path and to assess the risk of interference. This information is necessary in order to achieve an accurate link feasibility assessment.

The PMP/PTP 450 platform Series is designed to operate in Non-Line-of-Sight (NLoS) and Line-of-Sight (LoS) environments. An NLOS environment is one in which there is no optical line-of-sight, that is, there are obstructions between the antennas.

OFDM technology can often use multi-pathing to an advantage to overcome nLOS, especially in cases where the Fresnel zone is only partially blocked by buildings, “urban canyons”, or foliage. OFDM tends to help especially when obstacles are near the middle of the link, and less so when the obstacles are very near the ODU.

However, attenuation through walls and trees is substantial for any use of the 5.4 GHz and 5.8 GHz frequency bands. The lower frequency radio waves of 900 MHz radios provide greater penetration through walls, trees and other obstacles, making it optimal for most non-line-of-sight applications. Even with OFDM, these products are not expected to penetrate walls or extensive trees and foliage.

Path loss

Path loss is the amount of attenuation the radio signal undergoes between the two ends of the link. The path loss is the sum of the attenuation of the path if there were no obstacles in the way (Free Space Path Loss), the attenuation caused by obstacles (Excess Path Loss) and a margin to allow for possible fading of the radio signal (Fade Margin). The following calculation needs to be performed to judge whether a particular link can be installed:

$$L_{free\_space} + L_{excess} + L_{fade} + L_{seasonal} < L_{capability}$$

Where:	Is:
L_{free_space}	Free Space Path Loss (dB)
L_{excess}	Excess Path Loss (dB)
L_{fade}	Fade Margin Required (dB)
$L_{seasonal}$	Seasonal Fading (dB)

$L_{capability}$ Equipment Capability (dB)

Calculating Link Loss

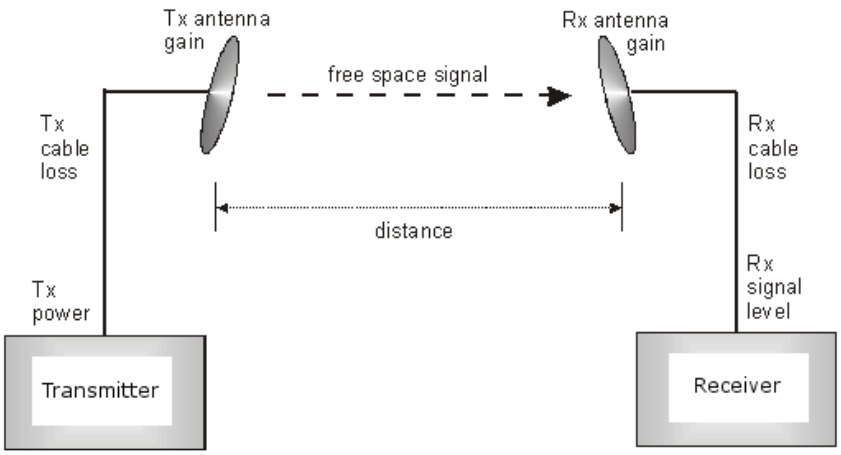
The link loss is the total attenuation of the wireless signal between two point-to-multipoint units. The link loss calculation is presented below:

Link Loss (dB) = Transmit power of the remote wireless unit (dBm) – Tx Cable loss (dB) – Received power at the local unit (dBm) – Rx cable loss (dB) + Antenna gain at the remote unit (dBi) + Antenna gain at the local unit (dBi)

Calculating Rx Signal Level

The determinants in Rx signal level are illustrated in Figure 35.

Figure 35 Determinants in Rx signal level



Rx signal level dB = Tx power – Tx cable loss + Tx antenna gain – free space path loss + Rx antenna gain – Rx cable loss

Note

This Rx signal level calculation presumes that a clear line of sight is established between the transmitter and receiver and that no objects encroach in the Fresnel zone.

Calculating Fade Margin

Free space path loss is a major determinant in Rx (received) signal level. Rx signal level, in turn, is a major factor in the system operating margin (fade margin), which is calculated as follows:

System operating margin (fade margin) dB = Rx signal level dB – Rx sensitivity dB

Thus, fade margin is the difference between strength of the received signal and the strength that the receiver requires for maintaining a reliable link. A higher fade margin is characteristic of a more reliable link.

Adaptive modulation

Adaptive modulation ensures that the highest throughput that can be achieved instantaneously will be obtained, taking account of propagation and interference. When the link has been installed, web pages provide information about the link loss currently measured by the equipment, both instantaneously and averaged. The averaged value will require maximum seasonal fading to be added, and then the radio reliability of the link can be computed.

For details of the system throughput, link loss and maximum distance for each frequency band in all modulation modes, see Link on page 10-24.

Planning for connectorized units

This section describes factors to be taken into account when planning to use connectorized ODUs with external antennas in PMP/PTP 450 platform links.

When to install connectorized units

The majority of radio links can be successfully deployed with the integrated ODU. However the integrated units may not be sufficient in some areas, for example:

- Where the path is heavily obscured by dense woodland on an NLOS link.
- Where long LOS links are required.
- Where there are known to be high levels of interference.

In these areas, connectorized ODUs and external antennas should be used.

Choosing external antennas

When selecting external antennas, consider the following factors:

- The required antenna gain.
- Ease of mounting and alignment.
- Use dual-polarization antenna (as the integrated antenna).

Note

Enter the antenna gain and cable loss into the Installation Wizard, if the country selected has an EIRP limit, the corresponding maximum transmit power will be calculated automatically by the unit.

Calculating RF cable length (5.8 GHz FCC only)

The 5.8 GHz band FCC approval for the product is based on tests with a cable loss between the ODU and antenna of not less than 1.2 dB. If cable loss is below 1.2 dB with a 1.3 m (4 ft) diameter external antenna, the connectorized PMP/PTP 450 platform may exceed the maximum radiated spurious emissions allowed under FCC 5.8 GHz rules.

Cable loss depends mainly upon cable type and length. To meet or exceed the minimum loss of 1.2 dB, use cables of the type and length specified in Table 51 (source: Times Microwave). This data excludes connector losses.

Table 51 RF cable lengths required to achieve 1.2 dB loss at 5.8 GHz

RF cable type	Minimum cable length
LMR100	0.6 m (1.9 ft)
LMR200	1.4 m (4.6 ft)
LMR300	2.2 m (7.3 ft)
LMR400	3.4 m (11.1 ft)
LMR600	5.0 m (16.5 ft)

Data network planning

This section describes factors to be considered when planning PMP/PTP 450 platform data networks.

Understanding addresses

A basic understanding of Internet Protocol (IP) address and subnet mask concepts is required for engineering your IP network.

IP address

The IP address is a 32-bit binary number that has four parts (octets). This set of four octets has two segments, depending on the class of IP address. The first segment identifies the network. The second identifies the hosts or devices on the network. The subnet mask marks a boundary between these two sub-addresses.

Dynamic or static addressing

For any computer to communicate with a module, the computer must be configured to either

- use DHCP (Dynamic Host Configuration Protocol). In this case, when not connected to the network, the computer derives an IP address on the 169.254 network within two minutes.
- have an assigned static IP address (for example, 169.254.1.5) on the 169.254 network.

Note

If an IP address that is set in the module is not the 169.254.x.x network address, then the network operator must assign the computer a static IP address in the same subnet.

When a DHCP server is not found

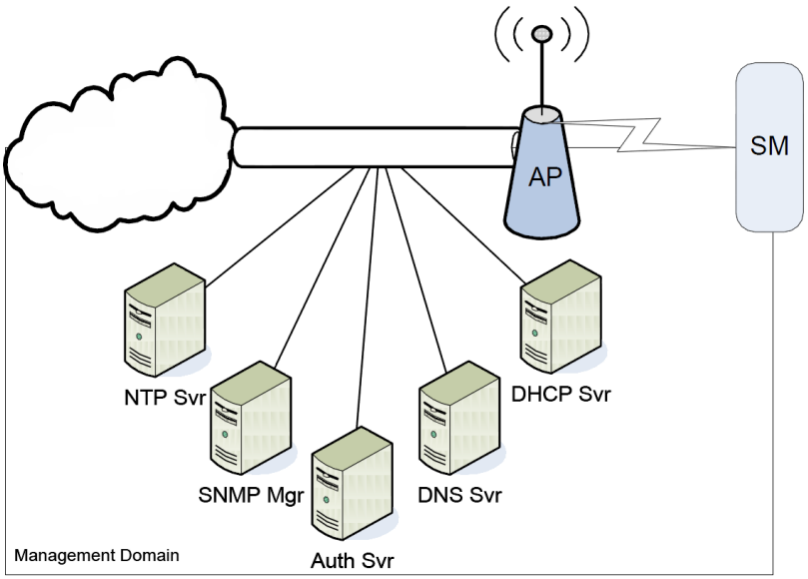
To operate on a network, a computer requires an IP address, a subnet mask, and possibly a gateway address. Either a DHCP server automatically assigns this configuration information to a computer on a network or an operator must input these items.

When a computer is brought on line and a DHCP server is not accessible (such as when the server is down or the computer is not plugged into the network), Microsoft and Apple operating systems default to an IP address of 169.254.x.x and a subnet mask of 255.255.0.0 (169.254/16, where /16 indicates that the first 16 bits of the address range are identical among all members of the subnet).

DNS Client

The DNS Client is used to resolve names of management servers within the operator's management domain (see Figure 36). This feature allows hostname configuration for NTP servers, Authorization Servers, DHCP relay servers, and SNMP trap servers. Operators may choose to either enter in the FQDN (Fully Qualified Domain Name) for the host name or to manually enter the IP addresses of the servers.

Figure 36 Cambium networks management domain



Network Address Translation (NAT)

NAT, DHCP Server, DHCP Client and DMZ in SM

The system provides NAT (network address translation) for SMs in the following combinations of NAT and DHCP (Dynamic Host Configuration Protocol):

- NAT Disabled
- NAT with DHCP Client (**DHCP** selected as the **Connection Type** of the WAN interface) and DHCP Server
- NAT with DHCP Client(**DHCP** selected as the **Connection Type** of the WAN interface)
- NAT with DHCP Server
- NAT without DHCP

NAT

NAT isolates devices connected to the Ethernet/wired side of a SM from being seen directly from the wireless side of the SM. With NAT enabled, the SM has an IP address for transport traffic (separate from its address for management), terminates transport traffic, and allows you to assign a range of IP addresses to devices that are connected to the Ethernet/wired side of the SM.

In the Cambium system, NAT supports many protocols, including HTTP, ICMP (Internet Control Message Protocols), and FTP (File Transfer Protocol). For virtual private network (VPN) implementation, L2TP over IPSec (Level 2 Tunneling Protocol over IP Security) and PPTP (Point to Point Tunneling Protocol) are supported.

DHCP

DHCP enables a device to be assigned a new IP address and TCP/IP parameters, including a default gateway, whenever the device reboots. Thus DHCP reduces configuration time, conserves IP addresses, and allows modules to be moved to a different network within the Cambium system.

In conjunction with the NAT features, each SM provides:

- A DHCP server that assigns IP addresses to computers connected to the SM by Ethernet protocol.
- A DHCP client that receives an IP address for the SM from a network DHCP server.

DMZ

In conjunction with the NAT features, a DMZ (demilitarized zone) allows the assignment of one IP address behind the SM for a device to logically exist outside the firewall and receive network traffic. The first three octets of this IP address must be identical to the first three octets of the NAT private IP address.

Developing an IP addressing scheme

Network elements are accessed through IP Version 4 (IPv4) addressing.
A proper IP addressing method is critical to the operation and security of a network.

Each module requires an IP address on the network. This IP address is for only management purposes. For security, you must either:

- Assign a non-routable IP address.
- Assign a routable IP address only if a firewall is present to protect the module.

You assign an IP addresses to computers and network components by either static or dynamic IP addressing. You will also assign the appropriate subnet mask and network gateway to each module.

Address Resolution Protocol

As previously stated, the MAC address identifies a module in:

- Communications between modules.
- The data that modules store about each other.

The IP address is essential for data delivery through a router interface. Address Resolution Protocol (ARP) correlates MAC addresses to IP addresses.

For communications to outside the network segment, ARP reads the network gateway address of the router and translates it into the MAC address of the router. Then the communication is sent to MAC address (physical network interface card) of the router.

For each router between the sending module and the destination, this sequence applies. The ARP correlation is stored until the ARP cache times out.

Allocating subnets

The subnet mask is a 32-bit binary number that filters the IP address. Where a subnet mask contains a bit set to 1, the corresponding bit in the IP address is part of the network address.

Example IP address and subnet mask

In Figure 37, the first 16 bits of the 32-bit IP address identify the network:

Figure 37 Example of IP address in Class B subnet

	Octet 1	Octet 2	Octet 3	Octet 4
IP address 169.254.1.1	10101001	11111110	00000001	00000001
Subnet mask 255.255.0.0	11111111	11111111	00000000	00000000

In this example, the network address is 169.254 and 2^{16} (65,536) hosts are addressable.

Selecting non-routable IP addresses

The factory default assignments for network elements are:

- Unique MAC address
- IP address of 169.254.1.1
- Subnet mask of 255.255.0.0
- Network gateway address of 169.254.0.0

For each radio and CMM4, assign an IP address that is both consistent with the IP addressing plan for your network and cannot be accessed from the Internet. IP addresses within the following ranges are not routable from the Internet, regardless of whether a firewall is configured:

- 10.0.0.0 – 10.255.255.255
- 172.16.0.0 – 172.31.255.255
- 192.168.0.0 – 192.168.255.255

Also, the subnet mask and network gateway for each CMM4 can be assigned.

Translation bridging

Optionally, the AP can be configured to change the source MAC address in every packet it receives from its SMs to the MAC address of the SM/BHS that bridged the packet, before forwarding the packet toward the public network. In this case:

- Not more than 128 IP devices at any time are valid to send data to the AP from behind the SM.
- SM populates the Translation Table tab of its Statistics web page, displaying the MAC address and IP address of all the valid connected devices.
- Each entry in the Translation Table is associated with the number of minutes that have elapsed since the last packet transfer between the connected device and the SM.
- If 128 are connected, and another attempts to connect:
  - If no Translation Table entry is older than 255 minutes, the attempt is ignored.
  - If an entry is older than 255 minutes, the oldest entry is removed and the attempt is successful.
- The **Send Untranslated ARP** parameter in the General tab of the Configuration page can be:
  - Disabled, so that the AP overwrites the MAC address in ARP packets before forwarding them.
  - Enabled, so that the AP forwards ARP packets regardless of whether it has overwritten the MAC address.

This is the **Translation Bridging** feature, which you can enable in the General page of the Configuration web page in the AP. When this feature is disabled, the setting of the **Send Untranslated ARP** parameter has no effect, because all packets are forwarded untranslated (with the source MAC address intact). See Address Resolution Protocol on Page 3-13.

Engineering VLANs

The radios support VLAN functionality as defined in the 802.1Q (Virtual LANs) specification, except for the following aspects of that specification:

- Protocols:
  - Generic Attribute Registration Protocol (GARP) GARV
  - Spanning Tree Protocol (STP)
  - Multiple Spanning Tree Protocol (MSTP)
  - GARP Multicast Registration Protocol (GMRP)
- Embedded source routing (ERIF) in the 802.1Q header
- Multicast pruning
- Flooding unknown unicast frames in the downlink

As an additional exception, the AP/BHM does not flood downward the unknown unicast frames to the SM/BHS.

A VLAN configuration in Layer 2 establishes a logical group within the network. Each computer in the VLAN, regardless of initial or eventual physical location, has access to the same data. For the network operator, this provides flexibility in network segmentation, simpler management, and enhanced security.

Special case VLAN numbers

This system handles special case VLAN numbers according to IEEE specifications:

Table 52 Special case VLAN IDs

VLAN Number	Purpose	Usage Constraint
0	These packets have 802.1p priority, but are otherwise handled as untagged.	Must not be used as a management VLAN.
1	Although not noted as special case by IEEE specifications, these packets identify traffic that was untagged upon ingress into the SM and must remain untagged upon egress. This policy is hard-coded in the AP.	Must not be used for system VLAN traffic.
4095	This VLAN is reserved for internal use.	Must not be used at all.

SM membership in VLANs

With the supported VLAN functionality, the radios determine bridge forwarding on the basis of not only the destination MAC address, but also the VLAN ID of the destination. This provides flexibility in how SMs are used:

- Each SM can be a member in its own VLAN.
- Each SM can be in its own broadcast domain, such that only the radios that are members of the VLAN can see broadcast and multicast traffic to and from the SM.
- The network operator can define a work group of SMs, regardless of the AP(s) to which they register.

PMP 450 platform modules provide the VLAN frame filters that are described in Table 53.

Table 53 VLAN filters in point-to-multipoint modules

Where VLAN is active, if this parameter value is selected ...	**then a frame is discarded if...**		**because of this VLAN filter in the software:**
	entering the bridge/ NAT switch through...		
	Ethernet...	**TCP/IP...**	
any combination of VLAN parameter settings	with a VID not in the membership table		Ingress
any combination of VLAN parameter settings		with a VID not in the membership table	Local Ingress
Allow Frame Types: Tagged Frames Only	with no 802.1Q tag		Only Tagged
Allow Frame Types: Untagged Frames Only	with an 802.1Q tag, regardless of VID		Only Untagged
Local SM Management: Disable in the SM, or **All Local SM Management: Disable** in the AP	with an 802.1Q tag and a VID in the membership table		Local SM Management
	leaving the bridge/ NAT switch through...		
	Ethernet...	**TCP/IP...**	
any combination of VLAN parameter settings	with a VID not in the membership table		Egress
any combination of VLAN parameter settings		with a VID not in the membership table	Local Egress

Priority on VLANs (802.1p)

The radios can prioritize traffic based on the eight priorities described in the IEEE 802.1p specification. When the high-priority channel is enabled on a SM, regardless of whether VLAN is enabled on the AP for the sector, packets received with a priority of 4 through 7 in the 802.1p field are forwarded onto the high-priority channel.

Operators may configure priority precedence as 802.1p Then Diffserv (Default) or Diffserv Then 802.1p. Since these priority precedence configurations are independent between the AP and SM, this setting must be configured on both the AP and SM to ensure that the precedence is adhered to by both sides of the link.

VLAN settings can also cause the module to convert received non-VLAN packets into VLAN packets. In this case, the 802.1p priority in packets leaving the module is set to the priority established by the DiffServ configuration.

If VLAN is enabled, immediately monitor traffic to ensure that the results are as desired. For example, high-priority traffic may block low-priority.

Q-in-Q DVLAN (Double-VLAN) Tagging (802.1ad)

PMP and PTP modules can be configured with 802.1ad Q-in-Q DVLAN (Double-VLAN) tagging which is a way for an operator to put an 802.1Q VLAN inside of an 802.1ad VLAN. A nested VLAN, which is the original 802.1Q tag and a new second 802.1ad tag, allows for bridging of VLAN traffic across a network and segregates the broadcast domains of 802.1Q VLANs. Q-in-Q can be used with PPPoE and/or NAT.

The 802.1ad standard defines the S-VLAN as the Service Provider VLAN and the C-VLAN as the customer VLAN. The radio software does 2 layer Q-in-Q whereby the C-VLAN is the 802.1Q tag and the S-VLAN is the second layer Q tag as shown in Table 54.

Table 54 Q-in-Q Ethernet frame

Ethernet Header	S-VLAN EthType 0x88a8	C-VLAN EthType 0x8100	IP Data EthType 0x0800

The 802.1ad S-VLAN is the outer VLAN that is configurable on the **Configuration > VLAN** web page of the AP/BHM. The Q-in-Q EtherType parameter is configured with a default EtherType of 0x88a8 in addition to four alternate EtherTypes that can be configured to aid in interoperability with existing networks that use a different EtherType than the default.

The C-VLAN is the inner VLAN tag, which is the same as 802.1Q. As a top level concept, this operates on the outermost tag at any given time, either “pushing” a tag on or “popping” a tag off. This means packets will at most transition from an 802.1Q frame to an 801.ad frame (with a tag “pushed” on) or an untagged 802.1 frame (with the tag “popped” off. Similarly, for an 802.1ad frame, this can only transition from an 802.1ad frame to an 802.1Q frame (with the tag “popped” off) since the radio software only supports 2 levels of tags.

Network management planning

This section describes how to plan for PMP/PTP 450 platform links to be managed remotely using SNMP.

Planning for SNMP operation

Cambium modules provide the following SNMP traps for automatic notifications to the NMS:

- coldStart, which signals that the SNMPv2c element is reinitializing itself and that its configuration may have been altered.
- warmStart, which signals that the SNMPv2c element is reinitializing such that its configuration is unaltered.
- authenticationFailure, which signals that the SNMPv2c element has received a protocol message that is not properly authenticated (contingent on the snmpEnableAuthenTraps object setting).
- linkDown, as defined in RFC 1573
- linkUp, as defined in RFC 1573
- egpNeighborLoss, as defined in RFC 1213
- whispGPSInSync, which signals a transition from not synchronized to synchronized.
- whispGPSOutSync, which signals a transition from synchronized to not synchronized.
- whispRegComplete, which signals registration completed.
- whispRegLost, which signals registration lost.
- whispRadarDetected, which signals that the one-minute scan has been completed, radar has been detected and the radio will shut down.
- whispRadarEnd, which signals that the one-minute scan has been completed, radar has not been detected and the radio will resume normal operation.

Note

The proprietary MIBs are provided in the PMP/PTP 450 platform Series software download files in the support website (see Contacting Cambium Networks on page 1).

Enabling SNMP

Enable the SNMP interface for use by configuring the following attributes in the SNMP Configuration page:

- SNMP State (default disabled)
- SNMP Version (default SNMPv2c)
- SNMP Port Number (default 161)

Security planning

This section describes how to plan for PMP/PTP 450 platform links to operate in secure mode.

- Managing module access by passwords
- Filtering protocols and ports
- Port Configuration

Isolating AP/BHM from the Internet

Ensure that the IP addresses of the AP/BHM in the network:

- are not routable over the Internet.
- do not share the subnet of the IP address of your user.

RFC 1918, Address Allocation for Private Subnets, reserves for private IP networks three blocks of IP addresses that are not routable over the Internet:

- /8 subnets have one reserved network, 10.0.0.0 to 10.255.255.255.
- /16 subnets have 16 reserved networks, 172.16.0.0 to 172.31.255.255.
- /24 subnets have 256 reserved networks, 192.168.0.0 to 192.168.255.255.

Encrypting radio transmissions

Cambium fixed wireless broadband IP systems employ the following form of encryption for security of the wireless link:

- **DES (Data Encryption Standard)**: An over-the-air link encryption option that uses secret 56-bit keys and 8 parity bits. DES performs a series of bit permutations, substitutions, and recombination operations on blocks of data. DES encryption does not affect the performance or throughput of the system.
- **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 than DES. AES products are certified as compliant with the Federal Information Processing Standards (FIPS 197) in the U.S.A.

The default encryption setting for 450 platform is "None".

Planning for HTTPS operation

Before starting to configure HTTPS operation, ensure that the cryptographic material listed in Table 55 is available.

Table 55 HTTPS security material

Item	Description	Quantity required
User Defined Security Banner	The banner provides warnings and notices to be read by the user before logging in to the ODU. Use text that is appropriate to the network security policy.	Normally one per link. This depends upon network policy.
Port numbers for HTTP, HTTPS and Telnet	Port numbers allocated by the network.	As allocated by network.

Planning for SNMPv3 operation

SNMP security mode

Decide how SNMPv3 security will be configured.

MIB-based security management uses standard SNMPv3 MIBs to configure the user-based security model and the view-based access control model. This approach provides considerable flexibility, allowing a network operator to tailor views and security levels appropriate for different types of user. MIB-based security management may allow a network operator to take advantage of built-in security management capabilities of existing network managers.

Web-based security management allows an operator to configure users, security levels, privacy and authentication protocols, and passphrases using the PMP/PTP 450 platform web-based management interface. The capabilities supported are somewhat less flexible than those supported using the MIB-based security management, but will be sufficient in many applications. Selection of web-based management for SNMPv3 security disables the MIB-based security management. PMP/PTP 450 platform does not support concurrent use of MIB-based and web-based management of SNMPv3 security.

Web-based management of SNMPv3 security

Initial configuration of SNMPv3 security is available only to HTTP or HTTPS user accounts with security role of Security Officer.

Identify the format used for SNMP Engine ID. The following formats are available:

- MAC address (default)
- 5 and 32 hex characters (the hex character input is driven by RFC 3411 recommendations on the Engine ID)

Identify the user names and security roles of initial SNMPv3 users. Two security roles are available:

- Read Only
- System Administrator

Identify the security level for each of the security roles. Three security levels are available:

(a) No authentication, no privacy

(b) Authentication, no privacy

(c) Authentication, privacy

If authentication is required, identify the protocol. The authentication protocol available is MD5.

If privacy will be used, identify the protocol. The privacy protocol available is cbc-des.

Managing module access by passwords

From the factory, each module has a preconfigured administrator-level account in the name `root`, which initially requires no associated password. When you upgrade a module:

- An account is created in the name `admin`.
- Both `admin` and `root` inherit the password that was previously used to access the module, if:
  - **Full Access** password, if one was set.
  - **Display-Only Access** password, if one was set and no Full Access password was set.

Caution

If you use Wireless Manager, do not delete the root account from any module. If you use a NMS that communicates with modules through SNMP, do not delete the root account from any module unless you first can confirm that the NMS does not rely on the root account for access to the modules.

Each module supports four or fewer user accounts, regardless of account levels. The available levels are

- ADMINISTRATOR, who has full read and write permissions. This is the level of the `root` and `admin` users, as well as any other administrator accounts that one of them creates.
- INSTALLER, who has permissions identical to those of ADMINISTRATOR except that the installer cannot add or delete users or change the password of any other user.
- TECHNICIAN, who has permissions to modify basic radio parameters and view informational web pages.
- GUEST, who has no write permissions and only a limited view of General Status tab.
- Admin, Installer and Tech accounts can be configured as READ-ONLY. This will allow the account to only see the items.

The ability to view information of General Status tab can be controlled by the "Site Information Viewable to Guest Users" under the SNMP tab.

From the factory default state, configure passwords for both the `root` and `admin` account at the ADMINISTRATOR permission level, using the **Account > Change Users Password** page. (If configure only one of these, then the other will still require no password for access into it and thus remain a security risk.) If you are intent on configuring only one of them, delete the `admin` account. The `root` account is the only account that CNUT uses to update the module.

After a password has been set for any ADMINISTRATOR-level account, initial access to the module GUI opens the view of GUEST level.

Planning for RADIUS operation

Configure RADIUS where remote authentication is required for users of the web-based interface. Remote authentication has the following advantages:

- Control of passwords can be centralized.
- Management of user accounts can be more sophisticated. For example; users can be prompted by a network manager to change passwords at regular intervals. As another example, passwords can be checked for inclusion of dictionary words and phrases.
- Passwords can be updated without reconfiguring multiple network elements.
- User accounts can be disabled without reconfiguring multiple network elements.

Remote authentication has one significant disadvantage in a wireless link product such as PMP/PTP 450 platform. If the wireless link is down, a unit on the remote side of the broken link may be prevented from contacting a RADIUS Server, with the result that users are unable to access the web-based interface.

One useful strategy would be to combine RADIUS authentication for normal operation with a single locally-authenticated user account for emergency use.

PMP 450 platform SM provides a choice of the following authentication methods:

- EAP-MSCHAPv2
- EAP-TTLS

Ensure that the authentication method selected in PMP/PTP 450 platform is supported by the RADIUS server.

Filtering protocols and ports

Configure filters for specified protocols and ports from leaving the AP/BHM and SM/BHS and entering the network. This protects the network from both intended and inadvertent packet loading or probing by network users. By keeping the specified protocols or ports off the network, this feature also provides a level of protection to users from each other.

Protocol and port filtering is set per AP/SM/BH. Except for filtering of SNMP ports, filtering occurs as packets leave the AP/SM/BH.

For example, if SM is configured to filter SNMP, then SNMP packets are blocked from entering the SM and, thereby, from interacting with the SNMP portion of the protocol stack on the SM.

Port Filtering with NAT Enabled

Where NAT is enabled on the SM/BHS, the filtering can be enabled for only the user-defined ports. The following are examples for situations where the configure port can be filtered where NAT is enabled:

- To block a subscriber from using FTP, you can filter Ports 20 and 21 (the FTP ports) for both the TCP and UDP protocols.
- To block a subscriber from access to SNMP, you can filter Ports 161 and 162 (the SNMP ports) for both the TCP and UDP protocols.

Note

In only the SNMP case, filtering occurs before the packet interacts with the protocol stack.

Protocol and Port Filtering with NAT Disabled

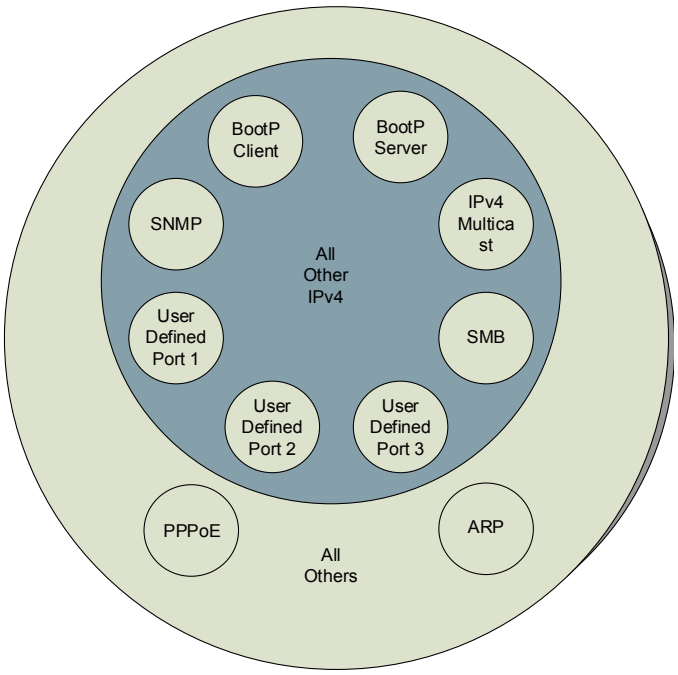
Where NAT is disabled on the SM/BHS, the filtering can be enabled for both protocols and the three user-defined ports. Using the check boxes on the interface, it can be either:

- Allow all protocols except those that user wish to block.
- Block all protocols except those that user wish to allow.

Allow or block any of the following protocols:

- PPPoE (Point to Point Protocol over Ethernet)
- Any or all of the following IPv4 (Internet Protocol version 4) protocols:
- Any or all of the following IPv4 (Internet Protocol version 4) protocols:
  - SMB (Network Neighborhood)
  - SNMP
  - Bootp Client
  - Bootp Server
  - Up to 3 user-defined ports
  - All other IPv4 traffic (see Figure 29)
- Any or all of the following IPv6 (Internet Protocol version 6) protocols:
  - SMB (Network Neighborhood)
  - SNMP
  - Bootp Client
  - Bootp Server
  - Up to 3 user-defined ports
  - All other IPv6 traffic (see Figure 29)
- Filter Direction – Upstream and Downstream
- ARP (Address Resolution Protocol)

Figure 38 Categorical protocol filtering



The following are example situations in which the protocol filtering is configured where NAT is disabled:

- If a subscriber is blocked from only PPPoE and SNMP, then the subscriber retains access to all other protocols and all ports.
- If PPPoE, IPv4, and Uplink Broadcast are blocked, and also check the **All others** selection, then only Address Resolution Protocol is not filtered.

The ports filtered as a result of protocol selections in the **Protocol Filtering** tab of the SM/BHS are listed in Table 56.

Table 56 Ports filtered per protocol selections

Protocol Selected	Port Filtered (Blocked)
SMB	Destination Ports UDP : 137, 138, 139, 445, 3702 and 1900 Destination Ports TCP : 137, 138, 139, 445, 2869, 5357 and 5358
SNMP	Destination Ports TCP and UDP : 161 and 162
Bootp Client	Source Port 68 UDP
Bootp Server	Source Port 67 UDP
User Defined Port 1..3	User defined ports for filtering UDP and TCP
IPv4 Multicast	Block IPv4 packet types except other filters defined
IPv6 Multicast	Block IPv6 packet types except other filters defined
ARP	Filter all Ethernet packet type 806
Upstream	Applies packet filtering to traffic coming into the FEC interface
Downstream	Applies packet filtering to traffic destined to exit the FEC interface

Port Configuration

PMP/PTP 450 platform supports access to various communication protocols and only the ports required for these protocols are available for access by external entities. Operators may change the port numbers for these protocols via the radio GUI or SNMP.

Table 57 Device default port numbers

Port	Usage	Port Usage	Device
21	FTP	Listen Port	AP, SM
80	HTTP	Listen Port	AP, SM
443	HTTPS	Listen Port	AP, SM
161	SNMP port	Listen Port	AP, SM
162	SNMP trap port	Destination Port	AP, SM
514	Syslog Server port	Destination Port	AP, SM
1812	Standard RADIUS port	Destination Port	AP
1813	Standard RADIUS accounting port	Destination Port	AP, SM