TSUNAMI MULTIPOINT

Connecting External Antennas

Proxim WIRELESS NETWORKS

Take your network further

CPN required

Issue Date: 03/05/2003

Copyright and Service Marks

The information contained in this manual is subject to change without notice. Proxim Corporation shall not be liable for errors contained herein or for incidental or consequential damages in connection with the furnishing, performance, or use of this manual or equipment supplied with this manual. Proxim Corporation makes no warranty of any kind with regard to this manual or any equipment supplied with this manual, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose.

Y2K (Year 2000 Issue): All software supplied by and for Proxim Corporation products adhere to the four-(4) digit year nomenclature as required for Year 2000 compliance.

Contents

Connecting External Antennas to the BSU and SU

Standard Tsunami Multipoint outdoor unit models include integral antennas. However, SU models 40100-xxxC and BSU models 40400-xxC replace the integral antennas with a type-N female connector, letting you purchase and use antennas better suited for your particular application, if so desired.

Planning for Antenna Installation

In general, the larger the antenna used with the radio, the better the link performs. Larger antennas have narrower beamwidth and higher gain, which yield better link performance (higher fade margin, better availability) and improve immunity to interference. However, larger antennas are more costly to purchase and install than smaller antennas and, in some cases, require special installation equipment and more robust mounting structures (due to increased weight and wind loading).

Base stations, however, require wide beamwidths in azimuth so that a large segment of subscribers can be accessed spatially. Antennas are available to allow sectors ranging from 30° to 360°. Of course, the larger the sector, the less antenna gain for longer transmission distance and interference immunity.

Finally, antenna polarization must be considered. The BSU and SU integral antennas use left-hand circular polarization (LHCP). External antennas with either linear or circular polarization can be considered. Use the following guidelines to assist in your planning.

1. The polarization of the BSU and SU antennas should be of the same type. For a given polarization, the same polarity (vertical ir horizontal) must be used at each end of the link.
2. Linear and circular polarization can be used at opposite ends of the link; however, this results in a 3 dB loss in signal strength.
3. Integral antenna units and external antenna units can be used in the same sector.
4. Only LHCP antennas can be used with SUs connecting to a BSU with Active Interference Rejection (A.I.R.).

Note: The A.I.R. BSU is compatible only with LHCP signals from SUs. SUs must use LHCP antennas; either the integral antenna or an LHCP external antenna.

You should consider all of these factors when selecting an antenna. This advanced planning also yields the transmission line requirements.

The following tables list antenna types, performance, and manufacturers.

BSU Antenna Information

Antenna Type	Manufacturer	Model Number	Mid-Band Gain (dBi)
Omni	Telex	5830AN	7.5
	MTI	MT-482009/N	9
	MTI	MT-483003/N	12
Flat Panel, Sector	European Antennas	SA16-30-58H/736	16
	European Antennas	SA17-55V/450	17
	Radio Waves	SEC-5V/H-90-17	17
	Radio Waves	SEC-5V/H-60-18	18

SU Antenna Information

Antenna Type	Manufacturer	Model Number	Mid-Band Gain (dBi)
Omni	Telex	5830AN	7.5
	MTI	MT-482009/N	9
	MTI	MT-483003/N	12
1-foot Flat Panel	Gabriel	DFPD1-52	23.5
	RFS	MA0528-23AN	23.0
	Andrew	FPA5250D12-N	23.6
2-foot Flat Panel	Gabriel	DFPD2-52	28.0
	RFS	MA0528-28AN	28.0
	MTI	MT-20004	28.0
	Andrew	FPA5250D24-N	28.2
2-foot Parabolic	RFS	SPF2-52A	27.9
	Gabriel	HSSP2-52	28.1
	Gabriel	SSD2-52A	28.4
	Gabriel	SSP2-52B	28.5
	YDI	A5.8-2'-RW	28.3
	Radio Waves	SP2-5.2/SPD2-5.2	28.0
	Radio Waves	SP2-5.8/SPD2-5.8	28.5
	Andrew	P2F-52/PX2F-52	29.4
3-foot Parabolic	Radio Waves	SP3-5.2/SPD3-5.2	31.2
	Radio Waves	SP3-5.8/ SPD3-5.8	31.4
	RFS	SPF3-52A	31.4
	YDI	A5.8-3'-RW	31.4
	Andrew	P3F-52/PX3F-52	33.4

Recommended transmission lines are listed in the following table.

Transmission Line

Type	Manufacturer	Model Number	Loss/100 ft, dB	Notes
½-inch foam coax	Andrew	LDF 4-50	6.1	Add –0.25 dB per connector
5/8-inch foam coax	Andrew	LDF 4.5-50	4.7	Add –0.25 dB per connector
Waveguide	Andrew	EW-52	1.2	Does not include transitions
½-inch foam coax	Times Microwave	LMR-600	7.3	Add –0.25 dB per connector
5/8-inch foam coax	Times Microwave	LMR-900	4.9	Add –0.25 dB per connector

Prior to installation, determine the specific antenna location and type of mounting. The transmission line should be kept as short as possible so, when line-of-sight placement of antennas allow flexibility, it is always desirable to locate the equipment closer to the antenna.

Within the USA and Canada, antennas other than those illustrated in these tables can be used with this radio, but must be of the same type (flat panel or solid parabolic), dimensions, and gain as those listed in the table. Antennas with gain less than 7.5 dBi are not approved for use within the USA or Canada. Consult governmental regulations or Proxim Corporation for applications outside of the USA or Canada.

For further information regarding antenna installation and adjustment, see "Installing and Adjusting the Antenna" later in this section.

Note: Max BSU Tx (dBm) is the lesser of 17 dBm and 36 - G + L

G is the antenna gain and L is the transmission line loss.

Reviewing the Installation Process

The following is an overview of the installation process to assist you in your planning activities.

1. Test Radios Back-to-Back and Configure

- Use at least 60 dB and no more than 80 dB attenuation and a short low-loss RF transmission line to connect the two radios.
- Apply power.
- Verify configuration settings (through the BSU Console) for proper configurations.
- Verify that the SU enters the network.
- Connect to services, if possible, to verify network connection and configurations.

2. Mount Antennas

- Antenna height can be critical for path clearance and line of sight.
- Ensure that antennas will not be blocked by people.
- Antenna structure must be secure for wind load and whatever climbing may be necessary.

3. Run Transmission Line Route and Egress, including Lightning Arrestors

- Use proper transmission line.
- Proper termination is critical, especially at 5.8 GHz.
- Be careful with the bend radius and never kink the transmission line.
- Secure transmission line to structures; be careful not to crush.
- A direct connection to the antenna feed is ideal (if required, you can use a flexible jumper at the antenna, a properly specified 90-degree connector/adaptor, or both).
- Weatherproof all outdoor connections when completed with installation.
- If the transmission line is longer than three meters, a lightning arrester located near the RF Unit is recommended. If the RF Unit is

located indoors, locate the lightning arrestor at the building egress point.

- All lightning arrestors and transmission line must be properly grounded.

4. Connect Radios to Antennas and Power, including Grounding

- Connect to RF transmission line from antenna directly or using flexible jumper, if necessary.
- Do not use 90° adapters unless rated at operating frequency.
- Connect CAT5 cable from power adapter to BSU/SU.
- Test power voltages and pinouts before connecting power to BSU/SU.

5. Align Antennas

- Rough align antenna azimuth and elevation based upon path planning (using compass bearing or milestone sighting, telescopic sight, binoculars, and so on).
- Use the audio indicator to align the SU antenna, or the received signal quality indicator display of the SU Utility software to peak antennas.
- Adjust alignment of one antenna at a time, one plane (azimuth versus elevation) at a time.
- Adjust each end multiple times until predicted RSL is achieved.

Installing the Units

Follow the instructions in "Chapter 2. Deploying the Base Station Unit" in the *Tsunami Multipoint Installation Manual* to unpack, mount, and configure the BSU. Chapter 2 includes these topics:

- Deploying the Base Station Unit
  - Unpacking the System
  - Mounting the Base Station Unit
  - Installing the GPS Antenna
  - Installing BSU Configuration Software
    - Operating in a Test Environment
    - Indoor Deployment
    - Configuring the Base Station
    - Adding Subscribers to the BSU Database
    - Configuring the System for Multi-Sector Mode
    - Testing the GPS Receiver

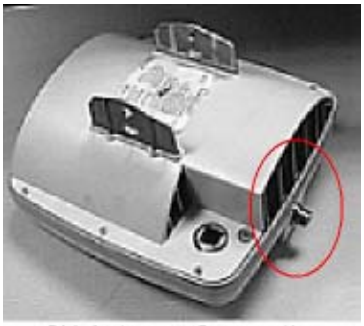
Follow the instructions in "Chapter 3. Deploying the Subscriber Unit" in the *Tsunami Multipoint Installation Manual* to mount and configure the SU. Chapter 3 includes these topics:

- Deploying the Subscriber Unit
  - Mounting the Subscriber Unit
  - Installing the Subscriber Utility Software
  - Aiming the SU
  - Displaying Link Status Information
  - Confirming Network Activity

Establishing Connections

Antenna Connection

The BSU and SU radios are equipped with an N-type female connector at the antenna port.



SU Antenna Connection

BSU Antenna Connection

You can use a short length jumper cable (such as ¼- to ½-inch coax or pigtail of approximately 6 feet in length) fitted with two N-type male connectors to connect the antenna port to the antenna (if the unit is located near the antenna) or to the primary transmission line (if the unit is mounted remotely from the antenna).

A low-loss 50-ohm cable is recommended for the antenna transmission line between the BSU/SU and the antenna (such as Andrew LDF4-50 or Times LMR-600 1/2-inch coaxial cable, an Andrew LDF4.5-50 or Times LMR-900 5/8-inch coaxial cable, or an EW-52 waveguide).

The return loss presented by the transmission line at the BSU/SU interface should be as high as possible (20 dB minimum recommended). The length of the antenna transmission line should be kept as short as possible to minimize loss.

Antenna Cabling Guidelines for 5.8 GHz Units

- Coaxial cables of $^{7}/_{8}$-inch or larger diameter can exhibit moding at 5.8 GHz and are never recommended. Also, some small diameter cable types, such as RG-8, have high loss or poor VSWR at these frequencies. If small diameter cables are required, be certain to keep the lengths of these cables as short as possible.
- For wave guide transmission line at 5.8 GHz, EW-52 wave guide is recommended. EW-63 also works, but exhibits more loss.
- Do not use right-angle N-type connectors with the BSU/SU radios operating at 5.8 GHz unless the connector has been specifically rated and tested up to 5850 MHz. Unless specifically designed for these frequencies, these connectors can present high loss at these frequencies.
- Do not use low quality jumper cables with the radios.
- Always precisely follow manufacturer's recommended procedures and tools for termination.

BSU/SU RF Connections

Prepare the RF transmission line feeder cable as follows:

1. Cut the cable to the approximate length (allowing some excess).
2. Install the appropriate connector on the antenna or BSU/SU end: Place tape or a covering over the connector end so that debris cannot harm the connector.

3. Pull the transmission line through the cable ducts, trays, or conduit (as required) to the antenna, while being careful not to kink or damage the transmission line in any way.

Note: **RF transmission line must never be bent, twisted, or deformed in any way.** Pay close attention to the transmission line specifications for bend radius when installing.

4. Support the transmission line in a tray on horizontal runs and by hangers on vertical runs. Space hangers according to the manufacturer instructions (typically every five feet under conditions of no ice and not greater than 85 mph winds).

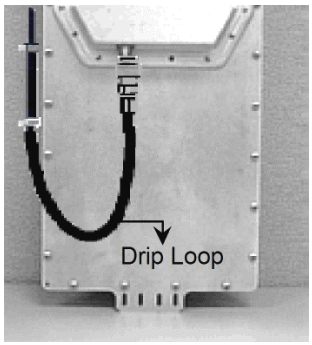
5. Ground the transmission line using the manufacturer grounding kit. Grounding kits attach to the outer copper conductor. Install grounds at the antenna, at the bottom of the antenna structure (if applicable), and where the transmission line enters the building. Be sure to ground long transmission line runs every 100 feet.

6. Lightning suppression (such as Polyphaser LSX) is required at the interconnection cable junction as close as possible to the BSU/SU when the cable is longer than 3 meters. There should always be a lightning protection device at the egress point for whatever cables egress the building or enclosure. Lightning arrestors must be properly grounded to operate.

7. After installation, terminate the transmission line with an N-type male connector or adapter attached at the equipment end. For wave guide, this typically requires a CPR-to-N adapter. Be sure to use manufacturer-specified connectors and termination tools, and follow termination instructions precisely. Improper transmission line terminations can cause excess losses and reflections that can lead to many problems with the system.

8. Prior to operation, check the electrical integrity of the transmission line, including all connectors, with a simple DC check between the center conductor and outer conductor (this is neither possible, nor required for wave guide). The transmission line ideally should be connected directly to the antenna at one end and to the BSU/SU antenna port at the other end (through the RF Lightning arrestor). However, short pigtail jumper cables may be required to avoid sharp bends in the primary transmission line to limit stress on either connection.

9. Connect the transmission line to the RF connector on the BSU or SU. Create a drip loop in the cable as shown in the figure below, and tie the cable to the mast or pole to remove any stress on the RF connector. The drip loop allows any moisture on the wires from rain or condensation to drip off.



[temporary photo]

BSU/SU Power Connections

Refer to "Appendix D. Constructing Power and Ethernet Cables" in the *Tsunami Multipoint Installation Manual* for instructions.

Installing and Adjusting the Antenna

The installation information discussed in this section is generic. For installation procedures specific to the antenna you are installing, refer to the antenna manufacturer's documentation.

Antenna Installation

WARNING
(FCC requirement for implementation in the USA)

Antennas used for the transmitter must be fix-mounted on outdoor permanent structures with a separation distance of at least 2 meters from all persons during normal operation. Antennas must be professionally installed. Installers must be provided with antenna installation instruct-tions and transmitter operating conditions, including antenna co-location requirements of CFR47 Part 1.1307(b)(3), for satisfying RF exposure compliance.

Antenna installation consists of permanently mounting the antenna to the mast, pole, or tower and then attaching the RF Unit (BSU or SU) to it.

The antenna and RF Unit must be mounted outdoors on a tower, building roof, or other location that provides line-of-sight path clearance to the far-end location. In some cases, the antenna can be mounted indoors, behind a window; however, RF attenuation through windows can vary greatly, depending upon the glass and any coatings that might be present, plus the precise location and angle of the antenna relative to the window.

In cases of indoor installations, ensure that the antenna location is restricted and bear in mind the RF exposure requirements of the warning statement above.

Antennas should be:

- Ordered with the suitable mounting kit specific to the site requirements.
- Very rigidly mounted, with adequate room for azimuth and elevation adjustment from the rear.

The antenna polarization must be the same at both ends of the link, either vertical or horizontal.

In general, antenna mountings require a support pipe to which upper and lower support brackets are attached with U-bolts. The antenna and optional elevation and azimuth adjustment rods are then mounted onto the support brackets.

The entire structure must be adequately grounded for lightning protection. The antenna system must always be installed according to the manufacturer's instructions.

Alignment Guidelines

When aligning antennas, if the SU is located indoors or distant from the antenna location, you may want to use a cellular telephone or two-way radio for relaying signal strength information from the SU Utility software to the antenna alignment location.

Similarly, a cellular telephone or two-way radio can be used to relay received signal strength information at the SU to the BSU alignment end.

- It is critical that antenna alignment be performed on one end of the link at a time, one plane at a time.
- One antenna should remain stationary at all times.
- Each end should be fine-aligned several times, until the planned RSL is reached.

In some cases, you may need to perform coarse alignment using a wide arc in both azimuth and elevation while reading the RSL to find the main beam of the opposite end antenna.

BSU Alignment

Coarse-align the BSU antenna by setting the antenna for flat elevation (no up-tilt or down-tilt) using a spirit level; point the antenna at a heading marker obtained using a compass/GPS (magnetic corrected) back-bearing from an adjacent location (ideally, 100 feet or more away from the antenna). If the path has substantial change to elevation from one end to the other, this may not be an advisable method for starting the alignment activities. In such cases, compare antenna elevations at each end of the link and set the initial elevation of the antenna to roughly match the anticipated up-tilt or down-tilt.

Once the coarse alignment is completed at both ends, the link can be powered and some level of reliable communication established. Fine-alignment of the BSU elevation is performed by using an SU located near the middle of the elevation pattern. For example, if there is a significant change in altitude of the terrain, choose an SU that is in the middle of the altitude range. If the terrain is flat however, choose an SU that is near the maximum distance of the sector.

When fine-aligning the BSU elevation:

- Adjust the elevation of the BSU antenna to maximize the RSL indication at the SU.
- Align the far-end antenna in the same manner, using the SU RSL indication.
- Multiple SU locations may be used to improve the quality of the BSU antenna adjustment.

SU Alignment

Coarse-align the SU antenna by pointing the antenna at the BSU if it can be seen. Otherwise, set the antenna for flat elevation (no up-tilt or down-tilt); point the antenna at a heading marker obtained using a heading marker obtained using a compass/GPS (magnetic corrected) back-bearing from an adjacent location (ideally, 100 feet or more away from the antenna). If the path has substantial change to elevation from one end to the other, set the initial elevation of the SU antenna to roughly match the anticipated up-tilt or down-tilt.

Once the coarse alignment is completed at both ends, the link can be powered and some level of reliable communication. Fine-alignment of the SU antenna is performed by listening to the SU's audio indicator, or observing the SU's RSL indication.

- Adjust the azimuth of the SU antenna to maximize the RSL indication at the SU.
- Adjust the elevation of the SU antenna to maximize the RSL indication at the SU.
- Alternate between adjusting the azimuth and elevation until no further improvement can be made.

Establishing a Connection Between the Units

See "Aiming the SU" and "Confirming Network Activity" in "Chapter 3. Deploying the Subscriber Unit" of the *Tsunami Multipoint Installation Manual* for a description of how to verify the wireless connection between a BSU and SU.