AirMAX™ 580/5800 Installation & Configuration Guide

November 20, 2002 P/N 8000505-000 B

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Notice

FCC Emission Information

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment to an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

FCC Radiation Hazard Warning

To ensure compliance with FCC RF exposure requirements, this device must be professionally installed outdoors on a permanent structure with an antenna that is separated from all persons by a minimum of two meters. Using higher gain antennas and types of antennas not covered under the FCC certification of this product is not allowed. Installers of the radio and end users of the system must adhere to instructions provided in this manual.

Safety

Warning: *To avoid shock, do not open or attempt to service the unit or its associated power supply. This unit is not a user serviceable device.*

Warning: *Do not touch antennas when transmission is in progress. Possible adverse health affects can occur.*

Warning: *Explosive Device Proximity Warning—do not operate your wireless network device near unshielded blasting caps or in an explosive environment unless the device has been modified to be especially qualified for such use.*

Caution: *This instrument transmits radio frequency energy during normal operation. Do not stand or work in its close proximity for extended periods of time to avoid possible harmful exposure. The long-term health effects of exposure to radio frequency energy are not fully understood.*

Caution: *When performing antenna installation and grounding, ensure that it presents no threat to people or property. Verify that the antenna mast is grounded properly and is protected from voltage surges and static charges. Observe all regional and national building and safety regulations.*

Contacting Malibu Networks For Information or Support

1107 Investment Blvd. Suite 250
El Dorado Hills, CA. 95762 USA

Telephone: +1.916.941.8777
Fax: +1.916.941.8850

Web: http://www.malibunetworks.com
Email: support@malibunetworks.com

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Chapter 1
Introduction

Product Overview

Malibu Networks 580/5800 AirMAX™ system provides fixed wireless broadband access in the 5.8GHz band with a wide array of features ideal for voice, video and data communications.

AirMAX uniquely takes bi-directional IP traffic and offers quality of service (QoS) features ideal for Internet Service Providers and corporate facility implementations. The system is composed of a BTS, CPE, a full featured optional Service Management System (SMS) and Malibu's patent pending *MAXimum IP*™ QoS.

The CPE and BTS portions of the system are all outdoor units (ODU) ruggedized for the harshest environments with an operating temperature range of up to 55ºC. Reliability and cost effectiveness were key design goals for this system. By utilizing many standard off-the-shelf components, AirMAX is mature, reliable, and takes advantage of volume production resulting in the best performance and value available today.

System Components

AirMAX system components are:

- Base Transceiver Station (BTS): transmits to and from one or more customer premises (CPE) systems.
- Customer Premises Equipment (CPE): transmits from a local customer site to and from a BTS system.

Note: Both CPE and BTS systems are functionally similar in that they are made up of an antenna, controller card, radio modem and power supply (items contained in the ODU and Power Injector units). When we discuss a BTS or CPE system therefore, remember that it consists of an ODU and a Power Injector.

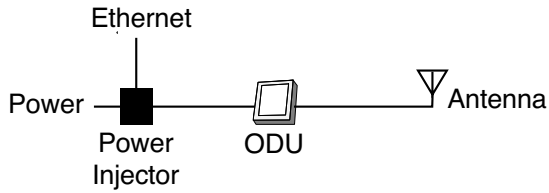


Figure 1-1. Basic System, CPE or BTS

- ODU: Outdoor Unit and antenna. The ODU is a ruggedized box, often antenna-mast mounted, that houses a radio modem and connects to an antenna. It has a special Power-over-Ethernet (PoE) cable that passes both data and power to/from the Power Injector. The radio modem and circuit board inside have non-volatile memory and a standalone CPU that communicates with other systems. Remote management software configures and controls the ODU.
- Power Injector: This unit is placed inside the customer's facility and connects the site's 10/100Base-T LAN to the ODU. It also functions as an AC adapter that passes power to the ODU—along with data—over the PoE ethernet cable.

The Power Injector has two parts, an AC adapter power module that plugs into a 100/240VAC 50-60Hz source and a small module (called the power injector) that has the two RJ-45 ethernet connections (LAN and ODU) and connects to the power module.

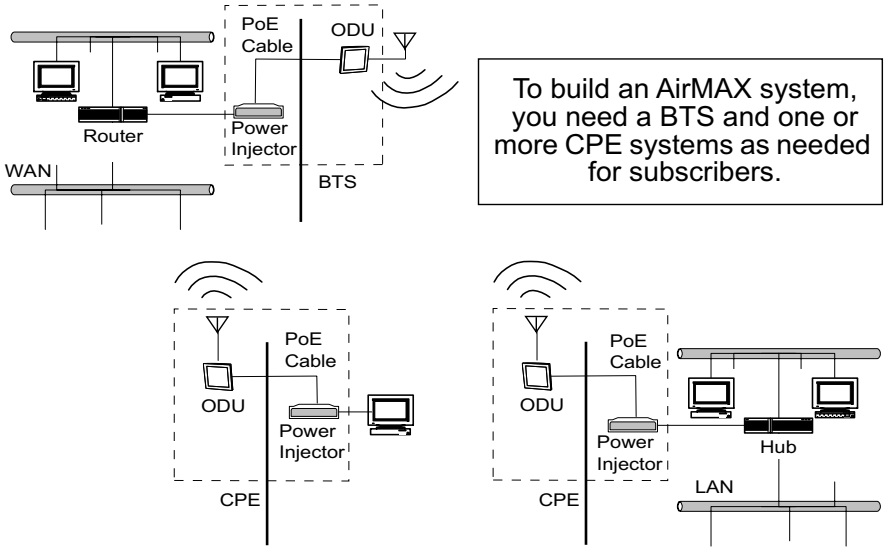


Figure 1-2. Simplified System Block Diagram

- SMS: manages all aspects of AirMAX. This system provides a robust suite of functions, from top-level network management integration, to system element management, to customer provisioning and management. Features include:

  JAVA-based user interface supports UNIX, and Windows client platforms with one application.

  Flow-through provisioning for rapid service configuration and deployment by any authorized entity.

SNMP interface is fully compliant with SNMP v2 using the Malibu enterprise MIB and the standard MIB II object library.

Distributed management technology: As the system grows from a few base stations to as many as hundreds of base stations, expensive, high-performance, single-point-of-failure servers can be avoided by distributing SMS functions over a number of low-cost servers

SLA (service level agreement) facilitation: SMS offers complete flexibility in service definition, provisioning, and monitoring. In addition, tools are provided to empower the service provider to customize SLAs to meet unique subscriber needs, and to meet the requirements of the operator's specific business model. Jitter and latency are all configurable characteristics of each Service Definition Suite. These definitions can be applied on a per-flow basis.

Intelligent provisioning: resource management is efficiently accomplished with constant monitoring of current service level agreements and available system resources, preventing unwanted over-subscription of guaranteed services. In this way, new subscribers and their services can be added to the network with the assurance that existing service level agreements will continue to be fully supported.

- *MAXimum IP (QoS):* a service provider will see an immediate, dramatic increase in their bottom line due to Malibu's QoS implementation in AirMAX. MAXimum IP accomplishes this through two primary means. First, the efficiency of the system is increased resulting in a subscriber throughput improvement compared to similar systems without MAXimum IP. Second, MAXimum IP offers considerably more than just minimum and maximum bandwidth control per CPE and per subscriber behind the CPE, a claim no other vendor can make today. MAXimum IP also gives the service provider the ability to control jitter and latency as well as enabling additional high value services to be sold and supported.

Product Names and Numbers

The following list shows the available Malibu Network Product names and numbers:

5.8 GHz Products

- AirMAX 5800 BTS (360 degrees)
- AirMAX 580 CPE
- ANT-58-14-D 14 dBi Directional CPE Antenna
- ANT-58-11-D 11 dBi Directional CPE Antenna
- ANT-58-10-O 10 Omni BTS Antenna
- Antenna Interconnect Cable, 4 foot, 1.5 dB loss

System Options:

- Power-over-Ethernet Cables:
  PoE-25: 25 ft. (7.62m) Power-over-Ethernet cable
  PoE-50: 50 ft. (15.24m) Power-over-Ethernet cable
  PoE-100: 100 ft. (30.48m) Power-over-Ethernet cable
  PoE-150: 150 ft. (45.72m) Power-over-Ethernet cable
  PoE-200: 200 ft. (60.96m) Power-over-Ethernet cable
  PoE-250: 250 ft. (76.2m) Power-over-Ethernet cable
- SMS: Service/Element Management System

Component Identification

The main physical components comprising the system are shown in the following photographs.

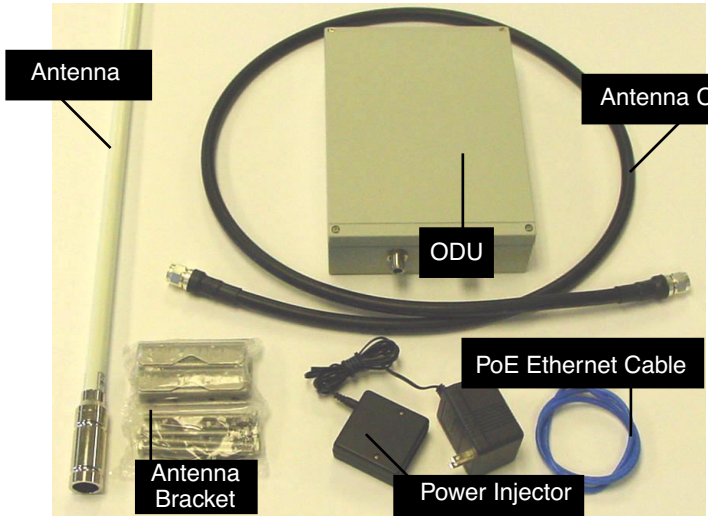


Figure 1-3. Typical Components of a BTS or CPE

Note: Omnidirectional Antenna shown—antenna models differ in appearance, size, and associated bracket hardware. Included ODU mounting brackets and clamps are not shown (they are illustrated in the installation Chapter).

Minimum Installation Requirements

An AirMAX system requires the following customer-supplied items when performing installation and configuration:

- Computer with an Internet web browser that supports Javascript. Examples in this manual show the Windows OS, although most operating systems can be used. The computer or workstation must have a 10/100Base-T Ethernet card (NIC).
- Category 5 crossover Ethernet cable with RJ-45 connector between the PC and the Power Injector. If desired, you could also connect through a hub or switch.

Note: When configuring a BTS and a CPE, they should not be set up on the same LAN segment.

About This Manual

This manual is intended for AirMAX system installers and as background reference information for system administrators. For detailed software configuration and remote management information see the *AirMAX System Administration Guide.*

Manual Conventions

Malibu Networks publications use the following conventions for better readability and communication of information:

Convention	Description
italics	Reference to an explicit button name when discussing a screen (spelling and case will match button item), or a reference to a specific topic or heading in the manual.
[text in brackets]	Optional items, keywords, or parameters.
boldface	Keywords or commands.
{ x | y | z }	When a choice exists between keywords or options, the options will be listed between braces, each separated by a vertical bar.
`on-screen text`	Text displayed on a computer screen will be shown in a monospaced font.
Note	Advisory notes or comments will be indicated by the word “Note” in bold followed by the supporting text.
 **CAUTION**	Important notes or comments communicating safety issues or possible damage to equipment will be indicated by the Caution symbol.
 **WARNING**	Important notices about danger to the reader, including injury or fatal consequences, will be indicated by the Warning symbol.

Chapter 2
Installation

Before Installation

When preparing to install an AirMAX™ system, first ensure you've gathered all the information needed:

- Analyze environmental and facility requirements and determine antenna, ODU, and Power Injector mounting locations. Ensure locations offer optimum direction for the terrain.
- Temperature limits at ODU mounting locations should be within this range: -30°C to +55°C
- Temperatures at Power Injector mounting locations should meet normal office or home conditions.
- Decide on antenna mounting specifics: do you want to pole or wall-mount the ODU? Locate antenna as high as practical for best coverage.

- Ensure antennas between communicating AirMAX systems are within a 12.4 mile range (20Km). You can have up to 100 subscribers per CPE and up to 100 CPEs per sector (with 500 subscribers per sector).
- Ensure that the overall Ethernet cabling between the ODU, Power Injector, and customer LAN connection (router/switch/etc.) is less than 300 feet total. If you need a longer distance, you can insert signal conditioning equipment between the Power Injector and customer equipment. The PoE cables supplied by Malibu are from 25 feet to 250 feet in length.

Caution: *when making actual cable connections at the time of installation, do not confuse the ethernet cable from the customer's LAN to the Power Injector—which is data only and does not have power—and the PoE Ethernet cable that runs between the ODU and Power Injector—which does have power. These connections are made at the Power Injector, which has two RJ45 connectors, and it is possible to plug in the wrong cable and damage equipment. Always check which cable you're plugging in when making Ethernet connections to the Power Injector. The correct Power Injector Ethernet connections are shown later in this Chapter. This manual illustrates the connections as the procedures are given.*

- Ensure the workers installing the ODU and antennas are experienced installation professionals familiar with all local building codes and safety regulations, and who are licensed for the type of work being performed.

Installation Overview

After choosing installation locations, you're ready for physical and electrical installation (explained in this chapter). Later in Chapter 3 we explain how to configure the system via web browser. To help give you an overview, let's summarize the complete installation procedure to install an AirMAX system:

1. First, install the physical BTS system hardware, including ODU, Power Injector, antenna, and cabling.
2. Connect a PC to the Power Injector with a crossover cable or LAN connection, set the IP of the PC to a value compatible with the BTS, and then configure BTS software from a web browser by entering the IP address of the BTS.
3. From the same PC connected to the BTS, add the CPEs you wish to communicate with the BTS.
4. With the BTS now installed and configured, you'll next install the physical CPE system hardware, including ODU, Power Injector, antenna and cabling.
5. Now, just as the BTS was configured, you'll then connect a PC to the CPE's Power Injector, set the IP of the PC to a value compatible with the CPE, and then configure the CPE's radio modem. As on the BTS, you'll enter the default factory IP address of the CPE into the PC browser to connect to it. .
6. Finally, you'll test the wireless communication between BTS and CPE using a PC attached to one system (BTS or CPE).

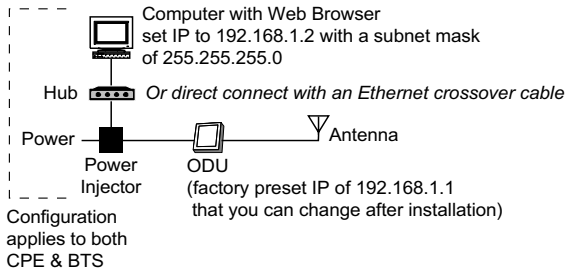


Figure 2-1. Basic Component Overview

Now that you have an overview, let's begin the physical installation of CPE and BTS components—antenna, ODU and Power Injector units, and cabling through the remainder of this chapter (steps 1 and 4 in our previous overview).

In Chapter 3 we'll go through all the detailed steps of configuration.

Mounting the BTS or CPE Antenna

The antenna supplied for use with ODUs can be omni-directional or directional. Positioning of BTS omnidirectional antennas is somewhat flexible. However, care should be taken to position it where topography or buildings do not impede transmission. CPE directional antennas require much more care in mounting since they must be directed toward the BTS antenna. Generally you should always plan for a line of sight position between antennas where possible.

Mount the antenna clear of obstructions that may affect performance. Ensure that the antenna is mounted so that people will be at least 2 meters away during system operation. Pole mounting of antennas is preferable to wall mounting. If you wall mount the antenna, you must ensure that people on the other side of the wall will remain 2 meters from the antenna when the system is in operation. You may not co-locate the antenna with other antennas.

To mount the antenna, follow the relevant steps for omnidirectional or directional antennas on the following pages.

Omnidirectional Antenna Mounting

1. Install a customer-supplied mast of 1 to 2 inches (2.54 to 5.8cm) in diameter. Position the mast for true vertical using a level. Brace the mast as necessary so that it remains stationary in expected wind conditions.
2. Locate the antenna mounting illustration on this page or on the next few pages, which corresponds to the antenna you purchased. Follow the instructions in the illustration to mount the antenna to the mast.
3. Slide the antenna cable up through the antenna base or bracket(s) as directed in the illustration and ensure all screws and mounting hardware are tightened securely.

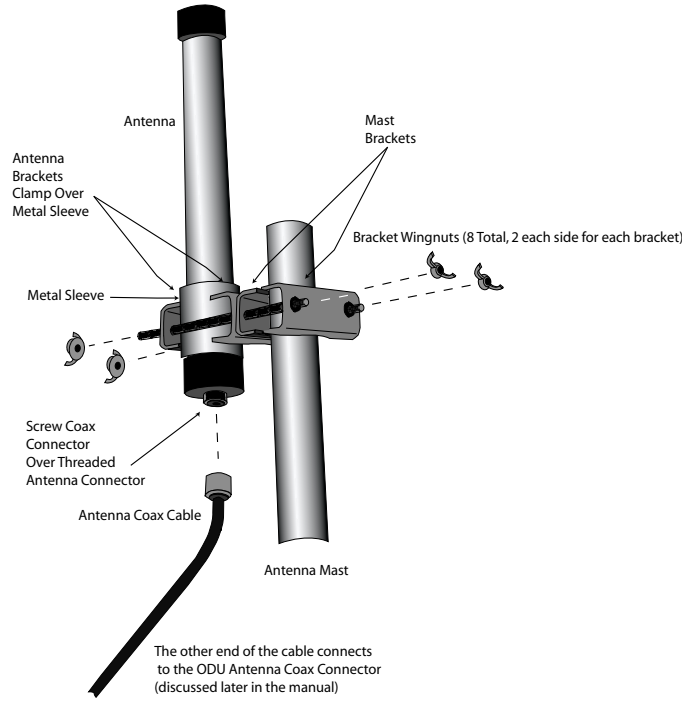


Figure 2-2. 10dBi Omnidirectional Antenna Mounting

CPE Directional Antenna Mounting

1. Install a customer-supplied mast of 1 to 2 inches in diameter. Position the mast for true vertical using a level. Brace the mast as necessary so that it remains stationary in expected wind conditions.
2. Place Antenna Brackets on back of directional antenna and secure with the hardware supplied (see figure).

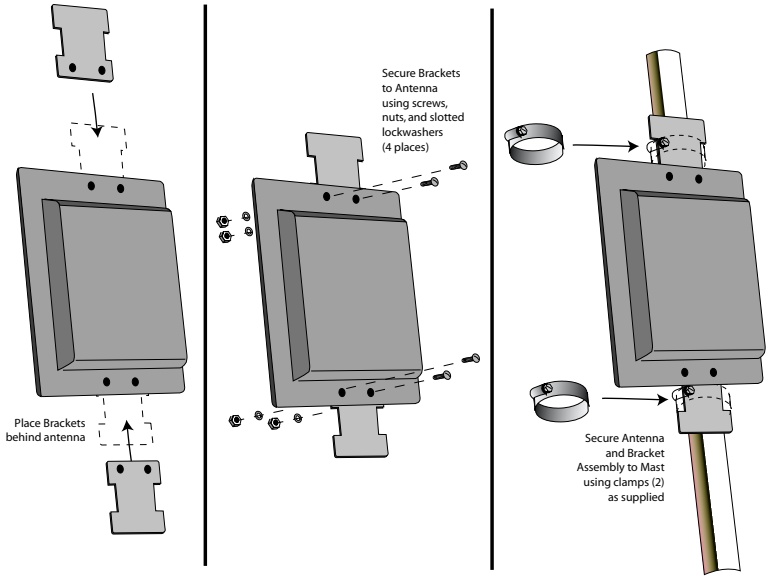


Figure 2-3. 14dBi Directional Antenna Mounting

3. Using a compass or GPS unit to judge direction, position the antenna so it is pointed toward the known BTS antenna location. Later in Chapter 3, when you configure the CPE, you'll use signal strength and quality metrics reported by the CPE Status web page to fine tune the antenna's direction.

Mount the ODU

You can mount the ODU most anywhere since it has a ruggedized enclosure and a flexible mounting system.

If you are mounting the ODU on a mast pole, use the included brackets to mount the unit securely.

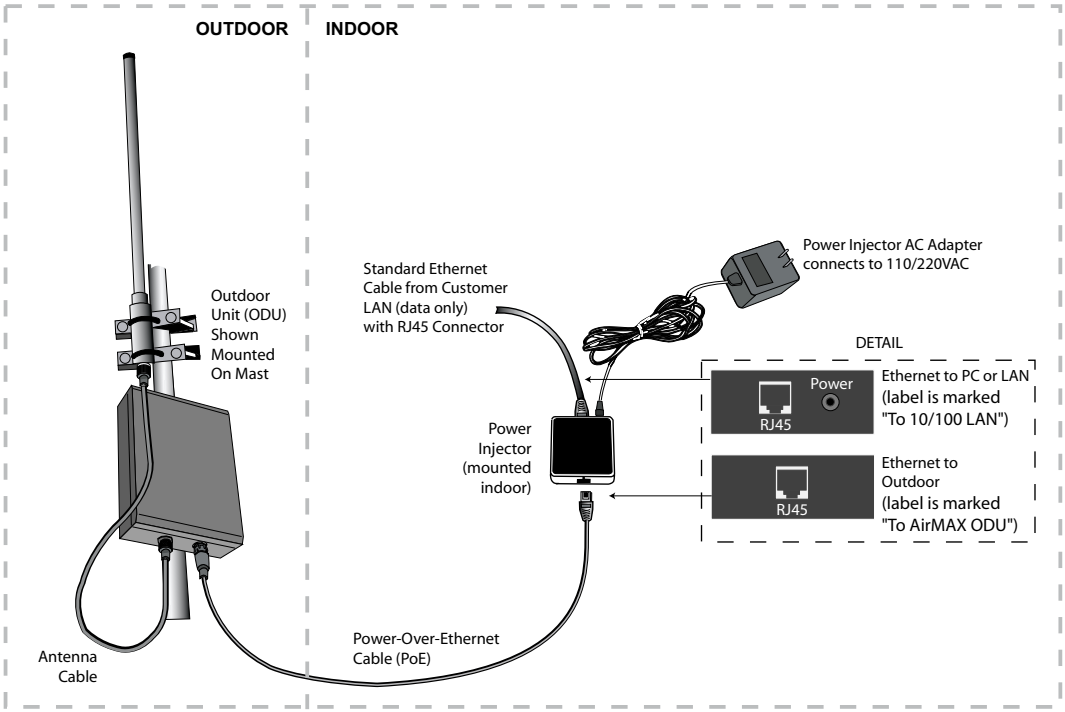


Figure 2-4. ODU Mounting

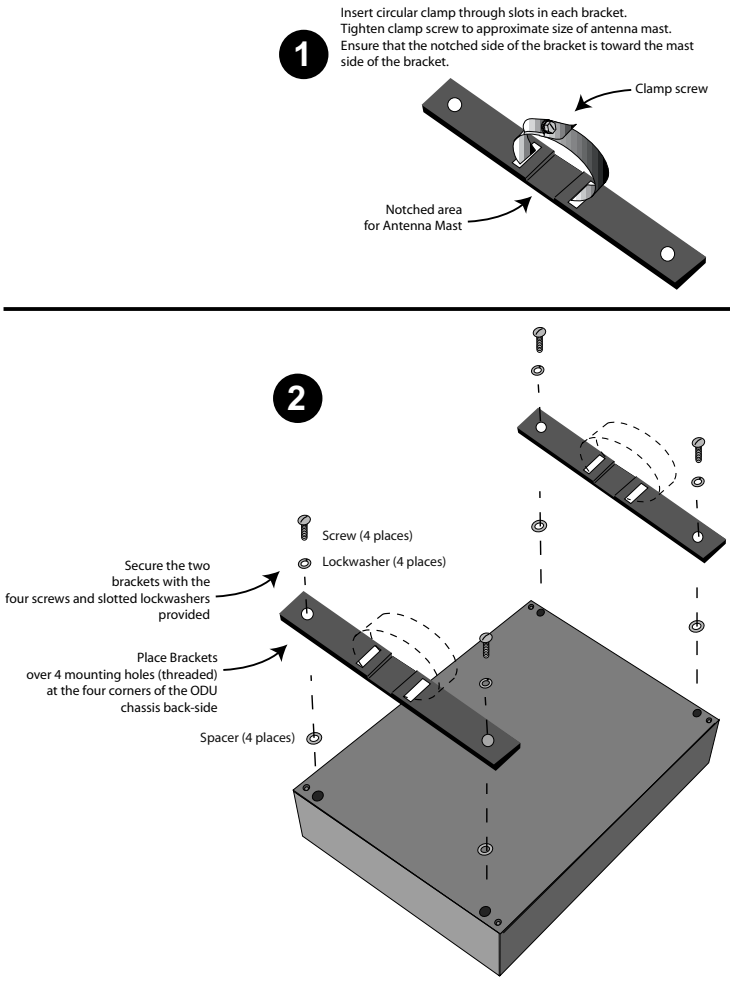


Figure 2-5. ODU Mounting Brackets

The included ODU mounting brackets require that you attach two supplied mounting brackets and circular mounting clamps with screws. Refer to the "*Attaching ODU Mounting Brackets"* illustration for instructions.

Connecting the Antenna to ODU

1. Place the end of the antenna cable next to the coax connector on the bottom of the ODU. (The other end is already connected to the antenna's coax connector from the earlier antenna installation.)
2. Thread the antenna cable male connector onto the ODU coax connector and tighten enough to secure the cable without overtightening.

See Figures 2-5 and 2-6 for reference.

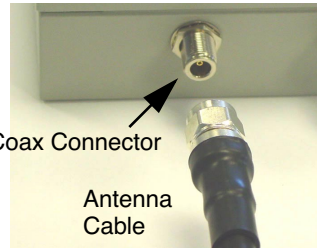


Figure 2-6. Connecting antenna cable to ODU

Connecting Ethernet and Power

The Power Injector connects to the customer LAN (or a single computer with web browser) and a source of AC power via the supplied Power Injector AC Adapter. The Power Injector also connects to the ODU via a single PoE cable passing 10/100 Ethernet and DC power.

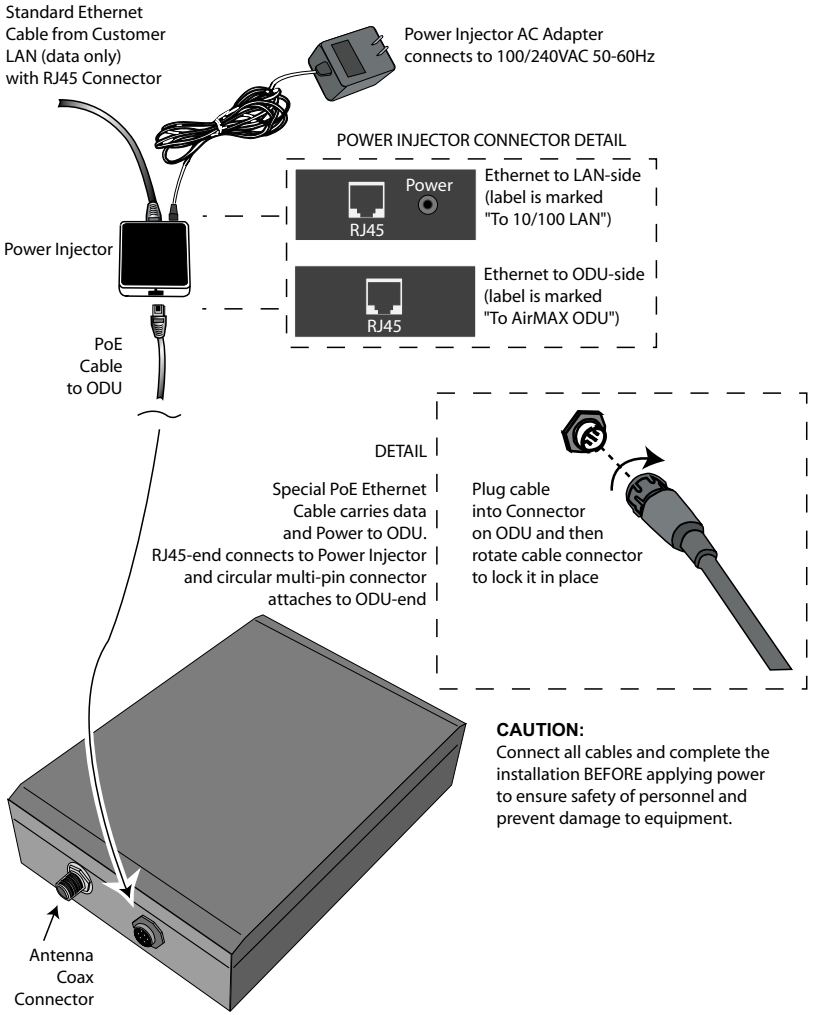


Figure 2-7. Power Injector Connections

Caution: *when connecting Ethernet cables to the Power Injector, do not confuse the ethernet cable from the customer's LAN —which is data only and does not have power—and the Ethernet cable that runs from the ODU—which does have power. These RJ45 connectors are identical, and it is possible to plug in the wrong cable and damage equipment. Always check which cable you're plugging in when making Ethernet connections to the Power Injector. The correct Power Injector Ethernet connections are shown in figure 2-6.*

1. Connect the ODU Ethernet cable carrying power and data to the circular Multipin Ethernet connector on the ODU. At the other end of the same Ethernet cable, plug the RJ45 connector into the Power Injector connector on the side of Power Injector that does not have the power connection.
2. Connect the Ethernet cable from the configuration PC (or the customer's LAN connection) to the RJ45 connector on the Power Injector adjacent to the power connector.

Note: If connecting a PC directly to the Power Injector, then you must use a crossover Ethernet cable. If connecting to a LAN, then use a standard Cat5 Ethernet cable.

3. Plug in the AC/DC power adapter cable into the Power Injector power socket.
4. Plug the AC/DC power adapter into an 100-240VAC 50-60Hz power source.

Note: Appearance and form factor of AC Adapter may differ from that shown in illustration.

The ODU contains a single board computer (SBC) that controls the QoS and wireless networking operation of the CPE or BTS it's part of. On the SBC is a radio modem, non-volatile memory and the ability to communicate with an external computer over its Ethernet link for remote management. In *Chapter 3, Configuration,* we'll describe how to configure the AirMAX system using a Windows PC running Windows 98, 2000, or NT*;* however, you can use any type of computer as long as it has an internet web browser and NIC.

Chapter 3
Configuration

Configuration Overview

Once your AirMAX™ BTS and CPE units are physically installed and cabled, they can then be configured remotely from a PC workstation running an internet web browser such as Internet Explorer or Netscape Navigator. The easy-to-use browser interface allows you to set up the TCP/IP addressing of the CPE and BTS system(s), determine system status, configure the wireless radio, and test or reboot the systems.

In this chapter we'll go through the steps of configuring a complete system, starting with a BTS unit, then a CPE unit, and then testing the two together as a complete wireless system. As discussed in Chapter 1: Introduction, here are the steps we'll cover:

1. Connecting a PC to the Power Injector with a crossover cable and configuring BTS software from a web browser.
2. From the same PC connected to the BTS, adding CPEs you wish to communicate with the BTS.

3. Connecting a PC to the CPE's Power Injector with a crossover cable and configuring the CPE's radio modem. You can also change CPE IP address (optional).
4. Testing BTS to CPE wireless communications using an attached PC.

Initial TCP/IP Configuration

All AirMAX systems come factory preset with a default IP address (192.168.1.1) to simplify network configuration. At configuration you then can change the default IP to a customer-provided valid IP on your LAN. Before configuring the AirMAX system, ensure that you know the IP addresses, router IP address (sometimes called *gateway IP*), and subnet mask that will be used for the AirMAX CPE or BTS system. Your network administrator should be able to provide you with the proper values.

Also, ensure that a PC with an internet browser is available that has connectivity to the AirMAX system Power Injector, either via a LAN connection (hub or switch) or by direct connection via an ethernet crossover cable. You will be using this PC to configure the AirMAX BTS and CPE units.

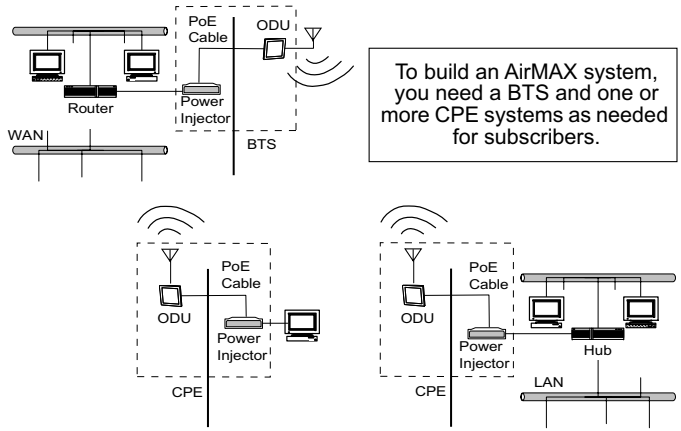


Figure 3-1. AirMAX BTS/CPE Network

Worksheet:

Before starting either BTS and CPE configuration, please have the following information ready. You can get these values from your network administrator. The terms are explained later in this manual where used.

Table 1. Initial TCP/IP Values Worksheet

Item	Value Needed
gateway IP	
subnet mask	
IP addresses for CPEs (1 for each if using static IPs—this may not be necessary)	

Configuring the BTS

To configure the BTS, we'll connect a PC to the Power Injector with a crossover cable, set the IP of the PC to match the subnet of the default BTS configuration, and then configure BTS software from a web browser. Follow the detailed steps:

1. Connect a computer with a javascript-ready internet web browser to the Power Injector via an Ethernet crossover cable. Here we discuss using a Windows 98/2000/NT/XP PC, but you could use some other platform such as Linux or MacOS. Power up the PC. (Chapter 2 provides photos and details on physical installation.)
2. Enter the Network Control Panel (Settings/Control Panels/Network) on the Windows PC, select the Configuration Tab and TCP/IP definition screen and then set the IP address of the PC to

192.168.1.2. Set the Subnet Mask to 255.255.255.0. This will put the PC on the same subnet as the default BTS TCP/IP configuration.

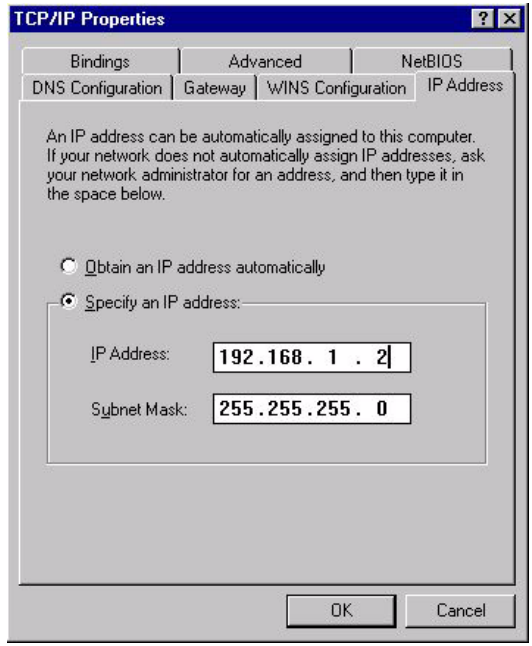


Figure 3-2. TCP/IP Settings on PC (Windows)

3. Restart the PC if the OS requires it (Windows 98 does).

Launch a Web Browser on the PC

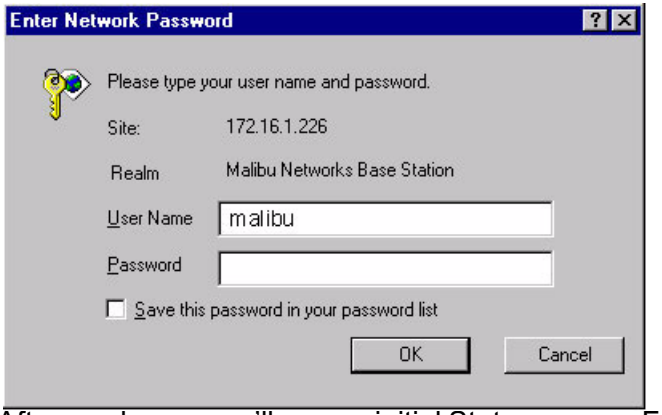
Your AirMAX BTS and CPE units are configured using a web browser running on a Windows PC or other workstation. The configuration web pages are entered by simply entering the IP address of the AirMAX BTS or CPE you wish to configure. This action launches a webserver built into the CPE or BTS and provides you with several web pages of information you can view and configure.

Follow these steps to access the BTS:

1. Launch Internet Explorer or Netscape Navigator on the PC.
2. Enter http://192.168.1.1 in the web browser's URL or Location field:

Figure 3-3. Enter BTS IP address in Browser URL field

After entering the IP address of the BTS, the browser should display a logon screen; enter "malibu" in lowercase as the user (no password is initially required—although you can add one as discussed later in this Chapter):



After you logon, you'll see an initial Status screen. From the Status screen, you can get to these additional screens as follows:

- Configure—this page is where you'll configure the BTS TCP/IP settings and CPE/BTS radio modem.

- Test—this page provides buttons to start continuous radio transmission, start continuous Ethernet data transmission, and stop both Ethernet and radio transmission. These functions are intended only for testing purposes. They should always be turned off for normal operation since they will block wireless LAN traffic.
- Statistics—this page shows data flow characteristics.
- Management Pages (Service Levels, Subscribers, Rules, and CPEs)—these pages are for assigning CPEs to a BTS and establishing Quality of Service. These pages apply to the BTS only (for setting up CPEs).

Before continuing to configure the BTS, read about the Status page and learn what the information displayed is all about, then go to the Configuration Web Page topic and begin configuring the BTS.

Status Web Page

The Status page is the initial screen you'll view when you enter a CPE or BTS IP address in a web browser's URL field. On the left of the page are navigation buttons for the four AirMAX configuration web pages (Status, Configure, Test, Statistics, and Policy—Add CPEs). Clicking on any of the buttons takes you to the corresponding page. Since you're already at the Status page, that button highlights showing you're there.

Shown on the right side of the Status page are the current settings of the CPE or BTS system you're configuring. Each of the fields and controls are described below. On the Status page, these values are read-only and cannot be changed. If you see a value you want to change, click on the Configure button to go to an editable page.

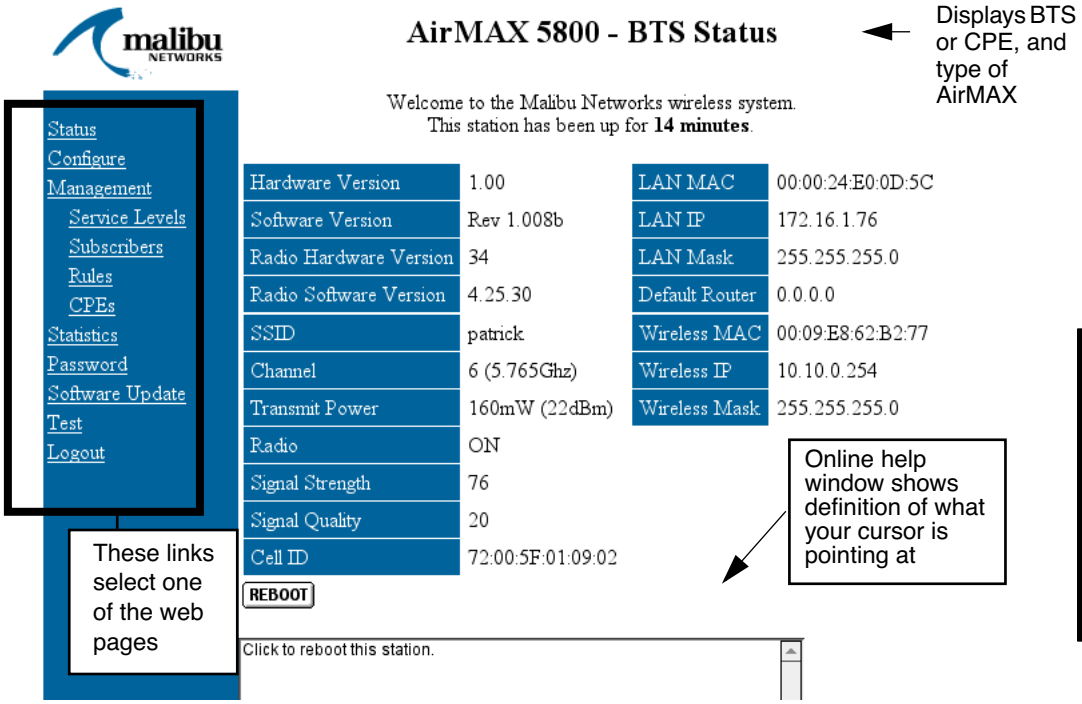


Figure 3-4. Status Page

SSID—this is the service set identifier name (up to 32 characters) defined for the cell area access point that the CPE or BTS will be operating in. This cell area will consist of one BTS system and one to many CPE systems. Whenever any new CPE systems are added, they must be configured to reference this SSID name. You can change this from the *Configure* web page.

Channel—this value indicates the channel number, from one to 11, that the cell SSID transmits and receives on. The actual frequency allocations for each channel can vary geographically. You can change the channel value from the *Configure* web page.

Transmit Power—this reflects the transmission power of the radio modem in milliwatts. Transmit power is set at the factory and is not user-adjustable.

Radio—this shows radio modem transmitter status as On or Off.

Signal Strength—a value from 0 to 100, where a higher number indicates higher signal strength.

Signal Quality—0 to 176 value indicates relative signal quality (lower number indicates better signal).

Cell ID— a unique number used by CPEs to associate with a BTS that has a matching SSID.

LAN MAC—all Ethernet devices have a unique 48-bit media access control (MAC) address built into them when manufactured. An example of a valid MAC address is "*00:08:21:31:4e:8f*". The field will contain "*ff:ff:ff:ff:ff:ff*" when radios have not yet been associated.

LAN IP—the IP Address is a 32-bit address in a dotted decimal notation. Each of the four fields of the IP can have a value from 1 to 255. For example, here is an IP address: *201.252.100.111*. The default BTS LAN IP should be changed to any subnet other than 192.168.1.0/24.

LAN Mask—a bit mask used to select bits from an Internet address for subnet addressing. Subnet addressing is a way to segment devices and nodes on a network for efficient use of network addresses and for controlling data traffic. Routers use the subnet mask to decide which data packets are forwarded or stay on the local network. The mask is 32 bits long and is used to select the network portion of the Internet address and a number of bits of the local portion. For example, *255.255.255.0 specifies 24 network bits and 8 local host bits*.

Default Router (BTS only)—specifies an IP address for your internet router. Your site's network administrator will know the number that should be in this field. It only needs to be set on the BTS. CPEs display a *Next Hop IP* field in its place (discussed later in *Configuring the CPE*).

Wireless MAC—like the LAN MAC, except this field specifies the Radio Modem's MAC. The radio modems in the CPE/BTS systems are Ethernet devices and thus each have a distinct MAC address that will be displayed in this field.

Wireless IP—like the LAN IP Address, except this field specifies the Radio Modem's IP. Note: this field cannot be edited. It is provisioned automatically from the BTS.

Wireless Mask—like the LAN Subnet Mask, except this field specifies the Radio Modem's Subnet mask.

Hardware Version—the revision level of the electronics contained inside the CPE or BTS system. Malibu Networks technical support may ask you for this value when helping to troubleshoot your system.

Software Version—the revision level of the software running inside the CPE or BTS system controller as stored in non-volatile flash memory. Malibu Networks technical support may ask you for this software revision level when helping to troubleshoot your system.

Radio Hardware Version—the revision level of the radio modem on the system controller inside the CPE or BTS system. Malibu Networks technical support may ask you for this value when helping to troubleshoot your system.

Radio Software Version—the revision level of the software embedded in the radio modem module. Malibu Networks technical support may ask you for this software revision level when helping to troubleshoot your system.

REBOOT—this button causes the CPE or BTS being configured to reboot its processor and restart the software.

Configure Web Page

The *Configure* web page has many of the same fields as seen on the *Status* page, however here they're changeable. To make changes to values, you first edit, enter or select the values on the Configure page. Then when you're ready to apply the changes—you click on the **Apply** button at the bottom of the page and the system loads the values inside the actual hardware and software.

Where there are more than two values to choose from, you'll select an item from a pull-down menu (see the *Channel* field). Fields where you can enter text (such as SSID) consist of an editable field.

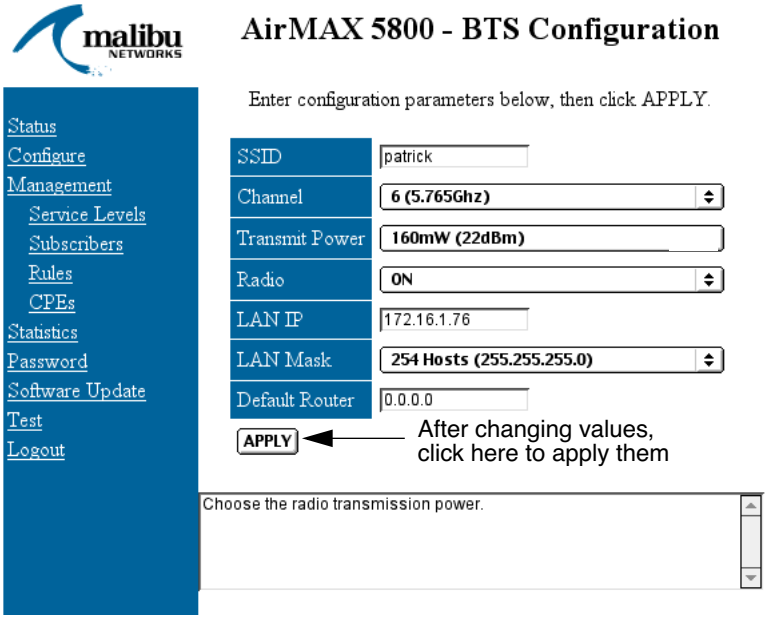


Figure 3-5. Configure Page

To perform initial BTS configuration, follow these steps:

1. Enter an SSID value for the base station. All CPEs configured later within the cell will also use this same value.
2. Enter the radio channel number, from one to 11, by using the pull down menu.
3. Verify that the Radio ON menu item is selected.
4. Enter a LAN IP for the BTS.
5. Select a Subnet Mask in the LAN Mask field. Later you can change this as directed by your network administrator.
6. Enter a default router for the BTS (get the value from your network administrator).
7. Click on the APPLY button at the bottom of the page.

The BTS unit should now be transmitting and ready to pass Ethernet traffic. With the BTS running, you'll now want to add CPEs to its cell area.

Adding CPEs From the BTS

To add CPEs to a BTS fixed wireless broadcast area, you run a web browser from a PC attached to the BTS, just like you did when configuring, but this time you go to the *Management* screens, specifically *the CPEs* web page.

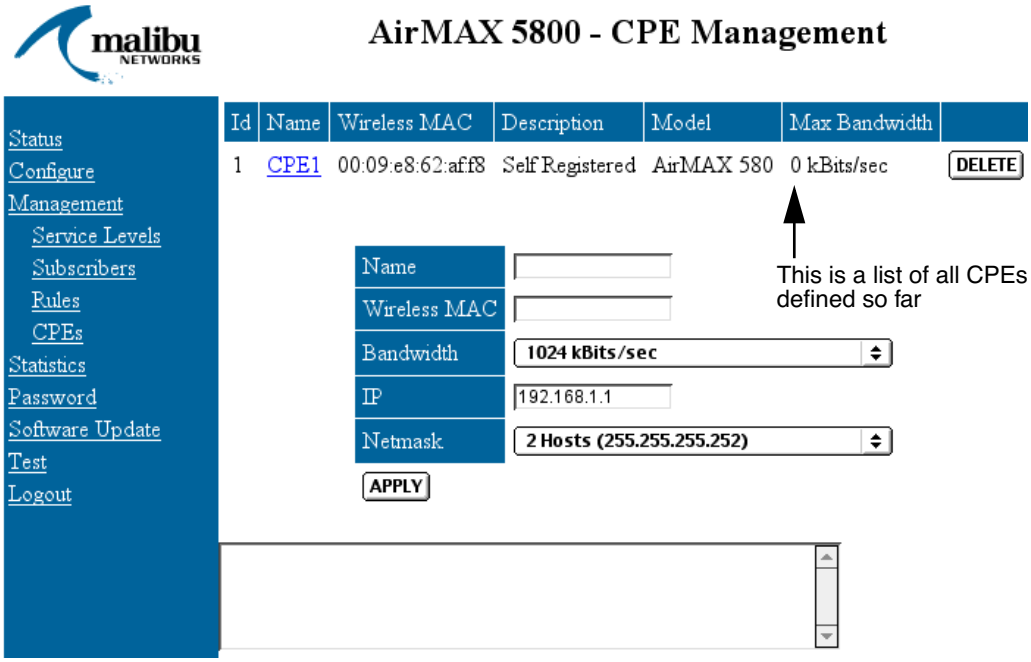


Figure 3-6. CPEs Page

When the page is loaded, you'll see a list at the top showing all the currently defined CPEs for the BTS. If none are yet defined (as shown in the example above), you'll just see the list headings.

To add a new CPE to the BTS, follow this procedure and select or make entries in the fields on the page:

1. Enter the CPEs Wireless MAC address. If not known, you can get this data later when

configuring the CPE. It is used for authenticating the CPE and preventing unauthorized access.

2. Enter a descriptive name for the CPE (for example, “CPE1” or “LABCPE”, etc.).
3. Select a desired bandwidth for the CPE. The value entered is an integer from 0 to 7168 representing Kbps.
4. Enter an IP address for the CPE on its local LAN.
5. In the Netmask field, enter a subnet mask for the CPE address (usually this will be 255.255.255.0, but check with your network administrator).
6. Click the *APPLY* button at the bottom of the screen.

To delete a CPE definition, just highlight it in the list at the top of the page and then click on the *DELETE* button.

Configuring the CPE

After you have configured the BTS, and added the CPE (or CPEs) to the BTS, you’re then ready to configure the CPE(s).

Configuring a CPE is much the same as configuring a BTS, with some small differences. Here are the steps and differences:

1. Just as when you configured the BTS, connect a PC to the CPE’s Power Injector with a crossover cable and repeat the same steps as in “Configuring the BTS.”
2. Run an Internet web browser on the PC, enter *http://192.168.1.1* in the web browser’s URL or Location field and go to the Configure web page. This time it will display “CPE Configuration” at the top of the Configure web page.

Note: If this fails, try pinging the CPE IP address from the PC (pinging is explained in the *Configuration Troubleshooting and Testing* topic at the end of this chapter).

3. Enter the same SSID value as entered for the BTS.
4. Click the *Radio ON* button.
5. Enter a LAN IP for the CPE. You can stay with the default; this is only used for initial configuration and troubleshooting. Additional IP addresses and routes are configured automatically based on subscriber IP address configuration. The IP should not conflict with the BTS LAN IP or be a public IP (e.g., any 192.168.*.* is okay).
6. Enter a Subnet Mask in the LAN Mask field. You can stay with the default; this is only used for initial configuration—afterward at provisioning, the BTS will set this value when the CPE is added to the BTS.
7. If you have a router connected directly to the CPE, select the *CPE Connected to A Router* “Yes”. Then enter the IP address of the router in the *Next Hop IP* field just below it.

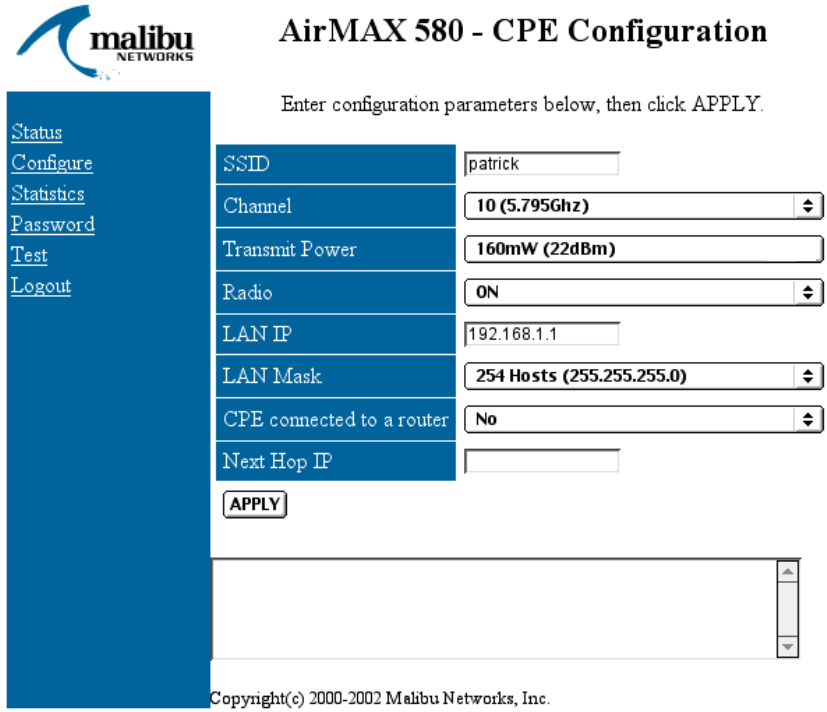


Figure 3-7. CPE Configuration

8. Click on the *APPLY* button at the bottom of the page.
9. The STATUS page will be redisplayed: click the *REBOOT* button at the bottom of the page and wait for two minutes while the CPE reboots and reinitializes the link. Click on the *Status* button at the left of the display after waiting the two minutes. You should see that the Cell ID field no longer contains all “FFs”, and now has a new value indicating the CPE has established a link with the BTS.

10. Observe the values in the Signal Strength and Signal Quality fields on the status page. Carefully rotate the CPE directional antenna through a 15 to 30 degree arc in small increments, rechecking the values by clicking the web browser's refresh button and looking again each time. Find the point where signal strength is the greatest (highest number). Afterward, tighten all antenna mounting nuts to lock the antenna into the final position.

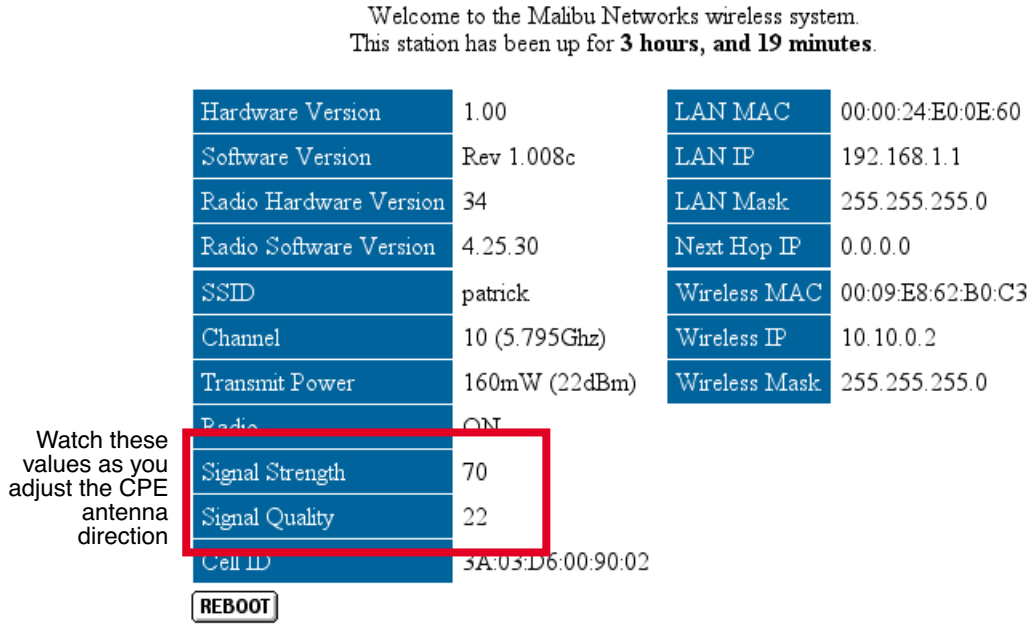


Figure 3-8. CPE Status, Signal Strength and Quality Fields

The CPE unit now passes Ethernet traffic to and from the BTS. You're ready to test the system as a whole.

QoS Management From the BTS

To configure the Quality of Service settings for CPEs and their subscribers, you'll use the *Management* web pages (just as you did when adding CPEs with the *CPE*s web page—also one of the *Management* pages). We've already described the CPEs page under *Management*; now we'll discuss the other pages and their intended purpose:

- Service Levels—this page allows you to set the type of QoS to be employed, including bandwidth, delay and jitter targets.
- Subscribers—this page associates subscribers with a CPE and configures their TCP/IP parameters.
- Rules—this page establishes the behaviors you want the system to follow when handling communications for a specific subscriber. Items you can control include the service level (defined under Service Levels), IP protocols, payload types, and behavior upstream and downstream from the CPE.

When You Log On

Whenever you leave the BTS web pages and return, you'll have to log back on by supplying the username and password ("*malibu*" is the default user without any password—until you change it). After logging on, you can select the QoS management page links (Service Level, Subscribers, Rules, etc.) on the left of the display. Changing the password is discussed later in this Chapter.

Click APPLY to Make Changes Active

Changes you make to any of the QoS Management pages do not take affect unless you click on the *APPLY* button at the bottom of the affected page after changing any values.

Service Levels

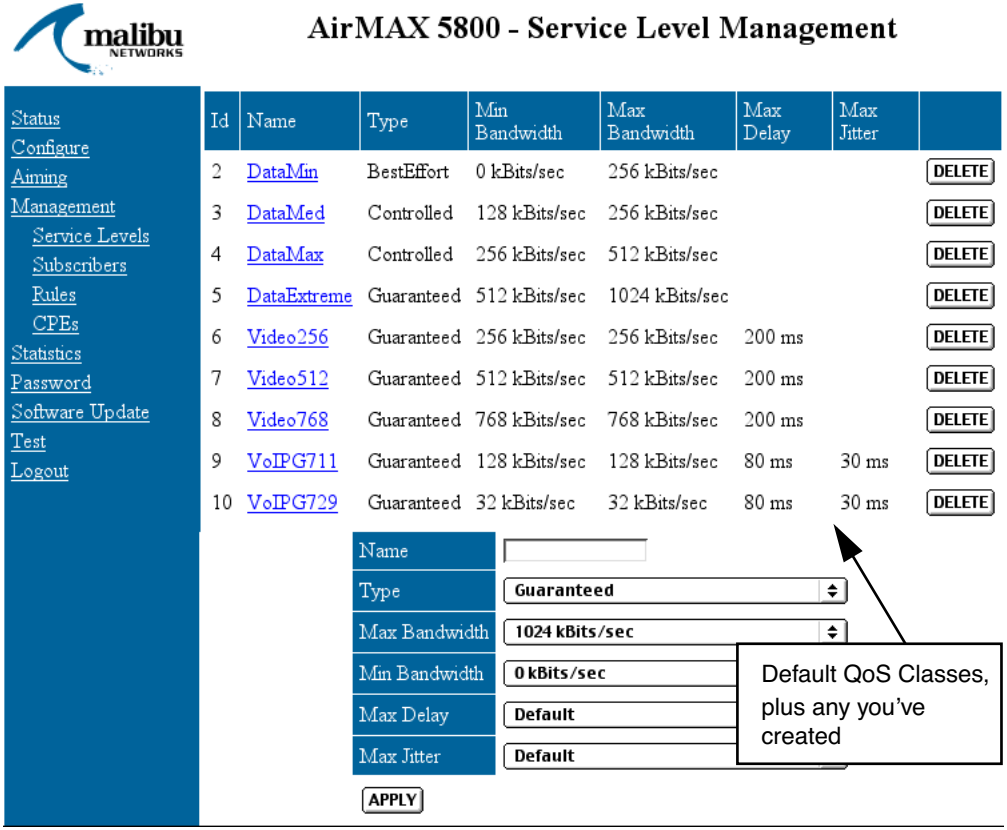


Figure 3-9. Service Levels Web Page

Name—Enter a unique name to identify the service level.

Type—Choose the type of service level; three factory defaults are predefined for you to choose from. Guaranteed is the highest level for the highest priority traffic. Delay and jitter targets may be applied for real-time audio and video traffic. Controlled offers a level for medium traffic without delay and jitter goals. Best Effort is for low priority traffic and only supports maximum bandwidth.

Max Bandwidth—Enter the maximum acceptable bandwidth for this service. The value selected is an integer from 0 to 7168 representing Kbps.

Min Bandwidth—Enter the minimum bandwidth that the system will guarantee for this service level. You must be careful to not over-provision the bandwidth for all active flows. The value selected is an integer from 0 to 7168 representing Kbps.

Max Delay—Packets exceeding this delay value will be dropped. You should only use this field for video or audio traffic. Using it for TCP/IP data traffic will adversely affect overall system throughput.

Max Jitter—Packets should arrive evenly spaced with a variation of less than this value. Note: this value must be less than the *Max Delay* value entered above.

Subscribers

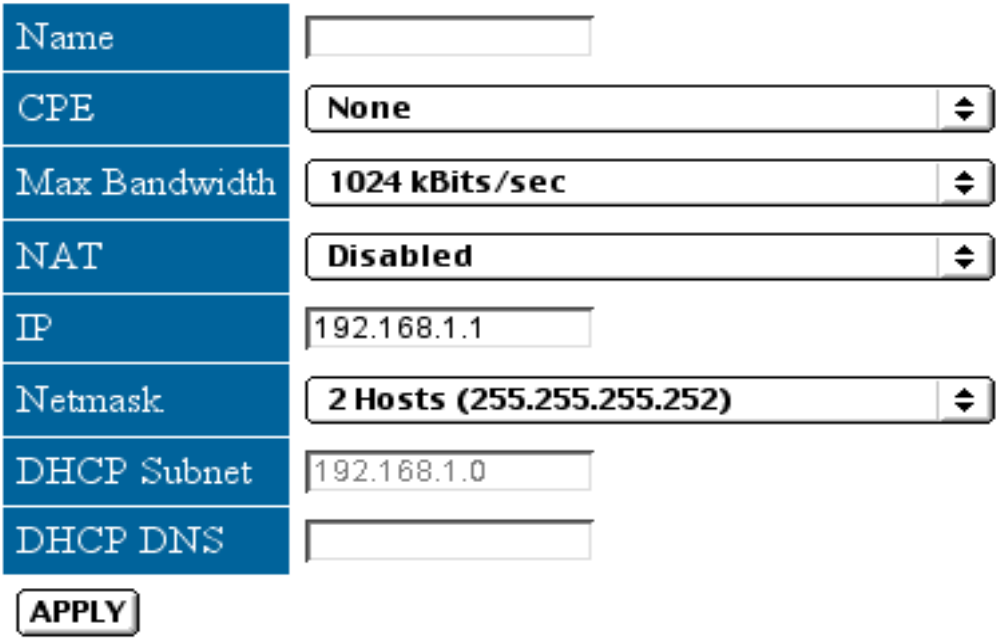


Figure 3-10. Subscribers Web Page

Name—Unique subscriber name.

CPE—Select the CPE that this subscriber is attached to from the list given (showing all CPEs defined thus far).

Max Bandwidth—Select the maximum bandwidth that the subscriber will be allowed from the drop down list. The value selected is an integer from 0 to 7168 representing Kbps.

NAT—Enable or Disable network address translation (NAT) and DHCP for this subscriber. If NAT is enabled, all subscriber LAN addresses will be automatically translated into a single public IP address.

IP—The subscriber public IP address (as seen from the Internet/WAN side).

Netmask—Subscriber's network mask that controls how many nodes a subscriber can access.

DHCP Subnet—If NAT is enabled, you can manually enter the subnet address here. If NAT is disabled, this will be a read-only field showing the DHCP subnet assigned.

DHCP DNS—If NAT is enabled, you can manually enter the IP addresses of up to three DNS servers, separated by spaces for use by DHCP clients. If NAT is disabled, this will be a read-only field.

APPLY button—Click this button after making your selections or changes.

Rules

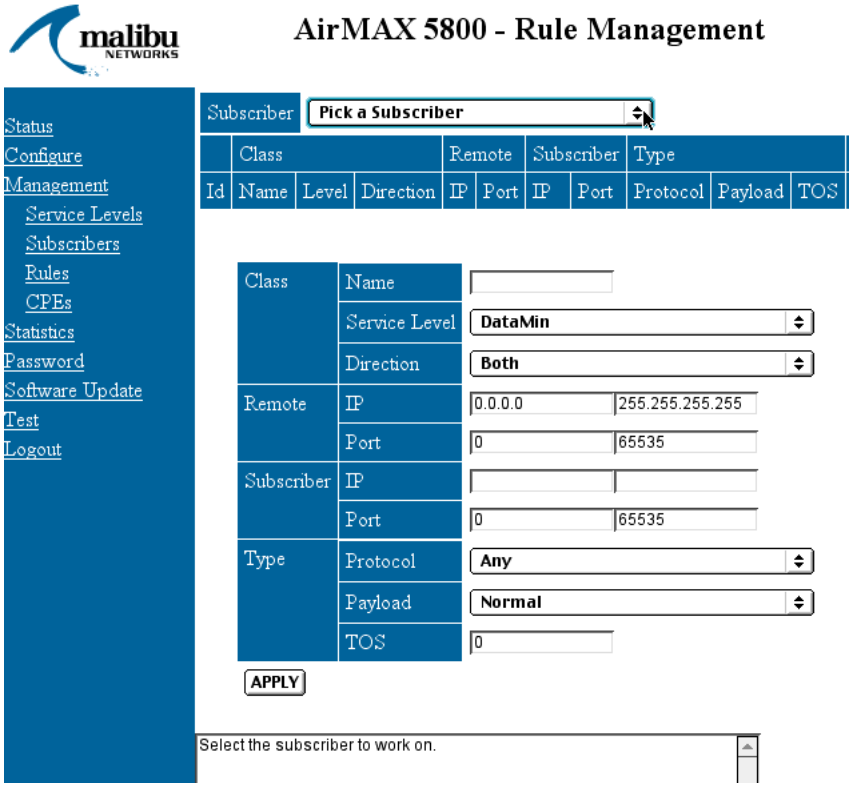


Figure 3-11. Rules Web Page

Subscriber—select a subscriber from a pull-down list of previously configured subscribers that the rule on this page will be applied to.

Class Name—a unique name for this rule

Class Service Level—pull down list of available defined service levels. The name indicates the QoS characteristics for the rule.

Class Direction—selects the direction of the rule, as either upstream-only, downstream-only, or applying to both directions. Upstream means from the subscriber to the BTS, while downstream means from the BTS to the subscriber.

Remote IP—enter the range of remote IP addresses that this rule will apply to. Specify both a starting and ending address. (Start address can be 0.0.0.0.)

Remote Port—enter a range of ports this rule will apply to. Specify both a starting and ending port.

Subscriber IP—enter the range of subscriber IP addresses that this rule will match. Specify both a starting and ending address.

Subscriber Port—enter the range of subscriber ports this rule will apply to. Specify both a starting and ending port. Some commonly used port numbers include:

20	FTP
21	FTP
23	TELNET
25	SMTP (e-post)
43	WHOIS
49	RLOGIN
53	DNS
70	GOPHER
79	FINGER
80	HTTP (www)
88	KERBEROS
105	PH
109	POP2 (e-post)
110	POP3 (e-post)
119	NNTP (usenet)
123	NTP
143	IMAP2, IMAP4 (e-post)
158	DMSP, PCmail (e-post)
161	SNMP
194	IRC
210	WAIS
220	IMAP3 (e-post)
540	UUCP

Type Protocol—select the IP protocol where this rule will apply; for example UDP or TCP.

Type Payload—select a payload type for the rule (audio, video or normal data). This value only applies to UDP traffic.

Type TOS—the Type of Service or Differentiated Services Code Point (DSCP) for this rule. TOS/DSCP is part of the IP packet header.

Changing The Password

Although initially the system has no password (only user “Malibu”), you can and should set a password to ensure system security. A *Password* link on the left of the display, under the *Management* links, takes you to a page where you can set or change password security.

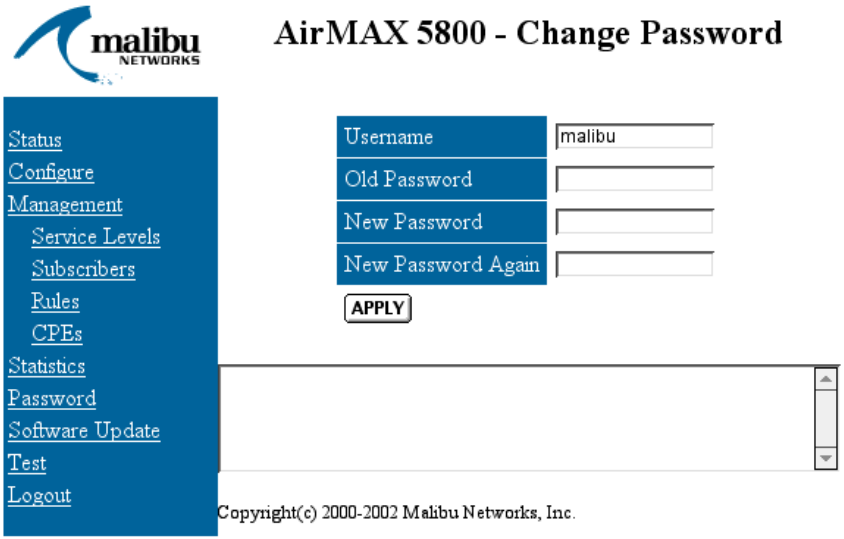


Figure 3-12. Password Page

1. The *Username* field displays the current user; if you wish to change the username, enter the new name in the field, overwriting the current name.
2. If there was a password already defined, it will be shown in the *Old Password* field. To define a new password, enter it in the *New Password* field and then enter it a second time in the field just below it, labelled *New Password Again*. This helps

ensure that you've entered what you really want and have typed it correctly.

3. When you're sure that you've got the correct username and password, then click on the *APPLY* button—only then will the changes be made to the system.

Note: Always write down username and password changes and store them in a secure place, so you can find them later in the event you forget what they are.

Testing BTS to CPE Wireless Communications

Testing a basic system consists of pinging the BTS and then the CPE. To test with a Windows PC (other computers and OS platforms also have "Ping" utilities available, but the exact steps will vary):

1. Connect a Windows PC to the BTS as described earlier in "Configuring a BTS" and then run a DOS window. On most Windows PCs, you will go to the Start button, look under "Programs" and then select "MS-DOS" or "MS-DOS Prompt".
2. Ensure that the BTS and CPE are not on the same LAN, so they can only communicate via the wireless link.
3. In the DOS window ping the CPE IP address set earlier during BTS configuration. For example, if the IP address for the CPE is 206.112.23.2, then enter:

   `>ping 206.112.23.2` *RETURN*

4. If it pings successfully, you have connectivity between the PC and the BTS. If it times-out and does not ping, ensure you are using the correct IP addresses and review the configuration data and physical installation.
5. Verify that you have a subscriber and rules for that CPE (see *QoS Management from the BTS* presented earlier in this Chapter).

Test Web Page

During testing and troubleshooting, you may want to use this *Test* web page to turn Radio and/or Ethernet *continuous transmission* on and off on one or more CPE and BTS units.

> **Caution:** *selecting continuous transmission will cause network disruption so it should only be used under test and troubleshooting conditions.*

On this screen you'll see the following control buttons. Pressing any of these buttons causes an immediate action:

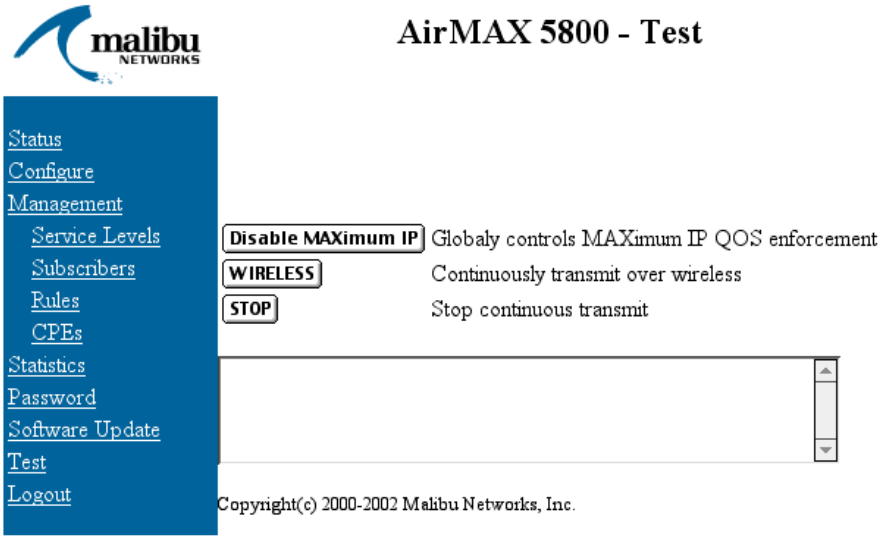


Figure 3-13. Test Page

WIRELESS—pressing this button commands the CPE or BTS to immediately begin continuous radio transmission of data from its radio modem—which continues until the *STOP* button is clicked.

Disable MAXimum IP—pressing this button commands the CPE or BTS to immediately stop the AirMAX Quality of Service enforcement, allowing all flows equal availability without any system throughput management.

STOP—pressing this button commands the CPE or BTS to immediately stop continuous transmit modes.

Note: After running these tests, reboot the system to restore normal operation.

Statistics Web Page

This web page shows data flow statistics for the CPE or BTS system being viewed.

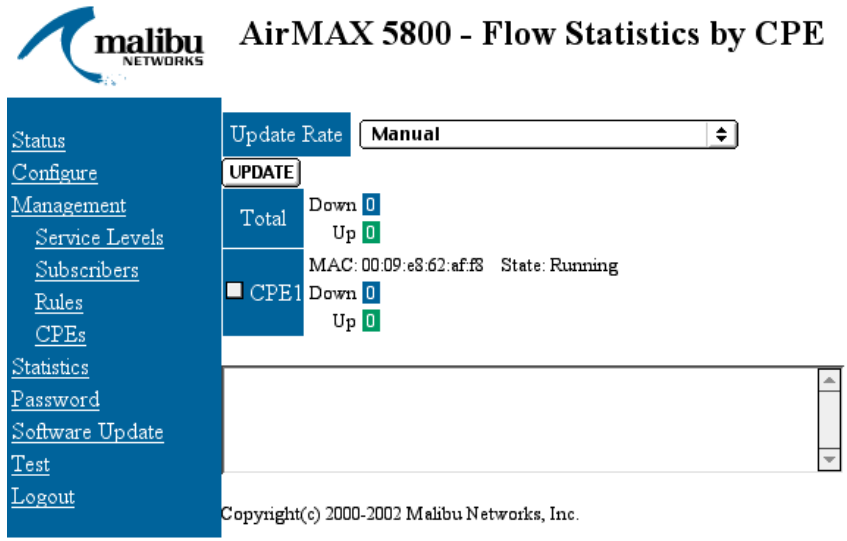


Figure 3-14. Statistics Page

To monitor flow, enter a value in seconds in the Update Rate field, select one or more CPEs, and then click on the *UPDATE* button. Select *Manual* from the pull down menu and then click the *UPDATE* button to stop or select a different web page.

WEP

Wired Equivalent Protocol, or WEP, is the security behind the wireless IEEE 802.11 protocol. With AirMAX systems you do not need to configure WEP; 128-bit WEP with dynamic key exchange is automatically configured and used by the system without any manual operator configuration required.

Configuration Troubleshooting and Testing

Verify Connections by Pinging

Pinging is a simple and reliable way to ensure you have basic TCP/IP connectivity between TCP/IP devices over a network. By running the ping utility on a PC connected to a network and then sending test packets to another device on the network, you can then tell if the link between the devices is working by monitoring packet send times or data loss.

To test with ping on a Windows PC, do the following:

1. Ensure the PC is attached to the network and configured with an appropriate subnet mask and IP address. (This was described at the beginning of this chapter in *Configuring the BTS*.)
2. Open a DOS window from Windows. On most Windows PCs, you will go to the Start button, look under “Programs” and then select “MS-DOS” or “MS-DOS Prompt”.
3. In the DOS window type:

   `>ping 192.168.1.1` *RETURN*

The ping utility will then send test data packets to 192.168.1.1—the factory default AirMAX IP—and measure the time it takes to respond. It also checks whether there is any data loss in the loop. You can use

Ping to test any IP address on your LAN or wireless connection.

Note: if you've changed the IP address from the factory default value, then correspondingly change the IP address in the ping parameter shown above.

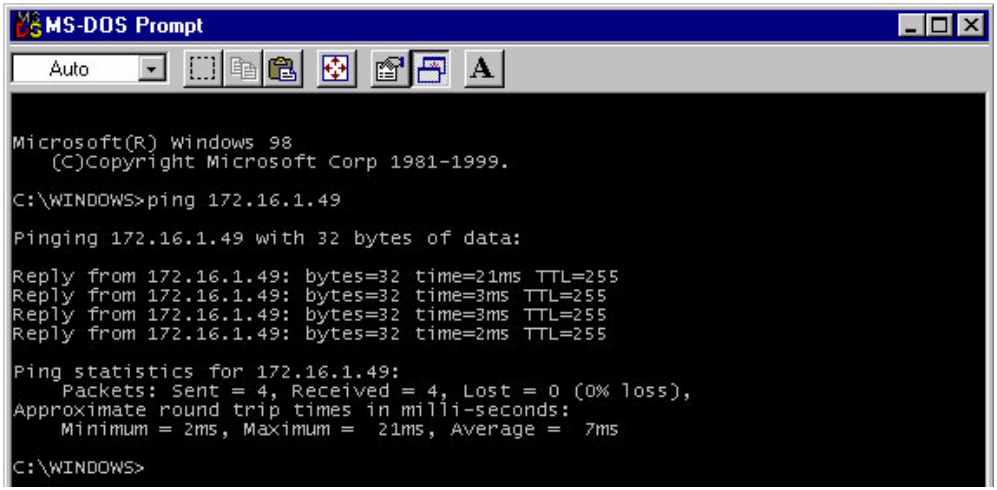


Figure 3-15. DOS Window Showing Ping Utility

If the Ping times out or reports excessive data loss, then re-check your cabling and ensure there is power to the AirMAX Power Injector. If the IP still won't Ping, read the *Symptom and Ready* table shown next.

Table 2. Symptom and Remedy Actions

Symptom or Condition	**Remedy or Action**
If the browser does not load the AirMAX configuration web page when its IP address is entered	Ping the CPE/BTS from the PC (type Ping <IP> from DOS). Check that the PC running the web browser is configured for the same network as the CPE/BTS being configured (check IP, subnet mask, and router IP, on both CPE/BTS and PC) and inspect physical cabling and connections.
CPE/BTS won't Ping from PC (packets aren't returned—Ping times out)	Check that the CPE/BTS is properly connected via the Power Injector ethernet cable and that the Power Injector power adapter is connected to AC power.
CPE/BTS won't respond to Ping from PC and cabling has been verified	Ensure you are using the proper IP address for the CPE/BTS system. If it is fresh from Malibu Networks, it will have the default IP address of 192.168.1.1. If it has been changed, you will need to find out the value it has been changed to.

Table 2. Symptom and Remedy Actions

Symptom or Condition	Remedy or Action
Ethernet works, but the radio modem does not	If you can Ping the CPE or BTS from the LAN side, but a PC on another CPE or BTS within the cell area cannot Ping it, then its radio modem may not be working. Enter the IP number of the suspected CPE/BTS from a PC browser attached to its local LAN and then if the AirMAX configuration pages load up, then verify it has a matching SSID value, verify the CELL ID as reported by the BTS is detected by the CPE, check signal strength, ensure power level is at maximum, and if those measures don't remedy the problem, then try rebooting the CPE/BTS. Also, verify that a subscriber and appropriate rule(s) have been configured for that CPE (see *QoS Management From the BTS*, presented earlier in this Chapter)

Diagnosing CPE Startup Failures

If you are looking at the Status screen for a CPE as it starts up (run a web browser with the CPE's IP address entered in URL field and "Status" link selected), you'll see a series of messages. The messages run through a specific cycle as the CPE initializes and becomes part of the network. If the CPE halts at a particular message, it can sometimes help you diagnose problem causes.

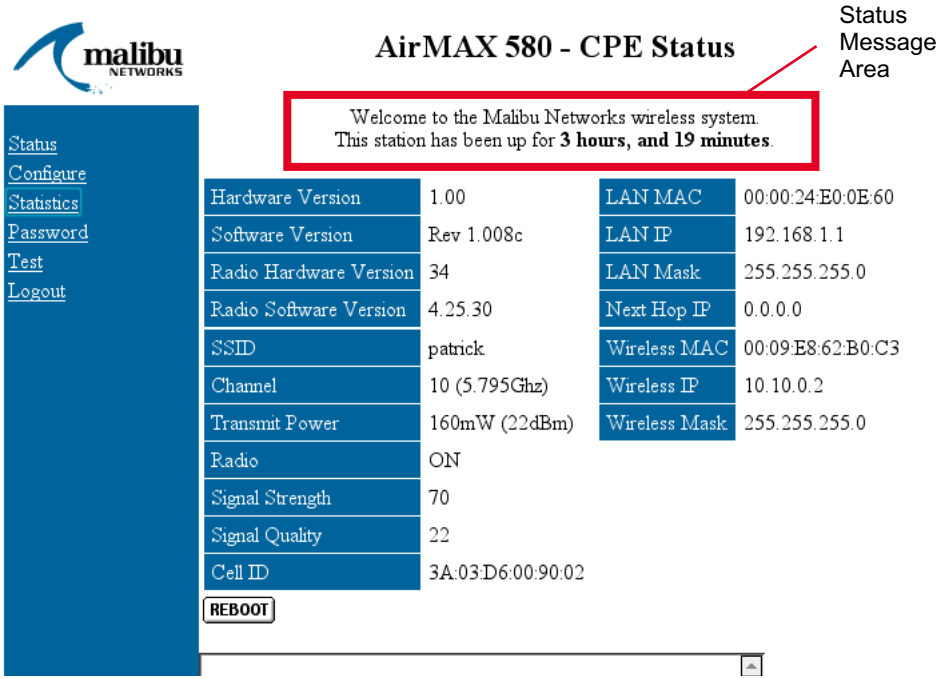


Figure 3-16. CPE Status Page

The messages and the order in which they occur, is as follows:

1. Initializing...
2. Searching for Cell ID
3. Initializing WAN
4. Initializing WEP keys

5. Provisioning

The system could also display a status message of “WIRELESS DOWN” somewhere during this sequence as well.

If the CPE halts or freezes up at one of these messages, it could mean:

Message Displayed When “Frozen”	**Possible Meaning**
Initializing...	Serious system problem. Notify Malibu Networks and report occurrence.
Searching for Cell ID	BTS could be turned off or down. Check the CPE SSID setting and antenna direction/positioning. Also check for physical obstructions.
Initializing WAN	SSID is okay if you’ve gotten this far; the problem may be inadequate signal strength or quality due to antenna obstructions or terrain.
Initializing WEP keys	The system should never become frozen on this message. If it occurs, notify Malibu Networks.
Provisioning	Wait quite awhile for this message to pass, especially if your system has a lot of CPEs. If it remains stuck, try rebooting the CPE in question.
WIRELESS DOWN	The CPEs RF modem is off.

Appendix A
Specifications

Specification Tables

AirMAX™ 580/5800 BTS and CPE performance specifications are listed in tables throughout this Appendix. Refer to the AirMAX Technical Data sheets for full specifications.

Table 1. System Specifications

Specification	Performance
Operating Frequency	5.725—5.825 GHz
Raw Data Rate per sector	11Mbps
Non-overlapping channels	3
CPEs per Sector	100
Subscribers per CPE	Up to 100 (500 Subscribers per sector)

Table 1. System Specifications

Specification	Performance
Range	8km Line-of-sight (4.97 miles)

Table 2. RF Specifications

Specification	Performance
Waveform	DSSS
Duplexing	TDD
Modulations	DBPSK, DQPSK, CCK
Conducted Transmit Power to Antenna	Up to 22dBm (160mW)
Receive Sensitivity at BER 10^{-5}	-92 dBm @ 1Mbps -89 dBm @ 2Mbps -87 dBm @ 5.5Mbps -83 dBm @ 11Mbps

Table 3. Networking and Security Specifications

Specification	Performance
Protocols Supported	Static IP, NAT, DHCP Server, SNMPv2
Interfaces	10/100Base-T
Security	Rule-based packet filtering, 128 bit WEP with Dynamic Key Exchange

Table 4. QoS Specifications

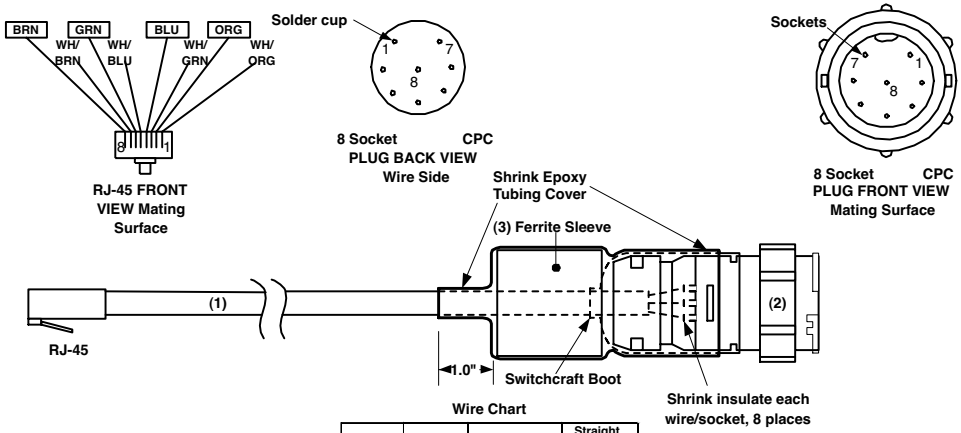
Specification	Performance
Implementation	Per flow queuing and scheduling, fair and dynamic bandwidth allocation
Traffic Shaping and Policing	Delay and jitter control
Class of Service	Guaranteed, Controlled and Best Effort
Packet Classification	Layer 3 and Layer 4 classification including TOS and RTP payload

Table 5. Physical and Environmental Specifications

Specification	Performance
Temperature Range	-30 to +55^{0}C Operational temperature range
Power Supply Consumption	100-240VAC, 50-60Hz 1.5A maximum
Mounting	1” to 2” (2.54cm to 5.8cm) pole mount
Dimensions	11” (27.94cm) height x 8” (20.32cm) width x 3” (7.62cm) depth

Appendix B
Drawings

ODU Ethernet and Power Cable



Wire Chart

Function	RJ-45 Contact #	WIRE COLOR	Straight Plug Contact #
Tx+	1	White/Orange	1
Tx-	2	Orange	2
Rx+	3	White/Green	3
DC Pos	4	Blue	4
DC Pos	5	White/Blue	5
Rx-	6	Green	8
DC Neg	7	White/Brown	7
DC Neg	8	Brown	6

Dash Number/Length Chart

Length (feet)	Length (Meters)	Dash Number
25	7.6	-001
50	15.2	-002
100	30.5	-003
150	45.7	-004
200	61.0	-005
250	76.2	-006

Notes:

1) Cable is Category 5, UV resistant, outdoor environment rated , color GRAY, Belden 1594A or equal.

2) Circular plastic connector is Switchcraft **EN3C8F** , assemble per manufacturers instructions

3) Ferrite Sleeve is Fair-Rite P/N **2631625102**

4) Cable shall be marked with Malibu Networks Part Number / Dash Number and Cable Length Only

Title: Cable Assemby, PoE, RJ-45 Plug to EN3C8F Cable Plug			
Part Number:	2220502-000		
Revision	E		
Drawn by:	L. Crawford	Date:	5/2/2002
Approved:	L. Crawford	Date:	5/2/2002
Released:	L. Crawford	Date:	5/2/2002
Last Rev:	L. Crawford	Date:	6/20/2002
Malibu Networks, Inc.			
1107 Investment Blvd. Suite 250			
El Dorado Hills, CA 95762			

Appendix C
Glossary

Glossary of Terms

This chapter provides definitions for terms commonly used in telecommunications, computer networking, and wireless equipment.

100BaseT — 100BaseT (defined by the IEEE 802.3) uses a star topology, with stations directly connected to a multiport hub, and offers up to 100 Mbps data rate. The standard specifies two pairs of unshielded twisted pair wire for 100BaseTX.

10BaseT — 10BaseT implements the IEEE 802.3 Ethernet standard over unshielded twisted-pair wiring using a star topology, with stations directly connected to a multiport hub. It runs at 10Mbits/sec and has a maximum segment length of 100 meters.

802.11b — An IEEE standard for wireless networking.

Address — An address is a unique code assigned to a network device.

Address Mask — A bit mask used to select bits from an Internet address for subnet addressing. The mask is 32 bits long and selects the network portion of the Internet address and one or more bits of the local portion. Sometimes called s*ubnet mask.*

AirMAX	Malibu Networks' wireless broadband access system comprised of a Base Transceiver Station (BTS) that transmits to and from one or more customer premises (CPE) units. Both CPE and BTS units are functionally similar in that they are made up of an antenna, controller card, radio modem and power supply (items contained in ODU and Power Injector units).
Backbone	The primary connectivity path of a hierarchical distributed network. All systems with connectivity to an intermediate system on the backbone are assured of connectivity to each other. Systems can set up private data transfers with each other to bypass the backbone, reducing backbone traffic and providing security.
Bandwidth	Bandwidth is the difference in MHz between the highest and lowest frequency a channel can conduct. The term also is commonly used to communicate throughput, typically measured in Kbits/sec or Mbps.
Base Transceiver Station (BTS)	Transmits to and from one or more customer premises (CPE) systems.
Bit Error Rate	A measure of transmission quality generally shown as a negative exponent.
Broadband	Any network that multiplexes multiple independent carriers on a single cable. This is done using frequency-division multiplexing. Broadband technology prevents traffic on one network from interfering with another, because the transfers happen on different frequencies.
Broadcast	A packet-delivery system where a copy of a given packet is given to all hosts attached to the network (such as Ethernet).
Buffer	Memory used to temporarily store data that compensates for differences in device transfer rates.
BW	Bandwidth. A numerical measurement of throughput for a system or network.
Cache	A portion of RAM used for temporary storage of data which must be accessed very quickly.
Category 5	The EIA/TIA 568 standard certifies Category 5 up to 100MHz.
Coaxial Cable	Coaxial cable has an inner conductor surrounded by insulation and wrapped in metal screen.
Customer Premises Equipment	End user equipment that resides on the customer's premise which may not be owned by the local exchange carrier.

CRC	Cyclic Redundancy Check. An algorithm that computes a numerical value based on the bits in a block of data to insure the accurate delivery of data
DHCP	Dynamic Host Control Protocol (DHCP) provides a method for automatic IP address allocation via a DHCP server that manages addresses.
DNS	Domain Name System. The distributed name/address mechanism used in the Internet. See also Domain Name Service.
Domain	In the Internet, a part of a naming hierarchy. An Internet domain name consists of a sequence of labels separated by periods.
Domain Name Service (DNS)	DNS allows you to use a name such as www.malibunetworks.com instead of a cryptic IP address such as 204.33.180.83. DNS names cannot have more than 255 characters.
Encryption	Data is scrambled into an unreadable form. Later, an application decodes the data when a user-supplied password matches a predefined value.
Enterprise Network	An enterprise network connects all computers and networkable devices in a company and runs the company's mission-critical applications.
Ethernet	A network that runs over thick coax, thin coax, twisted-pair, and fiber-optic cable. A thick coax Ethernet and a thin coax Ethernet use a bus topology. Twisted-pair Ethernet uses a star topology. Fiber Ethernet uses a point-to-point method. 802.3 is the IEEE specification; 8802/3 is the ISO specification; and DIX/Blue Book Ethernet is the name of the Digital Equipment Corp., Intel, and Xerox specification. Apple Computer’s version of Ethernet is called Ethertalk.
File Transfer Protocol (FTP)	The TCP/IP protocol for file transfer. Internet protocol for transferring files between hosts.
Filtering	A process used to remove particular source or destination addresses before crossing a bridge or router onto another area of a network.
Gateway	An alternate name for a router.
Hop	A term used in routing to represent one data link. The network path from the source to the destination consists of a series of hops.

Host	Refers to any device attached to a network providing application-level services. Examples are workstations, file servers, mainframes, etc.
HTTP	Hyper Text Transfer Protocol. A protocol used in the World-Wide Web to deliver data from Web servers to browsers.
Hub	A multiport repeater, sometimes called a concentrator, that provides an attachment point for multiple network nodes. Hubs often also incorporate bridges, routers, and network-management features.
Indoor Unit (Power Injector)	This unit is placed inside the customer's facility and connects the site's 10/100Base-T LAN to the ODU. It also functions as an AC adapter that passes power to the ODU—along with data—over a special ODU ethernet cable. The Power Injector has two parts, an AC to DC power module that plugs into a 110/220VAC source and a small module (called the power injector) that has the two RJ-45 ethernet connections (LAN and ODU) and connects to the power module.
Internet Address	A TCP/IP 32-bit address given to hosts.
Internet Protocol (IP)	Internet Protocol is a component of TCP/IP. IP is a network-layer protocol defining how packets are transmitted.
Internetwork	A group of networks connected by routers, bridges, and switches. The system is configured so users and devices can communicate with each other, regardless of where they are attached.
Interoperability	The ability of equipment made by one manufacturer to work with another's.
Intranet	A private network using standard Internet protocols (TCP/IP, HTTP servers, POP and SMTP servers for mail), typically found in businesses and organizations. An Intranet has no paths outside the organization, thus providing security to its assets.
IP	Internet Protocol. The network layer protocol for the Internet protocol suite.
IP Datagram	Basic building block of information passed across the Internet. An IP datagram is comprised of data, source and destination addresses, and fields that define its contents. The latter includes items such as the header checksum, datagram length, and flags indicating how the datagram can be used.

ISP — An Internet Service Provider (ISP) is a company that sells Internet access to organizations or individuals. Data rates offered by ISPs can vary, ranging from 300bps to OC-3. ISPs also sometimes offer help in planning and/or installing your network connection.

LAN — Local Area Network. A network that moves data between various devices within an organization.

Link — A physical or virtual connection between two nodes in different subnetworks.

Local Area Network (LAN) — See LAN.

Multicast — Data packets are sent to a select subset of network addresses, rather than being sent to all network addresses as in a *broadcast.*

Multi-Homed Host — A computer having more than one communications data link. Such data links may or may not be attached to the same network.

Multiplexing — The interleaving of information from multiple connections into one.

Network Availability — A measure of network uptime versus unplanned outages and downtime.

Network Interface Card (NIC) — A network interface card (NIC) plugs into a computer and, when attached to a network and used with the proper software, enables communication over the network. This is usually synonymous with Ethernet card.

Network — A system of interconnected computers and other hardware used to exchange data and messages. Networks may be local (LAN) or wide area (WAN).

NIC — See Network Interface Card.

Node — Shortened term for *logical node.*

Noise — Electrical signals superimposed over a desired signal due to environmental reasons or design limitations.

Outdoor Unit (ODU)	Outdoor Unit and antenna. The ODU is a ruggedized box, often antenna-mast mounted, that houses a radio modem and connects to an antenna. It also has an ethernet cable that passes both data and power to/from the Power Injector. The radio modem and circuit board inside have flash memory and a standalone CPU that can intelligently communicate with other systems. Remote management software configures and controls the ODU.
Outside Link	A link to an outside network node.
Packet	A base unit of data. In networking, a packet defines the syntax of data transmitted to and from an application.
Packet Scheduler	A packet scheduler determines when packets are sent to an intermediate router or final destination, as determined by your route and QoS selection.
Parity Check	Self-checking code that uses binary digits to indicate whether the total number of ones (or zeros) in each coded expression are always even or odd. Checks may be made for even, odd, or no parity (checks not performed).
Peer Group	Logical nodes grouped to create a routing hierarchy.
Peer-To-Peer	Nodes can directly begin communication with each other in a peer-to-peer architecture—*without an intermediary.*
Physical Link	A tangible physical link that provides a connection between two switching systems.
Physical Medium	Physical Medium are actual physical interfaces such as DS1, E1, DS2, E3, DS3, E4, FDDI-based, Fiber Channel-based, STS-1, STS-3c, STS-12c, STM-1, STM-4, and STP. These mediums range from 1.544Mbps through 622.08 Mbps in data rate.
Ping	Packet internet groper. A utility program that tests whether destinations can be reached by sending them an ICMP echo request and then waiting for a reply. Ping is a useful utility to check whether equipment is performing and connected properly on the network. Ping clients are available for the PC, Macintosh, and Unix computers.
PoE Cable	Power-Over-Ethernet Cable. This is a category 5 Ethernet cable that also includes power in addition to data signals. The cable is a single interconnect between the ODU and the Power Injector which supplies the Ethernet connection from the LAN and the power via an AC adapter that attaches to the Power Injector. Malibu Networks supplies PoE cables in various lengths.

Point of Presence (POP) — A communication access point along a network provider's backbone.

Port Identifier — Identifier assigned by a logical node that notes the point of attachment of a link to that node.

Power Injector — This unit is placed inside the customer's facility and connects the site's 10/100Base-T LAN to the ODU. It also functions as an AC adapter that passes power to the ODU—along with data—over a special ODU ethernet cable. The Power Injector has two parts, an AC adapter power module that plugs into a 100/240VAC 50-60Hz source and a small module (called the power injector) that has the two RJ-45 ethernet connections (LAN and ODU) and connects to the power module.

Propagation Delay — In networking jargon, propagation delay is the time it takes for a bit to travel across the network from its transmission point to its destination point.

Protocol — A definition of data to be sent and the negotiation rules to be followed when sending.

Public Data Network (PDN) — A network open to the public and run by a government or service provider for a fee.

QOS—Quality of Service — An acronym referring to the communication quality and data integrity of a network. It reflects whether the network can transport data without losing cells and has predictable delivery of data.

Real Time — The actual passage of time. An event in real time occurs as we would see and experience it in actual time, without delays or compromises.

Repeater — A device that delivers electrical signals from one cable to another without packet filtering or routing. Repeaters usually also boost signal strength to allow longer cable runs than possible with a single cable.

RJ11 — A four-wire modular connector used by the telephone system.

RJ45 — An eight-wire modular connector used by telephone systems. Special RJ45 modular connectors are also used for 10BaseT UTP cable, but have different electrical properties.

Route Discovery — A process that checks whether a packet destination exists, and how it should be reached (using the routing table).

Router	A network-layer device that connects networks using the same network-layer protocol, such as TCP/IP.
Semipermanent Connection	A connection established via a telephone company service order.
Server	A powerful computer host providing shared files and resources to network users.
Service Exchange Points (SEP)	These are points along a backbone where Network Providers allow traffic to cross between their network and another private network or the public Internet. Service Exchange Points are monitored so that only traffic destined for a paying customer is allowed to enter the private network.
Service Management System (SMS)	SMS is a Malibu Networks proprietary software option that manages all aspects of AirMAX systems. It provides a robust suite of functions, from top-level network management integration, to system element management, to customer provisioning and management.
Session	An online communications connection between two nodes.
Simple Network Management Protocol (SNMP)	A protocol used for gathering management information from network devices. SNMP is the standard protocol for network management.
Subnet Mask	See address mask.
Subnetting	Configuring servers using alternate data paths. Subnetting reduces network traffic and still allows connection when single paths fail.
T-1	North American standard for point-to-point digital circuits over two twisted pairs. Such a line can carry 24 64,000bps channels, allowing a usable bit rate of 1,536,000bps. Customers may lease all of a T-1 line or a fractional T-1 with only some of the 24 channels. A T-1C contains two T-1 lines. In Europe and Japan E-1 through E-5 offer similar features with differing numbers of channels and different data rates.
T-2	T-2 is the equivalent of four T-1s, offering 4 T-1 circuits with a 6.3Mbits/sec of bandwidth. T-2 is not commercially available, but rather is used within the telephone company service system.
T-3	T-3 supports 28 multiplexed T-1 circuits and provides 44.736Mbits/sec of bandwidth.
T-4	T-4 consists of 168 T-1 circuits.

TCP
A Transmission Control Protocol that provides end-to-end connection over IP controlled networks. TCP provides flow control between systems, acknowledges packets received, and sequences packets sent.

Telnet
A virtual terminal protocol in the Internet suite of protocols. Allows computer users to log into a remote host via TCP/IP and work as if they were local terminal users on that host.

Throughput
A measure in bits per second (bits/sec) or bytes per second (bytes/sec) of a channel's data carrying capacity.

Transceiver
Transmitter-receiver. A physical adapter device that connects a NIC or host interface to a local area network.

Tunneling
Encapsulating one protocol in another's format is called tunneling.

Twisted-Pair
A copper cable where two wires are twisted around each other to reduce noise.

Universal Resource Locator (URL)
A URL is an address that uniquely identifies a file anywhere on the Internet. Every URL has three parts: the protocol name, DNS name or IP#, and the directory or location. The protocol is usually *http* or *ftp* followed by two slashes and a colon (//:).

User Datagram Protocol (UDP)
A connection-less transport protocol within the TCP/IP suite.

UTP
Unshielded Twisted Pair cable. A cable having one or more twisted pairs without any pair shielding.

Virtual Circuit
A shared communications link that appears to the customer as a dedicated circuit. A virtual circuit passes packets sequentially between devices.

WAN
Wide Area Network. A WAN connects a larger geographic area than a LAN (Local Area Network) and uses a wide variety of equipment and switching services to route data. As a result, a WAN has greater transfer delays than a LAN.

Wireless LANs
A wireless LAN does not use cable to transmit signals, but rather uses radio or infrared to transmit packets.

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