MOTOROLA WIRELESS NETWORK SOLUTIONS
POINT-TO-MULTIPOINT

WIRELESS NETWORK DESIGN GUIDE
GET SET AND GO.

This guide will help you plan your wireless network—so you can be up and running right away. All of the information provided in this guide is subject to change as solutions evolve.

ALWAYS-AVAILABLE CONNECTIVITY, SECURE AND COST EFFECTIVE

Our solutions provide enterprises, government agencies and service providers with consistently reliable data, voice and video applications so they can do their job effectively and efficiently. The Motorola Wireless Network Solutions portfolio offers high-speed backhaul, distribution and access networks that support data, voice and video communications, enabling a broad range of fixed and mobile applications for public and private systems. With Motorola’s innovative software solutions, designing, deploying and managing a wireless network is feasible, maximizing uptime and reliability while lowering installation costs.
Motorola PMP distribution and access solutions provide:

- BUSINESS AND RESIDENTIAL BROADBAND ACCESS
- LEASED LINE REPLACEMENT
- SCADA BACKHAUL AND DATA COLLECTION THAT REDUCES OPEX
- VIDEO SURVEILLANCE THAT IS 90% LESS EXPENSIVE THAN WIRED SOLUTIONS
- 3G OFFLOAD

THESE SOLUTIONS ARE PROVEN IN MORE THAN 10,000 NETWORKS AROUND THE WORLD.
INDUSTRIES EMPOWERED WITH PMP CONNECTIVITY

EDUCATION
GOVERNMENT
HEALTH CARE
HOSPITALITY
MANUFACTURING
PUBLIC ADMINISTRATION
PUBLIC SAFETY
RETAIL
SERVICE PROVIDER
TRANSPORTATION
UTILITIES

PMP
RELIABILITY BY DESIGN

INTEROPERABILITY:
Vendor-agnostic with respect to backhaul, access and other distribution systems, Motorola’s IP-based solution offers interoperability to existing systems and other vendor solutions. In addition, the PMP 320 uses the 802.16e industry standard for interoperability between Access Points (AP) and Customer Premise Equipment (CPE).

INDUSTRY LEADING INTERFERENCE TOLERANCE:
Motorola Wireless Network Solutions provide an industry-leading Carrier to Interference (C to I) ratio, utilizing GPS synchronization to mitigate self-interference.

FAST, SIMPLE INSTALLATION:
APs and Subscriber Modules (SM) have easy-to-use alignment tools and require no equipment room or environment-controlled area at the tower location.

RELIABLE HARDWARE PERFORMANCE OVER TIME:
Motorola equipment operates with a passive heating and cooling system, achieving increased reliability and availability through extended periods of time.

PROVEN THROUGHPUT PERFORMANCE:
Performance specifications are validated by lab data and field verification in an operational environment.

SCALABLE AS SUBSCRIBER BASE GROWS:
GPS synchronization enables operators to build networks that grow with demand as new subscribers are added and network density increases, or as operators expand the network into new geography.

LOW LATENCY:
Voice and video applications require low latency. Motorola PMP solutions provide a seven msec round trip latency to provide clear reliable applications – even when the network is loaded with users.
Network operators need more throughput to more locations. For 2011, Motorola continues to invest in PMP distribution and access networks by adding new capabilities to dramatically expand the portfolio of options for network operators including:

**Licensed OFDM Solutions**
The PMP 320 provides connectivity at 3.3, 3.5 and 3.65 GHz.

**OFDM Solution at 5.8 and 5.4 GHz**
The PMP 430 provides 45+ Mbps of high-speed connectivity and OFDM technology at 5.8 and 5.4 GHz.

**Connectorized PMP 320**
To provide connectivity at special locations, the PMP 320 SM now comes in a connectorized version.

**Wireless Manager**
Software tools help network operators to design, deploy and manage outdoor wireless broadband networks to reduce the cost and time of operations.
EMPOWERED TODAY
EQUIPPED FOR TOMORROW

Motorola PMP solutions are one part of a total Broadband Wireless Access (BWA) solution for extending your existing network to provide wireless services to new users. It includes options to tailor the network to connectivity needs. Modules are available to support Line of Sight (LOS), Near-Line of Sight (nLOS) and Non-Line of Sight (NLOS) point-to-multipoint solutions. With a broad array of backhaul, distribution and access solutions, a Motorola solution can be extended and leveraged to meet current and future needs.

ENTERPRISE - SERVICE PROVIDERS

When a large town in Eastern Europe wanted to spark ongoing economic development in the city, Motorola was there to provide a wireless broadband solution. Click here for the Vologda case study.

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 to:

- 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-deploy, value-based broadband

ENTERPRISE CAMPUS

When a large university opted to make its campus locations wireless, Motorola delivered a secure, comprehensive and seamless solution for students inside and outside campus buildings. Click here for the Manipal University case study.

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 systems in order to gain:

- Rapid access to business information between locations
- A cost-effective solution; substantially less than cost of leased-line alternatives—no recurring monthly fee
- A wireless infrastructure to connect indoor wireless local area network (WLAN), creating a completely wireless IP network and connecting inside to outside

GOVERNMENT

When a town of 600,000 residents dealt with a storm of historic proportions, Motorola was there to assist government agencies during the aftermath. Click here for the Cobb County, Georgia case study.

Government network operators can establish cost-effective links for public safety, public service and public access to:

- 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
Motorola understands how important it is for you to leverage your current investment while expanding to meet your connectivity demands. Our solutions are completely adaptable—so you don’t have to build an entirely new network from scratch in order to enhance your current network. Motorola PMP Network Solutions can be used to complement DSL, Cable, Fiber and other wireless networks or used as a standalone configuration.

Motorola PMP Network Solutions make deploying and delivering low-cost broadband access faster and easier than ever before. They provide 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).

Motorola is an industry leader in wireless video surveillance solutions for public safety, with specific experience in business and technology issues. Our IP-based solutions provide a number of crucial advantages, including:

- Real-time situational awareness and response
- Remote monitoring and accessibility
- Faster, lower cost deployment than wired alternatives
- Existing networks leveraged
- Digital image encryption for security purposes

When it comes to delivering the industry’s most advanced and reliable voice solutions, Motorola has a proven track record for results. With 80 years of leadership in wireless voice communications, Motorola offers the in-depth knowledge and expertise, not only to deliver superior voice quality, but also to enable truly seamless communications between different devices on different networks.

Motorola also offers access network modules that can be used to transport Voice over IP (VoIP) services as a PBX extension when IP phones and typical hubs are used at the customers’ premises.
GET TO OPPORTUNITIES
FIRST WITH THE BEST CONNECTIVITY

With the capability to rapidly deploy broadband, government agencies can serve their community better, and enterprises can respond to opportunities faster than ever before.

SIMPLE NETWORK DESIGN
Time is a precious commodity, and Motorola helps you save it by making the process of setting up your network fast and easy. Motorola’s PMP system’s intelligent protocols streamline deployment and operation. Our simple network design allows the system to complement your existing network, making it exceptionally easy to install. Our equipment is intuitive and efficient, providing built-in installation and deployment assistance that makes it faster to get up and run often in a matter of hours or days instead of weeks or months.

PREDICTABLE AND DEPENDABLE PERFORMANCE
Unwanted signal interference can disrupt important business calls and cause data transfer issues and wireless interruptions, costing you valuable time and resources. With Motorola PMP solutions, you can avoid these disruptions and experience 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.

SECURITY YOU CAN RELY ON
An attack on your network can come at any time and from anywhere. Motorola arms you with a highly secure, highly reliable platform that includes over-the-air DES (Data Encryption Standard) encryption, also available with AES (Advanced Encryption Standard) capabilities, which provide FIPS 197 certified 128-bit encryption to ensure secure data delivery and exceptional reliability.

GREATER SPEEDS TO INCREASE PRODUCTIVITY AND RESULTS
Whether you are downloading an important graphic-intensive file for a business presentation or uploading video of a recent company event, Motorola’s PMP solutions offer speeds to 180 Mbps (aggregate data rates) from a tower location to serve a community. 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 can be designed into the system.
INTERFERENCE TOLERANCE
Because of its GPS signal synchronization, Motorola PMP solutions offer a high level of tolerance to self-interference. The system provides reliable service even when the Access Points are placed close together.

SCALABILITY SO YOU CAN GROW YOUR NETWORK
As organizations grow and expand, so do their network needs. With Motorola, your network is adaptable and strategically positioned to respond to your changing needs. Motorola PMP solutions scale to meet network growth so that throughput remains consistent as new subscribers are added to the network.

GREATER 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 wireless broadband equipment in a variety of applications. Refer to the last page of this document to access a list of successful deployments.
EXPAND COVERAGE

BETTER THROUGHPUT AND RANGE

Motorola PMP solutions are the result of hundreds of engineering years of design, more than 60 patents and hundreds of commercially deployed networks in more than 150 countries. Their proven design truly delivers broadband wireless access for all applications.

Designed to maintain consistent performance across the network, the PMP system has been proven to offer 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 AP location
- Network carrying varying types of traffic

Operating range and data throughput are dependent on many factors including terrain, foliage, background RF energy and other conditions. PMP 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 system’s unique signaling technique provides a consistent data rate and throughput to users across the entire service area.

CUTTING EDGE ACCESS NETWORKS

Motorola APs and SMs comprise the access network. APs are the distribution head end and each one serves up to 200 subscribers. APs can be clustered in groups providing coverage for a community of subscribers. SMs are installed at the subscriber location.

The PMP 320, 430, and 100 Series AP and SM products provide line-of-sight (LOS) and near-line-of-sight (nLOS) performance through the use of OFDM technology, longer cyclic prefixes and higher gain antenna solutions. The improvement is seen mostly 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 obstructions may be present.

A SOLID NETWORK INFRASTRUCTURE

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

Point to Point (PTP):
Deploy T1/E1 replacements or backups, building-to-building connectivity, WiMAX/LTE backhaul, video surveillance and links to NLoS areas with our industry-leading wireless Ethernet bridges. They operate in unlicensed and licensed spectrum and deliver highly reliable connections across challenging environments.

ACCESS

Outdoor Mesh Wireless Access Networks (MWAN):
Enable the mobile applications you need to access information, improve traffic control, read meters, and enhance security through video surveillance with our self-forming/self-healing outdoor mesh networks. Advance public safety, municipal services and enterprise operations with these outdoor WiFi access solutions.

Indoor WLAN: Provide WLAN indoor access with a variety of APs and controllers designed to meet the needs of your application. Advanced indoor RF modeling means better coverage planning for VoIP and data applications.

Voice over WLAN (VoWLAN): The TEAM VoWLAN solution enables instant voice and data communications through enterprise-grade smartphones and other devices.

SOFTWARE SOLUTIONS

Take the guesswork out of designing and deploying your networks with our proven software solutions. Intuitive 3D multi-level visuals help you determine the maximum performance of web surfing, download time, FTP file transfers, video conferencing and VoIP at a minimum cost.

Wireless Manager, the powerful and flexible deployment and management solution for outdoor wireless broadband networks shows a map-based view of all network layers with real-time performance.

AirDefense WLAN Security and Compliance module provides complete protection against wireless threats and shows real-time application-specific coverage for VoIP.
LICENSED AND UNLICENSED SOLUTIONS

LICENSED SOLUTIONS
Ours are designed for speed and throughput since a licensed spectrum doesn't encounter the usual noise and interference due to license regulations.

UNLICENSED SOLUTIONS
We designed ours 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.

THE ACCESS POINT MODULE (AP)
With our AP Module, you can distribute network or Internet services in a sector for as many as 200 subscribers. The AP is configurable through a web interface.

THE SUBSCRIBER MODULE (SM)
Motorola’s Subscriber Module 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

APs come in a wide range of frequencies from 900 MHz to 6 GHz. These modules can also be obtained with integrated antennas for ease of installation. Some modules in connectorized versions enable network operators to configure their network to meet their specific requirements. APs are also available with higher performance options to provide higher throughput and NLOS connectivity.

POINT-TO-MULTIPOINT

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<tr>
<th>PMP 120</th>
<th>PMP 120</th>
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<th>PMP 320</th>
<th>PMP 400</th>
<th>PMP 430 10 MHz Ch.</th>
<th>PMP 430 20 MHz Ch.</th>
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<tr>
<td><strong>RADIO FREQUENCIES</strong></td>
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<td>900 GHz</td>
<td>2.4, 5.1, 5.2, 5.4, 5.8, 6.05 GHz</td>
<td>3.3, 3.5, 3.65 GHz</td>
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<td>40 Mbps with MIMO B</td>
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<td><strong>SECURITY</strong></td>
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<td><strong>MAXIMUM SUBSCRIBERS Per Access Point</strong></td>
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Power levels must be set to local regulatory limits.
SUBSCRIBER MODULES

SMs are the CPE 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 come in a wide range of frequencies from 900 MHz to 6 GHz. These modules can be obtained with integrated antennas for ease of installation, or with connectorized versions to enable network operators to configure their network to meet their specific requirements. Many SMs can be equipped with passive range extenders to boost performance and to establish connectivity to distant locations. SMs are also available with higher performance options to provide higher throughput and NLOS connectivity. Power supplies and mounting brackets for SMs are sold separately.

PMP SUBSCRIBER MODULES (SM)
ACCESSORIES TO ENHANCE PERFORMANCE

ADVANCED CLUSTER MANAGEMENT MODULE (CMM)
The CMM provides GPS synchronization to the AP and all associated SMs. The CMMmicro or CMM4 provides power, GPS timing and networking connections for an AP cluster. One CMM can communicate with a variety of different AP modules located at the same tower. 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 PMP system is typically installed on outside infrastructure platforms such as radio towers and rooftop locations. Motorola recommends the use of shielded outdoor cables that adhere to Category 5 and 5e standards for the installation of AP, PTP and outdoor SM modules.

PASSIVE REFLECTOR
EXTENDING THE DISTANCE
The 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 reflector from an offset position. The module support tube provides the proper angle for this offset.

LENS
EXPANDING THE REACH
The LENS passive module enables service providers to provide reliable data, video 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. The LENS easily mounts directly onto existing 100 and 430 Series SMs and requires no additional mounting hardware.

SURGE SUPPRESSOR
PROTECTING EQUIPMENT
The Surge Suppressor provides a path to ground (Protective Earth) that protects connected subscriber home equipment from near-miss lightning strikes.
In addition to standard configurations with the AP at the distribution head end, the PMP system architecture supports remote AP configurations, where an AP is located with an SM to provide for remote distribution and increased network extensions. This technique is useful in two deployment situations:

- To extend range and coverage
- To get under the tree line and distribute the signal to a cluster of customers in a specific area.

**FLEXIBILITY IN NETWORK DESIGN**

Motorola Wireless Network Solutions system modules are available in different frequencies to offer 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 SMs to provide extended range capabilities to reach remote subscribers and also reduce interference by creating a smaller beam pattern.
POLARIZATION OPTIONS
TO DROWN OUT UNWANTED NOISE

Motorola offers 100 Series 5 GHz modules with either vertical or horizontal polarization. Polarization can provide isolation from ambient noise in the operating area. Network operators can select the signal polarization that best meets the needs of their environment.

EXCEPTIONAL PERFORMANCE

Motorola PMP solutions gracefully scale to support large deployments. The system’s GPS synchronization allows network operators to re-use frequencies within a geographic area and add capacity while ensuring consistency in the quality of service to customers. As a result, subscribers can experience stable and reliable service. The PMP 100 series 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 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.
WIRELESS ACCESS NETWORK CONNECTIONS
AT THE NETWORK CENTER

Figure 4: Wireless Access Network Connections at the Network Center
EMPOWERED WITH PMP
NETWORK MANAGEMENT

CONVENIENT ELEMENT MANAGEMENT
Operators of the Element Management network can control allocated bandwidth to assign maximum data rates per subscriber, including:

- Sustained Uplink
- Uplink Burst Allocation
- Sustained Downlink Data Rate
- Downlink Burst
- 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, which means you 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.

STREAMLINED NETWORK MANAGEMENT

- One Point Wireless Manager can be used to provide real-time monitoring of PMP, PTP, Mesh and indoor WLAN network performance in a unified Google maps-based view as well as performance trend analysis tools to localize any quality of service issues.

UNRIVALED 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 healthcare 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.
- PTP 300, PTP 500 and PTP 600 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
CONSIDER THE FOLLOWING ASPECTS WHEN DESIGNING A NETWORK:

<table>
<thead>
<tr>
<th>ASPECT</th>
<th>EXPLANATION</th>
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<tbody>
<tr>
<td>BANDWIDTH DISTRIBUTION</td>
<td>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. While a single AP can communicate with up to as many as 200 SMs, keep in mind that the aggregate throughput is distributed across the SMs that are actively getting data simultaneously. 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. 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.</td>
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<tr>
<td>NETWORK MANAGEMENT</td>
<td>Before diagramming network layouts: 1. Anticipate the correct amount of signal loss 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. 2. Recognize all significant RF conditions. 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. 3. Consider the specific site requirements:  • Tower rights  • Power availability  • Temperature control 4. Evaluate potential sites 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.</td>
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</table>

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 PMP system allows selectable Maximum Information Rates (MIR) to provide data rates that meet customer requirements.

There are many successful deployments of PMP networks, which apply the strengths of the different modules to meet the specific requirements of your network environment. These networks use combinations of 2.4 GHz, 3.5, 4.9, 5.1, 5.2, 5.4, 5.8 and 6.0 GHz APs and SMs, complemented with 900 MHz modules to fill in the holes or access difficult to reach areas of the network.
NETWORK DESIGN DOs AND DON’Ts

NETWORK DESIGN DOs
Considering the crowded bands that are typical in an unlicensed spectrum, there are some actions network operators can take to get the best advantage possible:

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

NETWORK DESIGN DON’Ts
Avoiding the following actions will help get the best advantage in operating the network:

• Don’t use omnidirectional antennas if it can be avoided. Omnidirectional antennas are exposed to interference from every direction.
• Don’t use vertical polarization for 900 MHz if it can be avoided. 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.

PRACTICAL TRAINING FOR BETTER PLANNING
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.
SCALABLE AND READY TO IMPLEMENT

Motorola PMP solutions 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.

IMPLEMENTING A MOTOROLA PMP SOLUTION

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 manmade 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 architecture in this document that most suits the business requirements. If the network includes diverse markets, a combination of reference architectures may be the most appropriate solution. Motorola PMP solutions are 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: DESIGN NETWORK

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

STEP 4: INSTALL AND VERIFY SERVICE

When properly planned, installation of a Motorola PMP solution is a task that 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 advanced 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 effective applications that carriers have deployed using Motorola PMP solutions.
REFERENCE ARCHITECTURE 1
NETWORK EXTENSIONS

Network extensions can be quickly deployed without the labor and material cost of laying down cable and DSL equipment. In addition, new broadband subscribers can be added without requiring grooming of the existing network for broadband services.

<table>
<thead>
<tr>
<th>USE CASES</th>
<th>VALUE</th>
<th>APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Education</td>
<td>Rapidly extend connectivity at a fraction of the cost of other solutions.</td>
<td>A service provider offers broadband service to a new construction residential community or business campus. Residents have reliable service available to them faster than wireline alternatives. Motorola PMP solutions complement the existing broadband network and allow 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. A carrier provides broadband service to new customers in an area where the DSL network is operating at capacity.</td>
</tr>
<tr>
<td>• Government</td>
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<tr>
<td>• Health Care</td>
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<td>• Hospitality</td>
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<td>• Manufacturing</td>
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<tr>
<td>• Public Administration</td>
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<td>• Public Safety</td>
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<tr>
<td>• Retail</td>
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<tr>
<td>• Service Provider</td>
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<tr>
<td>• Transportation</td>
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<td></td>
</tr>
<tr>
<td>• Utilities</td>
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</tbody>
</table>

USE CASES VALUE APPLICATION

Rapidly extend connectivity at a fraction of the cost of other solutions.

A service provider offers broadband service to a new construction residential community or business campus. Residents have reliable service available to them faster than wireline alternatives. Motorola PMP solutions complement the existing broadband network and allow 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. A carrier provides broadband service to new customers in an area where the DSL network is operating at capacity.
REFERENCE ARCHITECTURE 2
DATA COLLECTION AND CONTROL 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.

<table>
<thead>
<tr>
<th>USE CASES</th>
<th>VALUE</th>
<th>APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Government</td>
<td>Monitor and control facilities from a remote location to retrieve video, retrieve measurements and control switches and systems.</td>
<td>An international airport installed over 60 full motion cameras using PMP and PTP 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.</td>
</tr>
<tr>
<td>• Health Care</td>
<td></td>
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<tr>
<td>• Hospitality</td>
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</tbody>
</table>
Motorola’s wireless broadband access network enables service providers to reach into remote areas quickly without requiring expensive and time-consuming network build-outs. The PMP system can augment the existing network to reach out to remote dial-up users.

### USE CASES

- Education
- Government
- Health Care
- Manufacturing
- Public Safety
- Service Provider
- Transportation
- Utilities

### VALUE

Provide connectivity to the most remote locations at a fraction of the time and cost of other broadband solutions.

### APPLICATION

A carrier adds broadband network services to an area previously serviced only by dial-up using 900 MHz Subscriber Modules.
REFERENCE ARCHITECTURE 4
CAMPUS DEPLOYMENTS

This design provides IP connectivity to buildings not served by broadband or fiber services. Motorola Wireless Network Solution’s fast installation time and lower initial and operating costs allow network owners to connect broadband service in a matter of hours.

**USE CASES**
- Education
- Elementary
- Higher Education
- Government
- Health Care
- Hospitality
- Manufacturing
- Public Safety
- Retail
- Service Provider
- Utilities

**VALUE**
Connect any collection of buildings to rapidly provide data, voice and video connectivity to improve operations by using a single network.

**APPLICATION**
Business branch offices in remote locations use PTP and PMP links to share data with the regional center.
THE ULTIMATE IN RELIABLE, SECURE NETWORK EXTENSIONS FOR NETWORK OPERATORS

Network owners need to deploy reliable broadband services to meet demand. Network extensions must provide data, video and voice services quickly and efficiently, providing capacity in a “just-in-time” manner. Motorola PMP access networks provide proven secure, reliable broadband service over a wireless connection.

**NETWORK OPERATORS**

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 wireless network is comprised of PTP backhaul links and PMP access networks, which are easily configured to meet specific performance and cost requirements.

**SERVICE PROVIDERS**

Service providers require secure and reliable communications. Motorola PMP solutions, with patented signaling technology and military-level security, provide the reliability associated with wireline services with the cost advantage of wireless technology. The PMP system provides an opportunity to efficiently extend the network in areas where the investment required in deploying wireline service restricts growth.

<table>
<thead>
<tr>
<th>REQUIREMENT</th>
<th>POINT-TO-MULTIPOINT SYSTEM PERFORMANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>RELIABILITY</td>
<td>• Because of its unique signal modulation technique, the PMP system is the most interference tolerant system in the unlicensed spectrum.</td>
</tr>
<tr>
<td></td>
<td>• Data rate and throughput are consistent for all subscribers - even those at the outer edge of the network.</td>
</tr>
<tr>
<td>INSTALLATION AND MAINTENANCE</td>
<td>• Subscriber modules are fast to install.</td>
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<tr>
<td></td>
<td>• Built-in alignment tools verify installation and minimize truck rolls.</td>
</tr>
<tr>
<td></td>
<td>• Technical training available for support and to shorten the learning curve of installs.</td>
</tr>
<tr>
<td>SECURITY</td>
<td>• FIPS 197 AES encryption meets Health Insurance Portability and Accountability Act (HIPAA) and military specifications.</td>
</tr>
<tr>
<td></td>
<td>• Multiple layers of encryption and authentication restrict access to data.</td>
</tr>
<tr>
<td>ROI</td>
<td>• System payback is in terms of months.</td>
</tr>
<tr>
<td></td>
<td>• The system scales to deployment levels with low up front investment.</td>
</tr>
</tbody>
</table>
KEY POINTS TO KEEP IN MIND WHEN DESIGNING A NETWORK

QUALITY OF SERVICE (QoS):
Motorola PMP solutions provide reliable service because of its industry-leading interference tolerance.

CAPACITY:
Motorola’s PMP 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 PMP system has multiple layers of security with authentication and military-level data encryption to restrict access by unauthorized users.

NETWORK MANAGEMENT:
Motorola Wireless Network Solutions integrate 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:
Motorola PMP solutions are field-proven. All of the configurations and reference architectures in this document are based on actual installations.
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 Motorola PMP solutions—and whose performance, reliability and security have led to negative perceptions of interference problems, excessive downtime and loose security.

### FACTS AND FICTION ABOUT MOTOROLA PMP SOLUTIONS

<table>
<thead>
<tr>
<th>CONCERN</th>
<th>MOTOROLA PMP ACCESS NETWORK DEPLOYMENT FACT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Wireless Broadband Systems are not secure against hackers and intruders.</strong></td>
<td>Motorola’s PMP access network system has multiple security layers including signal modulation technique, authentication and military-level Advanced Encryption Standard (AES) encryption. It is certified FIPS 197 compliant by NIST and meets Health Insurance Portability and Accountability Act (HIPPA) requirements. Motorola solutions provide a level of security that is the equivalent of wireline services.</td>
</tr>
<tr>
<td><strong>Wireless Broadband Systems do not provide the advertised data rate to the maximum range.</strong></td>
<td>Motorola’s PMP wireless access network 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.</td>
</tr>
<tr>
<td><strong>The number of subscribers will load down the system.</strong></td>
<td>Motorola’s PMP system scales from an initial deployment to serving dense metropolitan area while maintaining a consistent throughput to all subscribers in the network.</td>
</tr>
<tr>
<td><strong>Unlicensed wireless communication is not reliable for quality service.</strong></td>
<td>Motorola’s portfolio of solutions operate in both the licensed or unlicensed frequencies. Network operators should choose the technology that best meets their business case. 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 PMP system is unique in that it was designed to be optimized for interference tolerance. The Motorola access network system’s synchronization and signal modulation yield an industry leading tolerance to interference.</td>
</tr>
<tr>
<td><strong>I don’t understand wireless technology enough to deploy it in my network with confidence.</strong></td>
<td>Motorola has deployed wireless technology for decades. Motorola wireless broadband access networks have been deployed to more than one million subscribers in more than 150 countries. Motorola provides training, technical support and will introduce new network operators to an enthusiastic community of users who have experienced the benefit of Motorola wireless access networks for themselves.</td>
</tr>
<tr>
<td><strong>Doesn’t the weather have an impact on the quality of service I can expect?</strong></td>
<td>Extreme weather can affect communications. Motorola wireless broadband access network modules operate at frequencies that are typically not affected by weather conditions. Motorola PMP systems are field proven in hot, cold, humid, and windy conditions. Refer to the product specification sheets listed on the last page for detailed information.</td>
</tr>
</tbody>
</table>
EXPANDED COVERAGE AFTER NETWORK DEPLOYMENT

With the many different Motorola PMP modules, network operators can follow demand when building the network and overlay different frequencies as required. By co-locating wireless network APs of different frequencies, network operators can provide coverage to dense locations while reaching out to remote locations.

<table>
<thead>
<tr>
<th>ISSUE</th>
<th>MOTOROLA SYSTEM PERFORMANCE</th>
<th>MOTOROLA BENEFIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCALABILITY</td>
<td>Motorola wireless broadband access network 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.</td>
<td>The Motorola PMP 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.</td>
</tr>
<tr>
<td>TRAFFIC TYPE</td>
<td>Motorola wireless broadband access networks support data, video and VoIP transmissions.</td>
<td>These services provide additional revenue streams.</td>
</tr>
<tr>
<td>SECURITY</td>
<td>Motorola wireless broadband access networks are available with either AES or DES encryption. All PMP system modules have multiple layers of authentication to restrict access.</td>
<td>Service providers can meet the encryption requirements of municipalities, hospitals and corporate enterprises.</td>
</tr>
<tr>
<td>REDUNDANCY</td>
<td>Motorola point-to-point links are cost effective redundant backhaul links where Ethernet connections are required.</td>
<td>Service providers can offer reliable redundant services at a fraction of the cost of building out the wireline network.</td>
</tr>
<tr>
<td>OPTIONS</td>
<td>Motorola wireless broadband modules are designed to be tailored to meet specific network requirements. Options for data encryption, passive reflectors and antennas make the system highly configurable.</td>
<td>Network investment is triggered by specific customer demand, lowering initial investment in network facilities.</td>
</tr>
</tbody>
</table>
NETWORK DESIGN TRADEOFFS

Motorola APs have the capacity to communicate with up to 200 SMs. AP throughput is divided across the subtending SMs, and priority SMs can be assigned Committed Information Rates (CIR). As the network grows and new SMs 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. Add new subscribers to a different AP frequency to continue providing service at a higher data rate.

SUBSCRIBER RANGE | Subscribers are too far from the AP to provide service. • Add a passive reflector dish at the SM location to extend the range.
• Add a passive LENS at the SM location to extend the range.
• Install a new AP closer to the subscribers.
• Install a remote AP at a subscriber location.
• Add distant subscribers at a lower frequency.

SUBSCRIBER THROUGHPUT | Individual subscribers require more bandwidth to transfer voice, video and data services efficiently. • Set the Maximum Information Rate (MIR) for subscribers to provide an upper transmission boundary for selected network users.
• Verify that the IP network architecture is configured to match the flow of data and not a "flat" architecture.
• Verify that backhaul links are providing sufficient throughput for associated APs and not contributing to information "bottlenecks".
• Check the number of SMs associated with the AP and consider adding an additional AP at a different frequency.
• Consider whether a point-to-point link will meet the needs of high bandwidth users.
SUPERIOR SYSTEM RELIABILITY

With its patented signaling technique, Motorola PMP solutions provide consistent managed throughput to all subscribers and an industry-leading low Carrier to Interference (C/I) ratio. Modules are robust and with GPS synchronization are able to perform even in the most crowded, license-free frequency bands. Subscribers receive dependable service – even those subscribers at the outer edge of the network. Motorola provides product support coverage and backs all access network equipment with a one-year warranty.

UNPARALLELED SYSTEM SECURITY

All Motorola PMP modules are equipped with multiple layers of security to protect IP communication and provide a secure air interface. PMP modules meet Health Insurance Portability & Accountability Act (HIPAA) compliance requirements. Motorola Wireless Network Solutions can be equipped with either 56-bit DES encryption or optional 128-bit AES 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
SERVICES
Motorola and our partner network can provide design, installation and management services to develop a turn-key solution.

WARRANTY
All Motorola PMP solutions equipment comes with a one-year warranty. Contact a Motorola reseller for more information. Extended warranty coverage is available for purchase.

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 Motorola PMP modules and software releases come with detailed installation and user guide descriptions. These documents are also available on the web. Refer to the last page of this document for a comprehensive list of information available on the web.

WEB SUPPORT
The Motorola website provides system users with product information and applications, as well as a venue for wireless access 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 PMP system modules.

THE MOTOROLA USER COMMUNITY
Motorola Wireless Network Solutions operators benefit from each other’s experience through access to a special knowledge base (http://motorola.canopywireless.com/kbase/) website discussion area and newsletters to keep informed of the latest applications and products.

QUALITY
Motorola Solutions is ISO 9001 certified.
FOR MORE INFORMATION:
Point-to-Multipoint, click here » motorola.com/pmp
Point-to-Point, click here » motorola.com/ptp
One Point Wireless, click here » motorola.com/onepoint/tour
Wireless LAN, click here » motorola.com/enterprisewlan
TEAM Solutions, click here » motorola.com/team
Mesh Wide Area Networks, click here » motorola.com/mesh

ABOUT MOTOROLA WIRELESS NETWORK SOLUTIONS

Motorola delivers seamless connectivity that puts real-time information in the hands of users, giving customers the agility they need to grow their business or better protect and serve the public. Working seamlessly together with its world-class devices, Motorola’s unrivaled wireless network solutions include indoor WLAN, outdoor wireless mesh, point-to-multipoint, point-to-point networks and voice over WLAN solutions. Combined with powerful software for wireless network design, security, management and troubleshooting, Motorola’s solutions deliver trusted networking and anywhere access to organizations across the globe.