



# MOTOwi4 Fixed Canopy® Point to Multipoint (PMP) System Planning Guide

## **PURPOSE**

The purpose of this document is to equip Motorola Canopy System customers with the information needed to effectively plan a wireless network.

This document is designed for general use. It is permissible to extract certain sections or subsections that apply to specific customer situations and incorporate them into sales collateral materials. This document should not be used for contracts or proposals in lieu of an official Motorola customer document. All information is subject to change.



## MOTOWi4 Wireless Broadband Solutions

The MOTOWi4™ portfolio of wireless broadband solutions combines speed and coverage to help network operators capture even the most demanding customers today and in the future. Network users want to share information in the form of data, voice and video images. The MOTOWi4 portfolio allows network operators to provide cost effective, reliable connectivity. Motorola's MOTOWi4 solutions provide a range of flexible, mix-and-match, cost-effective options to fit the network and business model: WiMAX, Fixed, Metro WiFi and mesh solutions and Broadband over Powerline (BPL).

### MOTOWi4 Fixed Solutions

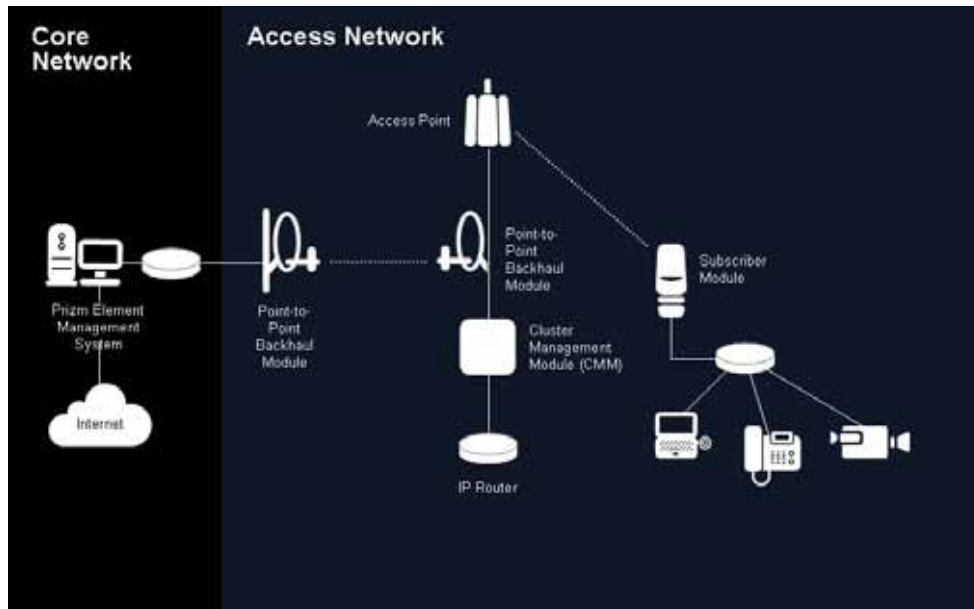
The wi4 Fixed portfolio combines point-to-point and point-to-multipoint solutions to enable cost-effective, reliable, and secure connectivity in thousands of networks in more than 150 countries today. Serving a broad range of licensed and unlicensed spectrums (with solutions at 900 MHz through the 5 GHz frequencies), the wi4 Fixed solutions are designed for even the harshest of outdoor environments to provide high-speed voice, access and data services.



### Motorola's Canopy System

The Canopy® system, Motorola's innovative wireless broadband solution, is the ideal technology for delivering high-demand technologies such as broadband Internet access, voice over IP, video services, security surveillance and E1/T1 connectivity. Canopy wireless broadband technology combines field proven toughness with exceptional performance, security, ease-of-use and cost effectiveness. It significantly reduces the time to design and deploy new commercial and enterprise broadband networks. It also seamlessly integrates with existing network systems and management tools to make extending and augmenting existing service simpler and less cost-intensive.

The Canopy platform offers one of lowest total costs of ownership in the industry, and can deliver proof of business case providing an ROI in just six-to-twelve months. The Canopy system leverages Motorola's more than 75 years of radio knowledge, experience and leadership. Motorola's dedication to creating and maintaining trusted relationships over the long-term means Canopy platform users are assured of high levels of worldwide service and support as their networks grow over the years.



The Motorola Canopy system is a total Broadband Wireless Access (BWA) solution for extending the existing network to provide broadband services to new users. The system provides a wireless Ethernet connection which can be used to transport voice, video and data in channelized or unchannelized formats. Modules are available to support Line of Sight (LOS) and Non-Line of Sight (NLOS) point-to-point links and point-to-multipoint last mile access solutions. With a broad array of Backhaul (PTP module), Access Point (AP) and Subscriber Modules (SM), the system can be configured to meet the current and future needs of business and residential network users.

Sources of additional information are listed on the last page of this document.

### Benefits of the Canopy System

- **Service providers can enhance their customer base and revenues** by extending the network to reach new business and residential subscribers beyond the reach of wireline broadband offerings.
  - Complement existing broadband network to reach customers in new territories, whether adjacent to an existing network or a completely new region
  - Offer wireless broadband services to existing subscribers currently using dial-up; alternative to other equipment like DSL and cable
  - Extend network geography into new, underserved areas
  - Rapidly mass-deployed, value-based broadband
- **Enterprises can establish cost-effective links** to campus locations or remote branch offices at a fraction of the cost of leasing lines or deploying wireline broadband systems.
  - Rapid access to business information between locations
  - Cost-effective; substantially less than cost of leased-line alternatives – no recurring monthly fee
  - Wireless infrastructure to connect indoor wireless local area network (WLAN), creating a completely wireless IP network and connecting inside to outside
- **Government Network Operators can establish cost-effective links** for public safety, public service, and public access.
  - Rapidly deploy video surveillance and data connectivity for public safety
  - Create a cost effective data network for public works
  - Create an infrastructure for community wide public access

## Applications

The Canopy system provides a wireless broadband connection for IP traffic. Canopy modules can be used to complement DSL, Cable, Fiber and other wireless networks or used in stand alone configurations.

- **Data Transfer** - The Canopy platform brings powerful radio technology to enterprise communications applications, making deploying and delivering low-cost broadband access faster and easier than ever before. It provides the performance, versatility, ease-of-use and affordability that enable enterprise environments—including corporate, municipal, healthcare, education and more—to improve communication, productivity, security and return on investment (ROI).



- **Video** - IP-based video surveillance is revolutionizing the way organizations, municipalities and institutions are protecting their property, personnel and proprietary assets. Motorola's proven Canopy wireless technology helps network operators and their customers join the revolution. Compared to analog or hybrid systems, IP-based solutions provide a number of crucial advantages, including:



- Real-Time Situational Awareness and Response
- Remote Monitoring and Accessibility
- Faster, Lower Cost Deployment
- Leverage the Existing Networks
- Maximize the Benefits of Smart Cameras and Software
- Optimized ROI
- Digital Image Encryption for Security Purposes

- **Voice** - Canopy modules can be used to transport Voice over IP (VoIP) services as a PBX extension when IP phones and typical hubs are used at the customer premises.



## Key Attributes of the Canopy System

In today's crowded broadband communications marketplace, no system can match the Motorola Canopy platform's combination of advanced technology, simplified configuration, rapid deployment and remarkable cost effectiveness. The system enables ISPs to differentiate themselves, create competitive advantage and attract and please increasingly demanding residential and business customers, even in hard-to-reach areas.

### Simple Network Design

The Canopy system's intelligent protocols streamline deployment and operation. A simple network design allows the system to complement the existing network, and makes it exceptionally easy to install. The equipment is intuitive and efficient, providing built-in installation and deployment assistance that makes it faster to get up and running... often in a matter of hours or days instead of weeks or months.

### Superior Performance

The Canopy solution delivers superior performance using a modulation scheme that improves the quality of data delivery and mitigates interference from other systems. The system's wireless signals are highly effective in penetrating obstacles and avoiding obstructions, making it as efficient in dense urban environments as it is in suburban areas or rural locations. The platform provides last mile access in a variety of spectrum choices, ensuring exceptional broadband performance no matter which spectrum is best for network performance.

### **Exceptional Security**

The platform also offers security with over-the-air DES (Data Encryption Standard) encryption and is also available with AES (Advanced Encryption Standard) capabilities, which provide 128-bit encryption, to ensure secure data delivery and exceptional reliability.

### **Incredible Speed**

The Canopy platform's upload and download speeds are as fast as or faster than virtually every other service available today. The point-to-multipoint Canopy system offers speeds from 512 Kbps to 21 Mbps (aggregate data rates) and the Motorola point-to-point bridges deliver from 7.5 to 300 Mbps (aggregate data rates) to network users. Of course, upload and download speeds are affected by several factors so actual speeds may vary, but the potential to offer an incredible broadband experience is inherent in the Canopy system.

### **Interference Tolerance**

Because of its unique signal synchronization, the Canopy system has a high level of tolerance to self-interference. The Canopy system provides reliable service even when the APs are placed close together.

### **Scalability**

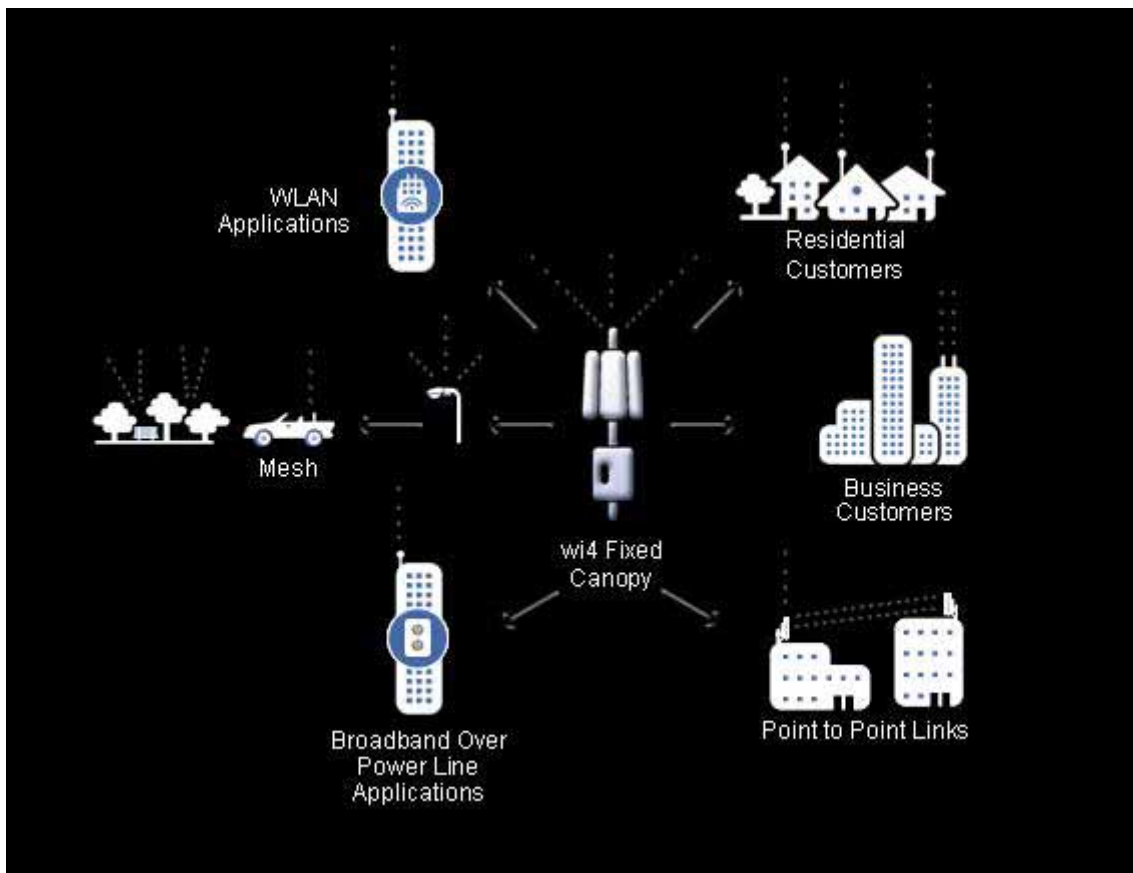
The Canopy system scales to meet network growth so that throughput remains consistent as new subscribers are added to the network.

### **Return on Investment**

Low infrastructure costs and wireless last mile connectivity yield a payback in terms of months. Motorola is glad to provide detailed case studies of customers who have successfully deployed the Canopy system in a variety of applications.

### **Flexible Configuration Options**

The Canopy system offers configuration options that meet and exceed both provider and customer expectations. The platform can be configured as a single-site point-to-multipoint system that supports subscribers for distances up to 15 miles (24 kilometers). The Motorola point-to-point series of wireless Ethernet bridges increase delivery range up to 124 miles (200 kilometers). In addition, the system includes interfaces that enable it to easily integrate with standard network management tools and billing systems, as well as diagnostic capabilities needed to remotely monitor the network.



Canopy solutions are used in the unlicensed bands and these products have been designed from the ground up to optimize interference tolerance. With GPS synchronization, they provide superior performance in areas where there is noise in the spectrum. These solutions can be deployed as an access network, or as a capacity injection layer for other last mile solutions.

Canopy solutions are proven reliable, cost effective proprietary solutions. To date, these solutions comprise the largest deployment of MOTOWi4 modules.

**AP and SM**

The Access Point Module (AP) distributes network or Internet services in a 60° sector for as many as 200 subscribers. The AP is configurable through a web interface. The Subscriber Module (SM) is a Customer Premise Equipment (CPE) device that extends network or Internet services by communication with an AP. The SM is configurable through a web interface.

**Access Points** are available in a wide range of frequencies from 900 MHz to 5.9 GHz. These modules are available with integrated antennas for ease of installation, or are available with connectorized versions to enable network operators to configure their network to meet their specific requirements. AP's are also available with higher performance options to provide higher throughput and NLOS connectivity.



**Canopy AP Cluster**



**400 Series AP**

**Subscriber Modules** are CPE equipment at the subscriber location. These modules are simple to install and can provide connectivity for a single device or a downstream access WLAN network. SMs are available in a wide range of frequencies for 900 MHz to 5.9 GHz. These modules are available with integrated antennas for ease of installation, or are available with connectorized versions to enable network operators to configure their network to meet their specific requirements. 900 MHz SMs have an Indoor option. SMs can be equipped with passive range extenders to boost performance to establish connectivity to distant locations. SM's are also available with higher performance options to provide higher throughput and NLOS connectivity. Power Supplies and mounting brackets for SMs are sold separately.



**SM with Reflector**



**900 MHz Indoor SM**



**400 Series SM**



### Point to Point (PTP) Links

PTP modules provide point-to-point connectivity in either

- a standalone RF or wired link to another PTP
- a wired link through a cluster management module to an AP cluster.

### Element Management

Canopy Prizm software allows network operators to

- distribute bandwidth
- manage authentication
- monitor network performance

### Cluster Management Module (CMM)

The Cluster Management Module provides GPS synchronization to the AP and all associated SMs. The CMMmicro or CMM 4 provides power, GPS timing, and networking connections for an AP cluster. If the CMM is also connected to a PTP module, then the CMM is the central point of connectivity for the entire site. The CMM can connect as many as eight collocated modules and an Ethernet feed.

### Power Connection and Cables

The 110-V AC input Motorola ACPSW-13B power supply provides 24-VDC/400-mA power to SMs in Canopy networks in U.S.A., NOM, and Canada. Other regions use the ACPSW-09B. The Canopy system is typically installed on outside infrastructure platforms such as radio towers and roof top locations. Motorola recommends the use of shielded outdoor cables that adhere to Category 5 and 5e standards for the installation of Canopy AP, PTP and outdoor SM modules.

### Coverage Extender

The Coverage Extender provides simple, high performance expansion of a Canopy network to serve potential end-customers outside of current wireless coverage range. The Coverage Extender enables service providers to deliver reliable VoIP and data service in areas that previously could not be cost effectively covered. These potential customers may simply be located beyond the line-of-sight (LOS) of the Access Point (AP) or AP cluster, or within range, but in a coverage dead-zone, blocked by manmade or natural obstructions.



### Reflector

The 27RD Passive Reflector Dish extends the distance range of a module and focuses the beam into a narrower angle. The internal patch antenna of the module illuminates the Canopy Passive Reflector Dish from an offset position. The module support tube provides the proper angle for this offset.



### LENS

The Canopy LENS Antenna enables service providers to provide reliable data and VOIP services in areas that could not previously be reached due to range limitations. By increasing the range and focusing the antenna beam, the LENS allows service providers the ability to reach more subscribers and results in a reduction of external RF noise. This compact yet durable product easily mounts directly onto existing Canopy radios and requires no additional mounting hardware.



### Surge Suppressor

The 200SS or 600SS Surge Suppressor provides a path to ground (Protective Earth) that protects connected subscriber home equipment from near-miss lightning strikes.



## Point-to-Multipoint Access

### Throughput and Range

The Canopy BWA system with its hundreds of engineering years of design, more than 60 patents, and hundreds of commercially deployed networks in over 150 countries, has the proven design to truly deliver Broadband Wireless Access for all applications. Designed from the ground up to optimize consistent performance across the network, the Canopy system has been proven to provide reliable throughput to all network users in the following cases:

- Small and large number of subscribers in the network
- Subscribers located both near to and far from the Access Point location
- Network carrying varying types of traffic

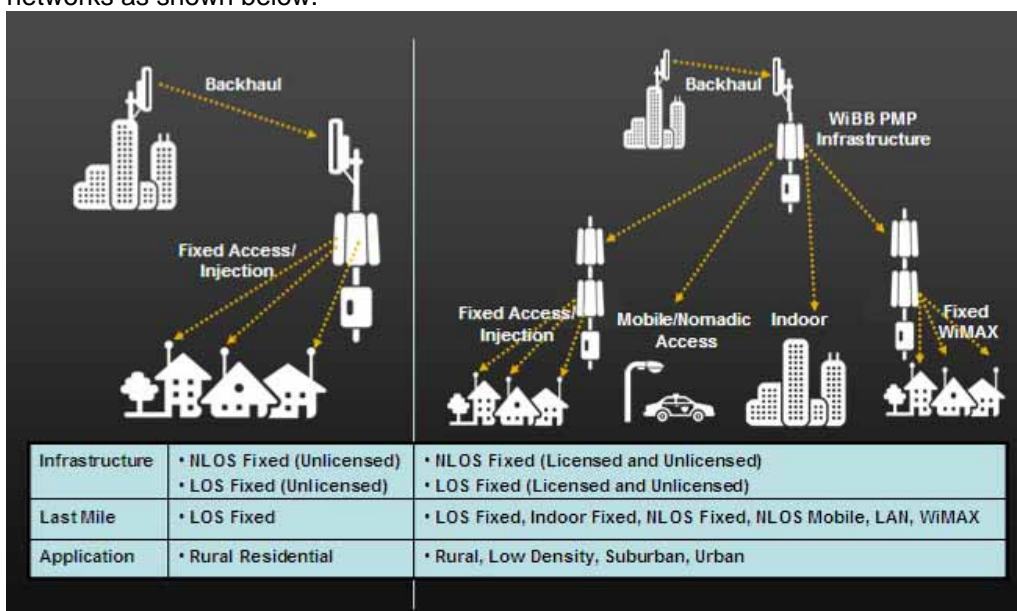
Operating range and data throughput are dependant on many factors including: terrain, foliage, background RF energy, and other conditions. Canopy system modules are designed to provide reliable communication with a minimal difference in throughput as distance increases and as subscribers are added to the network. The Canopy system's unique signaling technique provides a consistent data rate and throughput to users across the entire service area.

### Access Networks

Canopy system Access Points and Subscriber Modules comprise the access network. APs are the distribution head end and each one serves up to 200 subscribers in a 60° arc. APs can be clustered in groups of up to six providing 360° Line of Sight (LOS) coverage for a community of up to 1,200 subscribers. SMs are installed at the subscriber location. With the new Canopy 400 Series AP and SM products provide near-line-of-sight (nLOS) and non-line-of-sight (NLOS) performance through the use of OFDM technology, longer cyclic prefixes, and higher gain antenna solutions. The improvement is seen most in multi-path environments where the signal is reflected off other buildings and objects. Improvements in penetration of foliage are also possible. In general, OFDM technology improves performance in near- and non-line-of-sight environments. This makes it possible to provide connectivity in areas where trees or other items may be present.

### Network Infrastructure

A Canopy network can be deployed as an infrastructure to provide bandwidth to an access last mile application. Canopy networks can supply connectivity for WiMAX, WLAN, mesh and other networks as shown below.



In addition to standard configurations with the AP at the distribution head end, the Canopy system architecture supports remote AP configurations, where an AP is co-located with an SM to provide for remote distribution and increased network extensions. This technique is useful in two deployment situations:

- Extend range and coverage
- Get under the tree line and distribute the signal to a cluster of customers in an area

Canopy system modules are available in different frequencies to afford flexibility in network design and allow equipment selection for the best RF solution for each individual service area. In addition, passive reflectors are available for most Subscriber Modules to provide extended range capabilities to reach remote subscribers and also reduce interference by creating a smaller beam pattern.

Motorola recommends that the network be built with a backbone of 5.2 and 5.7 GHz equipment where possible because those frequencies typically have less interference. 2.4 GHz modules can provide extended range. 900 MHz modules can then be used to reach subscribers in sparsely

populated remote areas or in areas where increased Non Line of Sight (NLOS) performance is required to penetrate foliage.

Below is a sample chart of the different products available, their typical applications and features.

Product	Typical Application	Features
Canopy CSM54400 SM	<ul style="list-style-type: none"> <li>Enterprise and/or residential broadband services</li> </ul>	<ul style="list-style-type: none"> <li>21 Mbps maximum throughput to a single user</li> <li>nLOS/NLOS</li> <li>Operator configurable Cap on CIR</li> </ul>
Canopy Advantage SM	<ul style="list-style-type: none"> <li>Enterprise broadband services</li> </ul>	<ul style="list-style-type: none"> <li>14 Mbps maximum throughput to a single user</li> <li>Operator configurable Cap on CIR</li> </ul>
Canopy SM	<ul style="list-style-type: none"> <li>Residential and/or enterprise broadband services</li> </ul>	<ul style="list-style-type: none"> <li>7 Mbps maximum throughput to a single user</li> <li>Operator configurable Cap on CIR</li> <li>Upgradeable to Advantage SM capabilities to offer more bandwidth as demand grows</li> </ul>
Canopy Lite SM	<ul style="list-style-type: none"> <li>Emerging markets or for residential broadband services</li> </ul>	<ul style="list-style-type: none"> <li>Entry level pricing for emerging markets</li> <li>512 kbps maximum throughput to a single user</li> <li>100 kbps cap on CIR</li> <li>Throughput upgrades to 1, 2, 4, 7 Mbps throughput</li> </ul>

Frequency	Canopy 400 Series	Canopy Advantage	Canopy	Canopy Lite
900 MHz			•	
2.4 GHz		•	•	•
5.1 GHz		•	•	
5.2 GHz		•	•	•
5.4 GHz	•	•	•	•
5.7 GHz	•	•	•	•
5.9 GHz		•	•	

## Performance

The Canopy system gracefully scales to support large deployments. The system's unique synchronization allows network operators to re-use frequencies within a geographic area and add capacity while consistently ensuring consistency in the quality of service to customers. As a result, subscribers can experience consistently reliable service. The Canopy system's unique signal modulation technique yields an industry-leading nominal Carrier to Interference (C/I) ratio of less than 3 dB and ensures reliable communication when other transmitters are present.

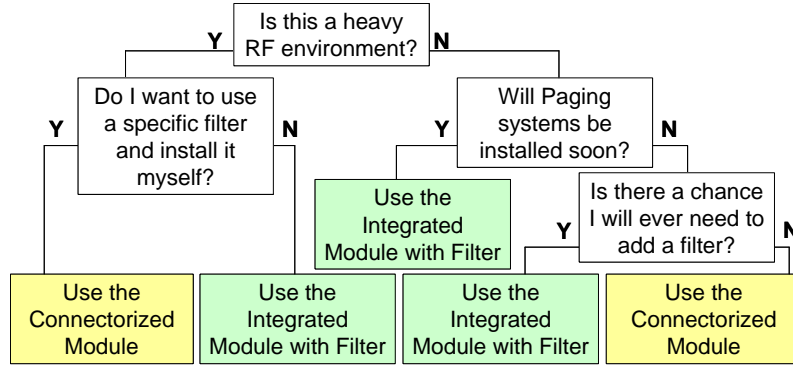
The following chart shows the differences in throughput, burst rates and Committed Information Rates (CIR) for each of the Canopy modules.

Product	Total Aggregate Throughput	Burst	CIR in Each Direction	VoIP Channels Supported	Typical Application
<b>Canopy 400 Series SM</b>	21 Mbps	21 Mb	No Cap	Multiple	Residential and/or Enterprise Broadband Services
<b>Canopy Advantage SM</b>	14 Mbps	14 Mb	No Cap	Multiple	Enterprise Broadband Services
<b>Canopy SM</b>	7 Mbps	14 Mb	No Cap	Multiple	Residential and/or Enterprise Broadband Services
<b>Canopy Lite SM</b>	512 Kbps	768 kb	100 kbps	1	Emerging Market or Residential Broadband Services
	1 Mbps	1.5 Mb	100 kbps	1	
	2 Mbps	3.0 Mb	100 kbps	1	
	4 Mbps	7.0 Mb	200 kbps	2	
	7 Mbps	7.0 Mb	200 kbps	2	

A Canopy Lite Upgraded to 7 Mbps of throughput does not have the same burst or QoS features as a Canopy SM

**Noise Filters**

900 MHz is a crowded frequency. Band pass filters are available to reduce the out of band noise received. The following chart will aid in deciding whether to use a filter for 900 MHz installations. The Canopy system now offers 2 channel and 3 channel filters, depending on which frequencies are desired to be used.

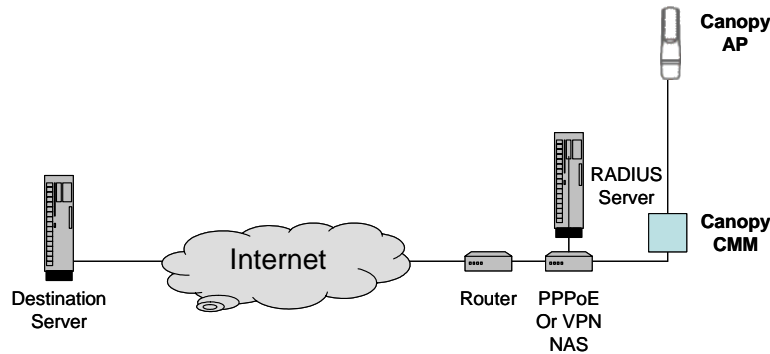


**Connecting the AP to the Network**

The Canopy system appears to the network like a layer 2 bridge and is transparent to layer 2 protocols. The AP is connected to the network via a UV rated CAT 5 cable approved for outdoor applications. Where more than one AP is installed in a cluster, a Cluster Management Module (CMM) will distribute and synchronize the signals of the AP cluster.

**Cables**

Proper cable and cable connections are critically important to ensuring the proper performance of the Canopy system. The Canopy system is typically installed on outside infrastructure platforms such as radio towers and roof top locations. Motorola recommends the use of shielded outdoor cables that adhere to Category 5 and 5e standards for the installation of Canopy AP and PTP module modules.



## Point-to-Point Links

The Canopy system modules provide 10, 20, 30, 60, 150, and 300 Mbps wireless Ethernet links at a number of frequencies. PTP modules are simple to install. PTP link installation can often be completed within a few hours, saving valuable time and expenses. There is no need to work out right-of-way issues or wait for costly network build-outs. Many of the backhaul modules are available with passive reflectors to extend range.

- **PTP 100 Series** – This series of radios makes use of Motorola’s proprietary technology to deliver high-speed bandwidth across distances of up to 2 miles at consistent data rates. These modules can be equipped with a passive reflector to increase the range up to 35 miles.
- **PTP 400 and 600 Series** – This series of radios enables users to achieve greater throughput at distances of up to 124 miles, using wireless Ethernet bridges that can deliver 99.999 percent availability in even the most challenging environments. At short distances, speeds of up to 300 Mbps are possible. These modules are available with integrated antennas or as connectorized modules to use with an external antenna.



The Return on Investment (ROI) is a matter of months because PTP links provide a permanent solution at a fraction of the cost of leased line alternatives.

Product	Frequencies	Usable Throughput	Typical LOS Range (miles)	Applications
PTP 100 Lite	2.4, 5.1, 5.2, 5.4, 5.8 GHz	7.5 Mbps	LOS-Up to 35 miles (56 km)	<ul style="list-style-type: none"> <li>• High throughput connection to backhaul voice, video and data</li> <li>• Backhaul for WiMAX base stations</li> <li>• Extend channelized T1/E1 services over a long distance</li> <li>• Interconnect campus buildings and remote branch offices</li> <li>• Reach remote AP clusters</li> <li>• Extend PBX circuits</li> <li>• Backhaul to Cellular sites</li> <li>• Provide secure stand-alone network</li> <li>• Cost effective backhaul link to reach AP clusters</li> <li>• Remote Security surveillance</li> </ul>
PTP 100	2.4, 5.1, 5.2, 5.4, 5.8 GHz	14.0 Mbps	LOS-Up to 35 miles (56 km)	
PTP 400 Lite	4.9, 5.4, 5.8 GHz	1.5-21 Mbps	LOS-Up to 124 miles (200 km) nLOS-Up to 25 miles (40 km) NLOS-Up to 6 miles (10 km)	
PTP 400	5.4 & 5.8 GHz	3-43 Mbps	LOS-Up to 124 miles (200 km) nLOS-Up to 25 miles (40 km) NLOS-Up to 6 miles (10 km)	
PTP 600 Lite	5.4 & 5.8 GHz	7-150 Mbps	LOS-Up to 124 miles (200 km) nLOS-Up to 25 miles (40 km) NLOS-Up to 6 miles (10 km)	
PTP 600	5.4 & 5.8 GHz	14-300 Mbps	LOS-Up to 124 miles (200 km) nLOS-Up to 25 miles (40 km) NLOS-Up to 6 miles (10 km)	

## Putting the Canopy Network in Service

Canopy system modules can be combined to tailor the network to meet current and emerging needs. As demand grows over time, new modules can be added to support network extensions or to add capacity to backhaul links.

### **Step 1 – Perform Site Survey**

A site survey includes both a physical and a radio frequency analysis of the area where the network is to be installed.

#### **Physical Survey Issues:**

- availability and height of tower locations
- estimate of coverage area
- type and density of foliage
- geographic conditions, including man made structures
- environmental conditions including seasonal changes

#### **RF Survey Issues:**

- spectrum analysis of the geographic area at desired frequency
- spectrum analysis at alternative frequencies
- polarization of signals
- anticipated changes in local RF conditions

### **Step 2 - Select Reference Architecture**

After considering goals and business strategy, select from the reference architectures in this document the ones that most suits the business requirements. If the network includes diverse markets, a combination of reference architectures may be the most appropriate solution.

The Canopy system is deployed in more than 150 countries, and trained Motorola account managers, distributors and resellers will help design a network that best meets current and future requirements.

### Step 3 - Plan Deployment

From the network specific architecture, detailed equipment requirements are developed. The network is engineered and module locations are verified.

The following aspects need to be fully considered:

Aspect	Explanation
<b>Bandwidth Distribution</b>	<p>The aggregate throughput requirement for each AP needs to be considered. This includes all downlink data to all subtending SMs and all uplink data from all SMs that link to the particular AP.</p> <p>While a single AP can communicate with up to as many as 200 SM's, keep in mind that the aggregate throughput is distributed across the SMs that are actively getting data simultaneously.</p> <p>Where a PTP module is co-located with an AP cluster, the total throughput of the AP cluster should be used to determine the bandwidth requirement for the associated PTP module link.</p> <p>For PTP modules, the aggregate throughput on the channel also needs to be considered in network design. If a PTP module is set to a downlink ratio of 50%, then the bandwidth in each direction is half of the total PTP module link bandwidth.</p>
<b>RF Planning</b>	<p>Before diagramming network layouts,</p> <ol style="list-style-type: none"> <li>1) <b>Anticipate the correct amount of signal loss</b> for link budget calculation. Motorola provides the antenna gain, receiver sensitivity, EIRP power level for each module. Use this information to determine the range of the system in a specific network application.</li> <li>2) <b>Recognize all significant RF conditions.</b> An RF signal in space is attenuated by Fresnel zones, 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.</li> <li>3) Consider the specific site requirements: <ul style="list-style-type: none"> <li>• Tower rights</li> <li>• Power availability</li> <li>• Temperature control</li> </ul> </li> <li>4) <b>Evaluate potential sites</b> by their fitness to address fade margin and ambient RF conditions. An essential element in RF network planning is the analysis of spectrum usage and the strength of the signals that occupy the spectrum planned for use.</li> </ol>
<b>IP Network Architecture</b>	<p>PMP network elements are accessed through IP Version 4 (IPv4) addressing. Proper IP addressing method is critical to the operation and security of the network. For security, the network operator should either assign a private IP address, or assign a public IP address only if a firewall is present to protect the module. The Canopy system allows selectable Maximum Information Rates (MIR) to provide data rates that meet customer requirements.</p>

There are many successful deployments of PMP networks which apply the strengths of the different modules to meet the specific requirements of the particular environment in which they are used. These networks use combinations of 2.4 GHz, 5.1, 5.2, 5.4, 5.7 and 5.9 GHz APs, SMs and Backhauls, complemented with 900 MHz modules to fill in the holes or difficult to reach areas of the network.

#### Network Planning “Do’s”

Given the crowded bands in the unlicensed spectrum, there are some things that network operators can do to get the best advantage possible:

- Understand that the spectrum can be very congested with both in-band and out-of-band interference.
- Perform a spectrum analysis of the area from the location where the AP’s are intended to be mounted and mount the AP as high as possible where there is a clean RF environment.
- Use regulatory certified sectorized antennas where possible.
- Ensure that the equipment is configured properly with correct “max range” and “antenna gain” settings.

#### Network Planning “Don’ts”

There are some key activities to avoid, and avoiding these will also help get the best advantage in operating the network successfully:

- Don’t use omni directional antennas if it can be avoided. Omni directional antennas are exposed to interference from every direction.
- If it can be avoided, don’t use vertical polarization for 900 MHz. Simply using horizontal polarization at this frequency is likely to reduce the noise level.
- Don’t set the “antenna gain” parameter with anything except the actual gain of the antenna. Other numbers may violate regulatory limits for power output.
- Don’t increase the value of the “antenna gain” parameter expecting it to increase power output.
- Don’t expect filters to help with in-band interference. Band pass filters specifically eliminate out-of-band interference, but have no effect on in band interference.

Motorola and many of our distributors offer specific training for network operators to ensure that the PMP system is planned correctly and implemented properly. This training includes discussion of case studies in network deployment and development of a high level deployment configuration for a sample network.

## PMP Network Management Capabilities

### Element Management

The Element Management System provides network operators bandwidth allocation control to assign maximum data rates per subscriber including:

- Sustained Uplink
- Uplink Burst Allocation
- Sustained Downlink Data Rate
- Downlink Burst.
- In addition, the EMS is the central point of authentication in the PMP system. Complementing the PMP system's data encryption, the element management system provides an additional layer of security to restrict access to system data.
- RADIUS Authentication enables network operators to exchange information freely from the PMP system and therefore, will not need to maintain separate databases.
- Support for a Variety of Databases means that the EMS will work with more installed operations systems including RADIUS servers, or to a specific database through ODBC.

### Security

- FIPS 197 Certified Advanced Encryption Standard (AES) encryption is a 128-bit encryption standard that meets the security requirements of federal, municipal, financial and health care institutions.
- DES (Data Encryption Standard) encryption that provides 56-bit encryption.
- BRAID Encryption - The AES key is encrypted by Motorola's 128-bit Telecommunications Industry Association (TIA) standard BRAID algorithm making it more secure than others in the market.
- Synchronization - The PMP system's unique synchronization technique provides higher security than 802.11 alternatives by requiring precise synchronization from all modules in the network.
- Authentication - PMP modules can be scheduled to periodically exchange a random number "challenge" to authenticate system users and keep out "rogue" modules.
- PTP400 and PTP600 units employ a built in proprietary signal with scrambling applied as an additional layer of security. In addition, this backhaul employs the following security levels:
  - Reed Solomon forward error correction
  - Scrambling code that repeats every eight Reed-Solomon code words (about 1 ms).
  - Interleaver where the signal is then changed in order
  - Convolutional Encoding where the signal is scrambled into two streams and then sent serially with some bits unsent.
  - Encoding into BPSK, QPSK, 16QAM or 64QAM waveforms
  - Interleaving across a 1024 carrier OFDM wave form.

### Step 4 - Install and Verify Service

Properly planned, installation of the Canopy system can be completed in a matter of hours. The PMP system includes detailed user interfaces to provide required information to the field technician. When necessary, the system also provides detailed diagnostic information to assist field technicians in the troubleshooting and repair process.

Motorola training includes modules on installation and repair and a hands-on lab where attendees work with live system modules to perform the installation and verification procedure.

## Reference Architectures for Access Networks

The following reference architectures illustrate some of the applications that carriers have deployed using Canopy systems. Canopy systems are used for:

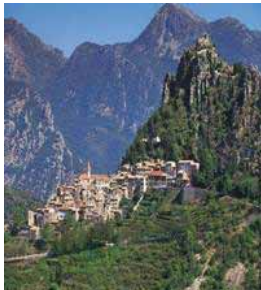
- Green field deployments and network extensions
- Establishing new links instead of leasing services
- Reaching new areas
  - Remote locations
  - Cross over obstructions or right of way
- Providing new services
  - Remote Video Monitoring
  - Broadband access

The following reference architectures are included:

- 1. Network Extensions
- 2. Video Monitoring at a Remote Location
- 3. Remote Area Service
- 4. Extend IP Networks
- 5. High Throughput Data Transfer
- 6. Connect over a Right of Way

**Reference Architecture 1: Network Extensions**

Network extensions can be quickly deployed without the labor and material cost of laying cable and a DSLAM. Also, new broadband subscribers can be added without requiring grooming of the existing network for broadband services.

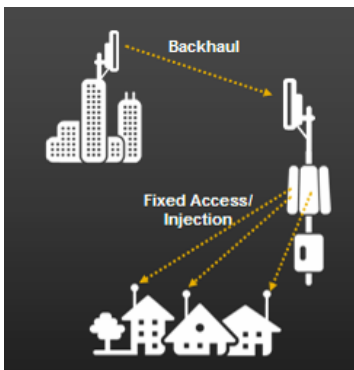


*Application:* A service provider offers broadband service to a new construction residential community or business campus. Residents have reliable service available faster than wireline alternatives.

The Canopy system complements the existing broadband network and allows service providers to build incremental extensions. In areas where existing DSL equipment is operating at capacity, it is difficult to cost justify capacity additions for incremental subscriber additions. Service providers have the opportunity to quickly provide broadband service to these customers.

*Application:* A LEC provides broadband service to new customers in an area where the DSL network is operating at capacity.

*Reference Architecture:*



**Reference Architecture 2: Video Monitoring at a Remote Location**

Because of the low installation cost and ease of relocation, wireless access may be the only viable solution for remote live motion video surveillance, automation control, portable applications or temporary broadband link requirements.



*Application:* An International airport installed over 60 full motion cameras using Canopy links to relay sound and video to a center to monitor cameras, gates and phones. The network operator did not have to incur the cost and time to dig a trench or lease T1 services.

*Reference Architecture:*



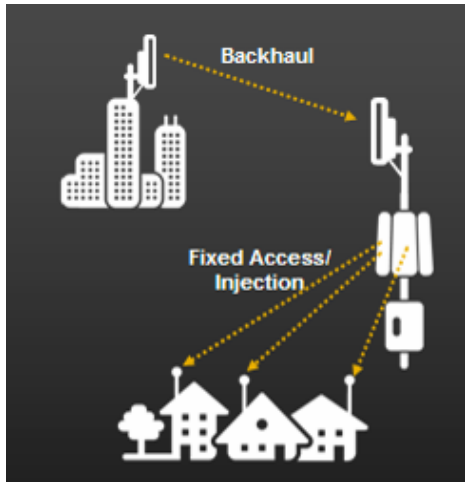
**Reference Architecture 3: Remote Area Service**

Motorola's Canopy system allows service providers to reach into remote areas quickly without requiring expensive and time consuming network build-outs. The Canopy system can augment the existing network to reach out to remote dial-up users.



*Application:* A Midwest LEC adds broadband network services to an area previously serviced only by dial-up using 900 MHz Subscriber Modules.

*Reference Architecture:*



**Reference Architecture 4: Extend IP Networks**

Provide IP connectivity to buildings not served by broadband or fiber services. The Canopy system's fast installation time and lower initial and operating costs allow network owners to connect broadband service in a matter of hours.



*Application:* Business branch offices in remote locations use Canopy links to share data with the regional center.

*Reference Architecture:*



**Reference Architecture 5: High Throughput Data Transfer**

Provide additional network link capacity to existing locations by adding multiple wi4 Fixed system backhaul modules to transfer information.

Application: Wi4 Fixed links enable doctors at five clinics to share information, images and x-rays for diagnostics and consultation.

Reference Architecture:



**Reference Architecture 6: Connect over a Right of Way**

Provide secure, reliable service on long-range, high-throughput LOS, nLOS and NLOS links with varying throughput levels.

Reference Architecture:



**Reliable, Secure Network Extensions for Network Operators**

Network owners need to deploy reliable broadband services to meet demand. Network extensions must provide data, voice and video services quickly and efficiently, providing capacity in a “just-in-time” manner. Motorola’s Canopy system provides proven secure, reliable broadband service over a wireless connection. Network operators can extend existing networks at a fraction of the cost of wireline alternatives because there is no trenching or waiting to increase network coverage. The Canopy system is comprised of point-to-point links and point-to-multipoint access networks which are easily configured to meet specific performance and cost requirements.

Service providers require secure and reliable communications. Motorola’s Canopy system, with patented signaling technology and military-level security, provides the reliability associated with wireline services with the cost advantage of wireless technology. The Canopy system provides an opportunity to efficiently extend the network in areas where the investment required to deploy wireline service is restricting growth.

Requirement	Canopy System Performance
<b>Reliability</b>	<ul style="list-style-type: none"> <li>Because of its unique signal modulation technique, the Canopy system is the most interference tolerant system in the unlicensed spectrum.</li> <li>Data rate and throughput is consistent to all subscribers – even those at the outer edge of the network.</li> </ul>
<b>Installation and Maintenance</b>	<ul style="list-style-type: none"> <li>Subscriber modules are fast to install.</li> <li>Built in alignment tools verify installation and minimize truck rolls.</li> <li>Technical training available to shorten the learning curve for installs and support</li> </ul>
<b>Security</b>	<ul style="list-style-type: none"> <li>FIPS 197 AES encryption meets HIPAA and military specifications.</li> <li>Multiple layers of encryption and authentication restrict access to data.</li> </ul>
<b>ROI</b>	<ul style="list-style-type: none"> <li>System payback is in terms of months.</li> <li>The system scales to deployment levels with low up front investment.</li> </ul>

**Key Points to Keep in Mind when Planning a Network**

- **Quality of Service:** The Canopy system provides carrier grade reliable service because of its industry leading interference tolerance.
- **Capacity:** The Canopy system provides a consistent data throughput to all subscribers. The data rate is consistent for even the most distant subscribers in the network and does not degrade as more subscribers are added to the network.
- **Security:** The Canopy system has multiple layers of security with authentication and military-level data encryption to restrict access by unauthorized users.
- **Network Management:** The Canopy system integrates into existing network management systems through open interfaces from an element manager.
- **Scalability:** With an array of access network modules and a selection of point to point links, carriers can expand their customer base and associated revenue quickly.
- **Reliability:** The Canopy system is field-proven. All of the configurations and reference architectures in this document are based on actual installations.

**Facts and Fiction about Broadband Wireless Access**

Network operators who have built their business on reliable service are rightfully concerned about perceptions regarding wireless broadband technology. There are wireless broadband products on the market that do not adhere to the same stringent requirements as the Canopy products and whose performance, reliability and security have led to negative perceptions of interference problems, excessive downtime and loose security.

Concern	Canopy System Deployment Fact
Wireless broadband systems are not secure against hackers and intruders.	The Canopy system has multiple security layers including signal modulation technique, authentication and military-level AES encryption. It is certified FIPS 197 compliant by NIST and meets HIPPA requirements. Canopy solutions provide a level of security that is the equivalent of wireline services.
Wireless broadband systems do not provide the advertised data rate to the maximum range.	The Canopy system's unique signal modulation is different from 802.11 systems and allows all subscribers to receive the design bandwidth regardless of the distance from the AP to the SM.
The number of subscribers will load down the system.	The Canopy system scales from an initial deployment to serving dense metropolitan area while maintaining a consistent throughput to all subscribers in the network.
Unlicensed wireless communication is not reliable for quality service.	The license-free spectrum is available for use at no charge and is open to many users, and network operators should check a frequency before they use it. The Canopy system is unique in that it was designed to be optimized for interference tolerance. The Canopy system's synchronization and signal modulation yield an industry leading tolerance to interference.
I don't understand wireless technology enough to deploy it in my network with confidence.	Motorola has deployed wireless technology for decades. In the few years that the Canopy system has been available, it has been deployed to tens of thousands of subscribers in more than 120 countries. Motorola provides training, technical support and will introduce new network operators to an enthusiastic community of users who have experienced the benefit of the Canopy system for themselves.
Doesn't the weather have an impact on the quality of service I can expect?	Extreme weather can affect communications. Canopy modules operate at frequencies that are not affected by weather conditions. Canopy systems are field proven in hot, cold, humid, and windy conditions. Refer to the product specification sheets for detailed information.

**Network Deployment**

With the many different Canopy system modules, network operators can follow demand when building the network and overlay different frequencies as required. Areas of access network coverage can be linked to the network by Canopy system backhaul connections.

By co-locating Canopy system AP's of different frequencies, network operators can provide coverage to dense locations while reaching out to remote locations.

Issue	Canopy System Performance	Canopy Benefit
<b>Scalability</b>	The Canopy system can scale from fewer than 200 subscribers in an area using a single AP to as dense as 4,800 subscribers in an urban area using multiple APs	The Canopy system provides “just-in-time” scalability so that the investment is made as subscribers are added, not upfront where usage must be anticipated weeks, months or even years in advance. As subscribers are added to the network, data throughput to each subscriber remains consistent.
<b>Traffic Type</b>	The Canopy system supports legacy voice, video and data transmissions.	These services provide additional revenue streams.
<b>Security</b>	The Canopy system products are available with either AES or DES encryption. All Canopy system modules have multiple layers of authentication to restrict access.	Service providers can meet the encryption requirements of municipalities, hospitals and corporate enterprises.
<b>Redundancy</b>	The Canopy system point to point links are cost effective redundant backhaul links where Ethernet connections are required.	Service providers can offer reliable redundant services at a fraction of the cost of building out the wireline network.
<b>Options</b>	The Canopy system modules are designed to be tailored to meet specific network requirements. Options for data encryption, passive reflectors and antennas make the system highly configurable.	Network investment is triggered by specific customer demand, lowering initial investment in network facilities.

**Network Design Tradeoffs**

Canopy system AP's have the capacity to communicate with up to 200 SM's. AP's can have a 7, 14 or 21 Mbps throughput (depending upon the platform Lite, Canopy, Advantage, or 400 Series) which is divided evenly across the subtending SM's. As the network grows and new SM's are added, network operators can add AP capacity by using an AP of a different frequency.

	Issue	Alternative Solutions
Subscriber Capacity	50 subscribers are connected to a single AP with 4 Mbps downstream capacity, yielding 80kbps downstream when all are active.	<ul style="list-style-type: none"> <li>• Add new subscribers to a different AP frequency to continue provide service at a higher data rate.</li> </ul>
Subscriber Range	Subscribers are too far from the AP to provide service.	<ul style="list-style-type: none"> <li>• Add a passive reflector dish at the SM location to extend the range.</li> <li>• Install a new AP closer to the subscribers.</li> <li>• Install a remote AP at a subscriber location.</li> <li>• Add distant subscribers at a lower frequency</li> </ul>
Subscriber Throughput	Individual subscribers require more bandwidth to transfer voice, video and data services efficiently.	<ul style="list-style-type: none"> <li>• Set the Maximum Information Rate (MIR) for subscribers to provide an upper transmission boundary for selected network users.</li> <li>• Verify that the IP network architecture is configured to match the flow of data and not a "flat" architecture.</li> <li>• Verify that backhaul links are providing sufficient throughput for associated AP's and not contributing to information "bottlenecks."</li> <li>• Check the number of SM's associated with the AP and consider adding an additional AP at a different frequency.</li> <li>• Consider whether a point-to-point link will meet the needs of high bandwidth users.</li> </ul>

## Canopy System Reliability

With its patented signaling technique, the Canopy system provides consistent managed throughput to all subscribers and an industry-leading low Carrier to Interference (C/I) ratio. Canopy modules are robust and able to perform even in the most crowded license free frequency bands. Subscribers receive dependable carrier grade service – even those subscribers at the outer edge of the network.

Motorola provides product support coverage and backs all Canopy equipment with a one-year warranty.

## Canopy System Security

All Canopy system modules are equipped with multiple layers of security to protect IP communication and provide a secure air interface. Canopy modules meet Health Insurance Portability & Accountability Act (HIPPA) compliance requirements. The Canopy system has Point-to-Point link and Point-to-Multipoint access network products with either 128-bit AES encryption or 56-bit DES encryption. AES encryption provides the highest level of security, as required for the following types of institutions:

- Banks
- Other financial institutions
- Health care organizations
- Government facilities
- High risk situations with specific security concerns

## Motorola Support

### Warranty

All Canopy system equipment comes with a one year warranty. Contact a Motorola reseller for more information.

### Training

Installation and System Management training is given by Motorola technical specialists. The training is offered either at Motorola's headquarters or as required at field locations.

### Documentation

All Canopy system modules and software releases come with detailed installation and user guide descriptions.

### Web Support

The Canopy system web site provides system users with product information and applications, as well as a venue for Canopy network operators to share applications.

### Product Support

Motorola trained support specialists are available to respond to questions should the need arise. Extended warranty coverage is available for Canopy system modules.

### The Canopy User Community

Canopy system users benefit from each other's experience through access to a special knowledge base (<http://motorola.canopywireless.com/kbase/>) web site discussion area and newsletters to keep informed of the latest applications and products.

## For More Information

### Customer Testimonials

More than 100 case studies are readily available for review at:	<a href="http://motorola.canopywireless.com/support/library/case_study.php">http://motorola.canopywireless.com/support/library/case_study.php</a>
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### Applications

Video Surveillance	<a href="http://motorola.canopywireless.com/solutions/video_surveillance/">http://motorola.canopywireless.com/solutions/video_surveillance/</a>
Education	<a href="http://www.motorola.com/content.jsp?globalObjectId=8589">http://www.motorola.com/content.jsp?globalObjectId=8589</a>
Enterprise	<a href="http://motorola.canopywireless.com/solutions/enterprise/">http://motorola.canopywireless.com/solutions/enterprise/</a>
Carrier	<a href="http://motorola.canopywireless.com/solutions/carrier/">http://motorola.canopywireless.com/solutions/carrier/</a>
ISP	<a href="http://motorola.canopywireless.com/solutions/isp/">http://motorola.canopywireless.com/solutions/isp/</a>
Government	<a href="http://motorola.canopywireless.com/solutions/metrowifi/">http://motorola.canopywireless.com/solutions/metrowifi/</a>

### Overview

Canopy System	<a href="http://motorola.canopywireless.com/solutions/">http://motorola.canopywireless.com/solutions/</a>
Brochure	<a href="http://motorola.canopywireless.com/support/library/">http://motorola.canopywireless.com/support/library/</a>
MOTOwi4 Solutions	<a href="http://www.motorola.com/wi4">http://www.motorola.com/wi4</a>

### Canopy Technology

Interference	<a href="http://motorola.canopywireless.com/pub_files/InterferenceWhitePaper91602.pdf">http://motorola.canopywireless.com/pub_files/InterferenceWhitePaper91602.pdf</a>
Synchronization	<a href="http://motorola.canopywireless.com/pub_files/DTSSWhitePaper.pdf">http://motorola.canopywireless.com/pub_files/DTSSWhitePaper.pdf</a>
Security	<a href="http://motorola.canopywireless.com/pub_files/SecurityFinal_F.pdf">http://motorola.canopywireless.com/pub_files/SecurityFinal_F.pdf</a>
Throughput and Latency	<a href="http://motorola.canopywireless.com/pub_files/Performance111503.pdf">http://motorola.canopywireless.com/pub_files/Performance111503.pdf</a>

### Canopy System Documentation

PTP Solutions	<a href="http://www.motorolapt.com/">http://www.motorolapt.com/</a>
Access Point Manual	<a href="http://canopywireless.com/products/">http://canopywireless.com/products/</a>
Subscriber Module Manual	<a href="http://canopywireless.com/products/">http://canopywireless.com/products/</a>

### System Demonstration

<http://motorola.canopywireless.com/#>