WAVE RELAY®
USER MANUAL

03EN009 (English) VERSION 3.1

PERSISTENT SYSTEMS

This User Manual applies to Wave Relay® Firmware Version 18.4.0+. For information on older firmware versions, contact Persistent Systems.

Headquartered in New York City since 2007, Persistent Systems LLC is a global communications technology company which develops, manufactures and integrates a patented and secure Mobile Ad Hoc Networking (MANET) system: Wave Relay®. The company's industry leading R&D team has designed wireless networking protocols to support their cutting edge Wave Relay® system and technology. Wave Relay® is capable of running real-time data, video, voice and other applications under the most difficult and unpredictable conditions. Their suite of products is field proven and utilized in Commercial, Military, Government, Industrial, Agriculture, Mining, Oil and Gas, Robotics, and Unmanned System markets.

The Wave Relay® System is a peer-to-peer wireless MANET networking solution in which there is no master node. If any device fails, the rest of the devices continue to communicate using any remaining connectivity. By eliminating master nodes, gateways, access points, and central coordinators from the design, Wave Relay® delivers high levels of fault tolerance regardless of which nodes might fail. The system is designed to maximize the capacity of the radio frequency (RF) spectrum and to minimize the network overhead. While optimizing efficiency, Wave Relay® also implements techniques that increase multicast reliability. The advanced multicast functionality allows the system to support both multicast voice and video over IP.

Wave Relay® is designed to maintain high bandwidth connectivity among devices that are on the move. The system is scalable, enabling it to incorporate unlimited meshed devices into the wireless network, where the devices themselves form the communication infrastructure. Even in highly dynamic environments, the system is able to maintain connectivity by rapidly re-routing data. Wave Relay® "self-form" and "self-heal" as nodes move unpredictably throughout the network, and Wave Relay® routing adapts in less than a second to fluctuations in topology and other environmental conditions, continuously maximizing the communication performance. Due to Wave Relay's® architecture, deploying the system and establishing the network are as easy as plugging in an Ethernet cable. The system operates on the data link layer (OSI Layer 2) rather than the network layer (Layer 3), facilitating plug-and-play operation.

Wave Relay® is a seamless wireless networking system offering a dynamic and reliable solution for all mobile networking needs. Wave Relay® offers all of these capabilities in an integrated and cost-effective package.
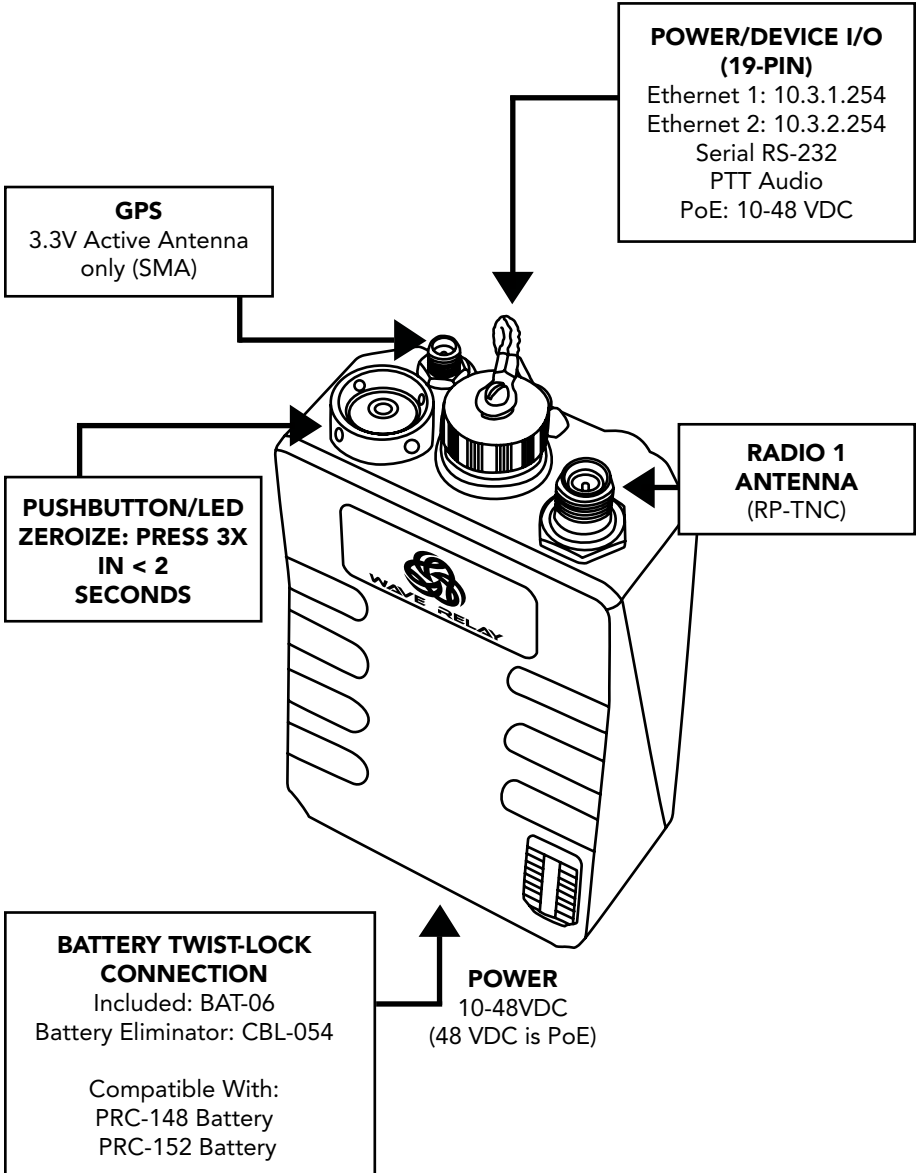
DEVICE HARDWARE INTRODUCTION

PERSISTENT SYSTEMS

MAN PORTABLE UNIT — GEN4

POWER/DEVICE I/O (19-PIN)
Ethernet 1: 10.3.1.254
Ethernet 2: 10.3.2.254
Serial RS-232
PTT Audio
PoE: 10-48 VDC

GPS
3.3V Active Antenna only (SMA)

RADIO 1 ANTENNA
(RP-TNC)

PUSHBUTTON/LED ZEROIZE: PRESS 3X IN < 2 SECONDS

BATTERY TWIST-LOCK CONNECTION
Included: BAT-06
Battery Eliminator: CBL-054

Compatible With:
PRC-148 Battery
PRC-152 Battery

POWER
10-48VDC
(48 VDC is PoE)

PERSISTENT SYSTEMS

MAN PORTABLE UNIT — GEN3 SINGLE

RADIO 1 ANTENNA
(RP-TNC)

POWER/DEVICE I/O (19-PIN)
Ethernet 1: 10.3.1.254
Ethernet 2: 10.3.2.254
Serial RS-232
PTT Audio
PoE: 10 - 48 VDC

AUXILIARY POWER (3-PIN)
10-48 VDC

PUSHBUTTON/LED
ZEROIZE: PRESS 3X IN < 2 SECONDS

GPS
3.3V Active Antenna only (SMA)

WAVE RELAY

QUAD RADIO ROUTER

ETHERNET 2 SWITCH PORT (RJ45)
CANNOT accept PoE
Ethernet 2 IP: 10.3.2.254

RADIO 2 ANTENNA
(N-type)

RADIO 1 ANTENNA
(N-type)

PUSH-TO-TALK (PTT) AUDIO (NATO 6-PIN CONNECTOR)

PERSISTENT SYSTEMS

GPS
3.3V Active Antenna only
(SMA)

**PUSHBUTTON/LED
ZEROIZE: PRESS 3X
IN < 2
SECONDS**

**RADIO 4
ANTENNA**
(N-type)

**RADIO 3
ANTENNA**
(N-type)

**ETHERNET 2 SWITCH PORT
(RJ45)**
CANNOT accept PoE
Ethernet 2 IP: 10.3.2.254

**POWER/ETHERNET 1
(RJ45)**
Accepts PoE, 10-48 VDC
Ethernet 1 IP: 10.3.1.254

**AUXILIARY POWER/
SERIAL (4-PIN)**
10-48 VDC

MAN PORTABLE UNIT — GEN3 DUAL

POWER/DEVICE I/O (19-PIN)
Ethernet 1: 10.3.1.254
Ethernet 2: 10.3.2.254
Serial RS-232
PTT Audio
PoE: 10 - 48 VDC

RADIO 1 ANTENNA
(RP-TNC)

RADIO 2 ANTENNA
(RP-TNC)

AUXILIARY POWER (3-PIN)
10-48 VDC

GPS
3.3V Active Antenna
only (SMA)

WAVE RELAY

PUSHBUTTON/LED ZEROIZE: PRESS 3X IN < 2 SECONDS

PERSISTENT SYSTEMS

AID

PUSH-TO-TALK (PTT) AUDIO (NATO 6-PIN CONNECTOR)

ETHERNET 2 (RJ45)
PoE,
10-48 VDC
Factory Setup IP: 10.3.2.254

POWER/ETHERNET 1 (RJ45)
Accepts PoE, 10-48 VDC
Factory Setup IP: 10.3.1.254

TO MPU (19-PIN)

DEVICE OPERATION

PERSISTENT SYSTEMS

PUSHBUTTON/LED OPERATION

NOTE:

STATE	LED STATUS
OFF	OFF
Boot Up (30s - 2 mins)	ON
Fully Operational	ON
Configuration Required	SLOW BLINK
Zeroize	FAST BLINK
Low Battery (MPU4 Only)	OFF 2 SEC, ON .5 SEC

OPERATION	INSTRUCTION
ON/OFF Power	**HOLD** (1 second)
Zeroize	**TAP 3 TIMES** (< 2 sec)

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CONFIGURATION

When a node is shipped from the factory, it is in a state that requires configuration. Nodes can be configured by using the Web Management Interface or through the Management API.

Follow the steps under "Initial Node Configuration" to put the nodes into an operational state. The basic steps required to configure a node to an operational state are:

SET ENCRYPTION KEY
A key must be set in order for a node to communicate with other nodes in the network. In order for two nodes to communicate, they must share a matching encryption key and crytpo mode.

SET CHANNEL
Each radio module on a node should be assigned a center frequency and channel width. In order for two nodes to communicate, each node must have at least one radio that shares the same center frequency and channel width.

SET IP ADDRESS
During node configuration, a node needs to be assigned a unique management IP address. This management IP address is used for monitoring, configuration, and device services (PTT, Google™ Earth, Tracking, RS-232, etc.).

In the event that two nodes are unable to communicate after initial configuration, refer to the "Troubleshooting" section starting on page 104.

PERSISTENT SYSTEMS

WEB MANAGEMENT OVERVIEW

PERSISTENT SYSTEMS

WEB MANAGEMENT INTRODUCTION

The Wave Relay® Web Management Interface enables users to configure and monitor Wave Relay® units through a web browser. A navigation bar organizes the Management Interface. The "Node Status" and "Node Configuration" tabs pertain only to the node to which the management computer is connected (either by Ethernet cable or by wireless), and the "Network Status" and "Network Configuration" tabs pertain to the entire network of nodes.

ACCESSING THE WEB MANAGEMENT INTERFACE

NODE CONNECTIVITY INFORMATION

Default Management Password Ethernet 1 Factory Setup IP Ethernet 2 Factory Setup IP	**Password** **10.3.1.254** **10.3.2.254**
• Factory Setup IP addresses are always accessible when directly connected to the radio. Use Factory IPs any time you do not remember the management IP address of the radio. • To connect to the Factory IP address, the management computer must be on the correct IP subnet and wired to the correct Ethernet port on the node.	

MANAGEMENT COMPUTER SETTINGS

IP Address Subnet Mask Default Gateway / Router	10.3.1.10 255.255.255.0 10.3.1.1
• To connect to the node using Ethernet 1, open a web browser and connect to **http://10.3.1.254**. • Each time you connect a new device, you may need to accept a security certificate before you can enter the Web Management Interface. • See next page for information on setting up the management computer.	

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CONFIGURING YOUR COMPUTER'S IP ADDRESS

For your computer to be able to communicate with the Wave Relay®, it must have an IP address that is in the same IP subnet mask as the Wave Relay®'s IP address. A subnet mask of 255.255.255.0 means that the computer can communicate with another device that has an IP address matching the first three numbers of its own IP address.

No Default Gateway or DNS server configuration is required; however they can be configured if necessary. Most computers are capable of having more then one IP address configured on a single Ethernet adapter. It is recommended that you add all three addresses to your wired Ethernet adapter so that you can easily manage your network.

LINUX:
[sudo] ifconfig eth0 10.4.1.10/24
[sudo] ip addr add 10.3.1.10/24 dev eth0
[sudo] ip addr add 10.3.2.10/24 dev eth0

WINDOWS:
Start > Network (Right Click) > Properties
Change Adapter Settings (Windows Vista / 7 only)
Local Area Connection (Right Click) > Properties
Select Internet Protocol Version 4 (TCP/IPv4)
Click Properties
Select Use the following IP Address
Click Advanced…
Click Add…
Enter IP Address and Subnet mask
Click Add and repeat for all IP Addresses
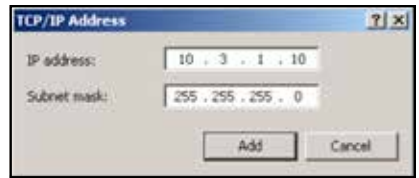
SECURITY CERTIFICATE WARNINGS

Recommended browsers are Firefox 3+, Internet Explorer 7+, and Google™ Chrome. Internet Explorer 6 is not compatible with the most recent Web Management Interface. If you are having difficulty connecting to the Web Management Interface, make sure you are using one of the recommended browsers.

When connecting to the Web Management Interface, Firefox and Internet Explorer may ask the user to accept a security certificate. Firefox and IE handle security certificates in different ways:

FIREFOX DISPLAYS A PAGE
Click "I understand the risks" > "Add Exception" > "Confirm Security Exception."

IE DISPLAYS A PAGE
Click the red X "Continue to this website (not recomended)."

GOOGLE™ CHROME DISPLAYS A PAGE
1.   Click the "Proceed anyway" button.
2.   When the Web Management Interface loads, enter the management password and click "Authenticate." The default management password is "password" which is set from the factory or after the key/configuration is zeroized by pushing the on/off button 3 time in less than 2 seconds.

INITIAL NODE CONFIGURATION

PERSISTENT SYSTEMS
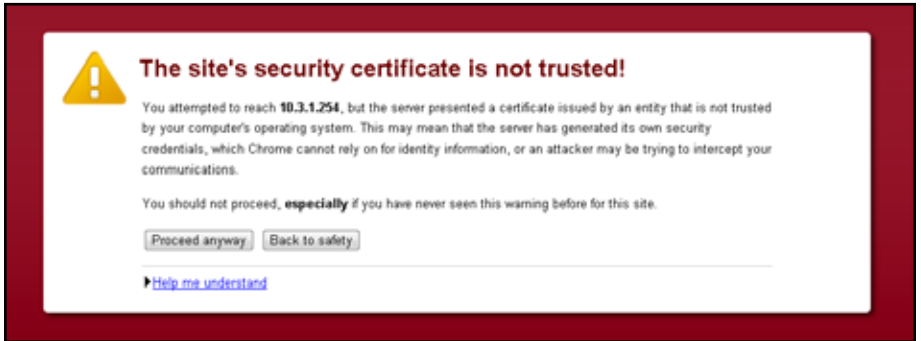
All nodes arrive set to factory default configuration. This section details the recommended setup and custom configuration procedure for a set of identical nodes, for example, a set of 50 MPU4s. In general, the procedure is completed as follows:

1.   Configure an individual node
2.   Save the individual node's configuration settings and key
3.   Load key and the saved configuration settings into remaining nodes
4.   Verify communication among the nodes

QUICK CONFIGURATION
If the network administrator provides a node configuration file, use it to facilitate quick device configuration. Please refer to Section "**Quick Setup**." If a node con-figuration file has been provided, skip to the "**Steps for Configuring the Remaining Nodes**" section.

STEPS FOR CONFIGURING THE FIRST NODE
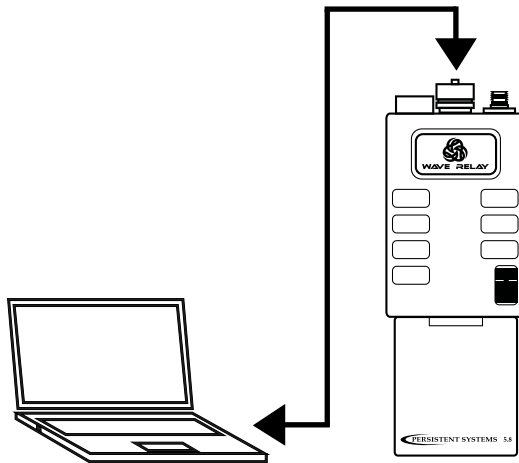
STEPS FOR CONFIGURING THE FIRST NODE

1.	Configure Network Defaults
2.	Customize Node Name and IP Address To Be Unique
3.	Configure Radio to Use Defaults
4.	Setup Node List
5.	Store Configuration File
6.	Set and Save Security Settings

STEP 1: CONFIGURE NETWORK DEFAULTS
Network Defaults are settings that will be used to manage the configuration of the network. Up to 16 different default Channel settings are able to be configured.

1. Click "Network Configuration" > "Network Defaults."
2. Choose the settings you would like to use for your network for each Channel.
3. Click the "Save to Network" button at the bottom of the page.

For more information on setting Network Defaults, refer to the section "Network Configuration > Network Defaults."

WARNING!

For units branded with an FCC label and FCC ID, only the provided antenna or equivalent type and gain can be used: this device must comply with Part 15 of the FCC rules.

FCC branded devices will be limited so users cannot set output power levels outside of those certified under the FCC rules.

FCC test results and reports can be provided by Persistent Systems, LLC upon request.

For more information, please contact Persistent Systems, LLC Quality/Compliance personnel.

STEP 2: CUSTOMIZE NODE NAME AND IP ADDRESS TO BE UNIQUE
Each node in the network should be assigned a unique node name and IP address to facilitate management and network operations.

1. Click "Node Configuration" > "Node Configuration."
2. Insert the new name and IP Address in the indicated fields.
3. Set the gateway to match the subnet of the node's IP address.
4. Click the "Save & Reconfigure Unit" button at the bottom of the page.
5. Load the key and saved configuration file into remaining nodes. Customize the Node Name and IP address for each node, then click the "Save & Reconfigure Unit" button at the bottom of the page.
6. Ensure that node names and IP addresses of all nodes are unique.

STEP 3: CONFIGURE RADIO TO USE DEFAULTS
The node must be configured to use the appropriate Network Defaults in order for the node to be managed by changes to the Network Configuration.
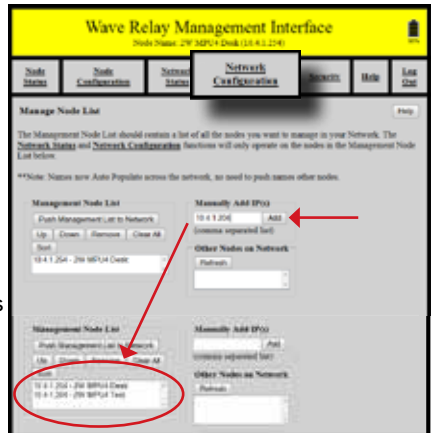
1. Click "Node Configuration" > "Node Configuration."
2. Select the appropriate Network Defaults in the drop down menus.
3. Click the "Save & Reconfigure Unit" button at the bottom of the page.

For more information, see section "Configuring Radio to Use Defaults."

STEP 4: SETUP NODE LIST
The Node List is a list of IP Addresses of nodes managed by the Web Management Interface.

1. Click "Network Configuration" > "Network Node List."
2. Enter the IP Address of a node in the "Manually Add IP(s)" field and click "Add" to add the node associated with that IP Address to the Node List. Nodes may also be added from the "Other Nodes on Network" window if they are detected by the network. These nodes may be added individually with the "Selected IPs" button or all at once with the "All" button.
3. Repeat this process for every node to be managed.
4. With all new nodes programmed and on, ensure that all nodes are on the Network Node List.
5. Click the "Push Management List to Network" button. This function will copy the node list to each node in the network. Only nodes in the node list will be affected by Network Configuration functions. Pushing the node list to the network allows network-wide settings to be managed from any node in the network.

STEP 5: STORE CONFIGURATION FILE
Device settings (both Node Configuration and Network Configuration settings) can be saved to a configuration file. The configuration file serves as a backup for device settings and provides the ability to easily transfer settings from one node to another.

1. Ensure Network Configuration and Node Configuration settings are set as desired.
2. Click "Node Configuration" > "Config Management."
3. Click the "Store" button. A prompt will appear to choose where to save the configuration file. Note specifically that this file contains settings (both Network Configuration and Node Configuration settings) for the current device only.
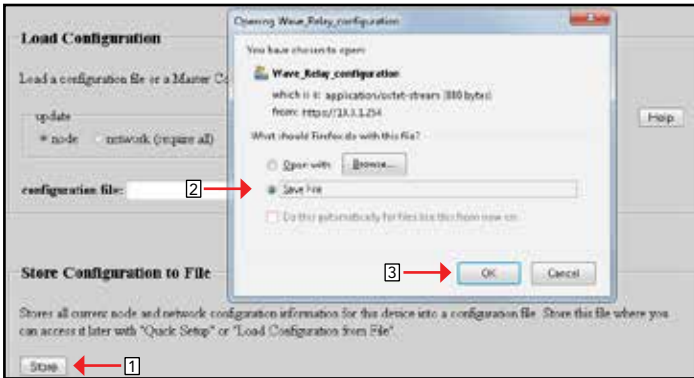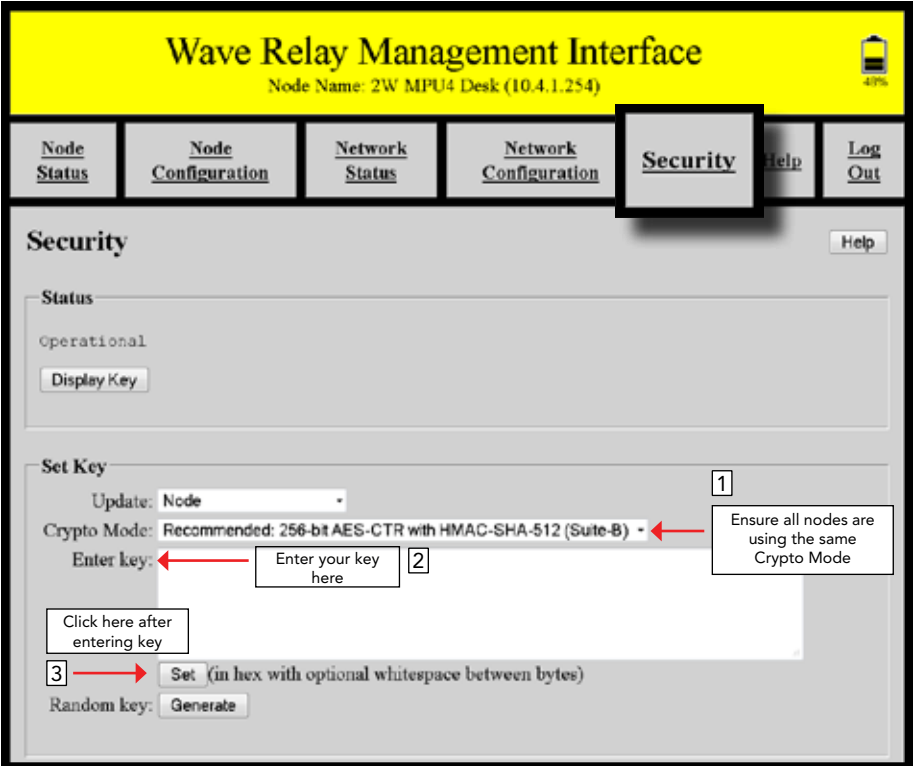
STEP 6: SET AND SAVE SECURITY SETTINGS

A node will not function properly unless it has a valid key. If the "Security" tab in the Web Management Interface is blinking red, then a proper key has not been set. All nodes in a network must use the same Crypto Mode AND Key in order to communicate.

1. Select the "Security" tab in the Web Management Interface.
2. Select a Crypto Mode to match your network requirements.
3. Once the Crypto Mode is set, enter a key value into the field and click "Set" or click "Generate" to generate a random key. The new key information is stored to the node or the network based on the setting in the "Update" menu.

For more information on Security information and selecting Crypto Mode options, refer to the "Security" section.

The key will NOT be stored in the configuration file. The key must be stored separately.

1. Click the "Display Key" button.
2. Select OK on the warning to open the key. Since the key is displayed in plaintext, only open the key in a secure environment.
3. Copy the key to a text file in a secure place on your management computer.

STEPS FOR CONFIGURING THE REMAINING NODES
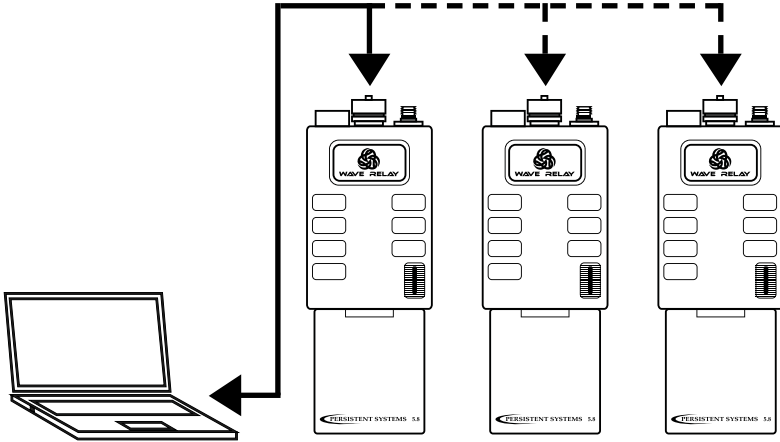
STEPS FOR CONFIGURING THE REMAINING NODES

1. Load Configuration File into All Other Nodes
2. Load Key into All Other Nodes
3. Verify Nodes are Communicating
4. Push Node List to Network
5. Set Management Password

STEP 1: LOAD CONFIGURATION FILE INTO ALL OTHER NODES

When setting up a network of new nodes from the factory, use the configuration file saved in the "Store Configuration File" step to upload the settings from the previously configured node into the new node. During this process, node specific settings (including IP Address, Radio Name, and other radio specific settings) can be configured separately for each node while preserving all other settings from the configuration file.

1. Click "Node Configuration" > "Config Management."
2. In the Load Configuration menu, select "network (require all)" or "network (any available)" to upload configuration settings to all nodes in the network. The "network (require all)" setting will require all nodes in the network be available for any changes to be applied. If not all nodes are available, no changes will be applied. The "network (any available)" setting will apply changes to available nodes only.
3. Click the "Choose File" button to find the the configuration file saved in the "Store Configuration File" step.
4. Click the "Load" button to upload configuration settings to other nodes in the network.

STEP 2: LOAD KEY INTO ALL OTHER NODES

The security key is NOT stored in the configuration file. You must load the key separately.

1. Select the "Security" tab in the Web Management Interface.
2. In the "Set Key" box, select "network (require all)" or "network (any available)" to upload the security key to all nodes in the network. The "network (require all)" setting will require all nodes in the network be available for any changes to be applied. If not all nodes are available, no changes will be applied. The "network (any available)" setting will apply changes to available nodes only.
3. Select the Crypto Mode chosen in Step 6 of First Node Configuration from the drop-down menu.
4. Copy the security key from the text file saved in Step 6 of First Node Configuration and paste the security into the "Enter key" field. All nodes MUST have the same security key to communicate.

STEP 3: VERIFY NODES ARE COMMUNICATING
After nodes have been configured, the connectivity of the nodes should be checked.

1. Ensure that all nodes are turned on, that at least one radio on each node has an antenna and is set to the same channel as the other nodes, and that each node has the same key.
2. Access one of the nodes and verify connectivity to all the nodes. Click "Node Status" > "Neighbor Status." The figure below displays the Node Neighbor Status, which shows which of the node's radios are communicating with other radios. This figure shows that Radio 1 is communicating with one other radio in a neighbor node.
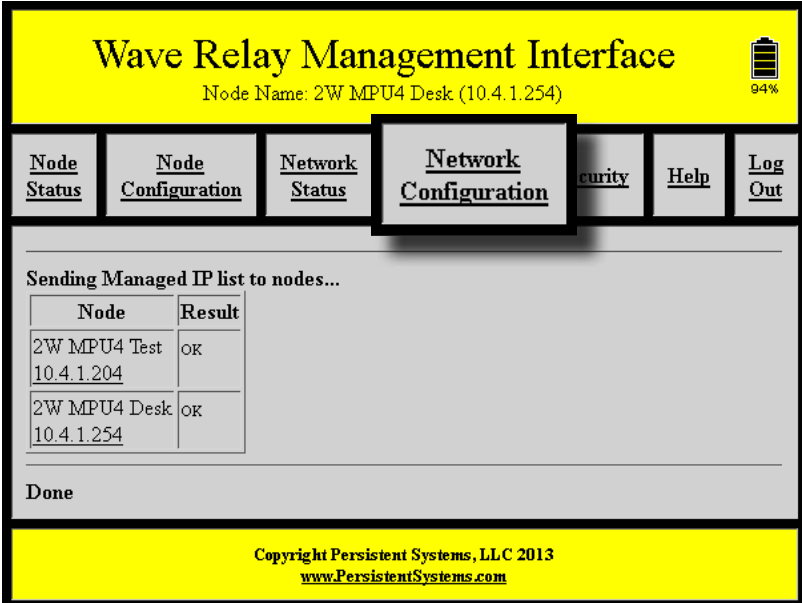
STEP 4: PUSH NODE LIST TO NETWORK
To be able to control configuration settings for the entire network from any node in the network rather than just this node, the user must push the Node List to all other nodes in the network.

1. Click "Network Configuration" > "Network Node List" > "Push Management List to Network." This function will share the Node List configured on this node with all nodes in the Node List.

STEP 5: SET MANAGEMENT PASSWORD
After all nodes have been configured, the management password should be changed.

1. Click "Network Configuration" > "Network Password."
2. Enter the old password in the "Old Password" field.
3. Enter the new password in both "New Password" fields.
4. Click the "Change" button to change the management password. The management password will be changed on all nodes in the node list. The current node list is displayed at the bottom of the page.

NODE LIST

The Node List contains a list of nodes specified by IP Address that are controlled by the Web Management Interface. Any function that resides under Network Status or Network Configuration operates on, and only on, the nodes listed in the node list.

NETWORK VS MANAGED NODES DEFINED

In the context of Wave Relay®, the network is defined as the set of nodes for which routing is possible. These nodes do not need to be specified in the Node List. By contrast, the Node List defines a set of Managed Nodes that are managed by the network operations in the Web Management Interface. That list, however, does not restrict connectivity between nodes specified in the Node List and nodes not specified in the Node List. Therefore, the Node List is just a management tool that defines the list of nodes on which network management functions operate.

In general, the Node List should be updated whenever the network changes in order to ensure that every node has complete and current information and is able to be monitored and controlled by the network operations in the Web Management Interface.

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NETWORK UPGRADE

Network Upgrade installs new firmware versions on large numbers of nodes with one operation. Since network upgrades function on all nodes in the Node List, make sure the Node List is complete and current before performing a Network Upgrade.

1. Click "Network Configuration" > "Network Upgrade."
2. Browse and select the appropriate upgrade file.
3. Check or uncheck "Require All." If checked, the update will be installed if and only if all the nodes in the Node List are accessible. If unchecked, the update will be installed to only those nodes in the Node List that are accessible. Network Upgrades will cause nodes to be reconfigured, an operation that causes a period of downtime. Do not perform Network Upgrades during mission critical operations that cannot tolerate such disruptions. Under such situations, perform Network Upgrades only during scheduled maintenance or other appropriate times.
4. Click the "Upload" button to upgrade firmware for all nodes in the Node List.

NOTE: When upgrading or downgrading a node's firmware, it is normal for the LED to turn off for 30 seconds then turn on.

Do not unnecessarily disturb devices during a Network Upgrade. Loss of power during the Network Upgrade can permanently damage a device.

To receive the latest firmware update:

1. Connect to: http://www.persistentsystems.com/requestfirmwareupdate.php
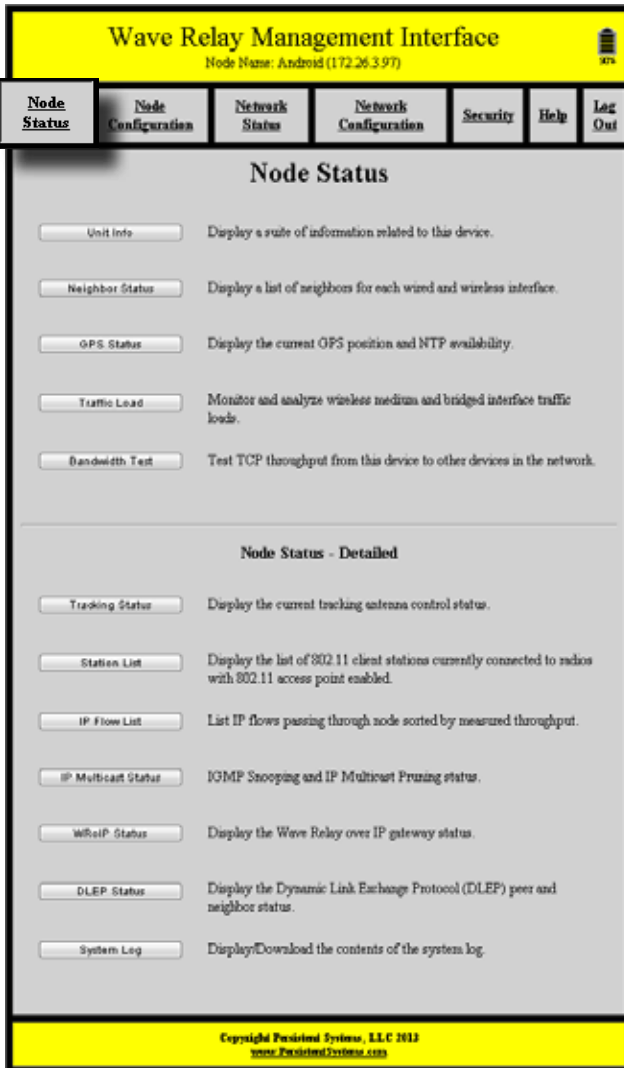2. Fill out all fields on the page.
3. Ensure the "Receive Firmware" box is checked.
4. Click the "Submit Query" button.

WEB MANAGEMENT INTERFACE REFERENCE

PERSISTENT SYSTEMS

NODE STATUS

The "Node Status" tab in the Web Management Interface contains node-specific information for the individual node that the user is connected to.

UNIT INFO
Unit Info displays a list of hardware and software information related to the node.

MENU ITEM	MENU ITEM DESCRIPTION
Firmware Version	Firmware version on node
Serial No.	Serial number of node
Uptime	Operating time since last node power on or reboot
Temperature	Temperature of node
Input Power Voltage	Voltage supplied to node
Real Time Clock Battery	Voltage of real-time-clock keep-alive battery (on units with RTC)
Current System Time	Current system time of node (in both UTC and current time zone if not UTC)
Management HW MAC Address	MAC Address for Management Hardware of node
Radio X HW MAC Address	MAC Address and bandwidth for each radio installed in node (X will vary based on number of radios installed)
Ethernet X HW MAC Address	MAC Address for each ethernet port in node (X will vary based on number of Ethernet ports in node)

NEIGHBOR STATUS

Neighbor Status page displays a list of neighbor nodes that the current node has an RF connection with.

If the neighbor node is in the node list and the "Update Network" operation has been performed, the node's name, IP address, and radio interface will be displayed. Otherwise, the neighbor node's MAC address will be displayed.

Neighbor Status

Interface	Neighbor	Receive SNR
Radio 3	13-A window (172.26.6.50) - Radio 3	6.79
Radio 3	2-B lunchroom window (172.26.6.40) - Radio 4	24.87
Radio 3	2-B mainroom window (172.26.6.70) - Radio 3	46.27
Radio 3	2-D DH desk (Receiver) (172.26.0.121) - Radio 1	30.83
Radio 3	2-E JH_EL desk (172.26.0.145) - Radio 1	45.53

[Return to Menu]   [MANET Monitor]

MENU ITEM	MENU ITEM DESCRIPTION
Interface	Each interface in use on node
Neighbor	Name, IP address, and interface of each neighbor node
Receive SNR	Signal-to-Noise Ratio at which local node hears remote node

GPS STATUS

Position Update Status:

MENU ITEM	MENU ITEM DESCRIPTION
Source	GPS information source
Latitude	Latitude of current node
Longitude	Longitude of current node
Altitude	Altitude above sea level of current node

System Clock Status:

When the system clock was set by GPS
Current system time

Internal GPS Status:

MENU ITEM	MENU ITEM DESCRIPTION
Fix Type	How node is connected (3D, 2D, or none)
Latitude	Latitude of current node
Longitude	Longitude of current node
Altitude	Altitude above sea level of current node
Speed	Speed of node (m/s) in the horizontal plane
Track	Path of travel with respect to the Earth expressed in degrees - 000 degrees is North (angle increases clockwise through 360 degrees)
Climb	Speed of node (m/s) in the vertical plane
Fix Time	When node obtained a satellite fix
Number of satellites	Number of satellites node is connected to
ID/PRN	ID/PRN of each satellite node is connected to
Signal	Strength of the connection between node and each satellite
NTP Server	Status of the NTP server (available or unavailable)

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TRAFFIC LOAD

Traffic load monitors and analyzes the trafffic load on the wireless and wired networking interfaces on the node.

Channel Usage:

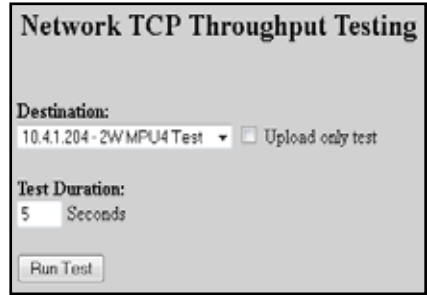| MENU ITEM	MENU ITEM DESCRIPTION
Sent	Transmission duty cycle of wireless medium usage
Received	Receiving transmission duty cycle of wireless medium usage
Noise	Duty cycle of wireless medium usage: Occupied by noise
Used	Total duty cycle of wireless medium usage
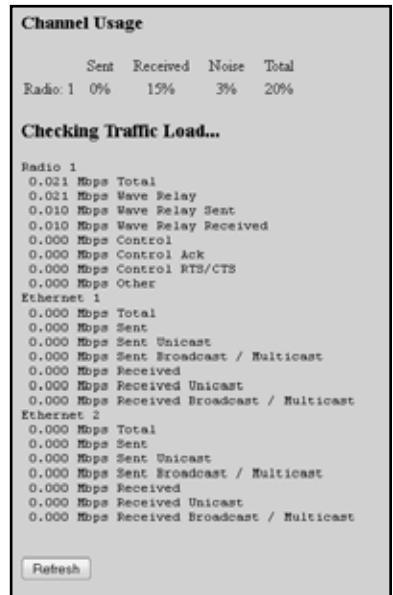
Checking Traffic Load:

MENU ITEM	MENU ITEM DESCRIPTION
Mbps Total	Total Mbps used on this interface
Mbps Wave Relay®	Total Mbps used by Wave Relay®
Mbps Wave Relay® Sent	Mbps used by Wave Relay® to send
Mbps Wave Relay® Received	Mbps used by Wave Relay® to receive
Mbps Control	Total Mbps used for control functions
Mbps Control Ack	Mbps used to control ACK
Mbps Control RTS/CTS	Mbps used to control RTS/CTS
Mbps Other	Mbps used for other functions
Mbps Sent	Total Mbps used for all transmissions
Mbps Sent Unicast	Mbps used for Unicast transmissions
Mbps Sent Broadcast/Multicast	Mbps used for Broadcast/Multicast transmissions
Mbps Received	Total Mbps used to receive all transmissions
Mbps Received Unicast	Mbps used to receive Unicast transmissions
Mbps Received Broadcast/Multicast	Mbps used to receive Broadcast/Multicast transmissions

BANDWIDTH TEST
Bandwidth Test is a tool for testing the data throughput from the node to another node in the network. It is recommended to perform at least a 5 second throughput test.

Wave Relay® nodes run a TCP iPerf server. To perform a TCP throughput test through the iPerf server, use the command "iperf -c X" (X is the IP address of the node) from the command line.

Network TCP Throughput Testing

Destination:
10.4.1.204 - 2W MPU4 Test ▾ ☐ Upload only test

Test Duration:
5   Seconds

Run Test

WARNING: Windows has known issues running iPerf and does not give true bandwidth readings. Contact Persistent Systems for more information.

TO PERFORM A THROUGHPUT TEST:

1. Select destination node for throughput test from drop-down menu. Desired destination node must be in Node List for it to appear on this menu.
2. Check or uncheck "Upload only test." If this box is checked, throughput test will only test upload to destination node.
3. Enter desired throughput test duration (in seconds) into "Test Duration" field. Caution: during tests of long duration, data will continue to be sent for the full specified duration even if a different data flow is started or the web browser is exited.
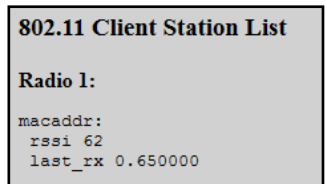
TRACKING STATUS

Tracking Status displays relevant antenna tracking status and diagnostic information.
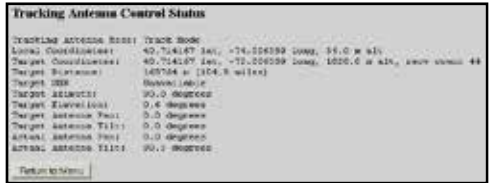
MENU ITEM	MENU ITEM DESCRIPTION
Tracking Antenna Mode	Tracking configuration of node
Local Coordinates	Coordinates of tracking node
Target Coordinates	Coordinates of tracked node
Target Distance	Distance of tracked node from tracking node
Target SNR	Signal-to-Noise ratio between tracking node and tracked node
Target Azimuth	Azimuth of tracked node
Target Elevation	Elevation of tracked node
Target Antenna Pan	Calculated necessary horizontal position of Tracking Antenna in degrees clockwise from North
Target Antenna Tilt	Calculated necessary vertical position of Tracking Antenna expressed in degrees
Actual Antenna Pan	Current horizontal position of Tracking Antenna in degrees clockwise from North (will only pan when Target changes at least 0.5 degrees from Actual)
Actual Antenna Tilt	Current vertical position of Tracking Antenna in degrees (will only tilt when Target changes at least 0.5 degrees from Actual)

STATION LIST

Station List displays the list of 802.11 client stations currently connected to radios with the 802.11 access point feature enabled.

MENU ITEM	MENU ITEM DESCRIPTION
macaddr	MAC Address of client device connected to access point
rssi	Strength of signal to client device
last_rx	Time (in seconds) since a packet was last received

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IP FLOW LIST
IP Flow List lists IP data flows passing through node sorted by measured throughput.

MENU ITEM	MENU ITEM DESCRIPTION
Mbit/s	Speed of each IP data flow in Mbps
Pkt/s	Number of packets transferred each second for each IP data flow
Total bytes	Number of bytes transferred for each IP data flow
Destination IP	IP address of destination node
Source IP	IP address of source node
Direction/Interfaces	Direction of and interfaces used by each IP data flow (MANET, Ethernet X, or this node)

IP MULTICAST STATUS
IP Multicast Status displays IGMP Snooping and IP Multicast Pruning status. This feature shows a table with a row for each multicast group, displaying an "F" if that group is forwarded over the MANET, or a "-" if it is not.

There are known issues with IGMP in Windows XP.

MENU ITEM	MENU ITEM DESCRIPTION
Group	Multicast address of nodes connected to managed node
Registered to receive packets for group	Interface used to receive data for each multicast address (Ethernet X or MANET)

WRoIP STATUS
WRoIP Status displays the Wave Relay® over IP gateway status.

MENU ITEM	MENU ITEM DESCRIPTION
Gateway	Which gateway the node is connected to as well as the priority of that gateway
Elected	Whether the gateway is elected or not
Election Priority	Election priority of the gateway over other gateways/number of other WRoIP gateways on the IP network.
WRoIP gateways detected	Displays names of detected WRoIP gateway nodes

When connected to a WRoIP-configured node, the Neighbor SNR status page for the node will NOT display other nodes connected over WRoIP. Instead, these nodes will be displayed on the MANET Monitor page with a SNR of "-" since they are not connected via radio.

For detailed information, see the Cloud Relay™ Manual

DYNAMIC LINK EXCHANGE PROTOCOL (DLEP) STATUS
The DLEP Status page shows if the DLEP services is running, what port, who it's connected to and the status of it. It also contains the status of the associated neighbors.

It is also possible to set the status of DLEP on the Cisco Router side.

SYSTEM LOG
The System Log page displays a history of node management operations. The "Refresh" button reloads the system log to add more recent operations. The "Download" button allows the user to download the log to the computer.

NODE CONFIGURATION

The "Node Configuration" tab in the Web Management Interface contains configuration options for managing an individual node. Click "Node Configuration" > "Node Configuration" to access basic Node Configuration settings.

SHOW/HIDE ADVANCED FIELDS

For convenience, this button allows you to show (or hide) many of the less frequently used node configuration fields. The default is to hide the advanced fields (and thus display a briefer page). If you choose to show the advanced fields, your choice will remain in effect when you revisit the page. Advanced fields are indicated as such in the descriptions below.

MANAGEMENT SETTINGS

MENU ITEM	MENU ITEM DESCRIPTION
Node Name	Nodes can be assigned a unique name which is displayed in all of the management status functions.
IP Address	A node IP address can be assigned to allow IP connectivity. The IP address is generally used for node management functions. An IP address is not required for actual network operation, only for management and configuration.
Netmask	This field defines the netmask for the Web Management Interface.
Gateway	This field defines the default gateway if a default gateway is required. The gateway must be set to an IP address on the same subnet as the IP address for the node.
VLAN ID (advanced)	This setting configures this node's management port VLAN ID. Management features will ONLY be accessible to the specified VLAN (traffic to/from all other VLANs is blocked/filtered).

MANET (ADVANCED)

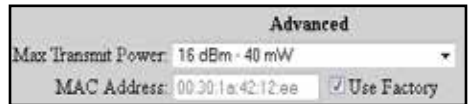| MENU ITEM	MENU ITEM DESCRIPTION
IP Multicast Routing	AUTO: Node will prune multicast packets that are not requested (default, most efficient setting for network). PULL ALL MULTICAST: Node will accept all multicast packets it hears on the network. Note: Windows CE/XP computers do not respond to IGMP Multicast Group Queries sent by Wave Relay nodes. "Pull All Multicast" should be used in networks with Windows CE/XP computers to work around this issue.
Root Gateway Priority (advanced)	**HIGH:** Any node in your network directly connected to wired infrastructure should have priority set to "HIGH." **MEDIUM:** All other non-mobile routers should be set to "MEDIUM." **LOW:** Mobile routers should be set to "LOW."
DHCP Server Filter (advanced)	**ALLOW:** Device will pass DHCP messages FROM a DHCP server which is bridged directly by one of its interfaces. Only the devices which are directly wired to the switch where the DHCP server resides need to be set to "ALLOW." **BLOCK:** Device will not bridge any DHCP reply packets that it picks up off of any of its bridged interfaces. By setting all of the nodes in the network (except the nodes physically connected to the real DHCP server) to "BLOCK," you will ensure that users of your system will always use the correct DHCP server.
SNAP OUI (advanced)	Controls the Subnetwork Access Protocol Organizationally Unique Identifier - The factory OUI, 0018A6, is registered to Persistent Systems, LLC with the IEEE. SNAP OUI is used to identify Wave Relay® packets. Changing this field allows the user to obscure which protocol is being used by the system. All nodes must be set to the same value or they will not communicate.

RADIO CONFIGURATION (BASIC RADIO SETTINGS)
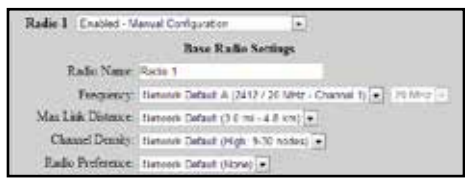
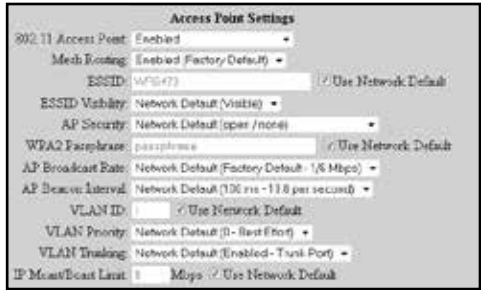| MENU ITEM	MENU ITEM DESCRIPTION
Name	Each radio can be assigned a name to be used in status functions.

PERSISTENT SYSTEMS

Frequency	Each radio should be a assigned a frequency. Two radios must be set to the same frequency in order to communicate. If the radio is configured to use a "Network Default" channel, the radio's channel assignment can be managed globally by clicking "Network Configuration" > "Network Defaults." Ensure that the frequency is set to match the radio installed in the unit. A warning will be displayed if the frequency setting does not match the radio hardware.
Bandwidth	Each radio should be assigned a bandwidth. Two radios must be set to the same bandwidth in order to communicate. Bandwidth should be increased for shorter distances and decreased for increased distances.
Max Link Distance	The Max Link Distance should be set to the upper bound of how long any individual link in the network may need to be. All nodes on the network MUST be set to the same Max Link Distance.
Channel Density	The channel density setting controls how aggressively the radios compete for access to the shared medium. A number of nodes will be displayed in parentheses after each menu item. Choose the menu item that corresponds to the number of nodes in your network.
Radio Preference	Radio Preference instructs the routing protocol to prefer links on a radio (consider them lower cost than normal). This can be used to help shift traffic towards radios running on certain channels. **None:** None is the default factory setting. All links are considered equally. **Medium:** Routing protocol is more likely to use this radio to forward traffic. **High:** Routing protocol is significantly more likely to use this radio to forward traffic.

RADIO CONFIGURATION
(ADVANCED RADIO SETTINGS)

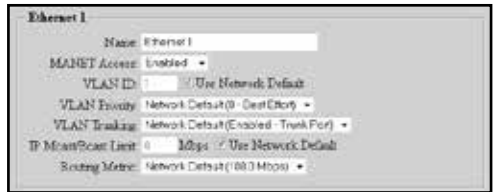| MENU ITEM	MENU ITEM DESCRIPTION
Max Transmit Power (advanced)	Max Transmit Power will control the radio's maximum output power. In general, this configuration is only used to reduce the output power of a radio for regulatory compliance reasons. The factory default setting should provide the best communication performance (highest power) in all other situations.
MAC Address (advanced)	A custom MAC address may be used for this radio. The entered value MUST be different from ALL other radio MAC addresses used in the same network or with the same encryption key. All radios are factory configured with a globally unique MAC. Since the MAC address is unencrypted, using a custom MAC that is periodically changed can help prevent identification and tracking of the same device across multiple uses.

ACCESS POINT SETTINGS (ADVANCED)

MENU ITEM	MENU ITEM DESCRIPTION
802.11 Access Point (advanced)	2.4GHz and 5.8GHz radios can be configured to function as an 802.11 access point. Standard clients such as laptops with built in 802.11 cards may access this system. If the AP is disabled, the ESSID and Beacon Interval configuration options have no effect. For maximum performance, always disable the 802.11 AP unless it is required. To use a radio as a 802.11 Access Point, the radio MUST be set to a valid 802.11 frequency and the channel width MUST be set to 20MHz.
The following fields are only visible when the 802.11 Access Point is "Enabled."	
Mesh Routing (advanced)	The Mesh Routing setting enables per radio selection of which radios participate in the multi-hop mesh routing process. In a multi-radio node where the user may only want the mesh running on the backhaul radios, this setting enables the user to specifically disable the mesh on the client access radios. Be aware that if a node is only accessible via the mesh and mesh routing is disabled, connection will be lost to that node.
ESSID (advanced)	Sets the name of the network that the access point advertises to clients.
ESSID Visibility (advanced)	The ESSID can be configured to be "Visible" or "Hidden." Generally, the ESSID is configured to be "Visible" to make it easy for clients to connect to the access point. For additional security/privacy the ESSID can be configured as "Hidden."
AP Security (advanced)	Enables or disables 802.11 security on the Access Point - Only WPA2-PSK (Wi-Fi Protected Access v2 with pre-shared keys) is supported.
WPA2 Passphrase (advanced)	Sets a shared passphrase when AP Security is set to WPA2 - The passphrase should be an ASCII string of length 8-63 characters, excluding these characters: ',"\&/<>
AP Broadcast Rate (advanced)	Controls the rate at which broadcasts are transmitted from an 802.11 Access Point - Increasing this rate can significantly increase network capacity but will reduce the range of client connectivity. If the rate is set too high, client devices will have trouble receiving broadcast packets from the 802.11 access point.

AP Beacon Interval (advanced)	The 802.11 access point can send beacons at an interval between twice and ten times per second.
VLAN ID (advanced)	Each 802.11 AP is a VLAN-aware bridge port. Each port is as-signed a VLAN ID. Untagged frames received by the port are tagged with the specified VLAN ID. Frames that are sent by the port which have a VLAN tag matching the specified VLAN ID will have their tags removed (i.e. they are sent by the port untagged).
VLAN Priority (ad-vanced)	Specifies the 802.11 priority of the VLAN tag added to untagged frames received by this port
VLAN Trunking (ad-vanced)	Controls the filtering of VLAN tagged frames that do NOT match this port's VLAN ID - Trunking enabled: ALL non-matching VLAN tagged frames are passed (no filtering). Trunking disabled: all non-matching VLAN tagged frames are blocked (filtered).
IP Mcast/Bcast Limit (advanced)	Defines the maximum bandwidth allowed for IP multicast or broadcast network traffic received on the given interface and retransmitted onto the Wave Relay® network - Traffic in excess of this limit will be dropped. Units are megabits/sec (Mbps). To disable the limit, set to zero.

ETHERNET CONFIGURATION (ADVANCED)

MENU ITEM	MENU ITEM DESCRIPTION
Name (advanced)	A name can be assigned to each Ethernet interface.
MANET Access (advanced)	Controls whether MANET traffic is available on a wired Ethernet port - This setting is useful in cases where the node is physically situated in an insecure location, and you want to prevent casual passersby from eavesdropping on the MANET by physically plugging into the Ethernet port (in this case, be sure to disable access for all wired Ethernet interfaces on the node). The default setting is "Enabled," i.e. the MANET traffic is available on the Ethernet port. Note: the permanent factory IP address for the node is still available on the Ethernet port, regardless of this setting. In addition, two Wave Relay® nodes connected via wired Ethernet can still communicate via encrypted link regardless of this setting.
VLAN ID (advanced)	Each Ethernet interface is a VLAN-aware bridge port. Each port is assigned a VLAN ID. Untagged frames received by the port are tagged with the specified VLAN ID. Frames that are sent by the port which have a VLAN tag matching the specified VLAN ID will have their tags removed (i.e. they are sent by the port untagged).

VLAN Priority (advanced)	Specifies the 802.11 priority of the VLAN tag added to untagged frames received by this port
VLAN Trunking (advanced)	Controls the filtering of VLAN tagged frames that do NOT match this port's VLAN ID - Trunking enabled: ALL non-matching VLAN tagged frames are passed (no filtering). Trunking disabled: all non-matching VLAN tagged frames are blocked (filtered).
IP Mcast/Bcast Limit (advanced)	Defines the maximum bandwidth allowed for IP multicast or broadcast network traffic received on the given interface and retransmitted onto the Wave Relay® network - Traffic in excess of this limit will be dropped. Units are megabits/sec (Mbps). To disable the limit, set to zero.
Routing Metric (advanced)	Defines link capacity for the routing protocol - A value lower than the 100 Mbps default should be used when nodes are connected via non-switched Ethernet (e.g. a third-party point-to-point wireless link). The metric allows the routing protocol to make an intelligent decision whether it is better to route over this Ethernet port or use a faster alternate route.

USB ETHERNET (ADVANCED)

MENU ITEM	MENU ITEM DESCRIPTION
USB Ethernet Charging Power	Controls how an EUD connected via a USB Ethernet cable receives a charge from the node - Should be set to "Always On" for the Samsung Note/Note II/Note III, Motorola EUDs, and Nexus 7 and "Carrier Sense" for the Samsung Galaxy SII 9100G.

DHCP SERVER (ADVANCED)

If enabled, the DHCP server will serve IP addresses to devices connected to the node via the wired Ethernet or wireless 802.11 Access Point interfaces.

MENU ITEM	MENU ITEM DESCRIPTION
DHCP Server Scope	Selects which DHCP clients the DHCP server serves IP addresses to. "Local Ethernet/AP Only" serves IP addresses to nodes connected via Ethernet or a wireless 802.11 Access Point. "Entire Network" serves IP addresses to all nodes in the network. "Local Ethernet/AP Only" is the recommended setting.
Address Range Start	Start of range of IP addresses assigned to DHCP clients
Address Range End	End of range of IP addresses assigned to DHCP clients
Netmask	Netmask assigned to DHCP clients
Default Gateway	Gateway assigned to DHCP clients
DNS Server 1	Primary DNS server assigned to DHCP clients
DNS Server 2	Secondary DNS server assigned to DHCP clients
WINS Server	WINS server assigned to DHCP clients
Lease Time	DHCP lease time (defaults to 1 hour)
Show Leases	Displays the MAC and IP address of assigned DHCP leases
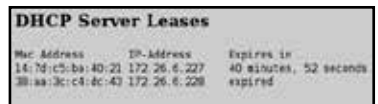
WAVE RELAY® OVER IP (WRoIP) (ADVANCED)

WRoIP allows the Wave Relay® network to extend over and seamlessly interact with a large routed IP network. In order to use this capability, one or more Wave Relay® nodes must be setup as WRoIP gateways. A WRoIP gateway must be directly connected to an appropriately configured IP router.

See Cloud Relay™ Manual

MENU ITEM	MENU ITEM DESCRIPTION
WRoIP (advanced)	WRoIP gateway nodes must have the WRoIP protocol enabled on the interface directly connected to the IP router. All other nodes should have the WRoIP protocol disabled. When the WRoIP protocol is enabled on an interface, the interface will no longer function as a normal Wave Relay® Ethernet port for connecting Ethernet devices: it will only work for connecting the IP router.
Multicast Routing Mode (advanced)	Selects pruning options for multicast traffic: IP Router Controlled (default): All multicast packets travel to the cloud network Wave Relay Controlled: Only subscribed multicast feeds are passed to the cloud network to reduce network traffic congestion.
IP Address (advanced)	Defines the IP address of the WRoIP gateway in the IP subnet specific to the directly connected IP router interface - WRoIP protocol packets will be sent over the IP network using this IP address.
Netmask (advanced)	Defines the netmask of the IP subnet specific to the directly connected IP router interface
Gateway (advanced)	Defines the IP address of the IP router in the IP subnet specific to the directly connected IP router interface - WRoIP protocol packets will be forwarded to this IP address in order to be sent over the IP network.
MTU (advanced)	Defines the maximum transmissible unit size for the IP network - WRoIP protocol packets sent over the IP network will be limited to this MTU. All nodes that communicate over the IP network should be set to the same value.
Multicast Address (advanced)	Defines the multicast IP address used by the WRoIP protocol - The next higher IP multicast address will also be used by the WRoIP protocol. For example, if 239.255.90.67 is set as the multicast address, both 239.255.90.67 and 239.255.90.68 will be used.
UDP Port (advanced)	Defines the UDP port used by WRoIP protocol packets

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NODE CONFIGURATION FOR DLEP
Dynamic Link Exchange Protocol (DLEP) (advanced):

DLEP is used to transmit characteristics and metrics of the wireless network to a connected DLEP-capable router such as the Cisco 5915. This feature is available on all Wave Relay® versions. It supports DLEP Draft 00.

The Wave Relay® MANET operates at Layer 2 of the OSI mode. The DLEP protocol runs between a router and its attached Wave Relay device, allowing the Wave Relay® to communicate link characteristics as they change, and convergence events (acquisition and loss of potential Layer 3 (L3) routing neighbors). Upon receipt of the signal, the local router may take whatever action it deems appropriate, such as initiating L3 discovery protocols, and/or issuing HELLO messages to converge the network on L3. On a continuing, as-needed basis, the Wave Relay devices utilize DLEP to report any characteristics of the link (bandwidth, latency, etc)to the L3 router that have changed. DLEP is independent of the link type and topology supported by the Wave Relay.

- DLEP (advanced): Enable/disable the DLEP subsystem.
- Local UDP Port (advanced): UDP port on the Wave Relay to receive DLEP traffic from the router.
- Router IP Address (advanced): Network address of the DLEP-capable router.
- Router UDP Port (advanced): UDP port on the DLEP-capable router for receiving DLEP packets.

POSITION

The node's position must be specified in order to provide data to the visualization, CoT, and tracking features. The position may be specified via internal or external GPS, manually, or from an external feed.
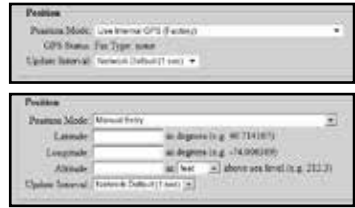
Position Mode:

MENU ITEM	MENU ITEM DESCRIPTION
Determines the source of local positioning information	
Use Internal GPS	Instructs node to receive GPS position information from the optional integrated GPS module - This control should not be enabled on a device that does not have an integrated GPS module or if a suitable GPS antenna with satellite connectivity is not attached.
Use External GPS	Instructs node to receive GPS position information from an external GPS device connected via the node's onboard serial port - A standard NMEA data stream is supported with the following RS-232 settings: 4800 baud, 8-N-1, no flow control. Higher baud rates are also autodetected. Note that this option is disabled on Wave Relay® units without serial connectors or units already using the serial port for other features (e.g. antenna tracking).
Manual Entry	Allows manual entry of latitude, longitude, and altitude.
Use External Feed	Instructs node to receive positioning information over the network via the external Wave Relay® 'wr-update-gps' command
Use ESD Feed	Instructs node to receive positioning information over the network via a ESD (Exploitation Support Data) feed
Use CoT Feed	Instructs node to receive positioning information over the network via a CoT (Cursor on Target) feed. This feature is not available on all firmware versions.
Use CDF Feed	Instructs node to receive positioning information over the network via Shadow CDF (Common Data Feed)
GPS Status	Displays the current status of the GPS (only visible in "Use Internal GPS" mode)

Latitude	Allows the user to manually define the node's latitude in decimal degrees (only visible in "Manual Entry" mode)
Longitude	Allows the user to manually define the node's longitude in decimal degrees (only visible in "Manual Entry" mode)
Altitude	Allows the user to manually define the node's altitude in feet above GPS ellipsoid - approximately equal to feet above mean sea level (MSL) (only visible in "Manual Entry" mode)
External Update UDP Port	Defines the port number to receive position updates via the external Wave Relay® 'wr-update-gps' command (only visible in "Use External Feed" mode)
ESD UDP Port	Defines the port number to receive position updates via an external ESD feed (only visible in "Use ESD Feed" mode)
CoT UDP Port	Defines the port number to receive position updates via external CoT feed (only visible in "Use CoT Feed" mode)
CDF UDP Port	Defines the port number to receive position updates via an external CDF feed (only visible in "Use CDF Feed" mode)
Update Interval	Controls how often nodes report information back to visualiziation server with visualization enabled - Smaller values allow finer mobile node movements in Google™ Earth. Shorter update intervals require more bandwidth.

WAVE RELAY® SA (GOOGLE™ EARTH NETWORK VISUALIZATION)

MENU ITEM	MENU ITEM DESCRIPTION
Report to Server	Sending visualization updates can be individually enabled or disabled on each node. Setting "Network Default," allows visualization to be turned on and off for the entire network at once via the Network Default configuration. Note that the selected server IP address is displayed here but is configured as part of the Network Default configuration. Visualization is also used by the Tracking Antenna system and should be enabled on nodes that you wish to track.
Icon	The user may select an icon that will be used to identify the node in Google™ Earth.

CURSOR ON TARGET (COT) SETTINGS

This feature enables transmission of local position-
ing information to a CoT server on the network.
This feature is not available on all firmware ver-
sions.

MENU ITEM	MENU ITEM DESCRIPTION
Send Position	Enables or disables transmission of CoT packets to server
Server IP	Defines the IP address of the CoT server - This IP address can be a unicast or multicast address
Server Port	Defines the UDP port of the CoT server
UID	Defines the contents of the CoT "uid" attribute
Type	Defines the contents of the CoT "type" attribute
Video Address	Defines the contents of the CoT "Video Address" attribute

SIMPLE SA PACKET GENERATOR (SSPG) (ADVANCED)

These settings exist for backwards compatability with an outdated protocol. See
earlier versions of the manual for more information.

PERSISTENT SYSTEMS

CONFIGURATION MANAGEMENT

A Master Configuration File allows the user to associate IP addresses, configuration files, and names with specific nodes.

See RCT Tool Manul

CREATING A MASTER CONFIGURATION FILE
1. Create a temporary directory in an easy to find location with a recognizable name.
2. Connect a node to the computer and set configuration as desired.
3. Click "Node Configuration" > "Config Management."
4. Click the "Store" button. A prompt will appear to choose where to save the configuration file. Save the configuration file to the directory created in Step 1.
5. Repeat steps 2 - 4 for each configuration file that will be uploaded to nodes. Ensure all configuration file names are unique.
6. In Microsoft Excel, create a spreadsheet with 4 columns: Serial Number, IP address, Profile, and Name.

	A	B	C	D
1	Serial Number	IP Address	Profile	Name
2	1447	172.26.3.90	PROFILE1	Unit 1
3	1448	172.26.3.91	PROFILE1	Unit 2
4	1449	172.26.3.92	PROFILE2	Unit 3
5	1450	172.26.3.93	PROFILE3	Unit 4

7. For each node to be managed by the Master Configuration File, enter that node's Serial Number, IP address, the name of the configuration file saved in Step 4 to be uploaded to the node, and the name of the node. Ensure all IP addresses and names are unique.

File name: Master Config File.csv
Save as type: CSV (Comma delimited) (*.csv)

8. Click "File" > "Save As" and save the spreadsheet as a CSV (Comma delimited) .csv file with a recognizable name in the directory created in Step1.
9. Create a .zip file containing the CSV file created in Step 8 and ALL configuration files created in Step 4.

UPLOADING A MASTER CONFIGURATION FILE

1. Ensure all nodes in the Master Configuration File are in the node list.
2. Click "Node Configuration" > "Config Management."
3. In the Load Configuration menu, select "network (require all)" or "network (any available)" to upload configuration settings to all nodes in the network. The "network (require all)" setting will require all nodes in the network be available for any changes to be applied. If not all nodes are available, no changes will be applied. The "network (any available)" setting will apply changes to available nodes only.
4. Click the "Choose File" button to find the the .zip file created in Step 9 above.
5. Click the "Load" button to upload configuration settings to other nodes in the network.
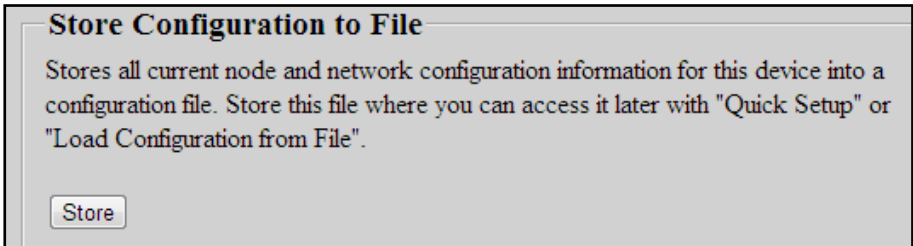
STORE CONFIGURATION TO FILE

Clicking the "Store" button allows the web browser to download the node's configuration settings as an encrypted file. Environment variables, node lists, and network defaults are stored.

THE CRYPTO KEY IS NOT STORED IN THE CONFIGURATION FILE.

QUICK SETUP

Both "Load Configuration from File" and "Quick Setup" load configuration settings from a configuration file. The difference between the functions is that "Quick Setup" loads all the configuration settings from a file (except Node Identifiers), whereas "Load Configuration from File" loads user-selected configuration categories. Quick Setup facilitates the configuration of a large number of nodes when the nodes share identical configuration settings. Note specifically that the only configuration categories that must be specified when using Quick Setup are Node Identifiers, which include IP Address, Node Name, and SSPG SA ID.

1. Click "Node Configuration" > "Config Management." Scroll down to the "Quick Setup" menu.
2. Click the "Base Configuration File" field or the "Browse..." button and select the configuration file to load to the device. Note that the configuration file should be from a device with the same firmware version and hardware setup (e.g. numbers and types of radios) as the device to which it is being uploaded.
3. Insert the IP Address, Node Name, SSPG SA ID, and SSPG SA Name to be set to the device.
4. Click the "Quick Setup" button. All settings from the configuration file will be applied to the device except IP Address, Node Name, SSPG SA ID, and SSPG SA Name, which will populate from the values specified.

RESET TO FACTORY CONFIGURATION

The Web Management Interface contains a "Reset to Factory Configuration" feature to remove all custom configuration and restore the node to its factory settings.

1. Click "Node Configuration" > "Config Management." Scroll to the bottom of the page. Resetting the node to its factory settings will remove all custom configuration and will reset the IP address to 10.4.1.254.
2. To retain the node name and IP address after the reset, ensure that the box labelled "Keep node name and IP address" is checked. The node's Crypto Key will NOT be zeroized. For instructions on how to zeroize the Crypto Key from the Security Configuration page, refer to the "Security" section.
3. When you are ready to remove all custom configuration and restore the node to its factory settings, click the "Reset" button.

PERSISTENT SYSTEMS
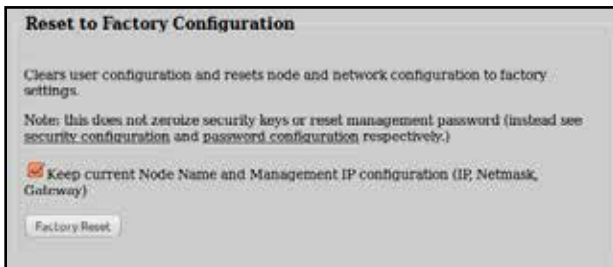
TRACKING ANTENNA CONTROL

For information on setting up the Tracking Antenna Control system hardware, please refer to the Tracking Antenna Manual.

TRACKING CONFIGURATION

To enable the tracking antenna control system, go to the "Node Configuration" tab and click on the "Tracking Configuration" button. On the drop down menu, select "Enabled" next to the Tracking Antenna Control option.
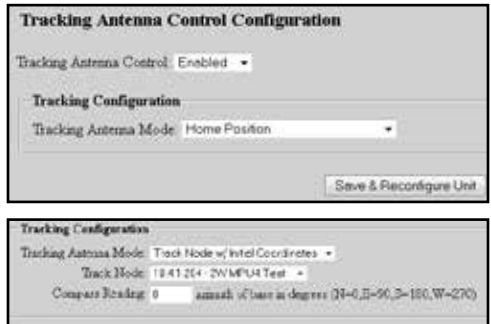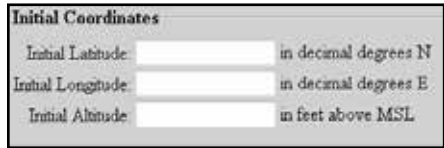
MENU ITEM	MENU ITEM DESCRIPTION
Tracking Antenna Mode	Use this menu to choose the source of the coordinates to track or to return the Pan/Tilt unit to its home position for storage. Possible tracking sources include another Wave Relay®, a ESD (Exploitation Support Data) feed, a CoT (Cursor on Target) feed, or CDF (Common Data Feed).
Home Position	Returns the Pan/Tilt unit to its home position for storage
Track Node	Instructs the node to track another Wave Relay® node position - This function works by receiving Wave Relay® visualization packets from the chosen node. Be sure that the tracked node is configured to transmit Google™ Earth Network Visualization packets.
Track Node w/ Initial Coordinates	This setting is the same as the "Track Node" setting (instructs the node to track another Wave Relay® node position), but also allows manual entry of initial coordinates in cases where no position has yet been received from the tracked Wave Relay® node.
Track via ESD Feed	Points the antenna based on coordinate data received via an external ESD feed
Track via CoT Feed	Points the antenna based on coordinate data received via an external CoT feed
Track via CDF Feed	Points the antenna based on coordinate data received via an external CDF feed
Track Node	Selects a Wave Relay® node to track from the Node List
ESD UDP Port	Defines the port number to receive coordinate updates via an external ESD feed

CoT UDP Port	Defines the port number to receive coordinate updates via an external CoT feed
CDF UDP Port	Defines the port number to receive coordinate updates via an external CDF feed
Compass Reading	Specifies the heading of the Pan/Tilt unit - The heading is defined as the compass reading taken when standing behind the Pan/Tilt unit while facing the large circular electrical connector. For more information, see the compass reading step of the setup procedure.

INITIAL COORDINATE SETTINGS

These fields allow specification of the initial antenna target location in cases where coordinates have not yet been received from the tracked node.
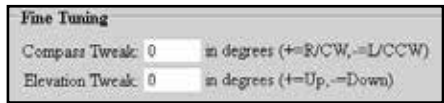
MENU ITEM	MENU ITEM DESCRIPTION
Initial Latitude	Sets the tracked node's initial latitude in decimal degrees
Initial Longitude	Sets the tracked node's initial longitude in decimal degrees
Initial Altitude	Sets the tracked node's initial altitude in feet above GPS ellipsoid, which is approximately equal to feet above mean sea level (MSL)

FINE TUNING SETTINGS

MENU ITEM	MENU ITEM DESCRIPTION
Compass Tweak	Defines the heading correction factor for tracking, specified in decimal degrees - Use a positive number for right/clockwise correction and a negative number for left/counterclockwise correction.
Elevation Tweak	Defines the elevation correction factor for tracking, specified in decimal degrees - Use a positive number for upward correction and a negative number for downward correction.

PUSH-TO-TALK (PTT)
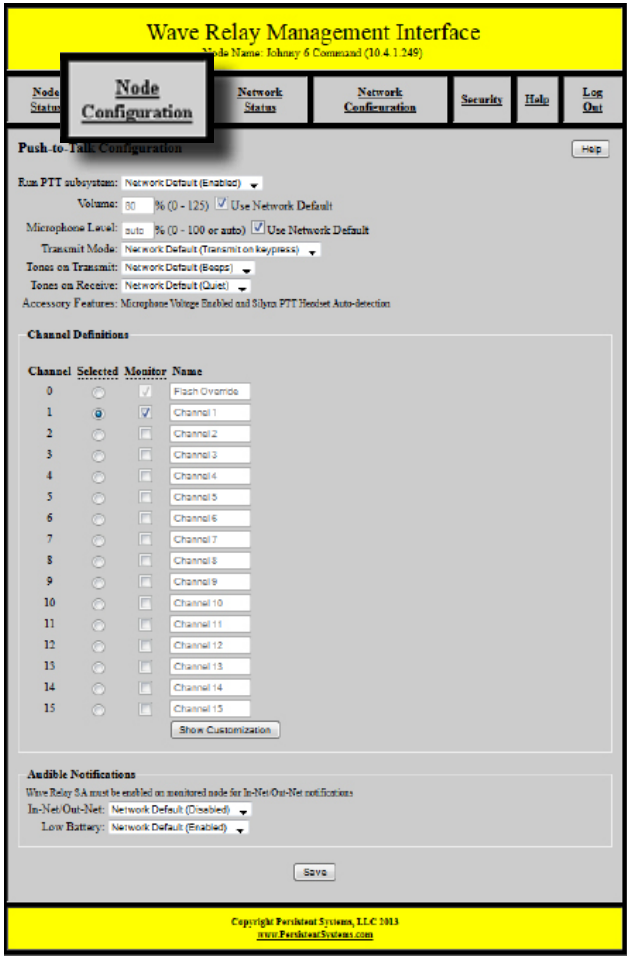
Push-to-Talk (PTT) voice is supported on all Wave Relay® nodes. By default, Wave Relay® supports single-channel PTT voice on a specified multicast IP address and port. You can "switch channels" by specifying an alternate IP address or port. Users can talk or listen (but cannot do both simultaneously). Transmissions from an individual user are broadcast to all other users on the network. Only one person can talk at a time. If a user tries to talk when another user is transmitting, a busy tone will be heard.

To configure Push-to-Talk settings, click "Node Configuration" > "PTT Configuration."

PUSH-TO-TALK CONFIGURATION
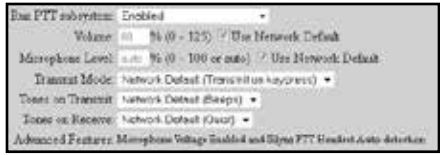
MENU ITEM	MENU ITEM DESCRIPTION
Run PTT subsystem	Enables or disables push-to-talk voice
Volume	Defines the default earpiece volume for headsets - Valid values are 0 through 125 (Values above 100 are digitally amplified)
Microphone Level	Defines the default microphone level for headsets - Valid values are 0 through 100 or "auto." The "auto" configuration uses automatic gain control for microphone input and is recommended for most users.
Transmit Mode	
Transmit on keypress	Audio is transmitted only when the PTT button is pressed on the headset.
Transmit continuously	Audio is continuously transmitted. Other nodes may monitor the channel only. Selected Channel audio transmissions will interrupt monitored continuously transmitted audio.
Tones on Transmit	Enables or disables an audible checktone (either Beeps or Verbal) at the beginning of each transmitted message
Tones on Receive	Enables or disables an audible checktone (either Beeps or Verbal) at the beginning of each received message
Advanced Features	If advanced features are able to be configured, a drop down menu will appear. If advanced features are not able to be configured, a string will appear displaying the current configuration. Available features vary among Wave Relay® hardware versions.
Silynx PTT Headset	Enables the serial port on the node (Silynx PTT Headsets require this setting be enabled)
Microphone Voltage	Enables +5V power supply voltage on the center pin of the 6-pin headset connector (required for some headsets)

PERSISTENT SYSTEMS

CHANNEL DEFINITIONS

The Wave Relay® Network has 16 channels numbered 0 through 15. Channel 0 is the Flash Override Channel and has priority over channels 1-15. The Flash Override Channel will always be enabled and is capable of both receiving and transmitting audio. Channels 1-15 are normal audio channels. Audio channels 1-15 may be configured to be either Selected Channels or Monitored Channels. Flash Override Channel audio will interrupt both Selected Channel audio and Monitored Channel audio. Each channel is defined by a Multicast Address and a Multicast Port. To display the Multicast Address and Multicast Port fields, click the "Show Customization" button. After Channel Definition settings have been configured, click the "Set All" button.

MENU ITEM	MENU ITEM DESCRIPTION
Channel	Displays the channel number to be configured
Selected	A Selected Channel is capable of both receiving and transmitting PTT audio. Selected Channel audio will NOT interrupt Flash Override Channel audio. Selected Channel audio will interrupt Monitor Channel audio. A user MUST choose a Selected Channel from channels 1-15.
Monitor	A Monitored Channel is only capable of receiving audio transmissions. Both Flash Override Channel audio and Selected Channel audio will interrupt Monitored Channel audio. A user may select none to multiple channels to be Monitored Channels.
Name	Defines the text name of the channel
Multicast Address	Defines the Multicast Address for the channel (Valid values are within the range of 224.0.0.0 through 239.255.255.255) - Note that each talk group must have a unique multicast address and port. This field is only visible if the "Show Customization" button has been clicked
Multicast Port	Defines the Multicast UDP port for audio traffic (Valid values are within the range of 1 through 65534) - Note that each talk group must have a unique multicast address and port. This field is only visible if the "Show Customization" button has been clicked.

FLASH OVERRIDE

Flash Override is a new feature which allows audio to be sent to all nodes even if those nodes have selected a different audio channel.

- A flash override transmission is triggered by a "tap-tap-hold" of the PTT button(button is pressed and released twice quickly in succession immediately preceding the normal hold for the duration of the transmission.)
- The user will hear a unique "triple" tone on TX and RX to indicate a flash override.

WEB MANAGEMENT INTERFACE REFERENCE

AUDIBLE NOTIFICATIONS

MENU ITEM	MENU ITEM DESCRIPTION
Low Battery	Enables or disables audible notification when the battery is depleted to 5% (notification will occur every 5 minutes)
In-Net/Out-Net	Enables or disables an audible notification when a chosen node enters or leaves the network
Node to Monitor	Selects a node to monitor for In-Net/Out-Net audible notifications from the node list (only visible when In-Net/Out-Net Audible Notifications are enabled)
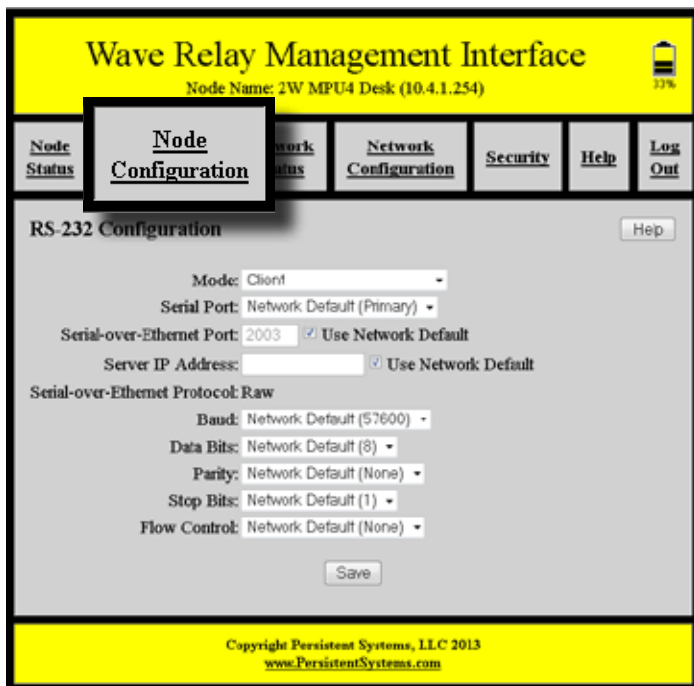
RS-232

The RS-232 serial-over-Ethernet feature can be used for remote control of a distant serial device via the Wave Relay® network. A typical application is for a local PC to control a distant pan/tilt camera via a serial link. If the PC and camera cannot be colocated, then two Wave Relay® devices can be used to connect them (similar to an old-fashioned modem-to-modem link). Thus, the serial port on the local PC can be hardwired to a local Wave Relay® device and the serial port on the distant camera can be hardwired to a distant Wave Relay® device. Communication between the two devices is then relayed via the Wave Relay® network. This is called "serial-to-serial mode."

Alternatively, the PC can run emulation software that allows it to create a local virtual COM port that is configured to communicate directly with a distant network-enabled serial port (e.g. as described in RFC 2217). Thus, the distant camera is hardwired to a distant Wave Relay® device and the local PC can then connect directly to the distant device via Ethernet. This is called "virtual-to-serial mode."

To access RS-232 configuration settings, click "Node Configuration" > "RS-232 Configuration."

CONFIGURING SERIAL-TO-SERIAL MODE
1. Connect the serial device to be controlled (e.g. pan/tilt unit) to the serial port on the distant Wave Relay® device. Configure the RS-232 Configuration Mode on the distant Wave Relay device to "Server" and set the Serial-over-Ethernet Port as desired. Set the Serial-over-Ethernet Protocol to "Raw." Set the serial port parameters (Baud, Data Bits, Parity, Stop Bits, Flow Control) to match those of the connected serial device (factory defaults for the Wave Relay® device are 57600 baud, 8 data bits, no parity, 1 stop bit, no flow control). Click "Save" to store the settings.
2. Connect the local serial device (e.g. PC) to the serial port on the local Wave Relay® device. Set the RS-232 Configuration Mode on the local Wave Relay® device to "Client," and set the Server IP Address and Serial-over-Ethernet Port to be those of the distant Wave Relay® device as configured in Step 1 above. Also set the serial parameters (Baud, Data Bits, Parity, Stop Bits, Flow Control) to match those of your local serial device. Click "Save" to store the settings.

CONFIGURING VIRTUAL-TO-SERIAL MODE
1. Connect and configure the serial device to be controlled (e.g. pan/tilt unit) as per Step 1 above for Configuring Serial-to-Serial mode. Set the Serial-over-Ethernet Protocol to whichever protocol is supported by your virtual client ("Raw" or "Telnet RFC 2217").
2. Install Virtual COM port software on the local PC (Eltima Serial to Ethernet Connector v5.0 for Windows has been tested and is known to work). Configure the virtual COM port in your software to connect to the distant serial port via the address/port as configured in Step 1.

SERIAL-TO-SERIAL MODE

Serial Link (RS232)

Computer

4-pin Power/Serial Port

Camera
(OEM Device)

PERSISTENT SYSTEMS
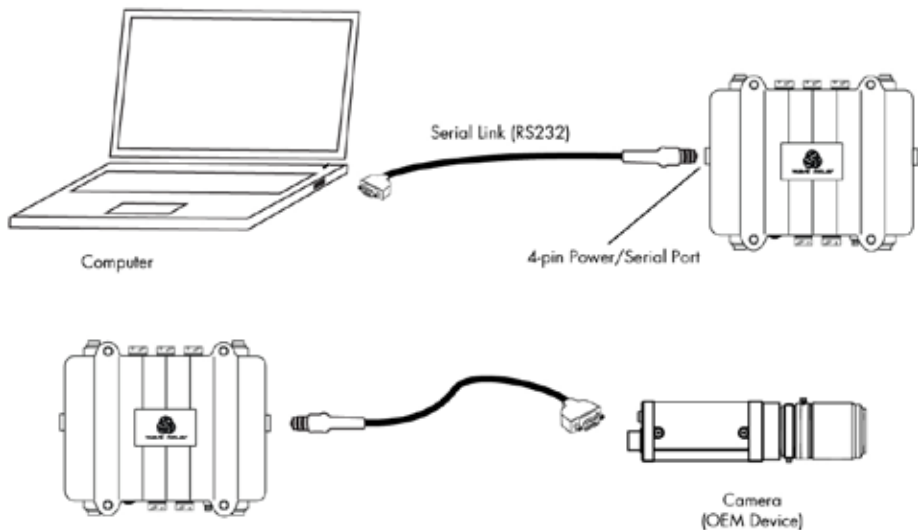
VIRTUAL-TO-SERIAL MODE
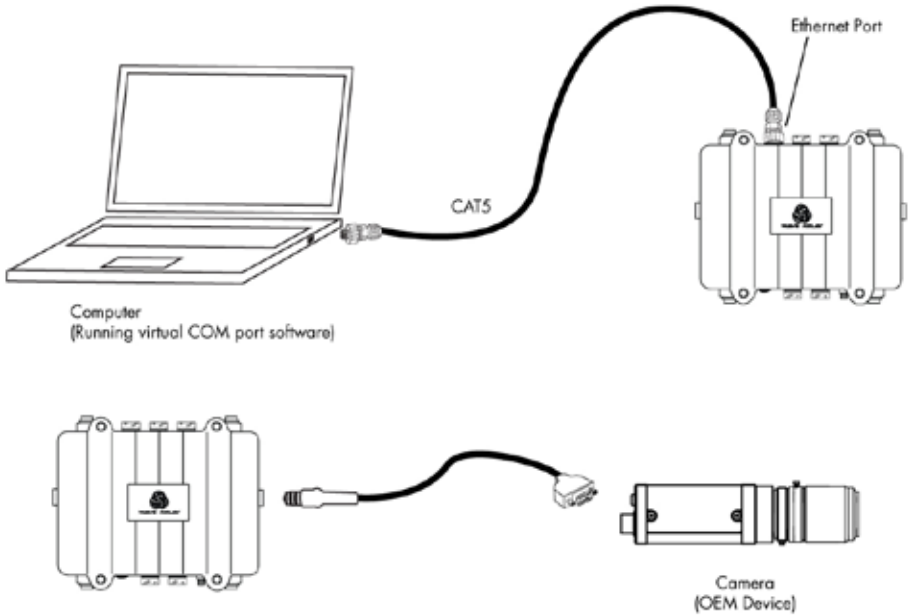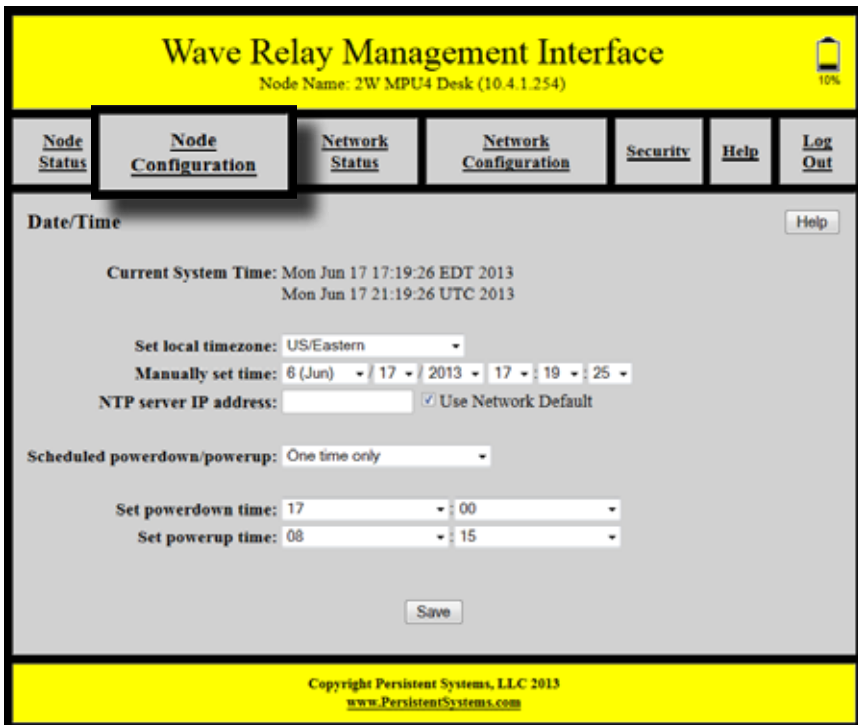
CONFIRMING SERIAL CONNECTIVITY

Once you have configured the server and client as described above, the network connection status is displayed on the "Current Status" line. Statistics are displayed for transmitted and received bytes to/from the attached serial device, which can be used to debug the connection to your serial hardware. For example, if the "tx" byte count increases but the "rx" byte count remains zero, bytes are being sent out on the Wave Relay® serial port but no reply is being received (possibly due to reversed transmit and receive wires in your cable). To update the status and statistics, click the "Refresh" button.

RS-232 CONFIGURATION

MENU ITEM	MENU ITEM DESCRIPTION
Mode	
Disabled	The serial-over-Ethernet feature is turned off.
Server	Use this mode when the device to be controlled (e.g. pan/tilt unit) is connected to a Wave Relay® device serial port.
Client	Use this mode when a controller (e.g. PC) is connected to a Wave Relay® device serial port.
Echo Mode	Instructs the serial port to retransmit any received serial data out on its transmit pin (useful for debugging serial connections in cases where Rx/Tx pins might be accidentally reversed in the cable)
Serial Port	Selects the primary or secondary RS-232 port on the Wave Relay®.
Serial-over-Ethernet TCP Port	Defines the TCP port for serial-over-Ethernet traffic
Server IP Address	Dfines the default IP address of the serial-over-Ethernet server
Serial-over-Ethernet Protocol	
Raw	Serial messages are encapsulated into packets and are transmitted unaltered over the network. This setting requires that the RS-232 parameters (baud, parity, etc.) be set correctly at both ends. This setting is typically used in serial-to-serial mode, e.g. when a hardware serial controller is used to control a remote serial device.
Telnet - RFC2217	Serial messages are encapsulated into packets as per RFC2217, and baud settings are automatically controlled by the protocol. This setting is typically used in serial-to-virtual mode, e.g. when a PC with virtual COM ports is used to control a remote serial device.
Baud	Valid settings are 300, 1200, 2400, 4800, 9600, 19200, 38400, 57600, or 115200.
Data Bits	Valid settings are 7 or 8 bits.
Parity	Valid settings are None, Even, or Odd.
Stop Bits	Valid settings are 1 or 2 bits.
Flow Control	Valid choices are XON/XOFF (a.k.a. software flow control) or None. Note that RTS/CTS (a.k.a. hardware flow control) is not supported.

DATE/TIME

When possible, Wave Relay® will obtain the current date and time from its internal GPS hardware. However, in cases where the GPS is unlocked (or absent), you may alternatively specify an NTP server or manually set the current date and time. You may also set the local time zone. The default time zone is UTC (a.k.a. GMT or Zulu time). Note that some Wave Relay® device models do not contain a clock, and thus these settings may be unavailable.
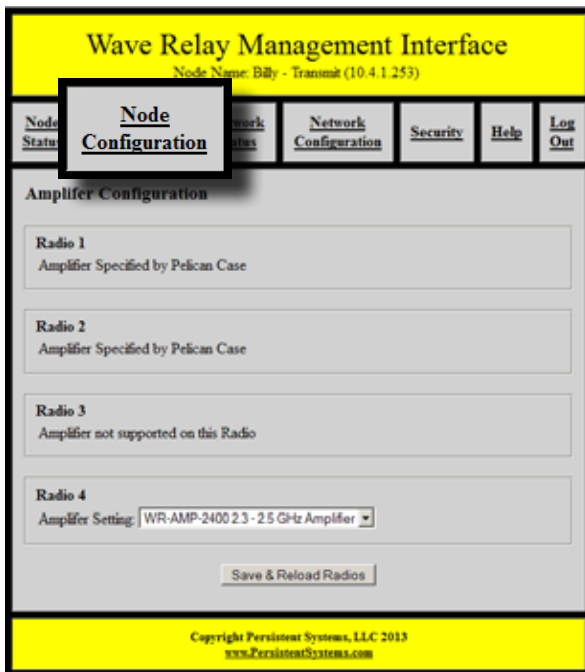
Wave Relay® also supports a sleep feature that allows scheduling remote unit power down and power up in order to conserve battery life and/or maintain radio silence. Sleep can be performed as a one-time power cycle or can be scheduled for repetitive daily or hourly operation. The sleep feature is not available on all Wave Relay® device models.

To access Date/Time Configuration, click "Node Configuration" > "Date/Time."

DATE/TIME SETTINGS

MENU ITEM	MENU ITEM DESCRIPTION
Current System Time	Displays the current system time (in both UTC and current time zone if not UTC)
Set local timezone	Sets the local time zone as ±12 hours from UTC (settings also include select US and other global time zones)
Manually set time	Manually sets the current local time
NTP Server Address	Defines the address, if available, of the NTP (Network Time Protocol) server for automatic clock synchronization
Scheduled powerdown/powerup	
One time only	Instructs nodes to perform a one-time power down and power up at specified times as set in the Set powerdown time and Set powerup time fields
Daily	Instructs nodes to perform a daily powerdown and powerup as specified in the Set powerdown time and Set powerup time fields
Twice daily	Instructs nodes to perform a twice-daily powerdown and powerup as specified in the Set powerdown time, Set powerup time, Set 2nd powerdown time, and Set 2nd powerup time fields
Hourly	Instructs nodes to perform hourly powerdowns and powerups as specified in the Set powerdown time and Set powerup time fields - powerdown and powerup times are specified as minutes past the hour (00 through 59)
Set powerdown time	Selects the hour and minute (in local time zone) for unit powerdown - If the powerdown/power up frequency is set to "Hourly," then you may only set minutes past the hour.
Set powerup time	Selects the hour and minute (in local time zone) for unit powerup - If the powerdown/powerup frequency is set to "Hourly," then you may only set minutes past the hour. If the powerup time is before the powerdown time, then the powerup happens the next day (or hour).
Set 2nd powerdown time	Selects the hour and minute (in local time zone) for second daily powerdown - This setting is valid only when power down/power up frequency is set to "Twice Daily."
Set 2nd powerup time	Selects the hour and minute (in local time zone) for second daily powerup - If the powerup time is before the powerdown time, then the powerup happens the next day (or hour). This setting is valid only when powerdown/powerup frequency is set to "Twice Daily."

PERSISTENT SYSTEMS

AMPLIFIER CONFIGURATION

Any Wave Relay® device (MPU4, MPU3 Single, MPU3 Dual, and Quad Radio Router) may be configured for use with an amplifier. To access Amplifier Configuration settings, select the "Node Configuration" tab, then click the "Amplifier Configuration" button. The page will display separate sections for each radio so that the amplifier settings for each radio may be configured separately.

Depending on the radios installed in the node, several different options will appear. If the radio installed in the node does not support the use of an amplifier, the section on the page corresponding to that radio will display the message "Amplifier not supported on this Radio."

If the radio installed in the node does support the use of an amplifier, a drop-down menu titled "Amplifier Setting" will appear. On the drop-down menu, select the amplifier setting that matches the amplifier being used with the radio.

VALID AMPLIFIER SETTINGS ARE:

- WR-AMP-0900 900 MHz Amplifier

- WR-AMP-1370 1.3 GHz Amplifier

- WR-AMP-2400 2.3 - 2.5 GHz Amplifier

When the Amplifier Configuration page for a QAMP device is accessed from the Web Management Interface, the sections for some radios may display the message "Amplifier Specified by Pelican Case." The amplifier settings for these radios have already been configured.

WARNING: WAVE RELAY® AMPLIFIERS REQUIRE REGULATED 28V DC POWER SUPPLY (DEVIATIONS WILL CAUSE DEGRADATION IN PERFORMANCE).

NETWORK STATUS
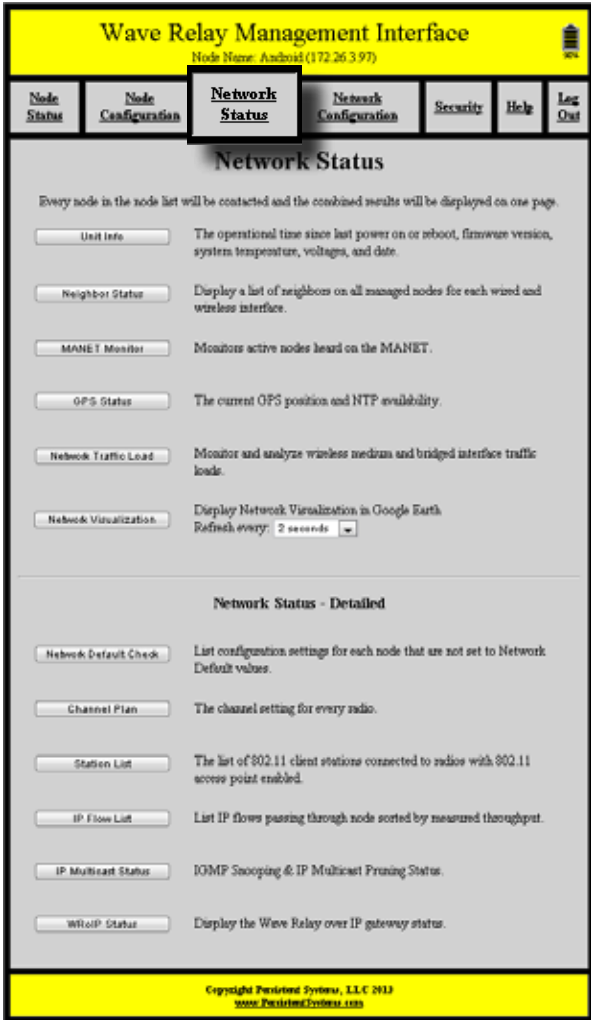
The "Network Status" tab in the Web Management Interface displays information about every node in the node list. Each time a network status feature is used, all nodes in the node list will attempt to be contacted and the combined results will be displayed on one page. This feature is useful for managing a network without having to individually connect to each node. Refer to the "Node Status" section for more detailed information about a specific feature.

UNIT INFO

MENU ITEM	MENU ITEM DESCRIPTION
Node	Node name and IP address of each node in the network
Uptime	Operating time since last node power on or reboot
Firmware Version	Firmware version on node
Temperature	Temperature (in celsius) of node
Supply Voltage	Voltage supplied to node
RCT Battery Voltage	Voltage of real-time-clock keep-alive battery. 3 year shelf life when not powered
System Clock	Current system time of node

NEIGHBOR STATUS

The Neighbor Status page displays a list of all neighboring nodes in the network.

MENU ITEM	MENU ITEM DESCRIPTION
Node	Name and IP address of node
Result	• Interface on managed node used • Name of each neighbor node • Interface on the neighbor node used • Receive Signal to Noise Ratio of each connection to each Interface on each neighbor node

PERSISTENT SYSTEMS

MANET MONITOR

MANET Monitor displays informa-
tion about active nodes heard on the
MANET.

MENU ITEM	MENU ITEM DESCRIPTION
Serial	Serial number of all nodes active on MANET network
Node	Node name and IP address of each neighbor node
Vector	Distance and direction from local node to remote node (Only valid if both nodes have a GPS fix or location)
Altitude	Altitude (above sea level) of each node in MANET network
Neighbors	Number of neighbor nodes (includes neighbors transmitting over the air and via Ethernet)
Battery	Battery percentage remaining (Only valid when using a MPU4 with compatible smart battery)
Receive SNR	Signal-to-Noise Ratio at which local node hears remote node
Reverse SNR	Signal-to-Noise Ratio at which the local node is heard by the remote node

GPS STATUS

MENU ITEM	MENU ITEM DESCRIPTION
Node	Name and IP address of each node
Result	
Fix Type	How node is connected (3D, 2D, or none)
Latitude	Latitude of current node
Longitude	Longitude of current node
Altitude	Altitude above sea level of current node
Speed	Speed of node (m/s) in the horizontal plane
Track	Path of travel with respect to the Earth expressed in degrees - 000 degrees is North (angle increases clockwise through 360 degrees)
Climb	Speed of node (m/s) in the vertical plane
Fix Time	When node obtained a satellite fix
Number of satellites	Number of satellites node is connected to
ID/PRN	ID/PRN of each satellite node is connected to
Signal	Strength of the connection between node and each satellite
NTP Server	Status of the NTP server (available or unavailable)

PERSISTENT SYSTEMS

NETWORK TRAFFIC LOAD

MENU ITEM	MENU ITEM DESCRIP-TION
Node	Name and IP address of each node
Result	
Mbps Total	Total Mbps used on this interface
Mbps Wave Relay®	Total Mbps used by Wave Relay®
Mbps Wave Re-lay® Sent	Mbps used by Wave Relay® to send
Mbps Wave Relay® Received	Mbps used by Wave Relay® to receive
Mbps Control	Total Mbps used for control functions
Mbps Control Ack	Mbps used to control ACK
Mbps Control RTS/CTS	Mbps used to control RTS/CTS
Mbps Other	Mbps used for other functions
Mbps Sent	Total Mbps used for all transmissions
Mbps Sent Unicast	Mbps used for Unicast transmissions
Mbps Sent Broad-cast/Multicast	Mbps used for Broadcast/Multicast transmissions
Mbps Received	Total Mbps used to receive all transmissions
Mbps Received Unicast	Mbps used to receive Unicast transmissions
Mbps Received Broadcast/Multicast	Mbps used to receive Broadcast/Multicast transmissions

NETWORK VISUALIZATION

This feature displays situational awareness GPS mapping for all network nodes in Google™ Earth. The drop down menu selects how often Google™ Earth will refresh its data from the visualization server. To access Network Visualization:

1. Click the "Network Visualization" button. The browser will attempt to open a file called "node-monitor.kml." This file contains geographic data to be displayed in Google™ Earth.
2. Either open the file directly from the pop-up dialogue box or save the file to the computer and open it separately.

The management computer must have Google™ Earth installed for this feature to work.

NETWORK DEFAULT CHECK

The Network Default Check page checks and displays which settings on each node are NOT set to the Network Default values. If a setting shows up in this list, it means that that particular setting on that node is NOT managed by Network Defaults and will NOT be changed if the Network Default is changed.

NETWORK CHANNEL PLAN

The Channel Plan page displays the channel center frequency and channel width for every radio of every node in the node list. Additionally, if "Network Default" is displayed before the channel information, it means that that setting is managed by Network Defaults.

MENU ITEM	MENU ITEM DESCRIPTION
Node	Name and IP address of each node
Result	
Radio X	Radio(s) in use on each node
Channel Y/Z	Channel center frequency/channel width for each radio

PERSISTENT SYSTEMS

STATION LIST

The Station List page displays the list of 802.11 client stations connected to radios with 802.11 access point enabled for each node.

MENU ITEM	MENU ITEM DESCRIPTION
Node	Name and IP address of each node
Result	
Radio X	Radio on the node
macaddr	MAC address of each client device connected to the access point
rssi	Signal strength to client device
last_rx	Time (in seconds) since a packet was last received

Network Station List

Node	Result
Spoke 67 WRoIP 172.26.6.216	-- Radio 1 -- macaddr: <14:7d:c5:ba:40:21> rssi 46 last_rx 0.000000 -- Radio 2 -- -- Radio 3 -- -- Radio 4 --

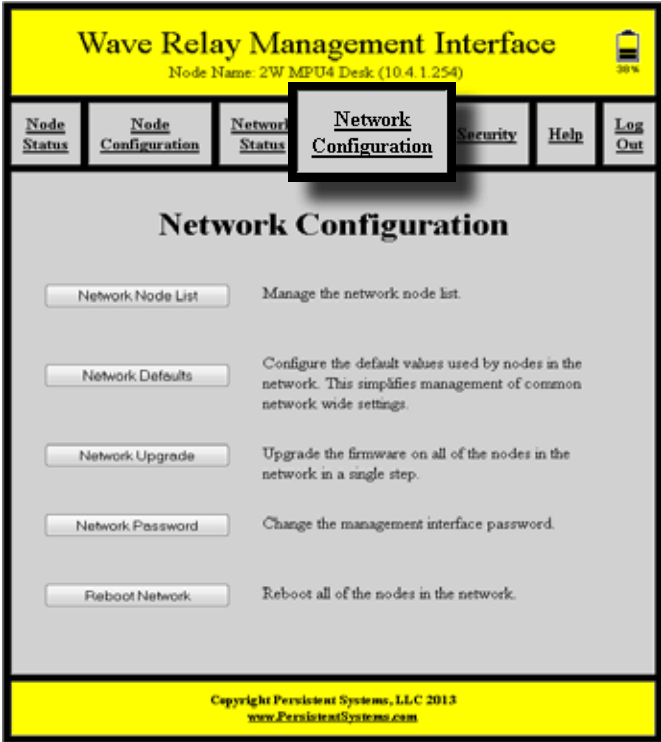## IP FLOW LIST

The IP Flow List page displays the list of IP data flows passing through node sorted by measured throughput.

IP Flows

Refresh

| Mbit/s	pkt/s	totalbytes	Destination IP	Source IP	Direction/Interfaces
0.005	3	360996	239.23.212.229	all	on MANET
0.001	1	85380	239.23.212.229	172.26.0.121	from MANET to this node
0.001	1	7752	10.3.255.255	10.3.1.100	from Ethernet 1 to MANET to Ethernet 2 to this node
0.000	0	31951	239.23.212.229	172.26.6.4	from MANET to this node
0.000	0	32041	239.23.212.229	172.26.6.40	from MANET to this node
0.000	0	34286	239.23.212.229	172.26.6.80	from this node to MANET
0.000	0	42474	239.23.212.229	172.26.6.40	from MANET to this node
0.000	0	40303	239.23.212.229	172.26.6.50	from MANET to this node
0.000	0	30908	239.23.212.229	172.26.0.145	from MANET to this node
0.000	0	38981	239.23.212.229	172.26.6.70	from MANET to this node
0.000	1	27768	239.24.100.39	all	on MANET
0.000	1	27768	239.24.100.39	172.26.6.80	from MANET
0.000	0	10550	224.0.0.22	10.3.1.100	from Ethernet 1 to Ethernet 2 to this node
0.000	0	10736	224.0.0.22	172.26.6.80	from this node to Ethernet 1 to Ethernet 2
0.000	0	25572	239.23.212.229	172.26.1.201	from MANET to this node
0.000	0	13350	224.0.0.1	all	on MANET from MANET to Ethernet 1 to Ethernet 2 to this node

MENU ITEM	MENU ITEM DESCRIPTION
Node	Name and IP address of each node
Result	
Mbit/s	Speed of each IP data flow in Mbps
Pkt/s	Number of packets transferred each second for each IP data flow
Total bytes	Number of bytes transferred for each IP data flow
Destination IP	IP address of destination node
Source IP	IP address of source node
Direction/ Interfaces	Direction of and interfaces used by each IP data flow (MANET, Ethernet X, or this node)

PERSISTENT SYSTEMS **85**

IP MULTICAST STATUS

IP Multicast Status displays IGMP Snooping and IP Multicast Pruning status. This feature shows a table with a row for each multicast group, displaying an "F" if that group is forwarded over the MANET, or a "-" if it is not.

There are known issues with IGMP in Windows XP.

ATTENTION: PRIOR TO FW VERSION 18.4.0, NETWORK WILL NOT FUNCTION PROPERLY IF PRUNING STATUS IS NOT CONSISTENT THROUGHOUT THE NETWORK.

MENU ITEM	MENU ITEM DESCRIPTION
Node	Name and IP address of each node
Result	
Group	Multicast address of nodes connected to managed node
Registered to receive packets for group	Interface used to receive data for each multicast address (Ethernet X or MANET)

WRoIP STATUS

WRoIP Status displays the Wave Relay® over IP gateway status for each node.

MENU ITEM	MENU ITEM DESCRIPTION
Node	Name and IP address of each node
Result	
Gateway	Which gateway the node is connected to as well as the priority of that gateway
Elected	Whether the gateway is elected or not
Election Priority	Election priority of the gateway over other gateways/number of other WRoIP gateways on the IP network.

NETWORK CONFIGURATION

The "Network Configuration" tab contains options to manage the network node list, configure the network defaults, upgrade and reboot the network, and change the network password.

PERSISTENT SYSTEMS
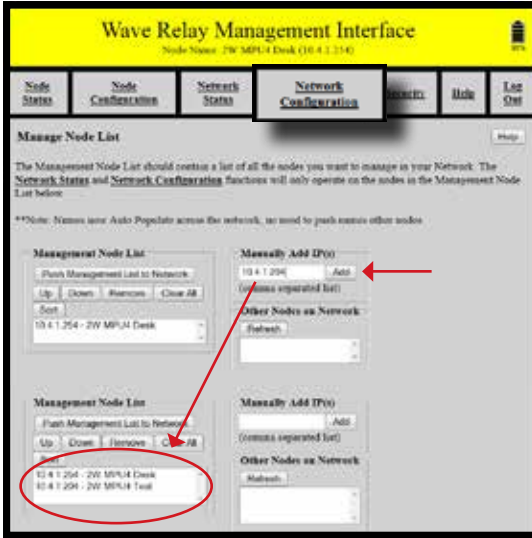
NETWORK NODE LIST

The Node List is a list of IP Addresses of nodes managed by the Web Management Interface.

1. To manage the Node List, click "Network Configuration" > "Network Node List."
2. Enter the IP Address of a node in the "Manually Add IP(s)" field and click the "Add" button to add the node associated with that IP Address to the Node List. Alternatively, nodes may be added from the "Other Nodes on Network" window if they are detected by the network. These nodes may be added individually with the "Selected IPs" button or all at once with the "All" button. The "Clear Nodes" button will clear the "Other Nodes on Network" window.
3. Repeat this process for every node to be managed. The IP Addresses will appear in the "Management Node List" window on the left side of the screen (see screenshot). The Node List may be rearranged and edited from the "Management Node List" window.
4. When the list is populated with all IP Addresses/Nodes, click the "Push Management List to Network" button to send the Managed IP List to all nodes in the network. Node names auto populate across the network.

NETWORK DEFAULTS

Network Defaults facilitate the management of a large number of nodes. Network Defaults enable administrators to manage settings on all network nodes specified in the Node List rather than to manage individual settings on single nodes. Any changes to Network Defaults will affect only nodes that are in the Node List. To ensure proper Network Default configuration, confirm that the Node List is current and configured properly before making changes to Network Defaults. Note that individual nodes will adopt Network Default settings only if those individual nodes are configured to use Network Defaults.

SHOW/HIDE ADVANCED FIELDS

For convenience, this button allows you to show (or hide) many of the less frequently used node configuration fields. The default is to hide the advanced fields (and thus display a briefer page). If you choose to show the advanced fields, your choice will remain in effect when you revisit the page. Advanced fields are indicated as such in the descriptions below.

MANAGEMENT SETTINGS

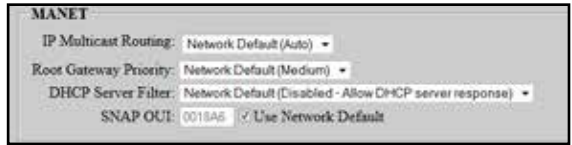| MENU ITEM	MENU ITEM DESCRIPTION
Netmask	Defines default netmask for the Web Management Interface
Gateway	Defines default gateway for the Web Management Interface

RADIO CHANNEL SETTINGS

Each radio must be a assigned a center frequency and bandwidth. These settings determine the "channel" on which the node operates. Up to 16 Network Default channel settings may be configured to facilitate management of groups of radios of different nodes.

MENU ITEM	MENU ITEM DESCRIPTION
Channel Name	Each channel can be assigned a name which to be used in status functions.
Frequency	Each radio should be a assigned a frequency. Two radios must be set to the same frequency in order to communicate. A warning will be displayed if the frequency setting does not match the radio hardware. A node with a radio channel set to "Network Default X" in node configuration will automatically change center frequency and bandwidth if the settings for "Network Default X" are changed in Network Default configuration.
Bandwidth	Each radio should be assigned a bandwidth. Two radios must be set to the same bandwidth in order to communicate. Bandwidth should be increased for shorter distances and decreased for increased distances.
Max Link Distance	Max Link Distance should be set to the upper bound of how long any individual link in the network may need to be. All nodes on the network MUST be set to the same Max Link Distance. A node with a radio channel set to "Network Default X" in node configuration will automatically change Max Link Distance if the settings for "Network Default X" are changed in Network Default configuration.
Channel Density	The channel density setting controls how aggressively the radios compete for access to the shared medium. A number of nodes will be displayed in parentheses after each menu item. Choose the menu item that corresponds to the number of nodes in your network. A node with a radio channel set to "Network Default X" in node configuration will automatically change Channel Density if the settings for "Network Default X" are changed in Network Default configuration.
Radio Preference	Radio Preference instructs the routing protocol to prefer links on a radio (consider them lower cost than normal). This can be used to help shift traffic towards radios running on certain channels. **None:** None is the default factory setting. All links are considered equally. **Medium:** Routing protocol is more likely to use this radio to forward traffic. **High:** Routing protocol is significantly more likely to use this radio to forward traffic. A node with a radio channel set to "Network Default X" in node configuration will automatically change Radio Preference if the settings for "Network Default X" are changed in Network Default configuration.

MANET

MENU ITEM	MENU ITEM DESCRIPTION
IP Multicast Routing	AUTO: Node will prune multicast packets that are not requested (default, most efficient setting for network). PULL ALL MULTICAST: Node will accept all multicast packets it hears on the network. Note: Windows CE/XP computers do not respond to IGMP Multicast Group Queries sent by Wave Relay nodes. "Pull All Multicast" should be used in networks with Windows CE/XP computers to work around this issue.
Root Gateway Priority (advanced)	**HIGH:** Any node in your network directly connected to wired infrastructure should have priority set to "HIGH." **MEDIUM:** All other non-mobile routers should be set to "MEDIUM." **LOW:** Mobile routers should be set to "LOW."
DHCP Server Filter (advanced)	**ALLOW:** Device will pass DHCP messages FROM a DHCP server which is bridged directly by one of its interfaces. Only the devices which are directly wired to the switch where the DHCP server resides need to be set to "ALLOW." **BLOCK:** Device will not bridge any DHCP reply packets that it picks up off of any of its bridged interfaces. By setting all of the nodes in the network (except the nodes physically connected to the real DHCP server) to "BLOCK," you will ensure that users of your system will always use the correct DHCP server.
SNAP OUI (advanced)	Controls the Subnetwork Access Protocol Organizationally Unique Identifier - The factory OUI, 0018A6, is registered to Persistent Systems, LLC with the IEEE. SNAP OUI is used to identify Wave Relay® packets. Changing this field allows the user to obscure which protocol is being used by the system. All nodes must be set to the same value or they will not communicate.

DHCP SERVER (ADVANCED)

If enabled, the DHCP server will serve IP addresses to devices connected to the node via the wired Ethernet or wireless 802.11 Access Point interfaces.

MENU ITEM	MENU ITEM DESCRIPTION
DHCP Server Scope	Selects which DHCP clients the DHCP server serves IP addresses to. "Local Ethernet/AP Only" serves IP addresses to nodes connected via Ethernet or a wireless 802.11 Access Point. "Entire Network" serves IP addresses to all nodes in the network. "Local Ethernet/AP Only" is the recommended setting.

Address Range Start	Start of range of IP addresses assigned to DHCP clients
Address Range End	End of range of IP addresses assigned to DHCP clients
Netmask	Netmask assigned to DHCP clients
Default Gateway	Gateway assigned to DHCP clients
DNS Server 1	Primary DNS server assigned to DHCP clients
DNS Server 2	Secondary DNS server assigned to DHCP clients
WINS Server	WINS server assigned to DHCP clients
Lease Time	DHCP lease time (defaults to 1 hour)

ACCESS POINT (AP) SETTINGS (ADVANCED)

MENU ITEM	MENU ITEM DESCRIPTION
802.11 Access Point (advanced)	Each radio can be configured to function as an 802.11 access point. Standard clients such as laptops with built in 802.11 cards may access this system. If the AP is disabled, the ESSID and Beacon Interval configuration options have no effect. For maximum performance, always disable the 802.11 AP unless it is required. To use a radio as a 802.11 Access Point, the radio MUST be set to a valid 802.11 frequency (Numbered channels in the frequency selection menu i.e. "2412 / 5-20 MHz - Channel 1") and the channel width MUST be set to 20 MHz.
The following fields are only visible when the 802.11 Access Point is "Enabled."	
ESSID (advanced)	Sets the name of the network that the access point advertises to clients.
ESSID Visibility (advanced)	The ESSID can be configured to be "Visible" or "Hidden." Generally, the ESSID is configured to be "Visible" to make it easy for clients to connect to the access point. For additional security/privacy the ESSID can be configured as "Hidden."
AP Security (advanced)	Enables or disables 802.11 security on the Access Point - Only WPA2-PSK (Wi-Fi Protected Access v2 with pre-shared keys) is supported.

WPA2 Passphrase (advanced)	Sets a shared passphrase when AP Security is set to WPA2 - The passphrase should be an ASCII string of length 8-63 characters, excluding these characters: ',"\&/<>
AP Broadcast Rate (advanced)	Controls the rate at which broadcasts are transmitted from an 802.11 Access Point - Increasing this rate can significantly increase network capacity but will reduce the range of client connectivity. If the rate is set too high, client devices will have trouble receiving broadcast packets from the 802.11 access point.
AP Beacon Interval (advanced)	The 802.11 access point can send beacons at an interval between twice and ten times per second.

ETHERNET SETTINGS (ADVANCED)

MENU ITEM	MENU ITEM DESCRIPTION
Routing Metric (advanced)	Defines link capacity for the routing protocol - A value lower than the 100 Mbps default should be used when nodes are connected via non-switched Ethernet (e.g. a third-party point-to-point wireless link). The metric allows the routing protocol to make an intelligent decision on if it is better to route over this Ethernet port or use an alternate route which is faster.

VLAN SETTINGS (ADVANCED)
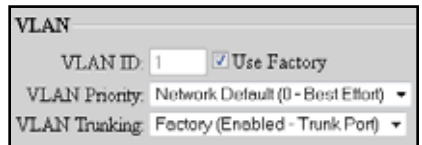
MENU ITEM	MENU ITEM DESCRIPTION
VLAN ID (advanced)	Each VLAN-aware bridge port is assigned a VLAN ID. Un-tagged frames received by the port are tagged with the specified VLAN ID. Frames that are sent by the port which have a VLAN tag matching the specified VLAN ID will have their tags removed (i.e. they are sent by the port untagged).
VLAN Priority (advanced)	Specifies the 802.11 priority of the VLAN tag added to untagged frames received by this port
VLAN Trunking (advanced)	Controls the filtering of VLAN tagged frames that do NOT match this port's VLAN ID. When trunking is enabled (trunk port), ALL non-matching VLAN tagged frames are passed (no filtering). When trunking is disabled (access port), all non-matching VLAN tagged frames are blocked (filtered)

BANDWIDTH MANAGEMENT SETTINGS (ADVANCED)
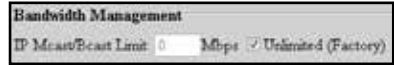
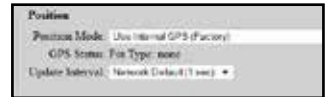| MENU ITEM	MENU ITEM DESCRIPTION
IP Mcast/ Bcast Limit (advanced)	Defines the maximum bandwidth allowed for IP multicast or broadcast network traffic received on the given interface and retransmitted onto the Wave Relay® network. Traffic in excess of this limit will be dropped. Units are megabits/sec (Mbps). To disable the limit, set to zero

WAVE RELAY® OVER IP (WROIP) SETTINGS (ADVANCED)

WRoIP allows the Wave Relay® network to extend over and seamlessly interact with a large routed IP network. In order to use this capability, one or more Wave Relay® nodes must be setup as WRoIP gateways. A WRoIP gateway must be directly connected to an appropriately configured IP router.

MENU ITEM	MENU ITEM DESCRIPTION
WRoIP (advanced)	WRoIP gateway nodes must have the WRoIP protocol enabled on the interface directly connected to the IP router. All other nodes should have the WRoIP protocol disabled. When the WRoIP protocol is enabled on an interface, the interface will no longer function as a normal Wave Relay® Ethernet port for connecting Ethernet devices: it will only work for connecting the IP router.
Multicast Routing Mode (advanced)	Selects pruning options for multicast traffic: IP Router Controlled (default): All multicast packets travel to the cloud network Wave Relay Controlled: Only subscribed multicast feeds are passed to the cloud network to reduce network traffic congestion.
Netmask (advanced)	Defines the netmask of the IP subnet specific to the directly connected IP router interface
Gateway (advanced)	Defines the IP address of the IP router in the IP subnet specific to the directly connected IP router interface - WRoIP protocol packets will be forwarded to this IP address in order to be sent over the IP network.

MTU (advanced)	Defines the maximum transmissible unit size for the IP network - WRoIP protocol packets sent over the IP network will be limited to this MTU. All nodes that communicate over the IP network should be set to the same value.
Multicast Address (advanced)	Defines the multicast IP address used by the WRoIP protocol - The next higher IP multicast address will also be used by the WRoIP protocol. For example, if 239.255.90.67 is set as the multicast address, both 239.255.90.67 and 239.255.90.68 will be used.
UDP Port (advanced)	Defines the UDP port used by WRoIP protocol packets

POSITION SETTINGS (ADVANCED)

MENU ITEM	MENU ITEM DESCRIPTION
Update Interval	Controls how often nodes report information back to visualiziation server with visualization enabled - A smaller value will result in smoother movement of mobile nodes in Google™ Earth. A shorter update interval uses more bandwidth.
ESD UDP Port	Defines the port number to receive position updates via an external ESD feed
External Update UDP Port	Defines the port number to receive position updates via the external Wave Relay® 'wr-update-gps' command
CoT UDP Port	Defines the port number to receive position updates via external CoT feed
CDF UDP Port	Defines the port number to receive position updates via an external CDF feed

WAVE RELAY® SA (GOOGLE™ EARTH NETWORK VISUALIZATION) SETTINGS

MENU ITEM	MENU ITEM DESCRIPTION
Report to Visualization Server	Enable or disables network visualization for all nodes set to use the Network Default (typically the whole network) - Visualization is also used by the Tracking Antenna system and should be enabled on nodes that you wish to be able to track.

Visualization Server (advanced)	Defines the IP address to which nodes will send their visualization updates (may be either a multicast address [224.0.0.0,239.255.255.255] or the unicast address of a device running the visualization server.) - The factory default is a multicast address. When using multicast, each node sends visualization updates to the entire connected network. All nodes run a visualization server and receive updates from all other connected nodes. When using unicast, each node sends visualization updates to the selected address only. If the unicast address is the management IP address of a node, that node will run a visualization server to receive the updates. Visualization updates are sent from the management IP address, so the selected address must be reachable by all nodes with visualization enabled; it should be either in the same subnet or reachable through the default gateway. Multicast operation allows the most robust visualization for mobile networks because it provides true distributed operation with partitions and merges. Unicast operation requires all visualization users to be able to contact the selected server, but offers reduced network overhead for larger static networks.

CURSOR ON TARGET (COT) SETTINGS (ADVANCED)

This feature enables transmission of local positioning information to a CoT server on the network. This feature is not available on all firmware versions.

MENU ITEM	MENU ITEM DESCRIPTION
Send Position	Enables or disables transmission of CoT packets to server
Server IP	Defines the IP address of the CoT server - This IP address can be a unicast or multicast address
Server Port	Defines the UDP port of the CoT server
Type	Defines the contents of the CoT "type" attribute

SIMPLE SA PACKET GENERATOR (SSPG) (ADVANCED)

These settings exist for backwards compatability with an outdated protocol. See earlier versions of the manual for more information.

PTT SETTINGS
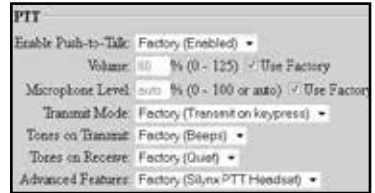
MENU ITEM	MENU ITEM DESCRIPTION
Enable Push-to-Talk	Enables or disables the PTT subsystem to allow push-to-talk communication among voice-equipped devices
Volume	Defines the default earpiece volume for headsets - Valid values are 0 through 100. Optimal values vary with headset manufacturer.
Microphone Level	Defines the default microphone level for headsets - Valid values are 0 through 100. Optimal values vary with headset manufacturer.
Transmit Mode (advanced)	
Transmit on keypress	Audio is transmitted only when the PTT button is pressed on the headset.
Transmit continuously	Audio is continuously transmitted. Other nodes may monitor the channel only. Selected Channel audio transmissions will interrupt monitored continuously transmitted audio.
Tones on Transmit (advanced)	Enables or disables an audible checktone (either Beeps or Verbal) at the beginning of each transmitted message
Tones on Receive (advanced)	Enables or disables an audible checktone (either Beeps or Verbal) at the beginning of each received message
Advanced Features (advanced)	
Silynx PTT Headset	Enables the serial port on the node (Silynx PTT Headsets require this setting be enabled)
Microphone Voltage	Enables +5V power supply voltage on the center pin of the 6-pin headset connector (required for some headsets)

CHANNEL DEFINITIONS (ADVANCED)

The Wave Relay® Network has 16 channels numbered 0 through 15. Channel 0 is the Flash Override Channel and has priority over channels 1-15. Channels 1-15 are normal audio channels. Each channel is defined by a Multicast Address and a Multicast Port. After Channel Definition settings have been configured, click the "Set All" button.

MENU ITEM	MENU ITEM DESCRIPTION
Channel	Displays the channel number to be configured
Name	Defines the text name of the channel
Multicast Address	Defines the Multicast Address for the channel - Valid values are within the range of 224.0.0.0 through 239.255.255.255. Note that each talk group must have a unique multicast address and port.
Multicast Port	Defines the Multicast UDP port for audio traffic - Valid values are within the range of 1 through 65534. Note that each talk group must have a unique multicast address and port.

FLASH OVERRIDE

Flash Override is a new feature which allows audio to be sent to all nodes even if those nodes have selected a different audio channel.

- A flash override transmission is triggered by a "tap-tap-hold" of the PTT button(button is pressed and released twice quickly in succession immediately preceding the normal hold for the duration of the transmission.)
- The user will hear a unique "triple" tone on TX and RX to indicate a flash override.

AUDIBLE NOTIFICATIONS

MENU ITEM	MENU ITEM DESCRIPTION
Low Battery	Enables or disables audible notification when the battery is depleted to 5% (notification will occur every 5 minutes)
In-Net/Out-Net	Enables or disables an audible notification when a chosen node enters or leaves the network
Node to Monitor	Selects a node to monitor for In-Net/Out-Net audible notifications from the node list

98 PERSISTENT SYSTEMS

RS-232 SETTINGS (ADVANCED)

The RS-232 serial-over-Ethernet feature can be used for remote control of a distant serial device via the Wave Relay® network. A typical application is for a PC to control a remotely located pan/tilt camera via a serial link. Two operational modes are supported: "serial-to-serial" mode and "virtual-to-serial" mode. For further description, see RS-232 Configuration Help.

MENU ITEM	MENU ITEM DESCRIPTION
Mode	
Disabled	The serial-over-Ethernet feature is turned off.
Server	Use this mode when the device to be controlled (e.g. pan/tilt unit) is connected to a Wave Relay® device serial port.
Client	Use this mode when a controller (e.g. PC) is connected to a Wave Relay® device serial port.
Echo Mode	Instructs the serial port to retransmit any received serial data out on its transmit pin (useful for debugging serial connections in cases where Rx/Tx pins might be accidentally reversed in the cable)
Serial Port (advanced)	Selects the primary or secondary RS-232 port on the Wave Relay®.
Serial-over-Ethernet TCP Port (advanced)	Defines the TCP port for serial-over-Ethernet traffic
Server IP Address (advanced)	Defines the default IP address of the serial-over-Ethernet server
Serial-over-Ethernet Protocol (advanced)	
Raw	Serial messages are encapsulated into packets and are transmitted unaltered over the network. This setting requires that the RS-232 parameters (baud, parity, etc.) be set correctly at both ends. This setting is typically used in serial-to-serial mode, e.g. when a hardware serial controller is used to control a remote serial device.
Telnet - RFC2217	Serial messages are encapsulated into packets as per RFC2217, and baud settings are automatically controlled by the protocol. This setting is typically used in serial-to-virtual mode, e.g. when a PC with virtual COM ports is used to control a remote serial device.
Baud (advanced)	Valid settings are 300, 1200, 2400, 4800, 9600, 19200, 38400, 57600, or 115200.
Data Bits (advanced)	Valid settings are 7 or 8 bits.
Parity (advanced)	Valid settings are None, Even, or Odd.
Stop Bits (advanced)	Valid settings are 1 or 2 bits.
Flow Control (advanced)	Valid choices are XON/XOFF (a.k.a. software flow control) or None. Note that RTS/CTS (a.k.a. hardware flow control) is not supported.

DATE/TIME SETTINGS

MENU ITEM	MENU ITEM DESCRIPTION
Set local timezone	Sets the local time zone as ±12 hours from UTC (settings also include select US and other global time zones)
NTP Server Address	Defines the address, if available, of the NTP (Network Time Protocol) server for automatic clock synchronization
Automatic powerdown/powerup	
One time only	Instructs nodes to perform a one-time power down and power up at specified times as set in the Set powerdown time and Set powerup time fields
Daily	Instructs nodes to perform a daily powerdown and powerup as specified in the Set powerdown time and Set powerup time fields
Twice daily	Instructs nodes to perform a twice-daily powerdown and powerup as specified in the Set powerdown time, Set powerup time, Set 2nd powerdown time, and Set 2nd powerup time fields
Hourly	Instructs nodes to perform hourly powerdowns and powerups as specified in the Set powerdown time and Set powerup time fields - powerdown and powerup times are specified as minutes past the hour (00 through 59)
Set powerdown time	Selects the hour and minute (in local time zone) for unit powerdown - If the powerdown/power up frequency is set to "Hourly," then you may only set minutes past the hour.
Set powerup time	Selects the hour and minute (in local time zone) for unit powerup - If the powerdown/powerup frequency is set to "Hourly," then you may only set minutes past the hour. If the powerup time is before the powerdown time, then the powerup happens the next day (or hour).
Set 2nd powerdown time	Selects the hour and minute (in local time zone) for second daily powerdown - This setting is valid only when power down/power up frequency is set to "Twice Daily."
Set 2nd powerup time	Selects the hour and minute (in local time zone) for second daily powerup - If the powerup time is before the powerdown time, then the powerup happens the next day (or hour). This setting is valid only when powerdown/powerup frequency is set to "Twice Daily."

SAVE TO NETWORK

Two check boxes are checked by default. **Reconfigure immediately** forces the network to apply the new settings and reboot immediately. **Require all** ensures all nodes in the managed node list receive the updated values or all will fail and not update.
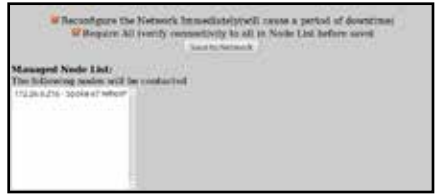
SECURITY

STATUS
The Status box indicates the current security configuration. "Operational" means a valid key is set and Wave Relay® is operational. If Wave Relay® is NOT operational, then the node will not communicate with any other nodes, and its management interface can only be accessed via connection to the Ethernet 1 interface. The Security tab on the navigation bar will have a red background and blink when the current status is not "Operational."

"Error: no security configuration" will be displayed if a node is booted without a key set. An error will also be displayed if the key has been zeroized (see below).

The current key, if one is set, can be viewed by selecting "Display Key." Since the key is displayed in plaintext, view the key in a secure environment only. The "Display Key" feature indicates the current Crypto Mode, Size, and Value of the key.

SET KEY

The Set Key box enables users to change the current security configuration. Changes can be applied to the current node only or to all the nodes in the Network as specified by the Node List. Ensure all nodes are running the latest firmware before making changes to the security configuration.

1. From the "Update" menu, select whether to update only the currently managed node ("Node") or all nodes on the network. The "network (require all)" setting will change security settings for all nodes in the network and will require all nodes in the network be available for any changes to be applied. If not all nodes are available, no changes will be applied. The "network (any available)" setting will change security settings for all available nodes on the network. Nodes that are not available will NOT be updated.

Crypto Mode	256-bit AES-CTR with HMAC-SHA-512	256-bit AES-GCM	256-bit AES-CTR with HMAC-SHA-1
Encryption Algorithm	256-bit AES in counter mode		
Authentication Algorithm	HMAC-SHA-512	Galois MAC (GMAC)	HMAC-SHA-1
MAC Tag Length	96-bits		
Suite-B Algorithms	Yes		No (due to SHA-1)
Minimum Key Length	512-bits (256-bit AES + 256-bit HMAC)	256-bits	512-bits (256-bit AES + 256-bit HMAC)
Maximum Key Length	1280-bits (256-bit AES + 1024-bit HMAC)	256-bits	768-bits (256-bit AES + 512-bit HMAC)

2. Select a Crypto Mode to match your network requirements. The "Crypto Mode" menu selects the the encryption and authentication algorithms used to secure Wave Relay® packets. The available set of crypto modes depends on the node's hardware capabilities. Newer Wave Relay® products have extra hardware to support additional Suite-B algorithms (SHA-2 family and GCM) in comparison to older Wave Relay® products, which do not. If you have a network of only older hardware, "256-bit AES-CTR with HMAC-SHA-1" will be your only choice. If you have a network with a mix of older and newer hardware, you should

select the "Backwards Compatible: 256-bit AES-CTR with HMAC-SHA-1" mode on the units with newer hardware; this will allow all the nodes in the network to communicate. If you have a network with only newer hardware you can select any of the three modes. We recommend "256-bit AES-CTR with HMAC-SHA-512" as the mode with the greatest security margin. "256-bit AES-GCM" is an alternate full Suite-B mode that can also be used based on user preference.

3. Once the Crypto Mode is set, enter a key value into the field and click the "Set" button, or click the "Generate" button to generate a random key. The new key information is stored to the node or the network.

ZEROIZE

The Zeroize box enables users to erase the key configuration on an individual node or on the entire network as specified by the Node List. When a node is zeroized, all traces of the current key are erased so that the key can no longer be recovered from the unit. Once a node has been zeroized, it cannot participate in any Wave Relay® network until it is re-keyed using the "Set Key" function.

1. From the "Update" menu, select whether to update only the currently managed node ("Node") or all nodes on the network. The "network (require all)" setting will zeroize the security configuration for all nodes in the network and will require all nodes in the network be available for any changes to be applied. If not all nodes are available, no changes will be applied. The "network (any available)" setting will zeroize the security configuration for all available nodes on the network. Nodes that are not available will NOT be updated.
2. Clicking the "Zeroize Key" button will erase the packet encryption key only. Clicking the "Zeroize All Configuration" button will erase not only the key but also the management password and the public/private key-pair used to connect to the Web Management Interface. If the "Zeroize All Configuration" button is clicked, the node(s) will also reboot.
3. To access the Web Management Interface after the "Zeroize All Configuration" button has been clicked and the node has rebooted, the user will need to accept a newly generated certificate and use the factory password to log into the Web Management Interface.

SECURITY FEATURES

Tamper Response: This menu enables or disables tamper detection. If tamper detection is enabled, disassembly of the Wave Relay® enclosure will cause a complete zeroize of the security configuration, including the encryption key, the management password, and the public/private key-pair used to connect to the Web Management Interface. This feature is only available on MPU versions of the Wave Relay®.

WAVE RELAY® API

The Wave Relay® router provides an API for configuring and monitoring the radio outside of the management interface. The API runs over the on-board HTTPS interface, allowing any program or package that submits requests according to the HTTP protocol (RFC 2616) to communicate with the Wave Relay®. Some example programs include custom programs written in Java or C/C++ as well as the Linux "Curl" command.

A typical request to the Wave Relay® has the form:
https://192.168.5.88/management.cgi?password-input=XXXXXX&command=param_get&name=WAVERELAY_IP&name=WAVERELAY_NETMASK

This example URL has the following syntax:
- Protocol: must be https
- Address: use the assigned IP address for the Wave Relay® node (in this example: **192.168.5.88**)
- Script name: must be management.cgi
- Required query string field: password-input (the assigned management password for the node)
- Required query string field: command (the management command to be performed)
- Additional query string fields: depend on the command. In this example, we are executing the command param_get in order to request the values for the two parameters with **name=WAVERELAY_IP and name=WAVERELAY_NETMASK**

Additional documentation on the Wave Relay® API can be found in the Wave Relay® Management API document available upon request.

TROUBLE-SHOOTING

PERSISTENT SYSTEMS

COMMON PROBLEMS AND TROUBLESHOOTING

This section contains a list of troubleshooting steps to follow when two or more nodes are unable to communicate.

The following must be configured correctly for Wave Relay® nodes to communicate:

1.	Encryption Key and Type
2.	Radio Enabled
3.	Channel Frequency and Channel Width
4.	Firmware Version
5.	Mesh Routing Enabled
6.	Antenna Connected

SYMPTOM	POTENTIAL ROOT CAUSE	POTENTIAL SOLUTION
NODES ARE UNABLE TO COMMUNICATE	NODES NOT POWERED ON	1. Check for depleted batteries and/or disconnected power cables.
	INADEQUATE POWER SUPPLY	1. MPU3/MPU4 can require as much as 18W of peak power to operate. Quads (with 2W radio) can require as much as 60W. 2. Ensure that 60W PoE injector is being used. 3. Ensure other power sources are adequate.
	CRYPTO MODE AND/OR CRYPTO KEY SET INCORRECTLY	1. The Crypto Mode and Crypto Key must be the same on all nodes. e.g. AES-256 + SHA1 will not communicate with AES-256 + SHA-512. 2. To check the Crypto Mode setting, click "Security" > "Display Key" and ensure that the Crypto Mode setting is the same on all nodes. 3. On the same page, ensure that the Crypto Key is the same on all nodes.
	RADIOS NOT ENABLED	1. Depending on node type, several radios may be available. At least one radio must be enabled for the node to communicate. 2. To enable a radio, click "Node Configuration" > "Node Configuration." Ensure "Enabled" is selected from the drop-down menu.
	FREQUENCY AND/OR CHANNEL WIDTH SET INCORRECTLY	1. Radios must be on the same Center Frequency and the same Channel Width in order to communicate. e.g. a node on 2412 MHz, Width = **5MHz** will not communicate with 2412 MHz Width = **20MHz**. 2. To set Frequency and/or Channel Width, click "Node Configuration" > "Node Configuration." In the Configuration Settings for an available Radio, ensure that the Center Frequency AND the Channel Width are the same on all nodes. Note that depending on the type of radio module installed, specific frequencies may not be available.

MAX LINK DISTANCE SET INCORRECTLY	1.	Radios ~~are~~ able to communicate when set to different link distances but will result in sub-optimal performance.
	2.	To set Max Link Distance correctly, determine the farthest distance any individual link on this frequency may need to be, then choose the next longest Max Link Distance. e.g. 13 mi = Max Link Distance should be set to 15 mi.
	3.	Click "Node Configuration" > "Node Configuration." Ensure that the Max Link Distance is correct and the same on all radios on the same frequency.
INCOMPATIBLE FIRMWARE VERSIONS	1.	All nodes must be running the same major firmware version in order to communicate. e.g. a node with firmware version 17.X.X will not communicate with a node with firmware version 18.X.X.
	2.	To check the firmware version of a node, click "Node Status" > "Unit Info." The firmware version will be displayed at the top of the list. If firmware versions are not the same, upgrade the nodes to the same firmware version (see "Node Upgrade").
MESH ROUTING DISABLED	1.	If mesh routing is disabled on the radio, it will not participate in the routing protocol and will not communicate with its neighbor nodes.
	2.	To enable mesh routing, click "Node Configuration" > "Node Configuration." Click on the "Show Advanced Fields" button if Advanced Fields are hidden. In the Configuration Settings for the desired radio, ensure that Mesh Routing is set to "Enabled."
ANTENNA CONNECTED TO WRONG RADIO	1.	The node that is being configured may have several available radios. Ensure that an antenna is connected to the correct RF port on the node that is being configured. Additionally, ensure that the antenna is for the correct frequency band for that radio.

POOR/LOW THROUGHPUT	RF INTERFER-ENCE	1. As a general rule of thumb, if there is no RF interference and nodes are in proximity to each other, a 20MHz channel should observe approximately 20Mbps throughput, a 10MHz channel should observe approximately 10Mbps, and a 5MHz channel should observe approximately 5Mbps. 2. If low throughput is measured, test other center frequencies until you achieve the highest throughput possible for a given channel width. 3. Resolve interference issue with other transmitter located nearby.
	MAX LINK DISTANCE SET INCORRECTLY	1. If Max Link Distance is set incorrectly and/or inconsistently in a network, throughput will be affected negatively. To set Max Link Distance correctly, determine the farthest distance any individual link on this frequency may need to be, then choose the next longest Max Link Distance. e.g. 13 mi = Max Link Distance should be set to 15 mi. To set Max Link Distance, click "Node Configuration" > "Node Configuration."
	CHANNEL DEN-SITY SET INCOR-RECTLY	1. If Channel Density is set incorrectly and/or inconsistently in a network, throughput will be affected negatively. To set Channel Density, click "Node Configuration" > "Node Configuration." Channel Density should be set by the number of nodes in the network.
	BLADE ANTEN-NA DOES NOT HAVE A GOOD (METALLIC) GROUND PLANE	1. Install a proper metallic ground plane.
POOR AUDIO	MICROPHONE VOLTAGE NOT ENABLED (MPU3 AND QUAD ONLY)	1. Microphone voltage must be enabled for use with certain headsets. 2. To enable microphone voltage, click "Node Configuration" > "PTT Configuration" > "Accessory Features."
	MICROPHONE GAIN NOT SET TO AUTO	1. To set microphone gain to auto, click "Node Configuration" > "PTT Configuration" > "Microphone Level" > enter "auto" into the field.

MULTICAST TRAFFIC STOPS AFTER A FEW SECONDS	**PRUNING STATUS SET INCORRECTLY (FW VERSIONS 18.3.X AND EARLIER ONLY)**	1. Prior to FW version 18.4.0, if pruning status is not the same on all nodes in the network, then multicast traffic will not forward properly. 2. To check Pruning status, click "Network Status" > "IP Multicast Status." If any nodes in the network have pruning status disabled, the page will report a message of "pruning disabled."
	CLIENT DEVICE IS USING WINDOWS CE/XP	1. Windows CE/XP computers have a known issue where they do not respond to IGMP Multicast Group Queries sent by Wave Relay nodes. "Pull All Multicast" should be used on Windows CE/XP computers to work around this issue. Pruning must be disabled on all nodes with FW versions 18.3.x and earlier or set to "Pull All Multicast" on all nodes with FW version 18.4.0 and later. 2. To disable pruning on FW versions 18.3.x and earlier, navigate to the "Network Defaults" page. Set IGMP Snooping & IP Multicast Pruning to "Disabled." 3. On FW versions 18.4.0 and later, set IP Multicast Routing to "Pull All Multicast" in the "Node Configuration" or "Network Defaults" page.

HARDWARE DETAILS

PERSISTENT SYSTEMS
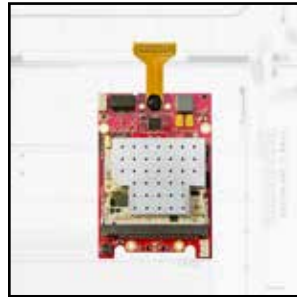
MAN PORTABLE UNIT — GEN4

PERSISTENT SYSTEMS

WAVE RELAY

PERSISTENT SYSTEMS 6.8

MAN PORTABLE UNIT — GEN4

Headset & Push-To-Talk Adapter
WR-ACC-067

Audio Options

6-pin to Micro USB Adapter Cable
CBL-117

19-Pin to 6-Pin Connector
CBL-115

GPS Stub Antenna
WR-ANT-071

MAN PORTABLE UNIT 4
WR-MPU4-XX

Android™ EUD

WAVE RELAY

PERSISTENT SYSTEMS   5.8

6-Pin Connectors
CBL-116
CBL-118

Battery
BAT-06
(Included with WR-MPU4-XX)

Samsung™ Galaxy Note Ruggedized Enclosure
MOLLE-IP67-NOTE
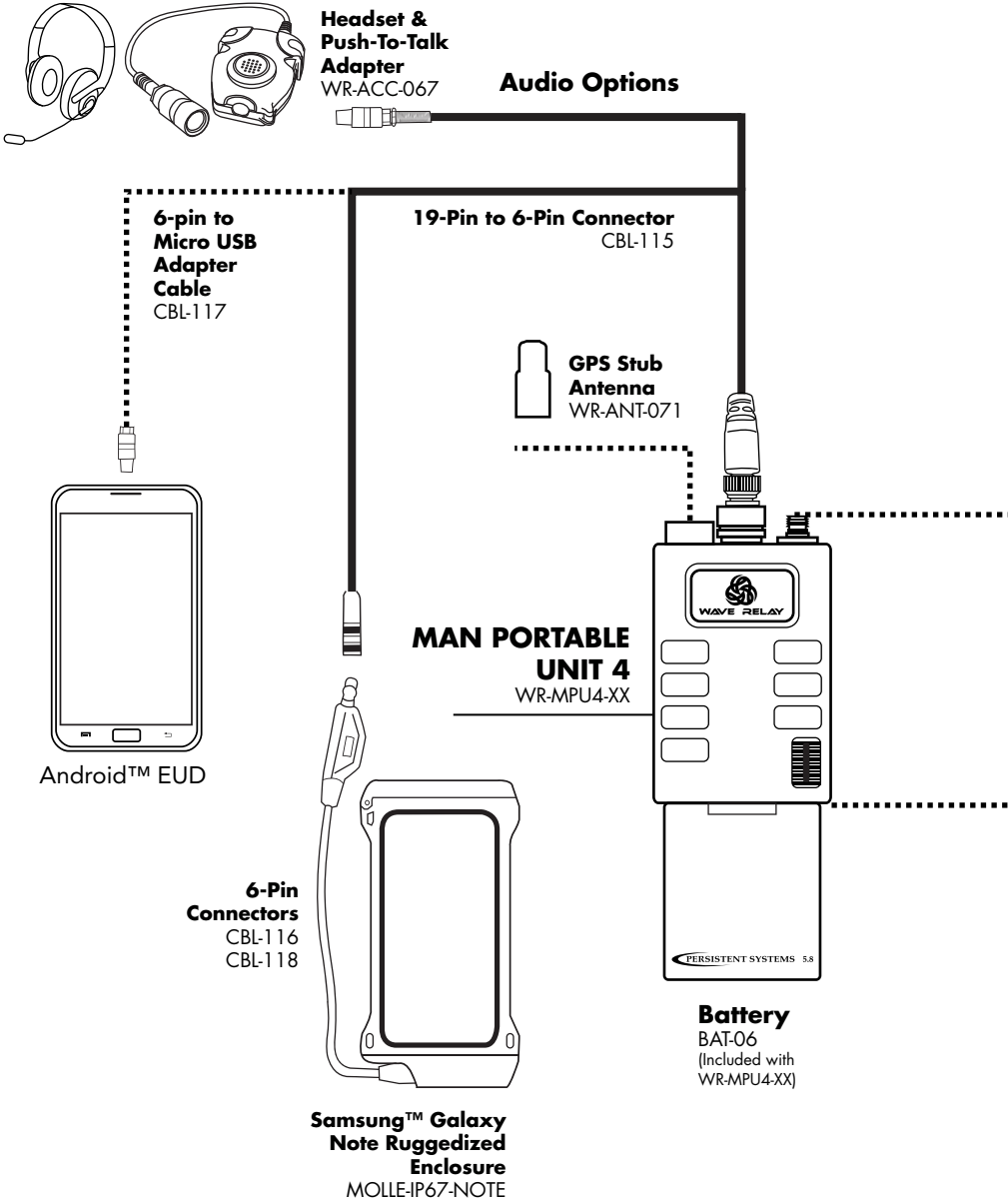
High-Performance Ground-to-Air
WR-ANT-059
2.3 - 2.5 GHz

Springbase Adapter
CBL-085

Antenna Options

760 - 780 MHz
WR-ANT-051

902 - 928 MHz
WR-ANT-073

2.3 - 2.5 GHz
WR-ANT-053

5.1 - 5.9 GHz
WR-ANT-052

4.4 - 5.0 GHz
WR-ANT-081

Battery Eliminator
CBL-054

CASE & POUCH OPTIONS

BA-2557 Pouch
MOLLE-BA-2557

BA-2590 Pouch
MOLLE-BA2590

MPU4 Pouch
MOLLE-MPU4-2
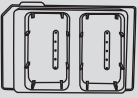
Transit Case
CASE-017

Battery
BAT-06
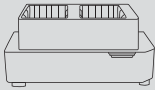
Battery Charging Adapter
BAT-07
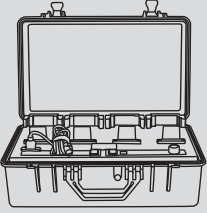
Two-Bay Battery Charger
BAT-11
(fits 2 MPU4 Batteries)

Battery Charger
BAT-05
(fits 4 Battery Charging Adapters)

BAT-04   BAT-03

BATTERY CHARGING ADAPTER
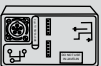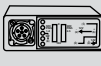
BA-2590
BAT-02

BA-2557
BAT-08

POWER OPTIONS

I/O CONNECTION – MPU4
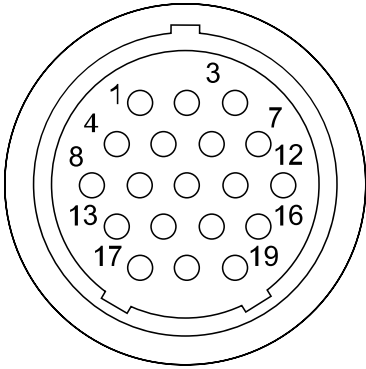
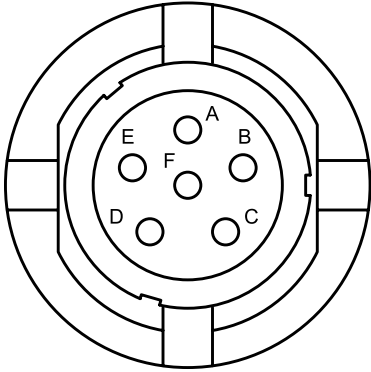| PIN	DESCRIPTION
1	Ethernet 2 RXN (RJ45 pin 6)
2	Ethernet 2 TXN (RJ45 pin 2)
3	Audio GND
4	Ethernet 1 RXP (RJ45 pin 3)
5	Ethernet 2 RXP (RJ45 pin 3)
6	Ethernet 2 TXP (RJ45 pin 1)
7	Audio Input (Microphone)
8	Ethernet 1 TXN (RJ45 pin 2)
9	Ethernet 1 RXN (RJ45 pin 6)
10	GPIO
11	Audio PTT or RS-232 WR Tx/Dev Rx
12	Audio Output (Speaker)
13	Ethernet 1 TXP (RJ45 pin 1)
14	Power GND
15	RS-232 Wave Relay® Rx/Device Tx
16	+5V Accessory Power (1 Amp Max)
17	3.3V Accessory Power (5 Amp Max)
18	+10-48VDC (VIN)
19	LED GND (Switched)

WHAT TO CONNECT

CBL-043 → I/O to Ethernet + PoE

CBL-035/CBL-077 → I/O to AID

CONNECTOR INFORMATION

- Glenair 801 Series "Mighty Mouse" Connector
- IP67 Rated in the Mated State

PERSISTENT SYSTEMS

PTT AUDIO – MPU4 AID
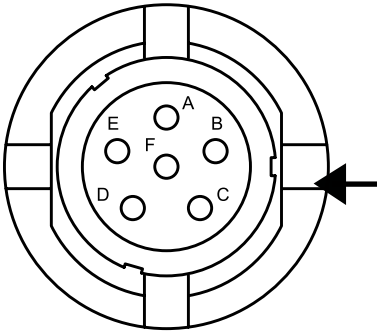
NOTE
The PTT Audio connections for the MPU4 is not wired the same as the MPU3 or Quad Radio Router.

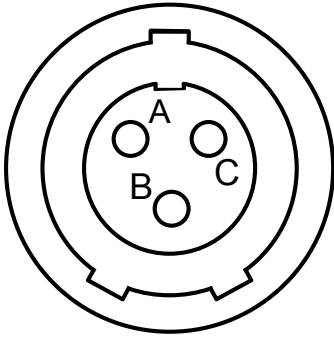| PIN	DESCRIPTION
A	Ground
B	Audio Output (speaker)
C	Audio PTT or RS-232 WR Tx/Dev Rx
D	Audio Input (microphone)
E	RS-232 Wave Relay® Rx/Device Tx
F	+5V Accessory Power

CONNECTOR INFORMATION

- NATO U-283/U Standard Wiring for PTT Devices
- IP67 Rated

WHAT TO CONNECT

WR-ACC-067, WR-ACC-079

BATTERY TWIST–LOCK CONNECTION - MPU4
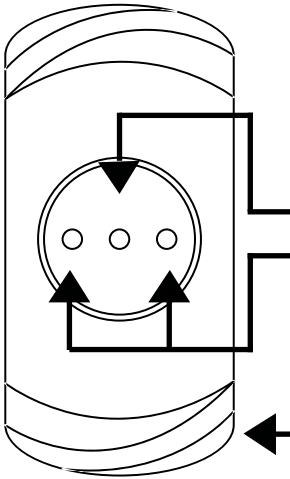
POWER SPECIFICATIONS

Voltage Range: 8-30 VDC

PIN	DESCRIPTION
Center	Smart I/O
Outer	Power
Flange	Ground

WHAT TO CONNECT
Included: BAT-06
Battery Eliminator: CBL-054

Compatible With:
PRC-148 Thales MBITR Battery
PRC-152 Harris Falcon III Battery

CONNECTOR INFORMATION

- IP67 Rated
- Used to power an MPU4 when not using 19-pin I/O PoE functionality

PERSISTENT SYSTEMS   5.8

MAN PORTABLE UNIT — GEN3

PERSISTENT SYSTEMS

HARDWARE DETAILS
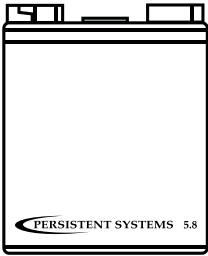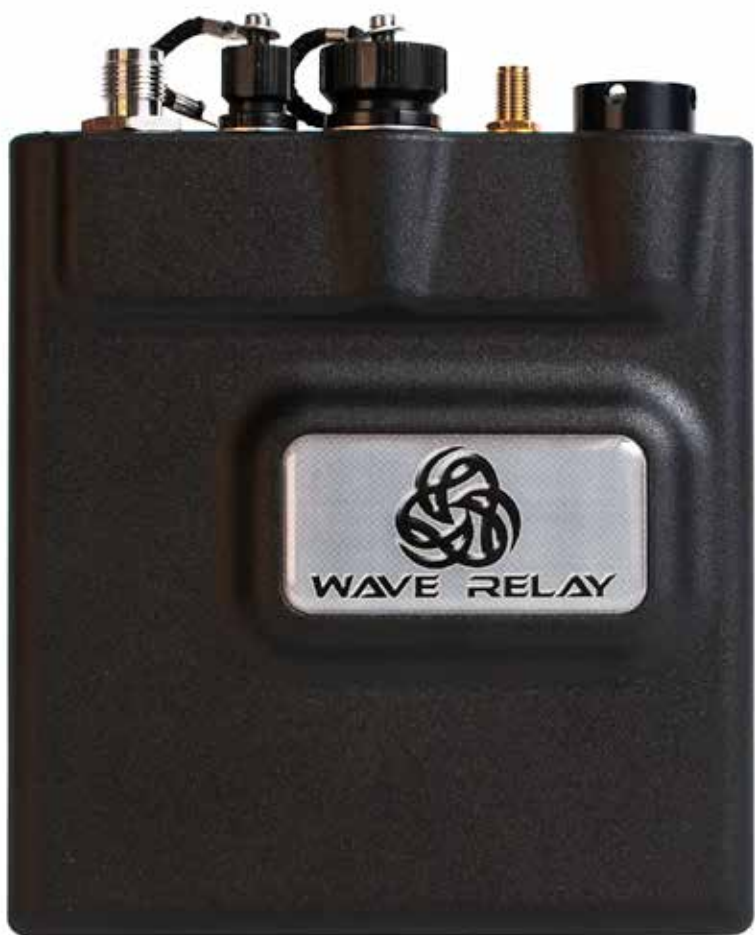
MAN PORTABLE UNIT — GEN3

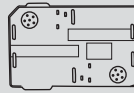### POWER OPTIONS

BA-2590
BAT-02

BA-2557
BAT-08

BATTERY CHARGING ADAPTER

BAT-04   BAT-03

Outdoor PoE Injector
WR-PWR-48V - 60W

Wall Power Supply
CBL-063

Battery Charger
BAT-05
(fits 4 Battery Charging Adapters)

24 inch Battery Cable
CBL-037

5 inch Battery Cable
CBL-045

MPU3 Dual Pouch
CASE-019

MPU3 Pouch
CASE-015

MPU3/BA-2557 Pouch
CASE-011

BA-2557 Pouch
CASE-020

Transit Case
CASE-012

BA-2590 Pouch
MOLLE-BB2590

CASE & POUCH OPTIONS

To Power
- 8-48V DC Input

Antenna Options

High-Performance Ground-to-Air
WR-ANT-059
2.3 - 2.5 GHz

Springbase Adaptor
CBL-085

760 - 780 MHz
WR-ANT-051

902 - 928 MHz
WR-ANT-073

2.3 - 2.5 GHz
WR-ANT-053

5.1 - 5.9 GHz
WR-ANT-052

4.4 - 5.0 GHz
WR-ANT-081

1.3 - 1.39 GHz
WR-ANT-084

PERSISTENT SYSTEMS
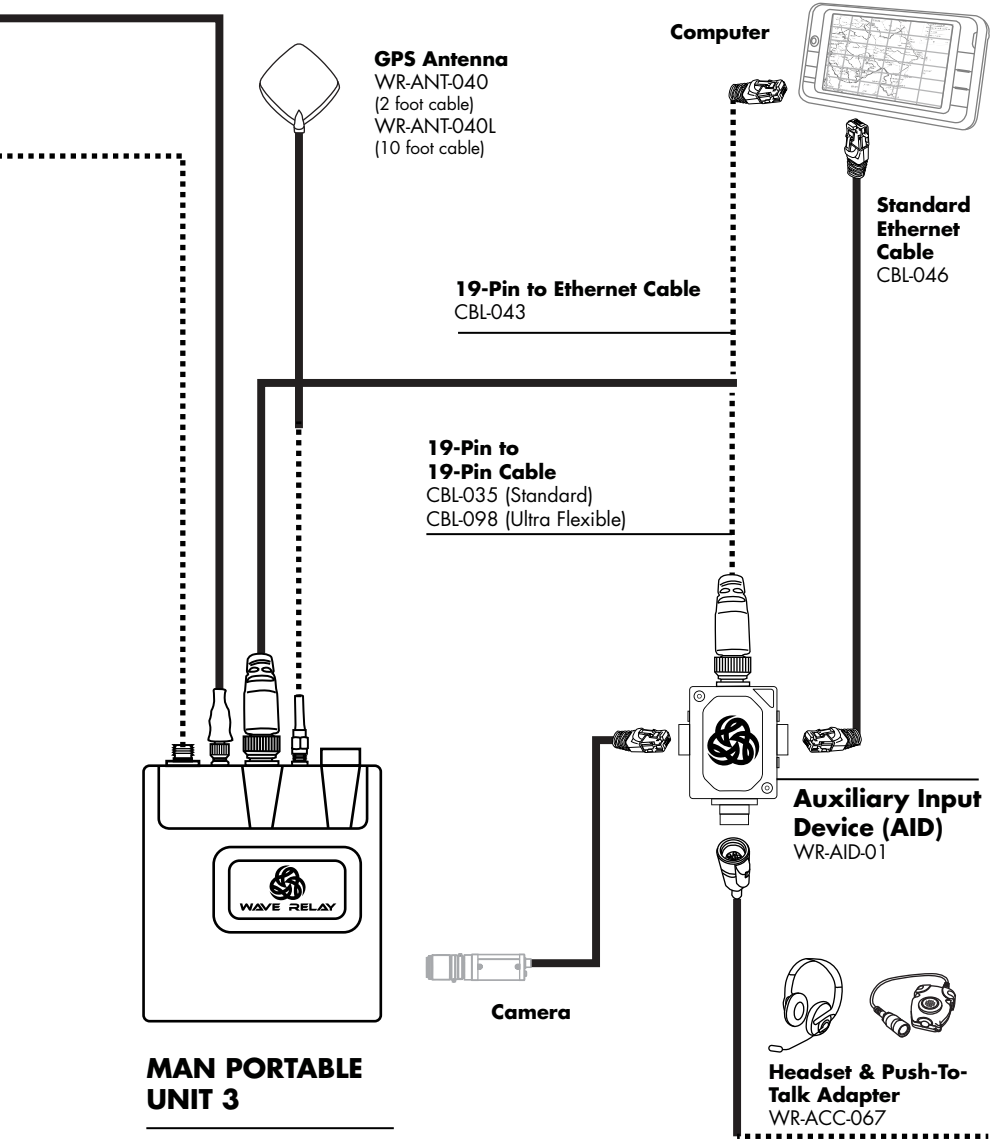
GPS Antenna
WR-ANT-040
(2 foot cable)
WR-ANT-040L
(10 foot cable)

Computer

**Standard
Ethernet
Cable**
CBL-046

19-Pin to Ethernet Cable
CBL-043

**19-Pin to
19-Pin Cable**
CBL-035 (Standard)
CBL-098 (Ultra Flexible)

**Auxiliary Input
Device (AID)**
WR-AID-01

Camera

**MAN PORTABLE
UNIT 3**

With One Radio: WR-MPU3-XX
With Two Radios: WR-MPU3-XXXX

WAVE RELAY

**Headset & Push-To-
Talk Adapter**
WR-ACC-067

Audio Options

I/O CONNECTION – MPU3

PIN	DESCRIPTION
1	Ethernet 2 RXN (RJ45 pin 6)
2	Ethernet 2 TXN (RJ45 pin 2)
3	Audio GND
4	Ethernet 1 RXP (RJ45 pin 3)
5	Ethernet 2 RXP (RJ45 pin 3)
6	Ethernet 2 TXP (RJ45 pin 1)
7	Audio Input (Microphone)
8	Ethernet 1 TXN (RJ45 pin 2)
9	Ethernet 1 RXN (RJ45 pin 6)
10	N/C
11	Audio PTT
12	Audio Output (Speaker)
13	Ethernet 1 TXP (RJ45 pin 1)
14	Power GND
15	Wave Relay® Tx/Device Rx
16	RS-232 Wave Relay® Rx/Dev Tx or +5V Accessory Power (1 Amp Max)
17	3.3V Accessory Power (3 Amp Max)
18	+10-48VDC (VIN)
19	LED GND (Cathode)

HOW TO CONNECT

CBL-043 → I/O to Ethernet + PoE

CBL-035/CBL-077 → I/O to AID

CONNECTOR INFORMATION

- Glenair 801 Series "Mighty Mouse" Connector
- IP67 Rated in the Mated State

PERSISTENT SYSTEMS

PTT AUDIO – MPU3 AID

NOTE
The PTT Audio connections on the MPU3 and the MPU4 are NOT wired identically.

PIN	DESCRIPTION
A	Ground
B	Audio Output (speaker)
C	Audio Push-To-Talk
D	Audio Input (microphone)
E	RS-232 Wave Relay® Tx/Dev Rx
F	RS-232 Wave Relay® Rx/Dev Tx or +5V Accessory Power (1 Amp Max)

CONNECTOR INFORMATION

- NATO U-283/U Standard Wiring for PTT Devices
- IP67 Rated

WHAT TO CONNECT

WR-ACC-067, WR-ACC-079

AUXILIARY POWER – MPU3

POWER SPECIFICATIONS

Voltage Range: 8-48 VDC
Maximum Current: 5 Amps

PIN	DESCRIPTION
A	Ground
B	Power IN
C	N/C

CONNECTOR INFORMATION

- Glenair 801 Series "Mighty Mouse" Connector
- IP67 Rated in the Mated State
- Used to power an MPU3 when not utilizing the 19pin I/O PoE fuction

WHAT TO CONNECT

CBL-037, 045 → PWR to BA-2557, BA-2590, BA-5590

CBL-059 → PWR to Vehicle DC Power Port

QUAD RADIO ROUTER

PERSISTENT SYSTEMS

QUAD RADIO ROUTER

MOUNTING OPTIONS
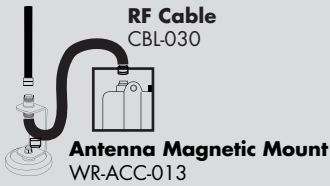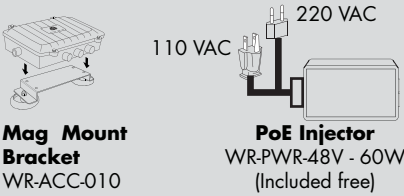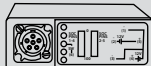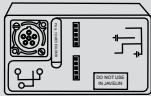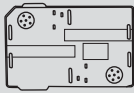
Mag Mount Bracket
WR-ACC-010

220 VAC
110 VAC

PoE Injector
WR-PWR-48V - 60W
(Included free)

RF Cable
CBL-030

Antenna Magnetic Mount
WR-ACC-013

4-Pin to RS-232
CBL-060 (Male)
CBL-061 (Female)

4-Pin to 4-Pin
CBL-034

4-Pin to Car Adapter
CBL-062

4-Pin to BA
CBL-029

Cable Options

BA-2590
BAT-02

BA-2557
BAT-08

BATTERY CHARGING ADAPTER

BAT-04   BAT-03

Battery Charger
BAT-05
(fits 4 Battery Charging Adapters)
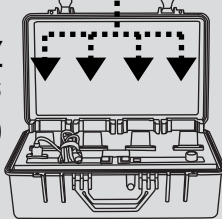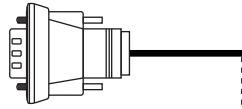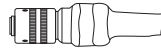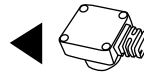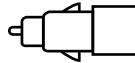
POWER OPTIONS
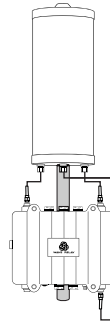
Sector Array Antenna
WR-RTR-XXXXXXXX

Tracking Antenna System
TRK-KIT-06

PERSISTENT SYSTEMS

5 GHz
WR-ANT-026

2.3 GHz
WR-ANT-015

760 - 780 MHz
WR-ANT-037

900 MHz
WR-ANT-085

Antenna Options

Antenna Connection

Headset & Push-To-Talk Adapter
WR-ACC-067

Audio Options

QUAD RADIO ROUTER
WR-RTR2-XXXXXXXX

Antenna Connection

Antenna Connection

▲
To Power

110 VAC

220 VAC

GPS Antenna
WR-ANT-040
(2 foot cable)
WR-ANT-040L
(10 foot cable)

GPS Antenna Options

Outdoor PoE Injector
WR-PWR-48V - 60W

SECTOR ARRAY KIT

MOUNTING OPTIONS
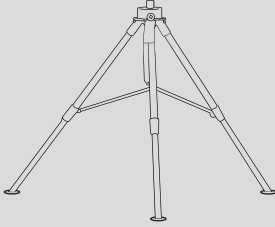
Heavy Duty Tripod
WR-ACC-034 (15 meters)
WR-ACC-028 (7 meters)
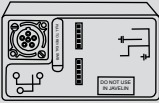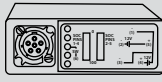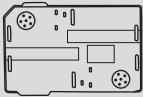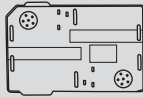
4-Pin to RS-232
CBL-060 (Male)
CBL-061 (Female)

4-Pin to 4-Pin
CBL-034

4-Pin to Car Adapter
CBL-062

4-Pin to BA
CBL-029

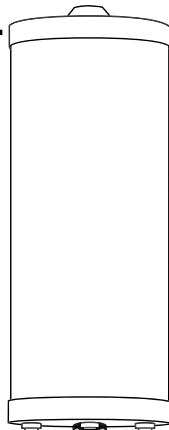**Cable Options**

BA-2590
BAT-02

BA-2557
BAT-08

BATTERY CHARGING ADAPTER

BAT-04   BAT-03

Battery Charger
BAT-05
(fits 4 Battery Charging Adapters)

POWER OPTIONS

To Power

110 VAC

220 VAC

PERSISTENT SYSTEMS
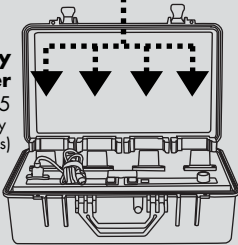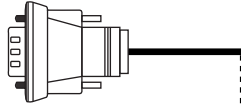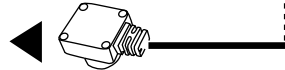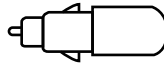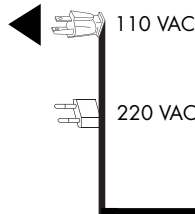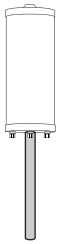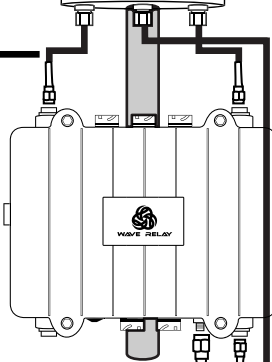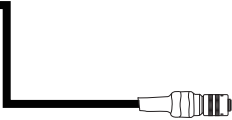
Antenna Options

2.3 GHz
WR-ANT-068

5 GHz
WR-ANT-067

Sector Array Antenna
WR-RTR-XXXXXXXX

Includes:
Sector Array Antenna
RF Cables

CBL-072
(Included free)
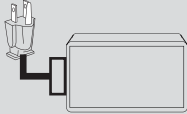
Audio Options

CBL-073
(Included free)

GPS Antenna
WR-ANT-040
(2 foot cable)
WR-ANT-040L
(10 foot cable)

**Outdoor
PoE Injector**
WR-PWR-48V - 60W

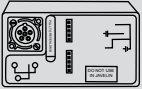**GPS Antenna Options**

TRACKER ANTENNA SYSTEM

Outdoor PoE Injector
WR-PWR-48V - 60W
(US, EU, UK)

5GHz
WR-ANT-026

760 - 780 MHz
WR-ANT-037

2.4GHz
WR-ANT-015

900MHz
WR-ANT-085

ANTENNA OPTIONS

BA-2590
BAT-02

BA-2557
BAT-08
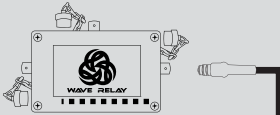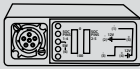
**Power / Communications
Junction Box**
TRK-07 (Included)

To 110V - 220V AC Power

POWER OPTIONS

PERSISTENT SYSTEMS

Tracking Antenna System
TRK-KIT-06

Includes:
- 2.3 Parabolic Grid and Antenna Element
- Tripod
- Pan/Tilt Motor
- Outdoor POE Injector
- Junction Box
- RF Cables

Audio Options

WR-RTR2-XXXXXXXX
with Pole Bracket
(Sold Seperately)

GPS Antenna
WR-ANT-040
WR-ANT040L

TRK-01

PERSISTENT SYSTEMS   **137**
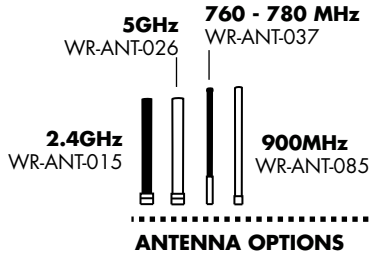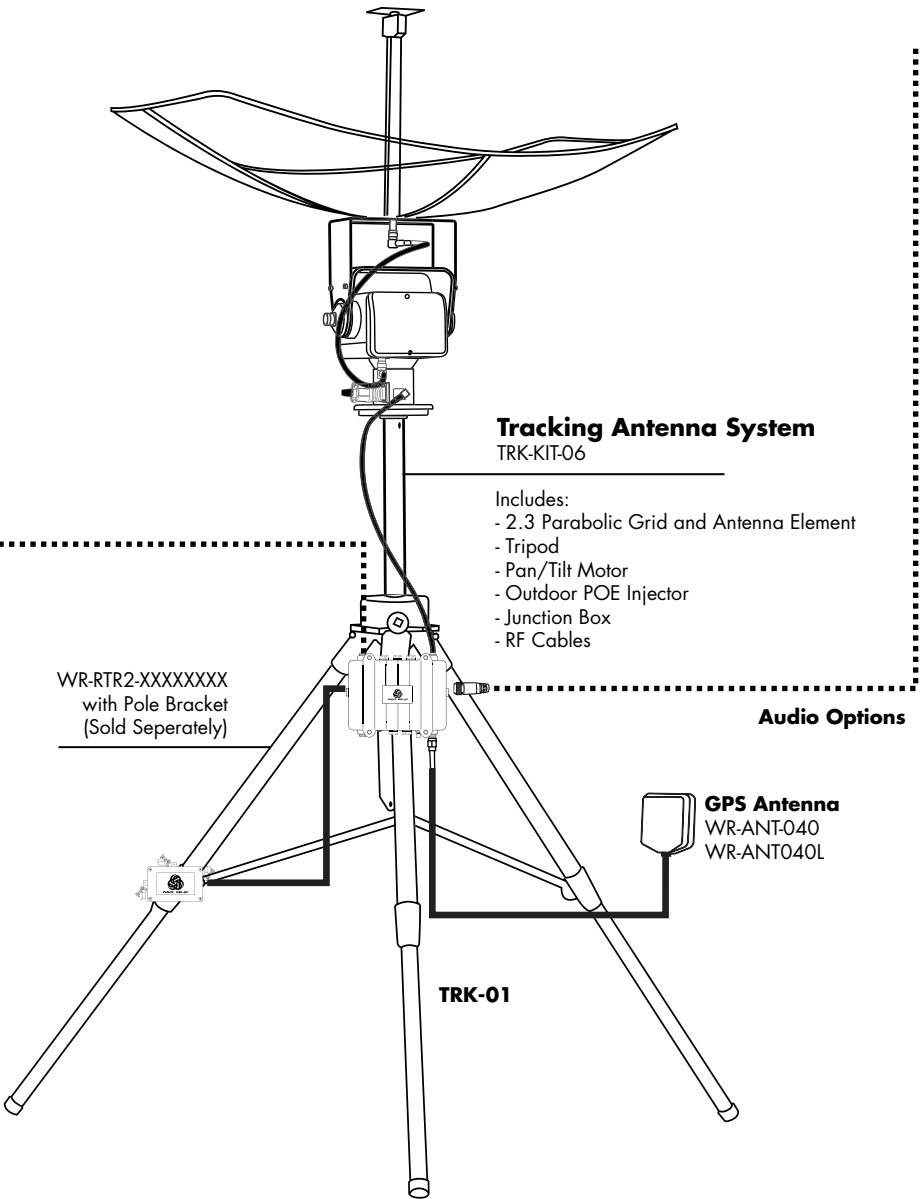
ETHERNET 1 PORTS – QUAD RADIO ROUTER

1   8
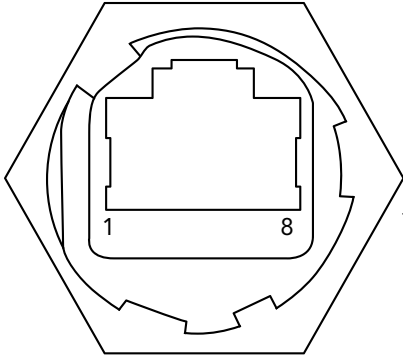
PoE INFORMATION

Ethernet 1 Accepts 8-48 VDC
Any standard Ethernet cable will carry
power and date

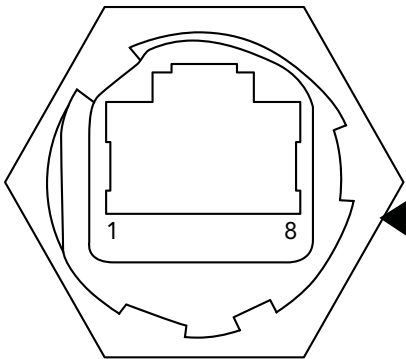| PIN	DESCRIPTION
1	Tx(+)
2	Tx(-)
3	Rx(+)
4	PoE Power
5	PoE Power
6	Rx(-)
7	PoE Ground
8	PoE Ground

CONNECTION INFORMATION

- Standard CAT5e/RJ45 Ethernet Connection
- Supports Power-Over-Ethernet PoE
- Ethernet 1 Factory Setup IP Address:
  10.3.1.254
- Receptacle is rated to IP67 in the unmated
  state.

WHAT TO CONNECT

- Standard Ethernet Cable
- Persistent Systems IP67 Rated Ethernet
  Cables: 10,15,25, & 100'
- Power-Over-Ethernet(PoE) device included
  with every Quad Radio Router System

ETHERNET 2 PORTS – QUAD RADIO ROUTER

WARNING

Ethernet ports 2-5 do NOT support Power-Over-Ethernet Functionality

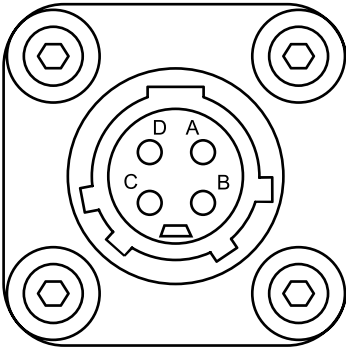| PIN	DESCRIPTION
1	Tx(+)
2	Tx(-)
3	Rx(+)
4	N/C
5	N/C
6	Rx(-)
7	N/C
8	N/C

CONNECTION INFORMATION

- Standard CAT5e/RJ45 Ethernet Connection
- Ethernet 2 Factory Setup IP Address: 10.3.2.254
- Receptacle is rated to IP67 in the unmated state.

WHAT TO CONNECT

- Standard Ethernet Cable
- Persistent Systems IP67 Rated Ethernet Cables: 10,15,25, & 100'
- Power-Over-Ethernet(PoE) device included with every Quad Radio Router System

AUXILIARY POWER – QUAD RADIO ROUTER

POWER SPECIFICATIONS

Voltage Range: 8-48 VDC
Maximum Current: 5 Amps

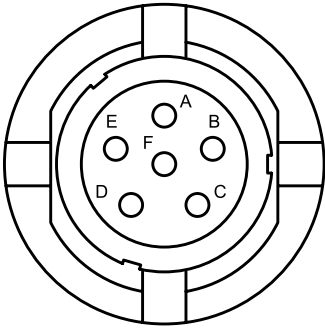| PIN	DESCRIPTION
A	Power In
B	Ground
C	RS-232 Wave Relay® Tx/Dev Rx
D	RS-232 Wave Relay® Rx/Dev Tx

CONNECTOR INFORMATION

- IP67 Rated
- Offers auxiliary power option and serial I/O
- Mating Plug: CONN-046

WHAT TO CONNECT

CBL-029, 062, 069, 034, 060, 061

PTT AUDIO = QUAD RADIO ROUTER

NOTE
The PTT Audio connections on the Quad Radio Router and the MPU4 are NOT wired identically.

PIN	DESCRIPTION
A	Audio Ground
B	Audio Input (microphone)
C	Audio Push-To-Talk
D	Audio Output (speaker)
E	RS-232 Wave Relay® Tx/Dev Rx
F	RS-232 Wave Relay® Rx/Dev Tx or +5 V Accessory Power

CONNECTOR INFORMATION

- NATO U-283/U Standard Wiring for PTT Devices
- IP67 Rated

WHAT TO CONNECT

WR-ACC-067, WR-ACC-079

REGULATORY INFORMATION

The following notes refer to these part numbers: WR-MPU4-04, WR-MPU3-04, WR-MPU3-0409, and WR-RTR2-04040909.

THIS DEVICE COMPLIES WITH PART 15 OF THE FCC RULES. OPERATION IS SUBJECT TO THE FOLLOWING TWO CONDITIONS:

(1) THIS DEVICE MAY NOT CAUSE HARMFUL INTERFERENCE, AND

(2) THIS DEVICE MUST ACCEPT ANY INTERFERENCE RECEIVED, INCLUDING INTERFERENCE THAT MAY CAUSE UNDESIRED OPERATION.

NOTE: THE MANUFACTURER IS NOT RESPONSIBLE FOR ANY RADIO OR TV INTERFERENCE CAUSED BY UNAUTHORIZED MODIFICATIONS TO THIS EQUIPMENT. SUCH MODIFICATIONS COULD VOID THE USER'S AUTHORITY TO OPERATE THE EQUIPMENT.

NOTE II: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at their own expense.

WAVE RELAY®
USER MANUAL

03EN009 (English) VERSION 3.1

PERSISTENT SYSTEMS