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.
- No bandwidth request and reservation process is involved.

For 10-Mbps BHs, the aggregate throughput on the channel is 7.5 Mbps. For 20-Mbps BHs, the aggregate throughput on the channel is 14 Mbps. If a BH is set to a downlink ratio of 50%, then the bandwidth in each direction is half of the total BH link bandwidth.

9 PREVIEWING NETWORK CONFIGURATIONS

The following are examples of network layouts. Customer experience case studies are also available.

9.1 VIEWING TYPICAL LAYOUTS

The following layouts are typical of Canopy system implementations:

- Figure 28: Typical network layout with no BH
- Figure 29: Typical network layout with BH
- Figure 30: Typical multiple-BH network layout

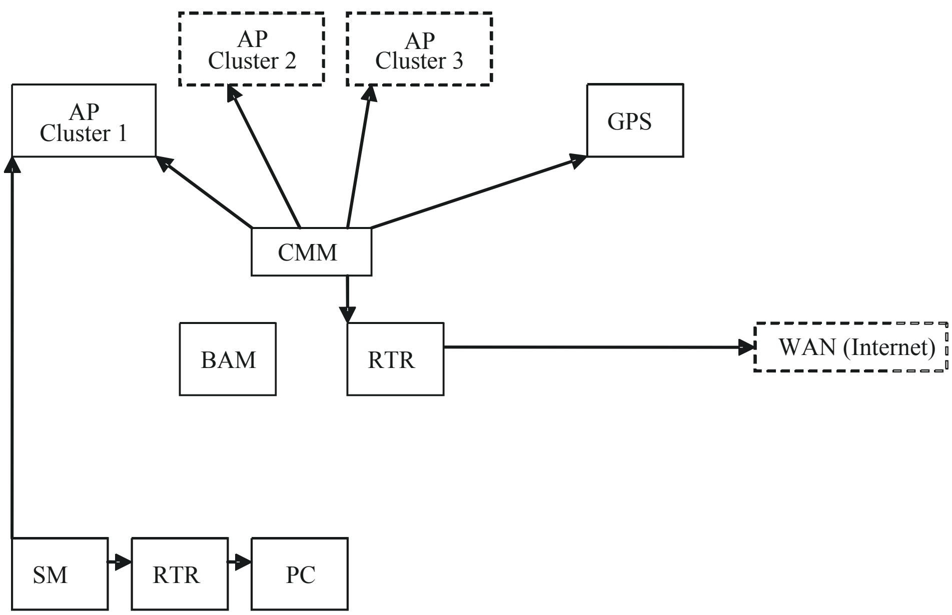


Figure 28: Typical network layout with no BH

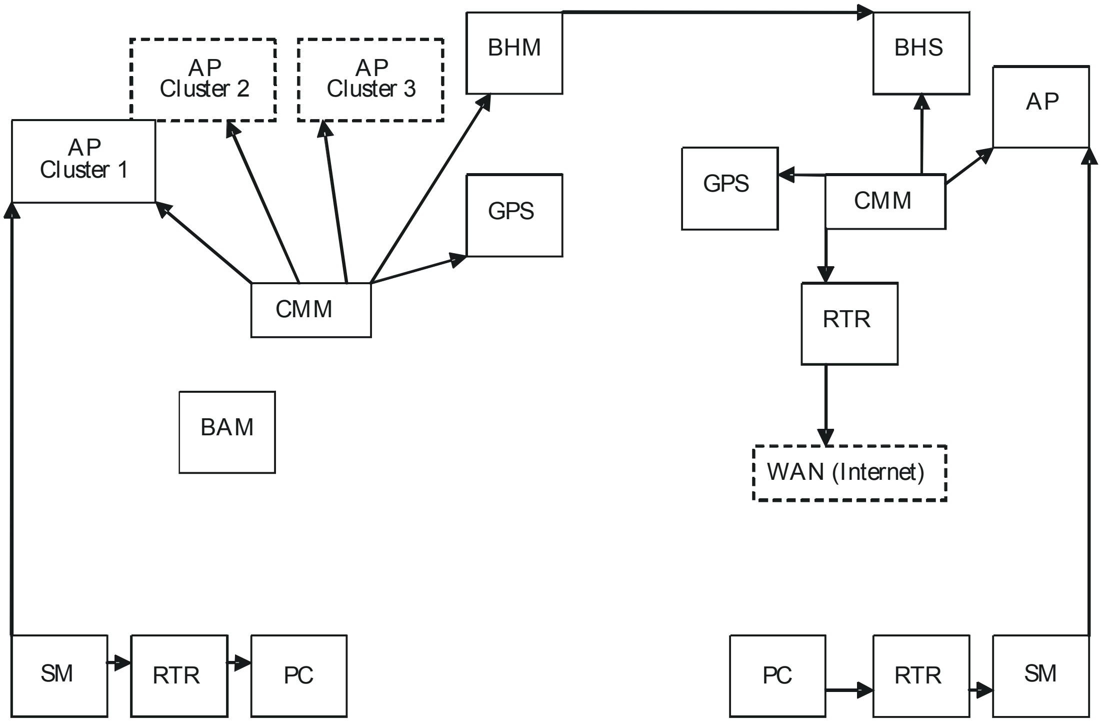


Figure 29: Typical network layout with BH

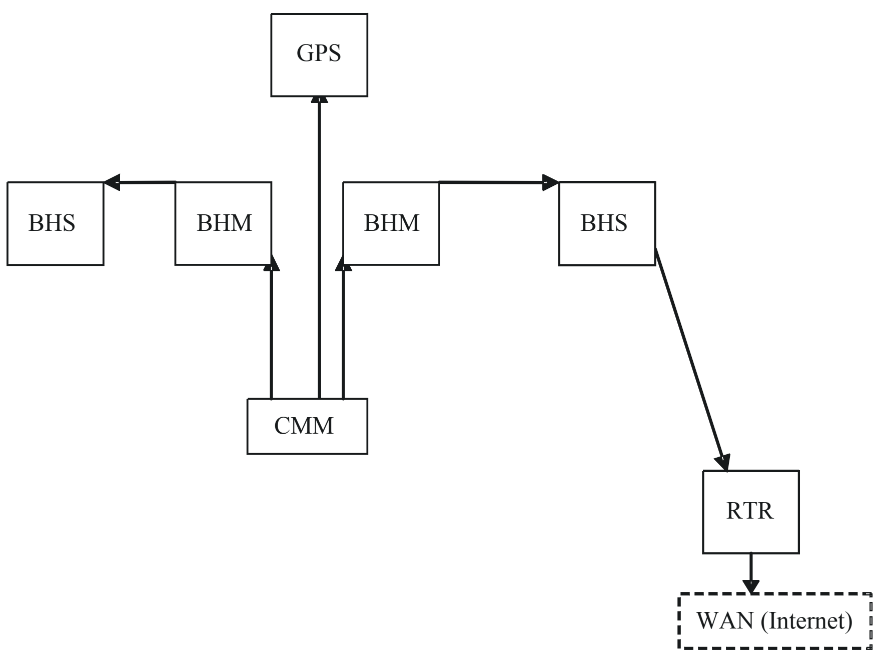


Figure 30: Typical multiple-BH network layout

9.2 VIEWING CASE STUDIES

Case studies of Canopy implementations are available as “Feature Articles” for download from http://www.connectwithcanopy.com/index.cfm?canopy=menu.case.

10 ACCESSING FEATURES

Canopy Release 8 networks support the features that are indicated in Table 26.

Table 26: Canopy features

Regulatory Features	Module Type(s)	Controlled in GUI Page/Tab	SNMP Control
RoHS compliant (EU "green" mandate)	All modules	no	no
WEEE compliant	All modules	no	no
Complies with Human RF exposure limits (ETSI)	All radios	no	no
Radio Features	**Module Type(s)**	**Controlled in GUI Page/Tab**	**SNMP Control**
Time Division Duplex	All radios	no	no
Scalable up to 6 sectors per cell.	AP SM	no	no
200 registered subscribers supported per AP	AP SM	no	no
Fixed /nomadic operation	All radios	no	no
20 ms or less round trip latency (OTA with Canopy MAC, under normal conditions)	All radios	no	no
Transmit frame spreading for geographical area co-existence	AP BHM	Configuration/Radio	yes
Radio statistics (scheduler)	All radios	Statistics/Scheduler	yes
2X rate, enabled per link (requires Advantage AP or 20 Mbps BH)	SM BHS	Configuration/General	yes
2X rate, enabled per sector (requires Advantage AP or 20 Mbps BH)	AP BHM	Configuration/General	yes
Manual transmit power control - normal and low (-18 dB)	All radios	Configuration/Radio	yes
Manual transmit power control, 1 dB increments over 25 dB at the AP	AP BHM	Configuration/Radio	yes

RF Configuration Features	Module Type(s)	Controlled in GUI Page/Tab	SNMP Control
Configurable center-channel carrier frequency	AP BHM	Configuration/Radio	yes
255 configurable "color codes" to manage SM to AP (or (BHS to BHM) registration	All radios	Configuration/Radio	yes
16 configurable "sector IDs" for administrative convenience	AP BHM	Configuration/Radio	yes
Configurable range settings (determines air turn-around time)	AP	Configuration/Radio	yes
Configurable downlink data % (determines transmit/receive ratio)	AP BHM	Configuration/Radio	yes
Configurable number of reserved control slots (manages contention for uplink requests)	AP	Configuration/Radio	yes
Configurable frequency scan list at SM	SM BHS	Configuration/Radio	yes
Packet stats - RF interface	All radios	Statistics/Radio	yes
Timing Features	**Module Type(s)**	**Controlled in GUI Page/Tab**	**SNMP Control**
Configurable AP/BHM sync source - Sync over Power over Ethernet, self-sync, or sync cable	AP BHM	Configuration/General	yes
"Remote AP" support, including timing pulse propagation through SM/BHS	SM BHS	Configuration/General	yes
Ethernet Interface Features	**Module Type(s)**	**Controlled in GUI Page/Tab**	**SNMP Control**
Selectable link speeds - 10/100 Base T, half, full-duplex	All modules	Configuration/General	yes
Ethernet link auto-negotiation	All modules	Configuration/General	no
Accepts straight-through or crossover Ethernet cable wiring (Auto-MDX)	All modules	no	no
Wire line Interface: Ethernet cable with proprietary PoE	All modules	no	no
Disable SM Ethernet link	SM	Configuration/General	yes
Packet stats - Ethernet interface	All radios	Statistics/Ethernet	yes

IP Interface Features	Module Type(s)	Controlled in GUI Page/Tab	SNMP Control
Configurable LAN settings (IP address, mask, gateway)	All radios	Configuration/IP	yes
Module's management IP address assignable via DHCP	All radios	Configuration/IP	yes
Private LAN to support AP to SM (or BHM to BHS) communications	All radios	Configuration/IP	yes
Configurable SM mgmt accessibility (Local/Ethernet only, or Public/RF and Local/Ethernet)	SM	Configuration/IP	yes
Security Features (Authentication, Encryption, and Access Control)	**Module Type(s)**	**Controlled in GUI Page/Tab**	**SNMP Control**
Configurable SM authentication using BAM/PrizmEMS	AP SM	Configuration/Security	yes
Configurable BH authentication, standalone	BHM BHS	Configuration/Security	no
DES encryption on standard product	All radios	no	yes
AES encryption on AES product	All radios	no	yes
Configurable whether SM/BHS displays AP/BHM beacon information	AP BHM	Configuration/Security	yes
Configurable web, telnet, and ftp session timeout	All radios	Configuration/Security	yes
Configurable access to radio management - up to 3 source IP addresses	All radios	Configuration/Security	yes
User/account names (up to 4) and passwords on modules	All radios	Account	yes
Permission levels control ability to add/delete users/passwords	All radios	Account	yes
Override plug to override lost IP address or user/password	All radios	no	no
Override plug configurable as a default plug - reset to factory defaults	AP SM BHM BHS	Configuration/Unit Settings	yes
Override switch to override lost IP address or user/password on CMM	CMMmicro	no	no

Monitoring Features	Module Type(s)	Controlled in GUI Page/Tab	SNMP Control
List of registered SMs/BHSs with full data, with hot links to SMs/BHSs	AP BHM	Configuration/General	multiple objects
Abbreviated list of SMs/BHSs, with hot links to SMs/BHSs	AP BHM	Configuration/General	multiple objects
Received power level indication	All radios	Configuration/General	yes
LEDs on modules to display states and activity	All modules	no	no
Received interference level indication (jitter)	All radios	Configuration/General	yes
Configurable web-page auto-refresh	All modules	Configuration/General	yes
SM registration failures	AP BHM	Statistics/Reg Failures	yes
Event log	All modules	Home/Event Log	no
Operator can use own logo on GUI pages	All modules	no	yes
Operator can use own style sheets for GUI	All modules	no	yes
Bridge Management Features	**Module Type(s)**	**Controlled in GUI Page/Tab**	**SNMP Control**
Configurable bridge entry timeout	All radios	Configuration/General	yes
Bridging table statistics (up to 4096 entries)	All radios	Statistics/Bridging Table	yes
Disable bridging on BHs	BHM BHS	Configuration/General	yes
SM Isolation Features (preventing communication between SMs)	**Module Type(s)**	**Controlled in GUI Page/Tab**	**SNMP Control**
SM isolation at AP	AP	Configuration/General	yes
SM isolation at CMM	CMMmicro	Configuration/General	yes
SM Isolation Features	**Module Type(s)**	**Controlled in GUI Page/Tab**	**SNMP Control**
Translation bridging (replace customer MAC with SM MAC address)	AP	Configuration/General	yes
With Translation bridging, choice of sending untranslated ARP	AP	Configuration/General	yes
Translation table statistics	All radios	Statistics/Translation Table	yes
Quick Start Feature	**Module Type(s)**	**Controlled in GUI Page/Tab**	**SNMP Control**
AP configuration quick-start wizard	AP BHM	Quick Start	

Bandwidth Management Features	Module Type(s)	Controlled in GUI Page/Tab	SNMP Control
AP Maximum Information Rate (MIR) default settings	AP	Configuration/QoS	yes
Per SM Maximum Information Rate (MIR)	SM	Configuration/QoS	yes
Per SM Committed Information Rate (CIR) for high and low channels	SM	Configuration/QoS	yes
"Configuration Source" for MIR/CIR/HP/VLAN can be either SM or BAM/Prizm	AP	Configuration/General	yes
CIR for low priority channel on BH	BHS	Configuration/QoS	yes
Configurable priority for TCP Acks, to optimize bandwidth use	AP BHM	Configuration/General	yes
Bandwidth Management Features	**Module Type(s)**	**Controlled in GUI Page/Tab**	**SNMP Control**
Configurable High Priority channel with configurable DiffServ mappings on AP, SM (2 classes of service)	AP SM	Configuration/DiffServe	yes
Permanent BH High Priority Channel with configurable DiffServ mappings on BH (2 classes of service)	BHM BHS	Configuration/DiffServe	yes
Virtual channel (high/low priority) statistics	All radios	Statistics/Data VC	yes
Network Address Translation (NAT) Features	**Module Type(s)**	**Controlled in GUI Page/Tab**	**SNMP Control**
NAT	SM	Configuration/NAT	yes
NAT DMZ	SM	Configuration/NAT	yes
NAT DHCP server on LAN with up to 254 IP addresses in pool	SM	Configuration/NAT	yes
NAT DHCP client on WAN (obtains NAT address from a DHCP server)	SM	Configuration/NAT	yes
NAT port mapping	SM	Configuration/NAT	yes
VPN "pass through" for L2TP over IPSec (but not PPTP)		no	no
NAT statistics	SM	Statistics/NAT Stats	yes
NAT DHCP statistics	SM	Statistics/NAT DHCP Statistics	yes
NAT table	SM	Logs/NAT Table	no
Filtering Features	**Module Type(s)**	**Controlled in GUI Page/Tab**	**SNMP Control**
Protocol filtering based on protocol	SM	Configuration/Protocol Filtering	yes
Operator-defined port filtering (3 ports)	SM	Configuration/Protocol Filtering	yes
Packet filter statistics	All radios	Statistics/Filter	yes

VLAN Management Features	Module Type(s)	Controlled in GUI Page/Tab	SNMP Control
Configurable VLAN	AP SM CMMmicro	Configuration/VLAN	yes
Highly configurable VLAN (802.1Q)	AP SM	Configuration/VLAN	yes
Use of VLAN priorities (802.1p) with high priority channel	AP SM	no	yes
Port-based VLAN switching on CMM	CMMmicro	Configuration	yes
VLAN statistics	AP SM	Statistics/VLAN	yes
Dynamic Frequency Selection (DFS) Feature	**Module Type(s)**	**Controlled in GUI Page/Tab**	**SNMP Control**
DFS v1.2.3	All radios	no	yes
Time Features	**Module Type(s)**	**Controlled in GUI Page/Tab**	**SNMP Control**
Time and Date from CMM via Network Time Protocol (NTP) server	AP BHM	Configuration/Time	yes
Time and Date manually settable	AP BHM	Configuration/Time	yes
CMM provides NTP server	CMMmicro	no	no
Spectrum Analyzer Features	**Module Type(s)**	**Controlled in GUI Page/Tab**	**SNMP Control**
Spectrum analyzer	SM BHS	Tools/Spectrum Analyzer	no
Ability to switch an AP to an SM (or BHS to BHM)	AP BHM	Configuration/General	yes
Aim/Link Quality Features	**Module Type(s)**	**Controlled in GUI Page/Tab**	**SNMP Control**
Alignment tone for using during aiming/alignment	SM BHS	no	no
Aiming support page when not using alignment tone	SM BHS	Tools/Alignment	multiple objects
LED for alignment	SM BHS	no	no
Configure SM power-up state - aiming or operational	SM BHS	Configuration/General	yes
Link capacity test, with configurable packet length	All radios	Tools/Link Capacity Test	yes
Display of SM configuration information at AP	AP BHM	Home/Session Status	yes
Display/evaluation of AP beacon data from all receivable APs	SM BHS	Tools/AP Evaluation	yes
Over-the-air radio Bit Error Rate (BER) indicator	All radios	Tools/BER Results	yes

Frame Tool Feature	Module Type(s)	Controlled in GUI Page/Tab	SNMP Control
Frame calculator for supporting collocation	All radios	Tools/Frame Calculator	no
Personal Digital Assistant (PDA) Interface Features	**Module Type(s)**	**Controlled in GUI Page/Tab**	**SNMP Control**
GUI automatically sized/styled for PDA when displayed on a PDA	All radios	all	no
Spectrum analyzer display for PDA	All radios	PDA/Spectrum Results (PDA)	no
Specific pages for PDA display	All radios	PDA	no
SNMP Interface Features	**Module Type(s)**	**Controlled in GUI Page/Tab**	**SNMP Control**
Support of SNMP v2	All modules	no	no
Canopy Enterprise MIB	All modules	no	no
Configurable SNMP community string	All radios	Configuration/SNMP	yes
Configurable SNMP accessing subnet	All radios	Configuration/SNMP	yes
10 configurable SNMP trap addresses	All radios	Configuration/SNMP	yes
Configurable traps (sync and session)	All radios	Configuration/SNMP	yes
Configurable SNMP permissions (read, read/write)	All radios	Configuration/SNMP	yes
Configurable site information, including site name	All modules	Configuration/SNMP	yes
Upgrade Process Features	**Module Type(s)**	**Controlled in GUI Page/Tab**	**SNMP Control**
Upgrading using CNUT and SM Auto-update for SMs	All modules	no	no
Configurable update address to support distributed software upgrades	AP	Configuration/General	yes
AP Cluster Management Features	**Module Type(s)**	**Controlled in GUI Page/Tab**	**SNMP Control**
CMM port power control	CMMmicro	Configuration	yes
CMM port reset	CMMmicro	Configuration	yes
CMM: Sufficient ports for at least 4 AP, 2 BH, plus management	CMMmicro	no	no
CMM: Sufficient power for at least 4 AP plus 2 BH	CMMmicro	no	no
Powered from 90-264 VAC, 50/60 Hz; 55 V DC power output	AP BH	no	no

Physical Features	**Module Type(s)**	**Controlled in GUI Page/Tab**	**SNMP Control**
MTBF > 45 years (~400 000 hours)	All modules	no	no
neg 40 C to + 55 C (Ambient) operation	All modules	no	no
Temperature indication	All radios	Home/General	no
Non-condensing (Indoor/outdoor), weather protected form factor/packaging	All modules	no	no
Element Management System (Prizm) Features			
Current Prizm to manage all elements of the system (including Mot Backhaul)			
Up to 1000 APs, plus 100 devices/AP); minimal storage / minimal polling			
Redundant configuration for additional storage/reporting capability			
Commercial Off the Shelf (COTS) Platform and OS support (e.g. Intel, Linux, Windows)			
COTS Database support (e.g. MySQL, PostgreSQL, MS SQL Server, etc..); Oracle optional			

10.1 ACTIVATING FEATURES

A Canopy feature is active if the software that allows the feature to be turned on or off (enabled or disabled) is present.

10.1.1 Fixed License Keys

Some features are activated by loading a fixed license key into the radio. Such a key arrives from Motorola as a `filename.url` file. When you double-click on this file, your browser opens and the location bar is populated by a lengthy string. This URL string begins with `http://<ModuleIPAddress>/`. If you need to load a key into a module whose IP address has changed since Motorola issued the key, perform the following steps.

Procedure 1: Modifying a fixed license key for a module IP address

1. Right-click on the license key filename.
2. Select **Properties**.
3. Select the **Web Document** tab.
4. At **URL**, substitute the current IP address for the original IP address in the URL.
5. Click **OK**.
6. Double-click on the license key filename.
   RESULT: The key loads into the module.

7. Open the Configuration web page of the module.
8. Review parameter settings and enable the feature if you wish to do so at this time (see next section).

=========================== **end of procedure** ===========================

10.2 ENABLING FEATURES

A Canopy feature is enabled (functioning) if the feature is both active and enabled. For example, Transmit Frame Spreading is active (*can be* enabled) in any AP or BHM that operates on Release 8. However, Transmit Frame Spreading functions only if the **Enable** selection for the **Transmit Frame Spreading** parameter is checked in the Radio tab of the Configuration web page in the module.

11 ACQUIRING PROFICIENCIES

Designing and operating a Canopy network requires fundamental knowledge of radio frequency transmission and reception, Internet Protocol addressing schemes, experimentation with Canopy equipment, and for most operators participation in some forms of Canopy training.

11.1 UNDERSTANDING RF FUNDAMENTALS

Canopy training and user interfaces presume an understanding of RF fundamentals. Excellent written sources for these fundamentals are available. One such source is *Deploying License-Free Wireless Wide-Area Networks* by Jack Unger (ISBN 1-58705-069-2), published by Cisco Press.

11.2 UNDERSTANDING IP FUNDAMENTALS

Canopy training and user interfaces also presume an understanding of Internet Protocol (IP) fundamentals. Excellent written sources for these fundamentals are available. One such source is *Sams Teach Yourself TCP/IP in 24 Hours* by Joe Casad (ISBN 0-672-32085-1), published by Sams Publishing.

> *NOTE:*
> The default IP address of each Canopy component is 169.254.1.1.

11.3 ACQUIRING A CANOPY DEMONSTRATION KIT

Canopy Demonstration Kits are available through your Canopy representative.

11.3.1 900-MHz with Integrated Antenna and Band-pass Filter Demonstration Kit

Each 900-MHz with integrated antenna and band-pass filter Demonstration Kit contains

- 2 9000SM SMs
- 1 9000APF AP
- 1 300SS Surge Suppressor
- 3 ACPSSW-02 90- to 230-V AC 50- to 60-Hz Power Supplies
- 3 CBL-0562 Straight-through Category 5 Cables
- 1 UGTK-0002 Trial Kit Quick Start Guide
- 1 CPT001-CD02EN Sales Overview on CD
- 1 CPT002-CD03EN Technical Overview on CD
- 1 CPT003-CD03EN Canopy User Guides on CD

Part numbers for Demonstration Kits are provided in Table 27.

11.3.2 900-MHz with Connectorized Antenna Demonstration Kit

Each 900-MHz with connectorized (external) antenna Demonstration Kit contains

- 2 9000SMC SMs

- 1 9000APC AP
- 3 AN900 60° 9-dBi Antennas
- 1 300SS Surge Suppressor
- 1 SMMB2 Universal Heavy Duty Mounting Bracket
- 3 ACPSSW-02 90- to 230-V AC 50- to 60-Hz Power Supplies
- 3 CBL-0562 Straight-through Category 5 Cables
- 1 UGTK-0002 Trial Kit Quick Start Guide
- 1 CPT001-CD02EN Sales Overview on CD
- 1 CPT002-CD03EN Technical Overview on CD
- 1 CPT003-CD03EN Canopy User Guides on CD

Part numbers for Demonstration Kits are provided in Table 27.

11.3.3 2.4-GHz with Adjustable Power Set to Low Demonstration Kit

Each 2.4-GHz with adjustable power set to low Demonstration Kit contains

- 1 2400SMWL SM
- 1 2450SMWL Advantage SM
- 1 2450APWL Advantage AP
- 1 300SS Surge Suppressor
- 1 SMMB1 Universal Mounting Bracket
- 3 ACPSSW-02 90- to 230-V AC 50- to 60-Hz Power Supplies
- 3 CBL-0562 Straight-through Category 5 Cables
- 1 UGTK-0002 Trial Kit Quick Start Guide
- 1 CPT001-CD02EN Sales Overview on CD
- 1 CPT002-CD03EN Technical Overview on CD
- 1 CPT003-CD03EN Canopy User Guides on CD

Part numbers for Demonstration Kits are provided in Table 27.

11.3.4 2.4-GHz with Adjustable Power Set to High Demonstration Kit

Each 2.4-GHz with adjustable power set to high Demonstration Kit contains

- 1 2400SM SM
- 1 2450SM Advantage SM
- 1 2450AP Advantage AP
- 1 300SS Surge Suppressor
- 1 SMMB1 Universal Mounting Bracket
- 3 ACPSSW-02 90- to 230-V AC 50- to 60-Hz Power Supplies
- 3 CBL-0562 Straight-through Category 5 Cables
- 1 UGTK-0002 Trial Kit Quick Start Guide
- 1 CPT001-CD02EN Sales Overview on CD
- 1 CPT002-CD03EN Technical Overview on CD
- 1 CPT003-CD03EN Canopy User Guides on CD

Part numbers for Demonstration Kits are provided in Table 27.

11.3.5 5.1-GHz Demonstration Kit

Each 5.1-GHz Demonstration Kit contains

- 1 5202SM SM
- 1 5252SM Advantage SM
- 1 5252AP Advantage AP
- 1 300SS Surge Suppressor
- 1 SMMB1 Universal Mounting Bracket
- 3 ACPSSW-02 90- to 230-V AC 50- to 60-Hz Power Supplies
- 3 CBL-0562 Straight-through Category 5 Cables
- 1 UGTK-0002 Trial Kit Quick Start Guide
- 1 CPT001-CD02EN Sales Overview on CD
- 1 CPT002-CD03EN Technical Overview on CD
- 1 CPT003-CD03EN Canopy User Guides on CD

Part numbers for Demonstration Kits are provided in Table 27.

11.3.6 5.2-GHz Demonstration Kit

Each 5.2-GHz Demonstration Kit contains

- 1 5200SM SM
- 1 5250SM Advantage SM
- 1 5250AP Advantage AP
- 1 300SS Surge Suppressor
- 1 SMMB1 Universal Mounting Bracket
- 3 ACPSSW-02 90- to 230-V AC 50- to 60-Hz Power Supplies
- 3 CBL-0562 Straight-through Category 5 Cables
- 1 UGTK-0002 Trial Kit Quick Start Guide
- 1 CPT001-CD02EN Sales Overview on CD
- 1 CPT002-CD03EN Technical Overview on CD
- 1 CPT003-CD03EN Canopy User Guides on CD

Part numbers for Demonstration Kits are provided in Table 27.

11.3.7 5.4-GHz Demonstration Kit

Each 5.4-GHz Demonstration Kit contains

- 1 5400SM SM
- 1 5450SM Advantage SM
- 1 5450AP Advantage AP
- 1 300SS Surge Suppressor
- 1 SMMB1 Universal Mounting Bracket
- 3 ACPSSW-02 90- to 230-V AC 50- to 60-Hz Power Supplies
- 3 CBL-0562 Straight-through Category 5 Cables
- 1 UGTK-0002 Trial Kit Quick Start Guide
- 1 CPT001-CD02EN Sales Overview on CD

- 1 CPT002-CD03EN Technical Overview on CD
- 1 CPT003-CD03EN Canopy User Guides on CD

Part numbers for Demonstration Kits are provided in Table 27.

11.3.8 5.7-GHz with Integrated Antenna Demonstration Kit

Each 5.7-GHz with integrated antenna Demonstration Kit contains

- 1 5700SM SM
- 1 5750SM Advantage SM
- 1 5750AP Advantage AP
- 1 300SS Surge Suppressor
- 1 SMMB1 Universal Mounting Bracket
- 3 ACPSSW-02 90- to 230-V AC 50- to 60-Hz Power Supplies
- 3 CBL-0562 Straight-through Category 5 Cables
- 1 UGTK-0002 Trial Kit Quick Start Guide
- 1 CPT001-CD02EN Sales Overview on CD
- 1 CPT002-CD03EN Technical Overview on CD
- 1 CPT003-CD03EN Canopy User Guides on CD

Part numbers for Demonstration Kits are provided in Table 27.

11.3.9 5.7-GHz with Connectorized Antenna and Adjustable Power Set to Low

Each 5.7-GHz with connectorized antenna and adjustable power set to low Demonstration Kit contains

- 1 5700SMC SM
- 1 5750SMC Advantage SM
- 1 5750APC Advantage AP
- 1 300SS Surge Suppressor
- 1 SMMB2 Universal Heavy Duty Mounting Bracket
- 3 ACPSSW-02 90- to 230-V AC 50- to 60-Hz Power Supplies
- 3 CBL-0562 Straight-through Category 5 Cables
- 1 UGTK-0002 Trial Kit Quick Start Guide
- 1 CPT001-CD02EN Sales Overview on CD
- 1 CPT002-CD03EN Technical Overview on CD
- 1 CPT003-CD03EN Canopy User Guides on CD

Part numbers for Demonstration Kits are provided in Table 27.

11.3.10 Demonstration Kit Part Numbers

The part numbers for ordering Canopy demonstration kits are provided in Table 27.

Table 27: Demonstration Kit part numbers

Frequency Band Range	Part Number
900 MHz integrated antenna with band-pass filter	TK10290
900 MHz connectorized antenna	TK10290C
2.4 GHz adjustable power set to low	TK10250
2.4 GHz adjustable power set to high	TK10251
5.1 GHz	TK10253
5.2 GHz	TK10252
5.4 GHz	TK10254
5.7 GHz	TK10257
5.7 GHz connectorized adjustable power set to low	TK10257C

11.4 ACQUIRING A CANOPY STARTER KIT

Canopy Starter Kits are also available through your Canopy representative.

11.4.1 900-MHz with Integrated Antenna and Band-pass Filter Starter Kit

Each 900-MHz with integrated antenna and band-pass filters Starter Kit contains

- 20 9000SM SMs
- 3 9000APF Advantage APs
- 1 1070CK CMMmicro
- 21 300SS Surge Suppressors
- 1 UGSK-0003 Quick Start Guide
- 1 CPT003-CD03EN Canopy User Guides on CD

Power supplies and SM mounting brackets *are not* included in this kit. Part numbers for Starter Kits are provided in Table 28.

11.4.2 900-MHz with Connectorized Antenna Starter Kit

Each 900-MHz with connectorized (external) antenna Starter Kit contains

- 20 9000SMC SMs
- 3 9000APC Advantage APs
- 23 AN900 60° 9-dBi Antennas
- 1 1070CK CMMmicro
- 21 300SS Surge Suppressors
- 20 SMMB2 Universal Heavy Duty Mounting Brackets
- 1 UGSK-0003 Quick Start Guide
- 1 CPT003-CD03EN Canopy User Guides on CD

Power supplies *are not* included in this kit. Part numbers for Starter Kits are provided in Table 28.

11.4.3 2.4-GHz with Adjustable Power Set to Low Starter Kit

Each 2.4-GHz with adjustable power set to low Starter Kit contains

- 30 2400SMWL SMs
- 6 2450APWL Advantage APs
- 1 1070CK CMMmicro
- 31 300SS Surge Suppressors
- 30 SMMB1 Universal Mounting Brackets
- 1 UGSK-0003 Quick Start Guide
- 1 CPT003-CD03EN Canopy User Guides on CD

Power supplies *are not* included in this kit. Part numbers for Starter Kits are provided in Table 28.

11.4.4 2.4-GHz with Adjustable Power Set to High Starter Kit

Each 2.4-GHz adjustable power set to high Starter Kit contains

- 30 2400SM SMs
- 6 2450AP Advantage APs
- 1 1070CK CMMmicro
- 31 300SS Surge Suppressors
- 30 SMMB1 Universal Mounting Brackets
- 1 UGSK-0003 Quick Start Guide
- 1 CPT003-CD03EN Canopy User Guides on CD

Power supplies *are not* included in this kit. Part numbers for Starter Kits are provided in Table 28.

11.4.5 5.1-GHz Starter Kit

Each 5.1-GHz adjustable power set to high Starter Kit contains

- 30 5202SM SMs
- 6 5252AP Advantage APs
- 1 1070CK CMMmicro
- 31 300SS Surge Suppressors
- 30 SMMB1 Universal Mounting Brackets
- 1 UGSK-0003 Quick Start Guide
- 1 CPT003-CD03EN Canopy User Guides on CD

Power supplies *are not* included in this kit. Part numbers for Starter Kits are provided in Table 28.

11.4.6 5.2-GHz Starter Kit

Each 5.2-GHz Starter Kit contains

- 30 5200SM SMs
- 6 5250AP Advantage APs
- 1 1070CK CMMmicro
- 31 300SS Surge Suppressors
- 30 SMMB1 Universal Mounting Brackets
- 1 UGSK-0003 Quick Start Guide
- 1 CPT003-CD03EN Canopy User Guides on CD

Power supplies *are not* included in this kit. Part numbers for Starter Kits are provided in Table 28.

11.4.7 5.4-GHz Starter Kit

Each 5.4-GHz Starter Kit contains

- 30 5400SM SMs
- 6 5450AP Advantage APs
- 1 1070CK CMMmicro
- 31 300SS Surge Suppressors
- 30 SMMB1 Universal Mounting Brackets
- 1 UGSK-0003 Quick Start Guide
- 1 CPT003-CD02EN Canopy System User Guide on CD

Power supplies *are not* included in this kit. Part numbers for Starter Kits are provided in Table 28.

11.4.8 5.7-GHz with Integrated Antenna Starter Kit

Each 5.7-GHz with integrated antenna Starter Kit contains

- 30 5700SM SMs
- 6 5750AP Advantage APs
- 1 1070CK CMMmicro
- 31 300SS Surge Suppressors
- 30 SMMB1 Universal Mounting Brackets
- 1 UGSK-0003 Quick Start Guide
- 1 CPT003-CD03EN Canopy User Guides on CD

Power supplies *are not* included in this kit. Part numbers for Starter Kits are provided in Table 28.

11.4.9 5.7-GHz with Connectorized Antenna and Adjustable Power Set to Low

Each 5.7-GHz with connectorized antenna and adjustable power set to low Starter Kit contains

- 30 5700SMC SMs
- 6 5750APC Advantage APs
- 1 1070CK CMMmicro
- 31 300SS Surge Suppressors
- 30 SMMB1 Universal Mounting Brackets
- 1 UGSK-0003 Quick Start Guide
- 1 CPT003-CD03EN Canopy User Guides on CD

Power supplies *are not* included in this kit. Part numbers for Starter Kits are provided in Table 28.

11.4.10 Starter Kit Part Numbers

The part numbers for ordering Canopy Starter kits are provided in Table 28.

Table 28: Starter Kit part numbers

Frequency Band Range	Part Number
900 MHz integrated antenna with band-pass filter	TK10190
900 MHz connectorized	TK10190C
2.4 GHz adjustable power set to low	TK10150
2.4 GHz adjustable power set to high	TK10151
5.1 GHz	TK10153
5.2 GHz	TK10152
5.4 GHz	TK10154

Frequency Band Range	**Part Number**
5.7 GHz	TK10157
5.7 GHz connectorized adjustable power set to low	TK10157C

11.5 EVALUATING CANOPY TRAINING OPTIONS

Canopy and its distributors make technical training available to customers. For information on this training, either

- send email inquiries to training@canopywireless.com.
- visit http://www.motorola.com/canopy. Under Contact Us, select **Request Product Info**, select **Product Info**, then under Support, select **Training**.

11.6 ATTENDING ON-LINE KNOWLEDGE SESSIONS

Irregularly but often, Canopy presents a knowledge session over the Internet about a new product offering. Some of these knowledge sessions provide the opportunity for participants to interact in real time with the leader of the session.

The knowledge session

- provides a high-level understanding of the technology that the new product introduces.
- announces any subtleties and caveats.
- typically includes a demonstration of the product.
- is usually recorded for later viewing by those who could not attend in real time.

To participate in upcoming knowledge sessions, ask your Canopy representative to ensure that you receive email notifications.

PLANNING GUIDE

12 ENGINEERING YOUR RF COMMUNICATIONS

Before diagramming network layouts, the wise course is to

- anticipate the correct amount of signal loss for your fade margin calculation (as defined below).
- recognize all permanent and transient RF signals in the environment.
- identify obstructions to line of sight reception.

12.1 ANTICIPATING RF SIGNAL LOSS

The C/I (Carrier-to-Interference) ratio defines the strength of the intended signal relative to the collective strength of all other signals. Canopy modules typically do not require a C/I ratio greater than

- 3 dB or less at 10-Mbps modulation and −65 dBm for 1X operation. The C/I ratio that you achieve must be even greater as the received power approaches the nominal sensitivity (−85 dBm for 1X operation).
- 10 dB or less at 10-Mbps modulation and −65 dBm for 2X operation. The C/I ratio that you achieve must be even greater as the received power approaches the nominal sensitivity (−79 dBm for 2X operation).
- 10 dB or less at 20-Mbps modulation.

12.1.1 Understanding Attenuation

An RF signal in space is attenuated by atmospheric and other effects as a function of the distance from the initial transmission point. The further a reception point is placed from the transmission point, the weaker is the received RF signal.

12.1.2 Calculating Free Space Path Loss

The attenuation that distance imposes on a signal is the free space path loss. PathLossCalcPage.xls calculates free space path loss.

12.1.3 Calculating Rx Signal Level

The Rx sensitivity of each module is provided at http://motorola.canopywireless.com/prod_specs.php. The determinants in Rx signal level are illustrated in Figure 31.

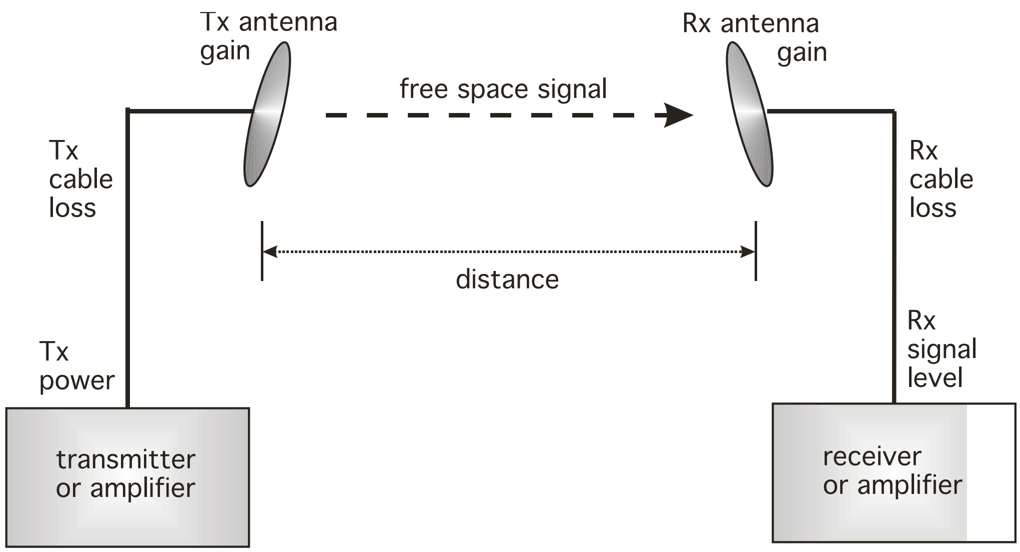


Figure 31: Determinants in Rx signal level

Rx signal level is calculated as follows:

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

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

12.1.4 Calculating Fade Margin

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

***system operating margin (fade margin)* dB = *Rx signal level* dB − *Rx sensitivity* dB**

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

12.2 ANALYZING THE RF ENVIRONMENT

An essential element in RF network planning is the analysis of spectrum usage and the strength of the signals that occupy the spectrum you are planning to use. Regardless of how you measure and log or chart the results you find (through the Spectrum Analyzer in SM and BHS feature or by using a spectrum analyzer), you should do so

- at various times of day.
- on various days of the week.
- periodically into the future.

As new RF neighbors move in or consumer devices in your spectrum proliferate, this will keep you aware of the dynamic possibilities for interference with your network.

12.2.1 Mapping RF Neighbor Frequencies

Canopy modules allow you to

- use an SM or BHS (or a BHM reset to a BHS), or an AP that is temporarily transformed into an SM, as a spectrum analyzer.
- view a graphical display that shows power level in RSSI and dBm at 5-MHz increments throughout the frequency band range, regardless of limited selections in the **Custom Radio Frequency Scan Selection List** parameter of the SM.
- select an AP channel that minimizes interference from other RF equipment.

The SM measures only the spectrum of its manufacture. So if, for example, you wish to analyze an area for both 2.4- and 5.7-GHz activity, take both a 2.4- and 5.7-GHz SM to the area. To enable this functionality, perform the following steps:

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

Procedure 2: Analyzing the spectrum

1. Predetermine a power source and interface that will work for the SM or BHS in the area you want to analyze.
2. Take the SM or BHS, power source, and interface device to the area.
3. Access the Tools web page of the SM or BHS.
   RESULT: The Tools page opens to its Spectrum Analyzer tab. An example of this tab is shown in Figure 137.
4. Click **Enable**.
   RESULT: The feature is enabled.
5. Click **Enable** again.
   RESULT: The system measures RSSI and dBm for each frequency in the spectrum.

6. Travel to another location in the area.
7. Click **Enable** again.
   RESULT: The system provides a new measurement of RSSI and dBm for each frequency in the spectrum.
   NOTE: Spectrum analysis mode times out 15 minutes after the mode was invoked.
8. Repeat Steps 6 and 7 until the area has been adequately scanned and logged.

============================ **end of procedure** ========================

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

> *RECOMMENDATION:*
> Wherever you find the measured noise level is greater than the sensitivity of the radio that you plan to deploy, use the noise level (rather than the link budget) for your link feasibility calculations.

12.2.2 Anticipating Reflection of Radio Waves

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

- 2 inches for 5.2- and 5.7-GHz signals.
- 5 inches for 2.4-GHz signals.
- 12 inches for 900-MHz signals.

A reflected signal can arrive at the antenna of the receiver later than the non-reflected signal arrives. These two or more signals cause the condition known as multipath. When multipath occurs, the reflected signal cancels part of the effect of the non-reflected signal so, overall, attenuation beyond that caused by link distance occurs. This is problematic at the margin of the link budget, where the standard operating margin (fade margin) may be compromised.

12.2.3 Noting Possible Obstructions in the Fresnel Zone

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

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

12.2.4 Radar Signature Detection and Shutdown

With Release 8.1, Canopy meets ETSI EN 301 893 v1.2.3 for Dynamic Frequency Selection (DFS). DFS is a requirement in certain countries of the EU for systems like Canopy to detect interference from other systems, notably radar systems, and to avoid co-channel operation with these systems. All 5.4 GHz modules and all 5.7 GHz

Connectorized modules running Release 8.1 have DFS. Other modules running Release 8.1 do not. With Release 8.1, Canopy SMs and BHSs as well as Canopy APs and BHMs will detect radar systems.

When an AP or BHM enabled for DFS boots, it receives for 1 minute, watching for the radar signature, without transmitting. If no radar pulse is detected during this minute, the module then proceeds to normal beacon transmit mode. If it does detect radar, it waits for 30 minutes without transmitting, then watches the 1 minute, and will wait again if it detects radar. If while in operation, the AP or BHM detects the radar signature, it will cease transmitting for 30 minutes and then begin the 1 minute watch routine. Since an SM or BHS only transmits if it is receiving beacon from an AP or BHM, the SMs in the sector or BHS are also not transmitting when the AP or BHM is not transmitting.

When an SM or BHS with DFS boots, it scans to see if an AP or BHM is present (if it can detect a Canopy beacon). If an AP or BHM is found, the SM or BHS receives on that frequency for 1 minute to see if the radar signature is present. For an SM, if no radar pulse is detected during this 1 minute, the SM proceeds through normal steps to register to an AP. For a BHS, if no radar pulse is detected during this 1 minute, it registers, and as part of registering and ranging watches for the radar signature for another 1 minute. If the SM or BH does detect radar, it locks out that frequency for 30 minutes and continues scanning other frequencies in its scan list.

Note, after an SM or BHS has seen a radar signature on a frequency and locked out that frequency, it may connect to a different AP or BHM, if color codes, transmitting frequencies, and scanned frequencies support that connection.

For all modules, the module displays its DFS state on its General Status page. You can read the DFS status of the radio in the General Status tab of the Home page as one of the following:

- `Normal Transmit`
- `Radar Detected Stop Transmitting for` *n* `minutes`, where n counts down from 30 to 1.
- `Checking Channel Availability Remaining time` *n* `seconds`, where n counts down from 60 to 1. This indicates that a 30-minute shutdown has expired and the one-minute re-scan that follows is in progress.

DFS can be enabled or disabled on a module’s Radio page: Configuration > Radio > DFS.

Operators in countries with regulatory requirements for DFS must not disable the feature and must ensure it is enabled after a module is reset to factory defaults.

Operators in countries without regulatory requirements for DFS will most likely not want to use the feature, as it adds no value if not required, and adds an additional 1 minute to the connection process for APs, BHMs, and SMs, and 2 minutess for BHSs.

–

> ***RECOMMENDATION:***
> Where regulations require that radar sensing and radio shutdown is enabled, you can most effectively share the spectrum with satellite services if you perform spectrum analysis and select channels that are distributed evenly across the frequency band range.

A connectorized 5.7-GHz module provides an **Antenna Gain** parameter. When you indicate the gain of your antenna in this field, the algorithm calculates the appropriate sensitivity to radar signals, and this reduces the occurrence of false positives (wherever the antenna gain is less than the maximum).

12.3 USING JITTER TO CHECK RECEIVED SIGNAL QUALITY (CANOPY FSK ONLY)

The General Status tab in the Home page of the Canopy SM and BHS displays current values for **Jitter**, which is essentially a measure of interference. Interpret the jitter value as indicated in Table 29.

Table 29: Signal quality levels indicated by jitter

Signal Modulation	Correlation of Highest Seen Jitter to Signal Quality		
	High Quality	**Questionable Quality**	**Poor Quality**
1X operation (2-level FSK)	0 to 4	5 to 14	15
2X operation (4-level FSK)	0 to 9	10 to 14	15

In your lab, an SM whose jitter value is constant at 14 may have an incoming packet efficiency of 100%. However, a deployed SM whose jitter value is 14 is likely to have even higher jitter values as interfering signals fluctuate in strength over time. So, *do not* consider 14 to be acceptable. Avoiding a jitter value of 15 should be the highest priority in establishing a link. At 15, jitter causes fragments to be dropped and link efficiency to suffer.

Canopy modules calculate jitter based on both interference and the modulation scheme. For this reason, values on the low end of the jitter range that are significantly higher in 2X operation can still be indications of a high quality signal. For example, where the amount of interference remains constant, an SM with a jitter value of 3 in 1X operation can display a jitter value of 7 when enabled for 2X operation.

However, on the high end of the jitter range, *do not* consider the higher values in 2X operation to be acceptable. This is because 2X operation is much more susceptible to problems from interference than is 1X. For example, where the amount of interference remains constant, an SM with a jitter value of 6 in 1X operation can display a jitter value of 14 when enabled for 2X operation. As indicated in Table 29, these values are unacceptable.

Canopy OFDM uses a different modulation scheme and does not display a jitter value.

12.4 USING LINK EFFICIENCY TO CHECK RECEIVED SIGNAL QUALITY

A link test, available in the Link Capacity Test tab of the Tools web page in an AP or BH, provides a more reliable indication of received signal quality, particularly if you launch tests of varying duration. However, a link test interrupts traffic and consumes system capacity, so *do not* routinely launch link tests across your networks.

12.4.1 Comparing Efficiency in 1X Operation to Efficiency in 2X Operation

Efficiency of at least 98 to 100% indicates a high quality signal. Check the signal quality numerous times, at various times of day and on various days of the week (as you checked the RF environment a variety of times by spectrum analysis before placing radios in the area). Efficiency less than 90% in 1X operation or less than 60% in 2X operation indicates a link with problems that require action.

12.4.2 When to Switch from 2X to 1X Operation Based on 60% Link Efficiency

In the above latter case (60% in 2X operation), the link experiences worse latency (from packet resends) than it would in 1X operation, but still greater capacity, if the link remains stable at 60% Efficiency. Downlink Efficiency and Uplink Efficiency are measurements produced by running a link test from either the SM or the AP. Examples of what action should be taken based on Efficiency in 2X operation are provided in Table 30.

Table 30: Recommended courses of action based on Efficiency in 2X operation

Module Types	Further Investigation	Result	Recommended Action
Advantage AP with Advantage SM	Check the General Status tab of the Advantage SM.[1] See Checking the Status of 2X Operation on Page 91.	Uplink and downlink are both ≥60% Efficiency.[2]	Rerun link tests.
	Rerun link tests.	Uplink and downlink are both ≥60% Efficiency.	Optionally, re-aim SM, add a reflector, or otherwise mitigate interference. In any case, continue 2X operation up and down.

Module Types	Further Investigation	Result	Recommended Action
Advantage AP with Canopy SM	Check the General Status tab of the Canopy SM.[1] See Checking the Status of 2X Operation on Page 91.	Uplink and downlink are both ≥60% Efficiency.[2]	Rerun link tests.
	Rerun link tests.	Uplink and downlink are both ≥60% Efficiency.	Optionally, re-aim SM, add a reflector, or otherwise mitigate interference. In any case, continue 2X operation up and down.
		Results are inconsistent and range from 20% to 80% Efficiency.	Monitor the Session Status tab in the Advantage AP.
	Monitor the Session Status tab in the Advantage AP.	Link fluctuates between 2X and 1X operation.[3]	Optionally, re-aim SM, add a reflector, or otherwise mitigate interference. Then rerun link tests.
	Rerun link tests.	No substantial improvement with consistency is seen.	On the General tab of the SM, disable 2X operation. Then rerun link tests.
	Rerun link tests.	Uplink and downlink are both ≥90% Efficiency.	Continue 1X operation up and down.

NOTES:

1. Or check Session Status page of the Advantage AP, where a sum of greater than 7,000,000 bps for the up- and downlink indicates 2X operation up and down (for 2.4- or 5.x-GHz modules.
2. For throughput to the SM, this is equivalent to 120% Efficiency in 1X operation, with less capacity used at the AP.
3. This link is problematic.

12.5 CONSIDERING FREQUENCY BAND ALTERNATIVES

For 5.2-, 5.4-, and 5.7-GHz modules, 20-MHz wide channels are centered every 5 MHz. For 2.4-GHz modules, 20-MHz wide channels are centered every 2.5 MHz. For Canopy OFDM, the operator can configure center channel frequencies of the 10 MHz channels with a granularity of 0.5 MHz.This allows the operator to customize the channel layout for interoperability where other Canopy equipment is collocated.

Cross-band deployment of APs and BH is the recommended alternative (for example, a 5.2-GHz AP collocated with 5.7-GHz BH).

> ***IMPORTANT!***
> In all cases, channel center separation between collocated Canopy FSK modules should be at least 20 MHz for 1X operation and 25 MHz for 2X. For Canopy OFDM, channel center separation between collocated modules should be at least XX MHz for 1X operation, XX for 2 X operation, and XX for 3X operation.

12.5.1 900-MHz Channels

900-MHz AP Available Channels

A 900-MHz AP can operate with its 8-MHz wide channel centered on any of the following frequencies:

(All Frequencies in MHz)

906	909	912	915	918	922
907	910	913	916	919	923
908	911	914	917	920	924

900-MHz AP Cluster Recommended Channels

Three non-overlapping channels are recommended for use in a 900-MHz AP cluster:

(All Frequencies in MHz)

906	915	924

This recommendation allows 9 MHz of separation between channel centers. You can use the Spectrum Analysis feature in an SM, or use a standalone spectrum analyzer, to evaluate the RF environment. In any case, ensure that the 8-MHz wide channels you select *do not* overlap.

12.5.2 2.4-GHz Channels

2.4-GHz BHM and AP Available Channels

A 2.4-GHz BHM or AP can operate with its 20-MHz wide channel centered on any of the following channels, which are separated by only 2.5-MHz increments.

(All Frequencies in GHz)

2.4150	2.4275	2.4400	2.4525
2.4175	2.4300	2.4425	2.4550
2.4200	2.4325	2.4450	2.4575
2.4225	2.4350	2.4475	
2.4250	2.4375	2.4500	

The center channels of *adjacent* 2.4-GHz APs should be separated by at least 20 MHz.

2.4-GHz AP Cluster Recommended Channels

Three non-overlapping channels are recommended for use in a 2.4-GHz AP cluster:

(All Frequencies in GHz)

2.4150	2.4350	2.4575

This recommendation allows 20 MHz of separation between one pair of channels and 22.5 MHz between the other pair. You can use the Spectrum Analysis feature in an SM or BHS, or use a standalone spectrum analyzer, to evaluate the RF environment. Where spectrum analysis identifies risk of interference for any of these channels, you can compromise this recommendation as follows:

- Select 2.4375 GHz for the middle channel
- Select 2.455 GHz for the top channel
- Select 2.4175 GHz for the bottom channel

In any case, ensure that your plan allows at least 20 MHz of separation between channels.

12.5.3 5.2-GHz Channels

Channel selections for the AP in the 5.2-GHz frequency band range depend on whether the AP is deployed in cluster.

5.2-GHz BH and Single AP Available Channels

A BH or a single 5.2-GHz AP can operate in the following channels, which are separated by 5-MHz increments.

(All Frequencies in GHz)

5.275	5.290	5.305	5.320
5.280	5.295	5.310	5.325
5.285	5.300	5.315	

The center channels of *adjacent* APs should be separated by at least 20 MHz. However, 25 MHz of separation is advised, especially for Advantage APs to take advantage of 2X operation.

5.2-GHz AP Cluster Recommended Channels

Three non-overlapping channels are recommended for use in a 5.2-GHz AP cluster:

(All Frequencies in GHz)

5.275	5.300	5.325

12.5.4 5.4-GHz Channels

Channel selections for the AP in the 5.4-GHz frequency band range depend on whether the AP is deployed in cluster.

5.4-GHz BH and Single AP Available

A BH or single 5.4-GHz AP can operate in the following channels, which are separated by 5-MHz.

(All Frequencies in GHz)

5495	5515	5535	5555	5575	5595	5615	5635	5655	5675	5695
5500	5520	5540	5560	5580	5600	5620	5640	5660	5680	5700
5505	5525	5545	5565	5585	5605	5625	5645	5665	5685	5705
5510	5530	5550	5570	5590	5610	5630	5650	5670	5690	

The channels of *adjacent* APs should be separated by at least 20 MHz, especially for Advantage APs to take advantage of 2X operation.

5.4-GHz AP Cluster Recommended Channels

The fully populated cluster requires only three channels, each reused by the module that is mounted 180° opposed. In this frequency band range, the possible sets of three non-overlapping channels are numerous. As many as 11 non-overlapping 20-MHz wide channels are available for 1X operation. Fewer 25-MHz wide channels are available for 2X operation, where this greater separation is recommended for interference avoidance.

5.4-GHz AP Cluster Limit Case

In the limit, the 11 channels could support all of the following, vertically stacked on the same mast:

- 3 full clusters, each cluster using 3 channels
- a set of 4 APs, the set using the 2 channels that no AP in any of the 3 full clusters is using

IMPORTANT!
Where regulations require you to have Dynamic Frequency Selection (DFS) enabled, analyze the spectrum, then spread your channel selections as evenly as possible throughout this frequency band range, appropriately sharing it with satellite services.

12.5.5 5.4-GHz OFDM Channels

Channel selections for the Canopy OFDM AP in the 5.4-GHz frequency band range depend on whether the AP is deployed in cluster.

5.4-GHz BH and Single AP Available

OFDM modules are configured by the operator for channels, using the Configuration => Custom Frequencies page.

The channels of *adjacent* APs should be separated by at least XX MHz, especially for APs to take advantage of 3X operation.

5.4-GHz AP Cluster Recommended Channels

The fully populated cluster may be configured for two or four channels. If configured for two channels, each channel is reused by the module that is mounted 180° opposed.

The modules are pre-configured with channels which can be used as a starting point for selecting the two or four for use in a full 4 AP cluster.

12.5.6 5.7-GHz Channels

Channel selections for the AP in the 5.7-GHz frequency band range depend on whether the AP is deployed in cluster.

5.7-GHz BH and Single AP Available Channels

A BH or a single 5.7-GHz AP enabled for frequencies can operate in the following channels, which are separated by 5-MHz increments.

(All Frequencies in GHz)

5.735	5.765	5.795	5.825
5.740	5.770	5.800	5.830
5.745	5.775	5.805	5.835
5.750	5.780	5.810	5.840
5.755	5.785	5.815	
5.760	5.790	5.820	

The channels of *adjacent* APs should be separated by at least 20 MHz. However, 25 MHz of separation is advised, especially for Advantage APs to take advantage of 2X operation.

5.7-GHz AP Cluster Recommended Channels

Six non-overlapping channels are recommended for use in 5.7-GHz AP clusters:

(All Frequencies in GHz)		
5.735	5.775	5.815
5.755	5.795	5.835

The fully populated cluster requires only three channels, each reused by the module that is mounted 180° offset. The six channels above are also used for backhaul point-to-point links.

As noted above, a 5.7-GHz AP can operate on a frequency as high as 5.840 GHz. Where engineering plans allow, this frequency can be used to provide an additional 5-MHz separation between AP and BH channels.

12.5.7 Channels Available for PTP 400 and PTP 600 radios

Channel selections for radios in the PTP400 and PTP 600 series are quoted in the user guides that are dedicated to those products. However, these units dynamically change channels when the signal substantially degrades. Since the available channels are in the 5.4- and 5.7-GHz frequency band ranges, carefully consider the potential effects of deploying these products into an environment where traffic in this range pre-exists.

12.5.8 Example Channel Plans for AP Clusters

Examples for assignment of frequency channels and sector IDs are provided in the following tables. Each frequency is reused on the sector that is at a 180**°** offset. The entry in the Symbol column of each table refers to the layout in Figure 32 on Page 142.

NOTE:
The operator specifies the sector ID for the module as described under Sector ID on Page 437.

Table 31: Example 900-MHz channel assignment by sector

Direction of Access Point Sector	Frequency	Sector ID	Symbol
North (0°)	906 MHz	0	A
Northeast (60°)	915 MHz	1	B
Southeast (120°)	924 MHz	2	C
South (180°)	906 MHz	3	A
Southwest (240°)	915 MHz	4	B
Northwest (300°)	924 MHz	5	C

Table 32: Example 2.4-GHz channel assignment by sector

Direction of Access Point Sector	Frequency	Sector ID	Symbol
North (0°)	2.4150 GHz	0	A
Northeast (60°)	2.4350 GHz	1	B
Southeast (120°)	2.4575 GHz	2	C
South (180°)	2.4150 GHz	3	A
Southwest (240°)	2.4350 GHz	4	B
Northwest (300°)	2.4575 GHz	5	C

Table 33: Example 5.2-GHz channel assignment by sector

Direction of Access Point Sector	Frequency	Sector ID	Symbol
North (0°)	5.275 GHz	0	A
Northeast (60°)	5.300 GHz	1	B
Southeast (120°)	5.325 GHz	2	C
South (180°)	5.275 GHz	3	A
Southwest (240°)	5.300 GHz	4	B
Northwest (300°)	5.325 GHz	5	C

Table 34: Example 5.4-GHz channel assignment by sector

Direction of Access Point Sector	Frequency	Sector ID	Symbol
North (0°)	5.580 GHz	0	A
Northeast (60°)	5.620 GHz	1	B
Southeast (120°)	5.660 GHz	2	C
South (180°)	5.580 GHz	3	A
Southwest (240°)	5.620 GHz	4	B
Northwest (300°)	5.660 GHz	5	C

Table 35: Example 5.7-GHz channel assignment by sector

Direction of Access Point Sector	Frequency	Sector ID	Symbol
North (0°)	5.735 GHz	0	A
Northeast (60°)	5.755 GHz	1	B
Southeast (120°)	5.775 GHz	2	C
South (180°)	5.735 GHz	3	A
Southwest (240°)	5.755 GHz	4	B
Northwest (300°)	5.775 GHz	5	C

12.5.9 Multiple Access Points Clusters

When deploying multiple AP clusters in a dense area, consider aligning the clusters as shown in Figure 32. However, this is only a recommendation. An installation may dictate a different pattern of channel assignments.

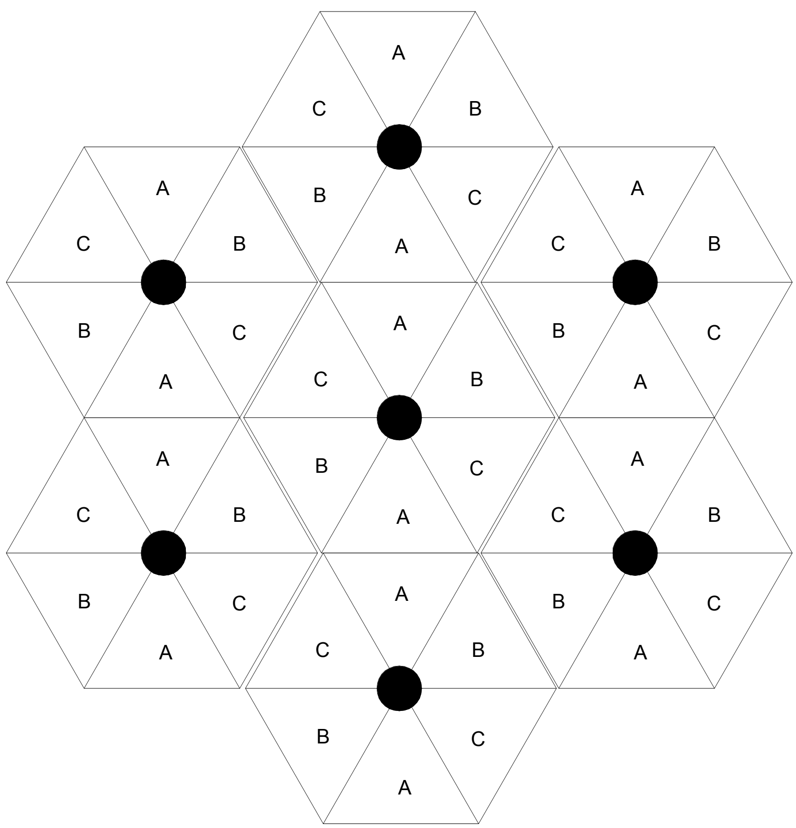


Figure 32: Example layout of 7 Access Point clusters

12.6 SELECTING SITES FOR NETWORK ELEMENTS

The Canopy APs must be positioned

- with hardware that the wind and ambient vibrations cannot flex or move.
- where a tower or rooftop is available or can be erected.
- where a grounding system is available.
- with lightning arrestors to transport lightning strikes away from equipment.
- at a proper height:
  - higher than the tallest points of objects immediately around them (such as trees, buildings, and tower legs).
  - at least 2 feet (0.6 meters) below the tallest point on the tower, pole, or roof (for lightning protection).
- away from high-RF energy sites (such as AM or FM stations, high-powered antennas, and live AM radio towers).
- in line-of-sight paths
  - to the SMs and BH.
  - that will not be obstructed by trees as they grow or structures that are later built.

> ***NOTE:***
> Visual line of sight does not guarantee radio line of sight.

12.6.1 Resources for Maps and Topographic Images

Mapping software is available from sources such as the following:

- http://www.microsoft.com/streets/default.asp
  - Microsoft Streets & Trips (with Pocket Streets)
- http://www.delorme.com/software.htm
  - DeLorme Street Atlas USA
  - DeLorme Street Atlas USA Plus
  - DeLorme Street Atlas Handheld

Topographic maps are available from sources such as the following:

- http://www.delorme.com/software.htm
  - DeLorme Topo USA
  - DeLorme 3-D TopoQuads
- http://www.usgstopomaps.com
  - Timely Discount Topos, Inc. authorized maps

Topographic maps with waypoints are available from sources such as the following:

- http://www.topografix.com
  - TopoGrafix EasyGPS
  - TopoGrafix Panterra

  – TopoGrafix ExpertGPS

Topographic images are available from sources such as the following:

- http://www.keyhole.com/body.php?h=products&t=keyholePro
  – keyhole PRO
- http://www.digitalglobe.com
  – various imagery

12.6.2 Surveying Sites

Factors to survey at potential sites include

- what pre-existing wireless equipment exists at the site. (Perform spectrum analysis.)
- whether available mounting positions exist near the lowest elevation that satisfies line of site, coverage, and other link criteria.
- whether you will always have the right to decide who climbs the tower to install and maintain your equipment, and whether that person or company can climb at any hour of any day.
- whether you will have collaborative rights and veto power to prevent interference to your equipment from wireless equipment that is installed at the site in the future.
- whether a pre-existing grounding system (path to Protective Earth ⏚) exists, and what is required to establish a path to it.
- who is permitted to run any indoor lengths of cable.

12.6.3 Assuring the Essentials

In the 2.4-, 5.2-, 5.4-, and 5.7-GHz frequency band ranges, an unobstructed line of sight (LOS) must exist and be maintainable between the radios that are involved in each link.

Line of Sight (LOS) Link

In these ranges, a line of sight link is both

- an unobstructed straight line from radio to radio.
- an unobstructed zone surrounding that straight line.

Fresnel Zone Clearance

An unobstructed line of sight is important, but is not the *only* determinant of adequate placement. Even where the path has a clear line of sight, obstructions such as terrain, vegetation, metal roofs, or cars may penetrate the Fresnel zone and cause signal loss. Figure 33 illustrates an ideal Fresnel zone.

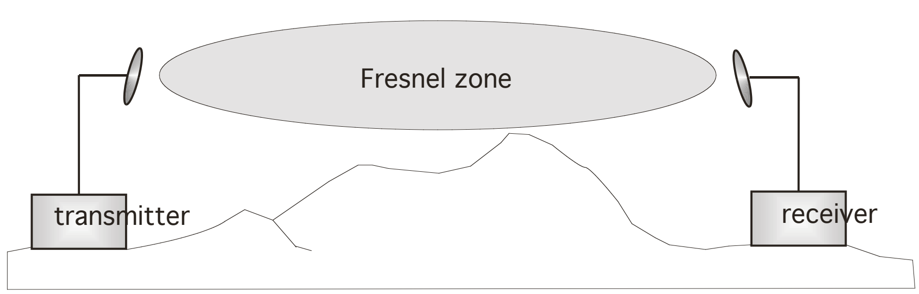


Figure 33: Fresnel zone

FresnelZoneCalcPage.xls calculates the Fresnel zone clearance that is required between the visual line of sight and the top of an obstruction that would protrude into the link path.

Non-Line of Sight (NLOS) Link

The Canopy 900-MHz modules have a line of sight (LOS) range of 40 miles (more than 64 km) and greater non-line of sight (NLOS) range than Canopy modules of other frequency bands. NLOS range depends on RF considerations such as foliage, topography, obstructions.

12.6.4 Finding the Expected Coverage Area

The transmitted beam in the vertical dimension covers more area beyond than in front of the beam center. BeamwidthRadiiCalcPage.xls calculates the radii of the beam coverage area.

12.6.5 Clearing the Radio Horizon

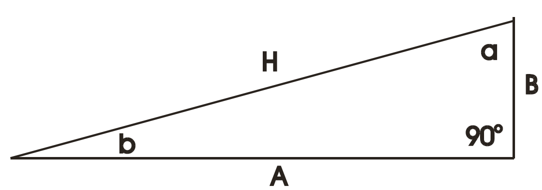
Because the surface of the earth is curved, higher module elevations are required for greater link distances. This effect can be critical to link connectivity in link spans that are greater than 8 miles (12 km). AntennaElevationCalcPage.xls calculates the minimum antenna elevation for these cases, presuming no landscape elevation difference from one end of the link to the other.

12.6.6 Calculating the Aim Angles

The appropriate angle of AP downward tilt is derived from both the distance between transmitter and receiver and the difference in their elevations. DowntiltCalcPage.xls calculates this angle.

The proper angle of tilt can be calculated as a factor of both the difference in elevation and the distance that the link spans. Even in this case, a plumb line and a protractor can be helpful to ensure the proper tilt. This tilt is typically minimal.

The number of degrees to offset (from vertical) the mounting hardware leg of the support tube is equal to the angle of elevation from the lower module to the higher module (<B in the example provided in Figure 34).



LEGEND

b	**Angle of elevation.**
B	**Vertical difference in elevation.**
A	**Horizontal distance between modules.**

Figure 34: Variables for calculating angle of elevation (and depression)

Calculating the Angle of Elevation

To use metric units to find the angle of elevation, use the following formula:

$$\tan b = \frac{B}{1000A}$$

where
B is expressed in meters
A is expressed in kilometers.

To use English standard units to find the angle of elevation, use the following formula:

$$\tan b = \frac{B}{5280A}$$

where
B is expressed in feet
A is expressed in miles.

The angle of depression from the higher module is identical to the angle of elevation from the lower module.

12.7 COLLOCATING CANOPY MODULES

A BH and an AP or AP cluster on the same tower require a CMM. The CMM properly synchronizes the *transmit start* times of all Canopy modules to prevent interference and desensing of the modules. At closer distances without sync from a CMM, the frame structures cause self interference.

Furthermore, a BH and an AP on the same tower require that the effects of their differing *receive start* times be mitigated by either

- 100 vertical feet (30 meters) or more and as much spectral separation as possible within the same frequency band range.
- the use of the frame calculator to tune the **Downlink Data** parameter in each, so that the receive start time in each is the same. See Using the Frame Calculator Tool (All) on Page 438.

Canopy APs and a BHS can be collocated at the same site only if they operate in different frequency band ranges.

Where a single BH air link is insufficient to cover the distance from an AP cluster to your point of presence (POP), you can deploy two BHSs, connected to one another by Ethernet, on a tower that is between a BHM collocated with the AP cluster and another BHM collocated with the POP. This deployment is illustrated in Figure 35.

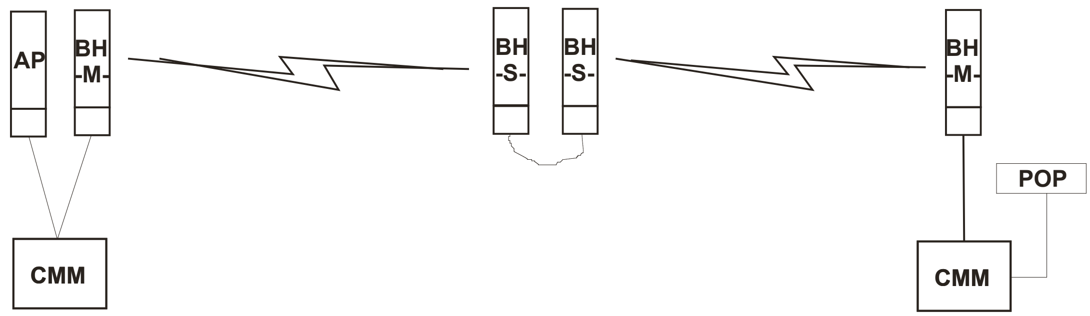


Figure 35: Double-hop backhaul links

However, the BHSs can be collocated at the same site *only if* one is on a different frequency band range from that of the other or one of the following conditions applies:

- They are vertically separated on a structure by at least 100 feet (30 m).
- They are vertically separated on a structure by less distance, but either
  - an RF shield isolates them from each other.
  - the uplink and downlink data parameters and control channels match (the **Downlink Data** parameter is set to **50%**).

The constraints for collocated modules in the same frequency band range are to avoid self-interference that would occur between them. Specifically, unless the uplink and downlink data percentages match, intervals exist when one is transmitting while the other is receiving, such that the receiving module cannot receive the signal from the far end.

The interference is less a problem during low throughput periods and intolerable during high. Typically, during low throughput periods, sufficient time exists for the far end to retransmit packets lost because of interference from the collocated module.

12.8 DEPLOYING A REMOTE AP

In cases where the subscriber population is widely distributed, or conditions such as geography restrict network deployment, you can add a Remote AP to

- provide high-throughput service to near LoS business subscribers.
- reach around obstructions or penetrate foliage with non-LoS throughput.
- reach new, especially widely distributed, residential subscribers with broadband service.
- pass sync to an additional RF hop.

In the remote AP configuration, a Canopy AP is collocated with a Canopy SM. The remote AP distributes the signal over the last mile to SMs that are logically behind the collocated SM. A remote AP deployment is illustrated in Figure 36.

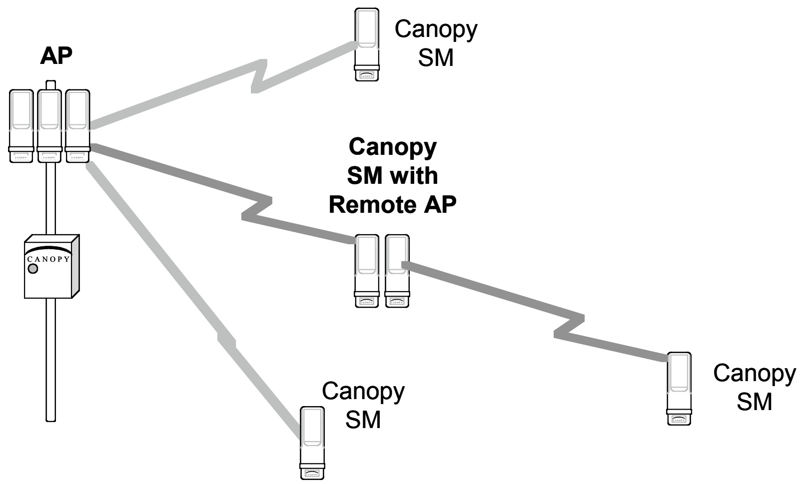


Figure 36: Remote AP deployment

The collocated SM receives data in one frequency band, and the remote AP must redistribute the data in a different frequency band. Base your selection of frequency band ranges on regulatory restrictions, environmental conditions, and throughput requirements.

> ***IMPORTANT!***
> Each relay hop (additional daisy-chained remote AP) adds latency to the link as follows:
> - approximately 6 msec where hardware scheduling is enabled.
> - approximately 15 msec where software scheduling is enabled.

12.8.1 Remote AP Performance

The performance of a remote AP is identical to the AP performance in cluster. Throughputs, ranges, and patch antenna coverage are identical. Canopy Advantage and Canopy modules can be deployed in tandem in the same sector to meet customer bandwidth demands.

As with all equipment operating in the unlicensed spectrum, Motorola *strongly* recommends that you perform site surveys before you add network elements. These will indicate that spectrum is available in the area where you want to grow. Keep in mind that

- non-LoS ranges heavily depend on environmental conditions.
- in most regions, not all frequencies are available.
- your deployments must be consistent with local regulatory restrictions.

12.8.2 Example Use Case for RF Obstructions

A remote AP can be used to provide last-mile access to a community where RF obstructions prevent SMs from communicating with the higher-level AP in cluster. For example, you may be able to use 900 MHz for the last mile between a remote AP and the outlying SMs where these subscribers cannot form good links to a higher-level 2.4-GHz AP. In this case, the short range of the 900-MHz remote AP is sufficient, and the ability of the 900-MHz wavelength to be effective around foliage at short range solves the foliage penetration problem.

An example of this use case is shown in Figure 37.

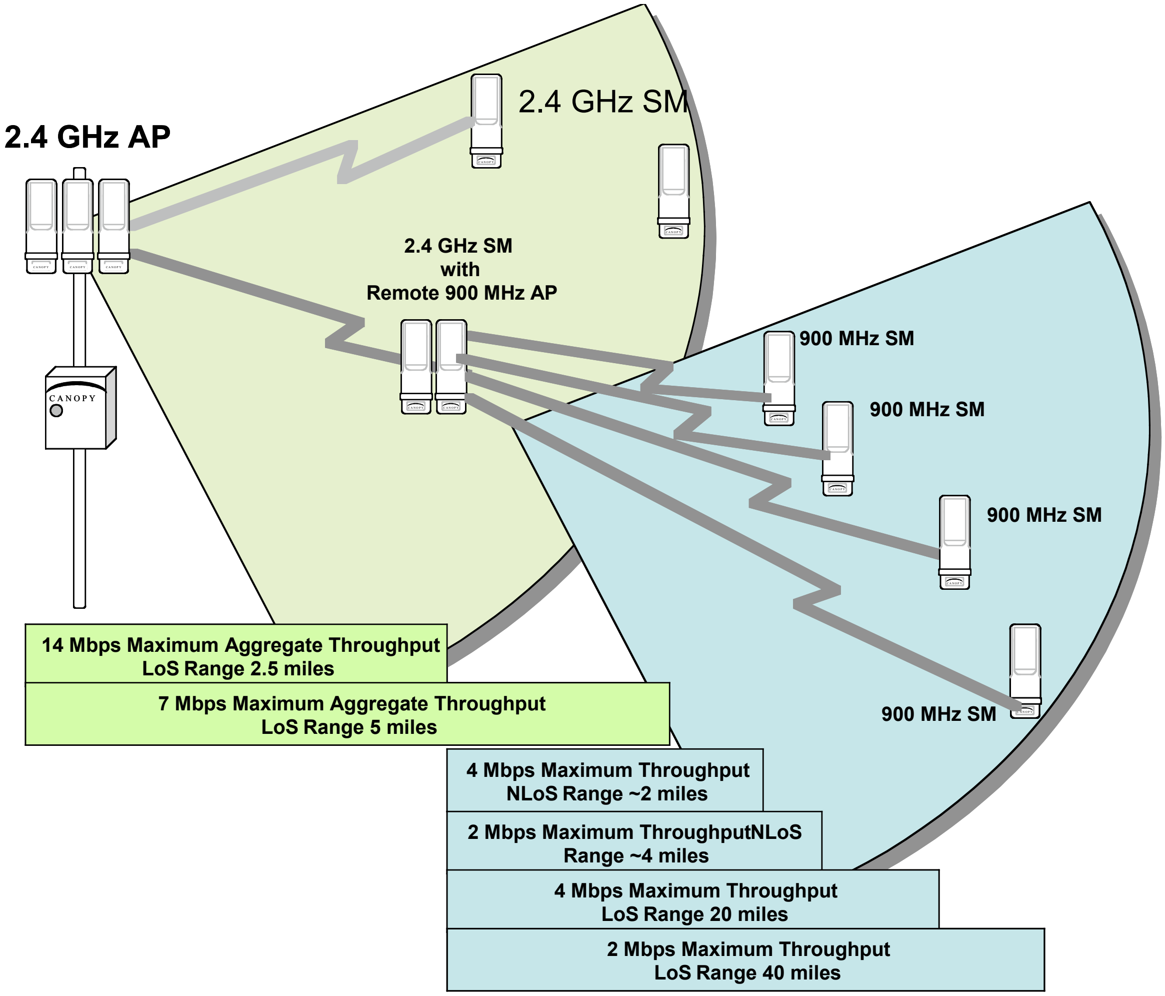


Figure 37: Example 900-MHz remote AP behind 2.4-GHz SM

The 2.4 GHz modules provide a sustained aggregate throughput of up to 14 Mbps to the sector. One of the SMs in the sector is wired to a 900-MHz remote AP, which provides NLoS sustained aggregate throughput[4] of

- 4 Mbps to 900-MHz SMs up to 2 miles away in the sector.
- 2 Mbps to 900-MHz SMs between 2 and 4 miles away in the sector.

12.8.3 Example Use Case for Passing Sync

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. Examples of passing

[4] NLoS ranges depend on environmental conditions. Your results may vary from these.

sync over cable are shown under Passing Sync in an Additional Hop on Page 95. The sync cable is described under Cables on Page 57.

The sync is passed in a cable that connects Pins 1 and 6 of the RJ-11 timing ports of the two modules. 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.

Perform Procedure 35: Extending network sync on Page 367.

12.8.4 Physical Connections Involving the Remote AP

The SM to which you wire a remote AP can be either an SM that serves a customer or an SM that simply serves as a relay. Where the SM serves a customer, wire the remote AP to the SM as shown in Figure 38.

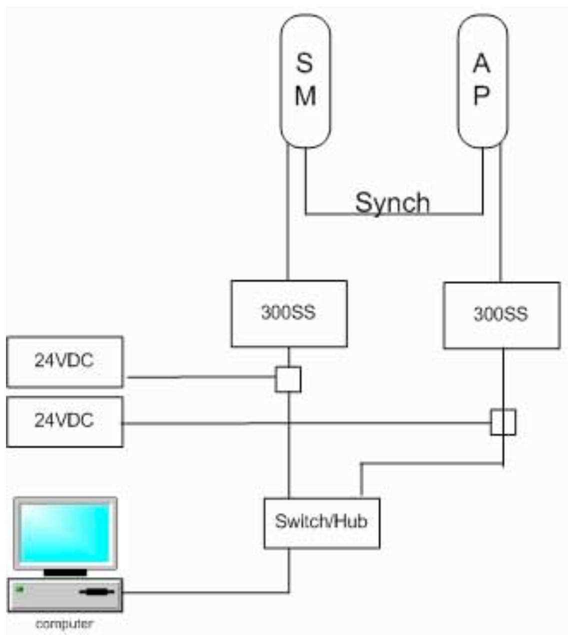


Figure 38: Remote AP wired to SM that also serves a customer

Where the SM simply serves as a relay, you must use a straight-through RJ-45 female-to-female coupler, and wire the SM to the remote AP as shown in Figure 39.

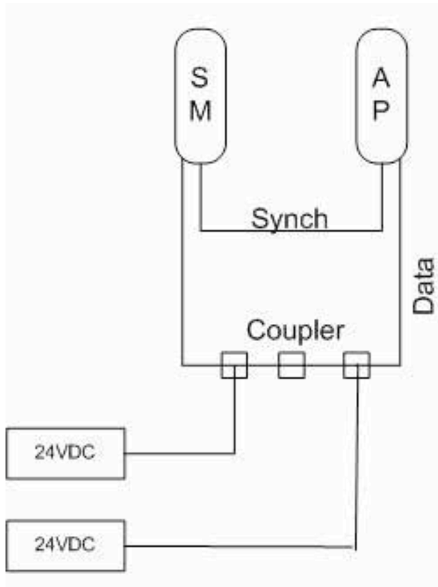


Figure 39: Remote AP wired to SM that serves as a relay

12.9 DIAGRAMMING NETWORK LAYOUTS

12.9.1 Accounting for Link Ranges and Data Handling Requirements

For aggregate throughput correlation to link distance in both point-to-multipoint and point-to-point links, see

- Link Performance and Encryption Comparisons on Page 61.
- all regulations that apply in your region and nation(s).

12.9.2 Avoiding Self Interference

For 5.2-, 5.4-, and 5.7-GHz modules, 20-MHz wide channels are centered every 5 MHz. For 2.4-GHz modules, 20-MHz wide channels are centered every 2.5 MHz. For 5.4-GHz OFDM modules, 10-MHz wide channels can be centered every 0.5 MHz. This allows you to customize the channel layout for interoperability where other Canopy equipment is collocated, as well as select channels with the least background interference level.

> ***CAUTION!***
> Regardless of whether 2.4-, 5.2-, 5.4-, or 5.7-GHz modules are deployed, channel separation between modules should be at least 20 MHz for 1X operation or 25 MHz for 2X.

Physical Proximity

A BH and an AP on the same tower require a CMM. The CMM properly synchronizes the *transmit start* times of all Canopy modules to prevent interference and desensing of the modules. At closer distances without sync from a CMM, the frame structures cause self interference.

Furthermore, a BH and an AP on the same tower require that the effects of their differing *receive start* times be mitigated by either

- 100 vertical feet (30 meters) or more and as much spectral separation as possible within the same frequency band range.
- the use of the frame calculator to tune the Downlink Data % parameter in each, so that the receive start time in each is the same. See Using the Frame Calculator Tool (All) on Page 438.

Spectrum Analysis (Not available on Canopy OFDM modules)

You can use an SM or BHS as a spectrum analyzer. See Mapping RF Neighbor Frequencies on Page 131. Through a toggle of the **Device Type** parameter, you can temporarily transform an AP into an SM to use it as a spectrum analyzer.

Power Reduction to Mitigate Interference

Where any module (SM, AP, BH timing master, or BH timing slave) is close enough to another module that self-interference is possible, you can set the SM to operate at less than full power. To do so, perform the following steps.

> ***CAUTION!***
> Too low a setting of the **Transmitter Output Power** parameter can cause a link to a distant module to drop. A link that drops for this reason requires Ethernet access to the GUI to re-establish the link.

Procedure 3: Reducing transmitter output power

1. Access the Radio tab of the module.
2. In the **Transmitter Output Power** parameter, reduce the setting.
3. Click **Save Changes**.
4. Click **Reboot**.
5. Access the Session Status tab in the Home web page of the SM.
6. Assess whether the link achieves good **Power Level** and **Jitter** values.
   NOTE: The received **Power Level** is shown in dBm and should be maximized. **Jitter** should be minimized. However, better/lower jitter should be favored over better/higher dBm. For historical reasons, **RSSI** is also shown and is the unitless measure of power. The best practice is to use **Power Level** and ignore **RSSI**, which implies more accuracy and precision than is inherent in its measurement.
7. Access the Link Capacity Test tab in the Tools web page of the module.
8. Assess whether the desired links for this module achieve
   - uplink efficiency greater than 90%.
   - downlink efficiency greater than 90%.
9. If the desired links fail to achieve any of the above measurement thresholds, then
   a. access the module by direct Ethernet connection.
   b. access the Radio tab in the Configuration web page of the module.
   c. in the **Transmitter Output Power** parameter, increase the setting.

d. click **Save Changes**.

e. click **Reboot**.

============================ **end of procedure** =======================

12.9.3 Avoiding Other Interference

Where signal strength cannot dominate noise levels, the network experiences

- bit error corrections.
- packet errors and retransmissions.
- lower throughput (because bandwidth is consumed by retransmissions) and high latency (due to resends).

Be especially cognitive of these symptoms for 900-MHz links. Where you see these symptoms, attempt the following remedies:

- Adjust the position of the SM.
- Deploy a band-pass filter at the AP.
- Consider adding a remote AP closer to the affected SMs. (See Deploying a Remote AP on Page 147.)

Certain other actions, which may seem to be potential remedies, *do not* resolve high noise level problems:

- *Do not* deploy an omnidirectional antenna.
- *Do not* set the antenna gain above the regulated level.
- *Do not* deploy a band-pass filter in the expectation that this can mitigate co-channel interference.

13 ENGINEERING YOUR IP COMMUNICATIONS

13.1 UNDERSTANDING ADDRESSES

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

13.1.1 IP Address

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

13.2 DYNAMIC OR STATIC ADDRESSING

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

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

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

13.2.1 When a DHCP Server is Not Found

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

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

13.3 NETWORK ADDRESS TRANSLATION (NAT)

13.3.1 NAT, DHCP Server, DHCP Client, and DMZ in SM

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

- NAT Disabled (as in earlier releases)
- NAT with DHCP Client and DHCP Server
- NAT with DHCP Client
- NAT with DHCP Server
- NAT without DHCP

NAT

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

In the Canopy system, NAT supports many protocols, including HTTP, ICMP (Internet Control Message Protocols), and FTP (File Transfer Protocol). For virtual private network (VPN) implementation, L2TP over IPSec (Level 2 Tunneling Protocol over IP Security) is supported, but PPTP (Point to Point Tunneling Protocol) *is not* supported. See NAT and VPNs on Page 161.

DHCP

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

In conjunction with the NAT features, each SM provides

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

DMZ

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

NAT Disabled

The NAT Disabled implementation is illustrated in Figure 40.

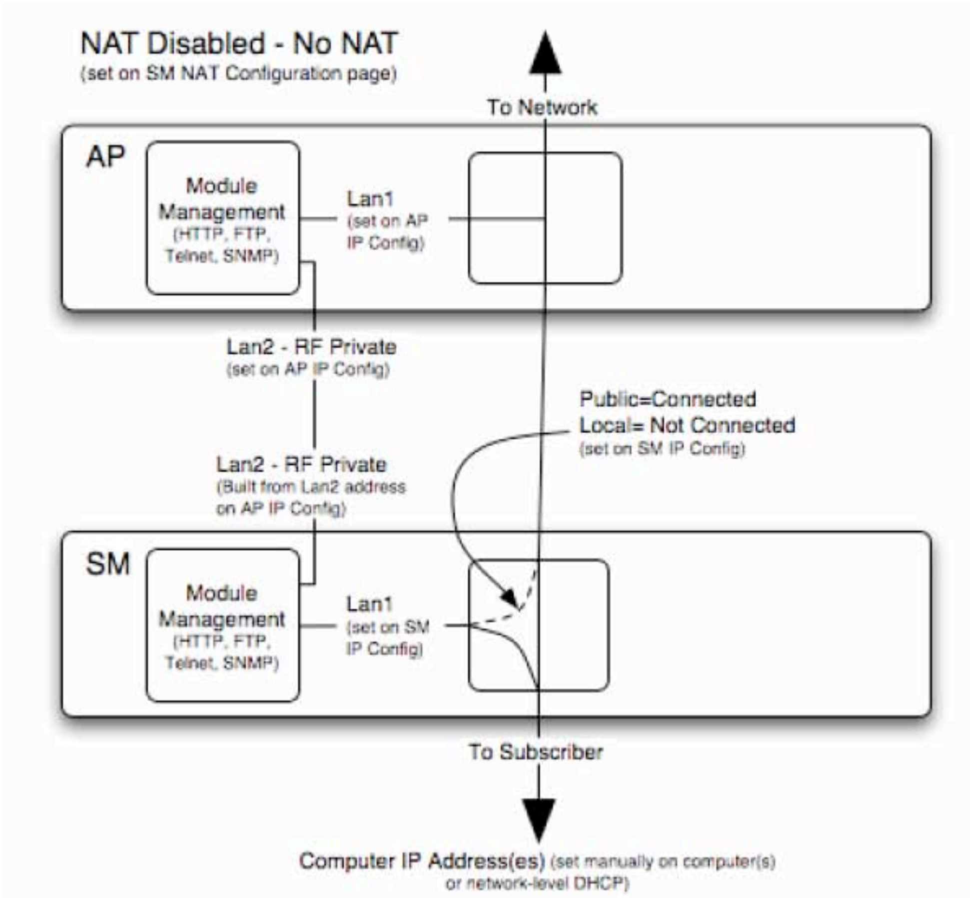


Figure 40: NAT Disabled implementation

NAT with DHCP Client and DHCP Server

The NAT with DHCP Client and DHCP Server implementation is illustrated in Figure 41.

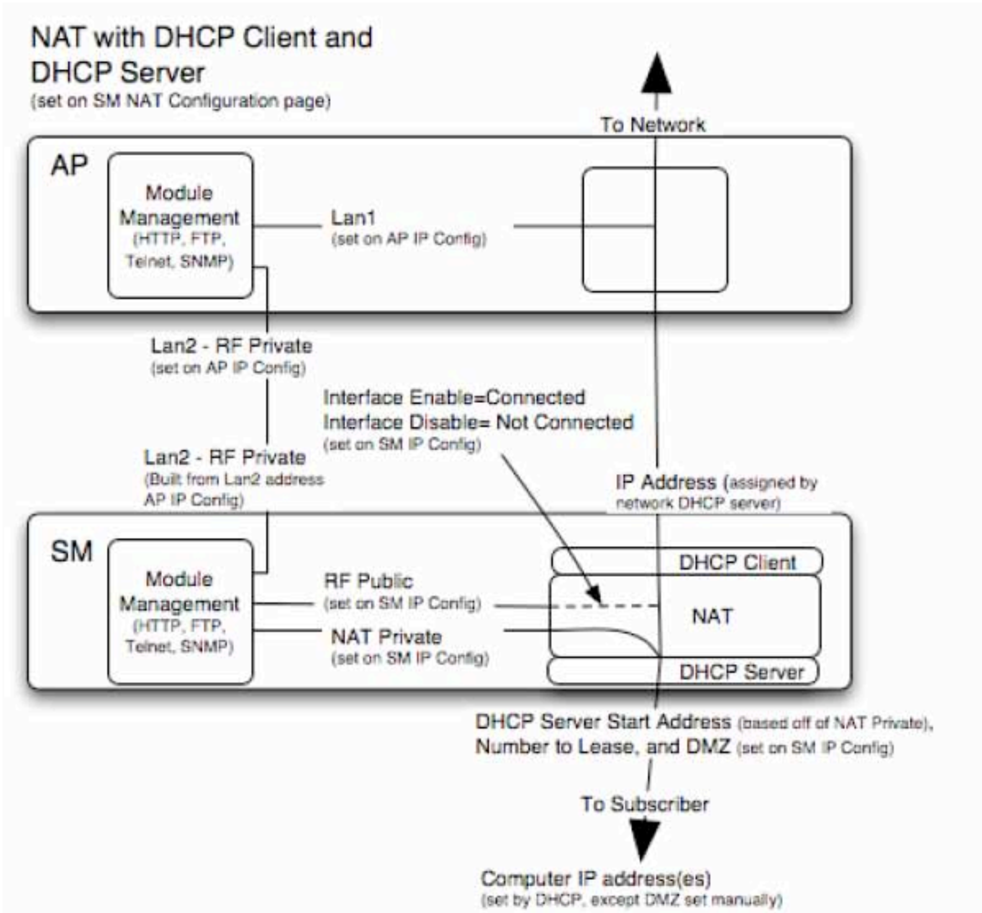


Figure 41: NAT with DHCP Client and DHCP Server implementation

NAT with DHCP Client

The NAT with DHCP Client implementation is illustrated in Figure 42.

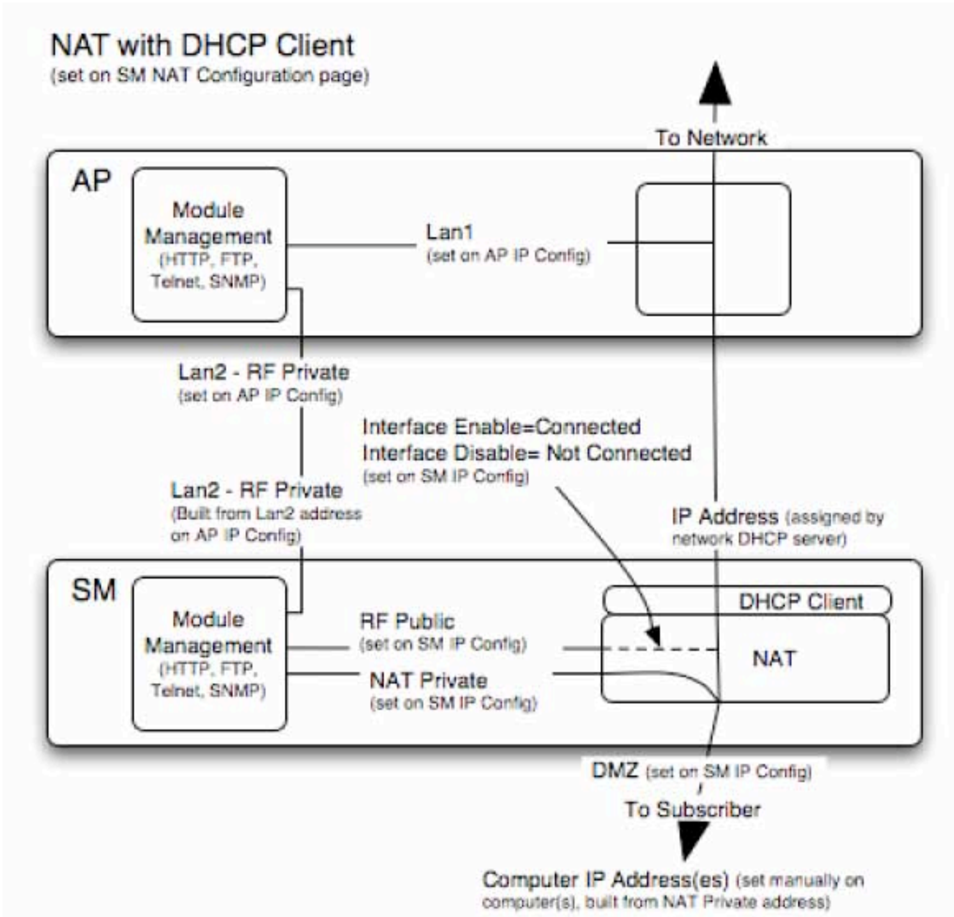


Figure 42: NAT with DHCP Client implementation

NAT with DHCP Server

The NAT with DHCP Server implementation is illustrated in Figure 43.

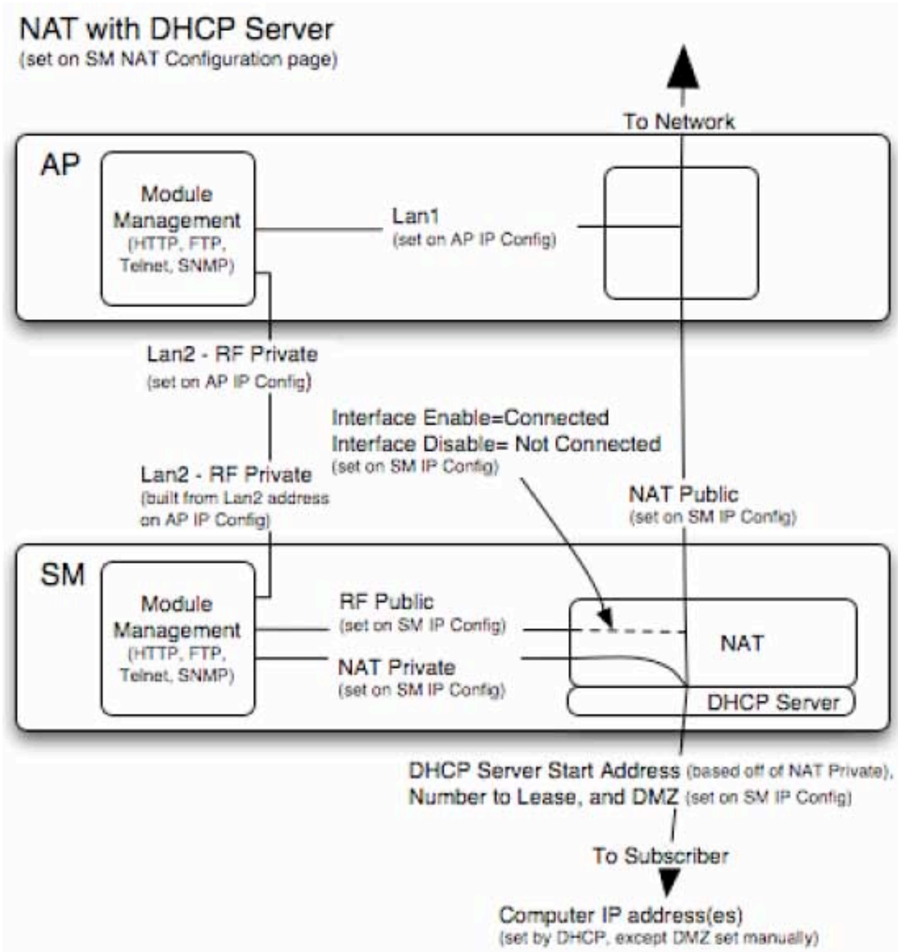


Figure 43: NAT with DHCP Server implementation

NAT without DHCP

The NAT without DHCP implementation is illustrated in Figure 44.

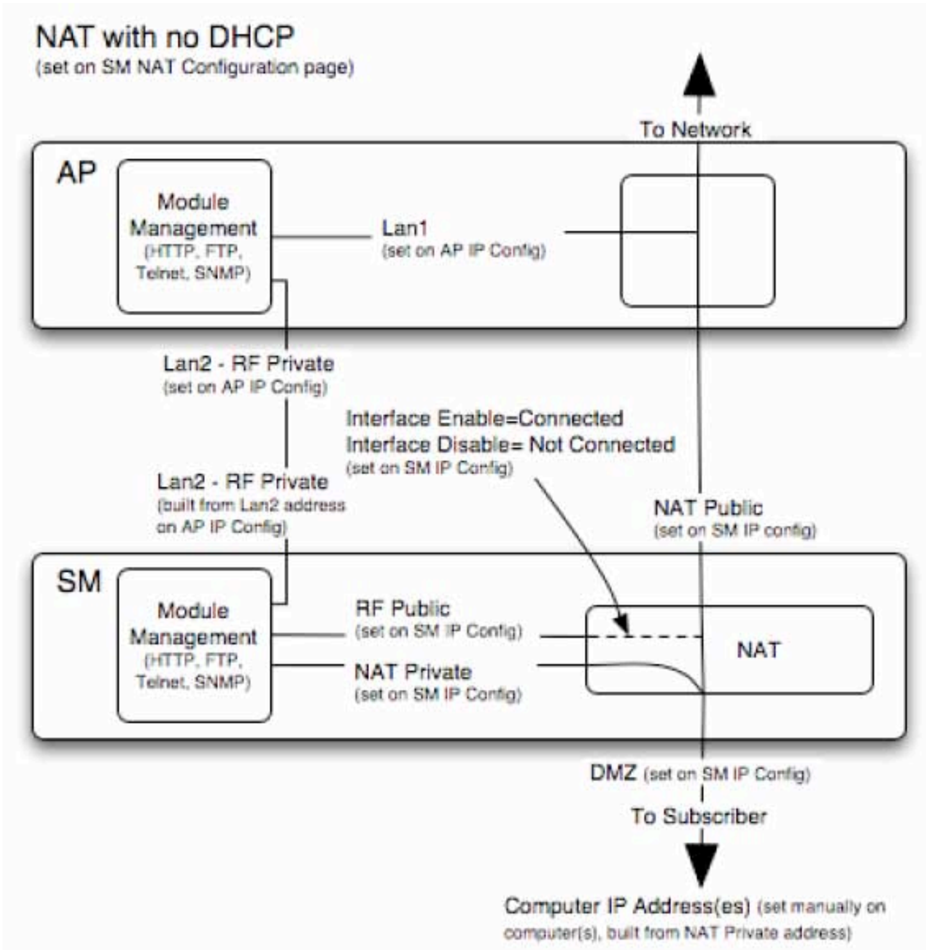


Figure 44: NAT without DHCP implementation

13.3.2 NAT and VPNs

VPN technology provides the benefits of a private network during communication over a public network. One typical use of a VPN is to connect remote employees, who are at home or in a different city, to their corporate network over the public Internet. Any of several VPN implementation schemes is possible. By design, NAT translates or changes addresses, and thus interferes with a VPN that is not specifically supported by a given NAT implementation.

With NAT enabled, SMs support L2TP over IPSec (Level 2 Tunneling Protocol over IP Security) VPNs, but *do not* support PPTP (Point to Point Tunneling Protocol) VPNs. With NAT disabled, SMs support all types of VPNs.

13.4 DEVELOPING AN IP ADDRESSING SCHEME

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

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

- assign an unroutable IP address.
- assign a routable IP address only if a firewall is present to protect the module.

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

13.4.1 Address Resolution Protocol

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

- communications between modules.
- the data that modules store about each other.
- the data that BAM or Prizm applies to manage authentication and bandwidth.

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

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

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

13.4.2 Allocating Subnets

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

Example IP Address and Subnet Mask

In Figure 45, the first 16 bits of the 32-bit IP address identify the network:

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

Figure 45: Example of IP address in Class B subnet

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

13.4.3 Selecting Non-routable IP Addresses

The factory default assignments for Canopy network elements are

- unique MAC address
- IP address of 169.254.1.1, except for an OFDM series BHM, whose IP address is 169.254.1.2 by default
- subnet mask of 255.255.0.0

- network gateway address of 169.254.0.0

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

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

You can also assign a subnet mask and network gateway for each CMMmicro.

14 ENGINEERING VLANS

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

- the following protocols:
  - Generic Attribute Registration Protocol (GARP) GARV
  - Spanning Tree Protocol (STP)
  - Multiple Spanning Tree Protocol (MSTP)
  - GARP Multicast Registration Protocol (GMRP)
- priority encoding (802.1P) before Release 7.0
- embedded source routing (ERIF) in the 802.1Q header
- multicast pruning
- flooding unknown unicast frames in the downlink

As an additional exception, the Canopy AP *does not* flood downward the unknown unicast frames to the Canopy SM.

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

14.1 SM MEMBERSHIP IN VLANS

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

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

Canopy point-to-multipoint modules provide the VLAN frame filters that are described in Table 36.

Table 36: VLAN filters in point-to-multipoint modules

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

14.2 PRIORITY ON VLANS (802.1p)

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

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

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

For more information on the Canopy high priority channel, see High-priority Bandwidth on Page 86.

INSTALLATION AND CONFIGURATION GUIDE

15 AVOIDING HAZARDS

Use simple precautions to protect staff and equipment. Hazards include exposure to RF waves, lightning strikes, and power surges. This section specifically recommends actions to abate these hazards.

15.1 EXPOSURE SEPARATION DISTANCES

To protect from overexposure to RF energy, install Canopy radios so as to provide and maintain the minimum separation distances from all persons shown in Table 37.

Table 37: Exposure separation distances

Module Type	Separation Distance from Persons
Canopy Module, FSK or OFDM	At least 20 cm (approx 8 in)
Canopy Module with Reflector Dish	At least 1.5 m (approx 60 in or 5 ft)
Canopy Module with LENS	At least 0.5 m (approx 20 in)
Antenna of connectorized 5.7 GHz AP	At least 30 cm (approx 12 in)
Antenna of connectorized or integrated 900 MHz module	At least 60 sm (24 in)
Indoor 900 MHz SM	At least 10 cm (4 in)

Section 15.1.1 and Table 38 give details and discussion of the associated calculations.

15.1.1 Details of Exposure Separation Distances Calculations and Power Compliance Margins

Limits and guidelines for RF exposure come from:

- US FCC limits for the general population. See the FCC web site at http://www.fcc.gov, and the policies, guidelines, and requirements in Part 1 of Title 47 of the Code of Federal Regulations, as well as the guidelines and suggestions for evaluating compliance in FCC OET Bulletin 65.
- Health Canada limits for the general population. See the Health Canada web site at http://www.hc-sc.gc.ca/rpb and Safety Code 6.
- ICNIRP (International Commission on Non-Ionizing Radiation Protection) guidelines for the general public. See the ICNIRP web site at http://www.icnirp.de/ and Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic, and Electromagnetic Fields.

The applicable power density exposure limits from the documents referenced above are

- 6 W/m^2 for RF energy in the 900-MHz frequency band in the US and Canada.
- 10 W/m^2 for RF energy in the 2.4-, 5.2-, 5.4-, and 5.7-GHz frequency bands.

Peak power density in the far field of a radio frequency point source is calculated as follows:

$$S = \frac{P \cdot G}{4 \pi d^2}$$

where
S = power density in W/m^2
P = RMS transmit power capability of the radio, in W
G = total Tx gain as a factor, converted from dB
d = distance from point source, in m

Rearranging terms to solve for distance yields

$$d = \sqrt{\frac{P \cdot G}{4 \pi S}}$$

Table 38 shows calculated minimum separation distances d, recommended distances and resulting power compliance margins for each frequency band and antenna combination.

Table 38: Calculated exposure distances and power compliance margins

<table>
<tr><th rowspan="2">Fre-quency Band</th><th rowspan="2">Antenna</th><th colspan="3">Variable</th><th rowspan="2">d (calcu-lated)</th><th rowspan="2">Recom-mended Separation Distance</th><th rowspan="2">Power Compliance Margin</th></tr>
<tr><th>P</th><th>G</th><th>S</th></tr>
<tr><td rowspan="3">900 MHz</td><td>external</td><td>0.4 W (26 dBm)</td><td>10.0 (10 dB)</td><td>6 W/m²</td><td>23 cm</td><td>60 cm (24 in)</td><td>7</td></tr>
<tr><td>integrated</td><td>0.25 W (24 dBm)</td><td>15.8 (12 dB)</td><td>6 W/m²</td><td>23 cm</td><td>60 cm (24 in)</td><td>7</td></tr>
<tr><td>indoor, integrated</td><td colspan="4">Simulation model used to estimate Specific Absorption Rate (SAR) levels</td><td>10 cm (4 in)</td><td>2</td></tr>
<tr><td rowspan="2">2.4 GHz</td><td>integrated</td><td>0.34 W (25 dBm)</td><td>6.3 (8 dB)</td><td>10 W/m²</td><td>13 cm</td><td>20 cm (8 in)</td><td>2.3</td></tr>
<tr><td>integrated plus reflector</td><td>0.34 W (25 dBm)</td><td>79.4 (19 dB)</td><td>10 W/m²</td><td>46 cm</td><td>1.5 m (5 ft)</td><td>10</td></tr>
<tr><td rowspan="3">5.2 GHz</td><td>integrated</td><td>0.2 W (23 dBm)</td><td>5.0 (7 dB)</td><td>10 W/m²</td><td>9 cm</td><td>20 cm (8 in)</td><td>5</td></tr>
<tr><td>integrated plus reflector</td><td>0.0032 W (5 dBm)</td><td>316 (25 dB)</td><td>10 W/m²</td><td>9 cm</td><td>1.5 m (5 ft)</td><td>279</td></tr>
<tr><td>integrated plus LENS</td><td>0.025 W (14 dBm)</td><td>40 (16 dB)</td><td>10 W/m²</td><td>9 cm</td><td>50 cm (12 in)</td><td>31</td></tr>
<tr><td rowspan="3">5.4 GHz</td><td>integrated</td><td>0.2 W (23 dBm)</td><td>5.0 (7 dB)</td><td>10 W/m²</td><td>9 cm</td><td>20 cm (8 in)</td><td>5</td></tr>
<tr><td>integrated plus reflector</td><td>0.0032 W (5 dBm)</td><td>316 (25 dB)</td><td>10 W/m²</td><td>9 cm</td><td>1.5 m (5 ft)</td><td>279</td></tr>
<tr><td>integrated plus LENS</td><td>0.020 W (13 dBm)</td><td>50 (17 dB)</td><td>10 W/m²</td><td>9 cm</td><td>50 cm (12 in)</td><td>31</td></tr>
<tr><td>5.4 GHz OFDM</td><td>integrated</td><td>0.01 W (10 dBm)</td><td>50 (17 db)</td><td>10 W/m²</td><td>6 cm</td><td>20 cm (8 in)</td><td>10</td></tr>
</table>

Frequency Band	Antenna	Variable			*d* (calculated)	Recommended Separation Distance	Power Compliance Margin
		P	*G*	*S*			
5.7 GHz	integrated	0.2 W (23 dBm)	5.0 (7 dB)	10 W/m^2	9 cm	20 cm (8 in)	5
	integrated plus reflector	0.2 W (23 dBm)	316 (25 dB)	10 W/m^2	71 cm	1.5 m (5 ft)	4.5
	Integrated plus LENS	0.2 W (23 dBm)	50 (17 dB)	1 W/m^2	28 cm	50 cm (12 in)	3.13

The “Recommended Distances” are chosen to give significant compliance margin in all cases. They are also chosen so that a given item (bare module, reflector, or LENS) always has the same distance, regardless of frequency band, to simplify following exposure distances in the field.

These are conservative distances:

- They are along the beam direction (the direction of greatest energy). Exposure to the sides and back of the module will be significantly less.
- They meet sustained exposure limits for the general population (not just short term occupational exposure limits), with considerable margin.
- In the reflector cases, the calculated compliance distance *d* is greatly overestimated because the far-field equation models the reflector as a point source and neglects the physical dimension of the reflector.

15.2 GROUNDING CANOPY EQUIPMENT

Effective lightning protection diverts lightning current safely to ground, Protective Earth (PE) ⏚. It neither attracts nor prevents lightning strikes.

> ***WARNING!***
> Lightning damage *is not* covered under the Canopy warranty. The recommendations in Canopy guides give the installer the knowledge to protect the installation from the harmful effects of ESD and lightning. These recommendation must be thoroughly and correctly performed. However, complete protection is neither implied or possible.

15.2.1 Grounding Infrastructure Equipment

To protect both your staff and your infrastructure equipment, implement lightning protection as follows:

- Observe all local and national codes that apply to grounding for lightning protection.
- Before you install your Canopy modules, perform the following steps:
  - Engage a grounding professional if you need to do so.

  - Install lightning arrestors to transport lightning strikes away from equipment. For example, install a lightning rod on a tower leg other than the leg to which you mount your module.
  - Connect your lightning rod to ground.
  - Use a Canopy 600SS Surge Suppressor on the Ethernet cable where the cable enters any structure. (Instructions for installing a Canopy 600SS Surge Suppressor are provided in Procedure 28 on Page 344.)
- Install your modules at least 2 feet (0.6 meters) below the tallest point on the tower, pole, or roof.

15.2.2 Grounding SMs

This section provides lightning protection guidelines for SMs to satisfy the National Electrical Code (NEC) of the United States. The requirements of the NEC focus on the safety aspects of electrical shock to personnel and on minimizing the risk of fire at a dwelling. The NEC does not address the survivability of electronic products that are exposed to lightning surges.

The statistical incidence of current levels from lightning strikes is summarized in Table 39.

Table 39: Statistical incidence of current from lightning strikes

Percentage of all strikes	Peak Current (amps)
<2	>140,000
25	>35,000
>50	>20,000
>80	>8,500

At peak, more than one-half of all surges due to direct lightning strikes exceed 20,000 amps. However, only one-quarter exceed 35,000 amps, and less than two percent exceed 140,000 amps. Thus, the recommended Surge Suppressor (300SS) provides a degree of lightning protection to electronic devices inside a dwelling.

Summary of Grounding Recommendations

Motorola recommends that you ground each SM as follows:

- Extend the SM mounting bracket extend to the top of the SM or higher.
- Ground the SM mounting bracket via a 10-AWG (6 mm^2) copper wire connected by the most direct path either to an eight foot-deep ground rod or to the ground bonding point of the AC power service utility entry. This provides the best assurance that
  - lightning takes the ground wire route
  - the ground wire does not fuse open
  - your grounding system complies with NEC 810-15.
- Ground the Canopy Surge Suppressor 300SS or 600SS ground lug to the same ground bonding point as above, using at least a 10-AWG (6 mm^2) copper wire. This provides the best assurance that your grounding system complies with NEC 810-21.

Grounding Scheme

The proper overall antenna grounding scheme per the NEC is illustrated in Figure 128 on Page 345. In most television antenna or dish installations, a coaxial cable connects the outdoor electronics with the indoor electronics. To meet NEC 810-20, one typically uses a coaxial cable feed-through block that connects the outdoor coax to the indoor coax and also has a screw for attaching a ground wire. This effectively grounds the outer shield of the coax. The block should be mounted on the outside of the building near the AC main panel such that the ground wire of the block can be bonded to the primary grounding electrode system of the structure.

For residential installs, in most cases an outdoor rated *un*shielded twisted pair (UTP) cable is sufficient. To comply with the NEC, Motorola provides the antenna discharge unit, 300SS or 600SS, for each conductor of the cable. The surge suppressor must be

- positioned
  - outside the building.
  - as near as practicable to the power service entry panel of the building and attached to the AC main power ground electrode, or attached to a grounded water pipe.[5]
  - far from combustible material.
- grounded in accordance with NEC 810-21, with the grounding wire attached to the screw terminal.

The metal structural elements of the antenna mast also require a separate grounding conductor. Section 810-15 of the NEC states:

> *Masts and metal structures supporting antennas shall be grounded in accordance with Section 810-21.*

As shown in Figure 128 on Page 345, the Motorola recommendation for grounding the metal structural element of the Canopy mounting bracket (SMMB1) is to route the grounding wire from the SMMB1 down to the same ground attachment point as is used for the 300SS discharge unit.

Use 10-AWG (6 mm^2) Copper Grounding Wire

According to NEC 810-21 3(h), either a 16-AWG copper clad steel wire or a 10-AWG copper wire may be used. This specification appears to be based on mechanical strength considerations and *not* on lightning current handling capabilities.

For example, analysis shows that the two wire types are not equivalent when carrying a lightning surge that has a 1-microsecond rise by 65-microsecond fall:

- The 16-AWG copper clad steel wire has a peak fusing current of 35,000 amps and can carry 21,000 amps peak, at a temperature just below the ignition point for paper (454° F or 234° C).
- The 10-AWG copper wire has a peak fusing current of 220,000 amps and can carry 133,000 amps peak, at the same temperature.

[5] It is *insufficient* to merely use the green wire ground in a duplex electrical outlet box for grounding of the antenna discharge unit.

Based on the electrical/thermal analysis of these wires, Motorola recommends 10-AWG copper wire for *all* grounding conductors. Although roughly double the cost of 16-AWG copper clad steel wire, 10-AWG copper wire handles six times the surge current from lightning.

Shielding is not Grounding

In part, NEC 810-21 states:

> *A lightning arrester is not required if the lead-in conductors are enclosed in a continuous metal shield, such as rigid or intermediate metal conduit, electrical metallic tubing, or any metal raceway or metal-shielded cable that is effectively grounded. A lightning discharge will take the path of lower impedance and jump from the lead-in conductors to the metal raceway or shield rather than take the path through the antenna coil of the receiver.*

However, Motorola does not recommend relying on shielded twisted pair cable for lightning protection for the following reasons:

- Braid-shielded 10Base-T cable is uncommon, if existent, and may be unsuitable anyway.
- At a cost of about two-thirds more than 10-AWG copper UTP, CAT 5 100Base-TX foil-shielded twisted pair (FTP) cable provides a 24-AWG drain wire. If this wire melts open during a lightning surge, then the current may follow the twisted pair into the building.

  More than 80 percent of all direct lightning strikes have current that exceeds 8,500 amps (see Table 39 on Page 172). A 24-AWG copper wire melts open at 8,500 amps from a surge that has a 1-microsecond by 70-microsecond waveform. Hence, reliance on 24-AWG drain wire to comply with the intent of NEC 810-21 is questionable.

Shielded twisted pair cable may be useful for mitigation of interference in some circumstances, but installing surge suppressors and implementing the ground recommendations constitute the most effective mitigation against lightning damage.

NEC Reference

NEC Article 810, *Radio and Television Equipment*, and associated documents and discussions are available from http://www.neccode.com/index.php?id=homegeneral, http://www.constructionbook.com/xq/ASP/national-electrical-code-2005/id.370/subID.746/qx/default2.htm, and other sources.

15.3 CONFORMING TO REGULATIONS

For all electrical purposes, ensure that your network conforms to applicable country and local codes, such as the NEC (National Electrical Code) in the US. If you are uncertain of code requirements, engage the services of a licensed electrician.

15.4 PROTECTING CABLES AND CONNECTIONS

Cables that move in the wind can be damaged, impart vibrations to the connected device, or both. At installation time, prevent these problems by securing all cables with cable ties, cleats, or PVC tape.

Over time, moisture can cause a cable connector to fail. You can prevent this problem by

- using cables that are filled with a dielectric gel or grease.
- including a drip loop where the cable approach to the module (typically a CMM2 or CMMmicro) is from above.
- wrapping the cable with weather-resistant tape.

On a module with an external antenna, use accepted industry practices to wrap the connector to prevent water ingress. Although the male and female N-type connectors form a gas-tight seal with each other, the point where the cable enters each connector can allow water ingress and eventual corrosion. Wrapping and sealing is critical to long-term reliability of the connection.

Possible sources of material to seal that point include

- the antenna manufacturer (material may have been provided in the package with the antenna).
- Universal Electronics (whose web site is http://www.coaxseal.com), who markets a weather-tight wrap named Coax-Seal.

Perform the following steps to wrap the cable.

Procedure 4: Wrapping the cable

1. Start the wrap on the cable 0.5 to 2 inches (about 1.5 to 5 cm) from the connection.
2. Wrap the cable to a point 0.5 to 2 inches (about 1.5 to 5 cm) above the connection.
3. Squeeze the wrap to compress and remove any trapped air.
4. Wrap premium vinyl electrical tape over the first wrap where desired for abrasion resistance or appearance.
5. Tie the cable to minimize sway from wind.

========================== **end of procedure** ======================

16 TESTING THE COMPONENTS

The best practice is to connect all components—BHs, APs, GPS antenna, and CMM2 or CMMmicro—in a test setting and initially configure and verify them before deploying them to an installation. In this way, any configuration issues are worked out before going on-site, on a tower, in the weather, where the discovery of configuration issues or marginal hardware is more problematic and work-flow affecting.

16.1 UNPACKING COMPONENTS

When you receive Canopy products, carefully inspect all shipping boxes for signs of damage. If you find damage, immediately notify the transportation company.

As you unpack the equipment, verify that all the components that you ordered have arrived. Save all the packing materials to use later, as you transport the equipment to and from installation sites.

16.2 CONFIGURING FOR TEST

You can use either of two methods to configure an AP or BHM:

- Use the Quick Start feature of the product. For more information on Quick Start, see Quick Start Page of the AP on Page 185.
- Manually set each parameter.

After you change configuration parameters on a GUI web page:

1. Before you leave a web page, click the **Save** button to save the change(s).
2. After making change(s) on multiple web pages, click the **Reboot** button to reboot the module and implement the change(s).

16.2.1 Configuring the Computing Device for Test

If your computer is configured for Dynamic Host Configuration Protocol (DHCP), disconnect the computer from the network. If your computer is instead configured for static IP addressing

- set the static address in the 169.254 network
- set the subnet mask to 255.255.0.0.

16.2.2 Default Module Configuration

From the factory, the Canopy AP, SM, and BH are all configured to *not transmit* on any frequency. This configuration ensures that you do not accidentally turn on an unsynchronized module. Site synchronization of modules is required because

- Canopy modules
  - cannot transmit and receive signals at the same time.
  - use TDD (Time Division Duplexing) to distribute signal access of the downlink and uplink frames.
- when one module transmits while an unintended module nearby receives signal, the transmitting module may interfere with or desense the receiving module. In this context, interference is self-interference (within the same Canopy network).

16.2.3 Component Layout

As shown in Figure 46, the base cover of the module snaps off when you depress a lever on the back of the base cover. This exposes the Ethernet and GPS sync connectors and diagnostic LEDs.

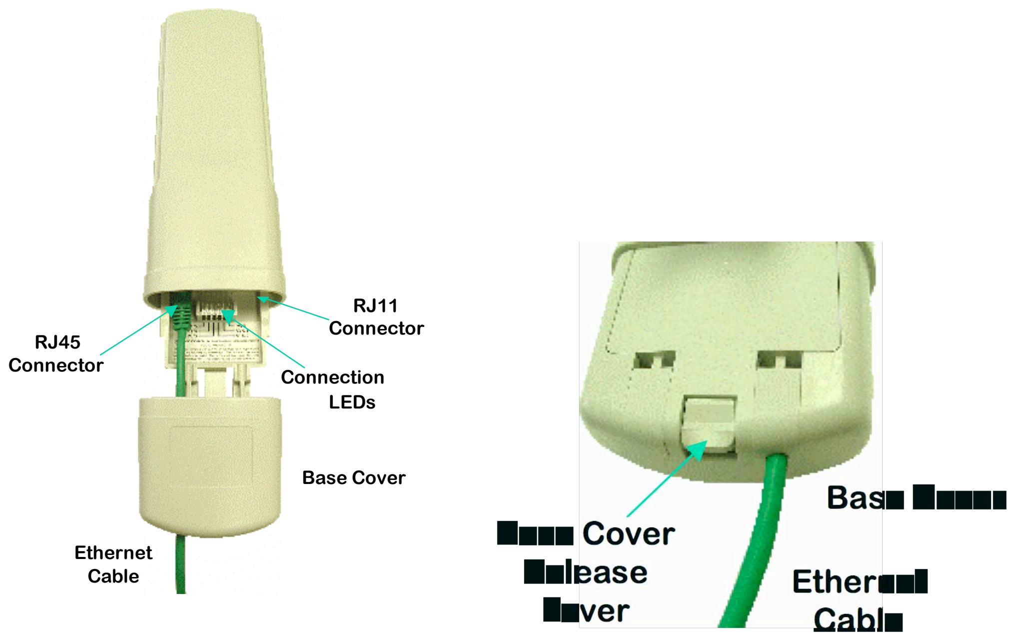


Figure 46: Canopy base cover, attached and detached

16.2.4 Diagnostic LEDs

The diagnostic LEDs report the following information about the status of the module. Table 40 and Table 41 identify the LEDs in order of their left-to-right position as the cable connections face downward.

> *NOTE:*
> The LED color helps you distinguish position of the LED. The LED color *does not* indicate any status.

Table 40: LEDs in AP and BHM

Label	Color when Active	Status Information Provided	Notes
LNK/5	green	Ethernet link	Continuously lit when link is present.
ACT/4	orange	Presence of data activity on the Ethernet link	Flashes during data transfer. Frequency of flash is not a diagnostic indication.
GPS/3	red	Pulse of sync	Continuously lit as pulse as AP receives pulse.
SES/2	green	*Unused on the AP*	SES is the session indicator on the CMM.
SYN/1	orange	Presence of sync	Always lit on the AP.
PWR	red	DC power	Always lit when power is correctly supplied.

Table 41: LEDs in SM and BHS

<table>
<tr><th rowspan="2">Label</th><th rowspan="2">Color when Active</th><th rowspan="2">Status if Registered</th><th colspan="2">Notes</th></tr>
<tr><th>Operating Mode</th><th>Aiming Mode</th></tr>
<tr><td>LNK/5</td><td>green</td><td>Ethernet link</td><td>Continuously lit when link is present.</td><td rowspan="5">These five LEDs act as a bar graph to indicate the relative quality of alignment. As power level and jitter improve during alignment, more of these LEDs are lit.</td></tr>
<tr><td>ACT/4</td><td>orange</td><td>Presence of data activity on the Ethernet link</td><td>Flashes during data transfer. Frequency of flash is not a diagnostic indication.</td></tr>
<tr><td>GPS/3</td><td>red</td><td>Unused</td><td rowspan="3">If this module is not registered to another, then these three LEDs cycle on and off from left to right.</td></tr>
<tr><td>SES/2</td><td>green</td><td>Unused</td></tr>
<tr><td>SYN/1</td><td>orange</td><td>Presence of sync</td></tr>
<tr><td>PWR</td><td>red</td><td>DC power</td><td>Always lit when power is correctly supplied.</td><td>Always lit when power is correctly supplied.</td></tr>
</table>

16.2.5 CMM2 Component Layout

As shown in Figure 125 on Page 339, the CMM2 comprises four assemblies:

- Ethernet switch
- Power transformer
- Interconnect board
- GPS receiver.

Some CMM2s that were sold earlier had four openings in the bottom plate, as shown in Figure 47. Currently available CMM2s have two *additional* Ethernet cable and GPS sync cable openings to allow use of thicker, shielded cables.

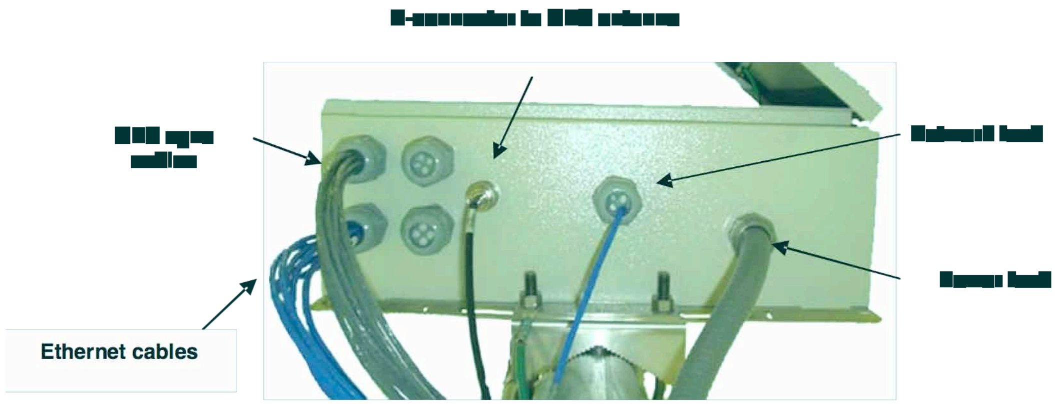
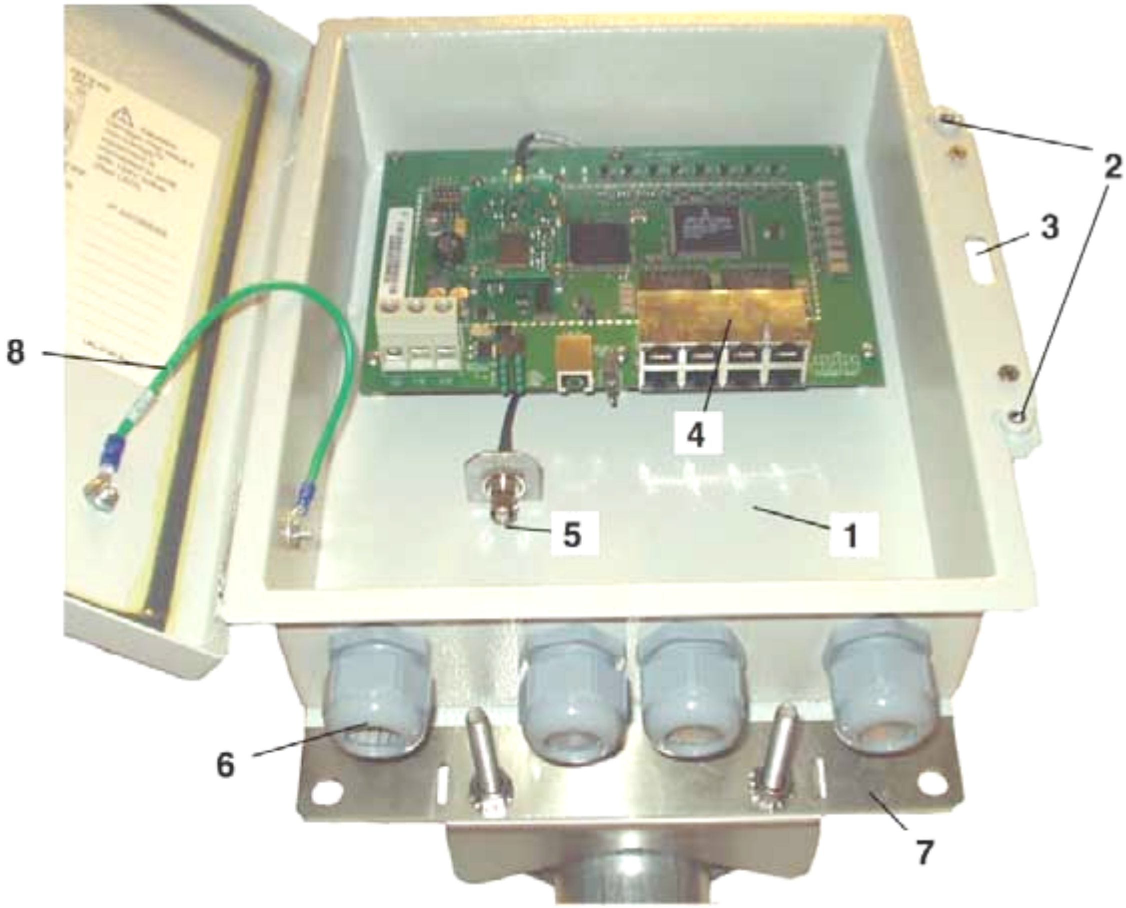


Figure 47: Canopy CMM2, bottom view

16.2.6 CMMmicro Component Layout

The layout of the CMMmicro is shown in Figure 48.



LEGEND

1. Weatherized enclosure
2. Thumb-screw/slot-screwdriver door fasteners
3. Punch-out for padlock
4. Ethernet switch and power module
5. Female BNC connector
6. Water-tight bulkhead connectors
7. Flange for attachment (stainless steel for grounding to tower or building) using U bolts (provided) or other hardware such as screws, lag bolts, or attachment straps (not provided)
8. Ground strap (for grounding door to enclosure)
9. 100-W 115/230-V AC to 24-V DC power converter, with 10 ft (3 m) of DC power cable (not shown)
10. 6-ft (1.8-m) AC power cord for 24 V power converter (not shown)

Figure 48: Cluster Management Module micro

16.2.7 Standards for Wiring

Canopy modules automatically sense whether the Ethernet cable in a connection is wired as straight-through or crossover. You may use either straight-through or crossover cable to connect a network interface card (NIC), hub, router, or switch to these modules. For a straight-through cable, use the EIA/TIA-568B wire color-code standard on both ends. For a crossover cable, use the EIA/TIA-568B wire color-code standard on one end, and the EIA/TIA-568A wire color-code standard on the other end.

Where you use the Canopy AC wall adapter

- the power supply output is +24 VDC.
- the power input to the SM is +11.5 VDC to +30 VDC.
- the maximum Ethernet cable run is 328 feet (100 meters).

16.2.8 Best Practices for Cabling

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

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

16.2.9 Recommended Tools for Wiring Connectors

The following tools may be needed for cabling the AP:

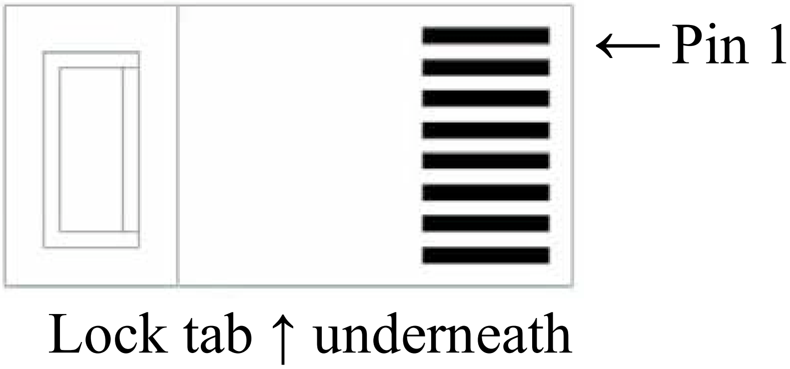
- RJ-11 crimping tool
- RJ-45 crimping tool
- electrician scissors
- wire cutters
- cable testing device.

16.2.10 Wiring Connectors

The following diagrams correlate pins to wire colors and illustrate crossovers where applicable.

Location of Pin 1

Pin 1, relative to the lock tab on the connector of a straight-through cable is located as shown below.



RJ-45 Pinout for Straight-through Ethernet Cable

Pin 1 →	white / orange	← Pin 1
Pin 2 →	orange	← Pin 2
Pin 3 →	white / green	← Pin 3
Pin 4 →	blue	← Pin 4
Pin 5 →	white / blue	← Pin 5
Pin 6 →	green	← Pin 6
Pin 7 →	white / brown	← Pin 7
Pin 8 →	brown	← Pin 8

Pins 7 and 8 carry power to the modules.

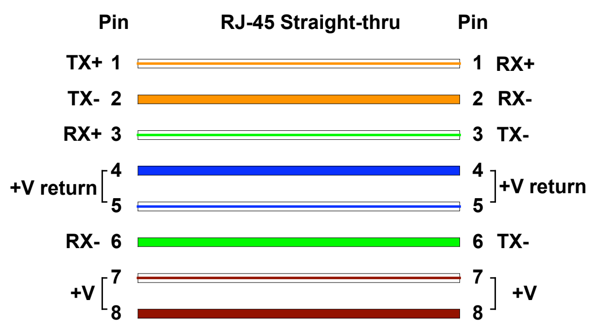


Figure 49: RJ-45 pinout for straight-through Ethernet cable

RJ-45 Pinout for Crossover Ethernet Cable

Pin 1 →	white / orange	← Pin 3
Pin 2 →	orange	← Pin 6
Pin 3 →	white / green	← Pin 1
Pin 4 →	blue	← Pin 4
Pin 5 →	white / blue	← Pin 5
Pin 6 →	green	← Pin 2
Pin 7 →	white / brown	← Pin 7
Pin 8 →	brown	← Pin 8

Pins 7 and 8 carry power to the modules.

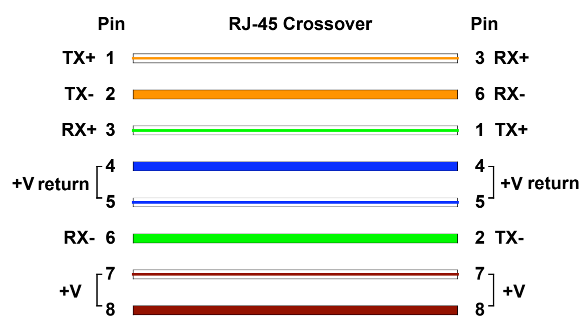


Figure 50: RJ-45 pinout for crossover Ethernet cable

RJ-11 Pinout for Straight-through Sync Cable

The Canopy system uses a utility cable with RJ-11 connectors between the AP or BH and synchronization pulse. Presuming CAT 5 cable and 6-pin RJ-11 connectors, the following diagram shows the wiring of the cable for sync.

Pin 1 → white / orange ← Pin 1
Pin 2 → white / green ← Pin 2
Pin 3 → white / blue ← Pin 3
Pin 4 → green ← Pin 4
Pin 5 → blue ← Pin 5
Pin 6 → orange ← Pin 6
NOTE: The fourth pair is not used.

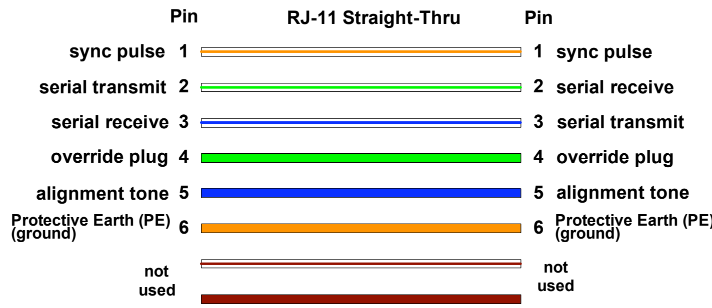


Figure 51: RJ-11 pinout for straight-through sync cable

16.2.11 Alignment Tone—Technical Details

The alignment tone output from a Canopy module is available on Pin 5 of the RJ-11 connector, and ground is available on Pin 6. Thus the load at the listening device should be between Pins 5 and 6. The listening device may be a headset, earpiece, or battery-powered speaker.

16.3 CONFIGURING A POINT-TO-MULTIPOINT LINK FOR TEST

Perform the following steps to begin the test setup.

Procedure 5: Setting up the AP for Quick Start

1. In one hand, securely hold the top (larger shell) of the AP. With the other hand, depress the lever in the back of the base cover (smaller shell). Remove the base cover.
2. Plug one end of a CAT 5 Ethernet cable into the AP.
3. Plug the Ethernet cable connector labeled To Radio into the jack in the pig tail that hangs from the power supply.

> ***WARNING!***
> From this point until you remove power from the AP, stay at least as far from the AP as the minimum separation distance specified in Table 37 on Page 169.

4. Plug the other connector of the pig tail (this connector labeled To Computer) into the Ethernet jack of the computing device.
5. Plug the power supply into an electrical outlet.
6. Power up the computing device.
7. Start the browser in the computing device.

============================ **end of procedure** ============================

The Canopy AP interface provides a series of web pages to configure and monitor the unit. You can access the web-based interface through a computing device that is either directly connected or connected through a network to the AP. If the computing device is not connected to a network when you are configuring the module in your test environment, and if the computer has used a proxy server address and port to configure a Canopy module, then you may need to first disable the proxy setting in the computer.

Perform the following procedure to toggle the computer to *not* use the proxy setting.

Procedure 6: Bypassing proxy settings to access module web pages

1. Launch Microsoft Internet Explorer.
2. Select **Tools→Internet Options→Connections→LAN Settings**.
3. Uncheck the **Use a proxy server…** box.
   NOTE: If you use an alternate web browser, the menu selections differ from the above.

============================ **end of procedure** ============================

In the address bar of your browser, enter the IP address of the AP. (For example, enter `http://169.254.1.1` to access the AP through its default IP address). The AP responds by opening the General Status tab of its Home page.

16.3.1 Quick Start Page of the AP

To proceed with the test setup, click the **Quick Start** button on the left side of the General Status tab. The AP responds by opening the Quick Start page. The Quick Start tab of that page is displayed in Figure 52.

NOTE:
If you cannot find the IP address of the AP, see Override Plug on Page 58.

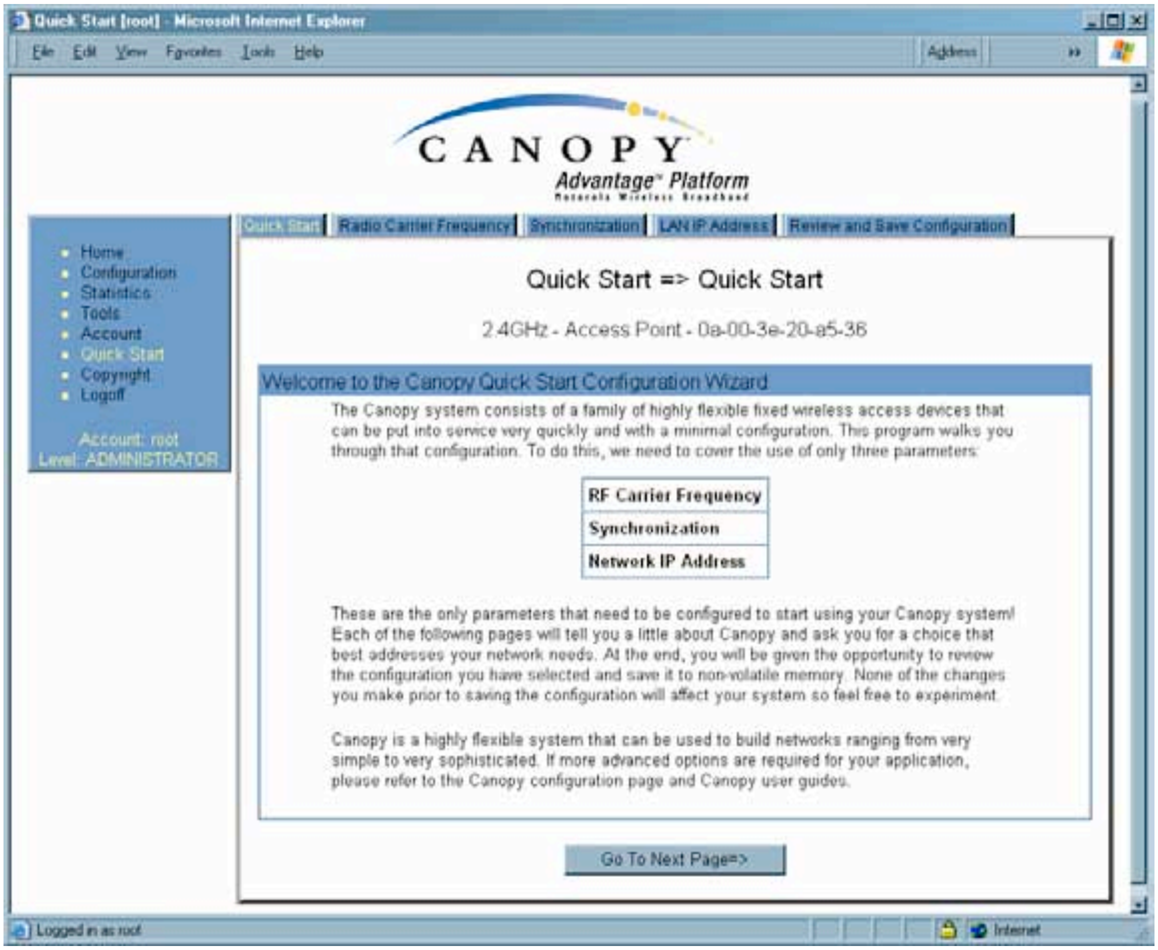


Figure 52: Quick Start tab of AP, example

Quick Start is a wizard that helps you to perform a basic configuration that places an AP into service. Only the following parameters must be configured:

- **RF Carrier Frequency**
- **Synchronization**
- **Network IP Address**

In each Quick Start tab, you can

- specify the settings to satisfy the requirements of the network.
- review the configuration selected.
- save the configuration to non-volatile memory.

Proceed with the test setup as follows.

Procedure 7: Using Quick Start to configure a standalone AP for test

1. At the bottom of the Quick Start tab, click the **Go To Next Page =>** button.
   RESULT: The AP responds by opening the RF Carrier Frequency tab.
   An example of this tab is shown in Figure 53.

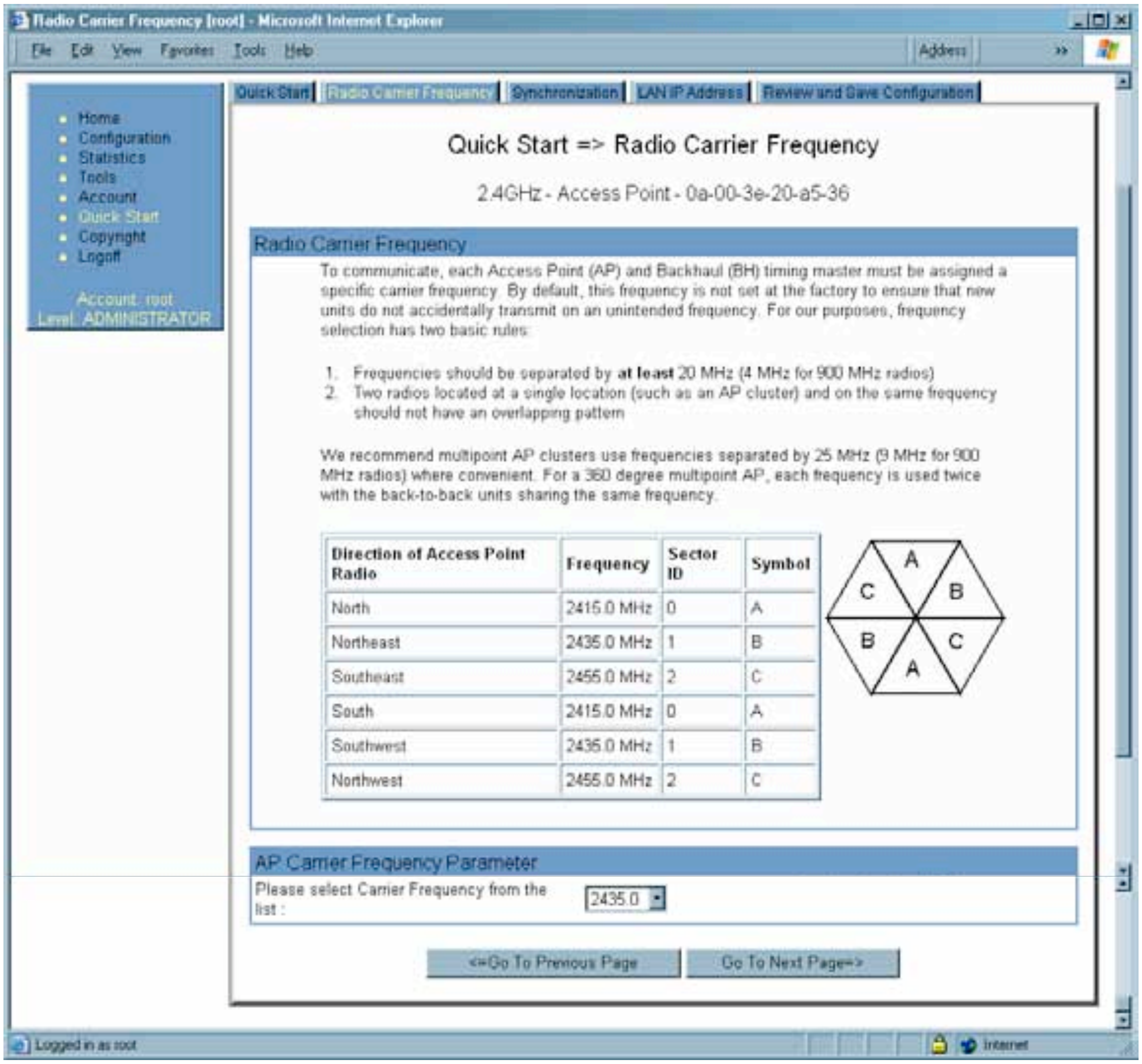


Figure 53: Radio Frequency Carrier tab of AP, example

2. From the pull-down menu in the lower left corner of this tab, select a frequency for the test.
3. Click the **Go To Next Page =>** button.
   RESULT: The AP responds by opening the Synchronization tab. An example of this tab is shown in Figure 54.

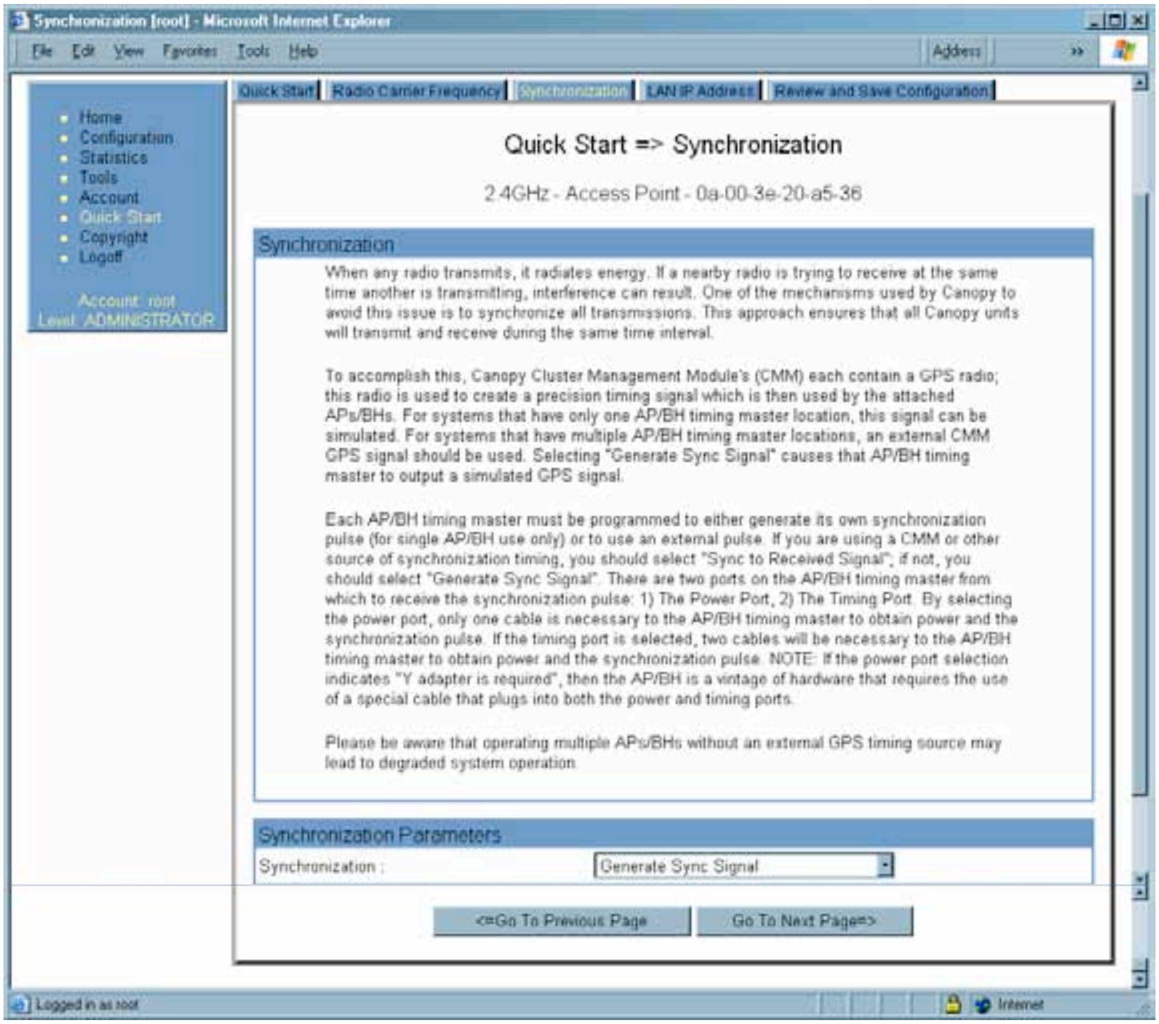


Figure 54: Synchronization tab of AP, example

4. At the bottom of this tab, select **Generate Sync Signal**.
5. Click the **Go To Next Page =>** button.
   RESULT: The AP responds by opening the LAN IP Address tab. An example of this tab is shown in Figure 55.

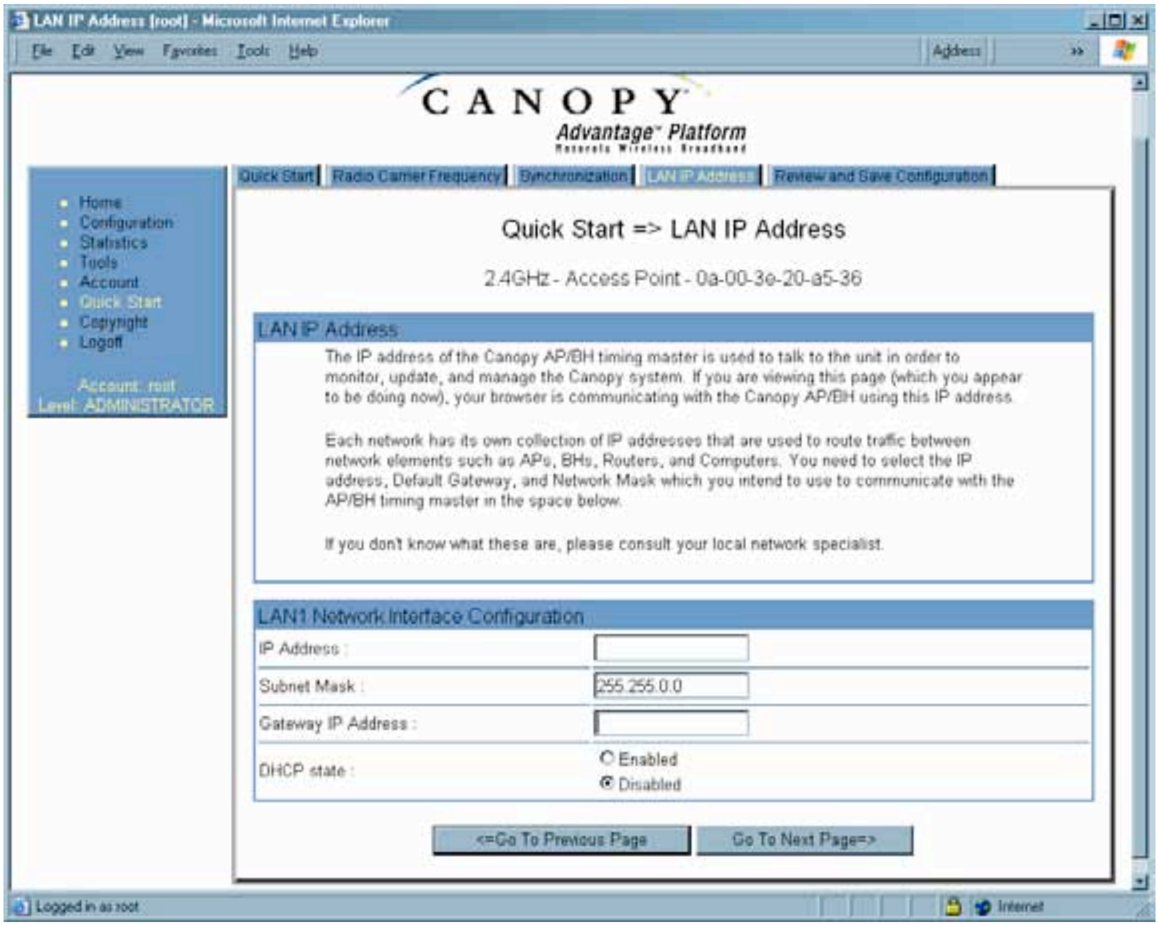


Figure 55: LAN IP Address tab of AP, example

6. At the bottom of this tab, either
   - specify an **IP Address**, a **Subnet Mask**, and a **Gateway IP Address** for management of the AP and leave the **DHCP state** set to **Disabled**.
   - set the **DHCP state** to **Enabled** to have the IP address, subnet mask, and gateway IP address automatically configured by a domain name server (DNS).
7. Click the **Go To Next Page =>** button.
   RESULT: The AP responds by opening the Review and Save Configuration tab. An example of this tab is shown in Figure 56.

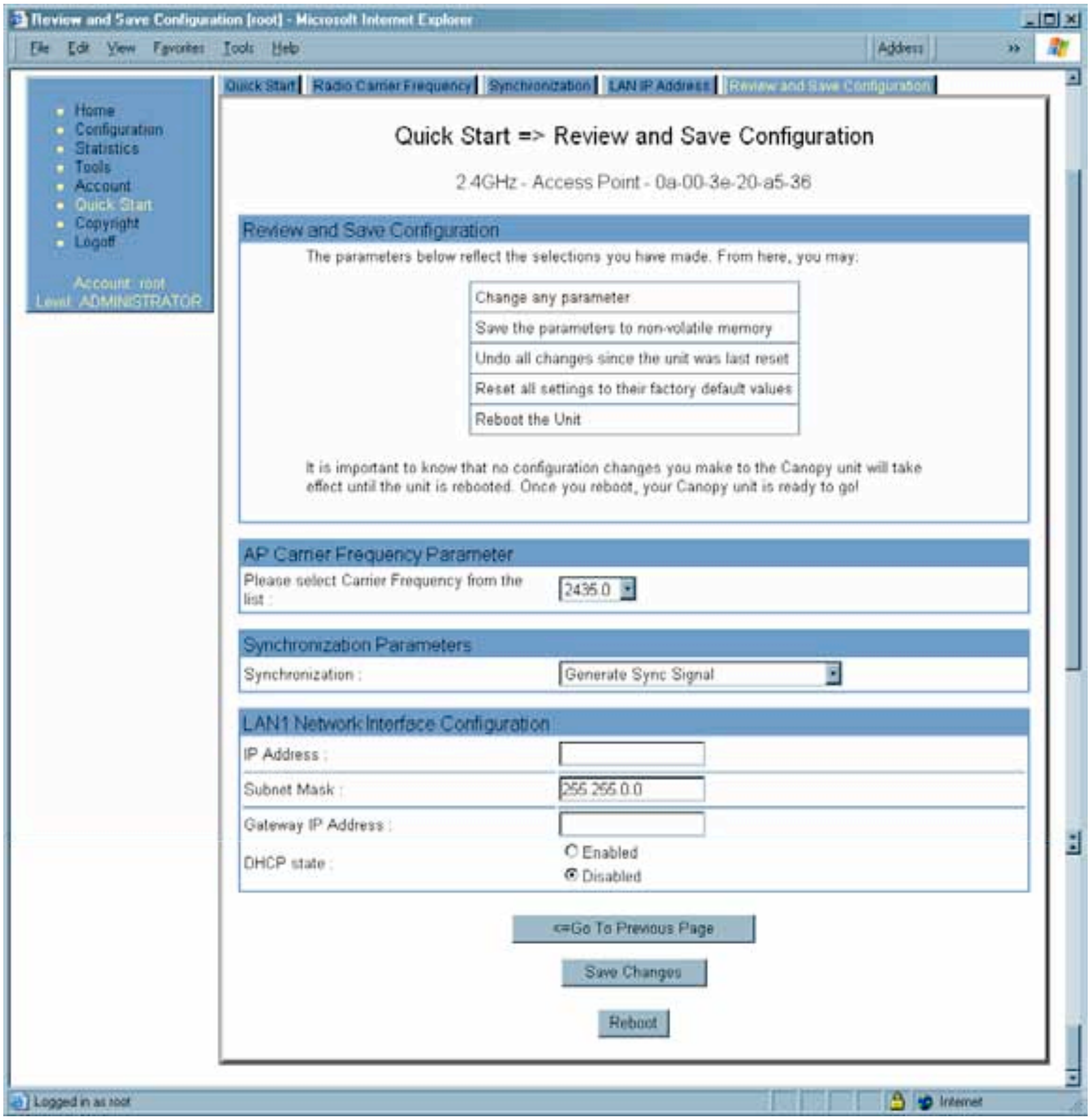


Figure 56: Review and Save Configuration tab of AP, example

8. Ensure that the initial parameters for the AP are set as you intended.
9. Click the **Save Changes** button.
10. Click the **Reboot** button.
    RESULT: The AP responds with the message **Reboot Has Been Initiated…**
11. Wait until the indicator LEDs are not red.
12. Trigger your browser to refresh the page until the AP redisplays the General Status tab.
13. Wait until the red indicator LEDs are not lit.

============================ **end of procedure** ============================

Canopy encourages you to experiment with the interface. Unless you save a configuration and reboot the AP after you save the configuration, none of the changes are effected.

16.3.2 Time Tab of the AP

To proceed with the test setup, click the **Configuration** link on the left side of the General Status tab. When the AP responds by opening the Configuration page to the General tab, click the Time tab. An example of this tab is displayed in Figure 57.

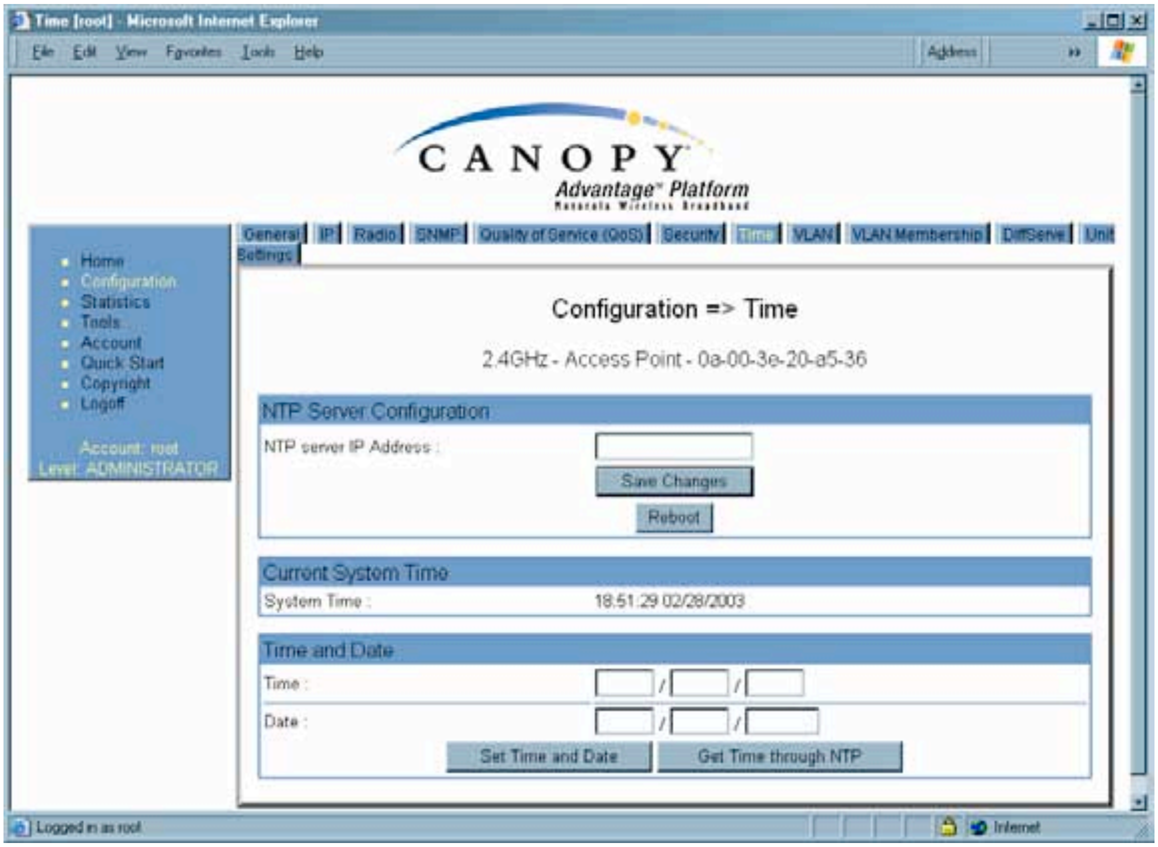


Figure 57: Time tab of AP, example

To have each log in the AP correlated to a meaningful time and date, either a reliable network element must pass time and date to the AP or you must set the time and date whenever a power cycle of the AP has occurred. A network element passes time and date in any of the following scenarios:

- A connected CMM2 passes time and date (GPS time and date, if received).
- A connected CMMmicro passes the time and date (GPS time and date, if received), but only if both the CMMmicro is operating on CMMmicro Release 2.1 or later release. (These releases include an NTP server functionality.)
- A separate NTP server is addressable from the AP.

If the AP should obtain time and date from either a CMMmicro or a separate NTP server, enter the IP address of the CMMmicro or NTP server on this tab. To force the AP to obtain time and date before the first (or next) 15-minute interval query of the NTP server, click **Get Time through NTP**.

If you enter a time and date, the format for entry is

Time :	*hh*	/	*mm*	/	*ss*
Date :	*MM*	/	*dd*	/	*yyyy*

where

- *hh* represents the two-digit hour in the range 00 to 24
- *mm* represents the two-digit minute
- *ss* represents the two-digit second
- *MM* represents the two-digit month
- *dd* represents the two-digit day
- *yyyy* represents the four-digit year

Proceed with the test setup as follows.

- Enter the appropriate information in the format shown above.
- Then click the **Set Time and Date** button.
  NOTE: The time displayed at the top of this page is static unless your browser is set to automatically refresh.

Procedure 8: Setting up the SM for test

1. In one hand, securely hold the top (larger shell) of the SM. With the other hand, depress the lever in the back of the base cover (smaller shell). Remove the base cover.
2. Plug one end of a CAT 5 Ethernet cable into the SM RJ-45 jack.
3. Plug the other end of the Ethernet cable into the jack in the pig tail that hangs from the power supply.
4. Roughly aim the SM toward the AP.

WARNING!
From this point until you remove power from the SM, stay at least as far from the SM as the minimum separation distance specified in Table 37 on Page 169.

5. Plug the power supply into an electrical outlet.
6. Repeat the foregoing steps for each SM that you wish to include in the test.
7. Back at the computing device, on the left side of the Time & Date tab, click **Home**.
8. Click the Session Status tab.

============================ **end of procedure** ============================

16.3.3 Session Status Tab of the AP

An example of the AP Session Status tab is displayed in Figure 58.

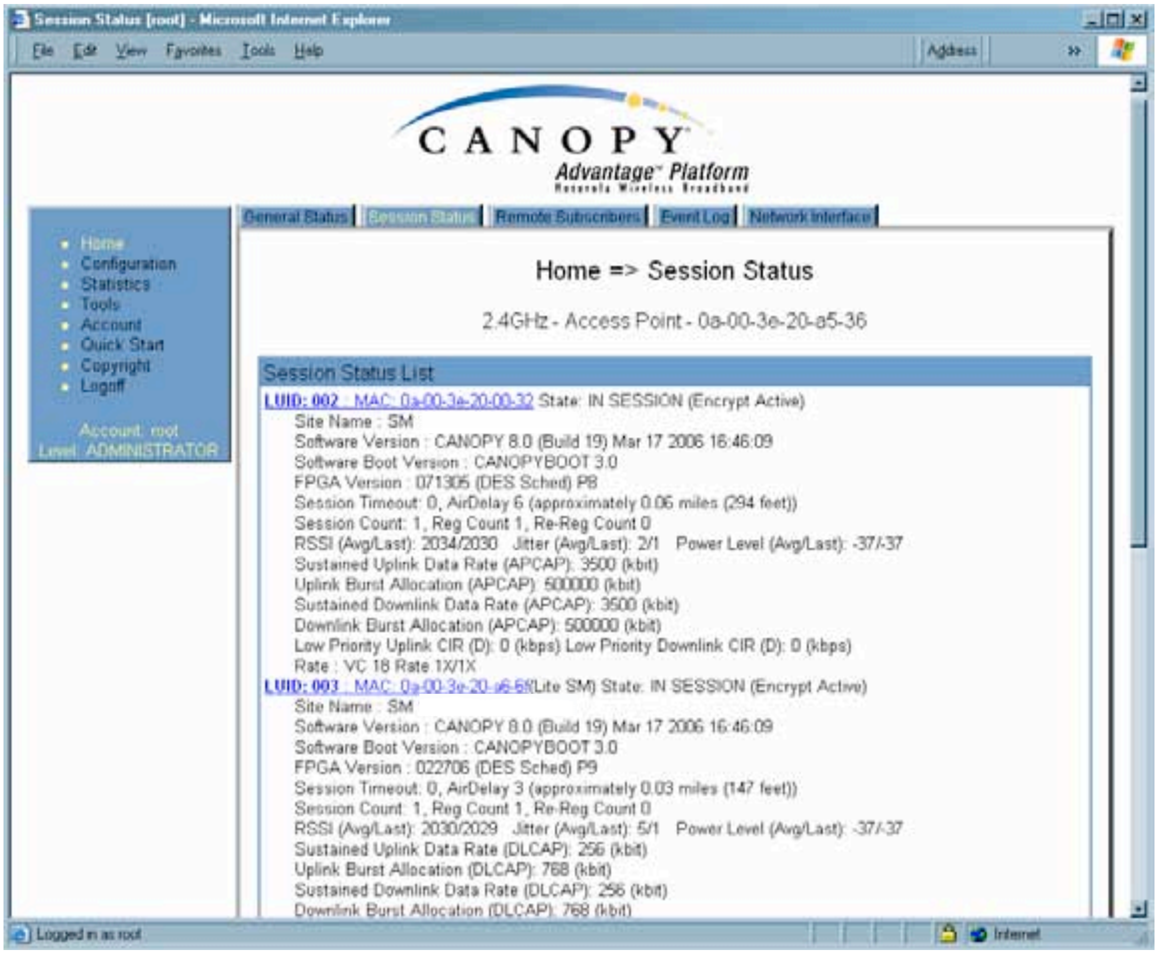


Figure 58: Session Status tab data from AP, example

If no SMs are registered to this AP, then the Session Status tab displays the simple message **No sessions**. In this case, try the following steps.

Procedure 9: Retrying to establish a point-to-multipoint link

1. More finely aim the SM or SMs toward the AP.
2. Recheck the Session Status tab of the AP for the presence of LUIDs.
3. If still no LUIDs are reported on the Session Status tab, click the **Configuration** button on the left side of the Home page.
   RESULT: The AP responds by opening the AP Configuration page.
4. Click the Radio tab.
5. Find the **Color Code** parameter and note the setting.
6. In the same sequence as you did for the AP directly under Configuring a Point-to-Multipoint Link for Test on Page 184, connect the SM to a computing device and to power.
7. On the left side of the SM Home page, click the **Configuration** button.
   RESULT: The Configuration page of the SM opens.

8. Click the Radio tab.
9. If the transmit frequency of the AP is not selected in the **Custom Radio Frequency Scan Selection List** parameter, select the frequency that matches.
10. If the **Color Code** parameter on this page is not identical to the **Color Code** parameter you noted from the AP, change one of them so that they match.
11. At the bottom of the Radio tab for the SM, click the **Save Changes** button.
12. Click the **Reboot** button.
13. Allow several minutes for the SM to reboot and register to the AP.
14. Return to the computing device that is connected to the AP.
15. Recheck the Session Status tab of the AP for the presence of LUIDs.

=========================== **end of procedure** ===========================

The Session Status tab provides information about each SM that has registered to the AP. This information is useful for managing and troubleshooting a Canopy system. All information that you have entered in the **Site Name** field of the SM displays in the Session Status tab of the linked AP.

The Session Status tab also includes the current active values on each SM (LUID) for MIR, CIR, and VLAN, as well as the source of these values (representing the SM itself, BAM, or the AP and cap, if any—for example, APCAP as shown in Figure 58 above). L indicates a Canopy Lite SM, and D indicates from the device. As an SM registers to the AP, the configuration source that this page displays for the associated LUID may change. After registration, however, the displayed source is stable and can be trusted.

The Session Status tab of the AP provides the following parameters.

LUID

This field displays the LUID (logical unit ID) of the SM. As each SM registers to the AP, the system assigns an LUID of 2 or a higher unique number to the SM. If an SM loses registration with the AP and then regains registration, the SM will retain the same LUID.

> *NOTE:*
> The LUID association is lost when a power cycle of the AP occurs.

MAC

This field displays the MAC address (or electronic serial number) of the SM.

State

This field displays the current status of the SM as either

- **IN SESSION** to indicate that the SM is currently registered to the AP.
- **IDLE** to indicate that the SM was registered to the AP at one time, but now is not.

This field also indicates whether the encryption scheme in the module is enabled.

Site Name

This field indicates the name of the SM. You can assign or change this name on the Configuration web page of the SM. This information is also set into the *sysName* SNMP MIB-II object and can be polled by an SNMP management server.

Software Version

This field displays the software release that operates on the SM, the release date and time of the software.

Software Boot Version

This field indicates the CANOPYBOOT version number.

FPGA Version

This field displays the version of FPGA that runs on the SM.

Session Timeout

This field displays the timeout in seconds for management sessions via HTTP, telnet, or ftp access to the SM. 0 indicates that no limit is imposed.

AirDelay

This field displays the distance of the SM from the AP. To derive the distance in meters, multiply the displayed number by 0.3048. At close distances, the value in this field is unreliable.

Session Count

This field displays how many sessions the SM has had with the AP. Typically, this is the sum of Reg Count and Re-Reg Count. However, the result of internal calculation may display here as a value that slightly differs from the sum.

If the number of sessions is significantly greater than the number for other SMs, then this may indicate a link problem or an interference problem.

Reg Count

When an SM makes a registration request, the AP checks its local data to see whether it considers the SM to be already registered. If the AP concludes that the SM is not, then the request increments the value of this field.

Re-Reg Count

When an SM makes a registration request, the AP checks its local data to see whether it considers the SM to be already registered. If the AP concludes that the SM is not, then the request increments the value of this field. Typically, a Re-Reg is the case where both

- an SM attempts to reregister for having lost communication with the AP.
- the AP has not yet observed the link to the SM as being down.

A high number in this field is often an indication of link instability or interference problems.

RSSI, Jitter, and Power Level (Avg/Last)

The Session Status tab shows the received **Power Level** in dBm and **Jitter**. Proper alignment maximizes **Power Level** and minimizes **Jitter**. As you refine alignment, you should favor lower jitter over higher dBm. For example, if coarse alignment gives an SM a power level of −75 dBm and a jitter measurement of 5, and further refining the alignment drops the power level to −78 dBm and the jitter to 2 or 3, use the refined alignment, with the following caveats:

- When the receiving link is operating at 1X, the **Jitter** scale is 0 to 15 with desired jitter between 0 and 4.
- When the receiving link is operating at 2X, the **Jitter** scale is 0 to 15 with desired jitter between 0 and 9.

The Session Status tab also shows a historical **RSSI**, a unitless measure of power. Use **Power Level** and ignore **RSSI**. **RSSI** implies more accuracy and precision than is inherent in its measurement.

Sustained Uplink Data Rate

This field displays the value that is currently in effect for the SM, with the source of that value in parentheses. This is the specified rate at which each SM registered to this AP is replenished with credits for transmission. The configuration source of the value is indicated in parentheses. See

- Maximum Information Rate (MIR) Parameters on Page 84
- Interaction of Burst Allocation and Sustained Data Rate Settings on Page 86
- Setting the Configuration Source on Page 292.

Uplink Burst Allocation

This field displays the value that is currently in effect for the SM, with the source of that value in parentheses. This is the specified maximum amount of data that each SM is allowed to transmit before being recharged at the **Sustained Uplink Data Rate** with credits to transmit more. The configuration source of the value is indicated in parentheses. See

- Maximum Information Rate (MIR) Parameters on Page 84
- Interaction of Burst Allocation and Sustained Data Rate Settings on Page 86
- Setting the Configuration Source on Page 292.

Sustained Downlink Data Rate

This field displays the value that is currently in effect for the SM, with the source of that value in parentheses. This is the specified the rate at which the AP should be replenished with credits (tokens) for transmission to each of the SMs in its sector. The configuration source of the value is indicated in parentheses. See

- Maximum Information Rate (MIR) Parameters on Page 84
- Interaction of Burst Allocation and Sustained Data Rate Settings on Page 86
- Setting the Configuration Source on Page 292.

Downlink Burst Allocation

This field displays the value that is currently in effect for the SM, with the source of that value in parentheses. This is the maximum amount of data to allow the AP to transmit to any registered SM before the AP is replenished with transmission credits at the **Sustained Downlink Data Rate**. The configuration source of the value is indicated in parentheses. See

- Maximum Information Rate (MIR) Parameters on Page 84
- Interaction of Burst Allocation and Sustained Data Rate Settings on Page 86

- Setting the Configuration Source on Page 292.

Low Priority Uplink CIR

This field displays the value that is currently in effect for the SM, with the source of that value in parentheses. The configuration source of the value is indicated in parentheses. See

- Committed Information Rate on Page 86
- Setting the Configuration Source on Page 292.

Low Priority Downlink CIR

This field displays the value that is currently in effect for the SM, with the source of that value in parentheses. The configuration source of the value is indicated in parentheses. See

- Committed Information Rate on Page 86
- Setting the Configuration Source on Page 292.

Rate

This field displays whether the high-priority channel is enabled in the SM and the status of 1X or 2X operation in the SM. See Checking the Status of 2X Operation on Page 91.

16.3.4 Beginning the Test of Point-to-Multipoint Links

To begin the test of links, perform the following steps:

1. In the Session Status tab of the AP, note the LUID associated with the MAC address of any SM you wish to involve in the test.
2. Click the Remote Subscribers tab.

16.3.5 Remote Subscribers Tab of the AP

An example of a Remote Subscribers tab is displayed in Figure 59.

Figure 59: Remote Subscribers tab of AP, example

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

16.3.6 General Status Tab of the SM

An example of the General Status tab of an SM is displayed in Figure 60.

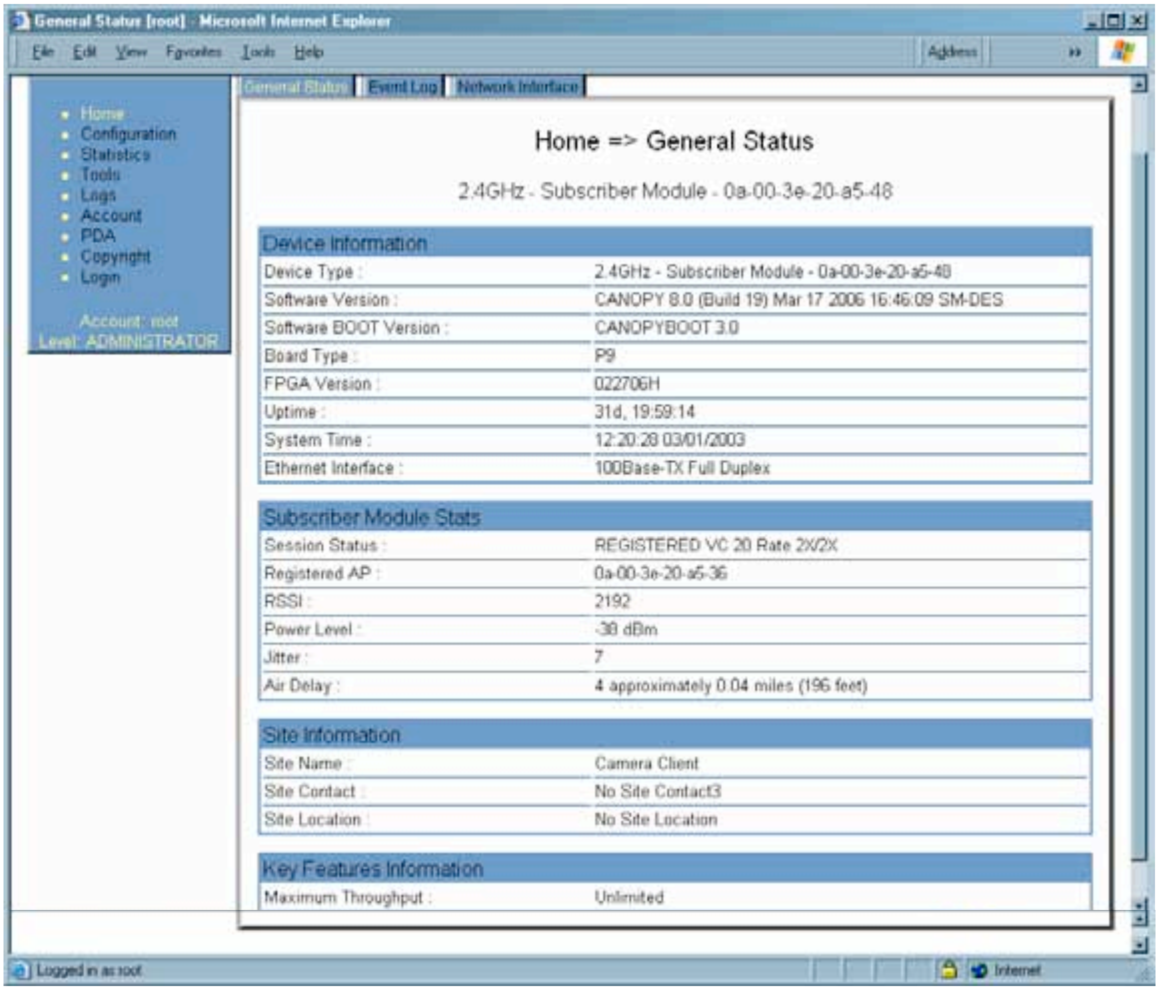


Figure 60: General Status tab of SM, example

The General Status tab provides information on the operation of this SM. This is the tab that opens by default when you access the GUI of the SM. The General Status tab provides the following read-only fields.

Device Type

This field indicates the type of the Canopy module. Values include the frequency band of the SM, its module type, and its MAC address.

Software Version

This field indicates the Canopy system release, the time and date of the release, and whether communications involving the module are secured by DES or AES encryption (see Encrypting Canopy Radio Transmissions on Page 369). If you request technical support, provide the information from this field.

Software BOOT Version

This field indicates the version of the CANOPYBOOT file. If you request technical support, provide the information from this field.

Board Type

This field indicates the series of hardware. See Designations for Hardware in Radios on Page 365.

FPGA Version

This field indicates the version of the field-programmable gate array (FPGA) on the module. When you request technical support, provide the information from this field.

Uptime

This field indicates how long the module has operated since power was applied.

System Time

This field provides the current time. Any SM that registers to an AP inherits the system time, which is displayed in this field as GMT (Greenwich Mean Time).

Ethernet Interface

This field indicates the speed and duplex state of the Ethernet interface to the SM.

Session Status

This field displays the following information about the current session:

- **Scanning** indicates that this SM currently cycles through the radio frequencies that are selected in the Radio tab of the Configuration page.
- **Syncing** indicates that this SM currently attempts to receive sync.
- **Registering** indicates that this SM has sent a registration request message to the AP and has not yet received a response.
- **Registered** indicates that this SM is both
  - registered to an AP.
  - ready to transmit and receive data packets.
- **Alignment** indicates that this SM is in an aiming mode. See Table 41 on Page 179.

Registered AP

This field displays the MAC address of the AP to which this SM is registered.

RSSI, Power Level, and Jitter

The General Status tab shows the received **Power Level** in dBm and **Jitter**. Proper alignment maximizes **Power Level** and minimizes **Jitter**. As you refine alignment, you should favor lower jitter over higher dBm. For example, if coarse alignment gives an SM a power level of −75 dBm and a jitter measurement of 5, and further refining the alignment drops the power level to −78 dBm and the jitter to 2 or 3, use the refined alignment, with the following caveats:

- When the receiving link is operating at 1X, the **Jitter** scale is 0 to 15 with desired jitter between 0 and 4.

- When the receiving link is operating at 2X, the **Jitter** scale is 0 to 15 with desired jitter between 0 and 9.

For historical relevance, the General Status tab also shows the **RSSI**, the unitless measure of power. Use **Power Level** and ignore **RSSI**. **RSSI** implies more accuracy and precision than is inherent in its measurement.

> *NOTE:*
> Unless the page is set to auto-refresh, the values displayed are from the instant the General Status tab was selected. To keep a current view of the values, refresh the browser screen or set to auto-refresh.

Air Delay

This field displays the distance in feet between this SM and the AP. To derive the distance in meters, multiply the value of this parameter by 0.3048. Distances reported as less than 200 feet (61 meters) are unreliable.

Site Name

This field indicates the name of the physical module. You can assign or change this name in the SNMP tab of the SM Configuration page. This information is also set into the *sysName* SNMP MIB-II object and can be polled by an SNMP management server.

Site Contact

This field indicates contact information for the physical module. You can provide or change this information in the SNMP tab of the SM Configuration page. This information is also set into the *sysName* SNMP MIB-II object and can be polled by an SNMP management server.

Site Location

This field indicates site information for the physical module. You can provide or change this information in the SNMP tab of the SM Configuration page.

Maximum Throughput

This field indicates the limit of aggregate throughput for the SM and is based on the default (factory) limit of the SM and any floating license that is currently assigned to it.

16.3.7 Continuing the Test of Point-to-Multipoint Links

To resume the test of links, perform the following steps.

Procedure 10: Verifying and recording information from SMs

1. Verify that the **Session Status** field of the General Status tab in the SM indicates **REGISTERED**.
2. While you view the General Status tab in the SM, note (or print) the values of the following fields:
   - **Device type**
   - **Software Version**
   - **Software BOOT Version**