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Reference Manual

Tsunami Multipoint Version 2.0

Proxim WIRELESS NETWORKS

Take your network further

P/N 63182v2r1

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Second Edition, December 2003

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Contents

About Tsunami Multipoint **5**
Chapter 1. System Overview **6**
System Overview and Radio Considerations 6
Packet Routing Modes: IP Routing and Bridging 14
Wireline Interface 15
VoIP Support 16
GPS Receiver 16
Base Station Configuration Software and Subscriber Utility 16
Chapter 2. Ethernet (MAC) Bridging Mode **17**
MAC Bridging Filtering 17
Static Entries 18
Limitations of the Bridging Mode 18
VLAN Switching – The PMP Implementation 19
SU VLAN Filtering 22
Chapter 3. IP Routing Mode **25**
ARP Tables 26
Access Modes 27
Wireless Link Packets Destined for Local Subnet IP Addresses 28
Wireless Link Packets Destined for Other Than Local Subnet: RIP Disabled 28
IP Routing Deployment with RIP Disabled 29
Packet Routing and RIP 32
Routing Mode Features Not Supported 37
Chapter 4. Active Interference Rejection **38**
Overview 38
Interference Rejection Technologies 39
Planning Ahead with Tsunami Multipoint 40
Technical Fundamentals 41
We improve, at all modulation modes, the carrier-to-interference ratio by 22 dB.Operation 42
Operation 43
Interference Rejection Command Summary 46
Chapter 5. Base Station Configuration Software and Subscriber Utility **47**
System Requirements 47
Removing the Previous BSU Console Version 48
Installing Configuration Software Version 2.0 48
Multi-BSU Configuration Software Version 2.0 50
Base Station Configuration Software Version 2.0 53
Subscriber Utility Software 54
SU Utility Operation 55
Using the Subscriber Utility for Antenna Pointing 59
Chapter 6. Advanced Configuration Options **61**
Multi-Sector Mode 61
Setting Ethernet Frame Type Filtering (EtherMode) 67
Configuring for IP Multicasting 67
Voice over IP (VoIP) 67
Choosing the Priority Connection Bandwidth 68
Chapter 7. Command Reference **76**
BSU Commands for Configuring and Monitoring the BSU 76
BSU Commands for Configuring and Monitoring the SU 77
SU Commands for Configuring and Monitoring the SU 77
Command Format 77
Valid IP/Gateway Addresses 79
Base Station Configuration Commands 79
BSU Commands for Configuring the SU's from the BSU 96
SU Commands for Configuring and Monitoring SUs 104
Appendix A. Troubleshooting **111**
Troubleshooting Data Stream Errors and Interference 112
Counteracting and Evaluating Interference 113
Appendix B. Technical Specifications **114**

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Burst-Rate Limit 114
Downlink/Uplink Throughput 114
Frequency Plans 114
Tx Power 114
Antenna 115
Receiver Sensitivity 115
Maximum Distance Between Base Station and Subscriber Unit 115
System 115
Standards Compliance and Interfaces 116
Configuration and Management 116
Power/Environment Safety 116
Physical Dimension 117
Installation Details 117
Optional Accessories 117
Tsunami Multipoint Version 2.0 BSU Models 117
Tsunami Multipoint Version 2.0 SU Models 118
Declaration of Conformity 118
Appendix C. Technical Support 119
Warranty 120
1 YEAR LIMITED EQUIPMENT WARRANTY 120

Figures

Figure 1. Wide Coverage, High Capacity TCP/IP Network 6
Figure 2. Single Frame 8
Figure 3. Model of the PMP Network 14
Figure 4. SU Filters in Bridging Mode 17
Figure 5. PMP VLAN Implementation 21
Figure 6. VLAN Tagging Support in PMP Network 22
Figure 7. Multiple VLAN IDs at an Individual SU 23
Figure 8. BSU/SU Connection by Switch 25
Figure 9. Proxy for Remote Devices Residing in the Same Subnet 29
Figure 10. Network Diagram Example 1 Configuration Settings 31
Figure 11. Sample Campus Networking Layout 32
Figure 12. Sector Acting as a Virtual Router in IP Routing Mode 33
Figure 13. Network Diagram – Example 2 36
Figure 14. Rejection to Linear Polarized Interference 41
Figure 15. intlog Example 45
Figure 16. Multi-BSU Console 63
Figure 17. Connect To Setup Window 64
Figure 18. Fresnel Zones 115

Tables

Table 1 Maximum Burst Rates 7
Table 2 Expected Ethernet Frame Throughputs (Aggregate) 8
Table 3 Expected Standard and Optional FTP Performance 9
Table 4 Standard and Optional Frame Structure 9
Table 5 Frame Durations 9
Table 6 Center Channel Frequencies 11
Table 7 Network Diagram Example 2 Configuration Settings 36
Table 8 Carrier to Interference Improvement Using A.I.R. 42
Table 9 Required VoIP Data Rates for Various Codecs 69
Table 10 Selection for T1/E1 70
Table 11 Maximum VoIP Connections per SU by VoIP Bandwidth 72
Table 12 Maximum VoIP Connections per SU due to Packet Rate Limitations 73
Table 13 Maximum Number of Simultaneous Calls per BSU 74
Table 14 Max Simultaneous Calls per BSU due to Packet Processing Limitations 75

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About Tsunami Multipoint

Tsunami Multipoint is a point-to-multipoint outdoor wireless system offering a high capacity alternative to wired data networks.

Using IP packet radio transmitters, standard Ethernet interfaces, and an easy-to-deploy design, the Tsunami Multipoint system enables high-speed network connections to multiple Ethernet switches, routers or PCs from a single location. With Tsunami Multipoint, you can avoid the delays and costs associated with wired connections such as DSL, cable modems, and leased T1/E1 lines.

Tsunami Multipoint systems consist of one or more Subscriber Units (SU) that communicates with a Base Station Unit (BSU) to provide high-performance wireless network connections.

The following documents comprise the Tsunami Multipoint documentation set.

- The *Tsunami Multipoint BSU Quick Install* provides just enough information for the experienced professional to install the Tsunami Multipoint BSU.
- The *Tsunami Multipoint SU Quick Install* provides just enough information for the experienced professional to install the Tsunami Multipoint SU.
- The *Tsunami Multipoint Installation Guide* provides detailed installation information for the less experienced professional to install and initially configure the Tsunami Multipoint system. If you are uncertain about any of the procedures in the Quick Install, refer to this document on the Tsunami Multipoint CD.
- The *Tsunami Multipoint Reference Manual* provides conceptual, advanced configuration, and command reference information about the Tsunami Multipoint system. See the Reference Manual for information about:
    - Routing modes
    - Active Interference Rejection (A.I.R.)
    - Priority Queuing
    - Advanced Configuration Options
    - Command Reference
    - Troubleshooting

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Chapter 1. System Overview

A Tsunami Multipoint system is comprised of one-to-six Base Station Units (BSUs) and associated Subscriber Units (SUs) that comprise a cell. Each BSU communicates with its associated SUs in its sector. Considered alone, the BSUs and SUs essentially function as radios. When configured together and attached to network segments separated over some distance with clear line of sight, they provide a wide-coverage, high-capacity TCP/IP network that transfers IP traffic between the cell hub and its multiple SUs.

Over this network, users can support services, such as the following (as well as other applications):

- Providing network connectivity between buildings or campuses (Virtual Private Network (VPN) scenario)
- Establishing high-speed connections between Internet Service Providers (ISPs) and their customers
- Providing surveillance over remote sites

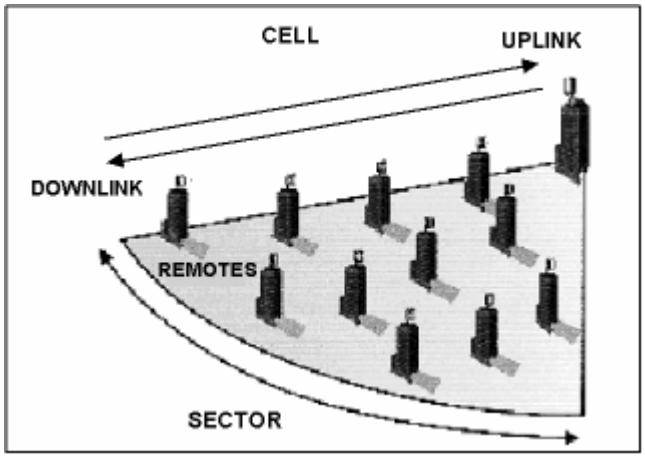


Figure 1. Wide Coverage, High Capacity TCP/IP Network

Note: **Uplink** and **downlink** are also referred as **inbound** (IB) and **outbound** (OB), respectively, throughout this document.

SYSTEM OVERVIEW AND RADIO CONSIDERATIONS

Communication

Each SU communicates with a BSU in a coordinated manner so that all SUs associated with the BSU have an equal amount of time to coordinate their data needs in both the uplink and downlink directions. The Tsunami Multipoint system uses a master-slave relationship with the BSU being the master and the SUs being the slaves. The BSU broadcasts to the SUs and all SUs capable of communicating at the BSU burst rate tune in. When an SU requires bandwidth, it makes a request to the BSU and the BSU, in turn, assigns a time period for the SU to transmit during the uplink portion of the frame. This bandwidth request and scheduling is handled on a frame-by-frame basis giving users the impression that they are in constant communication with their BSUs.

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A single cell of six 60-degree sectors can communicate in all directions (360°). Each sector, consisting of a single BSU and associated SUs (a single BSU can communicate with up to 1,023 SUs), can be configured to communicate at a maximum burst rate of 60 Mbps. Consequently, a single cell consisting of six BSUs has a maximum throughput of 360 Mbps.

Data Rate

SUs are available in versions with maximum burst rates of 60 Mbps and 20 Mbps. BSUs are available in 60 Mbps or 20 Mbps versions. These data rates are achieved by using a combination of different modulation and coding schemes. A BSU or SU can operate at its maximum burst rate or at any lower burst rate. For example, a 60 Mbps BSU can be configured to operate at 20 Mbps, 30 Mbps, 40 Mbps, or 60 Mbps. If set to operate at 20 Mbps, all SUs can communicate with it . A 60 Mbps BSU configured to 40 Mbps can communicate with SUs capable of 40 Mbps or faster, however, they could not communicate with SUs having a maximum burst rate of 20 Mbps.

Table 1 Maximum Burst Rates

Product	Burst-Rate Limit	Also Supports
Base Station Unit	60 Mbps 20 Mbps	20-40 Mbps burst rates
Subscriber Unit	60 Mbps 20 Mbps	20-40 Mbps burst rates

Note: This table describes the product upgrade/compatibility policy. The BSU and SU must use the same burst rate within a sector to achieve wireless communication. If an SU cannot operate at the speed at which the BSU is broadcasting, it displays a link status of "outbound detected."

Partitioning Uplink and Downlink Data Rates

The Tsunami Multipoint system operates using a frame-structured Time Division Duplexing (TDD). TDD means both the uplink and downlink operate on the same frequency at different times. At the beginning of a frame, data is broadcast from the BSU to all the SUs in a sector. After the downlink completes, the SUs transmit data on the uplink to the BSU. All the SUs share the uplink and transmit at different times. A single frame is shown in the following figure:

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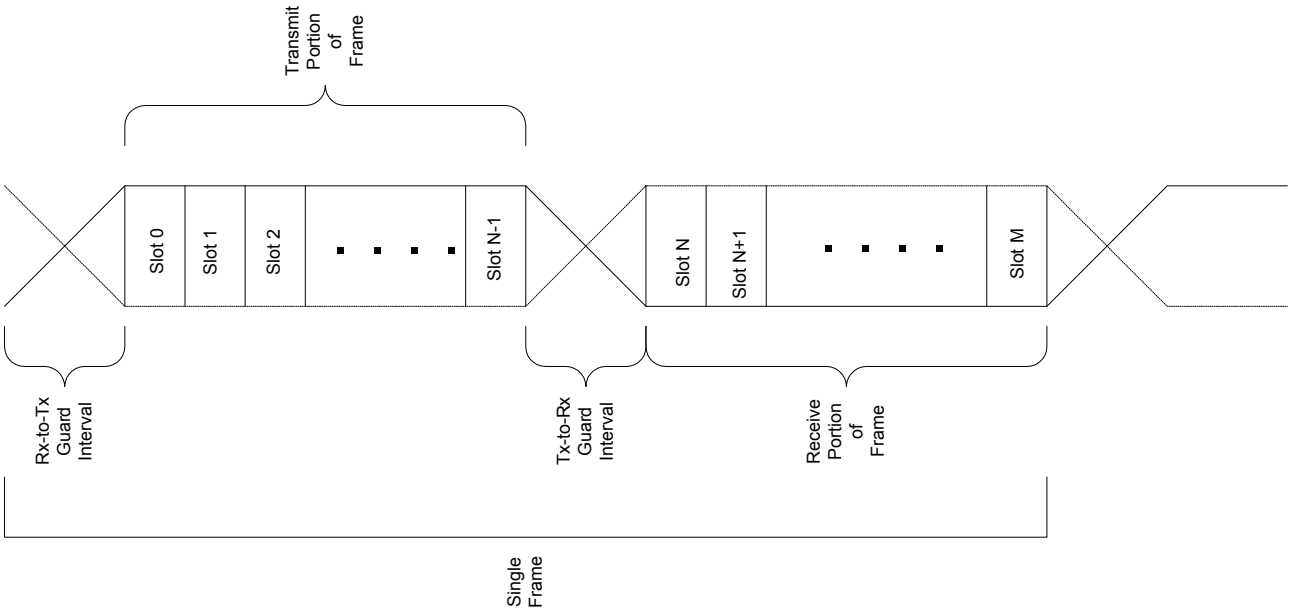


Figure 2. Single Frame

The BSU determines which SU is to transmit at what instant in time. The entire frame consists of a fixed number of slots (the exact number depends upon the data rate used (such as 30 Mbps, 40 Mbps, or 60 Mbps). You can use the **firstInboundSlot** command (on page 81) to set the ratio of downlink-to-uplink slots.

When setting the ratio, be aware that:

- Not all ratios are useable (see “firstInboundSlot” on page 81).
- There is a possibility of BSU-to-BSU interference if different sectors have different ratios of uplink to downlink traffic. All co-located BSUs should have the same ratio.
- The uplink has slightly lower capacity than the downlink for the same number of assigned slots due to link overhead. The following table provides expected throughputs for symmetrically configured links (same number of uplink and downlink slots), measured at level 2.

Table 2 Expected Ethernet Frame Throughputs (Aggregate)

Burst Rate (Mbps)	D/L Throughput (Mbps)	Uplink Throughput (Mbps)
20	9	8
30	13.5	12
40	18	16
60	27	24

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Table 3 Expected Standard and Optional FTP Performance

Burst Rate	Standard		Optional	
	Get, Mbps	Put, Mbps	Get, Mbps	Put, Mbps
20 Mbps	9.541	8.375	8.945	7.850
30	14.3	10.0	11.8	12.3
40	19.0	10.0	17.8	14.5
60	28.4	9.975	26.8	15.1

Frame Duration Options

The default frame duration is 7.5 msec for all modulation types (burst rates).

Table 4 Standard and Optional Frame Structure

Burst Rate	Standard		Optional	
	Slots/Frame	Length, ms	Slots/Frame	Length, ms
20 Mbps	8	7.5	8	8
30	12	7.5	8	6
40	16	7.5	8	4
60	24	7.5	12	4

The product also has an optional frame duration mode that can be enabled with the **setFrameDuration** command. Besides its modified frame duration, the Optional Mode uses longer guard intervals.

The following table contains the frame durations for this optional mode (as a function of burst rate).

Table 5 Frame Durations

Burst Rate	Frame Duration in Optional Mode (msec)
20	8
30	6.024
40	4
60	4

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The advantages of the Optional Mode are:

Longer maximum range

The maximum range (maximum distance between a BSU and SU) is determined by a number of factors including modulation type, transmit power, antenna gain, required fade margin, and length of guard interval. In the Standard mode the guard interval limits the maximum range to 6 miles. Consequently, even if the link budget would allow operation at greater distances (for example, a line-of-sight link with high-gain antennas), the maximum range is limited to 6 miles. The Optional mode increases this limit to 15 miles. Consequently, if the link budget allows operation at that distance, the framing structure will not limit it.

Faster FTP throughputs in burst rates greater than 20 Mbps

The latency at any given point in time is determined by system loading at that time. However, reducing the frame duration also reduces the average latency. A reduced latency link results in an increase in FTP throughput.

The disadvantages of using the optional frame duration mode are:

Less efficient

The reduction in frame duration coupled with the increase in guard duration results in a link that is slightly less efficient than the standard frame duration mode.

A.I.R. BSU's do not work in the optional frame duration mode

Console commands to enable the Optional Frame Mode are ignored when the BSU is configured for interference rejection. The BSU notifies the operator with the following console message: "Optional Frame Mode is not supported in Active Interference Rejection Mode". Similarly, console commands to enable interference rejection while in the Optional Frame Mode are ignored and result in the console warning message: "Active Interference Rejection Mode is not supported when in the Optional Frame Mode."

Interference in co-located BSUs

When multiple BSUs are operating at the same site, there is the potential for them to interfere with each other. For example, if a single tower has multiple sectors deployed and one BSU is transmitting while another BSU on the tower is receiving, there is a good possibility that the transmitting BSU will cause enough interference to severely degrade the performance of the receiving BSU. This can happen even when the BSUs are operating in different frequency bands.

One solution is to shield the BSU with electromagnetic radiation-absorbing material. Another solution is to deploy the BSUs far enough apart to reduce the interference to an acceptable level. However, even these solutions may not be enough to mitigate the interference.

Each Tsunami Multipoint BSU can synchronize its timing using GPS. In this mode, all BSUs start their frames at the same time (within some allowable tolerance). This way, one BSU is never listening while another BSU is transmitting. For this synchronization to work, all the BSU's must use the same frame duration and have the same ratio of uplink to downlink slots. This is easily accomplished using the standard frame duration mode. However, in the Optional Mode, due to the varying frame durations, it would be impossible to have different BSU's operating using different burst rates and still maintain BSU-to-BSU timing synchronization.

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Frequency Band

The Tsunami Multipoint operates in the 5.725 to 5.825 Unlicensed Frequency band. Within this band, you can select one of three channel plans: 4, 5, or 6. The following table contains the center frequencies for all of the channels in each of these plans.

Table 6 Center Channel Frequencies

Channel	Center Frequency (MHz)		
	4-Channel Plan	5-Channel Plan	6-Channel Plan
A	5725.86	5740.40	5740.40
B	5764.61	5757.69	5754.23
C	5725.36	5774.98	5768.07
D	5806.11	5792.28	5781.90
E	N/A	5809.57	5795.73
F	N/A	N/A	5809.57

The SU must be configured to be in the same frequency channel plan as the BSU if it is to enter the network. However, once the frequency channel plan is configured at the SU, it can be set to automatically search all available channels to find a BSU.

Transmit Power and Power Control

You can use the **txPowerLevel** command (page 94) to set the BSU transmit power from between 6 and 17 dBm (at the input to the transmit antenna). You can use the **txPowerAutoEnable** command (page 94) to set the BSU to automatically start transmitting whenever it is restarted or power is cycled.

The SUs automatically adjust their transmit power to ensure that the signals from all SUs arrive at the BSU at the same power level. This minimizes self-interference that can occur in a sector.

The IPC should never be set lower than 7 dB or higher than 13 dB at 60 dB, or higher than 25 at all other modulations. The normal value is 10 dB. For most users, nominal settings suffice. Higher IPC settings increase the link margin, but may make it impossible for SUs at the sector edge to successfully communicate with the BSU. Lower settings result in the greatest range, but may have a slightly higher BER (bit error rate). You can set the margin with the IPC command on page 84.

Network Entry and SU Monitoring

This section describes the process an SU follows when it is first turned on and must enter the network.

Downlink Synchronization

Immediately after being powered-up, the SU begins looking for the downlink signal. It cycles through all of the different frequency channels in the configured frequency plan looking for a valid signal. (If the SU has been configured to search over a single frequency, it does not search the rest of the frequencies in the plan.) Once it verifies that it has found a valid signal, the SU then synchronizes its timing and frequency to the downlink.

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Ranging and Power Adjustment

Tsunami Multipoint uses Time Division Multiple Access (TDMA) on the uplink to let multiple users use the single uplink. In TDMA different SUs are assigned different time sub-slots[1] to transmit their signals. A time sub-slot is referenced to the BSU; that is, the SU is told when its signal must arrive at the BSU. The reason for referencing the time slots to the BSU is to keep the signals of different SUs from overlapping, even when they are at vastly different ranges. It takes a longer time for the signal at the longest range to arrive at the BSU compared to a signal at the shortest range. For example, assuming that the minimum range is 50 meters and the maximum range is 10 km, it would take the signal at 10 km approximately 33 microseconds longer to reach the BSU than the signal at 50 m. In some cases, a sub-slot lasts only 9.75 microseconds.

Once the SU has obtained downlink synchronization, it goes through a ranging process. In the ranging process, the SU determines when it must transmit to be received at the BSU at a given instant in time. It then uses this information to determine when to begin its transmission to arrive at the BSU in its allotted time slot.

In addition to ranging, the SU must determine at what power level to transmit. Once again the path loss for an SU at maximum range would be much greater than the path loss for a subscriber unit at minimum range. If these two units are assigned adjacent TDMA slots, this power differential could lead to errors in the received signal. To avoid this, each SU adjusts it power so that it is received at the BSU at a given level (determined by the BSU) regardless of range.

Network Entry and Registration

Once the SU has synchronized to the downlink and completed the ranging and power adjustment process, it is ready to communicate with the BSU. Before it starts to transmit data, it first must register. Registration is by invitation only. The BSU periodically invites any SU in its database to register. When the SU receives this invitation, it transmits a response; if the BSU determines that it is a valid SU, it is allowed to enter the network. At this point, it is assigned an ID (SU id) that is used in the bandwidth request and assignment process. Net entry is now complete. If the SU is not determined valid by the BSU, the SU displays the following console message:

```
998  SU authentication fails, please check Base Station database.
```

Loss-of-Link

The SU can lose the link if the BSU loses power or experiences a deep fade (the path loss momentarily becomes excessive). The SU monitors the downlink control message, which is sent once a frame, to verify that it has not lost the link. If it does not see this control message for a pre-determined number of consecutive frames, the SU declares a loss-of-lock condition and attempts to re-acquire the network.

Re-acquisition After Loss-of-Link

When the SU has detected that it has lost the link, it immediately begins searching for the downlink. It initially searches the same frequency it was using when it lost the link. If it does not find the downlink within ten minutes, it begins searching all frequencies for the downlink.

---

[1] The use of the word sub-slot should not be confused with the slotted nature of the downlink and uplink. A single uplink/downlink slot is divided into 32 sub-slots. This way, up to 32 different SUs can transmit in a single uplink slot.

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Note: Waiting ten minutes before searching other frequencies was chosen for the following reason: A BSU using GPS to synchronize its timing can take close to 10 minutes to resume transmission after a power cycle. Much of this time is required for the GPS receiver to acquire the four satellites required to obtain accurate timing information. SUs are allowed to begin searching other frequencies before a power-cycled BSU can resume transmission. It is possible (even probable) that an SU that can see multiple BSUs will acquire the downlink of a different BSU (not the one to which it was originally attached) when its original BSU is power cycled. If it is not in the new BSU's database, it simply waits to be polled (it displays an 'Authorization Failed' message in the SU utility). This problem could occur whenever a BSU is power cycled (new code is downloaded). By forcing an SU to search on its last frequency for ten minutes, we ensure the SU reconnects with the power cycled BSU.

If the SU acquires the downlink on the same frequency, it resumes normal operation with the following exceptions:

- When polled, the SU sends a message to the BSU informing it that it has re-entered the network. This lets the BSU keep track of how often the SU loses lock. Because it sends this message in response to a poll, the SU actually can transmit data (if it has any) prior to sending this message.
- When the SU first transmits after the outage, it receives an acknowledgement from the BSU that the transmission was received. If it does not receive this acknowledgement, the SU retransmits the data. After a predetermined number of re-transmission failures, the SU assumes there is something wrong with the uplink and starts the ranging and power adjustment cycle.

If the SU does not acquire the downlink on the same frequency within 10 minutes, it begins searching all frequencies, looking for the downlink. Once the downlink is acquired, the SU proceeds to the ranging and power adjustment phase. Entering the network after a loss-of-link and a failure to quickly re-acquire the downlink on the same frequency is similar to the initial network entry procedure.

Monitoring the SU

Periodically the BSU polls the SU for status information. (The exact timing depends upon the number of SUs entered in the BSU's database and ranges from approximately once per second to once per ten seconds.) Issuing a **dspActiveSU** command displays all SUs that have recently responded when polled (**dspSU** simply displays all the SUs in the BSU database).

When an SU does not respond to consecutive polls, the following message is displayed on the Base Station Configuration Software console indicating that the SU has dropped from the network (a message also is displayed on the console when the SU re-enters the network).

```
999 SUx not responding to poll (where x is the SU ID) message
```

The **dspActiveSU** command lets the user know how many times the SU has entered the network since the last time the BSU was power cycled.

Point-to-Multipoint Network Model

In the Point-to-Multipoint (PMP) network, consider the SU and the BSU as an integrated transmission and switching medium with physical ports (or access points) that interface to end user devices. Each BSU or SU represents one such physical port (or access point).

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Data traffic between the BSU and an SU flows as follows:

- Packets received by an SU are transmitted to the BSU.
- Packets from all SUs emerge from the BSU as a single data stream. SUs only transmit packets to the BSU if the packet's destination address is not local to the SU. Each SU maintains an ARP table to distinguish between local and other addresses.
- Downlink packets are received by the BSU and broadcast to all SUs in the sector.

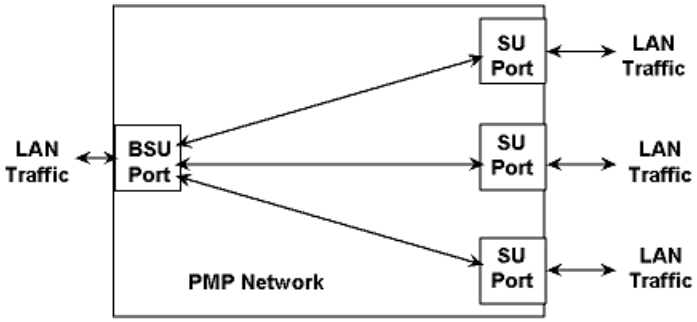


Figure 3. Model of the PMP Network

PACKET ROUTING MODES: IP ROUTING AND BRIDGING

The predominant task of a network is to route packets between devices (most commonly computers). Packets may have to travel just a few feet over a twisted wire, or they may have to travel thousands of miles and traverse many networks.

In an IP network, devices typically are assigned two different addresses. The first is the device's **MAC address** and the second is its **IP address**. The MAC (Ethernet) address is a layer 2 address; the IP address is a layer 3 address (referring to the OSI seven layer networking model).

Devices that route packets through networks using MAC addresses are called **Bridging** devices (a switch is a Bridging device); devices that use layer 3 addresses are called **IP Routing** devices (a router is a layer 3 device). Although bridging and routing devices both are designed to route packets, there are practical differences in how they work. The network architecture generally dictates which device to use (although in many situations, either is acceptable).

Tsunami Multipoint offers two routing modes—**IP Routing** mode and **Ethernet Bridging** mode. Tsunami Multipoint supports one mode at a time per BSU. Proxim recommends Bridging mode for most applications, as it is the most "plug-and-play" mode and requires little network reconfiguration.

Bridging Mode

In Bridging mode, the Tsunami Multipoint network uses the ARP table to filter packets; each SU can capture and store up to 8,000 local addresses in its ARP table. Proxim recommends using Bridging mode as it is the most "plug-and-play" mode and requires little network configuration.

- A local packet received by the SU on its Ethernet port is filtered through its ARP table before being transmitted uplink. If the destination MAC address of the received packet belongs to a local drive, the packet is dropped.

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- Similarly, any downlink packet received by the SU is filtered through the ARP table before being transmitted to its local network. If the destination address of the received packet cannot be found in the ARP table, the packet is dropped.

The downlink filtering operation can be turned off as a configuration option.

In **Bridging** mode, you can configure up to 16 VLAN filters per SU. In addition to the SU's own assigned VLAN ID, each filter defines the range of VLAN IDs of the received VLAN frames that may pass through the SU in either uplink or downlink direction. In addition, the Tsunami Multipoint network performs VLAN tagging and un-tagging operations. See "VLAN Switching – The PMP Implementation" on page 19.

You can configure the Tsunami Multipoint product to work in either **Ethernet Bridging** or **IP Routing** mode.

IP Routing Mode

In **IP Routing** mode, each SU or BSU behaves as an IP gateway to its local devices. Normally under this type of configuration, each SU or BSU occupies a unique, non-overlapping subnet. At the hub, each BSU is connected to an external router either individually or through a common switch, and serves as an IP gateway to all subnets that can be directly or indirectly accessed through its SUs.

- When the RIP option is enabled, the routes are exchanged automatically and updated periodically between the BSU and the external router. As such, no manual configuration of static routes in the external router is necessary. The same applies to the SU side when an SU is connected to an external router.
- When the RIP option is not enabled, all the routes associated with each BSU must be entered manually into the external router as static routes.

With the RIP feature enabled, all the BSUs and the external router can share the same subnet and interconnect through a simple switch. Rather than installing a router with many physical ports, one port for wireless network access and one port for Internet access are sufficient for network operations.

If Internet access at the BSU side, or SU-to-SU communication within the same BSU, are not required, you can completely eliminate the external router. For details about IP Routing mode operation, see "Chapter 3. IP Routing Mode" on page 25.

Note: Only IP packets (Ethertype 0x800) are passed in IP Routing mode.

WIRELINE INTERFACE

Tsunami Multipoint equipment is connected to a WAN or a LAN through a 10/100 Base-T Ethernet connection. This connection supports speeds of either 10 or 100 Mbps in half- or full-duplex mode. Most 100 Base-T interfaces support auto-negotiation, in which the end points negotiate the speed and duplex of the link. The default operating mode for the Tsunami Multipoint Ethernet interface is auto-negotiation.

However, auto-negotiation is not as standardized as you may have been led to believe, and it frequently does not perform as expected. Furthermore, if one side of the link is set to auto-negotiate and the other side is configured manually, auto-negotiation fails. In this case, the side set to auto-negotiate correctly determines the link speed but defaults to half duplex. This can lead to duplex mismatch between the two ends of the link.

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Symptoms of mismatch problems include:

- Network performance that is considerably lower than it should be
- Significant errors shown when using the **netstat –e** command

To alleviate this problem, you can disable the auto-negotiate feature of the BSU/SU and use the **setEthernet** command for the BSU and the **setSUEthernet** command (entered at the BSU to set the SU Ethernet interface) to manually set the Ethernet interface to the desired mode. Similarly, you should configure the host attached to the Tsunami Multipoint equipment for manual operation to ensure that both ends of the link are operating at the same speed and duplex mode.

See “setEthernet command” on page 89 and “setSUEthernet command” on page 100 for more information.

VOIP SUPPORT

Tsunami Multipoint SUs prioritize uplink voice traffic by first separating incoming traffic into voice and data queues. Traffic can be filtered based on the **ToS** (Type of Service) byte setting. Data is sent to the voice queue if its **ToS** byte falls within the user-selected range. When the SU receives an uplink bandwidth assignment, it transmits packets in the voice queue first.

In addition to prioritizing the transmission of voice IP traffic, an SU is assigned adequate bandwidth for each on-going VoIP connection to ensure the voice quality. The total bandwidth assigned to the SU is adjusted dynamically every 7.5 msec based upon the number of active VoIP connections monitored in the previous frame. A VoIP connection is taken down if no VoIP traffic is observed for that connection for the pre-defined period of time. In addition to the guaranteed VoIP bandwidth assignment, an SU is assigned additional bandwidth for its data traffic on a best-effort basis whenever leftover bandwidth is available.

At this time no priority assignment is given to differing types of downlink traffic. Typically, the downlink has enough bandwidth to handle all traffic in a timely manner even without specific priority mechanisms. In addition, because the downlink is a single flow, it is easy to use a third party QoS box.

GPS RECEIVER

Each Tsunami Multipoint BSU includes a GPS with a mechanical-mount GPS antenna. The GPS enables each Tsunami Multipoint BSU to start transmitting frames of data at the same time as other Tsunami Multipoint BSUs at the same or adjacent hub sites. This results in Tsunami Multipoint BSUs transmitting and receiving information at the same time and avoids interference between BSUs. (See “Multi-Sector Mode” on page 61.)

BASE STATION CONFIGURATION SOFTWARE AND SUBSCRIBER UTILITY

The majority of configuration is done at the BSU using the command line interface (CLI) provided by the Base Station Configuration Software. At the SU, the Subscriber Utility provides an interface to configure and monitor the SU. Both software programs run on PCs and communicate with the BSU or SU over their Ethernet interfaces.

The *Tsusnami Multipoint Installation Manual* contains information pertaining to installing and running these utilities.

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Chapter 2. Ethernet (MAC) Bridging Mode

In Ethernet Bridging mode, the PMP network provides a direct physical connection between an SU and its BSU for the exchange of Ethernet frames between the two units. To conserve wireless bandwidth, the SU uses some simple hardware and software filtering criteria to prevent traffic destined for a local network from being sent uplink.

MAC BRIDGING FILTERING

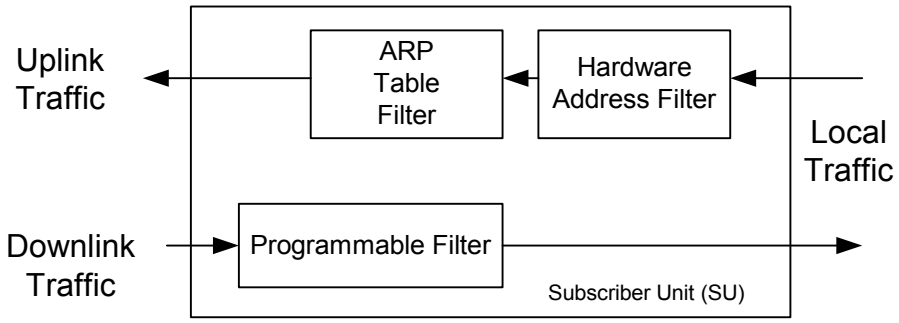


Figure 4. SU Filters in Bridging Mode

In the uplink direction (from an SU to its BSU), the filtering works as follows:

- If the received IP packet's destination Ethernet address is not in the SU's hardware table of local devices, the packet is passed to the software for further filtering; otherwise, it is discarded.
- The software provides further filtering by matching the destination address with local addresses stored in its ARP table. If the destination address matches a local address, the packet is discarded. Otherwise, it is sent on the uplink.
- Once the packet arrives at the BSU, it is passed through the BSU's Ethernet port onto the wireline.

In the downlink direction (from a BSU to an SU), the filtering works as follows:

- If the received packet's destination is not in the BSU's hardware table (of local addresses), it is broadcast on the downlink.

Traffic received at an SU (from the BSU) is further filtered as follows:

- If the MAC filtering mode has been set to **Off** using the **setSUMACFilter** command (on page 101), all packets received on the downlink at the SU are passed through the Ethernet interface onto the wireline network.

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- If the MAC filtering mode is set to **on**:
  - Packets addressed to a broadcast Ethernet address are passed onto the local network.
  - For other packets, the SU determines whether the downlink packet's destination Ethernet address triggers a "hit" in the filter list. If so, the hardware forwards the packet to software for delivery to the local network. If the packet's destination Ethernet address does not register a "hit" in the filter list, the packet is discarded. A packet registers a "hit" if the SU has seen traffic originating from the Ethernet address or the address has been entered as static as described in the following section.

Note: In pre-1.3 versions of the Tsunami Multipoint software, MAC filtering was set to **off**. This meant that all packets received at the SU on the downlink were passed onto the wireline network.

STATIC ENTRIES

Typically when one host (originating host) attempts to communicate with another host (destination host), it first sends an ARP to determine the destination host's address. This ARP is passed because it is addressed to a broadcast Ethernet address. When the destination host responds, the SU enters the address into its MAC filter list. This enables subsequent packets to pass through the filter.

Notes: If the packet's destination Ethernet address does not register a "hit" in the filter list, the packet is discarded. Whenever the SU sees traffic from a host, it enters it into its MAC filter list, with a 20-minute time-to-live (TTL).)

In a small number of situations, the originating host knows the destination host's Ethernet address through static means (the address was entered statically into the originating host's ARP table). In this case, the originating host does not ARP before sending a packet; consequently, the destination host is not in the SU's filter list and subsequent packets are discarded. To avoid this problem, you can enter up to five static IP addresses. The SU discovers the Ethernet addresses associated with these IP addresses and adds them to the filter list.

LIMITATIONS OF THE BRIDGING MODE

Again, when viewing the PMP network as a multi-port bridge, only a limited bridging function is exhibited. A true bridge can switch a packet arriving at any port to any other port. For the PMP network to behave similarly, whatever data received by the BSU from an SU would also need to be broadcast back downlink to all other SUs associated with the BSU. This is not done.

Note: The current design is driven by security concerns. Conventional bridging cannot be supported without additional add-on subsystems.

Bridging mode consumes more wireless bandwidth than IP Routing mode. The reasons for this are as follows:

- The entire Ethernet frame, including the Ethernet header, is transmitted between the SU and the BSU.
- All ARP and broadcast packets are transmitted between the SU and BSU. Empirical results have shown that, generally, Bridging mode consumes more bandwidth than IP Routing mode.
- Bridging mode does not currently support the spanning tree algorithm.

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VLAN SWITCHING – THE PMP IMPLEMENTATION

VLAN switching is used primarily for segregating LAN traffic based upon a VLAN ID that accompanies a received VLAN frame. VLAN switching is useful because:

- It lets network operators partition their LAN segment into closed user groups.
- It lets a device communicate only with other devices of the same group.
- Unlike a regular bridge, a VLAN switch can deliver received VLAN frames only to other ports tagged with the same VLAN ID, thus reducing unwanted network traffic.

VLAN switching is quick and simple from a switching node's perspective. However, setting up a VLAN network can be a tedious exercise for the network administrator because most of the end user devices today (such as PCs) are not VLAN aware.

This forces the network operator to place VLAN switches at critical junctions all over the network so that VLAN frames can be converted into regular Ethernet frames and vice versa. This can be a complex, time-consuming, and costly endeavor if proper planning does not take place beforehand.

To address this issue, PMP network provides a built-in VLAN-to-Ethernet conversion capability in the SUs and BSUs, as illustrated in the following example (Figure 5).

1. In Figure 5, both BSU1 and SU1 are tagged. When SU1 receives a VLAN frame from VLAN SW1, if the VLAN frame's ID is not 4 (SU1's own VLAN ID) or 5-6 (IDs defined in SU1's filter list), the frame is dropped. Otherwise, the frame is delivered to BSU1. In the downlink direction, when SU1 receives a VLAN frame from BSU1, if its VLAN ID is not 4-6, or its destination Ethernet address cannot be located in SU1's ARP table, the frame is dropped.
2. BSU2 is untagged which means, regardless of whether SU2 is tagged or not, it passes through either VLAN or Ethernet frames without conversion, even though the VLAN filtering operation described in step 1 continues to function if VLAN frames are received by SU2.
3. BSU3 is tagged while SU3 is untagged. This means, when SU3 receives an Ethernet frame from PC 7, it converts the Ethernet frame into a VLAN frame with VLAN ID 7 (SU3's assigned ID) and passes the converted frame to BSU3. When SU3 receives a VLAN frame from BSU3, if its VLAN ID is 7 and the destination address is for PC7, the frame is converted into a regular Ethernet frame and given to PC7. Any other VLAN frames received by SU3 are dropped.
4. The BS console can talk to all BSUs because they are all associated with VLAN 5.
5. Only PC1 can access Router 1 for Internet access because only they share the same VLAN ID.

General Comments

The VLAN switch has both tagged and untagged ports. A tagged port can receive and transmit only VLAN frames. When a port (such as port 1) is associated with multiple VLAN IDs, it must be tagged.

An untagged port can receive both tagged VLAN frames and untagged regular Ethernet frames, but transmits only untagged Ethernet frames. An untagged port is most commonly used to connect to VLAN-unaware devices. A tagged or untagged port can be assigned only a single VLAN ID. Up to 16 VLAN filters can be defined per port. If an SU receives a VLAN packet with an ID that does not match its assigned VLAN ID or any of the 16 VLAN filters, the packet is discarded.

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Note: The VLAN IDs of all BSUs default to VLAN ID 1. You can use the **setVLAN** command to set the BSU VLAN ID to a value between 1 and 4094, inclusive. See "setVLAN" on page 93.

For any device (such as the BSU console) to communicate with a BSU, the device must be connected to an untagged VLAN port associated with the BSU's VLAN ID. Otherwise, the BSU is not reachable.

When a BSU wants to transmit a control message or send a response to the BSU console, it transmits a tagged VLAN frame with its assigned VLAN ID that is received by all devices connected to VLAN ports associated with that VLAN ID.

In a PMP network, VLAN switching is a special Bridging mode (see the "routingMode" command on page 89 for information about configuring the system for Bridging mode).

To use VLAN switching:

- Enable VLAN tagging for the BSU; optionally, you can turn on and off VLAN tagging for specific SUs.
- Optionally, assign a VLAN ID to SUs.

(See the "setVLANTag" command on page 93 for information about VLAN tagging for the BSU. See the "setVLAN" command on page 93 for information about setting a BSU VLAN ID.)

Keep the following points in mind regarding VLAN tagging:

- When VLAN tagging is turned on, the BSU or SUs connect with PCs (equipped with 802.1q-compliant network cards) or 802.1q-compliant VLAN switches with VLAN IDs that match the BSU or SUs VLAN IDs.
- When VLAN tagging is turned on for the BSU, the BSU port transmits only VLAN frames.
- When VLAN tagging is turned on for the BSU and for the SU, the SU port transmits only VLAN frames (that is, operates as a "tagged" port).
- When VLAN tagging is turned on for the BSU, but is turned off for the SU, the SU port transmits only Ethernet frames (that is, operates as an "untagged" port).

As a Bridging mode option (VLAN switching is not supported in IP Routing mode), VLAN switching is also bounded by the same constraint as devices operating under Bridging mode; that is, SUs associated with the same BSU cannot communicate with each other.

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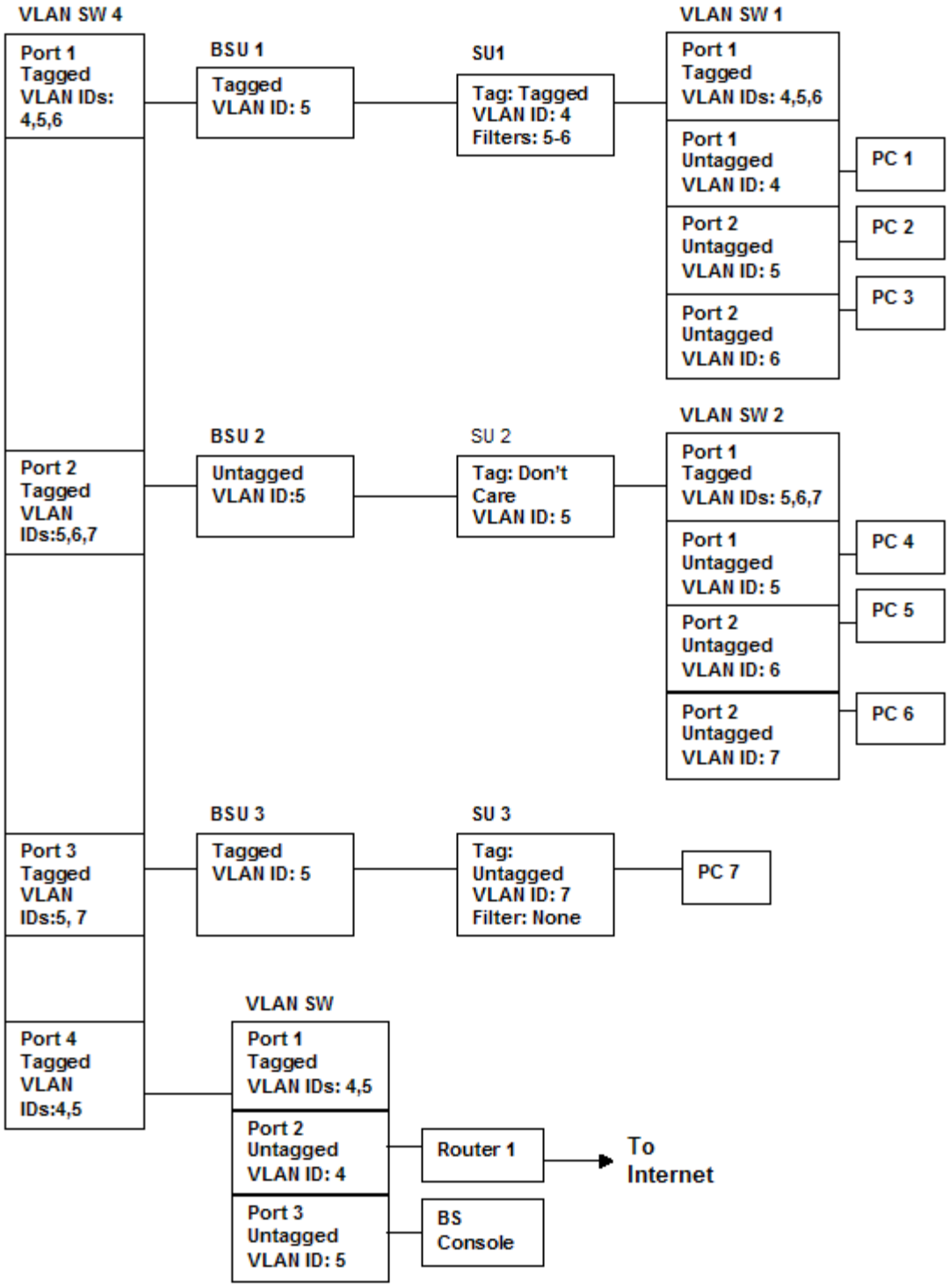


Figure 5. PMP VLAN Implementation

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The following table shows BSU/SU behavior when VLAN tagging is turned on for one or both devices.

BSU VLAN Tagging	SU VLAN Tagging	BSU Behavior	SU Behavior
Off	On or Off	Operates in Bridging mode.	Operates in regular Bridging mode.
On	On	Operates in Bridging mode, except control messages sent from BSU to BSU console or Wireless Manager are sent in VLAN format.	Tags any Ethernet frames received from the LAN before forwarding them to BSU. Transparently forwards any VLAN frames received from the BSU to the LAN. Discards packets tagged with VLAN IDs other than the SU's VLAN ID or IDs associated with the VLAN filters.
On	Off	Operates in Bridging mode, except control messages sent from BSU to BSU console or Wireless Manager are sent in VLAN format.	Tags any Ethernet frames received from the LAN before forwarding them to the BSU. Transparently forwards any VLAN frames received from the LAN to the BSU if a VLAN ID is the same as the VLAN ID associated with the SU or the VLAN filter. Otherwise, drops the frame. Converts any VLAN frame received from the BSU to a regular Ethernet frame before forwarding it to the LAN (if the VLAN ID is the same as a VLAN ID associated with the SU or the VLAN filters). Otherwise, drops the frame. Transparently forwards any Ethernet frames received from the BSU to the LAN.

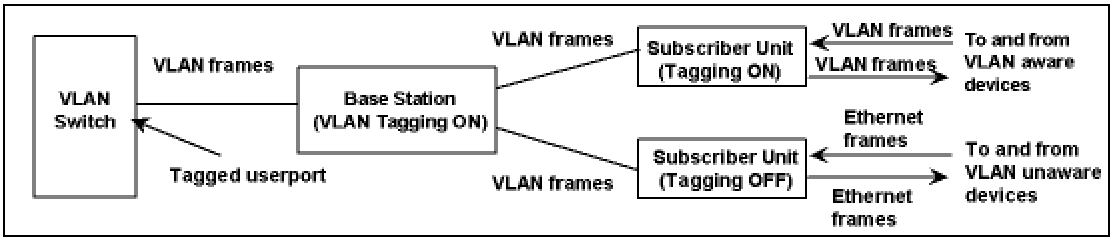


Figure 6. VLAN Tagging Support in PMP Network

SU VLAN FILTERING

The implementation of the VLAN filter lets an SU block any VLAN traffic in either uplink or downlink direction when an assigned VLAN ID is not within the ranges defined in its filter list. Three user commands support this filtering—**addSUVLANFilter**, **dspSUVLANFilter**, and **deleteSUVLANFilter.** Each of these commands is described in the following subsections.

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VLAN Filter Policy Summary

The following figure illustrates the concept of setting up multiple VLAN IDs at an individual SU. The X axis indicates the VLAN filter policies (1 ~ 16) and the Y axis indicates the available VLAN ID space (1 ~ 4095). The console command **addSUVLANFilter K N M** defines a continuous integer range of VLAN ID from N to M (including N and M) for the K^{th} SU. The range can be as small as just one (N=M) or as wide as the full scope (N=1, M=4095). Each SU allows up to 16 individual VLAN filter policies, and the total VLAN filtering is the aggregation of all defined policies.

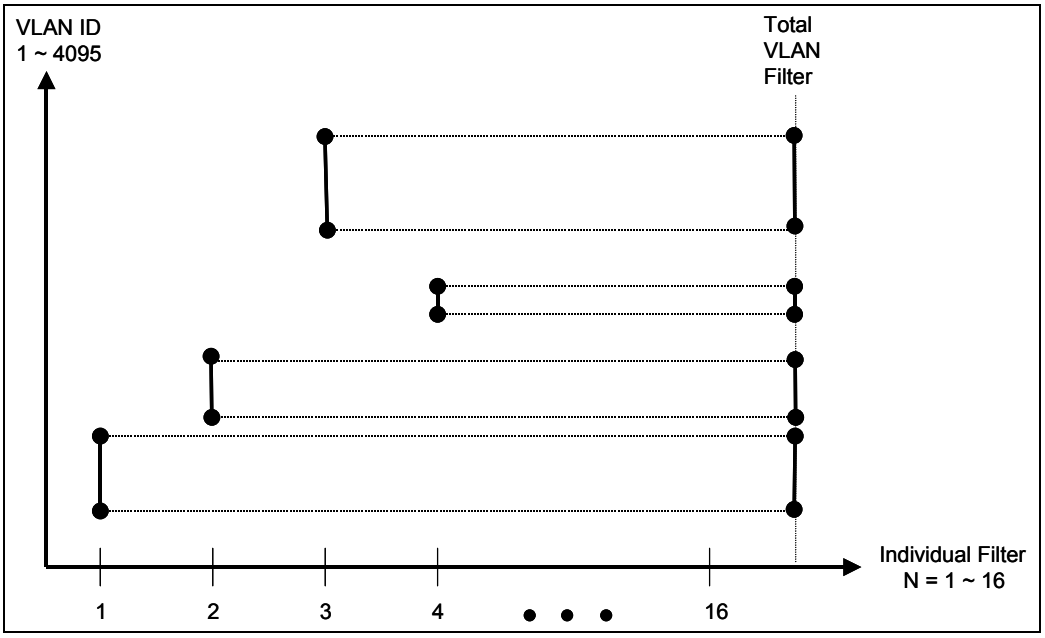


Figure 7. Multiple VLAN IDs at an Individual SU

Note: At any individual SU, two policies cannot be overlapped in the VLAN ID space. An error message would be displayed should such a situation occur.

Adding a VLAN Filter to the SU Filter List

You can use the **addSUVLANFilter** command (page 97) to add a VLAN filter to an SU's filter list. Up to 16 "ranges" of VLAN IDs can be defined. The command syntax is:

addSUVLANFilter <terminal ID> <start VLAN ID> <end VLAN ID>

where:

`terminal ID`	is the ID of the SU that the filter is defining.
`start VLAN ID`	is the first value of VLAN ID in the range of tag addresses being defined.
`end VLAN ID`	is the last value of VLAN ID in the range definition.

For example, `addSUVLANFilter 55 17 25` sets a VLAN filter range for SU #55 to pass VLAN packets with tag addresses ranging from 17 to 25, inclusively.

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Be aware of the following:

- The value of any VLAN ID should be from 1 to 4095.
- The **start VLAN ID** cannot be greater than the **end VLAN ID**.
- If the **end VLAN ID** is not indicated, the firmware sets the **end VLAN ID** to the same value as the **start VLAN ID**. For example, **addSUVLANFilter 55 235** sets a VLAN filter range for SU #55 with a start ID of 235 and also an end ID of 235.
- The firmware does not accept greater than 16 range definitions for any one SU.

Displaying an SU's VLAN Filter List

You can use the **dspSUVLANFilter** command (page 98) to display an SU's VLAN filter list. This list can contain a maximum of 16 entries. This command requires the SU's terminal ID be designated. To display the list of filters for an SU, enter:

```
dspSUVLANFilter <terminal ID>.
```

For example, entering **dspSUVLANFilter 55** displays the VLAN filter list for SU #55, which, using the previous examples, provides the following output:

```
VLAN range 1: from 17 to 25
VLAN range 2: from 237 to 237
Total VLAN filters found 2
```

Note the following special cases:

- Requesting the filter list of an invalid SU returns an error message. For example, **dspSUVLANFilter 914** returns an error message of "Illegal terminal ID 914."
- Requesting the filter list of an SU that does not have any filters set returns a message "Total VLAN filters found 0."

Deleting an SU's VLAN Filter List

You can use the **deleteSUVLANFilter** command (page 97) to delete an SU's VLAN filter list. The SU's terminal ID and the Start VLAN ID must be designated. To remove a specific VLAN filter range from the list of an SU, issue:

```
deleteSUVLANFilter <terminal ID> <start VLAN ID>
```

As in the previous examples, **deleteSUVLANFilter 55 237** removes the VLAN filter entry for SU #55 with a start ID of 237.

You can confirm whether the list still exists by issuing d**spSUVLANFilter 55,** which provides the following output:

```
VLAN range 1: from 17 to 25
Total VLAN filters found 1
```

WARNING! An input of '0' as the start ID value removes the entire filter list.

To remove the entire VLAN filter list for an SU, enter **dspSUVLANFilter <terminal ID> 0**. For example, **deleteSUVLANFilter 55 0** removes the entire VLAN filter list for SU #55. In this case, the SU behaves as if no filters are set. Entering d**spSUVLANFilter 55** produces the output "Total VLAN filters found 0."

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Chapter 3. IP Routing Mode

In contrast to **Bridging** mode, in which packets are delivered based upon their Ethernet addresses, **IP Routing** mode routes packets based upon their IP addresses. IP Routing makes more efficient use of the wireless link as the BSU and SU terminate broadcast messages and do not send them over the wireless link. In addition, IP Routing Mode facilitates more diverse and flexible network configurations. For example, in the following figure multiple BSUs are connected with a switch rather than a router (this configuration does not allow SU-to-SU loopback).

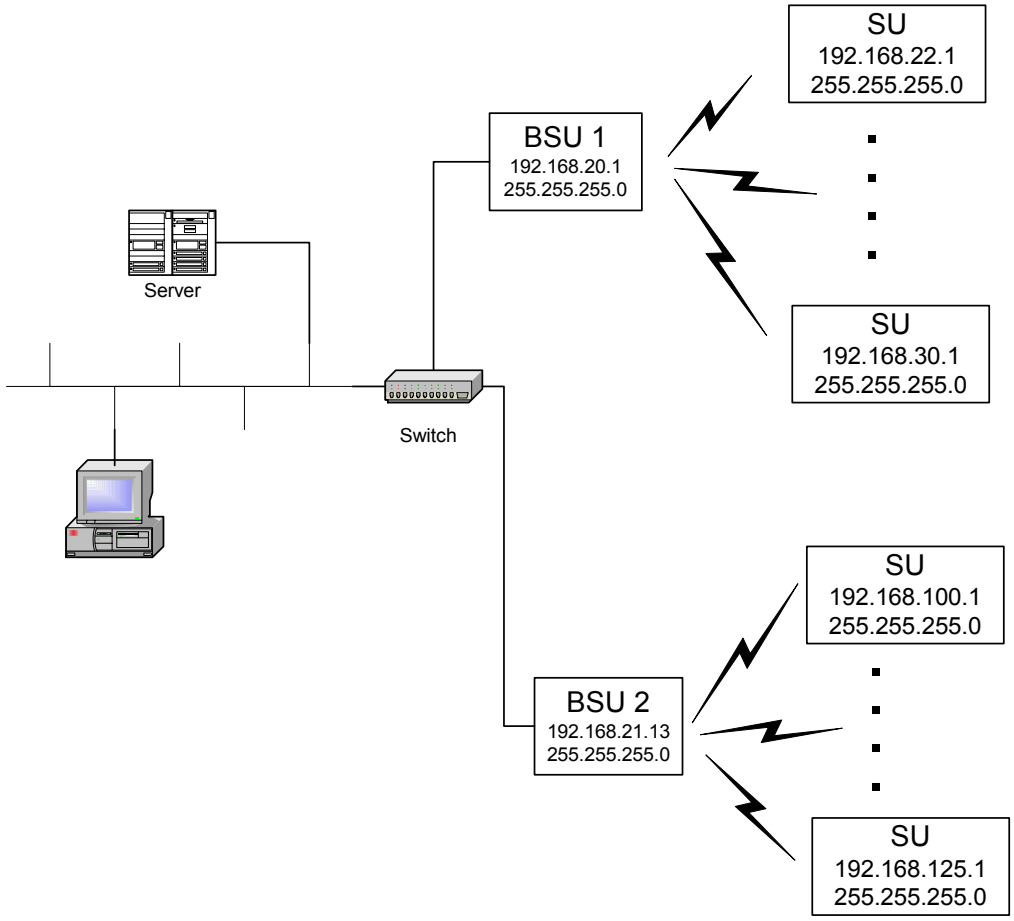


Figure 8. BSU/SU Connection by Switch

The two key features of IP routing mode are:

- The selected **access mode,** which determines which packets are allowed to pass between the BSU and the SU.
- The **routing features,** which are used both to route packets received on the wireless link to the wireline link, and to advertise which networks can be reached by the BSU and the SU.

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Note: Make sure that every BSU is on a different subnet while in IP Routing mode (see the routingMode command on page 89 for information about selecting the routing mode). If the BSUs are on the same subnet, the BSUs cannot respond properly to ARP requests. Also, the routers connected to the BSUs should have a separate subnet mapped to each BSU.

When Routing Information Protocol (RIP) is enabled, the BSU and SU perform the following functions.

- Route packets received on the wireless link to the appropriate host or network
- Advertise routes (to other routers in the network) that can be reached by the BSU and SUs.

Regardless of whether RIP is enabled, the SU also:

- Serves as a DHCP (Dynamic Host Configuration Protocol) relay agent to facilitate the exchange of DHCP packets between the local PC and a remote DHCP server.
- Provides additional network security measures by blocking any unauthorized PCs from accessing the wireless network (depending upon the access mode selected).

When RIP is not enabled, the system uses proxy and default gateways to transfer packets between the hosts on the SU and BSU sides of the network.

ARP TABLES

As stated previously, IP Routing mode routes packets based upon IP addresses. Packets still are delivered to hosts on local subnets based upon their Ethernet address. The address resolution protocol (ARP) is used to learn the Ethernet address corresponding to a specific IP address. The BSU and SUs keep ARP tables containing both the IP address and corresponding Ethernet address of hosts on their local subnet. Because this association can change over time (for example, an Ethernet NIC card fails and is replaced with a new card), the entries in the ARP table are given a TTL (time-to-live), after which the entries time out and must be learned again.

You can enter hosts into the ARP table (static) or by being discovered by the system (dynamic). You can enter the **arp** command at the BSU or SU local console to view the ARP table entries. The TTL value is given in seconds and, with the exception of static entries, is decremented approximately every second. Dynamic entries have an initial TTL of 1200 seconds (20 minutes). This includes any defined default gateway.

Use the **arp –s** command to enter a static entry in the ARP table. Static entries appear with a TTL of 999999 seconds, which never changes. Static entries are useful if a host is not set up to respond to ARP packets.

Whenever the SU/BSU sees traffic from a host with a dynamic ARP entry, it updates the ARP table TTL. When a dynamic ARP table entry is about to time-out, the BSU/SU sends an ARP packet to determine whether the host still is present and, if so, updates the TTL in the table. If the BSU/SU does not receive a response, the entry is dropped from the table. Furthermore whenever the SU/BSU sees traffic from a host entered in its ARP table, it updates the Ethernet address associated with the IP address automatically. Consequently, the ARP table always contains the latest and most up-to-date IP/Ethernet associations.

Note: Static entries are not stored in flash. If the SU/BSU loses power, all ARP table entries are deleted.

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ACCESS MODES

In IP routing mode, you can select one-of-two access modes for each SU—**restricted** or **open**. You select the desired mode using the **setSUFilter** command (page 100).

Note: Each SU can be set to a different access mode.

If restricted mode is selected, the SU passes traffic to and from hosts (on its side of the link) that:

- Get their IP address from a DHCP server (on the BSU side of the network)
- Are one of five statically configured hosts (see the "addSUIP" command on page 96)
- Is defined as the SU's default gateway

When a static IP address is configured (see the "**addSUIP"** command on page 96) or a gateway is defined for the SU (see the "**setSUGateway"** command on page 100), the SU automatically sends an ARP packet in an attempt to discover the Ethernet address associated with these hosts. If the SU receives no response, it periodically re-sends the ARP request. If the SU receives a response to the ARP packet, it enters the static IP addresses into the ARP table with a static entry (does not time out) and enters the gateway into the table with a dynamic entry. The rules for passing traffic when in this mode are described later in this chapter.

Restricted Mode

In restricted mode, a computer connected to the SU running the Subscriber Utility cannot configure or manage the SU if the computer is not one of the 5 statically configured hosts or the SU did not get its IP address from a DHCP server on the BSU side of the network.

In restricted mode, if you attempt to add a static ARP entry for an IP address that has not been defined as one of the five static IPs, the following occurs:

- If the host has received its address through DHCP or has been defined as the SU Gateway, the ARP value is entered as static; however, as soon as the SU sees traffic from this host, it converts the ARP entry to dynamic.
- If the host has been defined as one of the five static IPs, it is added to the table as a static entry.

  Note: If the IP address has been defined as static, it should already have been "discovered" and entered in the ARP table as a static entry. The only reason to do this manually is if the host does not respond to ARP requests.

- If the host did not receive its address through DHCP, is not the SU gateway, and is not a static IP, the attempt results in an error message. However, the entry is stored in the ARP table (no traffic passes) and, if at some future time the host is defined as one of the five static IP addresses, the entry is converted to a valid static entry and traffic is allowed to pass.

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Open Mode

In **open** mode, the SU passes traffic to the SU wireline for any host whose IP address is in the same subnet as the SU. If RIP is disabled and a default gateway is defined, the SU passes all downlink traffic not in the SU ARP table to the default gateway (this includes traffic in the same subnet as the SU that is not in the SU ARP table).

The SU passes traffic it receives to the Uplink regardless of the IP address of the originating traffic. For example, if a host is attached to the SU through a switch and that host is not in the SU's subnet but has the SU set as its default gateway, it can send uplink traffic. However, it cannot receive downlink traffic. The SU attempts to discover the Ethernet address for the gateway using the technique previously described for restricted mode. The rules for passing traffic with RIP enabled are described later in this chapter.

In **open** mode, a static entry to the SU ARP table can be added for any host in the same subnet as the SU. Entering a static entry for a host in a different subnet results in an error message.

Note: In restricted mode, the SU can track up to 8192 hosts. If more hosts are present, the unit is converted to **open** mode automatically.

Although access mode is defined only for the SUs, the BSU behaves as if it is in **open** mode.

WIRELESS LINK PACKETS DESTINED FOR LOCAL SUBNET IP ADDRESSES

When the system is operating in IP routing mode and the SU/BSU receives a downlink/uplink packet addressed to a host in the SU's/BSU's **local subnet**, the packet is processed as follows (assuming it meets the criteria of the access mode selected):

- If the destination host is in the ARP table, the packet is sent to the destination host.
- If the destination host is not in the ARP table and no gateway is defined, the SU/BSU drops the packet. If the SU/BSU has not attempted to locate the host in the last 12 seconds, the SU/BSU sends an ARP packet in an attempt to discover the corresponding Ethernet address. If the host responds, its entry is added to the ARP table.
- If the destination host is not in the ARP table and a gateway is defined, the SU/BSU sends the packet to the default gateway. If the SU/BSU has not attempted to locate the host in the last 12 seconds, the SU/BSU sends an ARP to find the host. When the host responds, its entry is added to the ARP table.

WIRELESS LINK PACKETS DESTINED FOR OTHER THAN LOCAL SUBNET: RIP DISABLED

When RIP is disabled, packets arriving at the SU that meet the access mode criteria are treated as follows:

- If no default gateway is defined, the packet is dropped.
- If a default gateway is defined, the packet is passed to the default gateway.

The behavior at the BSU is the same with the exception that access mode filtering is not applied.

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IP ROUTING DEPLOYMENT WITH RIP DISABLED

Firmware versions prior to Version 1.3 did not have routing features enabled. A combination of default gateways and proxy were used to deploy networks in IP routing mode in these versions of the firmware. It is still possible to deploy networks in this manner by disabling RIP and enabling proxy. How to do so is discussed in this section.

Point-to-Multipoint Proxy

When a device (an originating host such as a PC, router, SU, or BSU) wants to transmit an IP packet, it first must decide whether the destination IP address resides within its own subnet. If the answer is yes, the sending device searches for the corresponding Ethernet (MAC) address associated with the destination IP address. It does this by searching its ARP table to determine whether it has an Ethernet address corresponding to the IP address. If there is no entry in the ARP table for the IP address, the originating host broadcasts an ARP message with the IP address of the target host. If the target host is on the network, it responds to the originating host with its MAC address.

There are times when a host other than the target attempts to respond to the originating host's ARP message. In essence, when this occurs, the responding host is saying "if you have information to send to the target host, send it to me." The responding host is "proxying" for the target host.

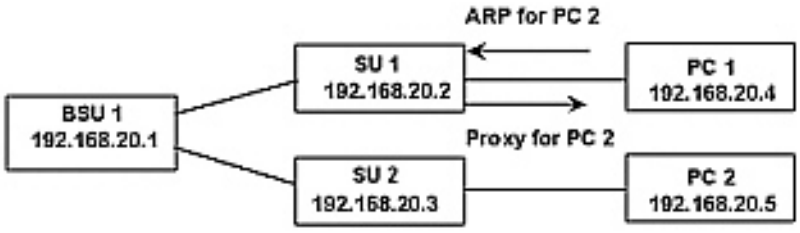


Figure 9. Proxy for Remote Devices Residing in the Same Subnet

If the destination IP address resides in a different subnet, the sending device does not issue an ARP request; instead, it forwards the packet to a default gateway for delivery.

Tsunami Multipoint Use of Proxy

The primary use of proxy in the Tsunami Multipoint product is when a BSU and an SU are deployed in IP Routing mode in the same subnet. *This should be done with RIP disabled and proxy set to* ***auto*** (see "Chapter 5. Base Station Configuration Software and Subscriber Utility" on page 47).

In IP Routing mode, broadcast messages are not sent on the wireless link (in general, routers terminate broadcast domains). Consequently, any ARP message sent from the BSU (SU) side of the subnet is not passed to the SU (BSU) side of the subnet. This means that hosts on the BSU (SU) side cannot automatically communicate with hosts on the SU (BSU) side. To allow all of the hosts in the same subnet to communicate, the BSU can proxy for hosts on the SU side of the subnet, and the SU can proxy for hosts on the BSU side of the subnet. The following example illustrates how a network is deployed with RIP disabled and proxy set to auto.

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Note: The BSU must only proxy for hosts on the SU side of the subnet and not for hosts on the BSU side of the network (and vice versa). If, for example, communication is lost with a particular host on the BSU local network and another device on the local network ARP is looking for the unavailable host, the BSU proxies for the unavailable host. From then on (until the ARP table times out) the host incorrectly sends its traffic to the BSU.

Example 1 — with RIP Disabled

This is an example of a fairly simple network deployment with only a single subnet attached to each SU. There are no routers on the SU side and the network administrator wants to use a minimum number of subnets. Some of the PCs receive their IP address through a DHCP server and others are assigned static IP addresses at the BSU. This network is deployed with RIP disabled and proxy set to **auto**.

In the configuration shown in the following table and figure, two subnets (191.168.20.0 and 192.168.21.0) are installed, with the following network configuration:

- BSU1 belongs to subnet 192.168.20.0 and is connected to one of the router ports (having the same subnet address).
- BSU2 belongs to subnet 192.168.21.0 and is connected to a second router port (having the same subnet address)

Note: In general, you should not assign BSUs to the same subnet; otherwise, you might create a proxy-ARP problem.

For PC1 to send a packet to PC2, the following occurs:

- PC1 issues an ARP request, to which SU1 responds on behalf of PC2 as part of the proxy process previously described (see “Point-to-Multipoint Proxy” on page 29).
- PC1 then transmits a data packet to SU1.
- SU1 strips off the 18-byte Ethernet header and then forwards only the IP portion of the packet to BSU1.
- BSU1 appends its own Ethernet address as the source Ethernet address and delivers the packet to Router1.
- Router1 recognizes that the destination address belongs to subnet 192.168.20.0 and forwards it back to BSU1 by way of the same router port (that is, the port associated with IP address 192.168.20.1).
- SU2 receives the packet from BSU1. PC2 has previously received its IP address using DHCP; therefore, PC2’s IP address is already recorded in SU2’s database and the packet is allowed to pass.
- The packet is delivered to software, which searches its ARP table, appends PC2's Ethernet address as the destination Ethernet address and SU2’s own IP address as the source Ethernet address, and delivers the packet to PC2.

For PC1 to send a packet to PC3, the following takes place:

- PC1 forwards the packet to SU1, because the destination address lies outside of PC1's subnet and SU1 is PC1's default gateway.
- When Router1 receives the packet, it recognizes that the destination address belongs to a different subnet than that of the receiving port.

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- Router1 sends packet to BSU2 by way of the other router port (the one associated with IP address 192.68.21.1).
- PC3 ultimately receives the packet by following a process similar to the one described above.

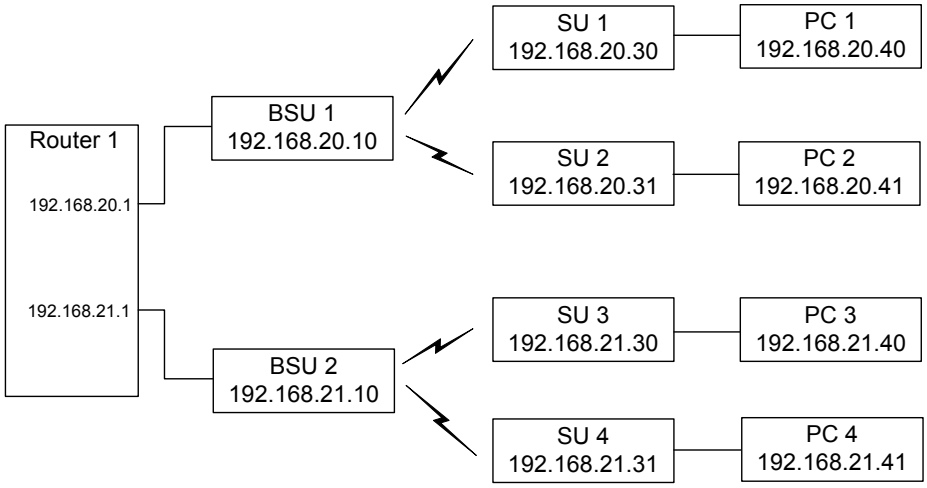


Figure 10. Network Diagram Example 1 Configuration Settings

Example 1 Configuration Settings					
	Access Mode	**Static IP Address**	**DHCP IP Address**	**Subnet Mask**	**Default Gateway**
Router 1	N/A	N/A	N/A	255.255.255.0	BSU 1 for subnet 192.168.20.0 BSU 2 for subnet 192.168.21.0
BSU 1	N/A	N/A		255.255.255.0	Router 1
BSU 2	N/A	N/A		255.255.255.0	Router 1
SU 1	Restricted	PC 1	None	255.255.255.0	None
SU 2	Restricted	PC 2	None	255.255.255.0	None
SU 3	Restricted	None	PC 3	255.255.255.0	None
SU 4	Restricted	None	PC4	255.255.255.0	None
PC 1	N/A	192.168.20.40	None	255.255.255.0	SU 1 (through configuration)
PC 2	N/A	192.168.20.41	None	255.255.255.0	SU 2 (through configuration)
PC 3	N/A	None		255.255.255.0	SU 3 (through DHCP)
PC 4	N/A	None		255.255.255.0	SU 4 (through DHCP)

A limitation of deploying a network in this manner (no RIP and proxy set to **auto**) is that using proxy is always a little risky. Proxy assumes that local PCs can always respond to ARP request and that their response does not get lost.

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PACKET ROUTING AND RIP

Tsunami Multipoint's IP routing capabilities are geared for a small campus environment in which a single company's IT infrastructure is distributed between different buildings. In the router environment, route information must be distributed to all users dynamically. An example network topology is provided in Figure 11. It is useful for all of the routers to automatically learn which routes they can reach and be able to dynamically adjust routes when a router or a link goes down.

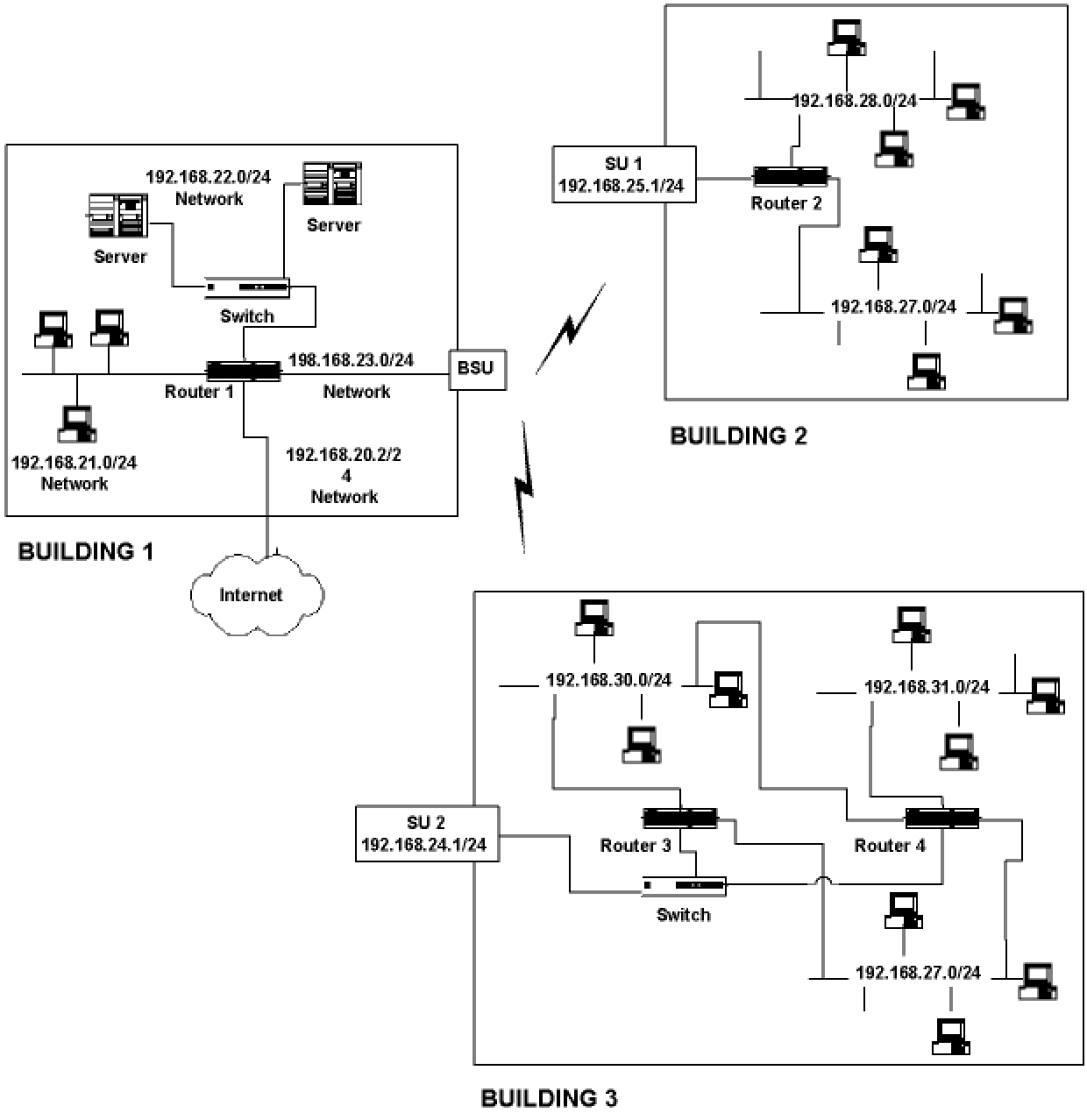


Figure 11. Sample Campus Networking Layout

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With Routing Information Protocol Version 2 (RIP V2) enabled, the combination of BSU and associated SUs act as a (virtual) multi-port router. The BSU and each SU act as different ports (interfaces) on the router. The BSUs and SUs can both advertise routes and receive route advertisements from routers using RIP V2.

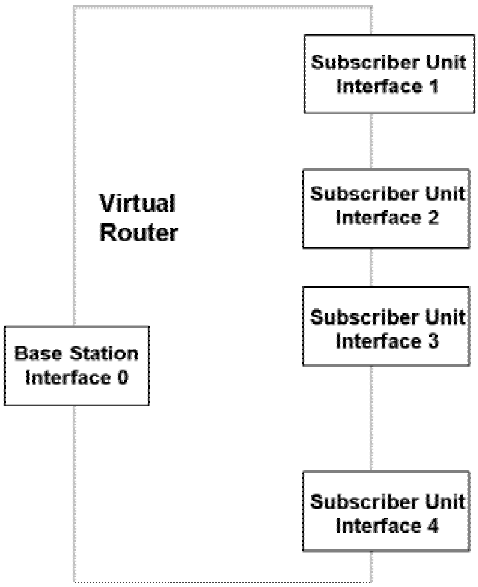


Figure 12. Sector Acting as a Virtual Router in IP Routing Mode

Route Discovery/Advertisement

The BSU/SU listens for RIP V2 route messages and adds any routes learned into its routing table. The BSU/SU also learns its local network, based upon its IP address and network mask, and adds them to the routing table. The routing table is kept at the BSU and distributed to each SU. The BSU and each SU advertise the routing table every thirty seconds using the RIP V2 message format, using multicast IP address 224.0.0.9.

You can view the routing table by issuing the **rip print** command (page 88).

Static Routes

Static routes can be added only if RIP is enabled. You can enter static routes into the routing table using the **rip add** command (page 87). Up to eight static routes can be entered at the BSU and each SU. Static routes do not time out and are NOT advertised to other routers.

Note: Static routes cannot be entered or seen with the SNMP Toolkit.

Static routes should be defined only for the wireline (Ethernet) interface. Every packet that arrives at an SU or a BSU (except those specifically destined for the SU or BSU) is automatically sent to the wireless interface. Because the SU or BSU does not advertise static routes to other routers and packets are sent automatically to the wireless interface, there is no reason to define a static route for the wireless interface.

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Earlier we stated that the BSU and collection of associated SUs form a virtual router with a single routing table. The **rip print** command can be used to print this routing table at either the BSU or any of the associated SUs. The only exception to this are the static routes. A BSU or SU does not advertise its static routes to other SUs or BSUs.

There is no reason for any SU to know the static routes of the BSU or any other SU, because any packet that arrives at the SU is sent automatically to the BSU, regardless of its routing table. Similarly, the BSU does not need to know the static routes of any of its associated SUs, because any packet arriving at the BSU is transmitted automatically to all SUs (which then filter out extraneous packets) regardless of their routing table.

Note: Be aware that the **rip print** command only lets you know of the static routes of the SU or BSU at which the command was entered. In order to get a complete picture of all the routes that can be reached by the "virtual router," you must enter a **rip print** command at every interface (SU/BSU) to see all the static routes entered.

Default Gateways (Default Routes)

If a BSU or an SU has a default gateway defined and RIP is enabled, that gateway becomes the default route for the BSU or SU.

An off-the-shelf router has, at most, a single default route defined. Typically, in IP Routing mode, the BSU has a default route (default gateway) defined to enable SU-to-SU loopback.

SU-to-SU loopback refers to the following:

- A packet originating at an SU destined to another SU in the sector first goes on the uplink to the BSU.
- The BSU sends the packet to the default gateway, which typically is a router that routes the packet back to the BSU.
- The BSU then sends the packet on the downlink to the receiving SU.

In most deployments, there is no reason to define a default gateway at an SU; however, there are situations in which an SU default gateway must be defined. For example, if the BSU is at a remote location and has no access to the Internet, it makes sense to have the BSU relay traffic from the SUs to a single SU that has a convenient connection to the Internet. In this situation, a default route (gateway) must be defined at the BSU to enable the SU-to-SU loopback, and at the SU that is connected to the Internet (to allow the Internet traffic to pass).

Note: Proxim strongly urges that default gateways be defined only at the BSU and, at most, a single SU. The software allows a default gateway to be assigned to each SU; however, assigning default gateways to multiple SUs can lead to duplicate packets being dumped onto the different wireline networks. If possible, only the BSU should have a default gateway.

When a default gateway (route) is defined at an SU, not all downlink traffic is automatically passed onto the SU's wireline network. Each SU knows what routes the other SUs can reach. If the SU receives a packet (on the downlink) that it knows can be reached by another SU, it discards the packet even if a default gateway is defined. This is done because the wireless downlink is a broadcast channel, so each SU sees all downlink traffic.

WARNING! ***Changing the default gateway on either the BSU or SU forces a warm restart!***

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Example 2 — Network Deployment with RIP Enabled

In this more complicated example, the SUs and BSUs are assigned to different networks. This is possible because, in IP Routing mode, the PMP network can function as a multi-port router, where each port has its own network address. Router 2 (which is connected to SU4) has been added. Router2 is also connected to PC4 through a second port with a different network interface (192.168.26.10). In this example, RIP is enabled and proxy is turned off at the BSU and all SUs.

For SU4 to receive IP packets for PC4 (or any unknown device that is connected to Router 2), its access mode (IP filter mode) must be set to **open** (see “setSUFilter” on page 100) or all devices on the far side of the router must receive their IP addresses from the DHCP server. It is easiest to set SU4’s access mode to **open**.

For PC4 to send data to PC2, the following takes place:

- PC4 delivers the packet to Router2 (PC4's gateway).
- Router2 forwards the packet to SU4 (because it has received an RIP V2 advertisement from SU4 that it is the next hop for the 192.168.23.0 network).
- SU4 delivers the packet to Router1 through BSU2.
- Router1 forwards the packet to BSU1 (because BSU1 has advertised (using RIP V2) that it is the gateway for the 192.168.23.0 network).
- SU2 receives the packet and delivers it to PC2. (SU1 also receives the packet; however. it discards it because it knows it cannot reach the network.)

If PC2 wants to send a packet to PC4, the following takes place:

- PC2 forwards the packet to SU2 (PC2’s default gateway).
- SU2 delivers the packet to Router 1 through BSU1 (it knows, by receiving RIP V2 advertisements or by having a static route entered, that Router 1 is the next hop to reach the 192.168.26.0 network).
- Router1 then sends the packet to SU4 through BSU2. (Because the access mode (IP filter mode) for SU4 is set to **open**, the hardware delivers the packet to software, bypassing the Programmable filter.)
- SU4 recognizes that this packet is intended for a different subnet and, after checking its routing table, it forwards the packet to the 192.168.25.20 port of Router 2 for delivery to PC4.

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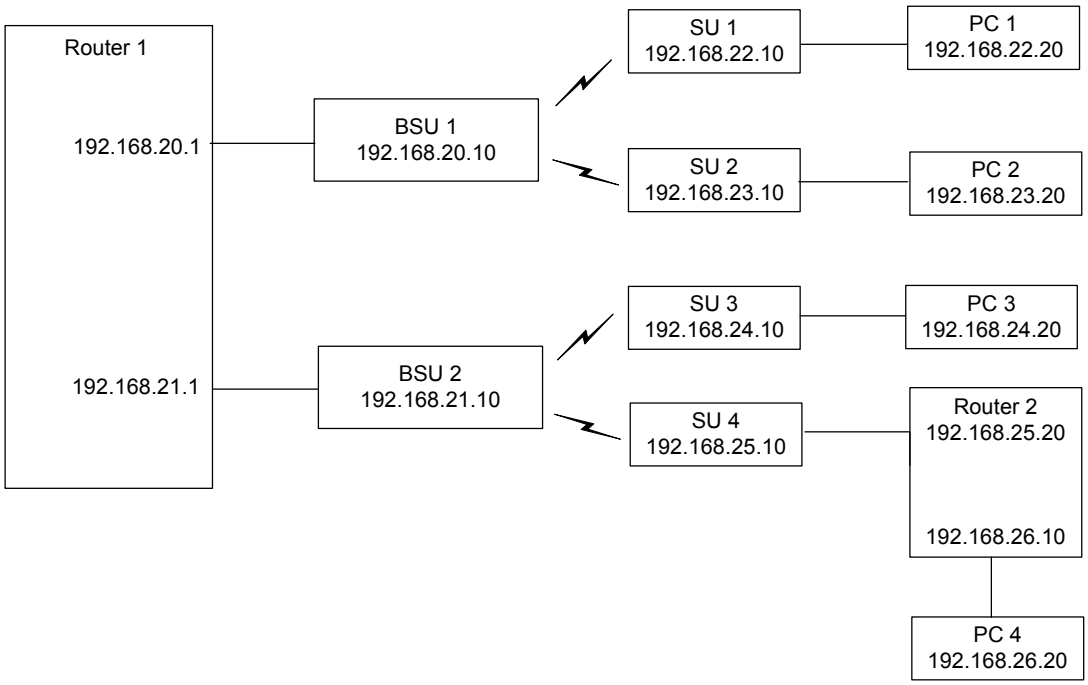


Figure 13. Network Diagram – Example 2

Note: To avoid creating an infinite loop in the network, Router 2 must be instructed to drop any un-routable packets received from SU4. In the previous example, this means that if Router 2 receives a packet from SU4 that is destined for networks beyond SU1, SU2, and SU3, the packet should be dropped.

Table 7 Network Diagram Example 2 Configuration Settings

Example 2 Configuration Settings					
	Access Mode	**Static IP Address**	**DHCP IP Address**	**Subnet Mask**	**Default Gateway**
Router 1	N/A	N/A	N/A	255.255.255.0	
Router 2	N/A	N/A	N/A	255.255.255.0	
BSU 1	N/A	N/A	N/A	255.255.255.0	Router 1
BSU 2	N/A	N/A	N/A	255.255.255.0	Router 2
SU 1	Restricted*	PC 1	None	255.255.255.0	None
SU 2	Restricted*	PC 2	None	255.255.255.0	None
SU 3	Restricted*	None	PC 3	255.255.255.0	None
SU 4	Open	None	None	255.255.255.0	None or Router 2
PC 1	N/A	192.168.22.20	None	255.255.255.0	SU 1
PC 2	N/A	192.168.23.20	None	255.255.255.0	SU 2
PC 3	N/A	N/A	192.168.24.20	255.255.255.0	SU 3
PC 4	N/A	N/A		255.255.255.0	192.168.26.10 port on Router 2
* Because RIP is enabled, these SUs could be run in open mode also.					

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Key Steps in Deploying RIP

The following steps are required to successfully deploy a wireless network using RIP:

- The BSU and all SUs must be in different subnets.
- A router is required at the BSU to successfully route packets between two SUs associated with the same BSU. (The current BSU does not take packets it receives on the uplink and route them back down the wireless link. A packet arriving from one SU on the uplink, destined to another SU in the sector, must first be sent from the BSU onto the wireside to a router that can route the packet back to the BSU, which sends it down the wireless link to the appropriate SU.)
- Access mode should be set to **open**.

Enabling RIP

To use IP Routing mode with RIP V2 enabled:

1. At the BSU console, enter **rip enable** (the default value is **off**).
2. Shut off proxy at the BSU and all SUs (see the “proxy” command on page 86).

Note: The router having to proxy the ARP table is a function of the network design and is not a function of the multipoint radio.

ROUTING MODE FEATURES NOT SUPPORTED

The BSU/SU does not act as a traditional router. The BSU/SU combination simply forwards packets between the BSU and the SU networks. The BSU does not route packets from one SU network to another SU network.

RIP V1 compatibility mode is not supported.

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Chapter 4. Active Interference Rejection

This document provides the following information for the operation of the Tsunami Multipoint Base Station Unit with Active Interference Rejection (A.I.R.):

Overview (below)
Provides fundamental information about the Tsunami Multipoint BSU with Active Interference Rejection (A.I.R).

Defensive Countermeasures (below)
Provides information about defensive countermeasures and self-managing interference rejection technologies that protect against both current and future sources of interference.

Technical Fundamentals (on page 41)
Provides technical discussions to enhance your understanding of underlying interference rejection techniques.

Operation 1-2-3 (on page 42)
Presents the commands associated with turning on and off the A.I.R. technology, selecting appropriate parameters, and monitoring interference rejection. Information is presented in a command-by-command basis with the focus on facilitating operation for the first-time user.
Commands to be used with the BSU with A.I.R. technology are summarized as the last section for a quick glance. These commands apply only at a BSU with A.I.R. technology.

OVERVIEW

As ISPs and enterprises increase deployments of wireless connections, the potential for interference among systems operating at or near the same frequency grows. This has become particularly evident in the 2.4 GHz band used by 802.11b wireless LANs, portable telephones, Bluetooth devices, and microwave ovens. To combat current and potential interference, service providers must undertake careful deployment planning and, in some cases, negotiations with other occupants of the frequency band.

The Tsunami Multipoint Base Station Unit with A.I.R. technology provides a combination of integrated defensive countermeasures and patented interference rejection technologies. The A.I.R. technology safeguards wireless access networks against interference in real time, enabling stable, consistent service deployment and co-existence with point-to-point and other multipoint networks.

Defensive Countermeasures

In its continuing effort to safeguard its wireless access networks against interference, Proxim Corporation now offers a new component for its Tsunami broadband wireless access system—the Tsunami Multipoint Base Station Unit with A.I.R. technology.

Tsunami Multipoint Wireless Ethernet systems provide maximum network reliability with defensive countermeasures and self-managing interference rejection technologies that protect against both current and future sources of interference, including:

- Directional antennas
- A variety of frequency channel plans
- Adaptive polarization rejection
- Spatial Interference Rejection

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Directional Antennas Optimize Performance and Thwart Potential Interference

Antennas frequently play a key role in reducing the potential for interference. They come in a variety of configurations that have different performance characteristics in terms of gain and direction. In radio parlance, *gain* refers to the antenna's ability to increase the transmitted and received signal, and *direction* refers to its ability to focus on a specific aperture for transmitting and receiving signals. Antennas that transmit and receive in all directions are known as *omni-directional*, while those that transmit and receive in one specific direction are categorized as *directional*. A third category, sector antennas, are used at hub sites to partition the geography amongst several BSUs.

Antennas also vary in beamwidth, which is the aperture to which they can "see" signals. Larger antennas typically provide narrower beamwidths and can diminish interference from nearby transmitters by:

- Focusing RF energy from the intended signal source
- Reducing the power of interfering sources not directly aligned to the antenna

Tsunami Multipoint Antennas: Narrower is Better

Tsunami Multipoint Subscriber Units (SUs) use directional antennas that transmit and receive a relatively narrow beamwidth of radio energy (<10 degrees Beamwidth), improving system performance by reducing the likelihood that surrounding RF clutter will interfere with reception. However, the Base Station Unit (BSU) must provide a wide azimuth Beamwidth for multipoint operation, thus making Active Interference Rejection essential.

Multiple Frequency Channels Bypass Interference

Tsunami Multipoint offers a variety of channel plans that provide a flexible tool for overcoming present and future interference. Four non-overlapping 20 MHz channels can be used to avoid existing traffic in the 5.8 GHz frequency band (ISM and U-NII). In addition, 5-channel and 6-channel overlapping frequency plans are available for greater flexibility. If one part of the 5.8 GHz spectrum is occupied when Tsunami Multipoint is initially deployed, another frequency channel can be selected to bypass the interfering signal. If interference arises after deployment, another frequency channel plan can be selected to "steer around" the impacted channel.

INTERFERENCE REJECTION TECHNOLOGIES

The Tsunami Multipoint Base Station Unit with Active Interference Rejection provides two levels of realtime interference protection to the BSU:

- Adaptive polarization cancellation
- Spatial cancellation

Combined, these interference rejection technologies can eliminate 99.5% to 99.9% of an interfering signal using realtime signal processing techniques. For the service provider, this translates into an upper hand in negotiating with a competing system, since it is likely that the competing system will cease to operate before the Tsunami Multipoint system. In addition, the A.I.R. technology lets multiple service providers using Tsunami Multipoint equipment in alternate polarization modes co-exist in the same cell.

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Adaptive Polarization Rejection

For any wireless link to function properly, the antennas at both ends must use the same type of polarization and must be set for the same polarization orientation. There are four basic types of polarization:

- Linear, vertical
- Linear, horizontal
- Circular, left-hand
- Circular, right-hand

The vast majority of wireless systems, including the Tsunami point-to-point bridges, use linear polarization. To mitigate the risk of interference from these systems, the Tsunami Multipoint employs the much less frequently used circular polarization. As a result, the A.I.R. technology actively rejects linear-polarization transmissions, vertical and horizontal, without dropping any subscribers.

The A.I.R. technology is even more effective against an orthogonal polarization from reflected signals. For example, a right-circular polarized signal is rejected where the cross polarization property of the antenna is used in addition to the integrated signal canceller. Numerically, Tsunami Multipoint adaptive circular polarization provides more than 25 dB of margin against a linear interferer and 30 dB of margin against a reversed circular polarized signal.

Spatial Interference Rejection

To protect against interference from systems in the same band with the same polarization, the A.I.R. technology provides a secondary layer of interference rejection: realtime spatial interference rejection of 22 dB or more, which can be used against the same polarization as the base station.

Within the 60-degree beamwidth of the base station, the A.I.R. technology performs calculations over 100 times per second, detecting and rejecting unwanted signals by blocking transmission in small geographical subsections (“slivers”) of the sector.

By pinpointing the exact location of the interfering signals, this technology provides highly granular interference rejection in slivers as narrow as 3 degrees (with up to three slivers per 60-degree sector). Because Tsunami Multipoint spatial interference rejection operates and adapts automatically, in real time, slivers are blocked only while there is a source of interference present, protecting the base station and limiting service outages for inadvertently dropped subscribers within the blocked area.

PLANNING AHEAD WITH TSUNAMI MULTIPOINT

Even in areas where no interference exists today, the possibility that another network will be installed nearby is an important consideration when planning to deploy, expand, or upgrade a wireless system. Tsunami Multipoint Wireless Ethernet systems provide maximum network reliability with defensive countermeasures and self-managing interference rejection technologies that protect against both current and future sources of interference.

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TECHNICAL FUNDAMENTALS

Why Interference Rejection is Needed

The Tsunami Multipoint access system operates at a license-exempt spectrum of 5.725 to 5.825 GHz. In this band, there is no guarantee of protection from other interfering RF sources. The Active Interference Rejection technology protects the wireless links from interference. It also improves the survivability of the system when other point-to-multipoint or point-to-point systems exist in the same neighborhood.

Uplink Direction Interference Rejection

In a typical point-to-multipoint system, the base station unit (BSU) is more vulnerable to interference than the subscriber unit (SU) due to being located at a higher tower and being equipped with a wider-angle antenna. Thus, the A.I.R. technology is available only in the uplink direction.

Interference Rejection by Antenna Nulling

The Tsunami Mutlipoint system has adapted multiple interference rejection techniques. The most effective feature is using an array antenna to perform adaptive nulling, one type of array signal processing. Such technology creates a null (the valley of the antenna pattern) dynamically at the direction of the interference to reduce the power received from such interfering signals. An example is illustrated in the following figure, in which the jammer is located at 15° from the boardside (peak) of the base station. A simulated result shows antenna response to such interference is 20-30 dB lower than the response to the desired signal.

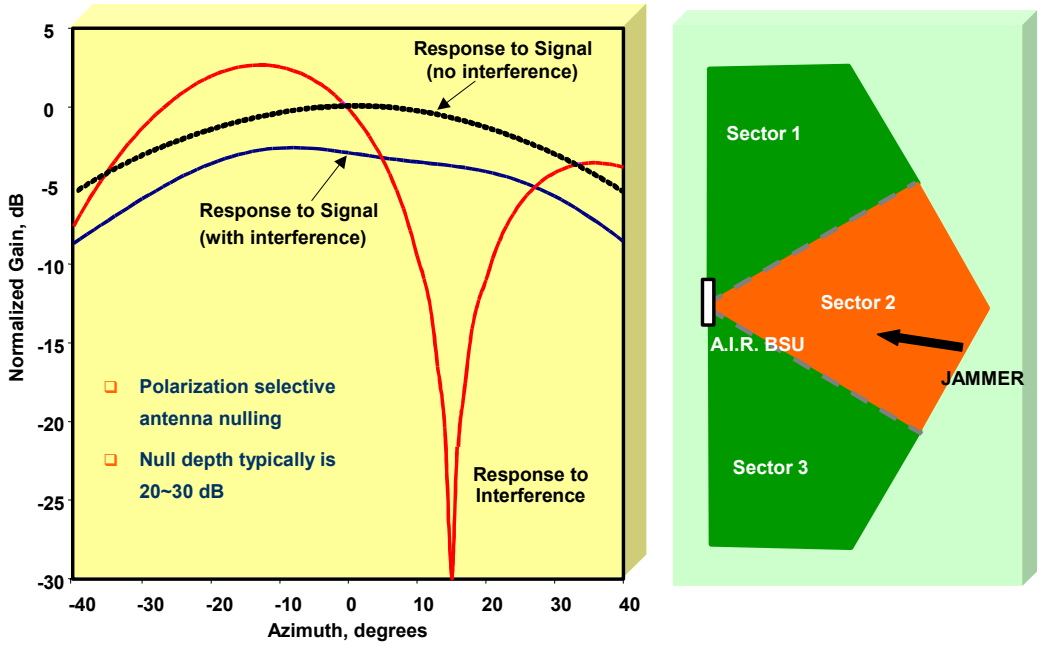


Figure 14. Rejection to Linear Polarized Interference

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Polarization Selective Nulling

The Tsunami Multipoint offers a novel polarization selective antenna nulling technique. The BSU with A.I.R. technology has the intelligence to identify the type of polarization of an interfering source and to protect the desired signal as well as possible. This is achieved as follows:

- If the source of interference is linear polarized, the BSU with A.I.R. technology creates a deep null at the direction of the interference and rejects only the linear polarized signal while maintaining uniform response to the desired left-hand circular polarized (LHCP) signal.
- If the source of interference is LHCP, the same as the desired signals, the BSU with A.I.R. technology creates a “spatial” null to the direction of the interference. Because the interference source also is LHCP, the subscriber units near that direction may also be nulled.
- If the source of interference is right-hand circular polarized (RHCP), reverse from the desired signal, the antenna cross-polarization discrimination rejects a certain amount of the RHCP interference. If the RHCP interference is stronger than the cross-polarization rejection, the BSU with A.I.R. technology cancels the residual RHCP interference.

Nulling Performance using A.I.R.

Enabling A.I.R. technology at the BSU significantly improves the carrier-to-interference capability of the uplink reception. An improvement of 20 to 30 dB can be expected in all the modulation modes. The following table shows the minimum improvement for each mode.

Table 8 Carrier to Interference Improvement Using A.I.R.

Modulation Mode	C/I without A.I.R.	C/I with A.I.R. enabled*
20 Mbps	6 dB	-16 dB
30 Mbps	9 dB	-13 dB
40 Mbps	14 dB	-8 dB
60 Mbps	20 dB	-2 dB
* C/I with A.I.R. performance applies to both adaptive polarization and spatial rejection.		

WE IMPROVE, AT ALL MODULATION MODES, THE CARRIER-TO-INTERFERENCE RATIO BY 22 DB.

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OPERATION

Turning Active Interference Rejection On and Off

Turning on the A.I.R. feature is as easy as entering the command **null 1** at the BSU console. In this section, details operators should know about this command are presented.

- When you enter the **null 0** command, the unit operates as though A.I.R. technology is not available on the unit.
- When you enter the **null 1** command, the unit detects whether the input interference is greater than the threshold.
  - If the interference surpasses the threshold, the nulling algorithm is invoked and the computed nulling weights are applied to the inputs of the channels.
  - If the input interference-to-noise ratio does not surpass the threshold, depending upon the number of consecutive frames below the threshold that have transpired, the smart antenna processor (SAP) at the front end of the BSU with A.I.R. technology either holds and uses the last weights or passes the data through an output gain stage and then to the modem.
- When you switch between **null 0** and **null 1**, it takes a few minutes for automatic gain control (AGC) levels to return to operational levels. It can actually be faster to restart the BSU with A.I.R. technology if GPS is off.
- When you switch from **null 1** to **null 0**, there is a 5-second "start-up" time for the input AGC to settle. In addition, the SAP output AGC (displayed as RXAGC on berlog) is held at 400 and then released. It should climb to a range between 500 and 660 before stabilizing. Overall, it may be a minute or two before optimal performance can be obtained.
- The same is true when going from **null 2** to **null 0**. The RXAGC is restarted at 168 and takes a few minutes to climb to its eventual level. Switching between **null 1** and **null 2** requires only a second or two to reestablish normal operation.

Adjusting the Nulling Threshold

Depending upon the environment of operation, the interference detection sensitivity may have to be changed. The command **INRthres x** sets the interferer to noise ratio (INR) of **x** dB where nulling is enabled. With no interference, the Interference/Noise ratio displayed should stay below –7 dB. Thus, you should use an INRthresh value of more than –5 or –4. An INRthresh set to –15 will probably enable nulling when there is only thermal noise.

The default INRthresh setting is –3. Thus, setting the INRthresh to an extremely high value (such as 62) is no different from disabling the nulling while keeping null =1. The computed INR will never reach this level.

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Nulling LHCP Interference

Because LHCP interference rejection using spatial nulling can result in some uplink signals from SUs also to be rejected, Proxim recommends leaving the spatial cancellation mode disabled until LHCP interference is detected using **intLog**, as described in "Monitoring IR Status" below.

- With spatial turned off (**spatialEnable 0**), only RHCP and linear interferers are nulled. If the base station detects LHCP interference, no nulling occurs.
- When spatial is turned on (**spatialEnable 1**), nulling of LHCP interferers can occur. In this situation, SUs in the same direction as the LHCP interference also are nulled, as the antenna cannot separate the desired RF signals from the interfered source.

Fine Tuning the Adaptive Convergence Rate

The convergence parameter defines how fast the nulling weights converge to their final solution and is changed using the command **convergence x**, where **x=1** is the slowest rate and **x=10** is the fastest rate.

If the parameter is too large, the weights may become too sensitive to noise. If the parameter is too small, the weights may not keep up with a changing interferer environment. The default value is 3, which is the recommended setting.

Monitoring IR Status

The **intLog** command provides a repetitive indication of the A.I.R. performance status. The format of the command is **intLog x** , where **x** sets the time interval, in seconds, between status reports. Entering **intLog 0** turns off the status log.

Each status report consists of six items, as shown in Figure 15.

Int/Noise
The interference-to-noise ratio, in dB, prior to nulling. This ratio value is valid for when the nulling is enabled or disabled.

INR Peak
The maximum Int/Noise level since the **intlog x** command was entered.

Ints Nulled
Indicates the number of interferences being nulled.

Type of Int
The polarization type of detected interference: Linear, LHCP, or RHCP.

Duty cycle
The percentage of frames for which interference is detected. For many pulsed or TDD interferences, the interference is not always present; thus, the duty cycle is not 100%.

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Rejection

The value of A.I.R. rejection in dB. This value is comparing the level of interference with and without multiplying with calculated coefficients. A typical value is around 20 dB. Number 99 indicates that interference is not detected and thus no rejection depth is calculated.

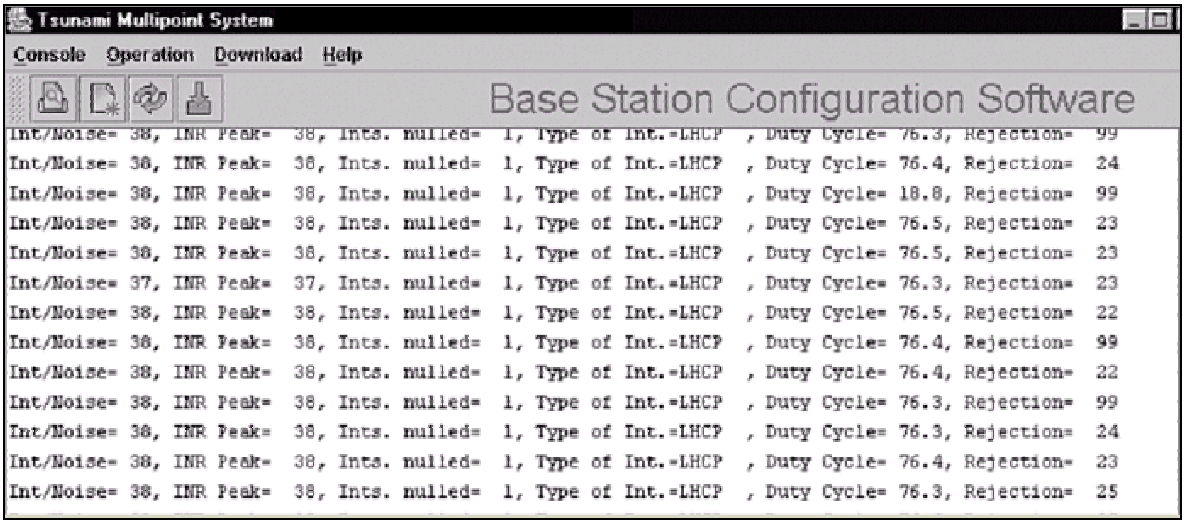


Figure 15. intlog Example

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INTERFERENCE REJECTION COMMAND SUMMARY

The following commands are entered at the BSU console.

null

Usage: **null x**

Where: **x**=0 Bypass mode; only one TX channel is activated.
x=1 Cancellation; antenna nulling is activated when interference is detected.
x=2 Detection; only displays the status of interference but disables nulling.

The default null setting is **0**.

INRthresh

Usage: **INRthresh x**

Where: **x** is in the threshold for interference to noise ratio in dB; the acceptable number is an integer within the range of –15 dB to 62dB.

The default INRthresh setting is **–3**.

spatialEnable

Usage: **spatialEnable x**

Where: **x**=0 Disables spatial nulling
x=1 Enables spatial nulling

convergence

Usage: **convergence x**

Where: **x** is a relative indicator for the convergence rate. An acceptable number is an integer within the range of 1 to 10. **1** is the slowest and **10** is the fastest.

intLog

Usage: **intLog x**

Where: **x** indicates the time interval, in seconds, between output records.

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Chapter 5. Base Station Configuration Software and Subscriber Utility

The Base Station Configuration Software is run on a PC and is used to enter commands and obtain status from the BSU. The PC running the Base Station Configuration Software communicates with the BSU through an Ethernet interface. The Subscriber Utility is used to communicate with an SU. As with the Base Station Configuration Software, the Subscriber Utility runs on a PC that communicates with the SU using IP over an Ethernet interface.

SYSTEM REQUIREMENTS

Hardware	Multimedia PC with a Pentium 200 MHz or higher processor (300 MHz recommended)
Operating System	Microsoft Windows® 98, NT 4.0, Me, 2000, XP
Java 2 Virtual Machine (JVM)	SDK or runtime (1.2.2_12 or later, 1.3.1_03 is provided)
Memory	64 MB for Windows® 95/98 or Windows® Me; 128 MB for Windows® NT 4.0 workstation, Windows® 2000 Professional, or Windows® XP Professional (256 MB RAM is recommended)
Hard Drive	2 GB hard disk with up to 250 MB of available hard-disk space
ROM Drive	Double speed (2x) or faster CD-ROM/DVD-ROM
Network Interface Card	10/100 Mbps NIC with RJ-45 input
Input Devices	Standard IBM-PC compatible 101-key style keyboard, PS2 or USB compatible mouse, or a compatible pointing device
Monitor	Super VGA 16-bit or higher monitor supporting 800 x 600 screen resolution Coordinated video driver for installed video card VGA not supported
Graphics Card	PCI, AGP, or on-board graphics card supporting 16-bit 640 x 480 video resolution or higher. Must Support 16 bit color.
Video Driver	Must support 16-bit color
Browser	Microsoft Internet Explorer 5.0 (6.0 recommended) software or later; other browsers also supported
Optional Hardware	16-bit sound card with speakers or headphones for audible alarm; 6 foot power strip with power surge protection
Optional Software	Microsoft Personal Web Server, Internet Information Server (IIS), or Apache 1.3.x can be served by VAR for over the Internet console installation

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REMOVING THE PREVIOUS BSU CONSOLE VERSION

Prior to installing the new BSU 2.0 Console, you must uninstall the current console version running on the PC. To uninstall:

1. From the PC Windows' **Start** Menu, select **Settings**, then **Control Panel**. A Control Panel window is opened.
2. From the Control Panel window, double-click on **Add/Remove Programs**. An **Add/Remove Programs** window is opened.
3. Under the **Currently installed program** section, set focus to the **Tsunami Multipoint Base Station Configuration Software** and click on **Change/Remove**. An **InstallAnywhere Uninstaller** window is opened.
4. From this window, click on the **Uninstall** button (located on the lower right-hand corner of the window). This uninstalls the selected application.
5. Once the uninstall is completed, the window displays an "**Uninstall Complete. All items were successfully completed**" message. Click on the **Quit** button (also located on the lower right-hand corner of the window).
6. Close the **Add/Remove Programs** window.

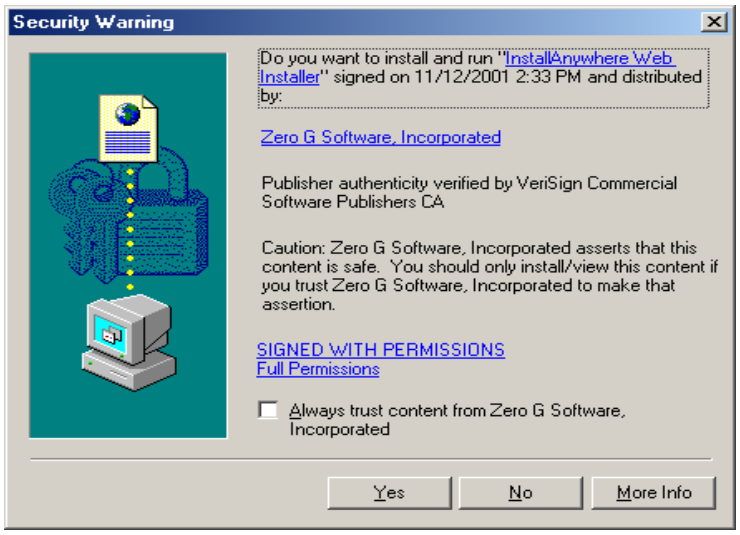
INSTALLING CONFIGURATION SOFTWARE VERSION 2.0

To install the BSU/SU Configuration Software:

1. From your server's Windows Explorer root directory, double-click on the BSU folder, then double-click on the Install icon (or **install.exe**).

   Or, if installing from Proxim's Internet site Tsunami Multipoint Download page (http://www.proxim.com/support/all/tsunami_pmp/software/tmp13b/dl2003_tmp13b.html), double-click on the **BSU Configuration Software** link.

2. Two windows open simultaneously: **InstallAnywhere Web Installer — Microsoft Internet Explorer** (in disabled mode) superimposed by **Security Warning** (in enabled mode).

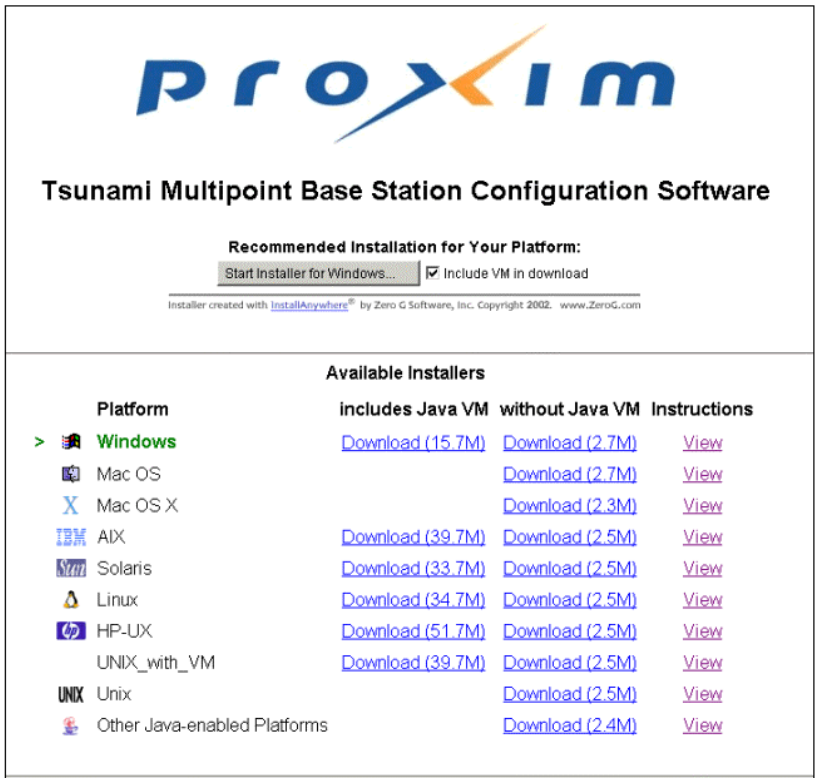


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Click the **Yes** button on the Security Warning window to close this window and view the Base Station Configuration Software window.

For the remainder of this procedure, only default settings are used.

3. Select the applicable installer for your network environment when performing these steps. For example, for Windows installation, click **Download 15.7M** to download the Tsunami Multipoint Base Station configuration software and Java VM; click **Download 2.7M** to download the Tsunami Multipoint Base Station configuration software without Java VM.



4. After the download completes, double-click on **BSsetup.exe** to begin installation.
5. When the Tsunami Multipoint Base Station Configuration Software **Introduction** window is displayed; click **Next**.
6. Click **Next** on the Important Information window once you have completed reading the text. When the License Agreement window is displayed, accept the terms of the License Agreement and click **Next** to proceed with the installation.
7. Click the **Next** button after making your choices on the following windows:
   - **Choose Install Folder** (you can select the default folder or specify another folder)
   - **Choose Java Virtual Machine** (you can select the default machine or specify another machine)
   - **Pre-Installation Summary** (summarizes the installation choices you have made)
8. When the **Install Complete** window is displayed, click on **Done** to return to the Web Installer window; then close the Web Installer window.

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MULTI-BSU CONFIGURATION SOFTWARE VERSION 2.0

Once properly installed, from the PC's Windows **Start** Menu, select:

Programs → Tsunami Multipoint Base Station Configuration Software

Two sub-menu options are displayed:

- Base Station Configuration Software (referred to as BSU 2.0 Console in this document)
- Multi-BSU Configuration Software (referred to as Multi-BSU in this document)

Both options have very similar features; however, Multi-BSU contains multiple tabs.

Upon launching the Multi-BSU software, a window with seven tabs is displayed. The default connection setting is **Dynamic Discovery** mode.

If there are live BSU connections through a router or switch, the application automatically searches for each unit's IP address and changes the tab label (chronologically) from "Connection: <tab #> - N/A" to the detected and found IP address value. Selecting one of these tabs lets you manage that particular unit.

Four main menus are located at the top left-hand section:

Console Enabled.

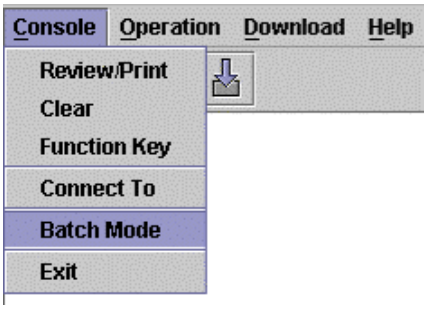
Operation Disabled in **Dynamic Discovery** mode and enabled in **Static Connection** mode when connected to a single BSU.

Download Enabled.

Help Enabled.

Console Menu

Click on the **Console** menu to display the following six options:



Review/Print

The console automatically saves a log file (text file) of command line entries that can be viewed by selecting the **Review/Print** option. The log file keeps the history of line-by-line transactions for ***all*** BSUs from the opening of the console.

Each recorded command line input or output is tagged with the BSU ID. Furthermore, commands entered into SUs from the BSU (by remote connection to the SU with the **remote** command) also are tagged with a capital **R** followed by the SU ID.

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There is a limit to how much history data is stored, and a rotating file system is used. The log is saved in the text file **console.dat** until it contains 25,000 lines (approximately 1 Megabyte). Once it reaches this point, it is copied over to the file **console.dat.bak** and cleared. This process is repeated every time **console.dat** reaches 25,000 lines. The files **console.dat** and **console.dat.bak** can be found in the install directory. (When using the default install settings this will be C:\Program Files\Tsunami Multipoint Base Station Configuration Software.)

Note: When the Base Station Configuration Software is closed, it deletes the **console.dat** file and all recent log information is lost. It does not delete the **console.dat.bak** file.

Clear

The **Clear** command lets you clear the transactional data currently displayed (current tab). This command does not clear the log file.

Clear All (available only with Multi-BSU)

The **Clear All** command lets you clear ***all*** the transactional data in ***all*** tabs (including those not currently selected). This command does not clear the log file.

Function Key

The **Function Key** lets you set commonly used commands to F1 and F12 keys for quick execution. Function keys operate for all windows.

Connect To

The **Connect To** command lets you determine how the Base Station Configuration Software is to connect to the BSUs.

- In **Dynamic Discovery** mode, the console automatically discovers all BSUs on its local subnet.
- In **Static Connection** mode, you enter the IP address of the BSUs to be connected. You can also enter the UDP port used by console. The default port is 3456, which can cause a conflict with Microsoft IIS. If Static Connection mode is selected and a single BSU is specified, the **Operation** menu becomes active.

Batch Mode

Batch mode lets you select a batch file to be executed. The batch file is simply a text file containing a sequential list of commands.

Exit

Exit lets you exit the application (the same as closing the window by clicking the X icon located at the upper right-hand corner of the pane).

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Operation Menu

Left mouse-click on the **Operation** menu to display three options:

Switch to IP Routing mode

This option is a shortcut to set the VLAN tagging OFF (if ON), and reset the mode to IP Routing mode.

Switch to Bridging mode

This option is a shortcut to set the VLAN tagging OFF (if ON), and reset the mode to Bridging mode.

Restore default IP Address

This option is used to restore the default IP of 192.168.20.253 to the device in case the Console is rendered inoperable due to a change in IP address of the BSU. Restore default IP does not work if the system is password protected.

Note: In pre-Version 1.3 firmware (with BSU console 1.4), the restore default address command may not work if the BSU was password-protected. Version1.3 and later firmware (with BSU console 1.5) restores the default IP address to the BSU under all conditions except if the BSU was power-cycled and is password-protected.

Download Menu

Left mouse-click on the **Download** menu to display these two options:

- Remote Firmware
- Local Firmware

Select the **Remote Firmware** option to download new code, over-the-air, to the SUs.

Select **Local Firmware** to download BSU firmware from the PC (running console) to the BSU over the Ethernet interface.

Help Menu

Left mouse-click on the Help menu to display these options:

Operator Commands

Documentation of available BSU operator commands.

Console Commands

Documentation about using Base Station Configuration Software.

System Information

Displays the system information; namely the OS, machine architecture, Java runtime, system username, and (PC's) IP Address.

About

Displays the link status and the software version.

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Shortcut Icons

Four shortcut icons are displayed directly below the menu options. These shortcut icons are as follows:

- First icon from left: Clicking this icon is the same as selecting the **Review/Print** option from the **Console** menu.



- Second icon from left: Clicking this icon is the same as selecting the **Clear** option from the **Console** menu.



- Third icon from left: Clicking this icon forces a warm restart of the unit (equivalent to entering **restart** from the CLI).



- Last icon from left – clicking this icon is equivalent to selecting local download from the download menu



BASE STATION CONFIGURATION SOFTWARE VERSION 2.0

Once properly installed, from the PC's Windows **Start** Menu, select:

Programs → Tsunami Multipoint Base Station Configuration Software

Two sub-menu options are displayed:

- Base Station Configuration Software (loosely referred to as BSU 1.5 Console)
- Multi-BSU Configuration Software (loosely referred to as Multi-BSU)

Selecting **Base Station Configuration Software** lets you communicate with a single BSU.

Note: Having multiple BSUs on the network and using the single BSU Base Station Configuration Software can lead to problems.

When the console program achieves communication with the BSU, the heading changes from **Configuration Software** to **Base Station Configuration Software**.

All menus and controls are the same as described under the Multi-BSU Console.

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Using Base Station Configuration Software with an SU

You can connect a PC running Base Station Configuration Software to an SU (or Multi-BSU Console to multiple SUs). When attached to an SU, the banner reads **Subscriber Configuration Software**. You can use the Console with an SU to perform local downloads (over the Ethernet) to the SU.

SUBSCRIBER UTILITY SOFTWARE

The Subscriber Utility is used to monitor and configure the Subscriber Unit.

The PC and the SU must be members of the same IP subnet to communicate properly. If the PC is on a different subnet, you can configure the SU, but you cannot successfully take it out of aiming mode, and the SU does not establish a link with the BSU.

On the PC that has the Subscriber Utility installed, change the IP address for its Ethernet card to 192.168.20.xx with a 255.255.255.0 subnet mask (where xx can be any available number between 1 and 254. Proxim recommends using 10 to avoid using the same IP address as the BSU or the SU). You can run the Multi-BSU configuration software to verify the IP address oif the SU that is displayed in the tab.

Installing the Subscriber Utility Software

1. Identify the computer on which you plan to run the Subscriber Utility.

   Note: See “System Requirements” in the *Tsunami Multipoint Installation Manual* for operating system and hardware requirements.

2. Insert the Tsunami MP CD (provided with the product) into the computer’s CD-ROM drive and open the CD’s **config software** folder.

   Note: If the computer has Microsoft IIS (Internet Information Services) running, disable or uninstall it before running the Subscriber Utility.

3. Double-click SUSETUP.HTM or use a Web browser to open the file.
4. Place a checkmark next to the **Include VM in download** option to install Java Virtual Machine (VM).

   Note: You need not add VM if your computer already has a version of VM installed.

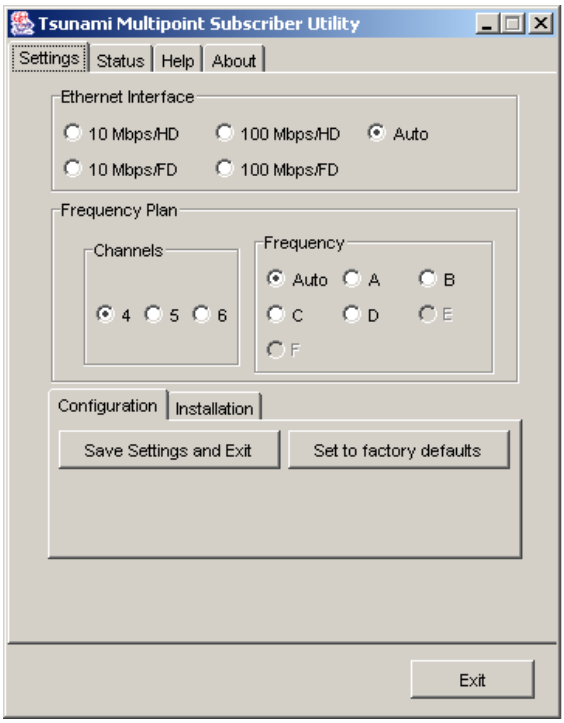
5. Click the **Start Installer for Windows** button to begin the software installation.
6. Follow the on-screen instructions to install the software.
7. Click **Done** when the installation is finished to close the installer.
8. Launch the Subscriber Utility.

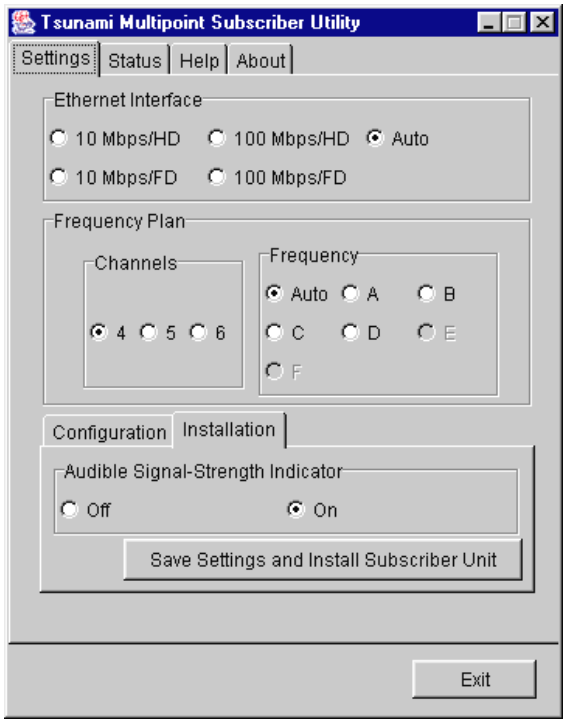
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SU UTILITY OPERATION

The SU utility has four tabs—**Settings**, **Status**, **Help**, and **About**. When you first select the Settings tab, the SU Utility polls the SU to determine its configured settings. This can take up to 3 seconds. After the initial update, the window is not updated as long as it remains open. This lets you make configuration changes without worrying that the Utility will poll the SU and change the settings before you have an opportunity to save them. If, at any point, you are unsure as to whether the displayed settings reflect the actual status of the SU, you can simply select a different window and then return to the Settings window. This causes an update of the Settings window (once again, this can take up to 3 minutes).

Settings Tab





Ethernet Interface

This section lets you select the Ethernet settings for the SU. You can select **10Mbps/HD** (half-duplex), **10 Mbps/FD** (full-duplex), **100Mbps/HD**, **100Mbps/FD**, and **Auto**. In **Auto** mode, the SU Ethernet interface auto-negotiates its settings with the Ethernet interface to which it is connected. **Auto** is the recommended setting.

Note that once the SU connects to the BSU, the local settings selected by the Subscriber Utility are overwritten with the configuration defined by the BSU. The Ethernet Interface settings on the Subscriber Utility should only be used for setting up the SU for when it is not connected to the BSU.

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Frequency Plan – Channels

The system can operate in one of three different channel plans. You must set the SU into the same frequency channel plan as the BSU .

- Four channels (four available frequency channels)
- Five channels (five available frequency channels)
- Six channels (six available frequency channels)

Frequency Plan – Frequency

In the **Auto** setting, the SU automatically searches all available frequencies in the channel plan to find a BSU. If you select a specific frequency, only that frequency is searched to find a BSU. The appropriate frequencies are darkened depending upon the frequency channel plan selected.

Configuration Tab

This entry lets you save the configurations settings and exit the utility. This tab also allows resetting the unit back to factory defaults (click the **Set to factory defaults** button).

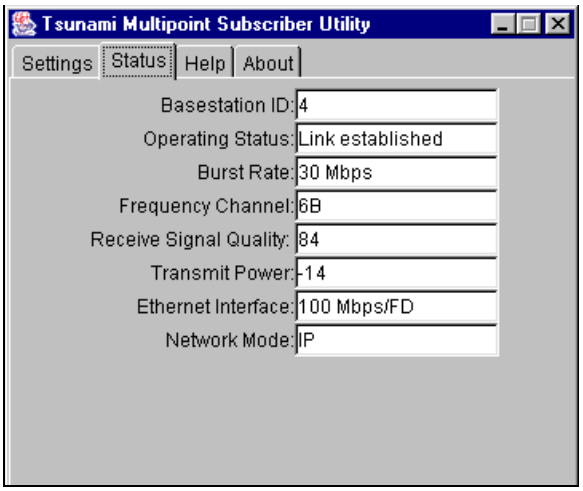
WARNING: ***Setting the unit back to factory defaults resets key parameters, such as IP addresses, modulation, and frequency plan. See the*** *setDefaults* ***command.***

Installation Tab

This entry lets you save the configurations and proceed with the installation. You then can choose whether you want to turn on the antenna pointing aid (**Audible Signal Strength Indicator**).

Status Tab

The **Status** window displays current status information for the SU, as well as information about the link between the BSU and the local SU.



Base Station ID

Displays the Terminal ID assigned to the BSU with which the SU communicates.

Operating Status

When the link status between the BSU and local SU changes (for example, when you first power up the units, change their configuration, and so on) the following status messages appear in this field:

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Searching for Outbound: The SU searches for an outbound signal (a signal transmitted from the BSU). Typically, the SU should be in this state for a short period of time (on the order of seconds). If the SU gets "stuck" in this state, one of the following problems could be indicated:

- The SU is shadowed and cannot see the downlink. The only way to solve this problem is to move the SU.
- The maximum burst rate of the SU is lower than the burst rate being transmitted by the BSU (for example, attaching an SU only capable of 20 Mbps to a sector running at 60 Mbps). In this case the SU is actually continuously cycling through the "Searching for Outbound" state followed by the "Outbound Detected State" and then, because it cannot decode the control message, it cycles to the "Network Control Message Not Received" state and quickly back into the "Searching for Outbound State". Because the latter two states are transitive, you are unlikely to see them displayed on the status tab; it will simply look as though the SU is stuck in the "Searching for Outbound" state. Be sure the SU is capable of handling the data rate being transmitted by the BSU.
- There is a problem with the SU receive chain and it cannot properly acquire the downlink.

Outbound Detected: The SU has detected an outbound signal. This is a transient state and you may never see this message. If it is displayed, it represents a normal state and does not indicate an error.

Network Control Message Not Received: The SU has detected an outbound signal and has locked to that signal. It is waiting to receive the system control message that is sent each frame on the outbound signal. If it does not receive this signal, it automatically starts searching for the outbound signal again. If this problem is present, the most likely cause is that the SU has a lower maximum burst rate then the BSU. A 20 Mbps SU can detect the downlink of a BSU transmitting at a higher burst rate (for example, 60 Mbps). However, it cannot decode the system message. The SU remains in this state indefinitely.

Searching for Inbound: This state indicates that the SU has locked to the downlink signal and has started the ranging process. (See "Ranging and Power Control" on page 11 in "Network Entry and SU Monitoring."). This state is a normal part of the acquisition process.

Contention Resolution: Contention resolution is part of the ranging process the BSU goes through to adjust its timing so that it can communicate with the BSU. Contention resolution is a normal part of the ranging process and does not indicate any problem. This is a transient state and the SU is only in this state for about a tenth of a second; consequently, it is rare for this state to be displayed in the status message,

Inbound fine sync: This state occurs during the final stages of ranging and power control. At this point the SU/BSU are making final adjustments to the SU's timing and power. Inbound fine sync is a normal part of the ranging process and does not indicate any problem. This is a transient state and the SU is only in this state for about a tenth of a second; consequently, it is rare for this state to be displayed in the status message,

Inbound Acquired: This state indicates that the ranging process is complete.

Authentication Failure: Once the SU has acquired the downlink and completed the ranging process it proceeds with authentication. Up until this point the BSU has no information as to which SU has completed the ranging process. If the Authentication Process fails, the Status window indicates this state. **The most common cause of authentication failure is that the SU is not entered in the BSU's data base.**

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Link established: Indicates the link is established between the BSU and local SU.

Note: Another status message that may be displayed is the "**ODU Not Connected"** message. This state indicates that the PC used to configure the SU is not communicating with it. See "Appendix A. Troubleshooting" on page 111 for possible causes and solutions to this problems.

Inbound fine sync: Indicates an outbound signal has been detected and the SU is attempting to synchronize with the inbound signal.

Link established: Indicates the link is established between the BSU and local SU.

No connection: Indicates that the software cannot establish a link between the BSU and local SU (possible causes include Range Security enabled and SU moved, SU disabled at SU, wrong cable type used, and so on). See "Appendix A. Troubleshooting" on page 111 for possible causes and solutions to these problems.

Note: The "**ODU not connected**" message indicates that the PC used to configure the SU is not communicating with it. See "Appendix A. Troubleshooting" on page 111 for possible causes and solutions to these problems.

Burst Rate

Shows the current operating burst rate mode. See "Configuring the Base Station" in the *Tsunami Multipoint Installation Manual* for information.

Frequency Channel

Shows the current channel plan/frequency setting (for example, 4C). See "Configuring the Base Station" in the *Tsunami Multipoint Installation Manual* for information. By default, the SU is set to automatically search for the correct frequency channel.

Receive Signal Quality (dBm)

Shows the quality of signal received by the local SU (in dBm). This value represents the estimated received signal level, plus an offset of 120 dB. A received signal quality level over 40 (which represents a signal level of -80 dBm) shows an acceptable signal quality.

Transmitter Power

Shows the SU's current transmitter power (-30 to +36).

Ethernet Interface

Shows the status of the Ethernet interface. When the interface has been set to auto-negotiate, this window contains the results of the auto-negotiation.

Network Mode

Shows the current network mode: **Bridging**, **VPN**, or **IP Routing**.

Help Tab

Clicking on the **Help** tab displays online command help.

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About Tab

The **About** tab displays version information about the Subscriber Utility.

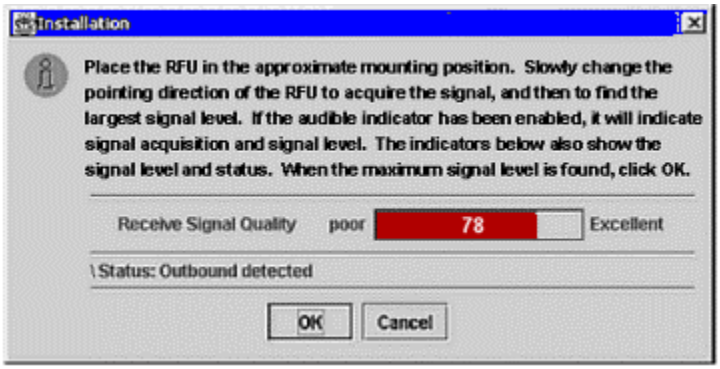


USING THE SUBSCRIBER UTILITY FOR ANTENNA POINTING

The SU is shipped from the factory in aiming mode so that you can install and aim it without first having to run the Subscriber Utility. You must run the Subscriber Utility, however, to take the SU out of aiming mode to establish a link with the BSU.

To use the Subscriber Utility for antenna pointing, following these steps.

1. In the **Settings** tab, set the frequency plan.
2. Click the **Configuration** tab and turn on the Audible Signal-Strength Indicator.
3. Click **Save Settings and Install Subscriber Unit** to launch the aiming tool.



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4. Slowly adjust the position of the SU until you have maximized the strength of the radio signal.
   - The SU beeps after it has detected a signal from the BSU. The beeps increase in frequency as the strength of the signal received from the BSU increases.
   - The Receive Signal Quality indicator within the Subscriber Utility's Installation window reports the strength of the radio signal.
5. Click **OK** to close the aiming tool. If you have left the Base Station Configuration Software running on the computer connected to the BSU, a notification is displayed once the SU has successfully joined the network (this is known as a "net entry" notification).

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Chapter 6. Advanced Configuration Options

This chapter describes the following advanced features that might not be implemented by all users:

- GPS Operation in Multi-Sector Mode
- The Multi-BSU Configuration Software

MULTI-SECTOR MODE

If you are installing BSUs in a location where one BSU could interfere with another, install the supplied GPS antenna on each BSU and set the unit to **Multi Sector** mode. This enables the GPS receiver and synchronizes the TDD timing to the GPS signal.

Note: The GPS antenna is a small metal plate with a black 2"x 2" antenna and thin cable; see “Installing the GPS Antenna” in the *Tsunami Mutlipoint Installation Guide* for guidance in installing and mounting the GPS antenna.

All BSUs operating in Multi Sector mode transmit and receive at the same time (within a pre-determined tolerance).

In addition to turning on Multi-Sector mode, you must set the ratio of downlink-to-uplink slots and frame duration the same for all BSUs that could interfere with each other. Together, synchronization-to-GPS and identical uplink/downlink ratio eliminate the possibility of a BSU transmitting while a co-located BSU is receiving. This synchronization is achieved using the timing signal supplied by the GPS receiver.

See “Configuring the System for Multi Sector Mode” in the *Tsunami Multipoint Installation Guide* for information about initial multi-sector mode configuration.

GPS Operation and Synchronization

- During initialization, the BSU does not transmit until the GPS receiver can see at least four satellites and obtain initial time.
- During operation, the BSU slaves its frame timing to GPS.
- If at any instant the GPS receiver loses all satellites, the BSU continues to transmit, while free-wheeling its frame timing (not slaved to GPS).
- If it regains visibility to one or more satellites:
  - **If it is in the multi-sector, no auto-resync mode**:
    Whenever the difference between the BSU frame time and the GPS supplied time is greater than ±4 microseconds, the BSU shuts down and restarts at step 1.
  - **If it is in the multi-sector with auto-sync mode**:
    The BSU uses its timing loop to slowly re-adjust its frame time to GPS frame time. The BSU does NOT shut down even if the difference in time between the BSU and GPS is greater than ±4 microseconds. However, it could take significant time (30 minutes or more) to re-align the BSU frame time with GPS time, depending upon the size of the discrepancy.
- If **setFrameSync** is set to **1** (independent), GPS is not used (that is, the BSU frame time is not slaved to GPS time).

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When using multi-sector mode, Proxim recommends enabling the auto-resynch feature (**setFrameSync 2**) to minimize any disruption in service due to GPS outages.

Note: When operating in Multi Sector mode, make sure all the BSUs are configured with the same frame timing symmetry (for example, all set to 50% TDD duty cycle). When using the Standard Frame Mode timing, synchronization is maintained even if BSUs are operating in different modulation modes (for example, one can be in 20 Mbps and one in 60 Mbps). When using the Optional Frame Mode all BSUs must be using both the same TDD duty cycle and the same modulation mode (that is, one cannot be in 20 Mbps and the other in 60 Mbps even if both have 50% duty cycles). The only exception is that the 40 and 60 Mbps modes are compatible.

Using the Multi-BSU Configuration Software

If your installation includes multiple BSUs, you can use the Multi-BSU software to:

- Dynamically discover the BSUs on the network or connect to specific BSUs
- Display and print console information associated with the BSUs
- Download firmware upgrades to the SUs associated with a specific BSU or to the local BSU

Dynamic Discovery mode is the default setting for connecting to the BSUs. In Dynamic Discovery mode, if you are connected to live BSUs through routers, the application automatically searches for each BSU's IP address.

To use the Multi-BSU software:

1. Make sure the Tsunami Multipoint Base Station Configuration Software is installed on the BSU console (the PC used to configure the BSU). If necessary, see "Installing the Base Station Configuration Software" in the *Tsunami Multipoint Installation Guide*.
2. From the Windows® **Start** menu, select **Programs → Tsunami Multipoint Base Station Configuration Software**. A sub-menu is displayed.
3. Select **Multi-BSU Configuration Software**.
    - A window displaying several tabs opens. When you first start the application, the tabs display the text "Connection: <tab #> - N/A." If you are in Dynamic Discovery mode (the default mode), after the application locates one or more BSUs, the tab labels display the detected IP address values of the BSUs.
4. To work on a certain BSU, select the tab representing that BSU.

Descriptions of the main menus in the Multi-BSU Configuration Software follow.

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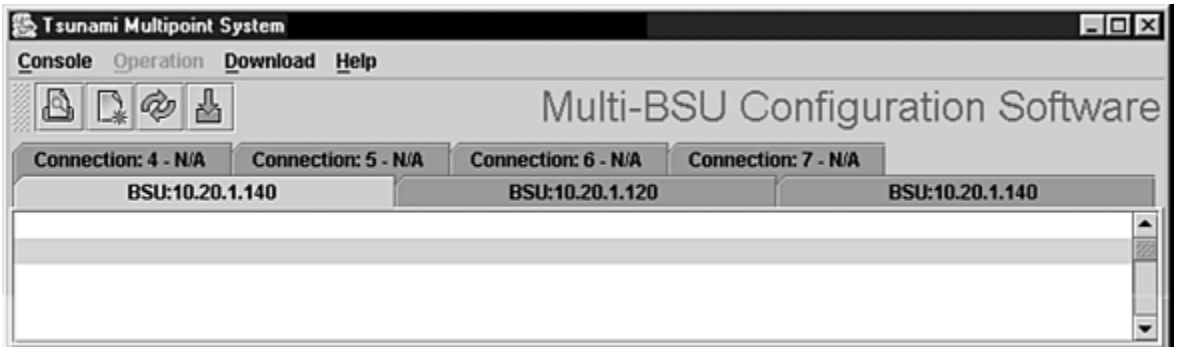


Figure 16. Multi-BSU Console

Console

Use the **Console** menu to select the connection mode (**Dynamic Discovery** or **Static Connection**) and to display, print, and clear information about the BSUs.

Descriptions of the Console options follow.

Review/Print

Select this option to save the line-by-line transaction history by all the BSUs from the time you opened the console. You can save this output to a text file. When you select this command, the console information appears in a WordPad file titled “console.txt.” Once the upper limit of history information is reached, the system automatically truncates the previously stored data to make way for the new data.

Clear

Select this option to clear the transactional data for the selected BSU.

Clear All

Select this option to clear the transactional data for all the located BSUs.

Function Key

Select this option to assign commonly used commands to the F1 to F12 function keys for quick command execution. When you select this command, the **Function Key** window is displayed. Enter a command in a function key field to assign the command to the function key. For example, enter **dspconf** in the **F1** field to assign this command to this function key. Close the Function Key window when you are finished assigning function keys.

Connect To

Select this option to switch between **Dynamic Discovery** and **Static Connection** mode. After you select this command, the **Connect To - Setup** window is displayed.

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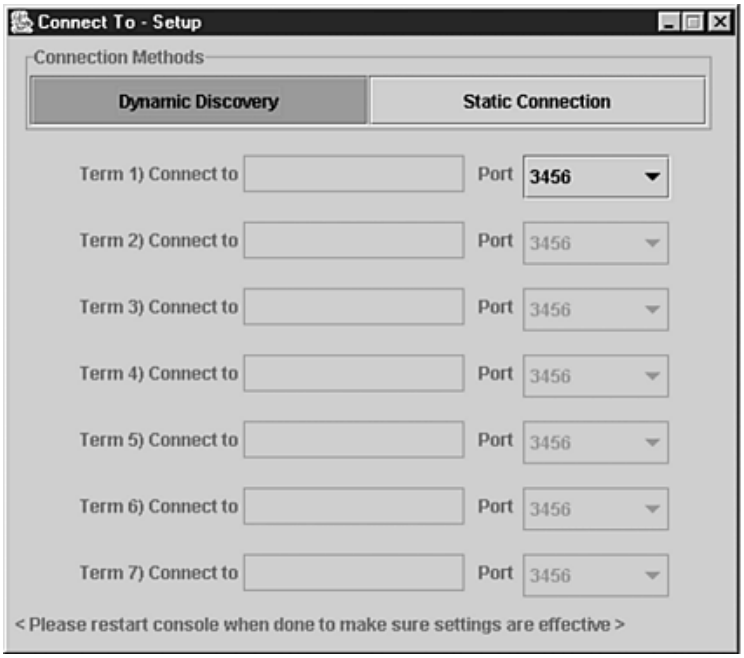


Figure 17. Connect To Setup Window

By default, **Dynamic Discovery** is selected. To switch to **Static Connection** and specify "Connect to" devices:

1. Click the **Static Connection** button.
2. Enter the IP address of the first device to connect to in the **Term 1** field.
3. Next to the IP address you entered, select the port to which you want to assign the device from the **Port** pop-up menu. Supported port numbers range from 3456 to 3467 and from 23456 to 34567. If you select a port that conflicts with another application, try selecting another port. You can connect to up to seven devices (Term 1 to 7) in this manner.

To switch from **Static Connection** mode to **Dynamic Discovery** mode:

1. Select the **Console → Connect To** command. The **Connect To - Setup** window is displayed.
2. Click the **Dynamic Discovery** button.

Note: You can use the Operation commands only on devices connected through a static connection.

If the devices to which you want to connect do not display in the tabs, close the Multi-BSU console and restart it to implement your changes.

Exit

Select this option to exit from the Multi-BSU application.

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Operation

Use the **Operation** menu to:

- Switch to IP Routing mode from Bridging mode
- Switch to Bridging mode from IP Routing mode
- Restore the BSU's default IP address

The following text describes the available Operation options.

Note: You can use the Operation commands only on devices connected through a static connection.

Switch to IP Routing Mode

Use this command to switch the selected BSU to IP Routing mode from Bridging mode. See "routingMode" on page 89 for more information.

Switch to Bridge Mode

Use this command to switch the selected BSU to Bridging mode from IP Routing mode. See "routingMode" on page 89 for more information.

Restore Default Address

Use this command to restore the selected BSU's IP address to its default value: 192.168.20.xxx. This is useful if the assigned IP address is lost and the console connection is broken.

Download

Use the **Download** menu to download new firmware to a remote or local BSU. The following sections describe the available **Download** options.

Remote Firmware

You can use this option to remotely upgrade SUs connected to a certain BSU.

With a wireless network of a BSU and multiple SUs, the SUs can be upgraded to the latest firmware from the Base Station Configuration Software Console. Normally, all SUs that are in the network are upgraded at the same time. However, if one or more SUs failed to receive the downloaded firmware correctly, they abort the upgrade and you should attempt again to upgrade them. SUs that have been successfully upgraded do not let themselves be reprogrammed with the same version of downloaded firmware.

To perform a remote over-the-air download to SUs using the Multi-BSU application:

1. Select the tab representing the BSU whose SUs you want to upgrade.
2. From the Multi-BSU console, enter **dspActiveSU**. This confirms that the SUs connected to the BSU have established a link with the BSU. Note the SUs connected to the BSU.
3. Click the **Download** menu and select **Remote Firmware**. The **Download – File Selection** window is displayed.
4. From the **Look In** search field, select the binary file to be downloaded from the appropriate directory (PMP_SU_release1-3.mot, for firmware release 1.3) and click **Select**. At this point, the Multi-BSU Console automatically processes the selected binary codes. When it finishes processing, the application displays an **Elapsed [time]** message, which shows the elapsed time in seconds.

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5. Let the SUs re-enter the network. It usually takes no more than five minutes for the SUs to enter the network from the start of the download. The following messages are displayed at the Multi-BSU Console for each SU as it enters the network:

   ```
   Received NetEntry Request from Eth <SU's Ethernet address>
   NetEntry completed: Assigned terminal ID <ID #>, VLAN ID 1, IP <SU's IP
   address>
   ```

6. Enter **dspActiveSU** to verify that the SUs have successfully entered the network. If an SU fails to enter the network, use the local SU download procedure described in the Tsunami Multipoint Firmware Release 1.3 Notes to upgrade the SU.

If the SU was correctly upgraded, the display reads: "ver 20031300" (for firmware release 1.3).

If the SU failed to upgrade and the link was restored, the display most likely reads: "ver 200311B0" or "ver 00000000."

If any SU that re-entered the network failed to upgrade to Release 1.3, repeat steps 2 to 6 above or upgrade the SUs that did not successfully upgrade (using the "Local Download to SU" instructions contained in the Tsunami Multipoint Firmware Release 1.3 Notes).

Local Firmware

This option lets you upgrade the local BSU (that is, the BSU to which the PC you are running the Multi-BSU application is connected).

Upgrade the local BSU after you have upgraded the SUs connected to it with the latest firmware.

To perform a download to the local BSU:

1. Select the tab representing the local BSU.
2. Click the **Download** menu and select **Local Firmware**. The **Download – File Selection** window is displayed.
3. From the **Look In** search field, select the binary file to be downloaded from the appropriate directory (PMP_BSU_release1-3.mot, for firmware release 1.3) and click **Select**.
4. Once the upgrade is successful, if SUs were connected to the BSU, the SUs re-acquire net entry. For each SU connection, two messages are displayed, as follows:

   ```
   20   Received NetEntry Request from Eth <SU's Ethernet address>
   21   NetEntry completed: Assigned terminal ID <SU's ID #>, VLAN ID 1, IP
   <SU's IP address>
   ```

It should take only a couple of minutes from the time the local download started before the SUs re-acquire NetEntry with the BSU.

If no SUs were connected to the BSU, after the upgrade is successful, the version banner is displayed, indicating the version number "20021200" (for firmware release 1.2), followed by these messages:

```
114   Completed flash sector verification
103   DB check completed
107   Save NV configuration Parameters
```


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SETTING ETHERNET FRAME TYPE FILTERING (ETHERMODE)

A common misconception is that there is a single type of Ethernet frame. In actuality, there are many different types of Ethernet frames. These include 802.3 (and variations) and Ethernet II frames. On the downlink, the hardware is designed to transparently pass all common types of Ethernet frames. The hardware passes all types of Ethernet frames; however, it does pad some types with zeros. This padding could cause problems when the frame is received and decoded at its destination. Because the processing is performed in hardware, it is extremely efficient. Using hardware control to pass packets is the standard operating mode.

If your network uses the less common Ethernet frame types and the padding causes a problem, you can switch to a mode that passes these packets without zero padding. This mode requires software intervention and can reduce the maximum throughput of the radio. Enter **setEtherMode 1** for this mode. To return to the standard mode (hardware control) enter **setEtherMode 0**. Examples of packets that may require the use of software control are IPX and 3COM MBX type-8868 packets.

CONFIGURING FOR IP MULTICASTING

Tsunami Multipoint supports IP Multicasting. This support lets multiple devices connected to an SU (such as a PC) receive the same data (commonly streaming data, such as streaming video). Support for IP multicasting and the IGMP (Internet Group Management Protocol) protocol helps conserve bandwidth, as this support typically reduces the number of copies of IP packets that must be propagated to multicast members. Multiple multicast members can simultaneously download data from the same server (typically a server that supports the IGMP protocol).

To take advantage of IP multicasting, you must add the devices you want to receive IP multicast packets to a multicast group. Typically, multicast members have multicast IP addresses that fall within a specific range of multicast IP addresses. See your application's documentation for information about adding devices to multicast groups. Examples of supported multicast applications include: IP/IV, NetMeeting, NetShow, RealAudio, ReadVideo, CD Streaming, VoIP, and Windows® 2000 Streaming Media. Also see RFC 1112 and RFC 2236 for information about the IGMP protocol.

VOICE OVER IP (VOIP)

Tsunami Multipoint provides uplink priority to support VoIP applications. Downlink priority service is not provided. However, because the downlink consists of a single stream of data arriving at the BSU, an external QoS solution is relatively easy to implement. This section provides an introduction to VoIP support, also known as Priority Queuing.

Priority service is implemented using two distinct mechanisms. The first mechanism is priority queuing, which consists of both the ability to separate priority from best-effort traffic and to give the priority traffic preferential treatment. The second mechanism is fixed bandwidth assignment, which consists of the ability to provide enough fixed bandwidth to support the priority traffic.

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Priority Queuing

The SU identifies priority traffic using the **ToS** byte in the IP header (this is the same byte as the **Diffserve** byte). If the value of the **ToS** byte satisfies the condition $\mathbf{ToS_{low} \leq ToS \leq ToS_{high}}$, the packet is considered to be high-priority and is stored in the high-priority queue. When a bandwidth assignment is received by the SU, the high-priority traffic packets are given preference. See the "voipTosRange" command on page 95.

Note: On the uplink, the SU divides a large packet into multiple small sub-packets called cells. If the SU is in the process of sending a best-effort packet (some but not all of the cells have been sent), when the high-priority packet arrives, it completes the best-effort packet before sending the high-priority packet.

Fixed Bandwidth Assignment

The second mechanism used to ensure priority service is fixed bandwidth assignment. With fixed bandwidth assignment, each priority connection is given a predetermined amount of bandwidth for the duration of the connection. Priority connections are used to group priority traffic and are defined by either the source IP of the packet or both the source IP and the UDP source port of the packet. You can choose the desired method of grouping priority packets into priority connections using the **voipMode** command (page 95).

When using the source IP mode, a priority connection is identified by the ToS byte and the source IP address of the packet. All packets with a ToS byte falling in the defined range are identified as being priority packets and all priority packets with the same source IP address belong to the same priority connection. When using source IP plus UDP source port, all priority packets with the same source IP address **and** the same UDP source port belong to the same priority connection (a single source IP address can have multiple priority connections).

The BSU examines all incoming priority packets and, whenever it identifies a new priority connection, it increases the associated SU's fixed bandwidth assignment to ensure that all priority connections receive adequate bandwidth. Similarly, if the connection times out (that is, the BSU sees no traffic for a given connection for 60 seconds (the default setting), it deletes the connection and reduces the SU's fixed bandwidth assignment.

The amount of bandwidth assigned to each priority connection can be set at the BSU using the **setSUvoipBandWidth** command (page 103). The total amount of fixed bandwidth assigned to a given SU at any instant in time is equal to the bandwidth assigned per priority connection times the number of priority connections active at the SU at that instant in time. All priority connections for a single SU receive the same amount of fixed bandwidth. The amount of bandwidth assigned for priority connections can be different for different SUs attached to the same BSU.

CHOOSING THE PRIORITY CONNECTION BANDWIDTH

VoIP Connections

You can use the **setSUvoipBandwidth** command (page 103) to set the bandwidth assigned to each priority connection from 10 kbps to 3000 kbps, using the values shown in Table 4. The choice of bandwidth depends upon the voice compression algorithm used and the signaling overhead required. Table 2 contains a summary of the required VoIP data rates for various codecs. Modes that are not recommended for each codec are grayed out. To simplify entry, you can enter G.711, G.723, G.726, or G.729 and the system picks the bandwidth; this works as long as the interframe interval lies in the highlighted area.

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When deploying a system that simultaneously uses multiple voice codecs through an SU, the operator must pick the bandwidth to support the least bandwidth efficient codec (that is, set the bandwidth for the codec that requires the highest bandwidth).

Table 9 Required VoIP Data Rates for Various Codecs

Codec	VoIP terminal configuration		Kbps rate to select with setSUBandwidth command	
	Interframe interval, ms	Payload, bytes	Bridging Mode	IP Routing Mode
G.711	5	40	200	200
	10	80	160	160
	20	160	100	100
	40	320	90	90
	60	480	80	80
	80	640	80	70
	100	800	70	70
	120	960	80	70
G.723	30	24	30	30
	60	48	20	20
	90	72	20	20
	120	96	20	20
G.726	5	20	200	100
	10	40	100	100
	20	100	80	80
	40	200	70	50
	60	240	50	40
	80	320	50	40
	100	400	40	40
	120	482	40	40
G.729	20	20	60	30
	40	40	30	30
	60	60	20	20
	80	80	20	20
	100	100	20	20
	120	120	20	20

Recall that the voice bandwidth selection is made on a per VoIP connection basis (see “Fixed Bandwidth Assignment” on page 68). The system automatically increases or decreases the total bandwidth assigned to each SU to account for the total number of simultaneous VoIP connections.

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E1/T1 Connections

The following table contains the rates to be selected to support E1/T1 traffic. It is important to note that E1/T1 traffic is treated as a single voice call. As with a standard voice call, an E1/T1 connection is identified by the **ToS** byte and sorted by the source IP (and possibly source UDP port). If multiple IP addresses have the **ToS** byte set at a given SU, the BSU attempts to assign a T1/E1 to each. If the total bandwidth required exceeds the bandwidth available, neither connection receives the allotted bandwidth.

Table 10 Selection for T1/E1

Codec	Basic Parameters			
	TDM Frame [Byte]	**Frame Rate [Pkt/Sec]**	**Ethernet Packet [Byte]**	**Kbps rate to select with setSUBandwidth**
T1	48	4107	94	Not supported
	96	2054	142	Not supported
	144	1369	190	3000
	192	1027	238	2700
	240	821	286	2700
	288	685	334	2700
	336	587	382	2700
	384	513	430	2000
Codec	**Basic Parameters**			
	TDM Frame [Byte]	**Frame Rate [Pkt/Sec]**	**Ethernet Packet [Byte]**	**Kbps rate to select with setSUBandwidth**
E1	48	5447	94	Not supported
	96	2724	142	Not supported
	144	1816	190	Not supported
	192	1362	238	3000
	240	1089	286	3000
	288	908	334	3000
	336	778	382	3000
	384	681	430	2700

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Maximum Number of VoIP Connections Per SU and Sector (single BSU)

The total number of simultaneous calls that a single SU can support, and that a single sector (BSU) can support, is limited by the:

- VoIP packet size
- VoIP packet rate
- Available bandwidth
- Maximum packet processing rate at the SU
- Maximum packet processing rate at the BSU
- Bandwidth assignment algorithm used

If an SU or sector exceeds its maximum number of calls, the excess uplink VoIP traffic is still treated as higher priority at the SU but is not allocated sufficient reserved bandwidth, and is treated as best-effort traffic as far as bandwidth assignment is concerned. Although this leads to a "graceful" degradation, the latency, jitter, and packet loss increases and performance suffers, especially as the system reaches capacity.

Unfortunately, it is not easy to predict the exact performance degradation because it depends upon so many factors. However, it is possible to determine the maximum number of simultaneous calls above which performance degrades. Table 4 contains the maximum number of simultaneous VoIP flows a **single SU** can support due to limitations of the fixed bandwidth assignment algorithm. Table 5 contains the maximum number of simultaneous calls an SU can support due to packet processing limitations.

If the total number of simultaneous calls at an SU does not exceed the maximum given in both tables, packet loss, latency, and jitter is minimized. For example, consider a 30 Mbps system deployed in IP Routing mode that uses a G.726 voice codec employing a 40-ms interframe interval.

From Table 9 we find that the VoIP bandwidth should be set to 50 kbps (see "VoIP Command Details" on page 75). From Table 11, we find that the bandwidth assignment scheme supports a maximum of 90 simultaneous voice connections. From Table 12, we see that a single SU has the packet-processing rate to support 80 simultaneous calls. Consequently, we would design our system not to exceed 80 simultaneous calls.

In this example, the maximum was due to packet rate. If we exceed this limit, we would expect to drop voice packets, which could lead to severe degradation of voice quality. In a different scenario the bandwidth assignment algorithm might limit us. In that scenario, we would expect to see increased jitter and latency as some of the VoIP traffic is sent best-effort. This would probably result in a more graceful degradation in voice quality (when compared with exceeding the maximum SU packet processing rate).

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Table 11 Maximum VoIP Connections per SU by VoIP Bandwidth

Entered VoIP rate, kbps	SU modulation mode (symmetric links)			
	20 Mbps	**30 Mbps**	**40 Mbps**	**60 Mbps**
10	120	180	240	360
20	120	180	240	360
30	120	180	240	360
40	60	90	120	180
50	60	90	120	180
60	60	90	120	180
70	40	60	80	120
80	40	60	80	120
90	40	60	80	120
100	40	60	80	120
120	30	45	60	90
140	24	36	48	72
160	24	36	48	72
180	20	30	40	60
200	20	30	40	60
400	10	15	20	30
800	5	7	10	15
1000	4	6	8	12
2000	2	3	4	6
2700	1	2	2	4
3000	1	2	2	4
G.711	40	60	80	120
G.723	120	180	240	360
G.726	40	60	80	120
G.729 in IP Routing mode	120	180	240	360
G.729 in Bridging mode	60	90	120	180

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Table 12 Maximum VoIP Connections per SU due to Packet Rate Limitations

Codec	Interframe interval, ms	Maximum number of simultaneous VoIP flows at a single SU
G.711	20	40
	40	80
	60	120
	80	160
G.723	30	60
	60	120
	90	180
G.726	20	40
	40	80
	60	120
	80	160
G.729	20	40
	40	80
	60	120
	80	160

In addition to the limit on the number of simultaneous calls an SU can support, there also is a limit on the number of simultaneous calls that a single BSU can support. These values are provided in Table 13, which contains a range of entries. The actual number the BSU can support varies depending upon the bandwidth assignment algorithm and, unfortunately, in many cases varies depending upon the combination of SUs transmitting the calls at any instant in time.

The lower number is simply the maximum number of calls for a single SU. The maximum number of calls is also limited by the maximum packet processing rates (at both the BSU and SU). Table 14 contains the maximum number of simultaneous calls based on packet processing limitations. The values contained in Table 14 tolerate a large amount of BE traffic without degrading the maximum number of VoIP calls.

Fixed and Best-Effort Bandwidth and Maximum Allowable Simultaneous VoIP Calls

Due to the nature of fixed bandwidth assignment, an SU cannot receive both a fixed-bandwidth and a best-effort bandwidth assignment during the same frame. Consequently, the best-effort throughput of an SU depends upon the number of priority connections active at the SU. Whenever an SU has between 1 and its maximum number of simultaneous VoIP connections (as provided in Table 11) **that** SU can receive, at most, 50% of the available uplink bandwidth (approximately 4, 6, 8, and 12 Mbps in the 20, 30, 40, and 60 Mbit Modes, respectively) for best-effort traffic. If the number of simultaneous VoIP connections exceeds the value provided in Table 11, the maximum amount of best-effort traffic is 50% minus the amount of VoIP bandwidth exceeding the maximum.

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Table 13 Maximum Number of Simultaneous Calls per BSU

Entered VoIP rate, kbps	SU modulation mode (symmetric links)			
	20 Mbps	**30 Mbps**	**40 Mbps**	**60 Mbps**
10	120-360	180-540	240-720	360-1,080
20	120-240	180-360	240-480	360-720
30	120-240	180-360	240-480	360-720
40	60-120	90-180	120-240	180-360
50	60-120	90-180	120-240	180-360
60	60-120	90-180	120-240	180-360
70	40-80	60-120	80-160	120-240
80	40-80	60-120	80-160	120-240
90	40-80	60-120	80-160	120-240
100	40-80	60-120	80-160	120-240
120	30-60	45-90	60-120	90-180
140	24-48	36-72	48-96	72-144
160	24-48	36-72	48-96	72-144
180	20-40	30-60	40-80	60-120
200	20-40	30-60	40-80	60-120
400	10-20	15-30	20-40	30-60
800	5-10	7-14	10-20	15-30
1000	4-8	6-12	8-16	12-24
2000	2-4	3-6	4-8	6-12
2700	1-2	2-4	2-4	4-8
3000	1-2	2-4	2-4	4-8
G.711	40-80	60-120	80-160	120-240
G.723	120-240	180-360	240-480	360-720
G.726	40-80	60-120	80-160	120-240
G.729 in IP Routing Mode	120-240	180-360	240-480	360-720
G.729 in Bridging Mode	60-120	90-180	120-240	180-360

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Table 14 Max Simultaneous Calls per BSU due to Packet Processing Limitations

Codec	Interframe interval, ms	Max # simultaneous VoIP flows at a single BSU
G.711	20	130
	40	260
	60	390
	80	520
G.723	30	195
	60	390
	90	585
G.726	20	130
	40	260
	60	390
	80	520
G.729	20	130
	40	260
	60	390
	80	520

VoIP Commands

dspvoip on page 81 (display activated VoIP connection)

voipMode on page 95 (enable or disable VoIP and distinguish VoIP connections)

voipTosRange on page 95 (set up ToS range or upper limit)

voipTTL on page 95 (set up VoIP connection timeout value)

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Chapter 7. Command Reference

This chapter contains an alphabetical listing of the commands used to configure and monitor the BSU and SUs in Version 2.0 of the Tsunami Multipoint firmware and Version 2.0 of the Base Station Configuration software.

- This chapter begins with a listing of all user commands sorted into logical groups (for example, all the RIP commands are together). This section can be used to quickly identify all commands related to a particular function.
- In the next section, the format used to describe the commands is presented.
- The final section contains command descriptions. These descriptions are divided into three subsections:
  - BSU commands used to configure and monitor the BSU
  - BSU commands used to configure and monitor the SUs (from the BSU)
  - SU commands used to configure and monitor the SUs

Within each subsection the commands are presented in alphabetical order.

BSU COMMANDS FOR CONFIGURING AND MONITORING THE BSU

General	Physical Link	Monitoring/Display	RIP
gprs on page 84	aloha on page 79	berlog on page 80	rip add on page 87
help on page 84	firstInboundSlot on page 81	BSUlog on page 81	rip clear on page 87
restart on page 87	freqPlan on page 83	dspconf on page 81	rip delete on page 87
setDefaults	frequency on page 83	dspStaticIP on page 98	rip disable on page 87
	IPC on page 84	dspvoip on page 81	rip enable on page 88
	modulation on page 85	pp3d on page 86	rip find on page 88
	pp3d on page 86	rip print on page 88	rip help on page 88
	setEtherMode on page 89	uplber on page 94	ripprint on page 88
	setFrameSync on page 90	version on page 95	
	txPower on page 94		
	txPowerAutoEnable on page 94		
	txPowerLevel on page 94		

Security	Networking	VLAN	VoIP
login on page 84	arp on page 80	setVLAN on page 93	dspvoip on page 81
logout on page 85	gateway on page 83	setVLANTag on page 93	voipMode on page 95
rangeSecurity on page 86	ping on page 85		voipTosRange on page 95
setpw on page 92	pp3d on page 86		voipTTL on page 95
	proxy on page 86		
	routingMode on page 89		
	setEthernet on page 89		
	setID on page 91		
	setIP on page 92		
	setSubnet on page 93		

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BSU COMMANDS FOR CONFIGURING AND MONITORING THE SU

General	Monitoring/Display	Networking	VLAN
addSU on page 96	dspActiveSU on page 98	addSUIP on page 96	addSUVLANFilter on page 97
disableSU on page 97	dspSU on page 98	removeSUIP on page 99	deleteSUVLANFilter on page 97
enableSU on page 99	dspSUVLANFilter on page 97	setSUEthernet on page 100	dspSUVLANFilter on page 97
remote on page 99	berlog on page 80	setSUFilter on page 100	setSUVLAN on page 102
removeSU on page 99		setSUGateway on page 100	setSUVLANTag on page 102
uplber on page 94		setSUIP on page 101	
		setSUMACFilter on page 101	
		setSUProxy on page 101	
		setSUSubnet on page 102	

VoIp
setSUvoipBandwidth on page 103

SU COMMANDS FOR CONFIGURING AND MONITORING THE SU

General	Physical Layer	Monitoring/Display	RIP
restart on page 106	freqMode on page 105	dspconf on page 104	rip add on page 106
setDefaults	freqPlan on page 105	searchstatus on page 108	rip clear on page 106
	frequency on page 105	SUlog1 on page 109	rip delete on page 107
	searchstatus on page 108	SUlog2 on page 110	rip find on page 107
		rip print on page 107	rip help on page 88
		version on page 110	rip print on page 107

Networking
arp on page 104
ping on page 105
pp3d on page 86
proxy on page 106
setEthernet on page 108
setIP on page 109
setSubnet on page 109

COMMAND FORMAT

The following format is used in describing each command:

command_name [<input 1>] [<input 2>] …[< input N>]

where:

command_name

The name of the command to be entered into the Command Line Interface (CLI) at the console. **Command names are NOT case sensitive (as of firmware version 1.3).**

Brackets

Square brackets ([]) are used for optional input, and less than (<) and greater than (>)symbols are used for required inputs. In some situations an input parameter may be bracketed by both square brackets and less than and greater than symbols. In this case, sometimes the parameter is optional and at other times it is required.

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For example the **addSUVLANFilter** command has two required parameters (**terminal id** and **start VLAN id**) and one optional parameter (**end VLAN ID**):

```
addSUVLANFilter <terminal ID> <start VLAN ID> [end VLAN ID]
```

The format used for describing the required or optional input parameters is:

```
< input 1> = <valid input parameter 1 (description of valid input parameter
1)|valid input parameter 2 (description of valid input parameter 2) |…. |
valid input parameter L (description of valid input parameter L)>
```

For example the **setFrameSync** command can be described as follows:

```
setFrameSync <0 (Multisector: with auto-restart) | 1 (independent) | 2
(Multisector: with auto-resync)>
```

Which means that the **setFrameSync** command has a single required parameter that can take on one of three values: 0, 1, or 2.

- If a 0 (zero) is entered, the result is multi-sector operation with auto-restart
- If a 1 is entered, the result is independent (no multi-sector)
- If a 2 is entered, the result is multi-sector operation with auto-resync

Note that entries within parentheses in the command format are informational only and do not represent valid input. For example, entering the following is not valid:

```
setFrameSync independent
```

It either is not accepted, or worse, the **independent** is interpreted as a 9 (zero) and the system is actually set to operate as multi-sector with auto-restart.

Notes: Do **not** enter a **?** (question mark) as a parameter for the following commands. Entering **?** as a parameter for these commands is interpreted as a value of 0 (zero).

aloha	setID
firstInboundSlot	setSubnet
IPC	setVLANTag
modulation	txPower
rangeSecurity	
routingMode	
setFrameSync	

For Console 2.0, multiple commands can be “batched.” Batched commands are executed in the order set by the user.

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VALID IP/GATEWAY ADDRESSES

User commands that require an IP entry are validation-implemented. The following rules are observed:

1. Positional validation. The firmware validates for dots (.) in their respective positions.
2. Numerical validation. The firmware validate for the numeric entries of the respective addresses. Refer to the following matrix:

IP/Gateway Address	1st position	.	2nd position	.	3rd position	.	4th position
Valid Range	1-223	.	0-255	.	0-255	.	1-254

Exception:

- For IP addresses entered for setting gateways (**gateway** and **setSUGateway**), any value between 0.0.0.0 and 255.255.255.255 is accepted; an entry of 0.0.0.0 is valid input, whereas for an IP address, this input is NOT valid.

Note: Just because the command accepts the IP entry does not imply that it is a valid entry for the deployed network configuration.

BASE STATION CONFIGURATION COMMANDS

The following commands are used to configure the BSU. To obtain the current state of the BSU and the format of the command input, simply enter the command name followed by a carriage return.

WARNING! Entering the restart command followed by a carriage return restarts the BSU.

aloha

Usage	aloha <aloha channels>
Parameters	<aloha channels> = integers from 1 to 15
Example	aloha 2
Description	Assigns the number of reserved aloha channels. An SU that has data to send, but is not currently transmitting, picks an ALOHA channel to request that the BSU reserve a portion of the next frame's available uplink traffic for the SU. ALOHA channels consume a portion of the uplink bandwidth, so use the fewest number of ALOHA channels as possible. By default, two ALOHA channels are reserved for the ALOHA mechanism. Proxim recommends that you do not change this setting unless instructed by a technical support representative. Assign at least one ALOHA channel (up to 15 total).
Notes	Default setting = 2; recommended setting = 2. After this command is issued, the BSU automatically restarts.

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arp

Usage	arp [tag] [<IP address>] [<MAC address>]
Parameters	**[**tag**]** = -s, -d, -a **-s** place static entry in the ARP table. This tag must be followed with both an IP and a MAC address **-d** delete entry from ARP table; This tag must be followed with an IP address, in which case the specified address is deleted. If * is specified as the IP address, all ARP entries are deleted. **-a** same as typing **arp** with no entries. **<IP address>** = IP address to be added or deleted. **<MAC address>** = MAC address to be added, along with the specified IP address; use colons or spaces to separate pairs of digits.
Examples	**arp** (displays BSU's ARP table; same as **arp -a**) **arp -s 192.168.20.10 00:40:a6:bc:de:23** (Adds specified IP/MAC addresses to the BSU's ARP table.) **arp -d *** (Deletes all ARP entries from the BSU's ARP table.) **arp -d 192.168.20.10** (Deletes IP address, 192.168.20.10, from the BSU's ARP table.)
Description	Without any input parameters, this command displays the BSU's ARP table. By adding the optional tag this command also can be used to add static entries, delete all ARP entries, and delete specific entries from the ARP table.
Notes	Static IP addresses added to the ARP table are removed when the BSU or SU are power cycled.

berlog

Usage	berlog <time>
Parameters	**<**time**>** = < 0 (shut off display) | an integer from 1 to 10 (accumulates errors for this duration of time and then displays)>
Example	**berlog 1** (Displays the BER information every second.) **berlog 0** (Shuts off the BER display.)
Description	Displays software BER test results.
Notes	This command is used in conjunction with the **uplber** command. **berlog 0** shuts off the display but does not stop the test itself.

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BSUlog

Usage	BSUlog <Terminal ID> <[time]>
Parameters	**<**Terminal ID**>** = Terminal ID of the SU of interest. 0 (zero) = cancel the BSUlog display. <[time]> = This parameter is required if a non-zero Terminal ID is entered. In this case, this entry is the polling interval in integral second increments; 1 is the minimum. If zero is entered for the Terminal ID, this parameter is ignored.
Example	**BSUlog 3 5** (Displays the log information for Terminal ID 3 every 5 seconds.) **BSUlog 0** (Shuts off the log.)
Description	Displays information about the BSU designed to help you track the network's service level. See "BSU and SU Logs" in the *Tsunami Multipoint Installation Guide* for more information.

dspconf

Usage	dspconf
Parameters	None.
Example	dspconf
Description	Displays the BSU's current configuration settings.

dspvoip

Usage	dspvoip
Parameters	None.
Example	dspvoip
Description	Displays the active uplink VoIP connections and their associated parameters.

econf

This command has been replaced by the **setEthernet** command on page 89.

firstInboundSlot

Usage	firstInboundSlot <slot number>
Parameters	<slot number> = integers from 4 to 22 For QPSK1H = min value is 4; default value is 4; max value is 6; total slots 8 For QPSK3Q = min value is 5; default value is 6; max value is 10; total slots 12 For QAM8 = min value is 5; default value is 8; max value is 14; total slots 16 For QAM16 = min value is 7; default value is 12; max value is 22; total slots 24
Example	**firstInboundSlot 18**

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Description	Assigns the **firstInboundSlot**. This command configures the downlink/uplink ratio. The number of available slots varies **depending upon** the chosen modulation setting. The default settings configure the link for 50% downlink/50% uplink. The following table shows **firstInboundSlot** settings for the available modulation settings and how they affect the downlink/uplink bandwidth ratio. Slot numbering begins at slot 0 (zero).
Notes	After this command is issued, the BSU automatically restarts and then comes up with the new configuration. If you upgrade to firmware version 1.3 or later, at system startup after the upgrade, the **firstInboundSlot** is set to the previous **firstInboundSlot** setting. After restarting the system, the **firstInboundSlot** setting changes to the default **firstInboundSlot** setting.

FirstInboundSlot and Downlink/Uplink Ratio

Modulation Setting / Data Rate	Number of Available Slots	FirstInboundSlot	Downlink/Uplink Ratio*
QPSK1H/20 Mbps	8	4	50/50%
		5	62.3/37.5%
		6	75/25%
QPSK3Q/30 Mbps	12	5	41.7/58.5%
		6	50/50%
		7	58.5/41.7%
		8	66.7/33.3%
		9	75/25%
		10	83/17%
QAM8/40 Mbps	16	5	31.3/68.7%
		8	50/50%
		10	62.5/37.5%
		12	75/25%
		14	87.5/12.5%
QAM16/60 Mbps	24	7	29.2/70.8%
		12	50/50%
		14	58.3/41.7%
		16	66.7/33.3%
		22	91.6/8.4%

*True network throughput is slightly lower due to network overhead. Typically, downlink and uplink efficiency are 90+ and 80+% of the given values, respectively.

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freqPlan

Usage	freqPlan <frequency plan>
Parameters	<frequency plan> = 4 | 5 | 6
Example	**freqPlan 5**
Description	Assigns the frequency plan. This command is used in conjunction with the **frequency** command. The default frequency plan setting = 4.
Notes	Also see the "frequency" command below, "Frequency Band" on page 9 and "Changing the Frequency Plan and Operating Frequency" in the *Tsunami Multipoint Installation Manual.*

frequency

Usage	frequency <frequency ID>
Parameters	For plan 4: <frequency ID> = a, b, c, or d For plan 5: <frequency ID> = a, b, c, d, or e For plan 6: <frequency ID> = a, b, c, d, e, or f
Example	**frequency d**
Description	Assigns the operating frequency. This command is used in conjunction with the freqPlan command.
Notes	The default frequency setting = a. Also see the "freqPlan" command above, "Frequency Band" on page 9, and "Changing the Frequency Plan and Operating Frequency" in the *Tsunami Multipoint Installation Manual.*

gateway

Usage	gateway [gateway address]
Parameters	<gateway address> = none or an IP address
Examples	**gateway** (displays the current gateway) **gateway 192.168.20.11** (sets the BSU gateway to 192.168.20.11)
Description	Displays/sets the BSU's gateway IP address.
Notes	To remove a gateway use the **gateway** command with an IP of 0.0.0.0. Tsunami Multipoint validates for the dots in their respective positions as well as the numeric entries of the respective address.

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gprs

Usage	gprs <Type of Restart>
Parameters	<Type of Restart> = <0 (cold restart} | 1 (warm restart)>
Example	**gprs 0**
Description	Restarts the GPS receiver.
Notes	Proxim recommends the cold restart option. The GPS Receiver is not reset on a warm restart of the BSU. It is reset by issuing a **gprs 0** command or cycling the BSU power.

help

Usage	help
Parameters	None.
Example	**help**
Description	Displays usage information about the available user commands.

IPC

Usage	IPC <IPC value>
Parameters	<IPC value> = integers from 0 (zero) to 25; recommended level 10 to 15
Example	**IPC 10**
Description	Sets the Inbound Power Control (IPC) margin in decibels (dB). IPC can be increased to overcome interference. However, increasing IPC can lead to excessive self-interference. Proxim recommends adjusting this setting over a range from 10 dB to 15 dB.
Notes	When there is little interference, do not set the IPC margin higher than 10; when there is interference and the network is not heavily loaded, do not set the IPC margin higher than 15 (12 dB for 60Mbps mode). The default IPC setting = 10.

login

Usage	login <password>
Parameters	Passwords can be from 1 to 16 characters; any combination of alphanumeric characters allowed, except for these special characters: " , . ' ‘ ^ { } | \ / ; :] [( ) Enter the correct user or display password (see “Password Protection” in the *Tsunami Multipoint Reference Manual* for information).
Example	**login Proxim1234**
Description	Allows the operators to log in with either user or admin privileges **depending upon** the password supplied. See “Protecting the System” in the *Tsunami Multipoint Installation Guide* for more information.

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logout

Usage	logout
Parameters	None.
Example	**logout**
Description	Logs the user out from the system. If the system is password protected, you must enter the user- or admin-level password to re-access the system (see "Protecting the System" in the *Tsunami Multipoint Installation Guide*). Also see the "login" command on page 84.

modulation

Usage	modulation <mode number>
Parameters	<mode number> = 0 (zero) = QAM16 (60 Mbps) 1 = QAM8 (40 Mbps) 2 = QPSK3Q (30 Mbps) 3 = QPSK1H (20 Mbps)
Example	**modulation 2**
Description	Specifies the modulation (data rate) to be used. See "Specify the Desired Modulation" in Appendix A of the *Tsunami Multipoint Installation Guide* for more information.
Notes	After this command is issued, the BSU automatically restarts and then comes up with the new configuration. The default modulation setting is the maximum allowable burst rate. Changing modulation mode resets the **firstInboundSlot** for 50/50 downlink/uplink operation. See the "firstInboundSlot" command on page 81.

ping

Usage	ping <IP address>
Parameters	<IP address> = IP address of the host that is to be pinged.
Description	Pings a device connected to the BSU. The device must be located on the BSU side. That is, you cannot ping a device connected to an SU from the BSU console.
Example	**ping 192.168.20.11**

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pp3d

Usage	pp3d <time>
Parameters	<time> = <0 (turns off display} | integers from 1 to 65535 (display interval)>
Description	Displays the following GPS status information: Column 1 – time error in half-chip; this value should be less than 80. Column 2 – frequency error Column 3 – synchronize filter; this value must equal 20 Column 4 – not applicable Column 5 – GPS message; this value must be 4 Column 6 – number of visible satellites Column 7 – time of week in 10 ms Columns 8 and 9 – not applicable
Example	**pp3d 1** (displays the log every 1 second)
Notes	The key information is contained in columns 1 and 6.

proxy

Usage	proxy <proxy mode>
Parameters	<proxy mode> = <auto | off >
Example	**proxy auto** (sets the BSU proxy mode to auto)
Description	Sets the BSU's proxy mode.
Notes	The <proxy mode> parameter is case sensitive and must be typed exactly as "off" or "auto." The default mode is auto. **Proxy auto** and **proxy smart** are the same.

rangeSecurity

Usage	rangeSecurity <tag>
Parameters	<tag> = < 0 (turned off) | 1 (turned on)>
Example	**rangeSecurity 1**
Description	Turns on and off the Range Security option. The default Range Security setting is off.
Notes	The Range Security option helps prevent unauthorized SUs from communicating with a BSU. When the Range Security option is on, if an SU attempts to enter the network, the BSU checks the range value reported by the SU. This works as follows: ▪ The first time the SU tries to enter the network, the SU's range is stored in the BSU's flash memory for future reference. ▪ Then, if the SU enters the network again (when Range Security is on) and its reported range does not match the range that was previously stored in the BSU's flash memory, the SU is denied network entry and an alarm is sent to the BSU console. To activate the Range Security option, from the BSU console, enter **rangeSecurity 1**.

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restart

Usage	restart
Parameters	None.
Example	**restart**
Description	Forces a warm restart of the BSU without cycling power

rip add

Usage	rip add <network address> <subnet mask> <next hop> <metric> <interface>
Parameters	<network address> = IP address of network to be reached via static route <subnet mask> = Subnet address of network to be reached via static route <next hop> = IP address of next hop <metric> = Number of hops <interface> = Ethernet (eth), wireless (wir), or static (s)
Example	**rip add 192.168.20.0 255.255.255.0 192.168.50.1 3 e** Lets the BSU or SU (where command was entered) know that it can reach the 192.168.20.0 network through 192.168.50.13 with a metric of 3 hops.
Description	Lets you add a static route.
Notes	Static routes are stored locally at the BSU or SU that they were entered and are saved in flash.

rip clear

Usage	rip clear
Parameters	None.
Example	**rip clear**
Description	Deletes the routing table of the SU or BSU at which the command is entered.

rip delete

Usage	rip delete <network address>
Parameters	<network address> = the network address of the route to be deleted
Example	**rip delete 192.168.20.0**
Description	Lets you delete a route from the ARP table.
Notes	This RIP command must be entered at the BSU or the SU at which the route was learned or entered statically.

rip disable

Usage	rip disable
Parameters	None.
Example	**rip disable**
Description	Disables RIP routing features.

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rip enable

Usage	rip enable
Parameters	None.
Example	**rip enable**
Description	Enables RIP routing features.

rip find

Usage	rip find <host or network ID>
Parameters	<host or network ID>
Example	**rip find 192.168.50.1**
Description	Lets you locate a particular entry in the ARP table.

rip help

Usage	rip help
Parameters	None.
Example	**rip help**
Description	Displays rip help.

rip print

Usage	rip print [interface]
Parameters	None (prints all routes) <interface> =<eth|wir|s> eth = only prints the routes that can be reached through the Ethernet interface wir = only prints the routes that can be reached through the wireless interface s = only prints static routes.
Example	**rip print eth**
Description	When entered at a local BSU or SU, the **rip print** command identifies all the routes that can be reached by the particular BSU or SU through the particular interface. If no interface is specified, all routes are printed. Consequently, entering **rip print w** at an SU lists all networks that the SU can reach by sending a packet up the wireless link; entering **rip print e** lists all the routes that can be reached through the SU's Ethernet interface (all wireline routes). The output contains the following information: Destination — Destination network or host Subnet Mask — Subnet mask of destination network (for example, 255.255.0.0) Gateway — Next hop IP address Met — Metric (number of hops to destination network) TTL — Time to live (length of time before network is marked as being not reachable). The actual TTL is the number displayed times 30 seconds. IF — Interface used to reach the gateway. Either Ethernet (wireside) or wireless. CNT — Number of packets routed to the network since the last reset (of the unit whose routing table is being printed).

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Notes	The **rip print** command must be entered at the BSU or an individual SU to see the static routes entered into that BSU or SU. This command looks at only the first letter of what is entered in the Interface field (therefore, an entry of “whoopee”, for example, is interpreted as the wireless interface).

routingMode

Usage	routingMode [mode]
Parameters	<mode> = <0 (IP routing) |1 (Bridging)> With no parameters, the command displays the current routing mode.
Example	**routingMode 1**
Description	Sets the sector routing mode: **Bridging** or **IP Routing**. By default, the BSU is configured for IP Routing. See “Packet Routing Modes: IP Routing and Bridging” on page 14 for information.
Notes	After this command is issued, the BSU automatically restarts and then comes up with the new configuration. The BSU also forces all the SUs in its sector to restart and then come up with the new routing mode configuration. You might have to restart the BSU console after issuing this command to modify its ARP table. In addition, you may have to clear the ARP table of all the devices connected directly (or through a switch) to the BSU or SU.

setDefaults

Usage	setDefaults factory
Example	**setDefaults factory**
Description	Command to reset BSU or SU configuration to its factory-default settings.
Notes	*WARNING: This will reset the BSU/SU back to its factory defaults. This includes its IP address and subnet mask. This will most likely end all communication between the console and the unit. The BS Configuration Software will discover the new BSU/SU IP address if the subnet address of the PC is wide enough to encompass both the BSU/SU and PC IP addresses. Also the PC’s ARP table may need to be cleared by deleting the entry for the old IP address.* Some key default BSU parameters are: IP routing mode; Access mode open; 20 Mbps; Frequency Plan 4; Frequency Channel a; IP address 192.168.20.252(BSU) & 192.168.20.253 (SU); Subnet mask 255.255.252.0 **This command will cause the BSU or SU to restart**

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setEtherMode

Usage	setEtherMode <0 | 1>
Parameters	0: Downlink optimized for speed and throughput 1: Downlink optimized for protocol compatibility
Example	**setEtherMode 1**
Description	Command to enable optional software downlink Ethernet frame processing for protocol compatibility.
Notes	When EtherMode is set to 0 (setEtherMode 0) the downlink passes most Ethernet frames transparently; however it zero-pads some types of Ethernet II frames. This mode is optimized for speed (packet processing rate). In Ethermode 1 (setEthermode 1) all Ethernet frames are passed without any zero padding. However, this mode is more processing intensive and the packet throughput is reduced.

setEthernet

Usage	setEthernet <auto | non-auto> [<100 | 10> <full | half>]
Parameters	<auto | non-auto> = whether auto-negotiation is to be used <100 | 10> = Mbps rate <full | half> = Full or half duplex mode
Example	**setEthernet non-auto 100 full**
Description	Command to change Ethernet interface.
Notes	Whenever the Ethernet interface for the device is changed, the PC to which it connects must have the same matched setting. The default setting is auto-negotiation. When setting the Ethernet to **non-auto**, both speed and duplex values must be entered or the command is ignored When setting the Ethernet to **auto** mode, speed or duplex mode entries are ignored.

setFrameDuration

Usage	setFrameDuration <mode>
Parameters	<mode> = <0|1> 0 (zero) = standard 7.5 msec frame (this is the default value) 1 = optional frame structure (see Table 3 Frame Durations)
Example	**setFrameDuration 0**
Description	Command to frame structure.
Notes	Optional frame structure is not available with A.I.R. See “Frame Duration Options” on page 9 for details.

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setFrameSync

Usage	setFrameSync <mode>
Parameters	<mode> =<0 | 1 | 2> 0 (zero) = Multi-Sector mode with auto-restart 1 = Independent mode 2 = Multi-Sector mode with auto-resynchronization
Example	**setFrameSync 0**
Description	Sets the frame synchronization mode. The multi-sector modes enable a BSU's GPS receiver and synchronize its frame timing to GPS to ensure all BSU's transmit at the same time. In independent mode, synchronization to GPS is turned off.
Notes	Sets the BSU to one of the two Multi-Sector modes when installing multiple BSUs in the same location. When the frame synchronization mode is set to either of the Multi-Sector modes, the BSU's transmitter power is disabled for up to 5.5 minutes at start up. (Note: The transmitter power is disabled until the GPS unit can locate 5 satellites.) After changing the **modulation**, **frequency**, or **firstInboundSlot** setting, when the frame synchronization mode is set to Multi-Sector, the BSU's transmitter power is disabled for 3 minutes. When the frame synchronization mode is set to Multi-Sector with auto-restart, whenever the difference between the BSU frame time and the GPS supplied time is greater than ±4 microseconds, the BSU shuts down and restarts with the GPS receiver attempting to obtain initial time. When the frame synchronization mode is set to Multi-Sector with auto-resynchronization, the BSU uses its timing loop to slowly re-adjust its frame time to GPS frame time. The BSU does NOT shut down even if the difference in time between the BSU and GPS is greater than ±4 microseconds. However, it could take significant time (30 minutes or more) to re-align the BSU frame time with GPS time, depending upon the size of the discrepancy. The **gprs** command (page 84) can be used to force a restart of the GPS if necessary. When the frame synchronization mode is set to **Independent**, the BSU's transmitter power is disabled for up to 10 seconds at start up. After changing the **modulation**, **frequency**, or **firstInboundSlot** setting, when the frame synchronization mode is set to **Independent**, the BSU's transmitter power is disabled for 5 seconds.

setID

Usage	setID [BSU ID]
Parameters	<BSU ID> = integers from 1 to 65535
Description	This command sets the BSU's terminal ID.
Examples	**setID** (causes the terminal ID of the BSU to be displayed) **setID 1** (sets the terminal ID of the BSU to 1)
Notes	BSU's default terminal ID is 1.

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setIP

Usage	setIP [IP address]
Parameters	[IP address] = IP address
Examples	setIP 192.168.20.10 (sets the BSU IP address to 192.168.20.10)
Description	With no parameters, this command displays the BSU IP address. With the IP address parameter, this command sets the BSU's IP address.
Notes	The BSU's default IP address is 192.168.20.253. Tsunami Multipoint validates for the dots in their respective positions as well as the numeric entries of the respective address. **WARNING**: Setting the BSU's IP address out of the subnet of the PC running the console could lead to an inability to communicate with the BSU. To reset the BSU's IP to the default value select the "restore default value" option from the Operations menu of the console (BSU Configuration Software).

setpw

Usage	setpw <level> <oldpw> <newpw> <newpw>
Parameters	<level> = <user | admin> user = new user-level password admin = new admin-level password <oldpw> = the old user- or admin-level password (the default password is "null") <newpw> = the new user- or admin-level password <newpw> = the new user- or admin-level password (entered again to confirm)
Example	**setpw admin null Proxim1234 Proxim1234** (Defines Proxim1234 as the new admin password (assumes old password is "null.")
Description	Defines password levels for protecting system from unauthorized users. Also used to remove password protection. You can specify a separate user-level and admin-level password. The user-level password lets users view only the system status information; the admin-level password lets users change the system's configuration. Passwords can be from 1 to 16 characters; any combination of alphanumeric characters allowed, except for these special characters: " , . ' ‘ ^ { } | \ / ; :] [( ) See "Password Protection" in the *Tsunami Multipoint Installation Manual* for more information.
Notes	After you define a new user or admin password, logout from the system to implement the new password (see the "logout" command (page 85) for information). To turn off password protection, enter **setpw <level> <oldpw> null null**, where <level> = either user or admin, **depending upon** which password level you want to remove. For example, to remove the admin-level password, enter **setpw admin superuser null null**, where "superuser" is the old password. If you turn off both user-level and admin-level password protection, restart the BSU to refresh its memory. If you forget your password, contact Proxim Customer Service to obtain a new password. See "Appendix C. Technical Support and Training" on page 119 for Proxim contact information.

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setSubnet

Usage	setSubnet <subnet mask>
Parameters	<subnet mask> = valid subnet mask for your network
Example	**setSubnet 255.255.248.0**
Description	With no parameters specified, the BSU's current subnet mask is printed. With a parameter, it sets the BSU's subnet mask.
Notes	To display the BSU's current subnet mask, enter **setSubnet**, without specifying a subnet mask. The default subnet mask is 255.255.252.0 **WARNING**: In order to communicate with the BSU console, the BSU and its console must be members of the same subnet.

setVLAN

Usage	setVLAN <VLAN ID>
Parameters	<VLAN ID> = integers from 1 to 4094
Example	**setVLAN 3**
Description	Assigns a VLAN ID to a BSU. VLAN tagging works only in Bridging mode.
Notes	You can only assign one VLAN ID per BSU. VLAN tagging is turned on for the BSU. See the "routingMode" command on page 89 for information about selecting the routing mode. See the "setVLANTag" command below for information about turning on VLAN tagging for the BSU. See "VLAN Switching – The PMP Implementation" on page 19 for more information about VLAN tagging.

setVLANTag

Usage	setVLANTag <tag>
Parameters	<tag> = < 0 (turn off VLAN tagging | 1 turn on VLAN tagging)
Example	setVLANTag 0
Description	Turns VLAN tagging on and off for the BSU and its sector.
Notes	BSU's default setVLANTag setting = 0 (zero). VLAN tagging only works in Bridging mode when VLAN tagging is turned on for the BSU. Also see "VLAN Switching – The PMP Implementation" on page 19 for information about VLAN tagging, the "setSUVLANTag" command on page 102 for information about turning VLAN tagging on and off for specific SUs, and the "setSUVLAN" command on page 102 for information about assigning VLAN IDs to SUs.

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txPower

Usage	txPower <tag>
Parameters	<tag> = <0 (zero - turn off transmitter) | 1 (turn on transmitter)>
Example	**txPower 1**
Description	Turns the BSU's transmitter on and off.

txPowerAutoEnable

Usage	txPowerAutoEnable <tag>
Parameters	<tag> = < 0 (zero - off) | 1 (on)>
Example	**txPowerAutoEnable 1**
Description	When turned on, the BSU automatically turns on its transmitter whenever the BSU is powered up.

txPowerLevel

Usage	txPowerLevel <level>
Parameters	<level> = integers from 6 to 17
Example	**txPowerLevel 17**
Description	Sets the BSU's transmit power level (in dBm).
Notes	This is the power level at the input to the transmit antenna. When setting up and testing the system in a lab, set the power level to 6; when installing the system in the field, set the power level to 17. Default is 17. See "Set the BSU's Transmit Power" in the *Tsunami Multipoint Installation Manual*.

uplber

Usage	uplber <Terminal ID>
Parameters	<Terminal ID> = <0 (shut off test) | valid SU Terminal ID>
Example	**uplber 101** (Run uplink ber test for terminal 101.)
Description	Runs an uplink ber test for a specified terminal.
Notes	This terminal cannot send data during the test period. This command is used in conjunction with the **berlog** command to display the results. See the "berlog" command on page 80.

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version

Usage	version
Parameters	None.
Example	**version**
Description	Displays the Base Station Configuration Software's startup screen, which shows the version number of the BSU's firmware.

voipMode

Usage	voipMode <value>
Parameters	<value> = <0 | 1 | 2> 0 = no priority transmission; all traffic is treated as best-effort. 1 = voice traffic gets priority, Source IP is used to identify individual voice flows 2 = voice traffic given priority at SU, Source IP and UDP source port is used to identify individual voice flows
Example	**voipMode 2**
Description	Lets you enable voice priority and the method of identifying individual priority flows.

voipTosRange

Usage	voipTosRange <ToS_{low}> [ToS_{high}]
Parameters	<ToS_{low}> = <1 | 2 | … | 255> <ToS_{high}> =<1 | 2 | … | 255> are integers between 1 and 255. If ToS_{high} is omitted, the command assumes that $ToS_{high} = ToS_{low}$.
Example	**voipTosRange 40 54**
Description	Lets you identify the ToS byte range for priority connections. Any IP packet arriving at the SU for transmission on the uplink with a ToS byte value that falls within the specified range is considered a priority (voice) packet.
Notes	If ToS_{high} is omitted, it is assumed to be the same as ToS_{low} $ToS_{low} \leq ToS_{high}$

voipTTL

Usage	voipTTL <value>
Parameters	<value> = integers from 1 to 255
Example	**voipTTL 10**
Description	Lets you set the length of time before the network is marked as being not reachable.
Note	There is one TTL for the whole sector The default **voipTTL** value is 60.

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BSU COMMANDS FOR CONFIGURING THE SU'S FROM THE BSU

addSU

Usage	addSU <MAC address> <Terminal ID>
Parameters	<MAC address> = SU's MAC address in the format <eth0>:<eth1>:<eth2>:<eth3>:<eth4>:<eth5> or <eth0> <eth1> <eth2> <eth3> <eth4> <eth5> <Terminal ID> = integer from 1 to 1023
Example	**addSU 00:04:44:12:34:56 2** (Adds an SU with a MAC address of 00:04:44:12:34:56 to the BSU database and assigns this SU a Terminal ID of 2).
Description	Adds an SU to the BSU's database and assigns the SU a Terminal ID.
Notes	Specify the SU's MAC address, which is printed on the SU's product label, along with a unique Terminal ID for each SU.

addSUIP

Usage	addSUIP <Terminal ID> <IP address>
Parameters	<Terminal ID> = Terminal ID of the SU to which the device with the static IP address is being added <IP address>= static IP address of device attached to SU
Example	**addSUIP 2 192.168.20.11**
Description	Adds the static IP address of a device (such as a PC) connected to an SU to the PMP's database. This is necessary to allow devices with static IP addresses to: • Access the PMP network while the system is operating in **IP Routing** mode and the SU's access mode is set to **Restricted**. • Allow access to a host on the SU side of a network (destination host) in **Bridging** mode when the originating host does not first send an ARP to discover the address of the destination host.
Notes	You can specify up to 5 static IP addresses per SU. If you attempt to add more than 5 static IP addresses, a warning message is displayed. Use the **removeSUIP** (page 99) to delete a static IP address. Use the **dspSU** command (page 98) with the terminal IP to display the static IP addresses associated with a specific SU. In addition, you can use the **dspStaticIP** command (page 98) to display all of the static IPs configured for all SUs This is necessary to allow devices with static IP addresses, access the PMP network, while the system is operating in **IP Routing** mode and the SU's IP filter type is set to **Restricted**. This command is also used to allow static entries for devices in **Bridging** mode.

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addSUVLANFilter

Usage	addSUVLANFilter <Terminal ID> <Start VLAN ID> [End VLAN ID]
Parameters	<Terminal ID> = Terminal ID of the SU to which the device with the static IP address is being added. <Start VLAN ID> = 1 | 2 | …. | 4094 [End VLAN ID] = 1 | 2 | …. | 4094. This value must be greater than or equal to Start VLAN ID
Example	**addSUVLANFilter 2 1 379**
Description	This command adds a VLAN filter to the designated SU. When in VLAN mode, the SU passes (both uplink and downlink) all VLAN traffic falling in the designated range. It can be used to define up to 16 “ranges” of VLAN ID’s that the SU is to pass in both the uplink and downlink directions.
Notes	The firmware does not accept more than 16 range definitions for a single SU If the **End VLAN ID** is omitted, it is assumed to be the same as the **Start VLAN ID**.

deleteSUVLANFilter

Usage	deleteSUVLANFilter <Terminal ID> <Start VLAN ID>
Parameters	<Terminal ID> = Terminal ID of the SU to which the device with the static IP address is being added. <Start VLAN ID> = 0| 1 | 2 | …. | 4094
Example	**deleteSUVLANFilter 2 1**
Description	This command deletes a previously configured VLAN filter at the designated SU.
Notes	Using a **Start VLAN ID** of zero causes all VLAN filters (associated with the designated SU) to be deleted.

disableSU

Usage	disableSU <Terminal ID>
Parameters	<Terminal ID> = Terminal ID of the SU to be disabled
Example	**disableSU 2**
Description	Disables a specified SU from the PMP network.
Note	Disabled SUs function only in listen mode. That is, they receive outbound control messages, but they do not receive or transmit user data. See the “enableSU” command (page 99) for information about re-enabling a disabled SU.

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dspActiveSU

Usage	dspActiveSU
Parameters	None
Example	**dspActiveSU**
Description	Displays the following information for all SUs currently connected to the PMP network: SU ID (Terminal ID of the SU) Ethernet address Software Version IP address Node Status (enabled or disabled) Network Entry (Number of times node has entered the network since BSU has been last restarted) Range (in meters) Range Alarm (has the distance between the BSU and SU changed when the SU last re-entered the network)

dspStaticIP

Usage	dspStaticIP
Parameters	None.
Description	Displays the assigned static IP addresses for all SUs.
Example	**dspStaticIP**

dspSU

Usage	dspSU [Terminal ID]
Parameters	<Terminal ID> = Terminal ID of the SU of interest
Example	**dspSU 2**
Description	If no parameter is entered, this command displays limited configuration information for all SU's configured at a BSU. If a terminal ID is entered, this command displays more detailed configuration information for that SU.

dspSUVLANFilter

Usage	dspSUVLANFilter <Terminal ID>
Parameters	<Terminal ID> = Terminal ID of the SU of interest
Example	**dspSUVLANFilter 34** (Displays all VLAN filters associated with SU 34.)
Description	Displays all VLAN filters associated with the designated SU.

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enableSU

Usage	enableSU <Terminal ID>
Parameters	<Terminal ID> = Terminal ID of the SU to be enabled
Example	**enableSU 2**
Description	Enables a previously disabled SU on the PMP network.
Notes	You must enable a disabled SU to allow it to receive and transmit user data. After this command is issued, the specified SU automatically restarts, comes up with the new configuration, and re-enters the PMP network.

remote

Usage	remote <0 | Terminal ID>
Parameters	<Terminal ID> = Terminal ID of desired remote SU 0 (zero) = break connection to remote SU, return to BSU
Example	**remote 5**
Description	Allows remote access to an SU from the BSU console.
Notes	It is a good idea to enter **dspconf** (see the "dspconf" command on page 81) or **version** (see the "version" command on page 95) to verify the connection to the SU after using the remote command. Enter **remote 0** (zero) to break the connection to the remote SU and return to the BSU. Once remotely connected to an SU, the operator can enter SU console commands such as **dspconf**, **arp –s**, **rip print**, and so on, at the BSU console. You cannot run commands remotely and locally at the SU at the same time. Make sure you enter **remote 0** (zero) to end the remote session (you may want to enter **dspconf** to verify that the session has ended).

removeSU

Usage	removeSU <Terminal ID>
Parameters	<Terminal ID> = Terminal ID of the SU to be removed.
Example	**removeSU 2**
Description	Deletes a specified SU from the BSU's database.

removeSUIP

Usage	removeSUIP <Terminal ID> <IP address>
Parameters	<Terminal ID> = Terminal ID of the SU to which the device (to be removed) is attached <IP address> = static IP address of the device to be removed
Example	**removeSUIP 2 192.168.20.11**
Description	Removes a previously defined static IP address from the SU with the designated Terminal ID.
Notes	Use the **dspSU** command (page 98) to display the static IP addresses associated with a specific SU. See the "addSUIP" command (page 96) for information about adding a static IP address.

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setSUEthernet

Usage	setSUEthernet <Terminal ID> <auto | non-auto> [<100 | 10> <full | half>]
Parameters	<Terminal ID> = SU's terminal ID number <auto | non-auto> = whether auto-negotiation is to be used <100 | 10> = Mbps rate <full | half> = Full- or half- duplex mode
Example	**setSUEthernet 3 auto**
Description	Command to change Ethernet interface of an SU.
Notes	Whenever the Ethernet interface for the device is changed, the PC to which it connects must have the same matched setting. The default setting is **Auto**. When setting the Ethernet to non-auto, both speed and duplex values must be entered or the command is ignored. When setting the Ethernet to auto mode, any speed or duplex mode entries are ignored. The only way of determining the setting of an SU's Ethernet interface is to remote to that SU and enter the **setEthernet** command. In Software Versions 1.3 and later, the BSU saves the SU interface Ethernet configuration in its database and downloads this information to the SUs. This information must be entered for each SU. If you change the interface parameters at the SU, they are reset whenever the SU enters the network.

setSUFilter

Usage	setSUFilter <Terminal ID> <mode>
Parameters	<Terminal ID> = Terminal ID of the SU to which the IP filter is being applied <mode > = <0 (zero – restricted)| 3 (open)>
Example	**setSUFilter 2 3** (Sets SU #2 to **open** mode.)
Description	Sets the access mode for the designated SU.
Notes	This setting is only applicable if the BSU is in **IP Routing** mode. Default setting for SUs is **Restricted** mode. See "Packet Routing Modes: Ip Routing and Bridging" (page 14) for a detailed discussion of the access modes. Access modes **local** and **subnet** are no longer supported.

setSUGateway

Usage	setSUGateway <Terminal ID> <gateway address>
Parameters	<Terminal ID> = Terminal ID of the SU whose gateway address is to be defined <gateway address> = IP address of the SU's gateway
Example	**setSUGateway 2 174.168.20.40**
Description	Sets the gateway address for an SU.
Notes	The default gateway setting for SUs = 0.0.0.0 (no gateway).

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setSUIP

Usage	setSUIP <Terminal ID> <IP address>
Parameters	<Terminal ID> = Terminal ID of the SU whose IP address is to be defined <IP address> = IP address to be assigned to the specified SU
Example	**setSUIP 2 192.168.20.10**
Description	Sets the IP address for an SU.
Notes	SU's default IP address = 192.168.20.253. After an SU connects to a BSU, if the SU's IP address is unassigned, the SU takes on the BSU's IP address.

setSUMACFilter

Usage	setSUMACFilter <Terminal ID> <MAC Filter mode>
Parameters	<Terminal ID> = Terminal ID of the SU <MAC Filter mode> = <0 (off) | 1 (on)>
Example	**setSUMACFilter 2 0**
Description	If the MAC filter mode is set to **on**, any downlink packet received by the SU is filtered. If the destination MAC address of the received packet belongs to a local device, the packet is forwarded to that device. Otherwise, it is dropped. If the MAC filter mode is set to **off**, no downlink filtering takes place and any downlink packet received is delivered to the local network. The MAC filter is applicable only to the **Bridging** mode. Proxim recommends setting the MAC filter mode to on when VLAN tagging/filtering is on. The default value is MAC filter mode **on**.

setSUProxy

Usage	setSUProxy <Terminal ID> <proxy mode>
Parameters	<Terminal ID> = * | Terminal ID of the SU whose IP address is to be defined <proxy mode> = <0 (off) | 1 (on) | 2 (auto)>
Example	**setSUProxy * 0** (Shuts off proxy for all SU's in the sector.)
Description	Sets the proxy mode for the designated SU. Using an asterisk (*) for Terminal ID causes the command to be implemented for every SU in the sector.
Notes	**Proxy auto** and **proxy smart** are the same. Entering any value other than 0, 1, or 2 sets the proxy to **off**.

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setSUSubnet

Usage	setSUSubnet <Terminal ID> <subnet mask>
Parameters	<Terminal ID> = Terminal ID of the SU whose subnet mask is to be defined <subnetmask> = Subnet mask to be assigned to the specified SU
Example	**setSUSubnet 2 255.255.248.0**
Description	Sets the subnet mask for an SU.
Notes	The default subnet mask setting for SUs = 255.255.252.0.

setSUVLAN

Usage	setSUVLAN <Terminal ID> <VLAN ID>
Parameters	<Terminal ID> = Terminal ID of the SU whose VLAN ID is to be defined <VLAN ID> = Integers from 1 to 4094 VLAN ID to be assigned to the specified SU.
Example	**setSUVLAN 2 3**
Description	Assigns a VLAN ID to the specified SU.
Notes	You can assign only one VLAN ID per SU. VLAN tagging only works while in **Bridging** mode and VLAN tagging is turned **on** for the BSU. See the "setVLANTag" command (page 93) for information about turning on VLAN tagging for the BSU. To use VLAN tagging for SUs, VLAN tagging must be turned on for the desired SUs. Also, the SUs must be assigned a VLAN ID (use this command to do this). See "VLAN Switching – The PMP Implementation" on page 19 for more information about VLAN tagging.

setSUVLANTag

Usage	setSUVLANTag <Terminal ID> <tag>
Parameters	<Terminal ID> = the terminal ID of the SU for which VLAN tagging is being turned on or off <tag> = <0 | 1> 0 (zero) = Turn off VLAN tagging for specified SU 1 = Turn on VLAN tagging for specified SU
Example	**setSUVLANTag 5 1**
Description	Turns VLAN tagging on and off for specified SUs.
Notes	VLAN tagging only works while in **Bridging** mode and VLAN tagging is turned on for the BSU. See "setVLANTag" command (page 93) for information about turning on VLAN tagging for the BSU. You can use the **setSUVLANTag** command to turn VLAN tagging on and off for specific SUs. To use VLAN tagging for SUs, you should assign the SUs valid VLAN IDs (see the "setSUVLAN" command (page 102) for information about assigning VLAN IDs to SUs). See "VLAN Switching – The PMP Implementation" on page 19 for more information about VLAN tagging.

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setSUvoipBandwidth

Usage	setSUvoipBandwidth <Terminal ID> <N>
Parameters	<Terminal ID> = the terminal ID of the SU for which bandwidth is being defined. <N> =<10 | 20| 30 | 40 | 50| 60 | 70 | 80 | 90 | 100 | 120 | 140 | 160 | 180 | 200 | 400 | 800 | 1000 | 2000 | 2700 | 3000 | G7.11 | G.723 | G.726 | G.729> Bandwidth in kbps.
Examples	**setSUvoipBandwidth 3 10** (Assigns 10 kbps to each VoIP (priority) connection associated with terminal 3.) **setSUvoipBandwidth 5 G.726** (Assigns 80 kbps to each VoIP (priority) connection associated with terminal 5.) **setSUvoipBandwidth 8 55** (Assigns 60 kbps to each VoIP (priority) connection associated with terminal 8.)
Description	Sets the bandwidth allocated for each VoIP (priority) connection at a given SU.
Notes	If you enter a different value, it is rounded up to one of these values. The following table contains the data rate used if you enter a G.711, G.723, G.726, or G.729 voice protocol. The default bandwidth is 90 kbps.

Codec Entered (N)	Equivalent Bandwidth Entry (kbps)	
	Bridging	IP Routing
G.711	100	100
G.723	30	30
G.726	80	80
G.729	60	30

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SU COMMANDS FOR CONFIGURING AND MONITORING SUS

The commands in this section are entered from the SU.

arp

Usage	arp [tag] [<IP address>] [<MAC address>]
Parameters	**[**tag**]** = -s, -d, -a **-s** = place static entry in the ARP table. This tag must be followed with both an IP and MAC addresses **-d** = delete entry from ARP table; This tag must be followed with an IP address in which case the specified address is deleted. (if * is specified as the IP address then all ARP entries are deleted) -a = same as typing arp with no entries **<IP address>** = IP address to be added or deleted **<MAC address>** = MAC address to be added, along with specified IP address; use colons or spaces to separate pairs of digits
Examples	**arp** (Displays SU's ARP table; same as **arp –a**.) **arp -s 192.168.20.10 00:40:a6:bc:de:23** (Adds specified IP/MAC addresses to the SU's ARP table.) **arp -d *** (Deletes all ARP entries from the SU's ARP table.) **arp -d 192.168.20.10** (Deletes IP address 192.168.20.10 from the SU's ARP table.)
Description	Without any parameters, this command displays the SU's ARP table. By adding the optional **tag**, this command also can be used to add static entries, delete all ARP entries, and delete specific entries from the ARP table.
Notes	Static IP addresses added to the ARP table are removed when the SU is power cycled.

dspconf

Usage	dspconf
Parameters	None.
Example	**dspconf**
Description	Displays the SU's current configuration settings.

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freqMode

Usage	freqMode <mode>
Parameters	<mode>=<0 (auto) | 1 (fixed)>
Example	**freqMode 1** (Sets the frequency mode to fixed.)
Description	When mode is set to **auto**, the SU searches all frequencies (within the given frequency plan (see the "freqPlan" command on page 83)) when attempting to establish a link. When mode is set to fixed the SU searches only the frequency set using the "frequency" command (page 83).
Notes	The default mode setting is **auto**. After setting **freqPlan**, **frequency**, and **freqMode,** the SU must be restarted (see the "restart" command on page 87) for the new settings to take effect.

freqPlan

Usage	freqPlan <frequency plan>
Parameters	**<**frequency plan**>** = 4 | 5 | 6
Example	**freqPlan 5**
Description	Sets the SU frequency plan.
Notes	**WARNING**: The SU must be set to the same frequency plan as the BSU or it cannot establish an RF link. The default frequency plan setting = 4. After setting **freqPlan**, **frequency**, and **freqMode,** the SU must be restarted (see the "restart" command on page 87) for the new settings to take effect.

frequency

Usage	frequency <frequency ID>
Parameters	For plan 4: <frequency ID> = a, b, c, or d For plan 5: <frequency ID> = a, b, c, d, or e For plan 6: <frequency ID> = a, b, c, d, e, or f
Example	**frequency d**
Description	Assigns the operating frequency. At the SU this command is used in conjunction with the **freqMode** and **freqPlan** command.
Notes	If **freqmode** is set to **auto**, this command has no use. After setting **freqPlan**, **frequency**, and **freqmode**, the SU must be restarted (see the "restart" command on page 87) for the new settings to take effect.

ping

Usage	ping <IP address>
Parameters	<IP address> = IP address of the host that is to be pinged
Example	**ping 192.168.20.11**
Description	Pings a device connected to the SU. The device must be located on the SU side. You cannot ping a device connected to a BSU from the SU.

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proxy

Usage	proxy <proxy mode>
Parameters	<proxy mode> = <auto | off>
Example	**proxy auto** (Sets the SU proxy mode to **auto**.)
Description	Temporarily sets the SU's proxy mode.
Notes	This command can be used to temporarily set the SU proxy mode. The next time the SU enters the network it downloads its proxy configuration that is saved in the BSU database (see setSUProxy command). The <proxy mode> parameter is case-sensitive and must be typed exactly as **off**, or **auto**. The default mode is **auto**. **Proxy auto** and **proxy smart** are the same.

restart

Usage	restart
Parameters	None.
Example	**restart**
Description	Forces a warm restart of the SU without cycling power.

rip add

Usage	rip add <network address> <subnet mask> <next hop> <metric> <interface>
Parameters	<network address> = IP address of network to be reached via static route <subnet mask> = Subnet address of network to be reached via static route <next hop> = IP address of next hop <metric> =Number of hops <interface> = Ethernet (eth), wireless (wir), or static (s)
Example	**rip add 192.168.20.0 255.255.255.0 192.168.50.1 3 e** (Lets the BSU or SU where command was entered know that it can reach the 192.168.20.0 network through 192.168.50.13 with a metric of 3 hops.)
Description	Lets you add a static route.
Notes	Static routes are stored locally at the BSU or SU at which they were entered and are saved in flash.

rip clear

Usage	rip clear
Parameters	None.
Example	**rip clear**
Description	Deletes the routing table of the SU or BSU at which it is entered.

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rip delete

Usage	rip delete <network address>
Parameters	<network address> = the network address of the route to be deleted
Example	**rip delete 192.168.20.0**
Description	Lets you delete a route from the RIP table.
Notes	This RIP command must be entered at the BSU or SU at which the route was learned or entered statically.

rip find

Usage	rip find <host or network ID>
Parameters	<host or network ID>
Example	**rip find 192.168.50.1**
Description	Lets you locate a particular entry in the ARP table.

rip print

Usage	rip print [interface]
Parameters	None (prints all routes) <interface> =<eth|wir|s> eth = only prints the routes that can be reached through the Ethernet interface. wir = only prints the routes that can be reached through the wireless interface. s = only prints static routes.
Example	**rip print eth**
Description	When entered at a local BSU or SU, the **rip print** command identifies all the routes that can be reached by the particular BSU or SU through the particular interface. If no interface is specified, all routes are printed. Consequently, entering **rip print w** at an SU lists all networks that the SU can reach by sending a packet up the wireless link; entering **rip print e** lists all the routes that can be reached through the SU's Ethernet interface (all wireline routes). The output contains the following information: Destination — Destination network or host Subnet Mask — Subnet mask of destination network (for example, 255.255.0.0) Gateway — Next hop IP address Met — Metric (number of hops to destination network) TTL — Time to live (length of time before network is marked as being not reachable. The actual TTL is the number displayed times 30 seconds.) IF — Interface used to reach gateway. Either Ethernet (wireside) or wireless. CNT — Number of packets routed to the network since the last reset (of the unit whose routing table is being printed).
Notes	The **rip print** command must be entered at the BSU or an individual SU to see the static routes entered into that BSU or an SU. The command only looks at the first letter of what is entered in the interface field (so an entry of "whoopee", for example, is interpreted as the wireless interface).

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searchstatus

Usage	searchstatus <Mode>
Parameters	<Mode> = <0 (off) | 1 (on)>
Example	**searchstatus 0**
Description	This commands lets the user disable the display scrolling that occurs when an SU is searching for a link and the user is using the Base Station Configuration Software at the SU.

setDefaults

Usage	setDefaults factory
Example	**setDefaults factory**
Description	Command to reset the SU to its factory default settings.
Notes	Entering **setDefaults** prints an error message. *WARNING: This will reset the SU back to its factory defaults. This includes its IP address and subnet mask. This will most likely end all communication between the SU Utility and the unit. The PC running the Utility must have its IP address and subnet mask reset so that it can communicate with a default SU (also its ARP table may need to be cleared).* Some key default SU parameters are: Frequency auto search; IP address 192.168.20.253; Subnet mask 255.255.255.0l **This command will cause the BSU to restart**

setEthernet

Usage	setEthernet <auto | non-auto> [<100 | 10> <full | half>]
Parameters	<auto | non-auto> = whether auto-negotiation is to be used <100 | 10> = Mbps rate <full | half> = Full- or half- duplex mode
Example	**setEthernet non-auto 100 full**
Description	Facility to TEMPORARILY change the SU Ethernet interface.
Notes	This command can be used to TEMPORARILY change the SU Ethernet interface operating mode. The next time the SU enters the network it downloads its Ethernet operating mode from the BSU (see the "setSUEthernet" command on page 100). Whenever the Ethernet interface for the device is changed, the PC to which it connects must have the same matched setting. The default setting is auto-negotiation. When setting the Ethernet to **non-auto**, both speed and duplex values must be entered or the command is ignored. When setting the Ethernet to **auto** mode, any speed or duplex mode entries are ignored.

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setIP

Usage	setIP [IP address]
Parameters	[IP address] = IP address
Examples	**setIP 192.168.20.10** (Sets the SU IP address to 192.168.20.10.)
Description	TEMPORARILY sets the SU's IP address.
Notes	The next time the SU enters the network it downloads the IP address from the BSU database and changes to this IP address. Tsunami Multipoint validates for the dots in their respective positions as well as the numeric entries of the respective address. **WARNING**: Setting the BSU's IP address out of the subnet of the pc running the Console could lead to an inability to communicate with the BSU. To reset the BSU's IP to the default value, select the "restore default value" option from the **Operation** menu of the Console (BSU Configuration Software).

setSubnet

Usage	setSubnet <subnet mask>
Parameters	<subnet mask> = valid subnet mask for your network
Example	**setSubnet 255.255.248.0**
Description	TEMPORARILY sets the BSU's subnet mask.
Notes	The next time the SU enters the network it downloads the subnet mask from the BSU database and changes to this mask. The default subnet mask is 255.255.252.0 **WARNING**: In order to communicate with the BSU console, the BSU and its console must be members of the same subnet.

SUlog1

Usage	SUlog1 <time>
Parameters	<time> = <0 (shut off log) | polling interval (in seconds)>
Description	Displays the following monitoring information for an SU: **SU ID** The Terminal ID of the monitored SU. **RSL** Shows the shows the RSL (receiver signal level) at the output of the antenna (in dBm). **TX Power** Shows the SU's transmitting EIRP (in dBm). **VCO** Shows the relative frequency offset of the VCO (voltage control oscillator) (in Hz). **Time error** Shows the synchronization error (in 1/512 symbol), generally magnitude (should be less than 8). **OB pkt error** Shows the number of out-of-sequence outbound packets. **Range** Shows the SU's distance from the BSU (in meters).
Example	**SUlog1 1**

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Notes	Enter **SUlog1 0** (zero) to cancel. You can run these commands from the BSU console by first remoting to the SU (see the “remote” command on page 99).

SUlog2

Usage	SUlog2 <time>
Parameters	<time> = the polling interval (in seconds)
Description	Displays the following monitoring information for an SU: **SU ID** The Terminal ID of the monitored SU. **Missed VARSYS** Shows the number of missing downlink control packets. **aloha retx** Shows the number of packets retransmitted due to collisions (collisions are a normal event on contingent channels. An excessive number may indicate a problem). **IB pkts** Shows the number of inbound packets transmitted. **OB pkts** Shows the number of outbound packets received. **OB PE** Shows the number of outbound packet errors. **OB PER** Shows the error rate for outbound packets received. **Time** Shows the cumulative polling time (in seconds).
Example	**SUlog2 1**
Notes	Enter **SUlog2 0** (zero) to cancel. You can run these commands from the BSU console by first remoting to the SU (see “remote” on page 99).

version

Usage	version
Parameters	None.
Example	version
Description	Displays the SU’s firmware version.

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Appendix A. Troubleshooting

The following table summarizes link and other problems you might experience, along with recommended ways to solve the problem.

Problem	Possible Cause	How to Resolve
"ODU not connected" message displayed in configuration software	• Range security enabled and SU moved? • SU disabled at BSU? • SU burst rate set lower than the BSU burst rate? • Cables between the BSU or SU and power supplies are not connected. • Wrong cable type used. • BSU in **IP Routing** mode, SU in **Restricted** mode, and PC is not one of five statically configured hosts or did not get its IP address via DHCP from across the link.	• Disable range security • Enable SU • Lower burst rate of BSU, or replace SU. • Connect the power and Ethernet cables to the BSU/SU and their respective power supplies. The BSU/SU emits a chirp to indicate it is receiving power. • If connecting a BSU/SU power supply to a switch, use a cross-over Ethernet cable; if connecting directly to a router or PC, use a straight-through cable. • Add PC as static host, use DHCP across the link, change access mode to **Open** or IP routing mode to **Bridging**.
"Authentication failure" message	The SU's MAC address has not been entered into the BSU's database or was entered incorrectly.	Verify MAC address of SU from **dspconf** from the BSU console on the SU or from the ARP table of the PC after pinging the SU, and make sure that this MAC address is properly entered into the BSU.
Link state is stuck in "Searching for outbound" mode OR Link state does not stay in "Link established" state.	• Higher interference over link. • Path between BSU/SU too great or is blocked. • Interference with other transmissions.	• Shorten the path between devices. • Try setting the system to a different frequency plan. • Try removing the BSU or SU to a different location.
Can't upgrade BSU or SU locally	PC on wrong subnet, Ethernet errors, or SU busy	Make sure PC is ion the same subnet. Make sure that Ethernet settings match and reboot the BSU or SU to restart auto-negotiation, if enabled. Change SU to an unused frequency so it is not attempting to connect to the BSU during the upgrade.
Low throughput	Ethernet setting mismatch, routing loop in IP routing mode	Make sure that Ethernet settings match and reboot the SU or BSU after disrupting the Ethernet connection to restart auto-negotiation, if enabled. Make sure that there are no routing loops by enabling RIP and optionally adding static routes.

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Problem	Possible Cause	How to Resolve
Cannot pass traffic across the link from a mobile user	User was once behind the other end of the link and has a mobility issue	Power cycle the far end
BSU console does not appear or you receive an error when trying to install the Base Station Configuration software.	Possible conflict with Microsoft Internet Information Services (IIS) software.	(1) Stop and disable the "IIS Admin" service software (this should also stop the FTP, WWW, NNTP, and SMTP software, if this software is installed. (2) Launch the BSU console and see whether you can connect to your BSU. (3) Select the **Console → Connect To** command in the BSU console. (4) Select any port number other than "3456" (the IIS Admin service software uses this port for remote management). (5) Re-enable the IIS Admin service software and restore it to the state it was in before you disabled it. Also, restart other related services.

TROUBLESHOOTING DATA STREAM ERRORS AND INTERFERENCE

This section describes troubleshooting methods for:

- Errors in the data stream
- Counteracting and evaluating interference

Errors in the Data Stream

When the BSU/SUs are in service, errors in the data stream can occur. This is usually known to the operator either by faulty data indications of downstream equipment or by external bit error rate testing.

Some errors are exhibited on downstream data processing equipment or during a BER test (see "Uplink BER Test" in the *Tsunami Multipoint Installation Manual* for information about testing the uplink bit error rate). In other cases, there could be data errors due to atmospheric conditions (fading), interference, or other reasons. In the case of these types of errors, the following information can be helpful to troubleshoot the link.

Indications

- During external BER test, test equipment indicates errors.
- Downstream equipment (switch, router, and so on) indicates errors.

Possible Causes

- Path fading due to atmospheric conditions
- Continuous or intermittent interference
- Antenna problems, misalignment, or path clearance
- Received signal level (RSL) is too strong
- Far-end transmitter circuitry is faulty
- Near-end receiver circuitry is faulty

Recommended Actions

- Verify 10/100 Base-T wiring.

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COUNTERACTING AND EVALUATING INTERFERENCE

Short Paths

The single most effective countermeasure against interference is to maintain a short path length. This can be achieved by dividing long paths into multiple small paths using cascading hops. Intermediate repeaters can be formed using back-to-back Tsunami BSUs.

By definition, “short path” is a path where fades are extremely rare and signal levels vary by no more than ±3 dB during fades. This distance varies with the RF frequency. Typically a short path is defined as any path length shorter than 5 miles/8 kilometers at 5.8 GHz.

Frequency Selection

The Tsunami Multipoint offers several distinct non-overlapping and overlapping frequency plans (see “Frequency Band” on page 9 for information). If you experience significant interference using one frequency plan, try selecting a different frequency plan (see “Change the Frequency Plan and Operating Frequency” in the *Tsunami Multipoint Installation Manual* for information).

Equipment/Antenna Location

Occasionally, interference is caused by the BSU or SU being too close to another similar transmitter. Moving the BSU/SU or the interfering equipment can reduce or eliminate interference.

Interference countermeasures rely to some extent upon the measurement of the received interference level and frequency. Prior to turning up a new hop, you can use a spectrum analyzer to monitor the spectrum at each end to check for possible interfering signals. For more details, see “Using a Spectrum Analyzer to Evaluate Potential Interference,” next, for information.

Using a Spectrum Analyzer to Evaluate Potential Interference

Connecting to the BSU or SU and using “peak hold” on a spectrum analyzer, the spectrum across the receive frequency range of the BSU/SU can be swept and any signals being received at levels above the device’s specified threshold identified. If potential interfering signals are found, the Tsunami frequency plan can be changed to avoid a receive channel that may contain significant interference (see “Change the Frequency Plan and Operating Frequency” in the *Tsunami Multipoint Installation Manual* for information). For example, interference can be reduced by moving from the 4A plan to the 4D plan. Signals outside the receiver frequency range can be ignored: they do not cause interference.

When using a spectrum analyzer for determining the presence of interference, very narrow resolution bandwidth settings must be used to detect signals down to the device’s threshold (approximately -89 dBm, **depending upon** the current modulation setting). See “Receiver Sensitivity” on page 115 for the thresholds associated with each modulation setting.

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Appendix B. Technical Specifications

The following technical specification is for reference purposes only. Actual product performance and compliance with local telecommunications regulations can vary from country to country. Proxim Corporation only ships products that are type approved in the destination country.

BURST-RATE LIMIT

Product	Burst-Rate Limit	Also Supports
Base Station Unit	60 Mbps 20 Mbps	20-40 Mbps burst rates
Subscriber Unit	60 Mbps 20 Mbps	20-40 Mbps burst rates

DOWNLINK/UPLINK THROUGHPUT

Burst Rate	D/L Throughput	U/L Throughput
20 Mbps	9 Mbps	8 Mbps
30 Mbps	13.5 Mbps	12 Mbps
40 Mbps	18 Mbps	16 Mbps
60 Mbps	27 Mbps	24 Mbps

Note: The above calculations are typical and based upon a 50/50 downlink (D/L) uplink (U/L) division of slots (see "firstinboundSlot Command" in the *Tsunami Multipoint Reference Manual*). SU throughput may be limited by a provider's Service Level Agreement or other D/L U/L settings.

FREQUENCY PLANS

The following table defines the frequencies associated with each plan.

Channel Plan	Frequency
4A	5743.86 MHz
4B	5764.61 MHz
4C	5785.36 MHz
4D	5806.11 MHz

Channel Plan	Frequency
5A	5742.19 MHz
5B	5758.79 MHz
5C	5775.39 MHz
5D	5791.99 MHz
5E	5808.59 MHz

Channel Plan	Frequency
6A	5740.40 MHz
6B	5754.23 MHz
6C	5768.07 MHz
6D	5781.90 MHz
6E	5795.73 MHz
6F	5809.57 MHz

TX POWER

BSU ..... +6 to +17 dBm (into antenna port)
SU ..... -48 to +15 dBm (into antenna port)

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ANTENNA

BSU.....Integrated, LHCP (left-hand circular polarization) 18 dBi
SU ..... Integrated, LHCP 21 dBi

RECEIVER SENSITIVITY

Burst Rate	Threshold
60 Mbps	-77 dBm
40 Mbps	-81 dBm
30 Mbps	-86 dBm
20 Mbps	-89 dBm

MAXIMUM DISTANCE BETWEEN BASE STATION AND SUBSCRIBER UNIT

BURST-RATE	CLOS[1]	NLOS[2]
60 Mbps	3 miles/5 km	1.2 miles/2 km
40 Mbps	4 miles/6.6 km	2 miles/3.5 km
30 Mbps	5 miles/8.3 km	2.4 Miles/4 km
20 Mbps	6 miles/10 km	3 miles/5 km

[1]Clear-Line-of-Sight distance is calculated for 99.995% availability assuming no obstructions in the first Fresnel Zone.

[2]Near-Line-of-Sight distance is for a typical installation with moderate multipath/shadowing due to terrain and structures.

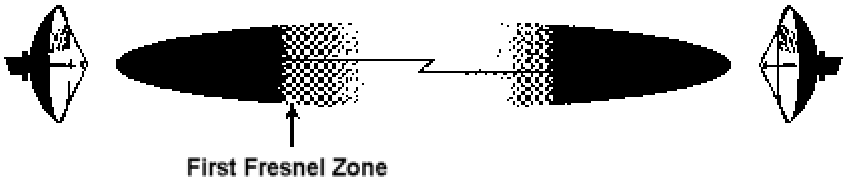


Figure 18. Fresnel Zones

The Fresnel Zone refers to the radio beam. The radio signal's path length and frequency determine the Fresnel Zone's width and shape. When a large part of the Fresnel Zone is blocked, some of the radio signal's energy is lost.

SYSTEM

Operating Frequency Range..... 5725-5825 MHz
Radio Access Method ..... TDMA
Duplexing ..... Time Division Duplex (TDD)
Integrated Antenna (BSU)..... 19 dBi (60° Azimuth. X 6° Elevation) LHCP
Integrated Antenna (SU) ..... 20 dBi (10° Azimuth. X 10° Elevation) LHCP
Max Subscriber Units/BSU..... 1,023
Frequency Channels ..... 4 non-overlapping, 5 and 6 overlapping available
Regulatory Compliance..... FCC Part 15-400 (U-NII), IC RSS21 0

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STANDARDS COMPLIANCE AND INTERFACES

Ethernet Interface..... 10/100 Base-T
Ethernet Connector..... RJ-45 female
BSU indoor-outdoor cable..... Circular plastic connectors with Category 5 cable
SU indoor-outdoor cable ..... RJ-45 (outdoor) and DIN (indoor) over CAT5 (UV) cable
Standards Compliance..... IEEE 802.1d Bridging Mode (a subset of the 802.d standard)
IEEE 802.1q VLAN

CONFIGURATION AND MANAGEMENT

BSU Configuration

Configuration..... via Ethernet or Wireless Manager (future release)
SNMP..... AgentMIB II (future release)
Security ..... Authentication, IP/MAC Filtering, passwords
Software Upgrades ..... Downloadable Base Station reprogramming

SU Configuration

Configuration..... Automatic
Security ..... Authentication, IP/MAC Filtering
Software Upgrades .....Over-the-air Subscriber Unit programming

POWER/ENVIRONMENT SAFETY

Electrical

Base Station Unit .....-36 to –60 Volts DC, 1.25 Amps
Base Station Unit Power Brick..... 100-240 Volts AC
Base Station Unit Power Block ..... 48 Volts DC
Subscriber Unit..... 18 to 28 Volts DC, 0.8 Amps
Subscriber Unit Power Brick .....115 or 100-240 Volts AC

Operational Temperature

Indoor.....0° to 55° C
Outdoor ..... -25° to 65° C

Humidity

Indoor ..... 95% non-condensing
Outdoor ..... 5% to 100%, condensing
EIVIC..... FCC Class B
Safety UL-1950
Environmental Compliance .....ETS 300 019

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PHYSICAL DIMENSION

Base Station (Outdoor Unit)

Size (WxHxD)..... 10.2 x 24 x 6.6 inches/25.9 x 61 x 16.8 cm
Weight ..... 20 lbs/9 kg

Base Station Power Brick (Indoor Unit) [sold separately]

Size (WxHxD)..... 37.4 x 70.9 x 24.8 inch/95 x 180 x 63 cm
Weight ..... 1.5 lbs/0.7 kg

Subscriber Unit (Outdoor Unit)

Size (WxHxD)..... 10.5 x 10.5 x 6.8 inches/26.5 x 26.5 x 17.4 cm
Weight ..... 10 lbs/4.5 kg

Subscriber Unit Power Brick (Indoor Unit)

Size (SxHxD)..... 36 x 5.1 x 2.6 inch/92 x 130 x 67 cm
Weight ..... 2.7 lbs/1.2 kg

INSTALLATION DETAILS

Base Station Unit (outdoor unit)..... Pole mounting, 1.5-4.5” diameter (w/supplied U-bolts)
Subscriber Unit (outdoor unit)..... Pole mounting, 1.25-1.75” diameter (w/supplied U-bolts)

OPTIONAL ACCESSORIES

Base Station Unit

Connector kit..... P/N ACC-5300
BSU Power Brick..... P/N 201-40100

Subscriber Unit

Wall mounting kit ..... P/N ACC-40100
Connector kit..... P/N ACC-5200

TSUNAMI MULTIPOINT VERSION 2.0 BSU MODELS

20 Mbps..... 301-40400-25
20 Mbps connectorized..... 301-40400-25C
20 Mbps A.I.R. 301-40400-25R

60 Mbps..... 301-40400-65
60 Mbps connectorized..... 301-40400-65C
60 Mbps A.I.R. 301-40400-65R

The above products comply with the requirements of the European Directive 1999/5/EC, the Radio and Telecommunications Terminal Equipment Directive, Low Voltage Directive 73/23/EEC, and the Electromagnetic compatibility Directive 89/336/EEC. (Original copies of the Declaration of Conformity are available on file.)

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TSUNAMI MULTIPOINT VERSION 2.0 SU MODELS

20 Mbps 110/220V 301-40100-252
20 Mbps connectorized 301-40100-25C

60 Mbps 110/220V 301-40100-652
60 Mbps connectorized 301-40100-65C

The above products comply with the requirements of the European Directive 1999/5/EC, the Radio and Telecommunications Terminal Equipment Directive, Low Voltage Directive 73/23/EEC, and the Electromagnetic compatibility Directive 89/336/EEC. (Original copies of the Declaration of Conformity are available on file.)

DECLARATION OF CONFORMITY

The Tsunami Multipoint products listed in the previous section are in conformity with the following standards:

Safety	IEC60950, 2nd Edition: 1991 + A1 + A2 + A3 + A4
Immunity	ETSI EN301 489-1; ETSI EN301 489-4; EN55024/CISPR24
Emissions	ETSI EN301 489-1; ETSI EN301 489-4; EN55022; EN61000-3-2; EN61000-3-3
Radio	ETSI EN 300 440-2; ETSI EN 300 440-1
Environmental	ETSI EN300 019-2-4; IEC 60068-2-1; IEC 60068-2-2; IEC 60068-2-14; IEC 60068-2-30; IEC 60068-2-56

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Appendix C. Technical Support

If you are having a problem using a Tsunami Multipoint and cannot resolve it with the information in "Appendix A. Troubleshooting" beginning on page 111, gather the following information and contact Proxim Technical Support:

- What kind of network are you using?
- What were you doing when the error occurred?
- What error message did you see?
- Can you reproduce the problem?

Have the following logs from the affected equipment before calling Technical Support:

- SUlog1
- SUlog2
- BSUlog (for each affected SU)
- uplber, berlog (for each affected SU)

Be sure to obtain an RMA number before sending any equipment to Proxim for repair.

To receive E-mail technical support, please be sure to include the serial number of the product(s) in question. We will be unable to respond to your inquiry without this information.

Access Knowledgebase: Ask a Wireless WAN Product question and get an express response: **WANsupport@proxim.com**

E-mail Technical Support: **WANtechnicalsupport@proxim.com**

Call Technical Support: Toll Free +1-866-674-6626 or +1-408-542-5390
Hours: 6:00 a.m. to 5:00 p.m. M-F Pacific Time

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Warranty

1 YEAR LIMITED EQUIPMENT WARRANTY

(1 year parts and labor)

1. LIMITED WARRANTY

   A. For the applicable Warranty Period (as defined in Paragraph 1.2 below) Proxim warrants that the hardware manufactured by Proxim and initially purchased or leased from one of Proxim's authorized resellers or distributors by the original end-user ("*you*") for your personal use and not for resale (the "*Equipment*") (a) substantially conforms to the specifications contained in the most recent version of the manual for the model of the Equipment purchased or leased by you (the "*Equipment Specifications*") and (b) is free from defects in materials and workmanship. This Limited Warranty only applies to the Equipment and its preloaded firmware. This Limited Warranty does not apply to any software (or its associated documentation), whether preloaded with the Equipment, installed subsequently or otherwise ("*Software*"), nor does it apply to any firmware revision that is not originally preloaded on the Equipment at the time the Equipment is purchased or leased. The Software is licensed to you pursuant to the software license agreement that accompanied the Software and is subject to the terms, including the limited warranty and limitation of liability, contained in that license agreement. Proxim has no obligation to repair or replace Software under this Limited Warranty.

   B. This Limited Warranty shall start on the date that the Equipment is first shipped to you (the "*Shipping Date*") and shall end one (1) year after the Shipping Date ("Warranty Period").

   C. Nothing in this Limited Warranty affects any statutory rights of consumers that cannot be waived or limited by contract.

2. LIMITED WARRANTY EXCLUSIONS AND LIMITATIONS

   A. The Limited Warranty covers customary and intended usage only. Proxim does not warrant, and is not responsible for damage, defects or failures caused by any of the following:

      1) Any part of the Equipment having been modified, adapted, repaired, or improperly installed, operated, maintained, stored, transported or relocated by any person other than Proxim personnel or a Proxim authorized service agent;

      2) External causes, including electrical stress or lightning, interference caused by other radios or other sources, unsuitable physical or operating environment and use in conjunction with incompatible equipment or accessories;

      3) Cosmetic damage, including all damage to the surface of the Equipment;

      4) Acts of God, fires, floods, wars, terrorist acts, sabotage, civil unrest, labor disputes or similar events, actions or hazards; and

      5) Accidents, negligence, neglect, mishandling, abuse or misuse, other than by Proxim personnel or a Proxim authorized service agent.

   B. The Limited Warranty does not apply to the following parts of the Equipment, which are not manufactured by Proxim, but which may be otherwise covered by an original manufacturer's warranty:

      1) antenna systems, including coaxial cable, wave guide, connectors, flex sections, mounts, and other parts of the antenna system and installation materials;

      2) rack mounted equipment, which is not manufactured by Proxim but which may be assembled, wired and tested at Proxim's factory or supplied as part of a system, including orderwire items, channel banks, multiplexers, fuse/alarm panels and remote alarm items; and

      3) all equipment which is not included in Proxim's specifications.

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C. Unless otherwise specified, equipment not manufactured by Proxim is provided "AS IS" AND WITHOUT WARRANTIES OF ANY KIND. Please refer to the original manufacturer's warranty, if any.

D. Any technical or other support provided for the Equipment by Proxim, such as telephone assistance or assistance regarding the installation, is provided "AS IS" AND WITHOUT WARRANTIES OF ANY KIND.

3. REPLACEMENT, REPAIR AND RETURN PROCESSES.

A. To request service under the Limited Warranty:

1) You must, within the applicable Warranty Period, promptly notify Proxim of the problem with the Equipment, provide the serial number of the Equipment, and provide your contact information during business hours, by contacting Proxim by telephone at 408-542-5390 during the business hours of 8:00 a.m. to 5:00 p.m., Pacific Time, Monday through Friday, excluding holidays, or by e-mail at wansupport@proxim.com or by mail to Support, Proxim Corporation, 935 Stewart Drive, Sunnyvale, CA 94085, USA, This notice is effective when received by Proxim during the business hours referenced above.

2) Proxim shall, at its sole option, either resolve the problem over the telephone or provide you with a returned materials authorization number ("*RMA Number*") and the address of the location to which you may ship the Equipment at issue.

3) If the problem is not resolved over the telephone, and Proxim gives you an RMA Number, you must, within ten (10) business days of your receipt of an RMA Number if you are located within the borders of the United States and within thirty (30) days of your receipt of an RMA Number if you are located beyond the borders of the United States, at your cost, ship the Equipment to the location specified by Proxim. The Equipment must be shipped in its original or equivalent packaging. You must also attach a label to each item of Equipment you are returning, which must include the following information: the RMA Number, a description of the problem, your return address and a telephone number where you can be reached during business hours. You must also include with the Equipment a dated proof of original purchase. **YOU ARE RESPONSIBLE FOR ALL EQUIPMENT UNTIL PROXIM RECEIVES IT, AND YOU ARE RESPONSIBLE FOR ALL SHIPPING, HANDLING AND INSURANCE CHARGES, WHICH MUST BE PREPAID**.

4) Proxim is not responsible for Equipment received without an RMA Number and may reject the return of such Equipment. Proxim is also not responsible for any of your confidential, proprietary or other information or data contained in Equipment you return to Proxim. You should remove any such information or data from the Equipment prior to making any return to Proxim.

5) The replacement or repair of Equipment in locations outside of the United States may vary depending on your location.

6) **FAILURE TO FOLLOW THE PROCEDURES FOR RETURNS LISTED ABOVE MAY VOID THE LIMITED WARRANTY.**

B. If the Equipment does not function as warranted, as determined by Proxim in its sole discretion, Proxim shall either repair or replace the returned Equipment at its sole option.

1) The replacement Equipment or parts may be new or refurbished. All parts removed from repaired Equipment and all returned Equipment that is replaced by Proxim become the property of Proxim.

2) Proxim shall, at its cost (which shall not include international customs, freight forwarding, or associated fees) ship the repaired or replacement Equipment to any destination, by carrier and method of delivery chosen by Proxim, in its sole discretion. Proxim will not pay, and you will be solely responsible for, any international customs, freight forwarding, or other associated fees related to such shipment. If you request some other form of conveyance, such as express shipping, you must pay the cost of return shipment.

C. Equipment which is repaired or replaced by Proxim under this Limited Warranty shall be covered under all of the provisions of this Limited Warranty for the remainder of the applicable Warranty

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Period or ninety (90) days from the date of shipment of the repaired or replacement Equipment, whichever period is longer.

4. LIMITATIONS OF RIGHTS AND DISCLAIMER OF OTHER WARRANTIES

   A. THE LIMITED WARRANTY CONTAINS LIMITATIONS ON YOUR RIGHTS AND REMEDIES AGAINST PROXIM. YOU ACKNOWLEDGE HAVING READ, UNDERSTOOD AND AGREED TO THOSE LIMITATIONS.

   B. Proxim does not warrant that the functions contained in the Equipment will meet your requirements or that any Equipment's operation will be uninterrupted or error free. **REPAIR OR REPLACEMENT OF THE EQUIPMENT AS PROVIDED HEREIN IS THE EXCLUSIVE REMEDY AVAILABLE TO YOU, AND IS PROVIDED IN LIEU OF ALL OTHER WARRANTIES, WHETHER ORAL OR WRITTEN, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT OF THIRD PARTY RIGHTS. ALL OTHER WARRANTIES ARE EXCLUDED TO THE FULLEST EXTENT PERMITTED BY LAW AND EXCEPT FOR THE LIMITED WARRANTY PROVIDED HEREIN, THE EQUIPMENT IS PROVIDED "AS IS".** No dealer, agent, or employee is authorized to make any modification, extension, or addition to the Limited Warranty.

5. LIMITATION OF LIABILITY

   PROXIM SHALL NOT BE LIABLE TO YOU FOR INDIRECT, SPECIAL, PUNITIVE, INCIDENTAL OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO, LOST PROFITS) OF ANY KIND SUSTAINED OR INCURRED IN CONNECTION WITH, OR RELATED TO, THE EQUIPMENT OR YOUR USE OF THE EQUIPMENT REGARDLESS OF THE FORM OF ACTION OR NATURE OF THE CLAIM (INCLUDING, BUT NOT LIMITED TO, BREACH OF WARRANTY, BREACH OF CONTRACT, TORT, NEGLIGENCE OR STRICT LIABILITY) AND WHETHER OR NOT SUCH DAMAGES ARE FORESEEABLE, AND EVEN IF PROXIM HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH LOSS. IN NO CASE WILL PROXIM BE LIABLE FOR ANY REPRESENTATION OR WARRANTY MADE BY ANY PARTY OTHER THAN PROXIM. PROXIM'S TOTAL LIABILITY TO YOU SHALL NOT EXCEED THE AMOUNT PAID BY YOU FOR THE EQUIPMENT AT ISSUE. This limitation of liability also applies to Proxim's authorized resellers and distributors and it is the maximum amount for which Proxim and the reseller or distributor who sold you the Equipment are collectively responsible.

6. DISCLAIMERS

   This Limited Warranty gives you specific legal rights, and you may also have other rights that vary from jurisdiction to jurisdiction. Some jurisdictions do not allow the exclusion or limitation of incidental or consequential damages, may not allow limitations on how long an implied warranty lasts, and may not allow provisions that permit a warranty to be voided. Consequently, such limitations and exclusions may not apply to you. In the event an implied warranty cannot be excluded under the law of the applicable jurisdiction, it is limited in duration to the applicable Warranty Period.

7. MISCELLANEOUS

   A. *Transfer.* You may not transfer or assign this Limited Warranty. Any transfers or assignments made in violation of this Paragraph shall be void.

   B. *Governing Law.* The Limited Warranty shall be governed by the laws of the State of California, without reference to its conflicts of laws provisions. The United Nations Convention on the International Sale of Goods shall not apply to this Limited Warranty.

   C. *Arbitration/Dispute Resolution.* Any dispute, controversy or claim arising out of or in connection with the Equipment shall be finally resolved by arbitration under the International Arbitration Rules of the American Arbitration Association. The place of arbitration shall be Sunnyvale, California. The number of arbitrators shall be one. The language of arbitration shall be English.

   D. *Indemnification.* You shall indemnify and hold harmless Proxim (including its directors, officers, employers and agents) against any and all claims (including all expenses and reasonable attorneys' fees) arising from or relating to the operation of the Equipment due to, in whole or in part, your (including your agents' or employees') negligence, gross negligence or misconduct.

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