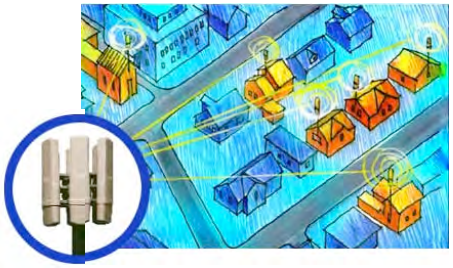
MOTOROLA



Canopy® System Release 8 User Guide

Sys8-UG-en
Issue 2
February 2007

includes…

- Planning Guide
- Installation and Configuration Guide
- Operations Guide
- Reference

MOTOWi4

CANOPY®
Motorola Wireless Broadband Platform

Draft 3 - for Regulatory Review

Notices

See the following information:

- important regulatory and legal notices in Section 36 on Page 489.
- personal safety guidelines in Section 15 on Page 169.

Trademarks, Product Names, and Service Names

http://www.motorola.com/canopy

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GUIDE TO THIS USER GUIDE

1 NEW IN THIS ISSUE

1.1 NEW PRODUCTS AND FEATURES DESCRIBED IN ISSUE 2

- Connectorized 5.7 GHz modules with FCC approval

1.2 NEW DESCRIPTIONS AND REVISIONS IN ISSUE 2

This section is a placeholder where other new descriptions, as wells as clarifications and corrections, will be listed in future issues.

1.3 MOTOwi4 PORTFOLIO

Motorola has introduced the broad MOTOwi4™ portfolio of fixed, nomadic, and mobile wireless broadband solutions, among which Canopy® products are significant. The MOTOwi4 portfolio meets residential and enterprise data transport needs with the following present and future solutions:

- residential access fixed solutions
  - Canopy Access Point and Subscriber Modules in the following frequency band ranges:
    - 900 MHz
    - 2.4 GHz
    - 5.1 GHz
    - 5.2 GHz
    - 5.4 GHz
    - 5.7 GHz
  - WiMAX fixed and mobile solutions, based on the 802.16e (WiMAX) standard, in the following frequency band ranges:
    - 2.3 GHz
    - 2.5 GHz
    - 3.5 GHz
- Metro WiFi local area mesh network solutions, based on the 802.11 standard
- backhaul solutions, based on the 802.16e (WiMAX) standard or Canopy protocols, in the following frequency band ranges:
  - 2.4 GHz
  - 5.2 GHz
  - 5.4 GHz
  - 5.7 GHz

1.4 PRODUCTS COVERED BY THIS USER GUIDE

Most Canopy products are covered by this user guide:

- radio-networked modules in the following frequency band ranges:
  - 900 MHz
  - 2.4 GHz
  - 5.1 GHz
  - 5.2 GHz
  - 5.4 GHz
  - 5.7 GHz
- Cluster Management Module-2 (CMM2)
- Cluster Management Module micro (CMMmicro)
- Surge Suppressor

1.5 PRODUCTS NOT COVERED BY THIS USER GUIDE

Some specific-use Canopy products are referred to in this user guide but fully described in their own separate user guides:

- 30-Mbps Backhaul Module. See *Canopy 30 Mbps 60 Mbps Backhaul User Guide* and *Motorola Canopy OFDM Backhaul Quick Start Guide*.
- 30/60-Mbps Backhaul Module. See *Canopy 30 Mbps 60 Mbps Backhaul User Guide* and *Motorola Canopy OFDM Backhaul Quick Start Guide* for (30/60 Mbps).
- 150/300-Mbps Backhaul Module. See *Canopy 150 Mbps 300 Mbps Backhaul User Guide* and *Motorola Canopy OFDM Backhaul Quick Start Guide* (for 150/300 Mbps).
- MOTOwi4 Ultra Light Access Point (ULAP) and Ultra Light Outdoor Subscriber Unit (OSU). See *Canopy 3500 System User Guide*.
- Bandwidth and Authentication Manager. See *Canopy Bandwidth and Authentication Manager (BAM) Release 2.1 User Guide* (or *Canopy Bandwidth and Authentication Manager (BAM) User Guide* for earlier releases).
- License Manager. See *Canopy Networks License Manager User Guide*.
- Prizm. See *Motorola Canopy Prizm User Guide*.
- T1/E1 Multiplexer. See *Canopy T1/E1 Multiplexer User Guide*.

1.6 SOFTWARE COMPATIBILITY DESCRIBED IN THIS USER GUIDE

The following sections of this document provide details and caveats about the compatibility of Canopy products:

- Designations for Hardware on Page 367
- CMMmicro Software and Hardware Compatibility on Page 368
- MIB File Set Compatibility on Page 368

2 USING THIS USER GUIDE

This document should be used with Canopy features through Software Release 8 and CMMmicro Release 2.1.1. The audience for this document includes system operators, network administrators, and equipment installers.

2.1 FINDING THE INFORMATION YOU NEED

2.1.1 Becoming Familiar with This User Guide

This is a guide to the guide. A high-level overview of the guide and some examples of where to look provide insight into how information is arranged and labeled.

The Table of Contents provides not only a sequential index of topics but also a visual glance at the organization of topics in this guide. A few minutes spent with the Table of Contents in either the paper or the electronic version of this guide can save much more time in finding information now and in the future. The List of Procedures may be especially useful in the paper version of this guide, particularly where you mark those procedures that you wish to frequently see.

In contrast, the List of Figures and List of Tables are most useful for automated searches on key words in the electronic version of this guide. If a match is present, the match is the first instance that the search finds.

Quick Reference

The Canopy User Guide comprises six sections, as described in Table 1.

Table 1: Canopy User Guide organization scheme

Section	Purpose
Guide to This User Guide (this section)	Identifies ◦ products covered by this user guide. ◦ products covered by their own separate user guides. ◦ how this user guide is organized. ◦ where to find module web pages and parameter descriptions. ◦ what the various typefaces and admonitions indicate. ◦ how to contact Canopy.
Overview of Canopy Networks	Provides ◦ references to RF and networking theory. ◦ a list of sections to see if you are building only a backhaul network. ◦ overviews and comparisons of Canopy products and how they communicate. ◦ descriptions of data handling and synchronization. ◦ a review of Canopy optional features. ◦ resources for developing familiarity and proficiencies with Canopy networks.
Planning Guide	Provides essential information for ◦ evaluating an area for a Canopy network. ◦ specifying the IP addresses and frequency band ranges to use for each type of link.
Installation and Configuration Guide	Provides systematic approaches for ◦ avoiding hazards from RF and natural causes. ◦ testing, storing, and deploying Canopy equipment.
Operations Guide	Provides guidance for ◦ expanding network coverage. ◦ improving the security of Canopy wireless links. ◦ distributing bandwidth resources. ◦ monitoring and changing variables through SNMP.
Reference Information	Provides supplemental information such as ◦ authorizations, approvals, and notices. ◦ a bibliography of adjunctive information sources. ◦ a history of changes in Canopy documentation.
Glossary	Defines terms and concepts that are used in this user guide.

Examples

A list of common tasks and references to information that supports each task is provided in Table 2.

Table 2: Examples of where to find information in this user guide

If you want to know…	then see…	because…
what the Spectrum Analyzer in SM and BHS feature does	Avoiding Self Interference on Page 151	this topic is important to RF planning.
	Monitoring the RF Environment on Page 365	this topic is also important to managing the network.
what types of slots compose the Canopy frame	Understanding Bandwidth Management on Page 83	this information is helpful for understanding Canopy networks.
how to calculate whether an object will interfere with a signal	Noting Possible Obstructions in the Fresnel Zone on Page 132	this topic is important to RF planning.
how long a cable you can use from the GPS antenna to the CMM	Cables on Page 35	cables are accessory components.
	Procedure 20 on Page 336 *or* Procedure 24 on Page 343	the advisory applies to mounting GPS antennas *and* CMMs.
how to react to a WatchDog Event Log message	Messages that Flag Abnormal Events on Page 414 *and* Messages that Flag Normal Events on Page 414	together, these two sections document all significant Event Log messages.
what beam angle the passive reflector dish produces	Specifications and Limitations on Page 73, then downward to a table for a Canopy Part Number that includes “RF.”	the beam angle is a specification.
how to aim the passive reflector dish	Installing a Reflector Dish on Page 352	aiming is associated with Backhaul Module installation.
how to set Differentiated Services values so that traffic with original ToS byte formatting continues to be prioritized as it was before DSCP fields.	High-priority Bandwidth on Page 88	DSCP fields specify the level of priority that the device is requesting for the packet.

2.1.2 Searching This User Guide

To search this document and the software release notes of supported releases, look in the Table of Contents for the topic and in the Adobe Reader® search capability for keywords that apply.[1] These searches are most effective when you begin the search from the cover page because the first matches may be in titles of sections, figures, tables, or procedures.

2.1.3 Finding Parameter and Field Definitions for Module Web Pages

Because this user guide is sequentially arranged to support tasks, and various tasks require different settings and readings, parameter and field definitions are scattered according to the tasks that they support. The locations of these are provided in Table 3.

Table 3: Locations of screen captures and associated documentation

[1] Reader is a registered trademark of Adobe Systems, Incorporated.

2.2 INTERPRETING TYPEFACE AND OTHER CONVENTIONS

This document employs distinctive fonts to indicate the type of information, as described in Table 4.

Table 4: Font types

Font	Type of Information
variable width bold	Selectable option in a graphical user interface or settable parameter in the web-based interface to a Canopy component.
`constant width regular`	Literal system response in a command-line interface.
`constant width italic`	Variable system response in a command-line interface.
`constant width bold`	Literal user input in a command-line interface.
`constant width bold italic`	Variable user input in a command-line interface.

This document employs specific imperative terminology as follows:

- *Type* means press the following characters.
- *Enter* means type the following characters and then press Enter.

This document also employs a set of consistently used admonitions. Each of these types of admonitions has a general purpose that underlies the specific information in the box. These purposes are indicated in Table 5.

Table 5: Admonition types

Admonition Label	General Message
	***NOTE:*** informative content that may ◦ defy common or cursory logic. ◦ describe a peculiarity of the Canopy implementation. ◦ add a conditional caveat. ◦ provide a reference. ◦ explain the reason for a preceding statement or provide prerequisite background for what immediately follows.
	***RECOMMENDATION:*** suggestion for an easier, quicker, or safer action or practice.

Admonition Label	General Message
	***IMPORTANT!*** informative content that may ◦ identify an indication that you should watch for. ◦ advise that your action can disturb something that you may not want disturbed. ◦ reiterate something that you presumably know but should always remember.
	***CAUTION!*** a notice that the risk of harm to equipment or service exists.
	***WARNING!*** a notice that the risk of harm to person exists.

2.3 GETTING ADDITIONAL HELP

Help is available for problems with supported products and features. Obtaining Technical Support on Page 477 provides the sequence of actions that you should take if these problems arise.

2.4 SENDING FEEDBACK

We welcome your feedback on Canopy system documentation. This includes feedback on the structure, content, accuracy, or completeness of our documents, and any other comments you have. Send your comments to technical-documentation@canopywireless.com.

Overview of Canopy Networks

3 ADVANCING FROM RESEARCH TO IMPLEMENTATION

Before you begin to research a possible Canopy implementation, you should have both

- basic knowledge of RF theory. See
  - Understanding RF Fundamentals on Page 117.
  - Engineering Your RF Communications on Page 129.
- network experience. See
  - Canopy Link Characteristics on Page 83.
  - Understanding IP Fundamentals on Page 117.
  - Engineering Your IP Communications on Page 155.

4 REALIZING A WIRELESS BACKHAUL NETWORK

Canopy backhaul modules (BHs) can connect Canopy access point clusters to the point of presence or be the backbone of a Metro WiFi mesh network. In other applications, the backhaul modules can be used to provide connectivity for

- cell sites, in lieu of leased T1/E1 telecommunications lines.
- buildings in corporate or institutional campuses.
- remote sites, including temporary sites set up for relief efforts.

These BHs are available in 10- or 20-Mbps modulation rates from the factory. The rate is distinguished as BH10 or BH20 in the Software Version field of the General Status tab (in the Home page) of the module GUI.

For these and any other backhaul networks, Table 6 provides a quick reference to information that you would need to establish and maintain the Canopy wireless backhaul network.

Table 6: Essential user guide elements for new backhaul network implementation

Element	Title	Page
Section 1.5	Products Not Covered by This User Guide	34
Section 5.1.8	Backhaul Module	51
Section 5.1.9	OFDM Series Backhaul Module	52
Section 5.1.10	Power Indoor Units for OFDM Series Backhaul Modules	53
Section 5.1.12	T1/E1 Multiplexer	54
Section 5.1.13	Cluster Management Module-2 (Part 1008CK-2)	55
Section 5.1.14	Cluster Management Module micro (Part 1070CK)	56
Table 15	Products with encryption options available per frequency band, PTP links	65
Table 16	Typical range and throughput per frequency band, PTP links	66
Section 8.2	BH-BH Links	99
Figure 36	Typical multiple-BH network layout	104
Section 12.2	Analyzing the RF Environment	131
Section 12.5	Considering Frequency Band	136
Section 15	Avoiding Hazards	169
Section 16.4	Configuring a Point-to-Point Link for Test	204
Section 17	Preparing Components for Deployment	233
Section 18.4	Configuring a BH Timing Master for the Destination	294
Section 18.5	Configuring a BH Timing Slave for the Destination	312
Section 19.4	Installing a GPS Antenna	336
Section 19.5	Installing a CMM2	337
Section 19.6	Installing a CMMmicro	342

5 EXPLORING THE SCOPE OF SOLUTIONS

Canopy wireless broadband applications include:

- local area network (LAN) extensions
- Internet subscriber service
- high-bandwidth point-to-point connections
- multicast video (for instruction or training, for example)
- private branch exchange (PBX) extensions
- point-to-multipoint data backhaul
- redundant network backup
- video surveillance
- voice over IP (VoIP)
- TDM over Ethernet (for legacy voice and data)

5.1 COMPONENTS

Canopy networks use some or all of the following components. For the components that provide a graphical user interface (GUI), access to the GUI is through a web browser. In Release 8 and later, cascading style sheets (CSS) configure the GUI. Thus an operator is able to customize the GUI by editing these style sheets.

5.1.1 Canopy Access Point Module

The Canopy Access Point (AP) module distributes network or Internet services in a 60° sector to not more than 200 subscribers or fewer and 4,096 MAC addresses, which may be directly-connected PCs, IP appliances, gateways, Subscriber Modules (SMs), and the AP, except that *no limit* applies behind subscriber network address translation (NAT) gateways. The AP is configurable through a web interface. A Canopy AP can communicate with only a Canopy SM, *not also* an Advantage SM or a Canopy Lite SM.

5.1.2 Advantage Access Point Module

The Canopy Advantage AP distributes services as broadly as the Canopy AP. However, the Advantage AP provides greater throughput and less latency. Each tab in the GUI for Canopy Advantage modules displays the distinctive branding shown in Figure 1.

Figure 1: Canopy Advantage Platform GUI logo

The Advantage AP communicates with all Canopy SMs in its frequency band range: Canopy SMs, Advantage SMs, and Canopy Lite SMs.

5.1.3 Access Point Cluster

The AP cluster consists of two to six APs that together distribute network or Internet services to a community of 1,200 or fewer subscribers. Each AP transmits and receives in a 60° sector. An AP cluster covers as much as 360°.

The variety of available APs and Advantage APs in frequency band range, power adjustability, and antenna configuration is shown under Acquiring a Canopy Demonstration Kit, beginning on Page 117.

An AP cluster is pictured in Figure 2.

Figure 2: Pole-mounted AP cluster

5.1.4 Canopy Subscriber Module

The Subscriber Module (SM) is a customer premises equipment (CPE) device that extends network or Internet services by communication with an AP. The SM is configurable through a web interface.

The variety of available SMs and Advantage SMs in frequency band range, power adjustability, and antenna configuration is shown under Acquiring a Canopy Demonstration Kit, beginning on Page 117.

A Canopy SM can communicate with either a Canopy AP or an Advantage SP.

An SM mounted directly to a structure is pictured in Figure 3.

Figure 3: Structure-mounted SM

5.1.5 Advantage Subscriber Module

The Canopy Advantage SM provides the same configurability and services as the Canopy SM. However, in a link with the Advantage AP, the Advantage SM provides uncapped sustained throughput through the 2X operation feature. See 2X Operation on Page 91. An Advantage SM can communicate with only an Advantage AP.

5.1.6 Canopy Lite Subscriber Module

Canopy Lite SMs cost less and provide less throughput than regular Canopy SMs. They support the same radio frequencies, interference tolerance, and product reliability. They give operators the additional option to serve cost-sensitive customers who want standard services (web browsing, email, VoIP, and downloads), but do not require the higher throughput that is available with a regular Canopy SM. Canopy Lite SMs support an aggregate(uplink plus downlink) throughput of 512 kbps. Through purchased floating licenses that Prizm manages, they are upgradeable to 1, 2, 4, or 7 Mbps aggregate throughput. A Canopy Lite SM can communicate with only a Canopy Advantage AP.
A comparison of the Canopy Lite SM to the Canopy SM and Advantage SM is provided in Table 28 on Page 100.

5.1.7 900-MHz AP and SM

Canopy 900 MHz AP and SM modules operate at 3.3 Mbps (compared to 10 Mbps for other Canopy frequency bands). With Downlink Data set to 75% in the AP, the AP supports high throughput to an SM.

Figure 4: Examples of flat panel antennas with 900-MHz modules

These 900-MHz modules run the same software and provide the same parameters, network features, and connections as all other Canopy APs and SMs. The physics of longer-wavelength 900 MHz, the power allowed by regulatory authorities, and the low required level of Canopy Carrier-to-Interference (C/I) ratio combine to support

- line of sight (LOS) range of up to 40 miles (over 64 km)
- increased non-line of sight (NLOS) range, depending on RF considerations such as foliage, topography, and obstructions.

When collocated with a Canopy SM of another frequency band range, the 900-MHz AP may serve, without a tower or BH, as a *remote* AP (see Deploying a Remote AP on Page 147). 900-MHz AP/SM links are logical choices for extending radio networks where you wish to

- add subscriber-handling capacity to a tower that is either
  - fully used in the other frequency band ranges.
  - not available to any other frequency band range.
- reach sparsely populated areas.
- penetrate foliage.
- add a remote AP behind an SM that operates in another frequency band range.

5.1.8 Backhaul Module

A pair of Backhaul Modules (BHs) provide point-to-point connectivity as either

- a standalone link
- a link through a cluster management module to an AP cluster.

Figure 5: Dish-mounted 10- or 20-Mbps BH

You must configure a BH as either a timing master (BHM) or timing slave (BHS). The BHM provides synchronization signal (sync) to the BHS.

A BH mounted to a passive reflector dish is pictured in Figure 5. Carrier applications for these modules include reaching remote AP clusters, interconnecting campus buildings or remote branch offices, extending private branch exchange (PBX) circuits, backhauling cell sites, and extending central office T1s/E1s.

These BHs are supported by this user guide. See Realizing a Wireless Backhaul Network on Page 47.

5.1.9 OFDM Series Backhaul Modules

These high-speed BHs provide point-to-point data connectivity via a 5.4- or 5.7-GHz wireless Ethernet bridge that operates at broadband data rates. They provide non-Line of Sight (NLOS) operation through the use of Orthogonal Frequency Division Multiplex (OFDM) modulation and Transmit Diversity. Transmissions penetrate foliage, such that almost universal coverage is typical at short range.

Figure 6: 30/60- or 150/300-Mbps Backhaul Module, integrated antenna

The link consists of a pair of identical BHs that transmit and receive on an automatically selected but configurable frequency. The installer sets up one unit as the master and the other as the slave. (Each unit is preconfigured as master or slave but can be reconfigured to the other.) These modules are available as either connectorized for an external antenna or equipped with an integrated antenna.

Each end of the link consists of both

- an outdoor transceiver (ODU) that contains all the radio and networking electronics (see Figure 6 and Figure 7)
- an indoor passive connection box (PIDU) that contains status indicators and network connection (see Figure 8 and Figure 9.

Available modulations are 30/60 Mbps and 150/300 Mbps. A 30-Mbps BH is software-

upgradable to 60 Mbps, and a 150-Mbps BH is likewise software-upgradable to 300 Mbps. Products in this series are supported by dedicated user guides.

By default, these BHs use a proprietary data scrambling and encryption scheme. The 30/60-Mbps BHs have AES encryption available as a licensed option. The 150/300-Mbps BHs support virtual private networking (VPN).

Carrier applications for these modules include reaching remote AP clusters, interconnecting campus buildings or remote branch offices, extending private branch exchange (PBX) circuits, backhauling cell sites, and extending central office T1s/E1s.

(OFDM Series BHs were previously available in 45-Mbps modulation, which can be upgraded to 60 Mbps by software.)

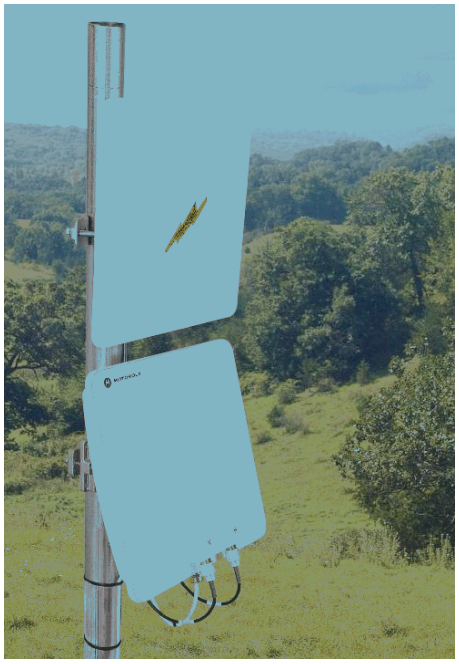


Figure 7: 30/60- or 150/300-Mbps Backhaul Module, connected to external antenna

5.1.10 Power Indoor Units for OFDM Series Backhaul Modules

Canopy also offers the required power indoor unit (PIDU) that generates the voltage for the 30/60- or 150/300-Mbps BHs. The PIDU provides status indicators for the ODU.

Examples of these PIDUs are shown in Figure 8 and Figure 9.

> ***CAUTION!***
>
> The PIDU for the 30/60-Mbps BH and the PIDU for the 150/300-Mbps BH are clearly distinguished by their front labels. These units are unique and *are not* interchangeable under any circumstances. Their pinouts vary. Using any power unit other than the proper one of these two will destroy the module.

Figure 8: PIDU for 30/60-Mbps BH

Figure 9: PIDU for 150/300-Mbps BH

5.1.11 Radio Adjustable Power Capabilities

To help network operators become or remain compliant with applicable regulations in their regions and nations, Canopy offers adjustable power radios in various frequency band ranges, as indicated in Table 7.

See also Adjusting Transmitter Output Power on Page 326 to ensure that your radios do not exceed the maximum permitted EIRP.

Table 7: Adjustable power radios

Frequency Band Range	Introduced in Canopy System Release
900 MHz[1]	7.0
2.4 GHz[1]	4.2.7
5.4 GHz[2]	4.2.7
5.7 GHz[1]	6.1

NOTES:

1. As a distinct part number.
2. In the base model.

5.1.12 T1/E1 Multiplexer

The Canopy T1/E1 Multiplexer converts the data stream from T1/E1 ports into Ethernet packets that are then transported over the Canopy BH link. This enables up to three T1 (or up to two E1) circuits to be extended over Ethernet networks. The T1/E1 Multiplexer is available in two power configurations:

- an external 3.3-v DC power source from a 120/240-v AC adapter (supplied by Canopy)
- an optional connection to an external −48 v DC supply for battery backup.

Figure 10: T1/E1 Multiplexer, front view

The T1/E1 Multiplexer supports

- synchronous TDM-based services over wireless Ethernet networks.
- CAS signaling transparent to all other signaling protocols on T1/E1.
- 10Base-T/100Base-TX uplink to the network.
- management interfaces.
- simplified troubleshooting through T1/E1 line loopback test.

Figure 11: T1/E1 Multiplexer, rear view

Applications include

- obviating leased lines.
- implementing wireless PBX networking.
- establishing cellular backhaul links.
- providing homeland security backup or emergency voice networks.
- routing LAN/WAN data on excess bandwidth.

This product is supported by the dedicated document *Canopy T1/E1 Multiplexer User Guide*.

5.1.13 Cluster Management Module-2 (Part 1008CK-2)

The Cluster Management Module-2 (CMM2) provides power, GPS timing from an antenna that is included, and networking connections for an AP cluster. The CMM2 can also connect to a BH, in which case the CMM2 is the central point of connectivity for the entire site. The CMM2 can connect as many as eight collocated modules—APs, BHMs, BHSs—and an Ethernet feed.

The CMM2 requires two cables for each connected module:

- One provides Ethernet communications and power. This cable terminates in an RJ-45 connector.
- The other provides synchronization (sync), GPS status, and time and date in a serial interface. This cable terminates in an RJ-11 connector.

A CMM2 is pictured in Figure 12. A CMM2 as part of a mounted Canopy system is pictured in Figure 13.

Figure 12: CMM2 enclosure

Figure 13: CMM2 pole-mounted

5.1.14 Cluster Management Module micro (Part 1070CK)

The Cluster Management Module micro (CMMmicro) provides power, GPS timing, and networking connections for an AP cluster. Unlike the CMM2, the CMMmicro is configurable through a web interface.

The CMMmicro contains an 8-port managed switch that supports Power over Ethernet (PoE)[2] on each port and connects any combination of APs, BHMs, BHSs, or Ethernet feed. The CMMmicro 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 CMMmicro requires only one cable, terminating in an RJ-45 connector, for each connected module to distribute

- Ethernet signaling.
- power to as many as 8 collocated 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 CMMmicro 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 CMMmicro, however

- CMMmicro 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 Canopy System Release 4.2 or later.
  See Time Tab of the AP on Page 191.
- CMMmicro *does not* provide time and date information to BHMs and APs if either the CMMmicro is operating on a release earlier than CMMmicro Release 2.1 or the AP/BHM is operating on a release earlier than Canopy System Release 4.2.

5.1.15 GPS Antenna

The Motorola GPS antenna provides either

- timing pulses to the CMMmicro.
- timing pulses and positioning information to the CMM2.

The GPS antenna is pictured in Figure 14.

Figure 14: Motorola GPS antenna

[2] Through a proprietary scheme, different from IEEE Standard 803.af. Also, BHs in the OFDM Series use yet another proprietary scheme.

5.1.16 Surge Suppressor (Part 300SS)

The 300SS Surge Suppressor provides a path to ground (Protective Earth ⏚) that protects connected equipment from near-miss lightning strikes. A 300SS is pictured in Figure 15.

Figure 15: 300SS surge suppressor

5.1.17 Accessory Components

In addition to the above modules, the following accessories are available.

Power Supplies

The various power supplies available for Canopy modules are listed in Table 8.

Table 8: Power supply descriptions

For Use With	Part Number	Voltage (AC)	Cycles per Second (Hz)	Includes
CMMmicro	ACPS81WA	100 to 240	50 to 60	US IEC line cord
	ACPS81W-02A	100 to 240	50 to 60	no IEC line cord
Canopy radio[2] (except OFDM backhauls)	ACPS110-03A[1]	120	50 to 60	US plug
	ACPSSW-09A[3]	90 to 240	50 to 60	US, Euro, and UK adaptors
	ACPSSW-10A[3]	90 to 240	50 to 60	Argentina adaptor
	ACPSSW-11A[3]	90 to 240	50 to 60	Australia adaptor
	ACPSSW-12A[3]	90 to 240	50 to 60	China adaptor
30/60-Mbps OFDM BH	ACPSSW200-02A[4]	100 to 250 AC or −48 DC	47 to 63	US, Euro, and UK leads
	ACPSSW200-01A	100 to 250	47 to 63	
150/300-Mbps OFDM BH	ACPSSW200-03A[5]	100 to 250	47 to 63	

NOTES:

1. Pictured in Figure 16.
2. Single transceiver.
3. Pictured in Figure 17.
4. Pictured in Figure 8 on Page 53.
5. Pictured in Figure 9 on Page 53.

Figure 16: ACPS110-03A power supply

Figure 17: ACPSSW-09A power supply

Passive Reflector Dish Assembly

The 27RD Passive Reflector Dish on both ends of a BH link extends the distance range of the link and focuses the beam into a narrower angle to reduce interference. The 27RD on an SM only helps to reduce interference. The module support tube provides the proper offset focus angle. See Figure 18.

For 5.*n*-GHz radios, the reflector gain is 18dB and the beam width is 6° at 3 dB. For 2.4-GHz radios, the reflector gain is 11dB and the beam width is 17° at 3 dB. These beam width statements apply to both azimuth and elevation in each case.

Figure 18: 27RD with mounted module

Module Support Brackets

The SMMB1 support bracket facilitates mounting the SM to various surfaces of a structure and has slots through which chimney straps can be inserted. An SMMB1 is pictured in Figure 19.

The SMMB2 is a heavy duty mounting bracket for the 900-MHz connectorized SM and its external antenna.

The BH1209 is a pole-mount bracket kit for Canopy backhaul modules.

Figure 19: SMMB1 SM support bracket

Cables

Canopy modules that are currently or recently sold can auto-sense whether the Ethernet cable is wired as straight-through or crossover. Some modules that were sold earlier cannot. The MAC address, visible on the module, distinguishes whether the module can. All CMMmicros can auto-sense the cable scheme.

Where a non auto-sensing module is deployed

- a straight-through cable must be used for connection to a network interface card (NIC).
- a crossover cable must be used for connection to a hub, switch, or router.

Canopy-recommended Ethernet and sync cables can be ordered in lengths up to 328 ft (100 m) from Best-Tronics Manufacturing, Inc. at http://www.best-tronics.com/motorola.htm. These cables are listed in Table 9 and Table 10.

Table 9: Recommended outdoor UTP Category 5E cables

Best-Tronics Part #	Description
BT-0562	RJ-45 TO RJ-45; straight-through Ethernet cable
BT-0562S	RJ-45 TO RJ-45; shielded straight-through Ethernet cable
BT-0565	RJ-45 TO RJ-45; crossover Ethernet cable
BT-0565S	RJ-45 TO RJ-45; shielded crossover Ethernet cable
BT-0563	RJ-11 TO RJ-11; sync cable
BT-0563S	RJ-11 TO RJ-11; shielded sync cable

NOTE:
Shielded cable is strongly recommended for all AP cluster and BH installations.

Table 10: Recommended indoor UTP Category 5E cables

Best-Tronics Part #	Description
BT-0596	RJ-45 TO RJ-45; straight-through Ethernet cable
BT-0595	RJ-45 TO RJ-45; crossover Ethernet cable

Approved Ethernet cables can also be ordered as bulk cable:

- CA-0287
- CA-0287S (shielded)

Canopy-approved antenna cables can be ordered in lengths up to 100 ft (30.4 m), as listed in Table 11.

Table 11: Recommended antenna cables

Best-Tronics Part #	Description
BT-0564	N TO N GPS antenna cable for CMM2
BT-0716	BNC TO N GPS antenna cable for CMMmicro

Category 5 Cable Tester

For purchase within the U.S.A., the CTCAT5-01 Cable Tester is available.

Override Plug

An override plug (sometimes called a default plug) is available to provide access to a module whose password and/or IP address have been forgotten. This plug allows the AP, SM, or 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. at http://www.best-tronics.com/motorola.htm as Part BT-0583 (RJ-11 Default Plug). Alternatively if you wish, you can fabricate an override plug. For instructions, see Procedure 36 on Page 376 and the pinout in Figure 146 on Page 376.

Alignment Headset

The ACATHS-01 Alignment Headset facilitates the operation of precisely aiming an SM toward an AP (or a BHS toward a BHM). This device produces infinitely variable

- pitch, higher when the received signal is stronger.
- volume, louder when jitter is less.

Figure 20: ACATHS-01 alignment headset

An ACATHS-01 is pictured in Figure 20.

Pinouts for an alternative listening device are provided under Alignment Tone—Technical Details on Page 184.

Module Housing

The HSG-01 Canopy Plastic Housing is available for replacement of a damaged housing on a module that is otherwise functional. The HSG-01 is pictured in Figure 21.

The HSG-01 and all module housings of this design provide clearances for cable ties on the Ethernet and sync cables.

> *RECOMMENDATION:*
> Use 0.14" (40-lb tensile strength) cable ties to secure the Ethernet and sync cables to the cable guides on the module housing.

For the Ethernet cable tie, the Ethernet cable groove is molded lower at the top edge. For the sync cable tie, removal of a breakaway plug provides clearance for the sync cable, and removal of two breakaway side plates provides clearance for the sync cable tie.

Figure 21: HSG-01 Housing

5.2 FREQUENCY BAND RANGES

In the 2.4-, 5.2-, 5.1-, 5.4-, and 5.7-GHz frequency band ranges, Canopy APs, SMs, and BHs are available. Additionally, in the 900-MHz frequency band range, Canopy APs and SMs are available. National restrictions may apply. See Legal and Regulatory Notices on Page 489.

To avoid self-interference, a Canopy network typically uses two or more of these ranges. For example, where properly arranged, all AP clusters and their respective SMs can use the 2.4-GHz range where the BH links use the 5.7-GHz range. In this scenario, subscriber links can span as far as 5 miles (8 km) with no reflector dishes, and the BH links can span as far as 35 miles (56 km) with reflector dishes on both ends.

Within this example network, wherever the 2.4-GHz module is susceptible to interference from other sources, AP clusters and their linked SMs may use the 5.2-GHz range to span as far as 2 miles (3.2 km) with no reflector dishes. The network in this example takes advantage of frequency band range-specific characteristics of Canopy modules as follows:

- The 900-MHz modules cover a larger area, albeit with lower throughput, than modules of the other frequency bands. The 900-MHz modules can be used to
  - penetrate foliage
  - establish links that span greater distances
  - add subscribers
  - add overall throughput where modules of other frequency bands cannot be used (such as where interference would result or space on a tower is limited).
- The 2.4-GHz frequency band range supports AP/SM links of greater than 2-mile spans (with no reflectors).
- The 5.7-GHz frequency band range supports BH links that span as far as 35 miles.

5.3 CANOPY PRODUCT COMPARISONS

5.3.1 Canopy Product Applications

The product applications per frequency band range are is summarized in Table 12.

Table 12: Product applications per frequency band range

Product	Frequency Band Range					
	900 MHz	2.4 GHz	5.1 GHz	5.2 GHz	5.4 GHz	5.7 GHz
Access Point Module	•	•	•	•	•	•
Subscriber Module	•	•	•	•	•	•
Subscriber Module with Reflector[1]		•		•	•	•
Backhaul Module		•	•	•	•	•
Backhaul Module with Reflector[1]		•	•	•	•	•
OFDM Series Backhaul Module					•	•
CMM2	•	•	•	•	•	•
CMMmicro	•	•	•	•	•	•
T1/E1 Multiplexer		•	•	•	•	•

Product	Frequency Band Range					
	900 MHz	2.4 GHz	5.1 GHz	5.2 GHz	5.4 GHz	5.7 GHz
Power supply	●	●	●	●	●	●
Surge suppressor	●	●	●	●	●	●

NOTES:

1. National or regional regulations may limit EIRP to the same as without a reflector, and therefore require Transmit Output Power to be reduced. See National and Regional Regulatory Notices on Page 489. In these cases
   - the reflector used with an SM reduces beamwidth to reduce interference, but *does not* increase the range of the link.
   - the reflector on both ends of a BH link reduces beamwidth to reduce interference and also increases the range of the link.

5.3.2 Link Performance and Encryption Comparisons

The encryption options on Canopy *point-to-multipoint* (PTMP) products are summarized in Table 13. Typical Line-of-Site (LOS) range and aggregate useful throughput for Canopy PTMP links are summarized in Table 14.

Table 13: Products with encryption options available per frequency band, PTMP links

Frequency Band	Products available with the following encryption options	
	DES or none	AES or none
2.4 GHz @100 mW (ETSI)	●	●
2.4 GHz @ 1W	●	●
5.1 GHz	●	
5.2 GHz	●	●
5.4 GHz	●	●
5.7 GHz	●	●
900 MHz	●	●

Table 14: Typical range and throughput per frequency band, PTMP links

Frequency Band	Advantage AP				Canopy AP			
	Range		Aggregate Throughput Mbps	Round-trip Latency msec	Range		Aggregate Throughput[3] Mbps	Round-trip Latency msec
	no SM Reflector mi (km)	with SM Reflector mi (km)			no SM Reflector mi (km)	with SM Reflector mi (km)		
2.4 GHz ETSI	0.3 (0.5)	0.3 (0.5)[1]	14	6	0.6 (1)	0.6 (1)[1]	7	20
	0.6 (1)	0.6 (1)[1]	7	6				
2.4 GHz	2.5 (4)	7.5 (12)	14	6	5 (8)	15 (24)	7	20
	5 (8)	15 (24)	7	6				
5.1 GHz	1 (1.6)	na	14	6	2 (3.2)	na	7	20
	2 (3.2)	na	7	6				
5.2 GHz	1 (1.6)	na[2]	14	6	2 (3.2)	na[2]	7	20
	2 (3.2)	na[2]	7	6				
5.4 GHz	1 (1.6)	1 (1.6)[1]	14	6	2 (3.2)	2 (3.2)[1]	7	20
	2 (3.2)	2 (3.2)[1]	7	6				
5.7 GHz	1 (1.6)	5 (8)	14	6	2 (3.2)	10 (16)	7	20
	2 (3.2)	10 (16)	7	6				
900 MHz[4]	40 (64)	na	4	15				

NOTES:

2. In Europe, 2.4-GHz ETSI and 5.4-GHz SMs can have a reflector added to focus the antenna pattern and reduce interference, but transmit output power must be reduced to maintain the same EIRP as without a reflector, so the throughput and range specs for PTMP links remain the same.
3. In the USA and Canada, the use of a reflector with a full power radio in the 5.2-GHz frequency band is not allowed.
4. These values assume a hardware series P9 AP running hardware scheduler. When running software scheduler on a series P7, P8, or P9 AP, aggregate throughput drops to 6.2 Mbps, and only 4 Mbps is available to any one SM. (Series P7 and P8 APs can only run software scheduler.)
5. All 900-MHz APs are Advantage APs.

GENERAL NOTES:

Range is affected by RF conditions, terrain, obstacles, buildings, and vegetation.

An Advantage AP in other than 900 MHz has an aggregate (sum of uplink plus downlink) throughput or capacity of 14 Mbps, if RF conditions, range, and SM hardware version permit.

An Advantage SM in other than 900 MHz has an aggregate sustained throughput of 14 Mbps if RF conditions and range permit.

A regular SM can burst to 14 Mbps if RF conditions and range permit, then run at 7 Mbps sustained throughput.

The encryption options on Canopy *point-to-point* (PTP) products are summarized in Table 15. Typical Line-of-Site (LOS) range and aggregate useful throughput for Canopy PTP links are summarized in Table 16.

Table 15: Products with encryption options available per frequency band, PTP links

Frequency Band	Modulation Rate (Mbps)	Products available with the following encryption options			
		DES or none	AES or none	Proprietary	Proprietary or AES licensed upgrade
2.4 GHz @100 mW (ETSI)	10	●	●		
	20	●	●		
2.4 GHz @ 1W	10	●	●		
	20	●	●		
5.1 GHz	10	●			
	20	●			
5.2 GHz	10	●	●		
	20	●	●		
5.2 GHz ER	10	●	●		
	20	●	●		
5.4 GHz	10	●	●		
	20	●	●		
	30 60				●
	150 300			●	
5.7 GHz	10	●	●		
	20	●	●		
	30 60				●
	150 300			●	

Table 16: Typical range and throughput per frequency band, PTP links

Frequency Band	Modulation Rate (Mbps)	Throughput	
		No Reflectors	Both Reflectors
2.4 GHz @100 mW (ETSI)	10	7.5 Mbps to 2 km	7.5 Mbps to 16 km
	20	14 Mbps to 1 km	14 Mbps to 8 km
2.4 GHz @ 1W	10	7.5 Mbps to 5 mi (8 km)	7.5 Mbps to 35 mi (56 km)
	20	14 Mbps to 3 mi (5 km)	14 Mbps to 35 mi (56 km)
5.1 GHz	10	7.5 Mbps to 2 mi (3.2 km)	
	20	14 Mbps to 2 mi (3.2 km)	
5.2 GHz	10	7.5 Mbps to 2 mi (3.2 km)	
	20		
5.2 GHz ER	10		7.5 Mbps to 10 mi (16 km)
	20		14 Mbps to 5 mi (8 km)
5.4 GHz	10	7.5 Mbps to 2 mi (3.2 km)	7.5 Mbps to 10 mi (16 km)[1]
	20	14 Mbps to 1 mi (1.6 km)	14 Mbps to 5 mi (8 km)[1]
	30	dynamically variable from 1.5 to 21 Mbps aggregate[2]	
	60	dynamically variable from 3 to 43 Mbps aggregate[2]	
	150	dynamically variable from 7 to 150 Mbps aggregate[2]	
	300	dynamically variable from 14 to 300 Mbps aggregate[2]	
5.7 GHz	10	7.5 Mbps to 2 mi (3.2 km)	7.5 Mbps to 35 mi (56 km)
	20	14 Mbps to 1 mi (1.6 km)	14 Mbps to 35 mi (56 km)
	30	dynamically variable from 1.5 to 21 Mbps aggregate[2]	
	60	dynamically variable from 3 to 43 Mbps aggregate[2]	
	150	dynamically variable from 7 to 150 Mbps aggregate[2]	
	300	dynamically variable from 14 to 300 Mbps aggregate[2]	

NOTES:

1. These ranges are with power reduced to within 1 W (30 dBm) EIRP.
2. Use the Link Estimator tool to estimate throughput for a given link.

5.3.3 Cluster Management Product Comparison

Canopy offers a choice between two products for cluster management: CMM2 and CMMmicro. Your choice should be based on the installation environment and your requirements. The similarities and differences between these two products are summarized in Table 17.

Table 17: Cluster management product similarities and differences

Characteristic	CMM2	CMMmicro
Approximate size	17” H x 13” W x 6.5” D (43 cm H x 33 cm W x 7 cm D)	12” H x 10” W x 3” D (30 cm H x 25 cm W x 8 cm D)
Approximate weight	25 lb (11.3 kg)	8 lb (3.5 kg)
Cabling	◦ one Ethernet/power cable per radio. ◦ one sync cable per radio.	one Ethernet/power/sync cable per radio.
Canopy network interconnection	8 Ethernet ports	8 Ethernet ports
Data throughput	auto-negotiates to full or half duplex	auto-negotiates to full or half duplex
Ethernet operating speed standard	auto-negotiates to 10Base-T or 100Base-TX	auto-negotiates to 10Base-T or 100Base-TX
Additional Ethernet ports	one for data feed one for local access (notebook computer)	none
Power supply	integrated 24-V DC to power APs, BHs, and GPS receiver	external 24-V DC to power APs, BHs, and GPS receiver
SNMP management capability	none	provided
Sync (to prevent self-interference)	carried by the additional serial cable to each AP and BHM	embedded in power-over-Ethernet cable
Time & Date	carried by the additional serial cable to each AP and BHM	provided by NTP (Network Time Protocol). CMMmicro can be an NTP server.
Weatherized	enclosure and power supply	only the enclosure (not the power supply)
Web interface	none	web pages for status, configuration, GPS status, and other purposes
NOTE: Auto-negotiation of data throughput and Ethernet operating speed depend on the connected device being set to auto-negotiate as well.		

5.4 ANTENNAS FOR CONNECTION TO 900-MHz MODULES

Like the 2.4-, 5.2-, 5.4-, and 5.7-GHz module, the 900-MHz connectorized module has

- the same housing.
- a covered Ethernet port.
- a utility port for alignment headset, sync cable to CMM2, or override plug.

The 900-MHz AP or SM is available either

- as a connectorized unit with a 16-inch (approximately 40-cm) cable with a male N-type connector for connection to the antenna.
- with an integrated antenna in a different form factor.

5.4.1 Certified Connectorized Flat Panel Antennas

Motorola has certified through regulatory agencies four connectorized flat panel antenna options. Motorola offers one of these, whose attributes include

- gain—10 dBi
- dimensions—8.8 x 8.1 x 1.6 inches (22.4 x 20.6 x 4.06 cm)
- weight—1.2 lbs (0.54 kg)
- polarization—vertical or horizontal
- cable—12-inch (30.5 cm)
- connector—female N-type
- beamwidth—approximately 60° vertical and 60° horizontal at 3 dBm

Motorola has certified three other antennas, which are available through Canopy resellers. The attributes of one of these other certified antennas include

- gain—10 dBi
- dimensions—12 x12 x 1 inches (30.5 x 30.5 x 2.5 cm)
- weight—3.3 lbs (1.5 kg)
- polarization—vertical or horizontal
- connector—female N-type
- beamwidth—approximately 60° vertical and 60° horizontal at 3 dBm

Examples of these antennas are pictured in Figure 4 on Page 51.

5.4.2 Third-party Certified Connectorized Flat Panel Antenna

A third party may certify additional antennas for use with the Canopy connectorized 900-MHz module.

5.5 ADJUNCTIVE SOFTWARE PRODUCTS

The capabilities of available applications and tools are summarized for comparison in Table 18. In this table CNUT represents Canopy Network Updater Tool, Release 1.1 or later, and BAM represents Bandwidth and Authentication Manager, Release 2.0 or later.

Table 18: Canopy applications and tools

Capability	Application or Tool		
	Prizm	CNUT	BAM
authenticates SMs	●		●
controls **authentication** in APs	●	●	
manages **Committed Information Rate** (CIR)	●		●
has **dependency** on another application[3]		●	
automatically **discovers** elements	●	●	
exports network information with hierarchy	●	●	
supports user-defined **folder**-based operations	●	●	
senses **FPGA version** on an element	●	●	
upgrades **FPGA version** on an element		●	
enables/disables **hardware scheduling**		●	
manages the **high-priority channel**	●		●
imports network information with hierarchy	●	●	
interface to a higher-level network management system (NMS)	●		
interface to an operations support system (OSS)	●		
manages **Maximum Information Rate** (MIR)	●		●
automatically works from **root** (highest) level		●	
element **selection** can be individual or multiple	●	●	●
element **selection** can be criteria based	●		
element **selection** can be user-defined branch	●	●	
senses **software release** on an element	●	●	
upgrades **software release** on an element		●	
manages **VLAN** parameters	●		●
provides access to element **web interface**	●		

5.6 BANDWIDTH AND AUTHENTICATION MANAGER

Canopy Bandwidth and Authentication Manager (BAM) software allows you to use

- a primary server to distribute bandwidth resources per subscriber, require SMs to authenticate per AP, and deny service to unauthorized SMs.
- a secondary server to redundantly store identical SM bandwidth and authentication data and become governing if the primary server goes out of service.
- an optional tertiary server to do the same if both the primary and secondary servers go out of service.

In BAM Release 2.1, subscriber administration for an SM or batch of SMs is performed as follows:

- Insert the ESNs.
- Specify MIR and Security attributes.
- Specify CIR attributes.
- Specify whether BAM should send its stored CIR attributes.
- Specify VLAN attributes.
- Specify whether BAM should send its stored VLAN attributes.
- Specify VLAN IDs to associate with the SM(s).

This product is supported by the dedicated document *Canopy Bandwidth and Authentication Manager Release 2.1 User Guide* and associated release notes.

The upgrade path from BAM Release 2.1 is Prizm Release 2.0. See *Motorola Canopy Prizm User Guide*, Issue 3, and *Motorola Canopy Prizm Release 2.0 Release Notes*.

5.7 Prizm

The product name PrizmEMS is changed to Prizm in Release 2.0 and later, to reflect that the product capabilities are expanded beyond those of the element management system (EMS). Throughout this user guide, the name change applies to text for Release 2.0 and for multiple releases that include 2.0. It does not apply to text that is for a previous release. Case by case, software elements such as the GUI in the client application and XML files on the server may retain the PrizmEMS syntax.

5.7.1 Network Definition and Element Discovery

Prizm allows the user to partition the entire Canopy network into criteria-based subsets that can be independently managed. To assist in this task of defining networks, Prizm auto discovers Canopy network elements that are in

- user-defined IP address ranges
- SM-to-AP relationships with APs in the user-defined range
- BHS-to-BHM relationships with BHMs in the user-defined range.
- PLV Modem-to-PLV Bridge relationships with PLV Bridges in the user-defined range.

For a Canopy AP, SM, BHM, BHS, PLV Bridge, PLV Modem, or CMMmicro, Prizm

- auto discovers the element to the extent possible.

- includes the element in the network tree.
- shows general information.
- shows Canopy information.
- supports Canopy-specific operations.

For a generic element, Prizm

- auto discovers the element as only a generic network element.
- includes the element in the network tree.
- shows general information.
- shows events and alerts.
- charts port activity.

For passive elements (such as CMM2 or a non-manageable switch or hub), Prizm allows you to enter into the network tree a folder/group with name, asset/owner information, and descriptive information.

Supported element types include

Canopy Access Point Module	Generic SNMP Device (16 Port)
Canopy Backhaul Master Module	Generic SNMP Device (24 Port)
Canopy Backhaul Slave Module	Generic SNMP Device (26 Port)
Canopy PrizmEMS	High-Speed Backhaul Master Module 150/300 Mbps
Canopy Subscriber Module	High-Speed Backhaul Master Module 30/60 Mbps
Cluster Management Module micro	High-Speed Backhaul Slave Module 150/300 Mbps
Cluster Management Module-4	High-Speed Backhaul Slave Module 30/60 Mbps
Cluster Management Module-4 Switch	PLV Bridge Unit
Generic Group	PLV Modem Unit
Generic SNMP Device	Ultra Light Access Point
Generic SNMP Device (08 Port)	Ultra Light Outdoor Subscriber Unit

5.7.2 Monitoring and Fault Management

Prizm receives the traps that Canopy elements send and generates an alert for each of these. Prizm also allows the user to establish sets of criteria that would generate other alerts and trigger email notifications. Optionally, the user can specify a trap template. In this case, Prizm receives traps for non-Canopy elements in the network.

For any individual element that the user selects, Prizm offers text and graphed displays of element configuration parameters and performance statistics from an interval that the user specifies.

5.7.3 Element Management

Prizm allows the user to perform any of the following operations on any specified element or group of elements:

- Manage
  - large amounts of SNMP MIB data.
  - module passwords.

  - IP addresses.
  - other communications setup parameters.
  - site information: Site Name, Site Location, and Site Contact parameters.
- Reset the element.

5.7.4 BAM Subsystem in Prizm

Prizm Release 2.0 and later integrates Canopy Bandwidth and Authentication Manager (BAM) functionality and supports simple migration of a pre-existing BAM data into the Prizm database. These releases also support the maintenance of authentication and bandwidth data on a RADIUS server, to the same extent that BAM Release 2.1 (the final release of BAM) did.

Either of the following modes is available for the Prizm server, subject to licensing:

- BAM-only functionality, which manages only
  - authentication, bandwidth service plans, and VLAN profiles of SMs.
  - authentication of Powerline LV modems.
- Full Prizm functionality, which manages attributes for all elements and authentication of SMs and Powerline LV modems.

One difference between a service plan (or VLAN profile) and a configuration template that has the identical set of attributes is that the former is a long-term association whereas the latter is a one-time push to the element. When a service plan or VLAN profile is modified, the change is automatically applied to all elements that have the association. Another difference is that a configuration template cannot overwrite any values that a service plan or VLAN profile has set in an element.

5.7.5 Northbound Interface

In Release 1.1 and later, Prizm provides three interfaces to higher-level systems:

- a Simple Network Management Protocol (SNMP) agent for integration with a network management system (NMS).
- a Simple Object Access Protocol (SOAP) XML-based application programming interface (API) for web services that supports integration with an operations support systems (OSS) such as a customer relationship management (CRM), billing, or provisioning system.
- console automation that allows such higher-level systems to launch and appropriately display the Prizm management console in GUI that is custom developed, using the *PrizmEMS™ Software Development Kit (SDK)*, which Canopy provides for this purpose.

Together these interfaces constitute the Northbound Interface feature. Prizm server administrator tasks and GUI developer information are provided in the *PrizmEMS™ Software Development Kit (SDK)*. This SDK also describes the how to define new element types and customize the Details views.

All other features of the Prizm product are supported by the dedicated document *Motorola Canopy Prizm User Guide* and associated release notes.

5.8 LICENSE MANAGEMENT

Under the original licensing regime for Canopy networks, licenses were permanently tied to the Media Access Control (MAC) address of the equipment that was licensed or that

used the licensed feature. Thus, they were not transferable. Under server-based license management, for some functionalities, Canopy offers licenses that

- float upon demand within the network.
- are tied to only the hostID (MAC address) of the license management server for which they were ordered.

In Release 4.2.3 and later, server-based license management adds flexibility and makes available licenses that previously would have been held by de-commissioned equipment. License management technology from Macrovision, based on a FLEXnet™ Publisher license management model, provides the platform for Canopy server-based licensing. Canopy capabilities that are authorized by licenses on this platform are *FLEXenabled* products.

In this platform, the license management server checks and then either assigns or declines to assign a license in real time. See the *Canopy Networks License Manager User Guide*.

The total number of floating license keys that you need for any feature is the highest number that you will ever want to have simultaneously in use. The proper placement of these keys and the number and placement of fixed Canopy licenses are listed in Table 19.

Table 19: Correct placement of license keys

In This Release	License Key	Must Be in Directory	If This Platform	On This Server Device
LM 1.0	License Manager Server	C:\Program Files\Motorola\Canopy\FLEXnet\license_files	Windows	LM Server
		/usr/local/Canopy/FLEXnet/license_files	Enterprise Linux	
BAM 2.0	BAM Server, AP Auth Server (APAS), Cap 2	C:\Program Files\Motorola\Canopy\FLEXnet\license_files	Windows	LM Server[1]
		/usr/local/Canopy/FLEXnet/license_files	Enterprise Linux	
		/usr/local/canopy/include	Enterprise Linux	BAM Server[2]
BAM 2.1	BAM Server, AP Auth Server (APAS), Cap 2	C:\Program Files\Motorola\Canopy\FLEXnet\license_files	Windows	LM Server[1]
		/usr/local/Canopy/FLEXnet/license_files	Enterprise Linux	
		/usr/local/Canopy/FLEXnet/license_files	Enterprise Linux	BAM Server[2]
PrizmEMS 1.0	PrizmEMS Server, Element Pack	C:\Program Files\Motorola\Canopy\FLEXnet\license_files	Windows	LM Server[3]
		/usr/local/Canopy/FLEXnet/license_files	Enterprise Linux	
		C:\Program Files\Motorola\Canopy\FLEXnet\license_files	Windows	PrizmEMS Server[4]
		/usr/local/Canopy/Prizm/license_files	Enterprise Linux	

In This Release	License Key	Must Be in Directory	If This Platform	On This Server Device
PrizmEMS 1.1	PrizmEMS Server, Element Pack	C:\Program Files\Motorola\Canopy\FLEXnet\license_files	Windows	LM Server[3]
		/usr/local/Canopy/FLEXnet/license_files	Enterprise Linux	
Prizm 2.0 and 2.1 for full mgmt	PrizmEMS Server, Element Pack BAM Server, AP Auth Server (APAS), Cap 2 Canopy Lite	C:\Program Files\Motorola\Canopy\FLEXnet\license_files	Windows	LM server[5]
		/usr/local/Canopy/FLEXnet/license_files	Enterprise Linux	
Prizm 2.0 and 2.1 for BAM-only or redundant BAM	BAM Server, AP Auth Server (APAS), Cap 2 Canopy Lite	C:\Program Files\Motorola\Canopy\FLEXnet\license_files	Windows	LM server[1]
		/usr/local/Canopy/FLEXnet/license_files	Enterprise Linux	

NOTES:

1. One key required per each deployed BAM server.
2. Copied here so that BAM can find License Manager. No additional charge for using this copy.
3. One key required per each deployed PrizmEMS server.
4. Copied here so that PrizmEMS can find License Manager. No additional charge for using this copy.
5. One BAMServer key and one PrizmEMSServer key required per each full management Prizm server.

5.9 SPECIFICATIONS AND LIMITATIONS

5.9.1 Radios

Canopy radio specifications are provided at http://motorola.canopywireless.com/products/specshome.php.

5.9.2 Cluster Management Products

Table 20: CMM2 specifications and limitations

Specification or Limitation	Canopy System Range
Max length from Cluster Management Module to any radio	328 cable feet (100 meters)
Max length from Cluster Management Module to GPS antenna	100 cable feet (30.5 meters)
Dimensions	17.00" H x 12.88" W x 6.50" D (43.18 cm H x 32.72 cm W x 16.51 cm D)
Weight	25.0 lbs. (11.3 kg)
Operation Temperature	-40°F to +131°F (-40°C to +55°C)
Overall	Meets CE IP44 according to EN60529:2000
AC Input Voltage and Frequency	100 V – 240 V~, 0.7 A – 0.35 A, settable to either 230 V or 115 V nominal input. 50 Hz – 60 Hz Note: Applying 230 V to a unit that is set to 115 V may damage the unit.
AC Input Power	Nominal 66 watts, max 92 watts with 8 modules connected to the CMM at max cable length.
24-V DC Input Voltage	18 to 32 V DC, measured at CMM
24-V DC Input Power	Nominal 60 watts. Maximum 84 watts with 8 modules connected to the CMM at maximum cable length. 9A inrush upon start-up.
24-V DC Usage	If using a typical "24V +/-5%" power supply, ensure that CMM is within 400 cable feet (120 m) of the power supply. Use minimum 12 AWG (4 mm^2) copper wire.
12-V DC Input Voltage	11.5 to 32 VDC, measured at CMM
12-V DC Usage	If using a 12V power source (typically an automobile battery in a test or emergency situation), use 12 AWG (4 mm^2) wire between the power supply and the CMM, ensure that the CMM is within 10 cable feet (3 m) of the power supply, and ensure the modules are within 20 cable feet (6 m) of the CMM.
Ethernet, GPS Sync, and GPS Coax Cables	The use of cables that conform to the operational temperature of the product as well as being UV light protected is mandatory.

Table 21: CMMmicro specifications and limitations

Specification or Limitation	Canopy System Range
Enclosure Size	Approximately 12" H x 10" W x 3" D (Approximately 30 cm H x 25 cm W x 7.5 cm D)
CMMmicro Weight (without DC power supply)	Approximately 8 lb (Approximately 3.5 k)
Max length from Cluster Management Module to any radio	328 cable feet (100 meters)
Max length from Cluster Management Module to GPS antenna	100 cable feet (30.5 meters)
Operating Temperature	-40°F to +131°F (-40°C to +55°C)
Provided DC Power Converter Input Voltage	100 – 240 V~
Provided DC Power Converter Input Frequency	50 – 60 Hz
CMMmicro Power Input Voltage	21.5 – 26.5 V DC
CMMmicro Power Current	3.36 A @ 24 V DC (3.75 – 3.0 A over voltage range)
Ethernet, GPS sync, and GPS coax cables	The use of cables that conform to the operational temperature of the product as well as having UV light protection is mandatory. Cables can be ordered from Best-Tronics Manufacturing, Inc. at http://www.best-tronics.com/motorola.htm.

5.9.3 300SS and 600SS Surge Suppressors

Canopy Surge Suppressor specifications are provided at http://motorola.canopywireless.com/products/specshome.php.

6 DIFFERENTIATING AMONG COMPONENTS

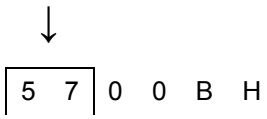
6.1 INTERPRETING MODEL (PART) NUMBER

The part number of a module typically represents

- the model number, which may indicate
  - radio frequency band range.
  - link distance range.
  - whether the module is Canopy Advantage.
  - the factory-set encryption standard.
- the module type.
- whether the reflector dish is included.
- the antenna scheme of the module.
- whether adjustable power in the module is preset to low.
- the modulation capability.

Radio Frequency Band Range

The leading digits usually indicate the frequency band range in which the module can operate. For example, if the part number is 5700BH, then the frequency band range of the module is 5.7 GHz.

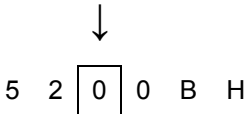


An exception to this general rule is that the leading digits in the part number of 5.1-GHz modules are 52. These modules are differentiated from 5.2-GHz modules by the leading four digits (5202 for 5.1 GHz, 5200 for 5.2 GHz).

You cannot change the frequency band range of the module.

Link Distance Range or Canopy Advantage

The third digit in the part number may indicate whether the module is an extended range, Canopy Advantage, or Canopy model. 1 indicates extended range. For example, if the part number is 5210BH, then the module *is* an extended range module. If the part number is 5200BH, then the module is not an extended range model.

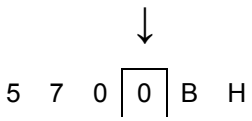


6 in the third position (5760SM, for example) indicates Canopy Lite. 5 in the third position (5250AP, for example) indicates that the module is Canopy Advantage. 0 in the third position (5200AP, for example) indicates that the module is Canopy. However, *part numbering for 900-MHz APs and SMs differs from this general rule*. All APs and SMs in this frequency band range are Canopy Advantage, but none of their part numbers use 5 in the third position.

You cannot change the link distance range of the module. However, you can license a Canopy SM to uncap its aggregate throughput (a capability of the Advantage SM).

Encryption Standard or Frequency Band Range

The fourth digit in the part number usually indicates the encryption standard that was preset at the factory. 1 indicates the Advanced Encryption Standard (AES). 0 indicates the Data Encryption Standard (DES) standard. For example, if the part number is 5201BH, then transmissions from the module are encrypted according to AES. If the part number is 5200BH, then transmissions from the module are encrypted according to DES.

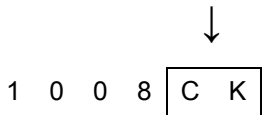


An exception to this general rule is that the fourth digit in the part number of 5.1-GHz modules is 2. These modules are differentiated from 5.2-GHz modules by the leading four digits (5202 for 5.1 GHz, 5200 for 5.2 GHz).

You cannot change the encryption basis (from DES to AES, for example), but you can enable or disable the encryption.

Module Type

The next two alpha characters indicate the module type. For example, CK indicates that the module is a Cluster Management Module.

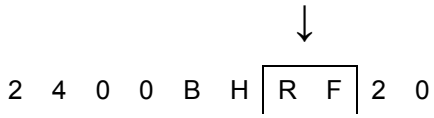


The module type cannot be changed.

Reflector Added

In specifications tables and price lists, the trailing characters RF or RF20 indicate that the associated information applies to the module being

- mounted to the 27RD Passive Reflector Dish, in the case of specifications.
- ordered with the 27RD Passive Reflector Dish, in the case of price lists.



However, this designation is not shown on either label of the module, and a module ordered with the dish can be deployed without the dish.

Antenna Scheme

In specifications tables and price lists, the trailing character C indicates that the module is connectorized for an external antenna.

An F in this position indicates that the module has an internal antenna with a band-pass filter (for example, 9000APF).

You cannot transform a module from connectorized to internal antenna or from internal antenna to connectorized, but you may have flexibility in what external antenna you deploy with it.

Adjustable Power Preset to High or Low

A trailing WL can indicate that the module had adjustable power that is preset to low.

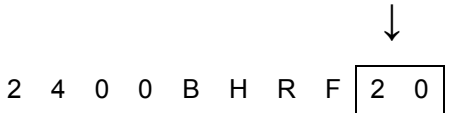
However, the 5700SMC and 5700APC are connectorized, but also have adjustable power preset to low. No special designation is made for adjustable power that is set to high (no trailing letters are used; for example, 5252AP).

You can reset power to higher in a module with adjustable power that is preset to low, but you are constrained by applicable regulations in your region and or nation.

Modulation Capability

A trailing 20 indicates that the module is capable of being set to either

- 20-Mbps modulation (aggregate throughput of 14 Mbps)
- 10-Mbps modulation (aggregate throughput of 7 Mbps).



The absence of a trailing 20 indicates that the module is capable of only 10-Mbps modulation.

6.2 SORTED MODEL (PART) NUMBERS

The various model/part numbers of Canopy products are categorically listed in Table 22.

Table 22: Canopy model numbers (part numbers) for AES and DES encryption modules

Range	Integrated Antenna				Connectorized for Antenna			
	Canopy		Advantage		Canopy		Advantage	
	DES	AES	DES	AES	DES	AES	DES	AES
5.7 GHz	5700AP 5700BH 5700BH20 5700BHRF 5700BHRF20 5700SM 5760SM	5701AP 5701BH 5701BH20 5701BHRF 5701BHRF20 5701SM	5750AP 5750SM	5751AP 5751SM	5700APC 5700BHC 5700BHC20 5700SMC	5701APC 5701BHC 5701BHC20 5701SMC	5750APC 5750SMC	5751APC 5751SMC
5.4 GHz	5400AP 5400BH 5400BH20 5400BHRF 5400BHRF20 5400SM	5401AP 5401BH 5401BH20 5401BHRF 5401BHRF20 5401SM	5450AP 5450SM	5451AP 5451SM				
5.1 GHz	5202AP 5202BH 5202SM 5212BH20 5212BHRF20		5252AP 5252SM					
5.2 GHz	5200AP 5200BH 5200SM 5210BHRF 5210BHRF20	5201AP 5201BH 5201SM 5211BH20 5211BHRF 5211BHRF20	5250AP 5250SM	5251AP 5251SM				
2.4 GHz	2400AP 2400APWL 2400BH 2400BH20 2400BHRF 2400BHRF20 2400BHWL 2400BHWL20 2400BHWLRF 2400BHWLRF20 2400SM 2400SMWL	2401AP 2401APWL 2401BH 2401BH20 2401BHRF 2401BHRF20 2401BHWL 2401BHWL20 2401BHWLRF 2401BHWLRF20 2401SM 2401SMWL	2450AP 2450APWL 2450SM 2450SMWL	2451AP 2451APWL 2451SM 2451SMWL				
900 MHz			9000AP 9000APF 9000SM 9000SMF	9001AP 9001APF 9001SM 9001SMF			9000APC 9000SMC	9001APC 9001SMC

Table 23: Canopy model numbers (part numbers) for proprietary encryption modules

Range	Integrated Antenna	Connectorized for Antenna
5.7 GHz	5830BH 5830BH15 5730BH 5730BH20	5830BHC 5830BHC15 5730BHC 5730BHC20
5.4 GHz	5430BH 5430BH20	5430BHC 5430BHC20

6.3 INTERPRETING ELECTRONIC SERIAL NUMBER (ESN)

Canopy module labels contain a product serial number that could be significant in your dealings with Motorola or your supply chain. This is the electronic serial number (ESN), also known as the Media Access Control (MAC) address, of the module. This hexadecimal number identifies the module in

- communications between modules.
- the data that modules store about each other (for example, in the **Registered To** field).
- the data that the BAM software applies to manage authentication and bandwidth.
- Prizm auto discovery of SMs through the AP (or BHS through the BHM).
- software upgrades performed by the Canopy Network Updater Tool (CNUT).
- information that CNUT passes to external tools.

6.4 FINDING THE MODEL (PART) NUMBER AND ESN

The labels and locations of Canopy module model (part) numbers and ESNs are shown in Table 24.

Table 24: Labels and locations of model (part) numbers and ESNs

Numeric String	Label and Location	
	Older Modules	Newer Modules
Model (part) number	**PN** outside	**Model #** outside
ESN/MAC address	**S/N** inside	**ESN** outside

7 CANOPY LINK CHARACTERISTICS

7.1 UNDERSTANDING BANDWIDTH MANAGEMENT

7.1.1 Downlink Frame Contents

The AP broadcasts downlink frames that contain control information, allocating slots in succeeding or future uplink frames to SMs that have requested service. The downlink frame also contains a beacon frame, control information, and data that specific SMs have requested. Each SM

- examines the downlink frame to distinguish whether data is addressed to that SM.
- retrieves data addressed to that SM.
- directs such data to the appropriate end user.

7.1.2 Uplink Frame Contents

Uplink frames contain control information from each SM that request service on succeeding uplink frames. SMs insert data into the uplink frames in an amount that the AP has established.

Optionally, you can configure the AP to change the source MAC address in every packet it receives from its SMs to the MAC address of the SM that bridged the packet, before forwarding the packet toward the public network. If you do, then

- not more than 10 IP devices at any time are valid to send data to the AP from behind the SM.
- the AP 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 10 are connected, and another attempts to connect
  - and no Translation Table entry is older than 255 minutes, the attempt is ignored.
  - and 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 will overwrite the MAC address in Address Resolution Protocol (ARP) packets before forwarding them.
  - enabled, so that the AP will forward ARP packets regardless of whether it has overwritten the MAC address.

This is the **Translation Bridging** feature, which you can enable in the General tab 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 162.

7.1.3 Frame Structure

The Canopy frame consists of

- Variable numbers of uplink and downlink 64-byte data slots, subject to the following factors:
  - Maximum range decreases the number of available slots.
  - Every two control slots that are reserved decrease the number of available data slots by one.
- 0 to 10 control slots, subject to operator setting
- 0 to 9 downlink acknowledgement slots, dynamically assigned
- 0 to 9 uplink acknowledgement slots, dynamically assigned
- 1 uplink schedule slot
- 1 beacon slot, which identifies the
  - timing and distribution for the SMs
  - ratio of uplink to downlink allocation
  - ESN of the AP
  - color code
  - protocol (point-to-point or point-to-multipoint)
  - number of registered SMs
  - frame number
  - control slot information
- air delay (guard time), subject to the value of the **Max Range** parameter in the AP

Control Slots

The Radio tab of the Configuration web page in the AP displays the total of control slots These control slots are reserved contention slots for bandwidth requests. If too many SMs contend for these slots, then the number of control slots may be increased.

Frame Scheduling

When an SM boots, the following sequence occurs:

1. The SM finds this beacon slot from an AP.
2. The SM synchronizes with the AP.
3. If BAM is configured on the AP and the AP is licensed for authentication, then
   a. the AP sends a Registration Request message to Prizm for authentication.
   b. following a successful challenge, Prizm returns an Authentication Grant message to the AP.
   c. the AP sends a Registration Grant to the SM.

   If BAM *is not* configured on the AP or the AP is not licensed for authentication, then the AP simply returns the Registration Grant to the SM.

This Registration Grant includes the distance between the AP and SM. The SM uses the distance to distinguish when to transmit data in the uplink frame. The AP performs advance scheduling of up to 1024 frames that each SM will be permitted to use in the uplink frame.

7.1.4 Media Access Control and AP Capacity

Regardless of whether the maximum number of SMs (200) all request service at the same time, the reservation Media Access Control (MAC) system allows the AP to give a reservation slot to each SM that requests service.

Regardless of the distance between any SM and the AP, the reservation MAC system ensures that all SM data slots are free of contention. For this reason

- all SMs are equally able to compete for uplink and downlink bandwidth.
- the capacity of the AP is not degraded by distance from the SMs.

7.1.5 Canopy Slot Usage

The frame illustrated in Figure 22 shows both packet fragments (yellow) and unused slot space (red) typical of uplink traffic. Packet sizes smaller than 64 bytes cause unused slot spaces.

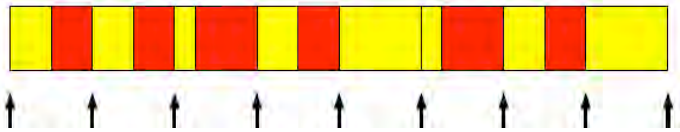


Figure 22: Uplink data slot usage

The following statistics apply to Canopy frame slot usage:

- Slot size is 64 bytes.
- The optimum Ethernet packet size is 1518 bytes.
- The maximum downlink throughput for one AP to one SM is 1800 packets per second (pps).
- The maximum uplink throughput for one AP to one SM is 300 pps.
- The maximum backhaul throughput is 3000 pps.

7.1.6 Data Transfer Capacity

Canopy modules use Time Division Duplex (TDD) on a common frequency to divide frames for uplink (orange) and downlink (green) usage, as shown in Figure 23.

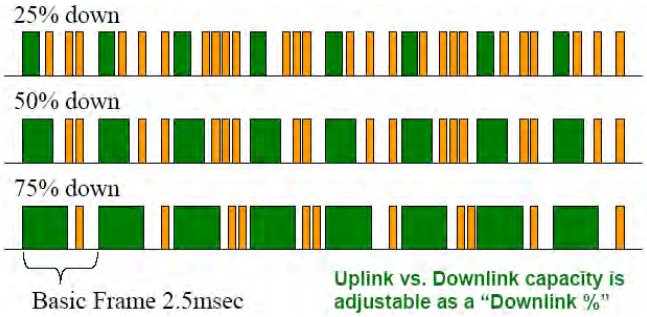


Figure 23: TDD dividing Canopy frames

7.1.7 Maximum Information Rate (MIR) Parameters

Canopy point-to-multipoint links use the following four MIR parameters for bandwidth management:

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

You can independently set each of these parameters per AP or per SM.

Token Bucket Algorithm

The Canopy software uses a *token bucket* algorithm that

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

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

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

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

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

Which set of these MIR parameters are applicable depends on the interactions of other parameter values. These interactions are described under Setting the Configuration Source on Page 292. Also, where the **Configuration Source** parameter setting in the AP specifies that BAM values should be used, they are used only if Prizm is configured to send the values that it stores for the MIR parameters.

MIR Data Entry Checking

Uplink and downlink MIR is enforced as shown in Figure 24.

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

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

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

Figure 24: Uplink and downlink rate caps adjusted to apply aggregate cap

For example, in the Canopy SM, if you set the **Sustained Uplink Data Rate** parameter to 2,000 kbps and the **Sustained Downlink Data Rate** parameter to 10,000 kbps, then the uplink and downlink MIR that will be enforced for the SM can be calculated as shown in Figure 25.

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

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

Figure 25: Uplink and downlink rate cap adjustment example

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

7.1.8 Committed Information Rate

The Committed Information Rate (CIR) capability feature enables the service provider to guarantee to any subscriber that bandwidth will never decrease to below a specified minimum, unless CIR is oversubscribed. Bandwidth can be, and typically will be, higher than the minimum, but this guarantee helps the WISP to attract and retain subscribers.

In BAM Release 2.1 and in Prizm Release 2.0, CIR configuration is supported as follows:

- The GUI allows you to view and change CIR configuration parameters per SM.
- When an SM successfully registers and authenticates, if BAM or Prizm has CIR configuration data for the SM, then messages make the CIR configuration available to the SM, depending on the Configuration Source setting. (See Setting the Configuration Source on Page 292.)
- The operator can disable the CIR feature in the SM without deleting the CIR configuration data.

7.1.9 Bandwidth from the SM Perspective

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

Example download times for various arbitrary tiers of service are shown in Table 60 on Page 384 and Table 61 on Page 385.

7.1.10 Interaction of Burst Allocation and Sustained Data Rate Settings

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

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

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

7.1.11 High-priority Bandwidth

To support low-latency traffic such as VoIP (Voice over IP) or video, the Canopy system implements a high-priority channel. This channel does not affect the inherent latencies in the Canopy system but allows high-priority traffic to be immediately served. The high-priority pipe separates low-latency traffic from traffic that is latency tolerant, such as standard web traffic and file downloads.

A Canopy module prioritizes traffic by

- reading the Low Latency bit (Bit 3) in the IPv4 Type of Service (ToS) byte in a received packet.
- reading the 802.1p field of the 802.1Q header in a received packet, where VLAN is enabled on the module.
- comparing the 6-bit Differentiated Services Code Point (DSCP) field in the ToS byte of a received packet to a corresponding value in the DiffServe tab of the Configuration page of the module.

Low Latency Bit

Bit 3 is set by a device outside the Canopy system. In the uplink frame, the SM monitors Bit 3. If this bit is set, then

- the SM prioritizes this traffic in its high-priority queue according to AP configuration settings for the high-priority channel.
- the system sends the packet on the high-priority channel and services this channel before any normal traffic.

802.1P Field

See Priority on VLANs (802.1p) on Page 166.

DSCP Field

Like Bit 3 of the original IPv4 ToS byte, the DSCP field (Bits 0 through 5) in the redefined ToS byte is set by a device outside the Canopy system. A packets contains no flag that indicates whether the encoding is for the Low Latency bit or the DSCP field. For this reason, you must ensure that all elements in your trusted domain, including routers and endpoints, set and read the ToS byte with the same scheme.

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

- The 6-bit length of the field allows it to specify one of 64 service differentiations.
- These correlate to 64 individual (**CodePoint**) parameters in the DiffServe tab of the Configuration page.
- Per RFC 2474, 3 of these 64 are preset and cannot be changed. (See http://www.faqs.org/rfcs/rfc1902.html.)
- For any or all of the remaining 61 CodePoint parameters, you can specify a value of
  - 0 through 3 for low-priority handling.
  - 4 through 7 for high-priority handling.

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

An example of the DiffServe tab in the Configuration page and parameter descriptions are provided under DiffServe Tab of the AP on Page 256. This tab and its rules are identical from module type to module type in Canopy. However, any of the 61 configurable Code Points can be set to a different value from module to module, thus defining unique per-hop behavior for some traffic.

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

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

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

The standard channel in Canopy PTMP communications is illustrated in Figure 26.

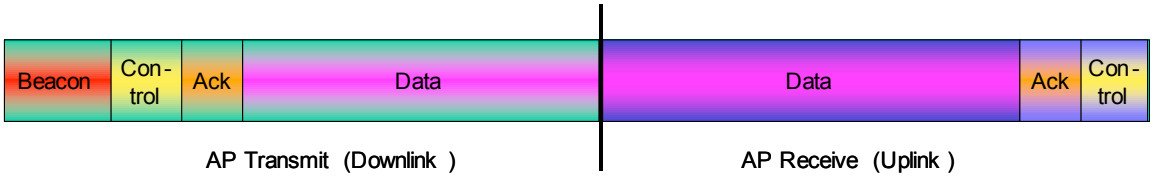


Figure 26: Canopy channel, 75% downlink, 0% high priority in uplink

7.1.12 Hardware Scheduling

Canopy Release 8 supports only hardware scheduling. Hardware scheduling always sends high-priority traffic first, even to the exclusion of other traffic.

> ***IMPORTANT!***
> The number of channels available to the AP is reduced by the number of SMs configured for the high-priority channel. With this feature enabled on all SMs, an AP can support only 100 SMs (instead of 200).

> ***IMPORTANT!***
> In a Canopy BH link with Canopy T1/E1 Multiplexers, the BHs must be configured for an uplink/downlink ratio of 50% uplink/50% downlink. The Canopy T1/E1 Multiplexers are full duplex.

Canopy Release 8 requires APs, BHs, and AES SMs to be Series P9 or later hardware.[3] The characteristics of hardware scheduling in a Canopy sector are summarized in Table 25.

[3] See Designations for Hardware in Radios on Page 367.

Table 25: Characteristics of hardware scheduling

Category	Factor	Treatment
Throughput	Aggregate throughput, less additional overhead	14 Mbps
	ACK slots in downlink used for data except when request for uplink is present	Yes
Latency	Number of frames required for the scheduling process	1
	Round-trip latency[1]	≈ 6 ms
	AP broadcast the download schedule	No
High-priority Channel	Allocation for *uplink* high-priority traffic on amount of high-priority traffic	Dynamic, based on amount of high-priority traffic
	Allocation for *downlink* high-priority traffic on amount of high-priority traffic	Dynamic, based on amount of high-priority traffic
	Order of transmission	1. CIR high-priority 2. CIR low-priority 3. Other high-priority 4. Other low-priority
Transmit Frame Spreading	Support for Transmit Frame Spreading feature	In Release 7.0 and later
CIR	Capability	In all releases
NOTES: 1. For 2.4- and 5.*n*-GHz modules.		

CAUTION!

Power requirements for modules that run hardware scheduling affect the recommended maximums for power cord length feeding the CMMmicro. See Table 55 on Page 344. However, the requirements *do not* affect the maximums for the CMM2.

Packets that have a priority of 4 to 7 in either the DSCP or a VLAN 802.1p tag are automatically sent on the high-priority channel, but only where the high-priority channel is enabled.

7.1.13 2X Operation

A General tab option in both Advantage SMs and some Canopy SMs provides double the aggregate throughput for SMs that are nearer than half of the distance range from the AP

(the nearest one-fourth of the SMs in the sector). The requirements of this feature are as follows:

- The AP must be an Advantage AP.
- The SM must be near the AP, as described above.
- The SM must be of the P9 hardware series and enabled for hardware scheduling. See Designations for Hardware on Page 367.
- The **2X Rate** parameter in the SM must be set to enabled. This is the default setting.
- The amount of noise and multipath must be low enough to allow the receiver in the 6-dB less sensitive (2X) state to maintain a high carrier-to-interference (C/I) ratio.

The flexibility of this feature is as follows:

- At the time of registration, signaling is at the 1X rate. However, if the above requirements are all met, then the SM switches to 2X.
- Thereafter, whenever RF conditions are unfavorable for 2X operation, the SM switches to 1X. When favorable RF conditions allow, the SM switches back to 2X, if user data is present at that time.
- Similarly, whenever no user data is present, the SM switches to 1X. When user data flow resumes, the SM switches back to 2X, if RF conditions allow.
- Both links for the SM (uplink and downlink) are independent for this feature. (One can be operating at 2X operation while the other is operating at 1X.)
- Other SMs in the sector can be communicating with the AP at the other modulation rate.
- Although subscribers with Canopy SMs realize higher bursts, and subscribers with Advantage SMs realize both higher burst and higher sustained throughput, the network operator realizes higher sector throughput capacity in the AP.

The effect of 2X operation on aggregate throughput for the SM is indicated in Table 26.

Table 26: Effect of 2X operation on throughput for the SM

Type of SM		Typical Aggregate Rates[1]	
		Sustained[2]	Burst[2]
Advantage	900 MHz[3]	4 Mbps	4 Mbps
	Any other frequency band range	14 Mbps	14 Mbps
Canopy P9	Any frequency band range except 900 MHz	7 Mbps	14 Mbps

NOTES:

1. Subject to competition among all SMs in the sector.
2. Can be less if limited by the value of **Downlink Data** set in the Radio tab of the Configuration page in the AP.
3. All 900-MHz modules are Advantage.

Competition for Bandwidth

When multiple SMs vie for bandwidth, the AP divides its bandwidth among them, considering their effective CIR and MIR values. However, 2X operation uses bandwidth twice as efficiently as 1X, even where MIR values apply. This is because, in 2X operation, the modules transmit their data in 4-level frequency shift keying (FSK), not 2-level as they would in 1X operation. This moves twice the data per slot. Thus, for the sum of all bandwidth that 2X-eligible customers use, the bandwidth available to the remaining customers increases by half of that sum when these eligible customers are transmitting and receiving in 2X operation.

Engineering for 2X Operation

The following priorities should guide your implementation of 2X operation:

- In the near half of the distance range of the AP
  - identify the customers who use the most bandwidth.
  - enable their SMs first for 2X operation.
- When you have deployable Canopy P7 and P8 SMs, *do not* deploy Canopy Advantage SMs or Canopy P9 SMs beyond half the distance range of the AP. At this distance, steady and reliable 2X operation typically is not achievable. Deploy the Canopy P7 and P8 SMs here.
- Wherever practical, implement 25 MHz of channel separation for 2X operation.

Checking Link Efficiencies in 2X Operation

Unlike in 1X operation, efficiencies below 90% on the Link Capacity Test tab in the Tools web page of the SM do not necessarily indicate a poor quality link. Efficiency of 45% in 2X operation is equivalent to efficiency of 90% in 1X. If you read efficiency between 45% and 90%, check the status of 2X operation (as described below) to confirm that the link is operating at 2X.

Since received signal strength typically varies over time, you should perform link tests at various times of day and on various days of the week. Efficiencies should consistently be 45% or greater for 2X operation. Where readings are lower, you are unlikely to solve the RF problem by enabling 1X operation. (For example, if you read 40% at 2X, you can expect 80% at 1X.) In these cases, you may be able to achieve better efficiencies by re-aiming the SM, mounting it elsewhere, or retrofitting it with a reflector dish.

Checking the Status of 2X Operation

The Session Status tab in the Home page of the AP provides operation status information about each *SM-to-AP* link. Under the MAC address of each SM, the data in this tab includes a line such as the following:

RATE : VC 19 Rate 2X/2X VC 255 Rate 2X/1X

Interpret this information is as follows:

- VC means virtual channel. If one VC is displayed, the high-priority channel is disabled. If two are displayed, the high-priority channel is enabled and is using the higher number VC (255 in the above example).
- 2X/2X indicates that the SM-to-AP link is in 2X operation.
- 2X/1X indicates that the SM is capable of 2X operation but the SM-to-AP link is in 1X operation. This can be for either of the following reasons:
  - The SM has not sent data on the channel yet.

  - The received signal does not support 2X operation.
- 1X/1X indicates that the SM is capable of only 1X operation. This can be for either of the following reasons:
  - The SM does not support 2X operation (SM is of the hardware series P7 or P8).
  - The **2X Rate** parameter is disabled in the General tab of the Configuration page in the SM.

CAUTION!

2X operation requires approximately 3 to 5% more power than 1X operation. This additional power affects the recommended maximum for power cord length feeding the CMMmicro. See Table 55 on Page 344. However, 2X operation *does not* affect the maximums for the CMM2.

Disabling 2X Operation

Disabling 2X operation for an SM can be helpful for alignment, troubleshooting, or preventing frequent automatic switches between 2X and 1X, where RF conditions are only marginally favorable to 2X. The ability to disable 2X for an SM is inherent since the 2X Operation feature was introduced.

Disabling 2X operation for a sector can be helpful for identifying a baseline for 1X-to-2X comparison, broader troubleshooting activities, or forcing all SMs to 1X rather than disabling 2X in each SM. Release 8 provides a **2X Rate** parameter in the General tab of the Configuration page in the AP:

- If you click **Disable**, then **Save Changes** and **Reboot**, 2X operation is disabled for the sector, regardless of the 2X Rate setting in each SM.
- If you later click **Enable**, then **Save Changes** and **Reboot**, 2X operation is enabled in the sector for SMs with 2X Rate enabled on their Configuration>General page. SMs with 2X Rate disabled on their Configuration>General page (or P7 or P8 SMs that don't support 2X Rate) will only operate at 1X.

7.2 UNDERSTANDING SYNCHRONIZATION

The system usesTime 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 must provide sync to its SMs – it must keep them in sync. Furthermore, collocated APs must be synced together - an unsynchronized AP that transmits during the receive cycle of a collocated AP can prevent that second AP from being able to decode the signals from its SMs. In addition, across a geographical area, APs that can "hear" each other benefit from using a common sync to further reduce self-interference within the network.

7.2.1 GPS Synchronization

The Navigation Satellite Timing and Ranging (NAVSTAR) Global Positioning System (GPS) uses 24 satellites to relay information for precise derivation of position and time.

The Canopy Cluster Management Module (CMM) contains a Motorola Oncore GPS Receiver. The CMM is a critical element in the operation of the Canopy system. At one

AP cluster site or throughout an entire wireless system, the CMM provides a GPS timing pulse to each module, synchronizing the network transmission cycles.

The Oncore GPS Receiver tracks eight or more satellites. The CMM uses the signal from at least four of these satellites to generate a one-second interval clock that has a rise time of 100 nsec. This clock directly synchronizes APs and BHMs which, in turn, synchronize the SMs and BHSs in the Canopy network.

The Oncore GPS Receiver also provides

- the latitude and longitude of the GPS antenna (collocated with the CMM)
- the number of satellites that are being tracked
- the number of satellites that are available
- the date
- the time in Universal Coordinated Time (UCT)
- the altitude of the GPS antenna
- other information that can be used to diagnose network problems.

Alternative to GPS Sync

A Canopy link can operate without *GPS* sync, but cannot operate without sync. The alternative to GPS sync is to configure the AP or BHM in the link to generate a sync pulse to pass to the SM or BHS, respectively. Depending on the RF environment in which the link operates, this latter alternative may or may not be plausible.

For example, in Figure 27, AP4

- is not synchronized with any of the other APs.
- is transmitting nearby the other APs while they are expecting to receive SM transmissions from a maximum distance.

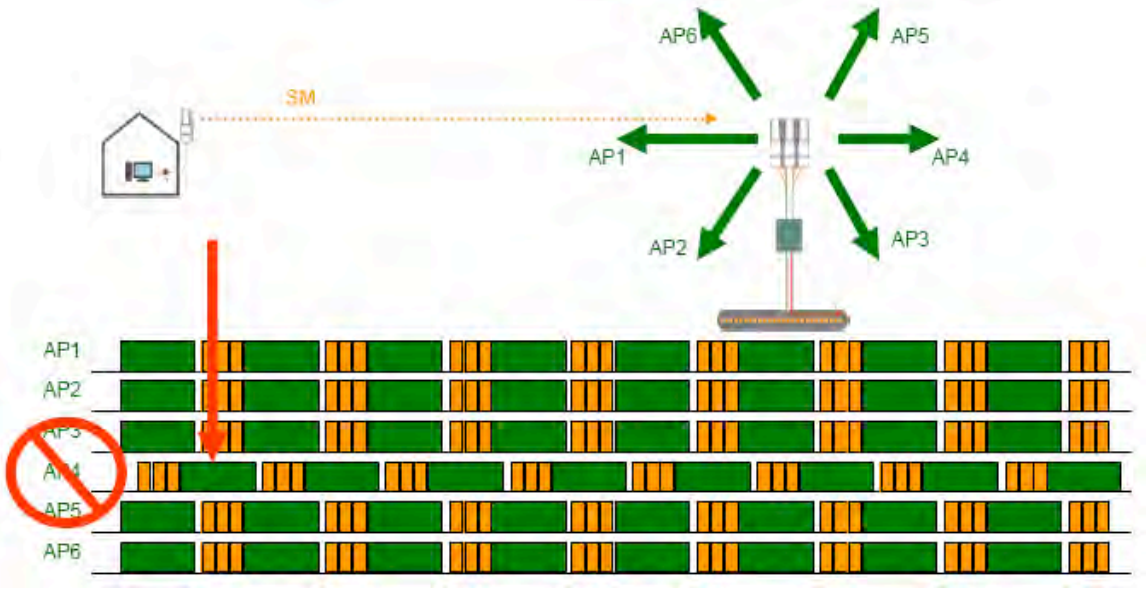


Figure 27: One unsynchronized AP in cluster

The result is self-interference. In this scenario, the self-interference can be avoided only by synchronizing the TDD transmit cycles of all APs that operate in the same frequency band.

An AP that is isolated by at least 5 miles (8 km) from any other Canopy equipment, or a BHM in an isolated standalone BH link can generate and pass sync pulse without GPS timing and not risk that interference will result from the generated sync. In any other type of Canopy link, sync should be derived from GPS timing.

NOTE:
The OFDM Series BHMs generate their own sync. For more information about these modules, see the user guides that support them. Titles are listed under Products Not Covered by This User Guide on Page 34.

Advantage of GPS Sync

Although the embedded timing generation capability of the Canopy AP and BHM keeps a precise clock, no trigger exists to start the clock at the same moment in each AP of a cluster. So, the individual AP can synchronize communications between itself and registered SMs, but cannot synchronize itself with other Canopy modules, except by GPS timing (shown in Figure 28).

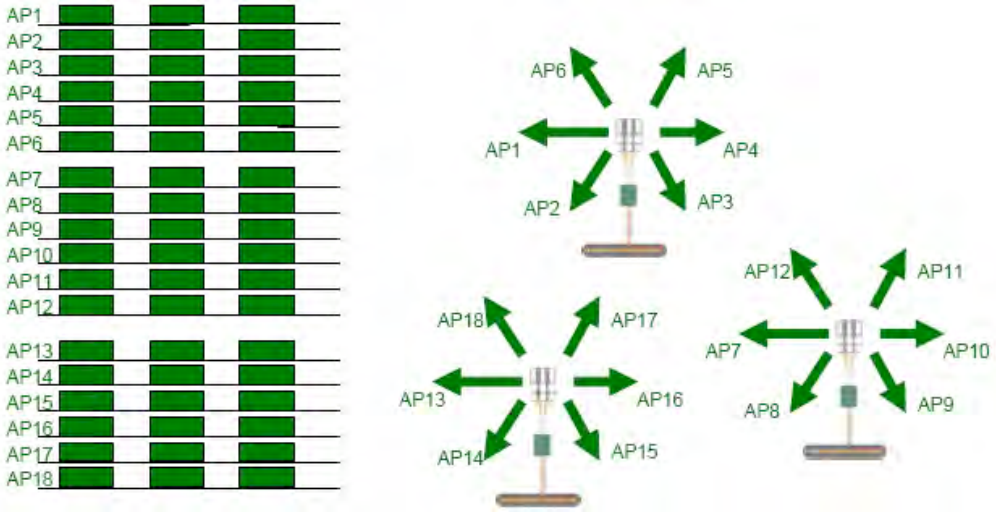


Figure 28: GPS timing throughout the Canopy network

7.2.2 Passing Sync in a Single Hop

Network sync can be passed in a single hop in the following network designs:

- Design 1
  1. A CMM provides sync to a collocated AP.
  2. This AP sends the sync over the air to SMs.
- Design 2
  1. A CMM provides sync to a collocated BH timing master.
  2. This BH timing master sends the sync over the air to a BH timing slave.

7.2.3 Passing Sync in an Additional Hop

Network sync can be extended by one additional link in any of the following network designs:

NOTE:
In each of these following designs, Link 2 *is not* on the same frequency band as Link 4. (For example, Link 2 may be a 5.2-GHz link while Link 4 is a 5.7- or 2.4-GHz link.)

- Design 3
  1. A CMM provides sync to a collocated AP.
  2. This AP sends the sync over the air to an SM.
  3. This SM delivers the sync to a collocated AP.
  4. This AP passes the sync in the additional link over the air to SMs.

This design is illustrated in Figure 29.

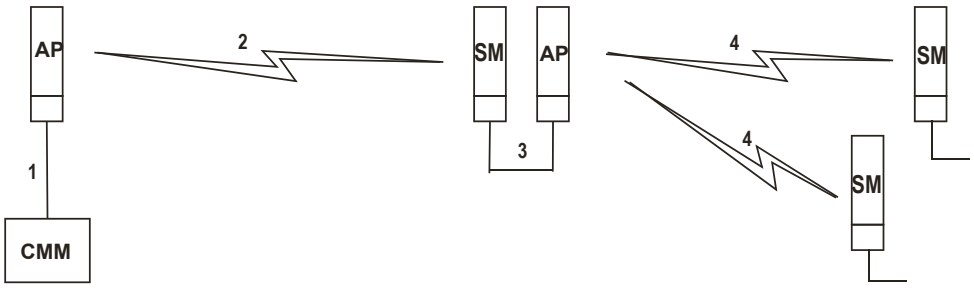


Figure 29: Additional link to extend network sync, Design 3

- Design 4
  1. A CMM provides sync to a collocated AP.
  2. This AP sends the sync over the air to an SM.
  3. This SM delivers the sync to a collocated BHM.
  4. This BHM passes the sync in the additional link over the air to a BHS.

This design is illustrated in Figure 30.

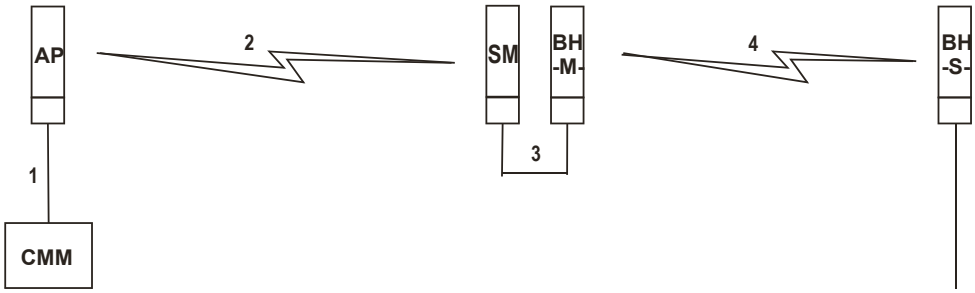


Figure 30: Additional link to extend network sync, Design 4

- Design 5
  1. A CMM provides sync to a collocated BHM or the BHM generates timing.
  2. This BHM sends the sync over the air to a BHS.
  3. This BHS delivers the sync to a collocated AP.
  4. This AP passes the sync in the additional link over the air to SMs.

This design is illustrated in Figure 31.

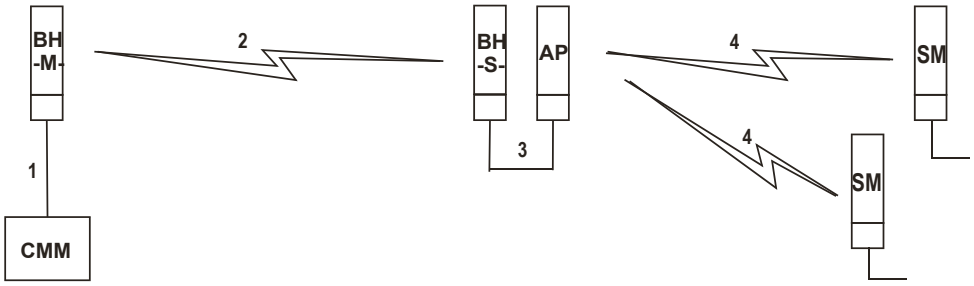


Figure 31: Additional link to extend network sync, Design 5

Wiring and configuration information for this sync extension is described under Wiring to Extend Network Sync on Page 369.

All Canopy radios support the remote AP functionality. The BHS and the SM can reliably pass the sync pulse, and the BHM and AP can reliably receive it. The sync is passed in a cable that connects Pins 1 and 6 of the RJ-11 timing ports of the two modules. (The sync cable is described under Cables on Page 59.) When you connect modules in this way, you must also adjust configuration parameters to ensure that

- the AP is set to properly receive sync.
- the SM will not propagate sync to the AP if the SM itself ceases to receive sync.

8 MEETING LINK REQUIREMENTS

8.1 AP-SM LINKS

APs communicate with SMs using a point-to-multipoint protocol. An AP-SM link has lower throughput and higher latency than a backhaul link for two reasons:

- Many endpoints are involved.
- The bandwidth request and reservation process consumes bandwidth.

In the 900-MHz frequency band range, round-trip latency is typically

- 40 msec with software scheduling.
- 15 msec with hardware scheduling.

In all other Canopy frequency band ranges, round-trip latency is typically

- 15 msec with software scheduling.
- 6 msec with hardware scheduling.

At range settings of greater than 40 miles (64 km) in the 900-MHz AP, more time elapses between transmit and receive cycles to compensate for greater air delay. In each frame, this reduces the number of data slots, which slightly reduces the aggregate throughput of the link. However, the throughput is as predictable as in other Canopy point-to-multipoint links.

Throughput is a factor of the **Max Range** parameter in the AP and is effective for all SMs, regardless of their distance from the AP. Throughput includes all downlink data to all SMs and all uplink data from all SMs that link to the AP. For throughput with hardware scheduling, see Table 14 on Page 64.

End user perspective of throughput is based on both bandwidth in the sending direction and the return of TCP acknowledgement packets in the other. Where sufficient downlink bandwidth exists to support downlink traffic and overhead, transient traffic congestion in the uplink can cause some TCP acknowledgement packets to be dropped, and the end user to perceive a reduction in throughput. This can also occur with sufficient uplink bandwidth and dropping acknowledgment packets in the downlink.

However, a Canopy network operator can optionally enable the **Prioritize TCP ACK** parameter in the AP and BHM, giving these packets priority over other packet types. This results in fewer of them being dropped.

The effects of changing network conditions on PTMP throughput are indicated in Table 27.

Table 27: Effects of network conditions on PTMP throughput

Changing Network Condition	Effect on AP Aggregate Throughput
Increasing the **Max Range** parameter setting[1] in the AP	somewhat decreased[2]
Increasing the number of SMs that register in the AP	no effect
Increase in downlink traffic	
Increase in uplink traffic	
Increasing the average bandwidth allotted to the SMs that register in the AP	no effect, even when the additional bandwidth is used.

NOTES:

1. For non 900-MHz APs, the AP accepts a **Max Range** value of up to 30 miles (48 km). See Max Range on Page 242.
2. To avoid a decrease of unnecessary proportion, set to not much further than the distance between the AP and the furthest SM that registers in the AP.

A comparison of SM products in link with a Canopy Advantage AP is shown in Table 28.

Table 28: Comparison of SM products with Canopy Advantage AP

Product	Maximum Sustained Aggregate Throughput to a Single SM	Burst	Cap on Committed Information Rate	Upgradability	VoIP Channels Supported
Canopy Advantage SM	14 Mbps	14 Mb	none	none	multiple
Canopy SM	7 Mbps	14 Mb	none	to Advantage SM capabilities	multiple
Canopy Lite SM as purchased	512 kbps	768 kb	100 kbps	to 1, 2, 4, or 7 Mbps	1
Canopy Lite SM upgraded to 1 Mbps	1 Mbps	1.5 Mb	100 kbps	none	1
Canopy Lite SM upgraded to 2 Mbps	2 Mbps	3 Mb	100 kbps	none	1
Canopy Lite SM upgraded to 4 Mbps	4 Mbps	7 Mb	200 kbps	none	2
Canopy Lite SM upgraded to 7 Mbps	7 Mbps	7 Mb	200 kbps	none	2

8.2 BH-BH LINKS

Canopy BHs communicate with each other using a point-to-point protocol. This point-to-point protocol uses a 2.5-msec frame. A BH link has higher throughput and lower latency (typically 5 msec, 2.5 msec in each direction) for two reasons:

- Only two endpoints are involved.