Document No. TR0153 Rev E2

EnRoute50x/51x

User's Guide

Rev. E1

TRANZEO
WIRELESS TECHNOLOGIES INC.

Communicate Without Boundaries

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FCC Notice to Users and Operators

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.

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

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

To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (EIRP) is not more than that required for successful communication.

- This device must be installed so that there is a minimum of 172.9 cm between the antenna and any person.

⚠ Any changes or modification to said product not expressly approved by Tranzeo Wireless Technologies Inc. could void the user's authority to operate this device.

INFO The Tranzeo EnRoute500 Mesh Router must be installed by a trained professional, value added reseller, or systems integrator who is familiar with RF cell planning issues and the regulatory limits defined by the FCC for RF exposure, specifically those limits outlined in sections 1.1307.

Table of Contents

1 Working with the EnRoute500

Thank you for choosing the Tranzeo EnRoute500 Wireless Mesh Router. The EnRoute500 allows a wireless mesh network to be rapidly deployed with minimal configuration required by the end user. This user's guide presents a wide array of configuration options, but only a limited number of options have to be configured in order to deploy a mesh network of EnRoute500s.

1.1 EnRoute500 Variants

The following is a list of Enroute varients, as shown in Table 1.

Model Number	Included Antennas
EnRoute500	AP 5dBi, Mesh 8.5dBi
EnRoute510	AP 7.5dBi, Mesh 10.5dBi

Table 1. EnRoute500 variants

The following is a list of supported accessory antennas sold with the Enroute family, as shown in Table 2.

Model Number	Included Antennas
TR-ODH24-12	Vertical Omnidirectional 2.4 Ghz 12 dBi
TR-SA24-90-9	Vertical Sector, 2.4 Ghz, 90 degree, 9 dBi
TR-HTQ-5.8-12	Vertical Omnidirectional, 5.8 Ghz, 12 dBi
TR-58V-60-17	Vertical Sector, 5.8 Ghz, 60 degree, 17 dBi
TR-5X-Ant-24	Panel, 5.8 Ghz, 24 dBi
TR-5.8-32Db-Ant	Parabolic dish, 5.8 Ghz, 32 dBi

Table 2 Supported Accessory antennas

INFO

Throughout the manual, "EnRoute500" will be used to collectively refer to this family of products. Where the functionality of the variants differ, the actual model number will be used.

1.2 EnRoute500 Capabilities

The EnRoute500 is capable of automatically forming a mesh network that allows devices that are connected to it, either with a wired or a wireless connection, to communicate with each other and external networks that are accessed through gateway devices. The EnRoute500 has two radios, an 802.11a mesh backhaul radio and an access point radio for 802.11b/g-client devices. An EnRoute500 will currently support up to four virtual access points (VAPs), each with different access and performance settings. It is also possible to connect devices to an EnRoute500 using an Ethernet connection.

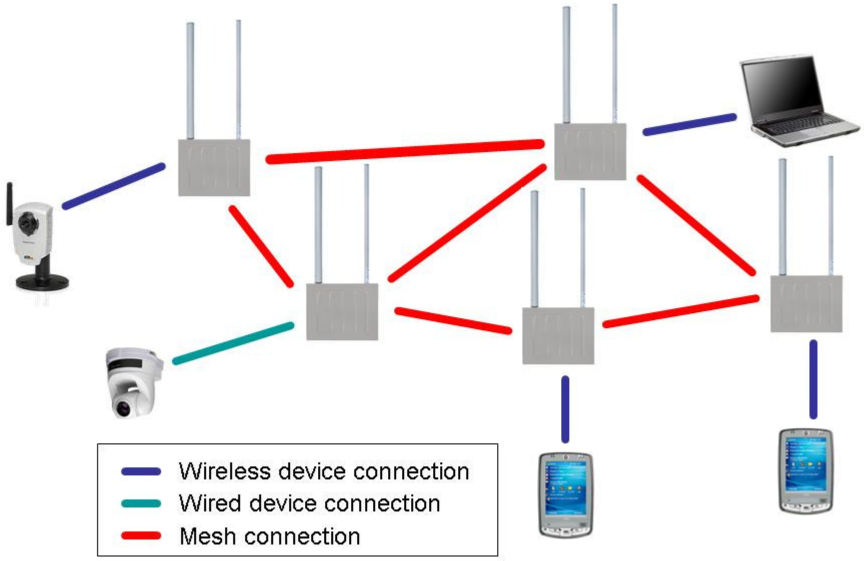


Figure 1. EnRoute500 sample network – devices attach to the EnRoute500 through both wired and wireless connections

1.3 Network Topology

EnRoute500s can be used to create two network topologies: a stand-alone network or an Internet extension network that attaches to a network with connectivity to the Internet.

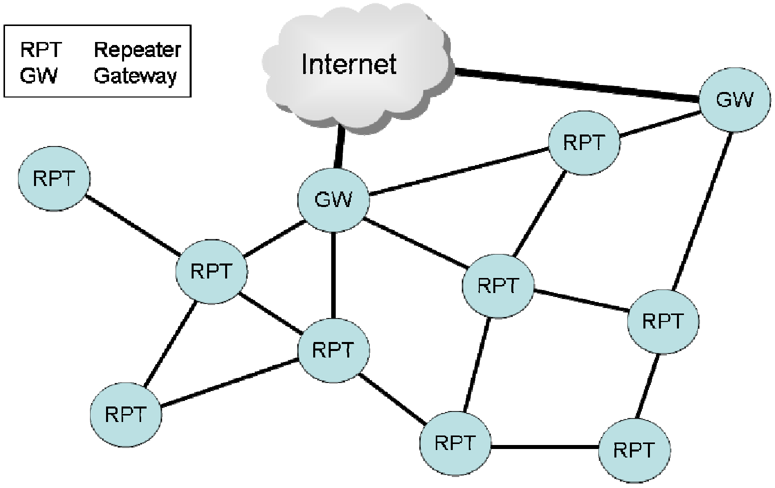


Figure 2. Internet extension network

An Internet extension network (shown in Figure 2) is typically used when the goal is to provide Internet access to a number of clients that connect to the mesh network. Alternatively, this configuration can be used to provide access for client devices to remote resources on a private network. The key feature to note is that there is a gateway device that provides access from the mesh network to an external network.

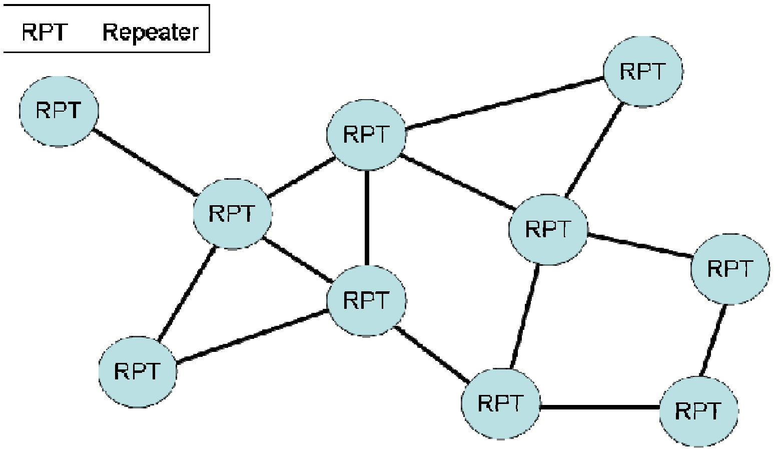


Figure 3. Stand-alone network

In a stand-alone network, as shown in Figure 3, all devices are configured to operate in the same mode (repeater mode). This network configuration is suitable for applications where the clients using the mesh only need to communicate with each other and do not need to access the Internet or other remote network resources that are not directly connected to the mesh.

1.4 Network Terminology

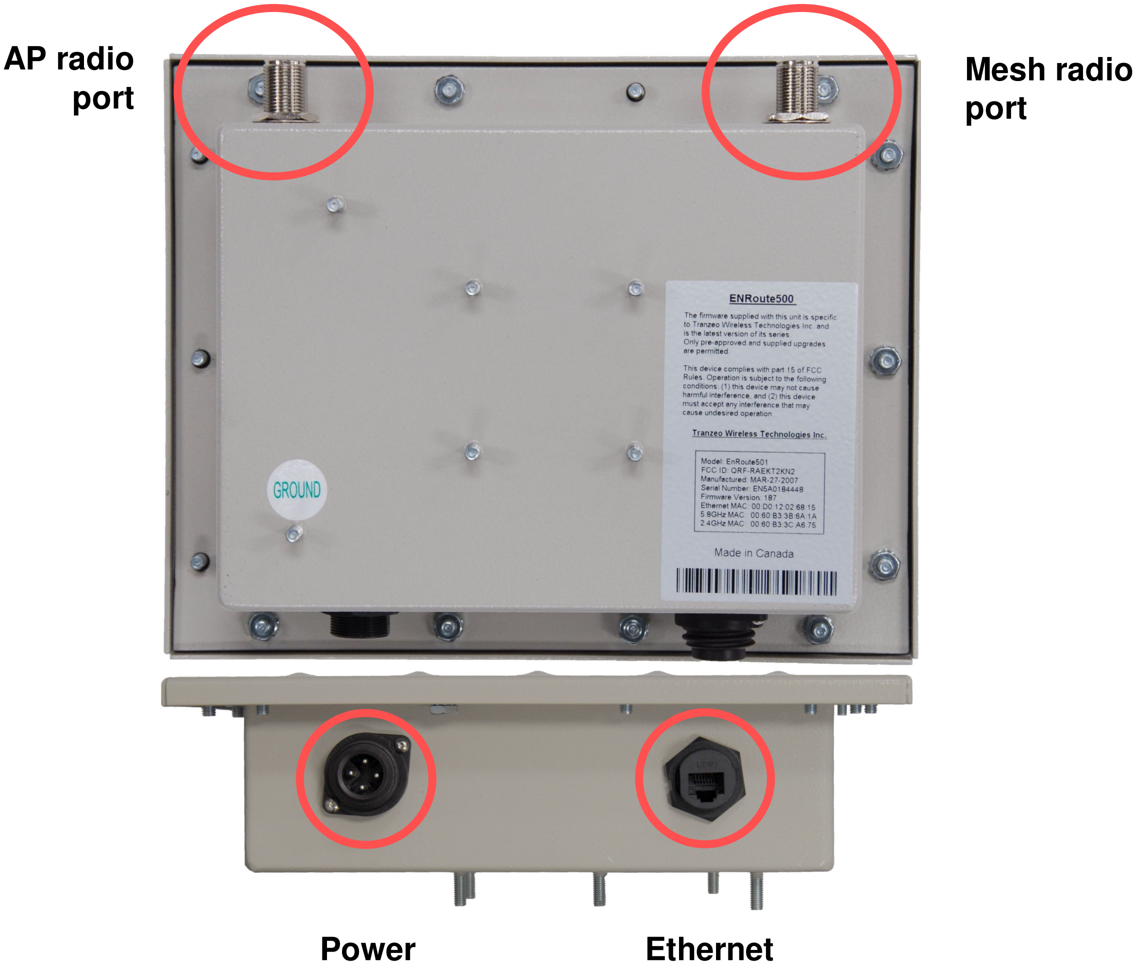
The following terms will be referred to throughout this manual.

Mesh neighborhood – a group of two or more EnRoute500 devices with at least one configured as a gateway

Mesh device – a single EnRoute500 that is part of a mesh network

1.5 EnRoute500 Interfaces

The interfaces available on the EnRoute500 are Ethernet and two radio ports. On the EnRoute5x1 models, an external AC power port is also present.



ENRoute500

The firmware supplied with this unit is specific to Tranzeo Wireless Technologies Inc. and is the latest version of its series. Only pre-approved and supplied upgrades are permitted.

This device complies with part 15 of FCC Rules. Operation is subject to the following conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference that may cause undesired operation.

Tranzeo Wireless Technologies Inc.

Model: EnRoute501
FCC ID: QRF-RAEKT2KN2
Manufactured: MAR-27-2007
Serial Number: EN5A0184448
Firmware Version: 187
Ethernet MAC: 00:D0:12:02:68:15
5.8GHz MAC: 00:60:B3:3B:6A:1A
2.4GHz MAC: 00:60:B3:3C:A6:75

Made in Canada

Figure 4. EnRoute500 interfaces. EnRoute501 shown

Interface	Description
Power (EnRoute 5x1 only)	Power input (100-240VAC 50-60 Hz)
Mesh radio port	N-type antenna connector for mesh radio
AP radio port	N-type antenna connector for access point radio
Ethernet	10/100 Mbit Ethernet interface
Passive PoE	PoE power input (9-28VDC, 12W) *Not compatible with IEEE 802.3af*

Table 2. EnRoute500 Interfaces

1.5.1 Ethernet and PoE

The EnRoute500 has a 10/100 Ethernet port that supports passive Power over Ethernet (PoE). The PoE power injector should supply an input voltage between 9-28VDC and a minimum of 12W. The pinout for the Ethernet interface on the EnRoute500 is provided in Table 3.

INFO

> The EnRoute500 is equipped with an auto-sensing Ethernet port that allows both regular and cross-over cables to be used to connect to it.

Pin	Signal	Standard Wire Color
1	Tx+	White/Orange
2	Tx-	Orange
3	Rx+	White/Green
4	PoE V+	Blue
5	PoE V+	White/Blue
6	Rx-	Green
7	Gnd	White/Brown
8	Gnd	Brown

Table 3. Ethernet port pinout

To power the EnRoute500, connect an Ethernet cable from the Ethernet port of the EnRoute500 to the port labeled “CPE” on the supplied PoE injector and apply power to the PoE injector using the supplied power supply

⚠ **DO NOT CONNECT ANY DEVICE OTHER THAN THE ENROUTE500 TO THE PORT LABELED "CPE" ON THE PoE INJECTOR. NETWORK EQUIPMENT THAT DOES NOT SUPPORT PoE CAN BE PERMANENTLY DAMAGED BY CONNECTING TO A PoE SOURCE. NOTE THAT MOST ETHERNET INTERFACES ON PERSONAL COMPUTERS (PCs), LAPTOP/NOTEBOOK COMPUTERS, AND OTHER NETWORK EQUIPMENT (E.G. ETHERNET SWITCHES AND ROUTERS) DO NOT SUPPORT PoE.**

1.5.2 Antennas

Attach the supplied antennas to the mesh and access point (AP) radio ports on the EnRoute500. The antennas used for the two radios are band-specific and therefore it is important to correctly match the antennas with the radio ports.

The thicker of the two antennas is the 2.4 GHz antenna, which should be attached to the AP connector. The thinner antenna is the 5.8 GHz antenna, which should be attached to the mesh connector.

1.6 Deployment Considerations

The EnRoute500's radios operate in the unlicensed 2.4 GHz and 5.8 GHz ISM bands. It is possible that there will be other devices operating in these bands that will interfere with the EnRoute500's radios. Interference from adjacent EnRoute500s can also degrade performance if the EnRoute500s are not configured properly.

It is advisable to carry out a site survey prior to installation to determine what devices are operating in the two bands that the EnRoute500 uses. To detect the presence of other 802.11 devices, a tool such as Netstumbler (http://www.netstumbler.com/downloads/) can be used. A spectrum analyzer can be used for further characterization of interference in the band.

1.6.1 Mesh Channel Selection

The mesh radio channel must be the same for all EnRoute500s in a given mesh neighborhood. Adjacent mesh neighborhoods will get a performance benefit if they are on different channels as the neighborhoods will not interfere with each other. The 802.11a channels that the EnRoute500 mesh radio can be configured to use are all non-overlapping.

1.6.2 AP Channel Selection

The access point radio channels used by the EnRoute500s in a mesh neighborhood may differ. It is advisable to use different access point channels for adjacent mesh devices to reduce interference.

However, it may be more important to select the access point channel based on the presence of other 802.11 devices in the area rather than configuring it to be different than that of an adjacent EnRoute500. A site survey should be conducted to determine which access point channel will provide the best performance.

Some of the 802.11b/g channels that the EnRoute500 access point radio can be configured to use are overlapping. Only channels 1, 6, and 11 are non-overlapping.

2 Connecting to the EnRoute500

The EnRoute500 can be configured and monitored by connecting to one of its network interfaces. The wired Ethernet interface on the EnRoute500 should be used for initial configuration of the device, but other network interfaces can be used to connect to the device after initial configuration has been completed.

2.1 Network Interfaces

The EnRoute500 has several network interfaces, as shown in Table 4.

INFO

> The network interfaces listed in the table below are logical, not hardware, interfaces. Some of the interfaces listed in the table share the same hardware interface.

Interface	Hardware Interface	Primary Function	Interface Availability	Default Address	Fixed Address?
Wired	Ethernet	Connecting to a WAN or supporting wired client connections	Enabled by default	10.253.253.225/27	No
Static Configuration	Ethernet	Configuring the device before a unique Ethernet IP address has been configured	Always present	169.254.253.253/16	Yes
OnRamp Configuration	Ethernet	Configuring the device before a unique Ethernet IP address has been configured. Unlike the static configuration interface, this interface’s address can be modified, allowing multiple unconfigured EnRoute500s to be attached to a LAN	Disabled by default	N/A	No
Mesh	Mesh radio	Mesh communication	Always present	172.29.253.253/16	No
VAP 1 – 4	AP radio	Connecting to wireless clients	Only VAP1 enabled by default	10.253.253.1/26 10.253.253.129/27 10.253.253.161/27 10.253.253.193/27	No
Centralized DHCP		Provides a gateway for client devices when using centralized DHCP server mode	All disabled by default	N/A	No

Table 4. EnRoute500 network interfaces

Note that the "Static Configuration" interface is the only interface that has a fixed address that cannot be changed by the user. Since this interface is known to always be present, it can be used for initial configuration and for accessing devices whose configuration settings are unknown.

2.2 Connecting to an Unconfigured EnRoute500

Use the Static Configuration interface with IP address **169.254.253.253** and netmask **255.255.0.0** to establish network connectivity to an unconfigured EnRoute500.

⚠ **The Static Configuration interface functions only with the EnRoute500's wired interface. Do not try to access the EnRoute500 over a wireless link using the address of this interface.**

To connect to an EnRoute500 using its Static Configuration IP address, you must configure your computer's IP address to be in the 169.254.253.253/16 subnet, e.g. 169.254.253.1 and connect the computer's Ethernet cable to the "DATA" port on the EnRoute500's PoE injector.

⚠ **ENSURE THAT THE DATA CONNECTION FROM THE PC OR THE LAN IS MADE TO THE "PC" PORT. DO NOT CONNECT ANY DEVICE OTHER THAN THE ENROUTE500 TO THE PORT LABELED "CPE" ON THE PoE INJECTOR. NETWORK EQUIPMENT THAT DOES NOT SUPPORT PoE CAN BE PERMANENTLY DAMAGED BY CONNECTING TO A PoE SOURCE. NOTE THAT MOST ETHERNET INTERFACES ON PERSONAL COMPUTERS (PCs), LAPTOP/NOTEBOOK COMPUTERS, AND OTHER NETWORK EQUIPMENT (E.G. ETHERNET SWITCHES AND ROUTERS) DO NOT SUPPORT PoE.**

⚠ **Since the Static Configuration IP address is the same for all EnRoute500s, you should not simultaneously connect multiple EnRoute500s to a common LAN and attempt to access them using the Static Configuration IP address.**

If you are configuring multiple EnRoute500s with the same computer in rapid succession, it may be necessary to clear the ARP cache since the IP addresses for the EnRoute500s will all be the same, but the MAC addresses will vary. The following commands can be used to clear the ARP cache

Windows XP (executed in a command prompt window)

```
arp -d *
```

to clear the entire cache, or

```
arp -d 169.254.253.253
```

to just clear the EnRoute500 entry

Linux

```
arp -d 169.254.253.253
```

2.3 Default Login and Password

The EnRoute500's default login is '**admin**' and the default password is '**default**'. The login and password are the same for the web interface and the CLI. Changing the password using one of the interfaces will change it for the other interface as well.

2.4 Resetting the 'admin' Password

The EnRoute500 supports a password recovery feature for the 'admin' account, should the password be lost.

Completing the password recovery procedure requires that you contact Tranzeo technical support. Please check the Tranzeo website (www.tranzeo.com) for how to contact technical support and hours of operation.

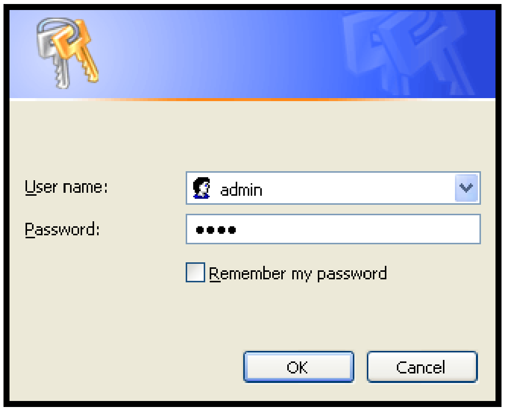
For security purposes, the 'admin' password can only be reset in the first 15 minutes of operation of the device. You will be able to power the unit on and off to be able to reset the password.

3 Using the Web Interface

The EnRoute500 has a web interface accessible through a browser that can be used to configure the device and display status parameters.

3.1 Accessing the Web Interface

You can access the web interface by entering one of the EnRoute500's IP addresses in the URL field of a web browser (see section 2.2 for a description of how to access an unconfigured EnRoute500 using its Ethernet interface). When you enter this URL, you will be prompted for a login and password. The default login and password used for the web interface are '**admin**' and '**default**', respectively.



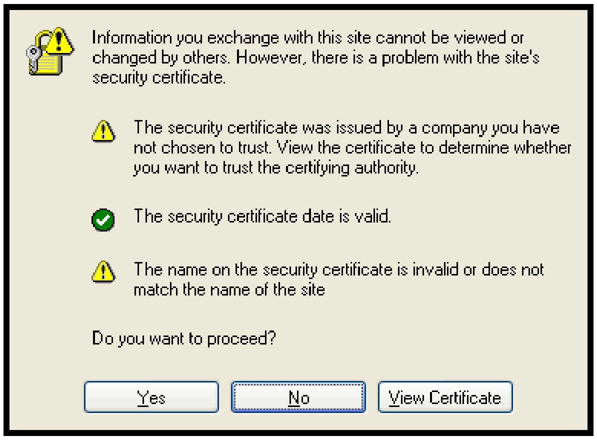
User name: admin

Password: ●●●●

□ Remember my password

Figure 5. Login window for web interface

Since the certificate used in establishing the secure link to the EnRoute500 has not been signed by a Certification Authority (CA), your browser will most likely display one or more warnings similar to those shown below. These warnings are expected and can be disregarded.



Information you exchange with this site cannot be viewed or changed by others. However, there is a problem with the site's security certificate.

The security certificate was issued by a company you have not chosen to trust. View the certificate to determine whether you want to trust the certifying authority.

The security certificate date is valid.

The name on the security certificate is invalid or does not match the name of the site

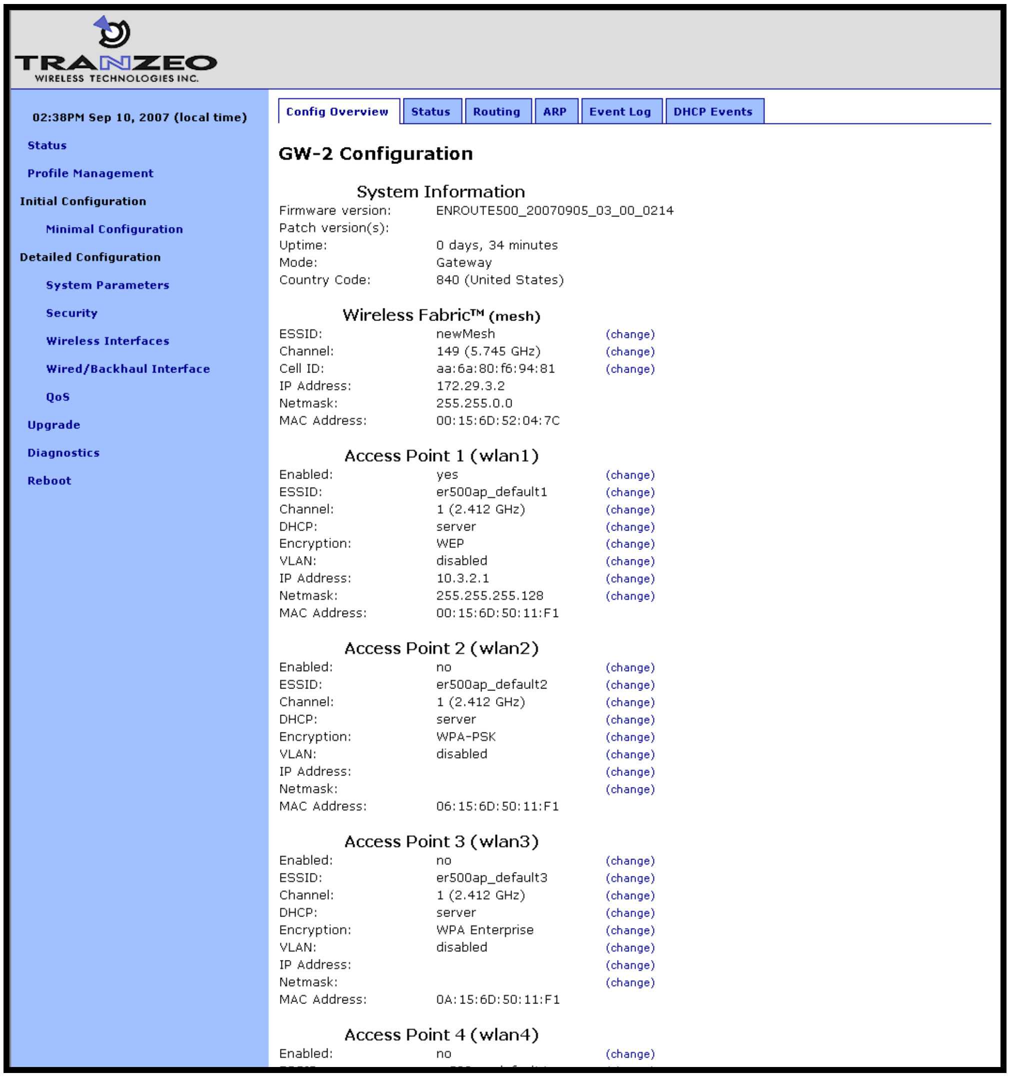
Do you want to proceed?

Figure 6. Certificate warning

A configuration overview page is loaded by default after the login process has been completed. This page contains the following information

- Firmware version and list of installed patches
- System uptime
- System mode of operation (gateway or repeater)
- Mesh channel and ESSID
- IP addresses, netmask, and MAC addresses for each client access interface
- Status, channel, ESSID, and encryption type for each virtual access point interface
- VLAN status and ID for all interfaces
- Ethernet interface use (client access or backhaul)

To access the status page from any other page in the web interface, click on the "Status" link in the navigation bar that appears on the left side of the web interface.



GW-2 Configuration

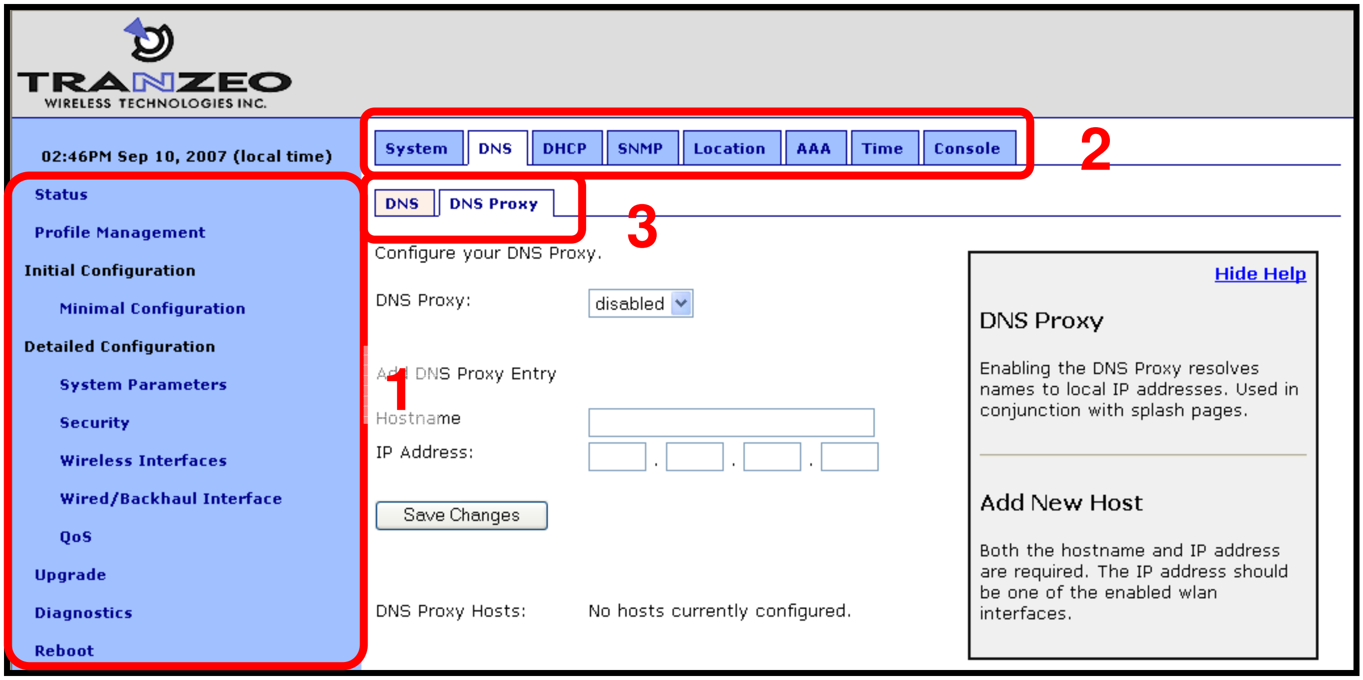
```
          System Information
Firmware version:        ENROUTE500_20070905_03_00_0214
Patch version(s):
Uptime:                  0 days, 34 minutes
Mode:                    Gateway
Country Code:            840 (United States)

        Wireless Fabric™ (mesh)
ESSID:                   newMesh                 (change)
Channel:                 149 (5.745 GHz)         (change)
Cell ID:                 aa:6a:80:f6:94:81       (change)
IP Address:              172.29.3.2
Netmask:                 255.255.0.0
MAC Address:             00:15:6D:52:04:7C

        Access Point 1 (wlan1)
Enabled:                 yes                     (change)
ESSID:                   er500ap_default1        (change)
Channel:                 1 (2.412 GHz)           (change)
DHCP:                    server                  (change)
Encryption:              WEP                     (change)
VLAN:                    disabled                (change)
IP Address:              10.3.2.1                (change)
Netmask:                 255.255.255.128         (change)
MAC Address:             00:15:6D:50:11:F1

        Access Point 2 (wlan2)
Enabled:                 no                      (change)
ESSID:                   er500ap_default2        (change)
Channel:                 1 (2.412 GHz)           (change)
DHCP:                    server                  (change)
Encryption:              WPA-PSK                 (change)
VLAN:                    disabled                (change)
IP Address:                                      (change)
Netmask:                                         (change)
MAC Address:             06:15:6D:50:11:F1

        Access Point 3 (wlan3)
Enabled:                 no                      (change)
ESSID:                   er500ap_default3        (change)
Channel:                 1 (2.412 GHz)           (change)
DHCP:                    server                  (change)
Encryption:              WPA Enterprise          (change)
VLAN:                    disabled                (change)
IP Address:                                      (change)
Netmask:                                         (change)
MAC Address:             0A:15:6D:50:11:F1

        Access Point 4 (wlan4)
Enabled:                 no                      (change)
```

Figure 7. Configuration overview page displayed when logging in

3.2 Navigating the Web Interface

The web interface uses a three-tiered navigation scheme.

1. The first tier of navigation is the navigation bar shown on the left side of the screen. This navigation bar is displayed on all pages in the web interface and remains the same on all pages.
2. The second tier of navigation is the primary row of tabs shown across the top of the screen on many of the pages in the web interface. The labels in these tabs vary based on which page is selected on the navigation bar.
3. The third tier of navigation is the second row of tabs shown below the first row. These tabs are not present on all pages and their labels vary based on the selections made on the navigation bar and the primary row of tabs.



Configure your DNS Proxy.

DNS Proxy: disabled

Add DNS Proxy Entry

Hostname

IP Address: . . .

DNS Proxy Hosts: No hosts currently configured.

DNS Proxy

Enabling the DNS Proxy resolves names to local IP addresses. Used in conjunction with splash pages.

Add New Host

Both the hostname and IP address are required. The IP address should be one of the enabled wlan interfaces.

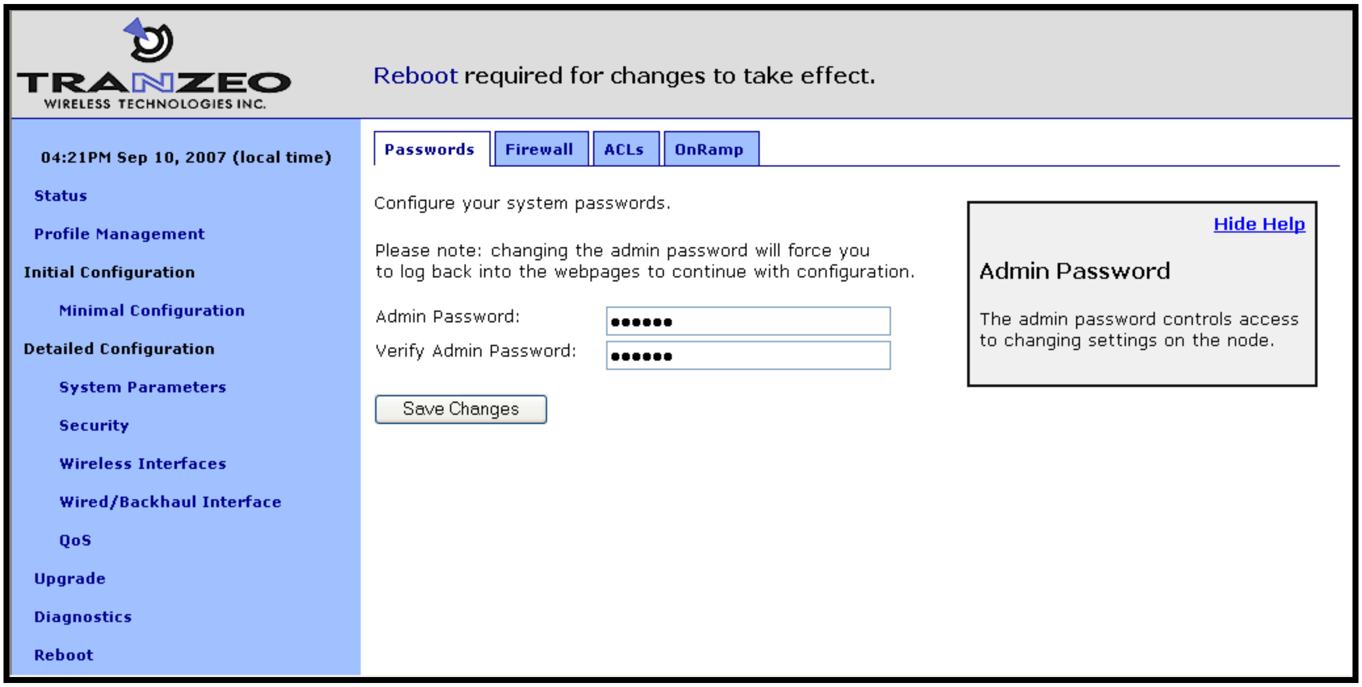
Figure 8. Web interface navigation components

The time displayed at the top of the navigation bar is the current time of the PC used to log in to the web GUI, not the time kept by the EnRoute500.

3.3 Setting Parameters

Many of the web interface pages allow you to set EnRoute500 operating parameters. Each page that contains settable parameters has a “Save Changes” button at the bottom of the page. When you have made your changes on a page and are ready to commit the new configuration, click on the “Save Changes” button. It typically takes a few seconds to save the changes, after which the page will be reloaded.

For the changes to take effect, the EnRoute500 must be rebooted. After a change has been committed, a message reminding the user to reboot the EnRoute500 will be displayed at the top of the screen.



Reboot required for changes to take effect.

Configure your system passwords.

Please note: changing the admin password will force you to log back into the webpages to continue with configuration.

Admin Password: ••••••

Verify Admin Password: ••••••

Admin Password

The admin password controls access to changing settings on the node.

Figure 9. Page showing "Save Changes" button and message prompting the user to reboot

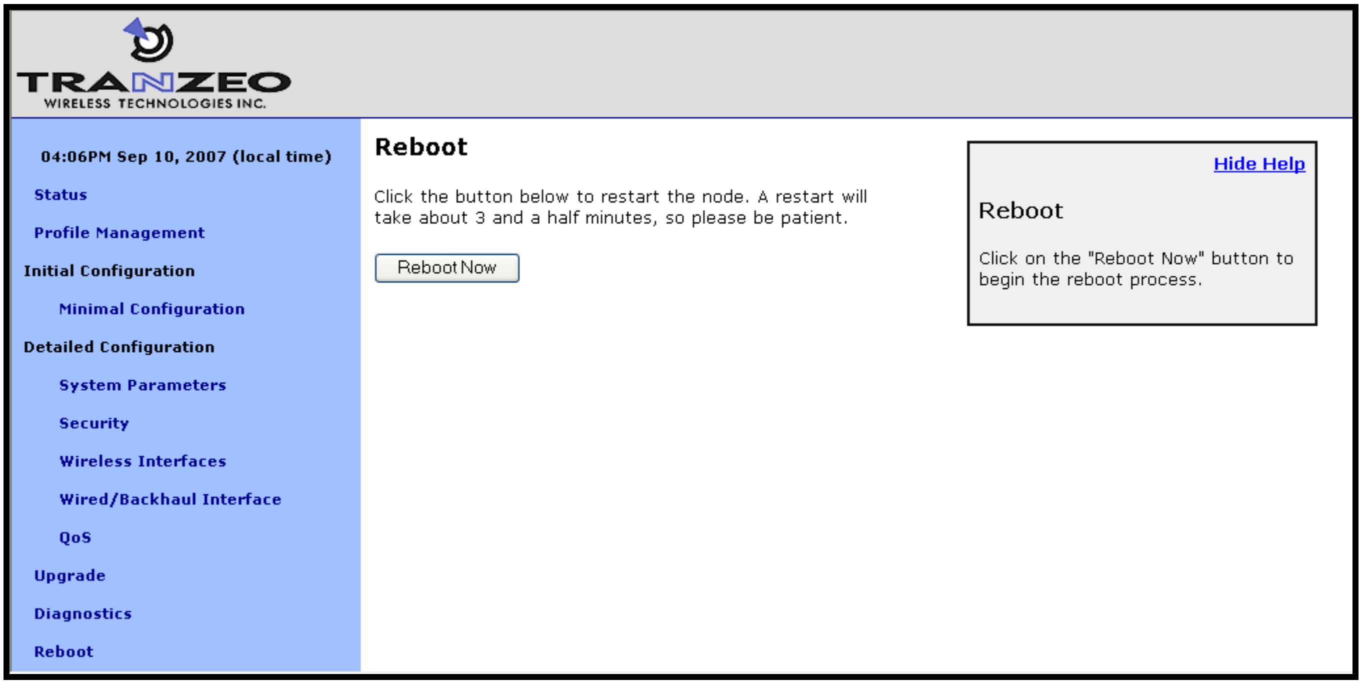
3.4 Help Information

Help information is provided on most web GUI pages. The help information is shown on the right-hand side of the page. The help information can be hidden by clicking on the ‘Hide Help’ link inside the help frame. When help is hidden, it can be displayed by clicking on the ‘Show help’ link.

3.5 Rebooting

Click on the “Reboot” link on the left of the page and then click on the “Reboot Now” button to reboot the EnRoute500. Any changes made prior to rebooting will take effect following completion of the boot process.

It takes approximately 3 minutes for the device to reboot.



Reboot

Click the button below to restart the node. A restart will take about 3 and a half minutes, so please be patient.

Reboot

Click on the "Reboot Now" button to begin the reboot process.

Figure 10. Rebooting the EnRoute500

4 Using the Command Line Interface

All configurable EnRoute500 parameters can be accessed with a Command Line Interface (CLI).

The CLI allows you to:

- Modify and verify all configuration parameters
- Save and restore device configurations
- Reboot the device
- Upgrade the firmware

4.1 Accessing the CLI

The EnRoute500's command-line interface (CLI) is accessible through its network interfaces using an SSH client. Any of the network interfaces can be used to establish the SSH connection to the EnRoute500. However, connecting through the Ethernet port is required for devices that have not previously been configured.

Windows XP does not include an SSH client application. You will need to install a 3rd-party client such as SecureCRT from Van Dyke software (http://www.vandyke.com/products/securecrt) or the free PuTTY SSH client (http://www.putty.nl/) to connect to an EnRoute500 using SSH.

When you log in to the EnRoute500, the CLI will present a command prompt. The shell timeout is displayed above the login prompt. The CLI will automatically log out a user if a session is inactive for longer than the timeout period. Section 8.14 describes how to change the timeout period.

```
Shell timeout: 3 minutes.

Press '?' for help..
>
```

4.2 User Account

The user login used to access the EnRoute500 is 'admin'. The procedure for changing the password for this account is described in section 8.1.

4.3 CLI Interfaces

The CLI provides the user with a number of interfaces that contain related parameters and controls. Some of these interfaces are hardware interfaces, such as Ethernet, while others are virtual interfaces that contain a set of related parameters.

The available interfaces are:

- mesh0 – controls for the mesh radio
- wlan1, wlan2, wlan3, wlan4 – controls for the virtual APs supported by the EnRoute500
- eth0 – controls for the Ethernet interface
- firewall – controls firewall settings for client device, mesh device and mesh network access
- qos – controls Quality of Service (QoS) settings
- version – displays version information for the installed firmware
- system – system settings

The currently selected interface is shown as part of the command prompt. For example, when the mesh interface is selected, the command prompt will be

```
mesh0>
```

After logging in, no interface is selected by default. Before setting or retrieving any parameters, an interface must be selected.

4.4 CLI Features

The CLI has a number of features to simplify the configuration of the EnRoute500. These features are explained in the following sub-sections.

4.4.1 Control of the Cursor

The cursor can be moved to the end of the current line with Ctrl+E. Ctrl+A moves it to the beginning of the line.

4.4.2 Cancel a Command

Ctrl+C cancels the input on the current command line and moves the cursor to a new, blank command line.

4.4.3 Searching the Command History

The command history can be searched by pressing Ctrl+R and entering a search string. The most recently executed command that matches the string entered will be displayed. Press 'Enter' to execute that command.

4.4.4 Executing a Previous Command

By using the up and down arrow keys you can select previously executed commands. When you find the command you wish to execute, you can either edit it or press 'Return' to execute it.

4.5 CLI Commands

The usage of all CLI commands is explained in the following subsections. The command syntax used is

```
command <mandatory argument>
```

```
command [optional argument]
```

4.5.1 '?' command

Syntax `?`

Description Pressing '?' at any time in the CLI will display a help menu that provides an overview of the commands that are described in this section. It is not necessary to press 'Enter' after pressing '?'.

4.5.2 'whoami' command

Syntax `whoami`

Description Displays the name of the user you are logged in as.

4.5.3 ‘help’ command

Syntax

```
help [command|parameter]
```

where the optional argument is either one of the CLI commands (“[command]”) or a parameter in the currently selected interface (“[parameter]”).

Description

When no argument follows the help command, a help menu showing a list of available commands is displayed. When a command is supplied as the argument, a help message for that particular command is displayed. When a parameter in the current interface is specified as the argument, help information for it is displayed.

Example

```
help get
```

will display the help information for the ‘get’ command. With the ‘sys’ interface selected

```
sys> help scheme
```

displays help information about that ‘scheme’ parameter, as shown below

```
          scheme : wireless node type
```

4.5.4 ‘show’ command

Syntax

```
show
```

Description

Displays all available interfaces. An interface in this list can be selected with the ‘use’ command.

4.5.5 ‘use’ command

Syntax

```
use <interface>
```

where <interface> is one of the EnRoute500’s interfaces. A complete list of interfaces is available with the ‘show’ command.

Description

Selects an interface to use. By selecting an interface you can view and modify the parameters associated with the interface.

Example

```
use mesh0
```

will select the backhaul mesh radio interface and change the CLI prompt to

```
mesh0>
```

to reflect the interface selection.

4.5.6 ‘set’ command

Syntax

```
set <parameter>=<value>
```

where <parameter> is the parameter being set and <value> is the value it is being set to.

Description

Sets a configuration parameter. Note that is only possible to set the parameters for the currently selected interface. If the value of the parameter contains spaces, the value must be surrounded by double quotes (“ “).

If a valid 'set' command is entered, it will output its result and any effects on other parameters. If changes are made to attributes of other interfaces as a result of changing the parameter, these attributes are preceded by a '/' to signify that they are in another interface.

Changing certain parameters will require the EnRoute500 to be rebooted.

Example

With the ‘sys’ interface selected

```
set id.node=2
```

will set the node ID to 2, while

```
set id.mesh=1
```

will have an impact on a larger number of parameters as can be seen in the output below.

```
             id.mesh : 1
private.nets.default : "172.29.0.0/16 10.1.0.0/16"
/mesh0.routes.static : 224.0.0.0/4,10.1.0.0/16
splash.local_network : "172.29.1.0/24 10.1.0.0/16"
       /mesh0.cellid : 00:05:88:01:0a:01
   /mesh0.ip.address : 172.29.1.7
Reboot needed.
```

Note that changes were made to variables in the ‘mesh0’ interface, as indicated by the ‘/’ at the beginning of those lines.

4.5.7 ‘get’ command

Syntax

```
get <parameter>
```

where <parameter> is the parameter whose value is being fetched.

Description

Gets the value of one or more configuration parameters for the currently selected interface. The ‘*’ character can be used to specify wildcard characters. This allows multiple values to be fetched with a single command.

Example

With the ‘sys’ interface selected

```
get id.node
```

will return the node’s ID, while

```
get id.*
```

will return all parameters that begin with ‘id.’

```
 sys.id.lanprefix = 10
 sys.id.mesh = 4
 sys.id.meshprefix = 172.29
 sys.id.node = 7
```

4.5.8 ‘list’ command

Syntax

```
list
```

Description

Lists all parameters for the selected interface

Example

With the ‘firewall’ interface selected

```
list
```

will display

```
firewall.gateway.enable : prevent uninitiated incoming connections
past the gateway?
 firewall.node.allowc2c.eth0 : allow clients to see each other if
.role=access
 firewall.node.allowc2c.wlan1 : allow clients to see each other if
.role=access
 firewall.node.allowc2c.wlan2 : allow clients to see each other if
.role=access
 firewall.node.allowc2c.wlan3 : allow clients to see each other if
.role=access
 firewall.node.allowc2c.wlan4 : allow clients to see each other if
.role=access
 firewall.node.enable : firewall enabled? if not, nothing else
here matters.
 firewall.node.tcp.allow.dest : tcp dest ports (space separated)
to allow to this node
 firewall.node.tcp.allow.source : tcp source ports (space
separated) to allow to this node
 firewall.node.udp.allow.dest : udp dest ports (space separated)
to allow to this node
 firewall.node.udp.allow.source : udp source ports (space
separated) to allow to this node
```

4.5.9 ‘ping’ command

Syntax

```
ping <IP address or hostname>
```

Description

Pings a remote network device. Halt pinging with Ctrl+C

Example

```
ping 172.29.1.1
```

4.5.10 'ifconfig' command

Syntax

```
ifconfig <eth0|wlan[0-4]>
```

Description

Displays information, such as IP address and MAC address, for the specified network interface.

Example

```
ifconfig wlan1
```

will display

```
wlan1     Link encap:Ethernet  HWaddr 00:15:6D:52:01:FD
          inet addr:10.2.10.1  Bcast:172.29.255.255  Mask:255.255.0.0
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:2434 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:0
          RX bytes:0 (0.0 b)  TX bytes:233128 (227.6 Kb)
```

4.5.11 'route' command

Syntax

```
route
```

Description

Displays the current route table.

4.5.12 'clear' command

Syntax

```
clear
```

Description

Clears the screen

4.5.13 ‘history’ command

Syntax

```
history
```

Description

Shows the command history since the EnRoute500 was last rebooted

Example

After switching to the ‘wlan1’ interface, inspecting the ESSID setting, and then changing it

```
history
```

will display

```
1: use wlan1
2: get essid
3: set essid=new_ap_essid
```

4.5.14 '!' command

Syntax

```
!<command history number>
!<string that matches start of previously-executed command>
!!
```

Description

Executes a previously-executed command based either on a command history number or matching a string to the start of a previously-executed command. Note that there is no space between the '!' and the argument.

The 'history' command shows the command history, with a number preceding each entry in the command history. Use this number as an argument to the '!' command to execute that command from the history.

When a string is provided as an argument to the '!' command, the string will be matched against the beginning of previously-executed commands and the most recently executed command that matches will be executed.

Use '!!' to execute the last command again.

Example

If the command history is as follows

```
1: use wlan1
2: get essid
3: set essid=new_ap_essid1
4: use wlan2
5: set essid=new_ap_essid2
```

the command

```
!1
```

will execute

```
use wlan1
```

The command

```
!use
```

will execute

```
use wlan2
```

4.5.15 ‘exit’ command

Syntax `exit`

Description Terminates the current CLI session and logs out the user

4.5.16 ‘quit’ command

Syntax `quit`

Description Terminates the current CLI session and logs out the user

5 Initial Configuration of an EnRoute500

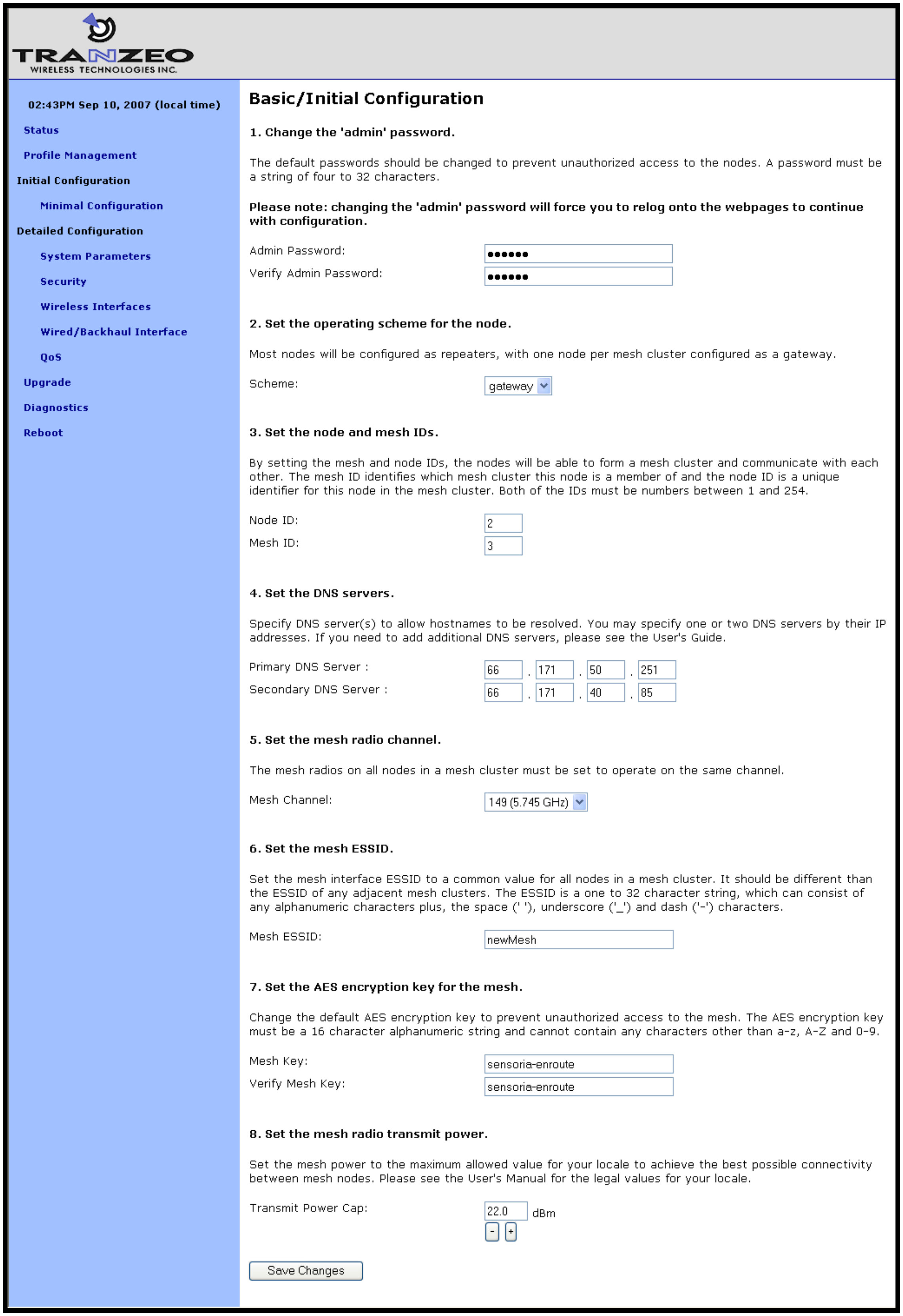
This user's guide provides a comprehensive overview of all of the EnRoute500's features and configurable parameters. However, it is possible to deploy a network of EnRoute500s while only changing a limited number of parameters. The list below will guide you through a minimal configuration procedure that prepares a network of EnRoute500s for deployment.

1	**Change the 'admin' password.** The default password should be changed to prevent unauthorized access to the EnRoute500.	See section 8.1
2	**Set the operating scheme for the EnRoute500** Most EnRoute500s will be configured as repeaters, with at least one EnRoute500 per mesh neighborhood configured as a gateway.	See section 8.2
3	**Set the node and mesh IDs** The node and mesh IDs uniquely identify an EnRoute500.	See section 8.3
4	**Set the DNS servers** Specify DNS servers to allow hostnames to be resolved.	See section 8.6
5	**Set the mesh radio channel** The mesh radios on all EnRoute500s in a mesh neighborhood must be set to operate on the same channel.	See section 10.1
6	**Set the mesh ESSID** Set the mesh interface ESSID to a common value for all EnRoute500s in a mesh neighborhood. It should be different than the ESSID for any adjacent mesh neighborhoods.	See section 10.2
7	**Set the AES encryption key for the mesh** Change the default AES encryption key to prevent unauthorized access to the mesh. The mesh encryption key must be the same for all EnRoute500s in a mesh neighborhood.	See section 10.3
8	**Set the mesh radio transmit power** Set the mesh power to the maximum allowed value to achieve the best possible connectivity in the mesh.	See section 10.4

⚠ **In addition to setting the parameters on the "Minimal Configuration" page, OnRamp access should be disabled after initial programming. See section 8.16 for instructions on how to enable OnRamp access to the EnRoute500.**

After these settings have been changed, the EnRoute500s will be able to form a mesh neighborhood so that further configuration can be done from a central location, using the connectivity of provided by the mesh. This minimal configuration must be performed prior to deployment, but all other configuration can be carried out after deployment.

To simplify initial configuration, the web GUI has a page that allows the user to change all the parameters listed in this section on a single page. This page can be accessed by clicking on the ‘Minimal configuration’ link in the web interface navigation bar on the left side of the web interface.



Basic/Initial Configuration

1. Change the 'admin' password.

The default passwords should be changed to prevent unauthorized access to the nodes. A password must be a string of four to 32 characters.

Please note: changing the 'admin' password will force you to relog onto the webpages to continue with configuration.

Admin Password: ••••••

Verify Admin Password: ••••••

2. Set the operating scheme for the node.

Most nodes will be configured as repeaters, with one node per mesh cluster configured as a gateway.

Scheme: gateway

3. Set the node and mesh IDs.

By setting the mesh and node IDs, the nodes will be able to form a mesh cluster and communicate with each other. The mesh ID identifies which mesh cluster this node is a member of and the node ID is a unique identifier for this node in the mesh cluster. Both of the IDs must be numbers between 1 and 254.

Node ID: 2

Mesh ID: 3

4. Set the DNS servers.

Specify DNS server(s) to allow hostnames to be resolved. You may specify one or two DNS servers by their IP addresses. If you need to add additional DNS servers, please see the User's Guide.

Primary DNS Server : 66 . 171 . 50 . 251

Secondary DNS Server : 66 . 171 . 40 . 85

5. Set the mesh radio channel.

The mesh radios on all nodes in a mesh cluster must be set to operate on the same channel.

Mesh Channel: 149 (5.745 GHz)

6. Set the mesh ESSID.

Set the mesh interface ESSID to a common value for all nodes in a mesh cluster. It should be different than the ESSID of any adjacent mesh clusters. The ESSID is a one to 32 character string, which can consist of any alphanumeric characters plus, the space (' '), underscore ('_') and dash ('-') characters.

Mesh ESSID: newMesh

7. Set the AES encryption key for the mesh.

Change the default AES encryption key to prevent unauthorized access to the mesh. The AES encryption key must be a 16 character alphanumeric string and cannot contain any characters other than a-z, A-Z and 0-9.

Mesh Key: sensoria-enroute

Verify Mesh Key: sensoria-enroute

8. Set the mesh radio transmit power.

Set the mesh power to the maximum allowed value for your locale to achieve the best possible connectivity between mesh nodes. Please see the User's Manual for the legal values for your locale.

Transmit Power Cap: 22.0 dBm

Figure 11. Initial configuration web page

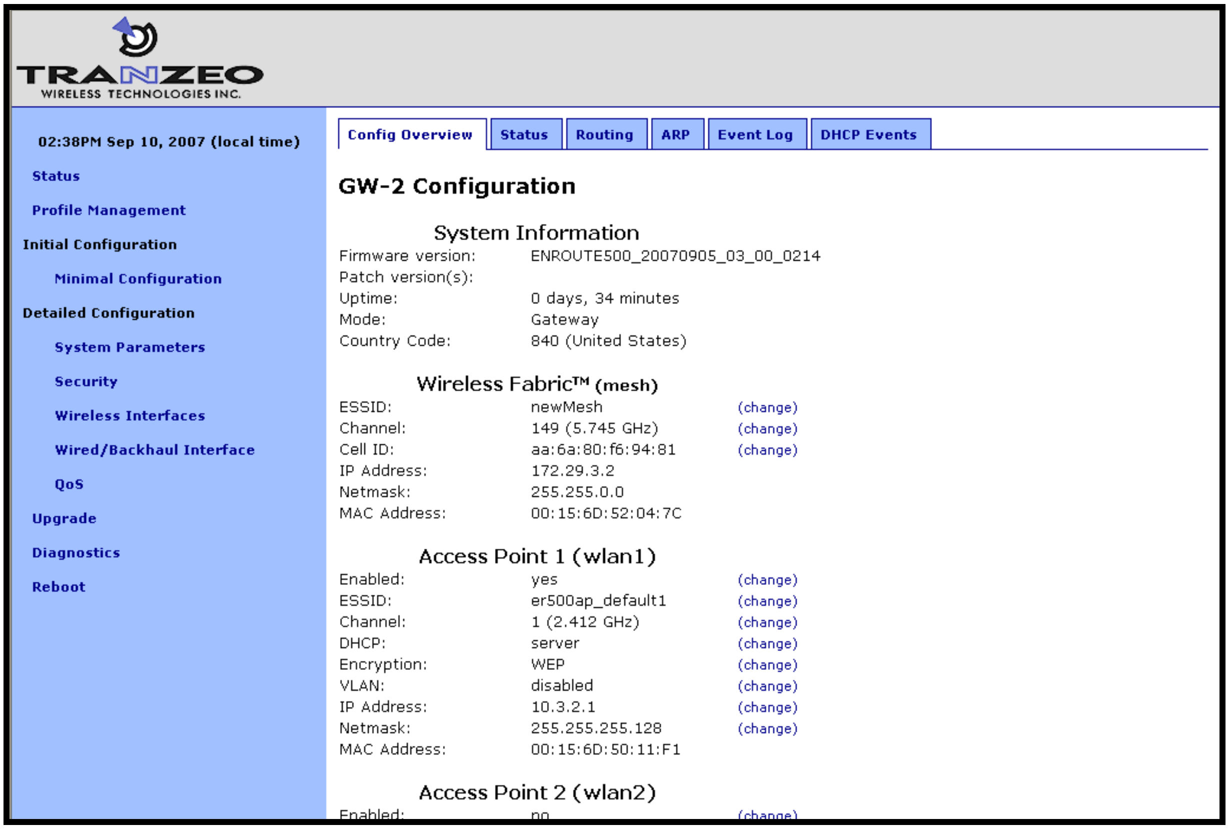
6 Status Information

Multiple web interface pages that display status information about the EnRoute500 and client devices attached to it are available. These web pages are accessible by clicking on the “Status” link in the navigation bar and then selecting the appropriate tab shown at the top of the page.

The status information is not accessible through the CLI.

6.1 Configuration Overview Page

The main status page, which is displayed when clicking on “Status” in the navigation bar and when logging in, is the “Config Overview” page.



GW-2 Configuration

System Information

Firmware version:	ENROUTE500_20070905_03_00_0214	
Patch version(s):		
Uptime:	0 days, 34 minutes	
Mode:	Gateway	
Country Code:	840 (United States)	

Wireless Fabric™ (mesh)

ESSID:	newMesh	(change)
Channel:	149 (5.745 GHz)	(change)
Cell ID:	aa:6a:80:f6:94:81	(change)
IP Address:	172.29.3.2	
Netmask:	255.255.0.0	
MAC Address:	00:15:6D:52:04:7C	

Access Point 1 (wlan1)

Enabled:	yes	(change)
ESSID:	er500ap_default1	(change)
Channel:	1 (2.412 GHz)	(change)
DHCP:	server	(change)
Encryption:	WEP	(change)
VLAN:	disabled	(change)
IP Address:	10.3.2.1	(change)
Netmask:	255.255.255.128	(change)
MAC Address:	00:15:6D:50:11:F1	

Access Point 2 (wlan2)

Enabled:	no	(change)

Figure 12. Partial configuration overview page

The configuration overview page shows a summary of settings for the mesh interface, the virtual access point interfaces, and the wired interface. The firmware version, uptime of the device, and its operating mode are also displayed.

Links labeled "(change)" are shown next to the settable parameters. These links take you to the appropriate page to change the setting.

6.2 Interface Status

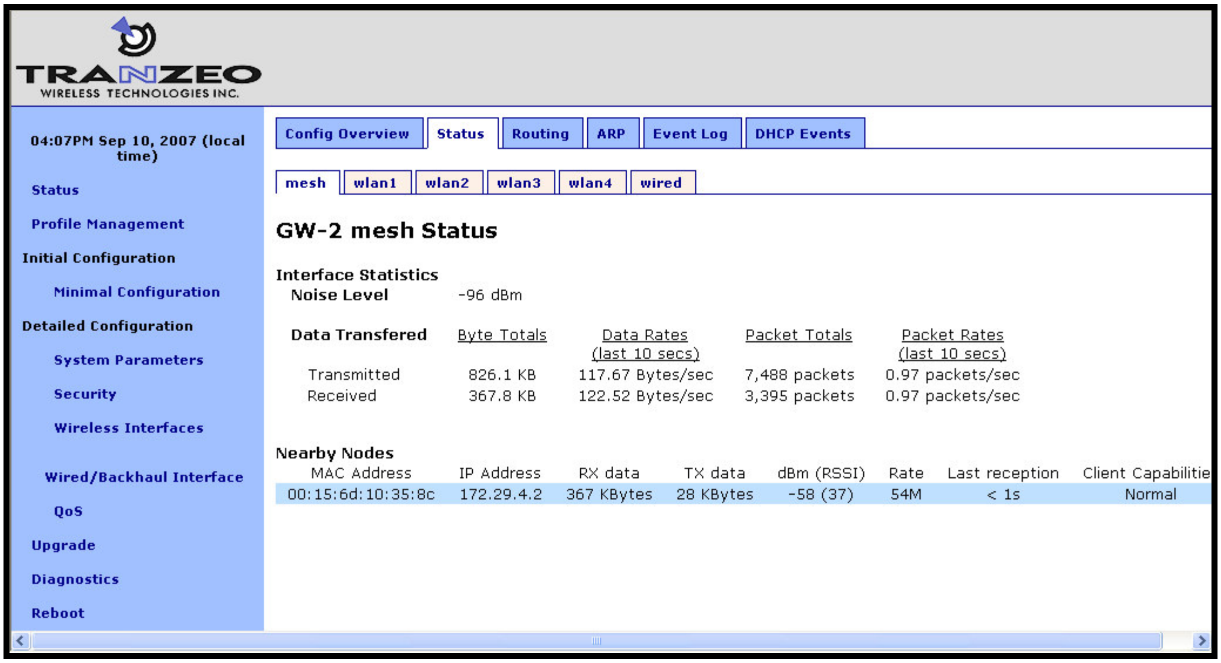
Traffic and neighbor information for the mesh, virtual AP, and wired interfaces are available on the "Status" tab of the "Status" page. Select the appropriate interface for which you wish to view information from the row of tabs below the primary tab row.

6.2.1 Mesh and Virtual AP Interfaces

The sub-tabs display status information about the mesh and virtual AP interfaces. Data statistics information for the interface are displayed, showing received and transmitted data in terms of bytes and packets.

In the case of the "mesh" sub-tab, the neighboring mesh devices that this device can communicate directly with are displayed. On the "wlan" sub-tabs, the client devices connected to the virtual APs are displayed. The following information is displayed for each mesh neighbor or client device:

- MAC address
- IP address
- Quantity of data received from the neighbor/client device and transmitted to the neighbor/client device
- Received signal strength (RSSI) in dBm and in parentheses the associated signal level based on a noise floor of -95dBm
- Time since last reception from the device
- A summary of the capabilities of the client device's radio card



GW-2 mesh Status

Interface Statistics

Noise Level -96 dBm

Data Transfered	Byte Totals	Data Rates (last 10 secs)	Packet Totals	Packet Rates (last 10 secs)
Transmitted	826.1 KB	117.67 Bytes/sec	7,488 packets	0.97 packets/sec
Received	367.8 KB	122.52 Bytes/sec	3,395 packets	0.97 packets/sec

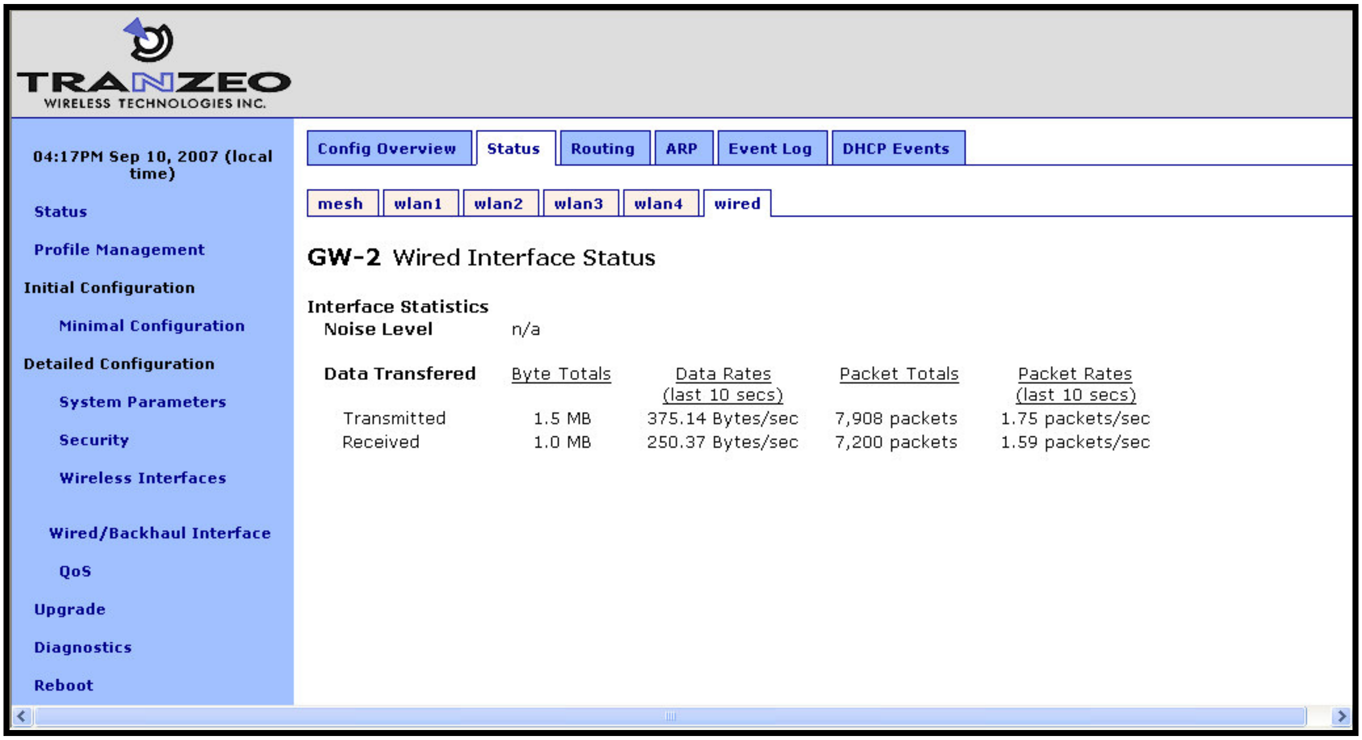
Nearby Nodes

MAC Address	IP Address	RX data	TX data	dBm (RSSI)	Rate	Last reception	Client Capabilitie
00:15:6d:10:35:8c	172.29.4.2	367 KBytes	28 KBytes	-58 (37)	54M	< 1s	Normal

Figure 13. Mesh status information

6.2.2 Wired Interface Status

The wired interface status pages is similar to the wireless interface status pages, with the exception that it only displays summary information for the interface and does not break down data transferred on a per-device basis.



GW-2 Wired Interface Status

Interface Statistics

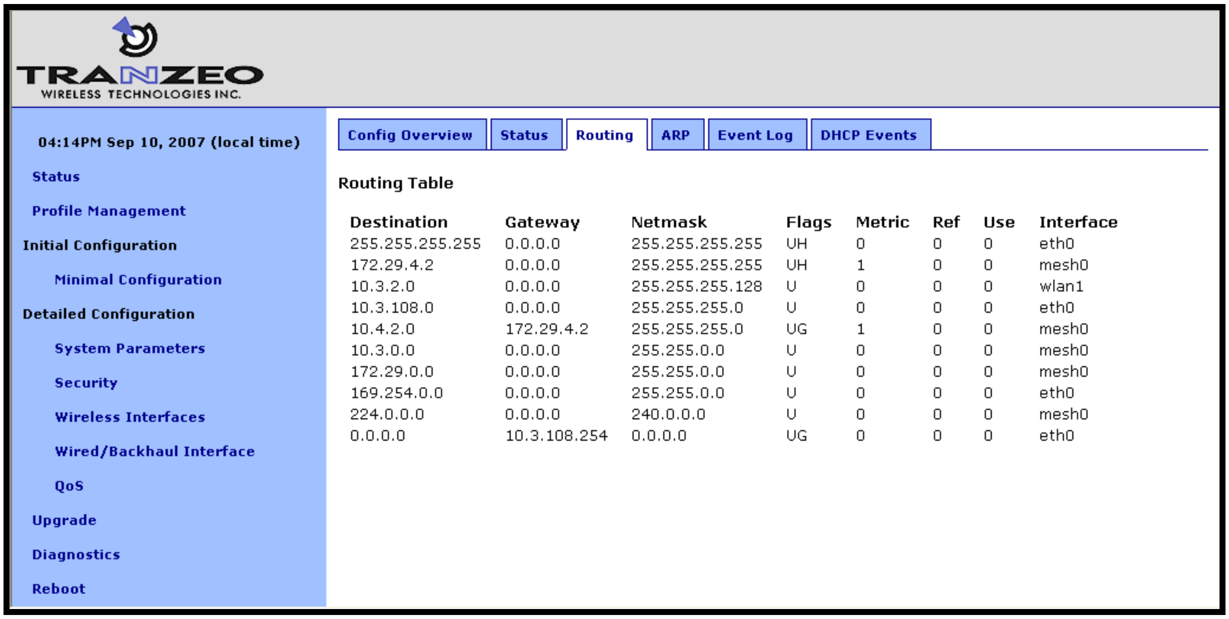
Noise Level n/a

Data Transfered	Byte Totals	Data Rates (last 10 secs)	Packet Totals	Packet Rates (last 10 secs)
Transmitted	1.5 MB	375.14 Bytes/sec	7,908 packets	1.75 packets/sec
Received	1.0 MB	250.37 Bytes/sec	7,200 packets	1.59 packets/sec

Figure 14. Wired interface status information

6.3 Routing Table

The routing table used by the device can be displayed by selecting the "Routing" tab on the "Status" page.



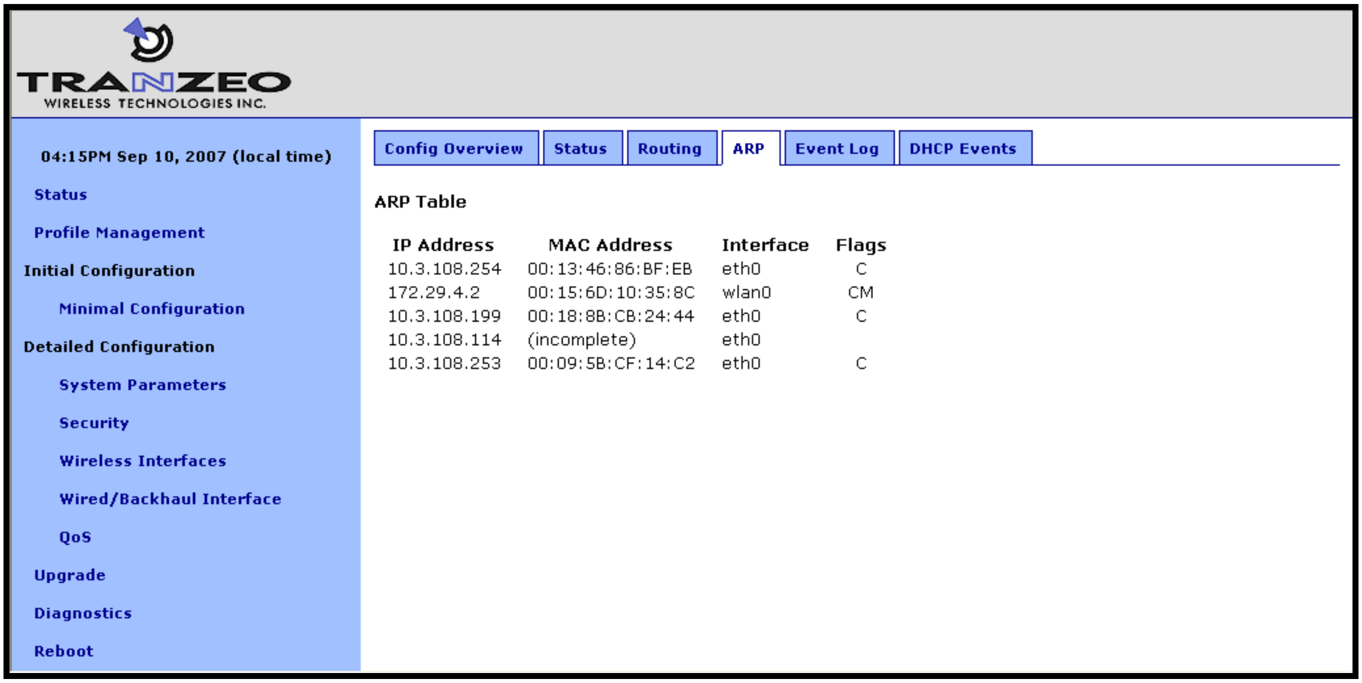
Routing Table

Destination	Gateway	Netmask	Flags	Metric	Ref	Use	Interface
255.255.255.255	0.0.0.0	255.255.255.255	UH	0	0	0	eth0
172.29.4.2	0.0.0.0	255.255.255.255	UH	1	0	0	mesh0
10.3.2.0	0.0.0.0	255.255.255.128	U	0	0	0	wlan1
10.3.108.0	0.0.0.0	255.255.255.0	U	0	0	0	eth0
10.4.2.0	172.29.4.2	255.255.255.0	UG	1	0	0	mesh0
10.3.0.0	0.0.0.0	255.255.0.0	U	0	0	0	mesh0
172.29.0.0	0.0.0.0	255.255.0.0	U	0	0	0	mesh0
169.254.0.0	0.0.0.0	255.255.0.0	U	0	0	0	eth0
224.0.0.0	0.0.0.0	240.0.0.0	U	0	0	0	mesh0
0.0.0.0	10.3.108.254	0.0.0.0	UG	0	0	0	eth0

Figure 15. Routing table

6.4 ARP Table

The device's ARP table can be displayed by selecting the "ARP" tab on the "Status" page.



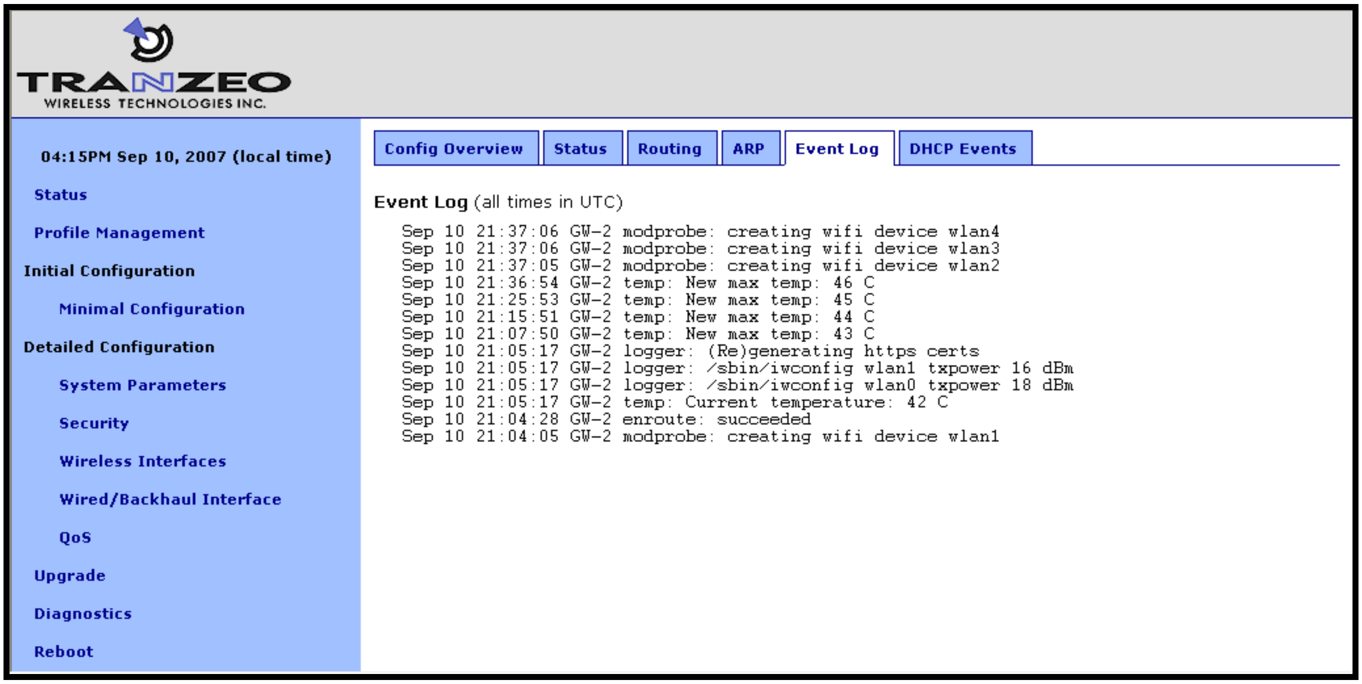
ARP Table

IP Address	MAC Address	Interface	Flags
10.3.108.254	00:13:46:86:BF:EB	eth0	C
172.29.4.2	00:15:6D:10:35:8C	wlan0	CM
10.3.108.199	00:18:8B:CB:24:44	eth0	C
10.3.108.114	(incomplete)	eth0	
10.3.108.253	00:09:5B:CF:14:C2	eth0	C

Figure 16. ARP table

6.5 Event Log

The main system log for the device is accessible by selecting "Event Log" on the "Status" page. The log is displayed in reverse chronological order, with the last recorded event appearing at the top of the page.



Event Log (all times in UTC)

```
Sep 10 21:37:06 GW-2 modprobe: creating wifi device wlan4
Sep 10 21:37:06 GW-2 modprobe: creating wifi device wlan3
Sep 10 21:37:05 GW-2 modprobe: creating wifi device wlan2
Sep 10 21:36:54 GW-2 temp: New max temp: 46 C
Sep 10 21:25:53 GW-2 temp: New max temp: 45 C
Sep 10 21:15:51 GW-2 temp: New max temp: 44 C
Sep 10 21:07:50 GW-2 temp: New max temp: 43 C
Sep 10 21:05:17 GW-2 logger: (Re)generating https certs
Sep 10 21:05:17 GW-2 logger: /sbin/iwconfig wlan1 txpower 16 dBm
Sep 10 21:05:17 GW-2 logger: /sbin/iwconfig wlan0 txpower 18 dBm
Sep 10 21:05:17 GW-2 temp: Current temperature: 42 C
Sep 10 21:04:28 GW-2 enroute: succeeded
Sep 10 21:04:05 GW-2 modprobe: creating wifi device wlan1
```

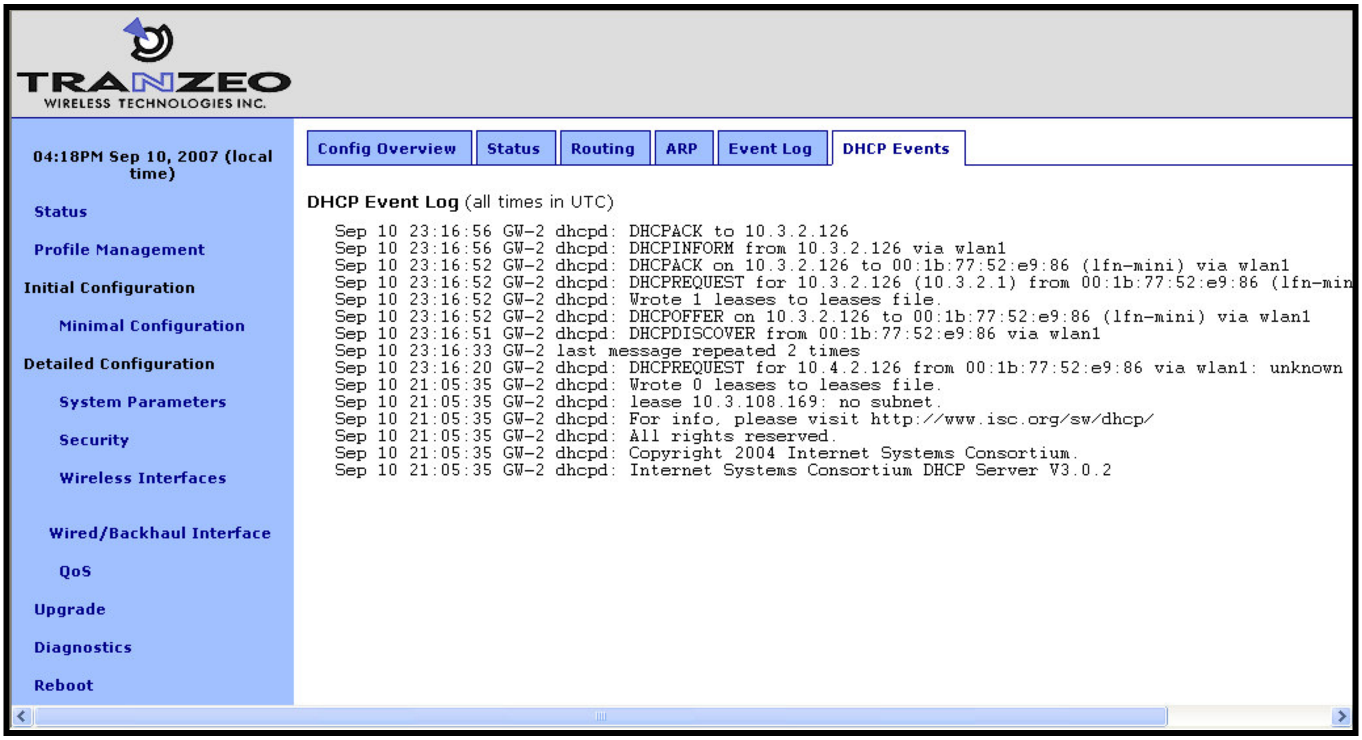
Figure 17. Event log

INFO

The time reported in the Event Log corresponds to the time maintained by the EnRoute500and may not be consistent with that shown in the upper left corner of the webpage as this is the time maintained by the computer running the web browser.

6.6 DHCP Event Log

The log of DHCP-related events for the device is accessible by selecting “DHCP Events” on the “Status” page. The log is displayed in reverse chronological order, with the last recorded event appearing at the top of the page. All times in the log are in UTC time. Messages related to both local and relayed DHCP activity are displayed in the log.



DHCP Event Log (all times in UTC)

```
Sep 10 23:16:56 GW-2 dhcpd: DHCPACK to 10.3.2.126
Sep 10 23:16:56 GW-2 dhcpd: DHCPINFORM from 10.3.2.126 via wlan1
Sep 10 23:16:52 GW-2 dhcpd: DHCPACK on 10.3.2.126 to 00:1b:77:52:e9:86 (lfn-mini) via wlan1
Sep 10 23:16:52 GW-2 dhcpd: DHCPREQUEST for 10.3.2.126 (10.3.2.1) from 00:1b:77:52:e9:86 (lfn-min
Sep 10 23:16:52 GW-2 dhcpd: Wrote 1 leases to leases file.
Sep 10 23:16:52 GW-2 dhcpd: DHCPOFFER on 10.3.2.126 to 00:1b:77:52:e9:86 (lfn-mini) via wlan1
Sep 10 23:16:51 GW-2 dhcpd: DHCPDISCOVER from 00:1b:77:52:e9:86 via wlan1
Sep 10 23:16:33 GW-2 last message repeated 2 times
Sep 10 23:16:20 GW-2 dhcpd: DHCPREQUEST for 10.4.2.126 from 00:1b:77:52:e9:86 via wlan1: unknown
Sep 10 21:05:35 GW-2 dhcpd: Wrote 0 leases to leases file.
Sep 10 21:05:35 GW-2 dhcpd: lease 10.3.108.169: no subnet.
Sep 10 21:05:35 GW-2 dhcpd: For info, please visit http://www.isc.org/sw/dhcp/
Sep 10 21:05:35 GW-2 dhcpd: All rights reserved.
Sep 10 21:05:35 GW-2 dhcpd: Copyright 2004 Internet Systems Consortium.
Sep 10 21:05:35 GW-2 dhcpd: Internet Systems Consortium DHCP Server V3.0.2
```

Figure 18. DHCP event log

INFO

The time reported in the DHCP Log corresponds to the time maintained by the EnRoute500and may not be consistent with that shown in the upper left corner of the webpage as this is the time maintained by the computer running the web browser.

7 Configuration Profile Management

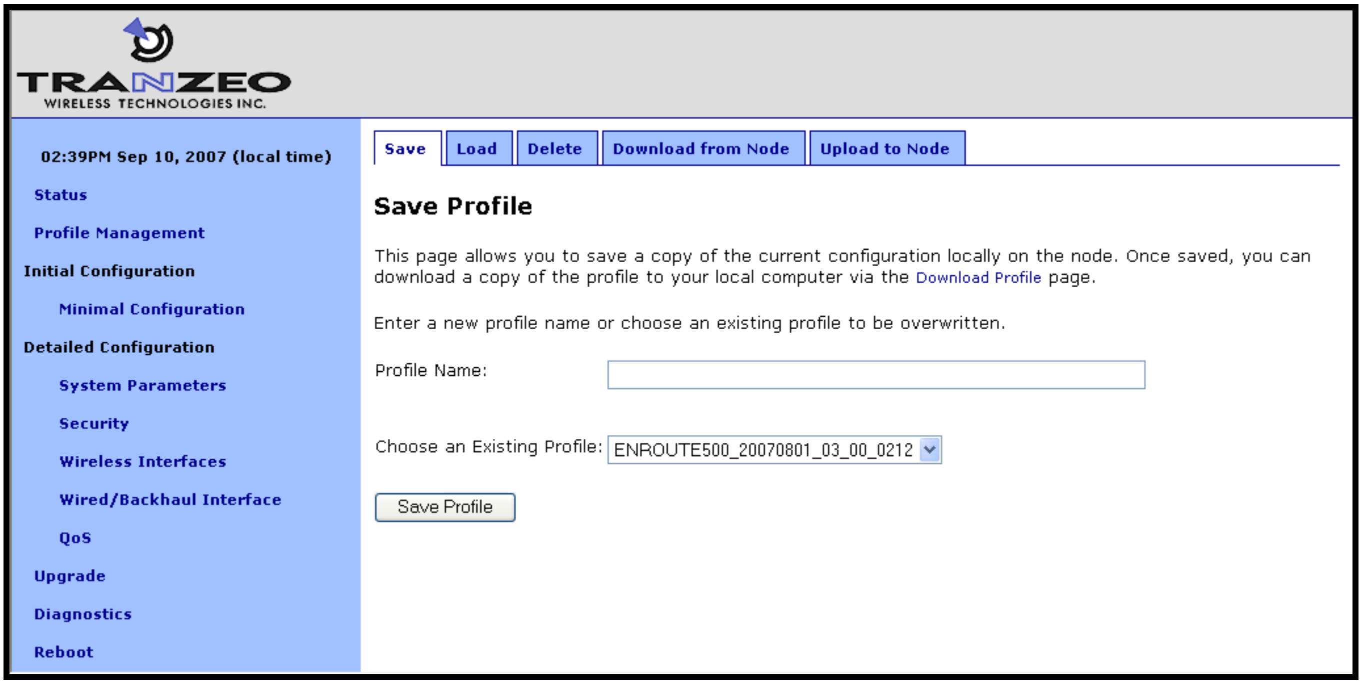
Configuration profiles describe an EnRoute500's configuration state and can be created to simplify the provisioning and management of devices. The EnRoute500 supports the following configuration profile-related actions:

- Saving the current configuration as a configuration profile
- Loading, or applying, a configuration profile stored on an EnRoute500 to the device
- Downloading a configuration profile stored on the EnRoute500 to a computer
- Uploading a configuration profile from a computer to the EnRoute500
- Deleting a configuration profile stored on the EnRoute500

Currently configuration profile management is only supported via the web interface.

7.1 Saving the Current Configuration

The current configuration can be saved on the "Save" tab on the "Profile Management" page. Enter a profile name or select an existing profile name from the list of existing configurations, and then click on "Save Profile". The saved profile is stored locally on the EnRoute500 and will appear in the "Existing profiles" text box. Use the "Download from Node" tab to download it to a different device.



02:39PM Sep 10, 2007 (local time)

Save Profile

This page allows you to save a copy of the current configuration locally on the node. Once saved, you can download a copy of the profile to your local computer via the Download Profile page.

Enter a new profile name or choose an existing profile to be overwritten.

Profile Name:

Choose an Existing Profile: ENROUTE500_20070801_03_00_0212

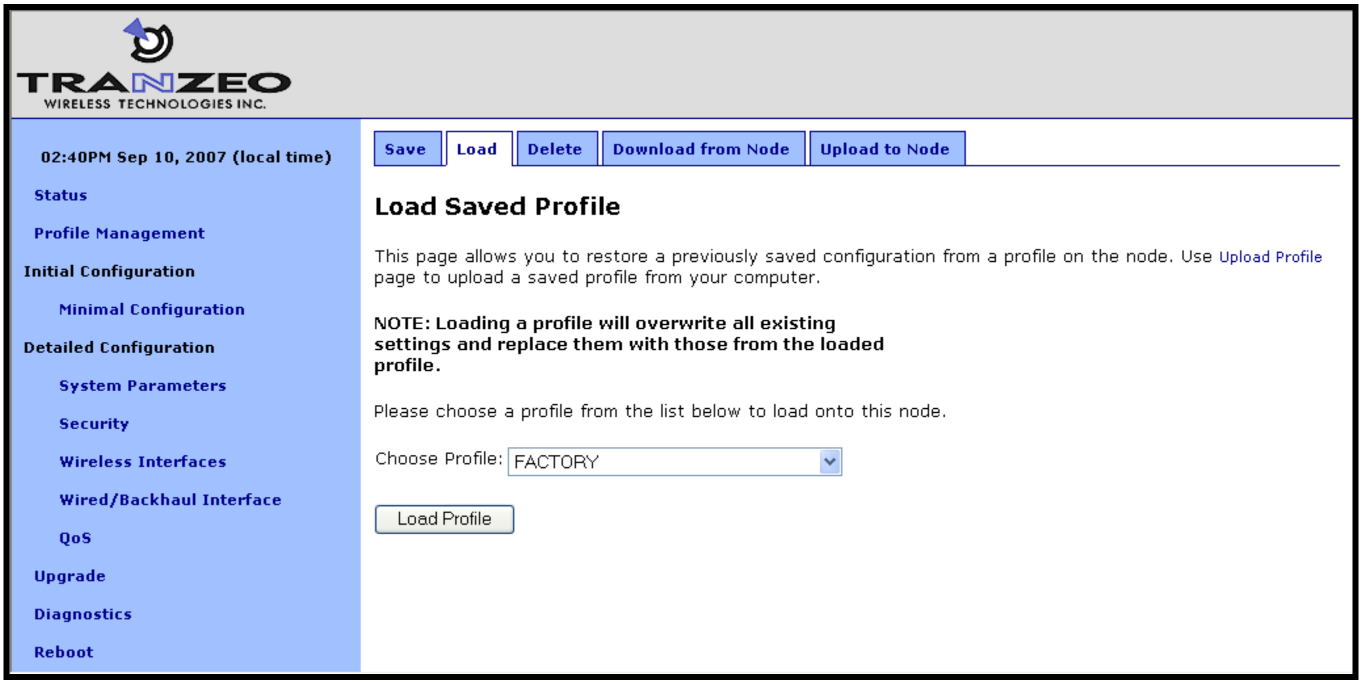
Figure 19. Save a configuration profile

7.2 Load a Configuration Profile

A configuration stored on the EnRoute500 can be applied using the “Load” tab on the “Profile Management” page. This profile must either have been saved earlier or uploaded to the EnRoute500. Choose a profile name from the “Existing Profiles” box and then click on “Load Profile”. It is necessary to reboot the EnRoute500 for the loaded profile settings to take effect.

INFO

A number of default configuration profiles are available on the EnRoute1000. There is a “FACTORY” profile, which contains the default settings for the firmware version that is installed. By applying this profile, an EnRoute500 will revert to the default settings for that particular firmware version. If the EnRoute500 firmware has been upgraded, there will also be a profile with the same name as the firmware version, e.g. ENROUTE500_20060419_00_00_0133. This profile contains the settings that were set when the new firmware was installed. If you wish to roll back to the settings that were originally set when a particular firmware version was installed, apply the profile with the name that matches the firmware version name.



Load Saved Profile

This page allows you to restore a previously saved configuration from a profile on the node. Use Upload Profile page to upload a saved profile from your computer.

NOTE: Loading a profile will overwrite all existing settings and replace them with those from the loaded profile.

Please choose a profile from the list below to load onto this node.

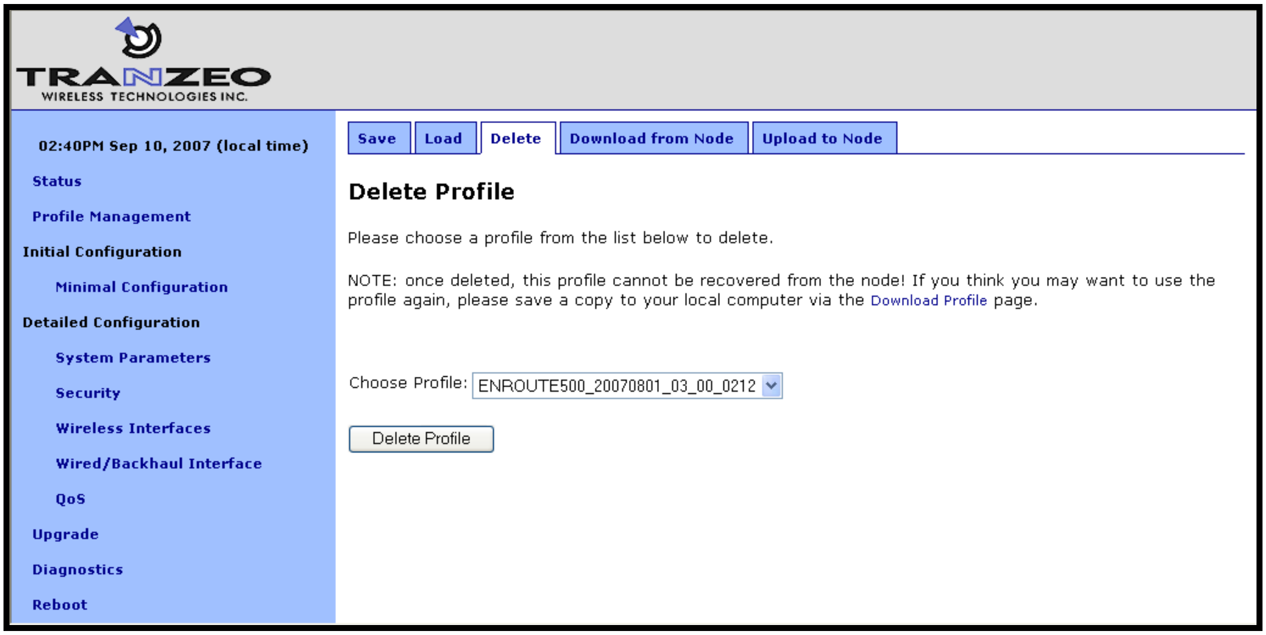
Choose Profile: FACTORY

Figure 20. Load a configuration profile

After loading the same profile to multiple EnRoute500s, at a minimum the node ID of the devices must be changed if they are to operate on the same mesh neighborhood. It is recommended that after the same profile is loaded onto multiple EnRoute500s, the parameters in the minimal configuration web-page are reviewed for each.

7.3 Delete a Configuration Profile

A locally-stored configuration profile can be deleted using the “Delete” tab on the “Profile Management” page. Choose a profile to delete from the profile drop-down box on the page and then click on “Delete Profile”.



Delete Profile

Please choose a profile from the list below to delete.

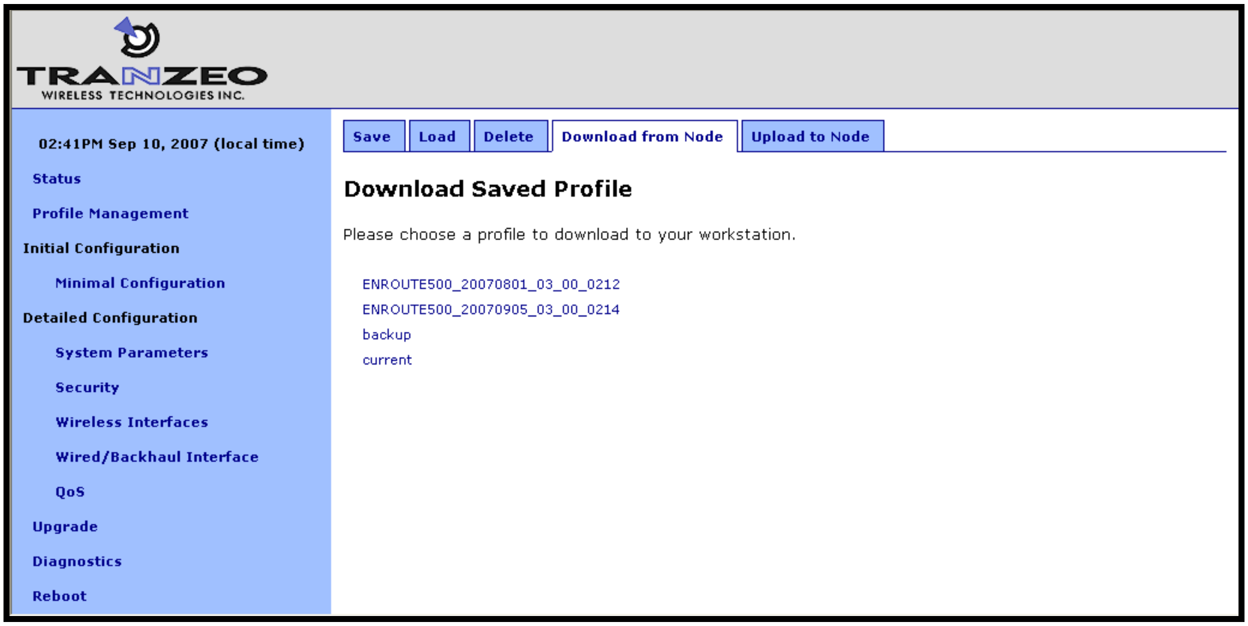
NOTE: once deleted, this profile cannot be recovered from the node! If you think you may want to use the profile again, please save a copy to your local computer via the Download Profile page.

Choose Profile: ENROUTE500_20070801_03_00_0212

Figure 21. Deleting a configuration profile

7.4 Downloading a Configuration Profile from an EnRoute500

A configuration profile can be download from an EnRoute500 using the “Download from node” tab on the “Profile Management” page. The existing configuration profiles are listed on this page. Click on the one that is to be downloaded to your computer and you will be given the option to specify where the profile should be saved on the host computer.



Download Saved Profile

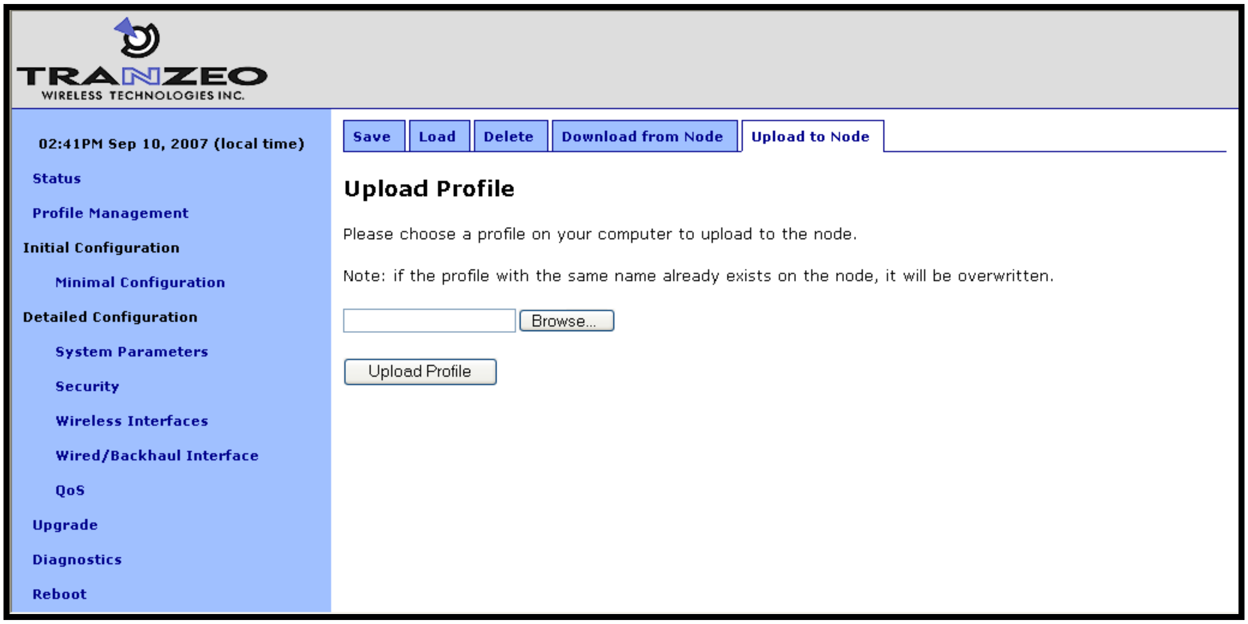
Please choose a profile to download to your workstation.

ENROUTE500_20070801_03_00_0212
ENROUTE500_20070905_03_00_0214
backup
current

Figure 22. Downloading a configuration profile from an EnRoute500

7.5 Uploading a Configuration Profile to an EnRoute500

A configuration profile can be uploaded to an EnRoute500 using the “Upload to node” tab on the “Profile Management” page. Use the “Browse” button to select a profile file on your host computer for upload to the EnRoute500. Alternatively, enter the file name by hand in the text box adjacent to the “Browse” button. Click on the “Upload Profile” button to upload the selected file to the EnRoute500.



Upload Profile

Please choose a profile on your computer to upload to the node.

Note: if the profile with the same name already exists on the node, it will be overwritten.

Figure 23. Uploading a configuration profile to an EnRoute500

8 System Settings

This section describes settings that are applicable to the overall operation of the EnRoute500, but are not related directly to a particular interface.

8.1 User Password

The password for the ‘admin’ user is configurable. The default password is ‘default’.

See section 2.4 for instructions on resetting the ‘admin’ password if it has been lost.

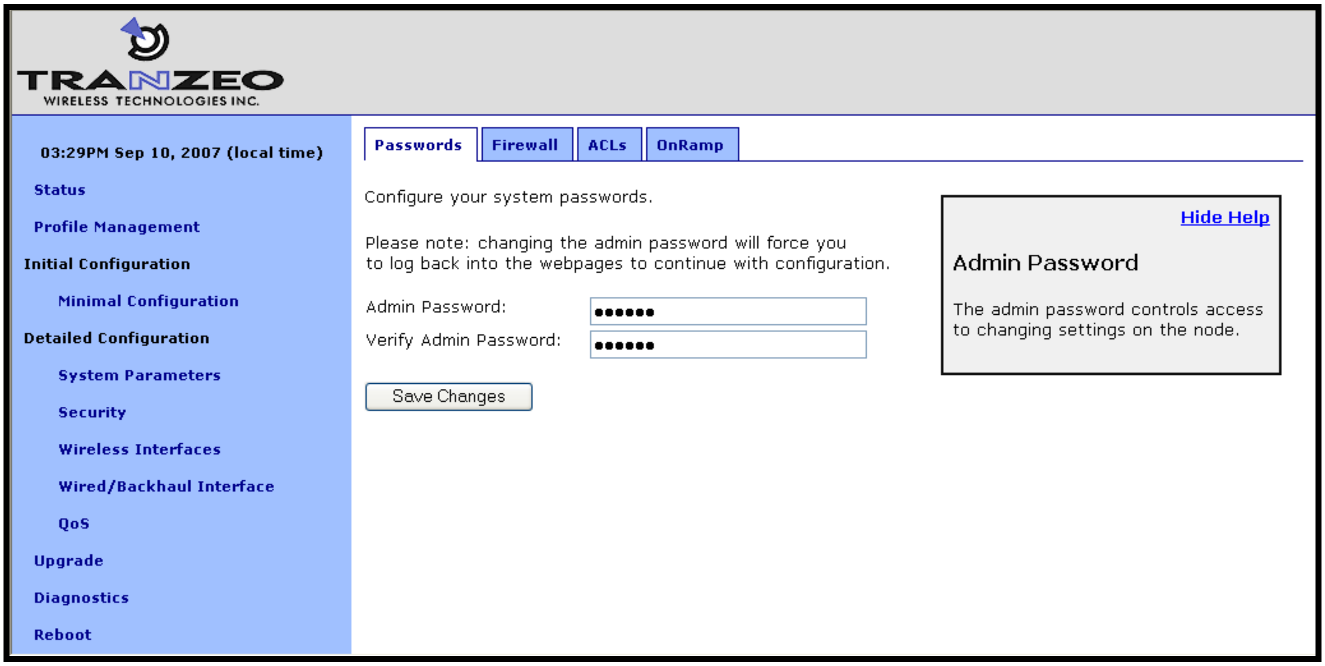
CLI

The password for the ‘admin’ user can be set using the ‘password.admin’ parameter in the ‘sys’ interface. The password will not be displayed when using the ‘get’ command with these parameters. The example below shows how to set the ‘admin’ password using the CLI.

```
> use sys
sys> set password.admin=newpass
```

Web GUI

The ‘admin’ password can be changed via the web interface using the “Passwords” tab on the “System Parameters” page.



Configure your system passwords.

Please note: changing the admin password will force you to log back into the webpages to continue with configuration.

Admin Password: ●●●●●●

Verify Admin Password: ●●●●●●

Admin Password

The admin password controls access to changing settings on the node.

Figure 24. Passwords page

8.2 Operating Scheme

The operating scheme determines an EnRoute500's role in the mesh network. Typically one of two configurations will be used in a network:

- All EnRoute500s will be configured as repeater devices to create a stand-alone mesh neighborhood
- At least one of the EnRoute500s in a mesh neighborhood will be configured as a gateway device, with the remaining devices configured either as gateways or repeaters. The gateway devices are connected to an external network using the devices' Ethernet interfaces. This network configuration will create an Internet extension network.

Mode	Description	Ethernet interface
Repeater	The EnRoute500 will function as a relay in the mesh network. Client devices can connect to the EnRoute500 using both wired (10/100 Ethernet) and wireless (built-in virtual APs) interfaces. The EnRoute500 can provide IP addresses to clients on both the wired and wireless interfaces.	Client devices can connect to it. IP addresses can be provided to client devices by a DHCP server or be manually configured.
Gateway	The EnRoute500 will function as a relay in the mesh network and a gateway to a WAN. Client devices can only connect to the EnRoute500 using the wireless (built-in virtual APs) interfaces. The EnRoute500 can provide IP addresses to clients on the wireless interface.	Used to connect the mesh neighborhood to an external network. The interface can be provided an IP address by a DHCP server or have a static IP address assigned to it.

Table 5. EnRoute500 operating schemes

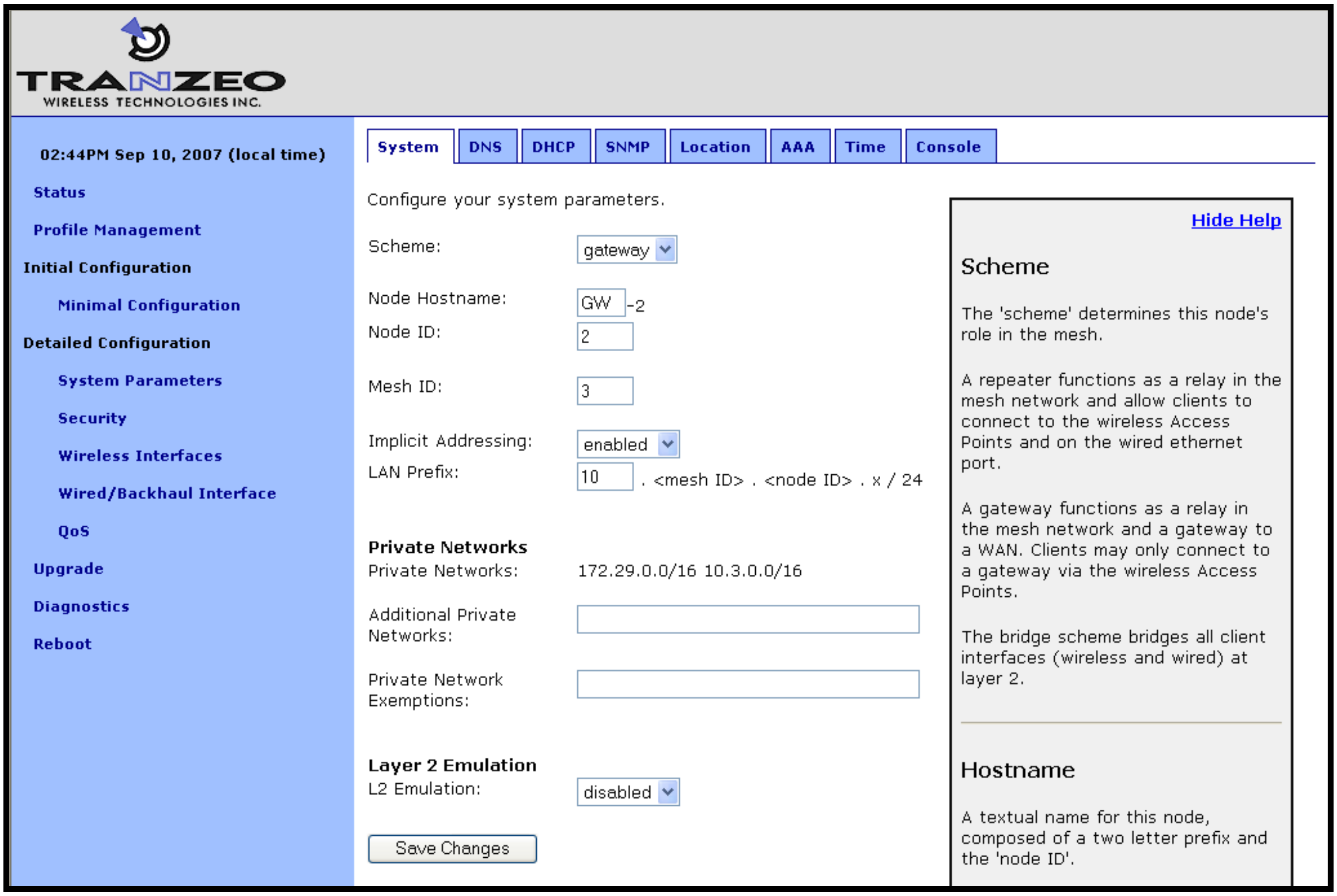
CLI

The EnRoute500's operating scheme is set with the 'scheme' parameter in the 'sys' interface. Valid values are 'apgateway' and 'aprepeater'. For example, set the operating scheme to gateway mode with:

```
> use sys
sys> set scheme=apgateway
```

Web GUI

The operating scheme can be set via the web interface using the "System" tab on the "System Parameters" page.



Configure your system parameters.

Scheme: gateway

Node Hostname: GW -2

Node ID: 2

Mesh ID: 3

Implicit Addressing: enabled

LAN Prefix: 10 . <mesh ID> . <node ID> . x / 24

Private Networks

Private Networks: 172.29.0.0/16 10.3.0.0/16

Additional Private Networks:

Private Network Exemptions:

Layer 2 Emulation

L2 Emulation: disabled

Scheme

The 'scheme' determines this node's role in the mesh.

A repeater functions as a relay in the mesh network and allow clients to connect to the wireless Access Points and on the wired ethernet port.

A gateway functions as a relay in the mesh network and a gateway to a WAN. Clients may only connect to a gateway via the wireless Access Points.

The bridge scheme bridges all client interfaces (wireless and wired) at layer 2.

Hostname

A textual name for this node, composed of a two letter prefix and the 'node ID'.

Figure 25. Setting system parameters

8.3 Using Multiple Gateways

It is possible to have more than one gateway device per mesh neighborhood to provide redundancy. The simplest method for creating a second gateway for a mesh neighborhood is to save the profile from the existing gateway, apply it to the device that will become the second gateway, and change at a minimum the following parameters on the new gateway:

- Node ID (see section 8.4)
- Base address, if using centralized DHCP server mode (see section 13.2.2)
- Ethernet IP configuration, if wired interface is not configured as a DHCP client (see section 11.2)

It is also required that L2 MAC forwarding is enabled on all devices in the mesh when multiple gateways are used (see 18.2 for more information on enabling L2 MAC emulation mode) No additional configuration of WAN devices, e.g. routers, is necessary when using a multiple gateway configuration.

It is important that all gateways for a common mesh neighborhood connect to the same LAN segment/VLAN trunk, such that the gateways can receive each other's control messages over the wired backhaul.

8.4 Mesh / Node ID

An EnRoute500 must be assigned mesh and node IDs before it is deployed as part of a mesh neighborhood. Together, these values uniquely identify an EnRoute500 within a mesh neighborhood and no two devices in a neighborhood are allowed to have the same combination of mesh and node IDs.

The node and mesh IDs are part of the EnRoute500's IP address as shown in Figure 26. The allowable range for node IDs is 1 through 254, while mesh IDs must be in the range from 0 to 255.

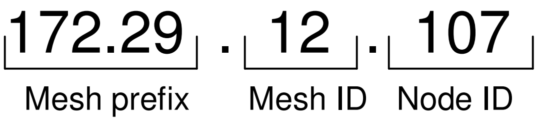


Figure 26. EnRoute500 mesh interface IP address

CLI

The mesh ID is set with the 'id.mesh' parameter in the 'sys' interface as shown below.

```
> use sys
sys> set id.mesh=12
```

The node ID is set with the 'id.node' parameter in the 'sys' interface as shown below.

```
> use sys
sys> set id.node=107
```

Web GUI

The mesh and node IDs can be set via the web interface using the "System" tab on the "System Parameters" page as shown in Figure 25.

8.5 Mesh Prefix

The mesh prefix parameter sets the first two octets of an EnRoute500's mesh interface IP address. It must be set the same for all devices in a given mesh neighborhood.

It is recommended that the mesh prefix default value of 172.29 is used.

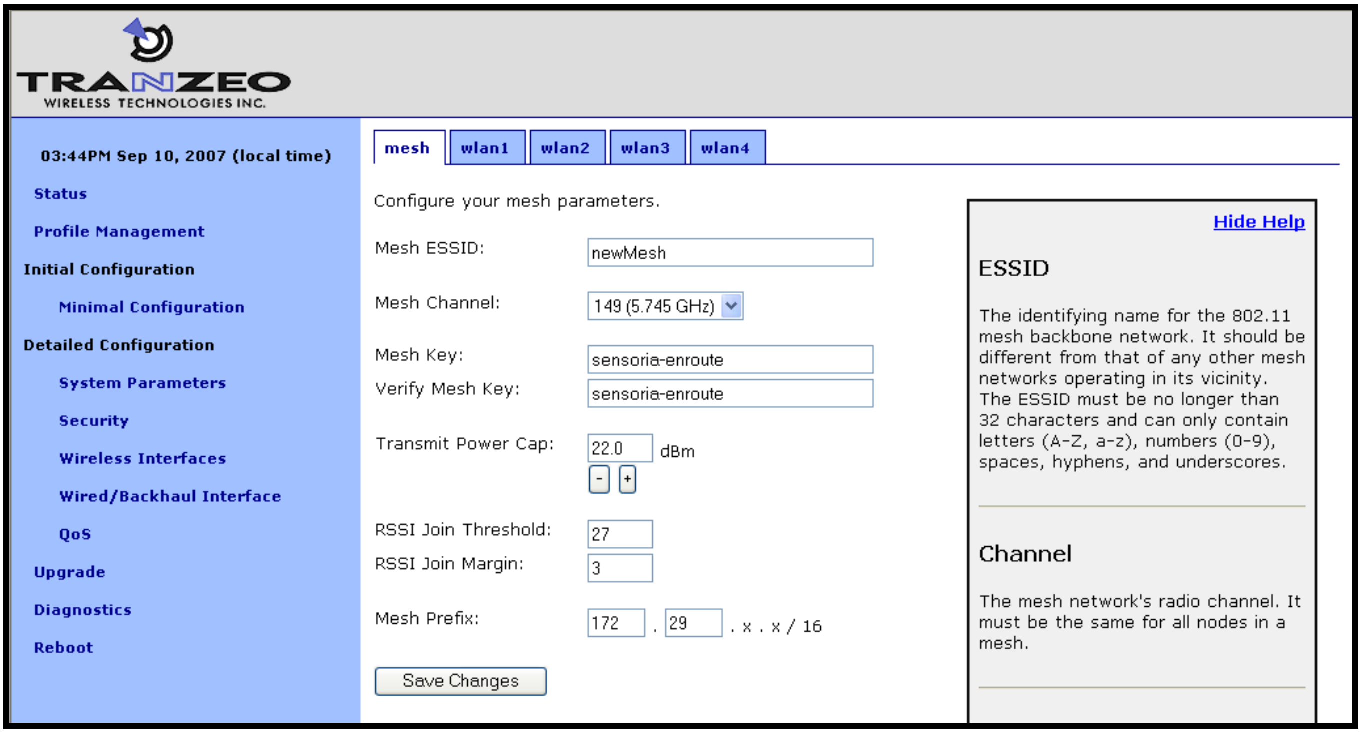
CLI

The mesh prefix is set with the ‘id.meshprefix’ parameter in the ‘sys’ interface as shown in the example below.

```
> use sys
sys> set id.meshprefix=172.29
```

Web GUI

The mesh prefix can be set via the web interface using the “Mesh” tab on the “Wireless Interfaces” page.



Configure your mesh parameters.

Mesh ESSID: newMesh

Mesh Channel: 149 (5.745 GHz)

Mesh Key: sensoria-enroute

Verify Mesh Key: sensoria-enroute

Transmit Power Cap: 22.0 dBm

RSSI Join Threshold: 27

RSSI Join Margin: 3

Mesh Prefix: 172 . 29 . x . x / 16

ESSID

The identifying name for the 802.11 mesh backbone network. It should be different from that of any other mesh networks operating in its vicinity. The ESSID must be no longer than 32 characters and can only contain letters (A-Z, a-z), numbers (0-9), spaces, hyphens, and underscores.

Channel

The mesh network's radio channel. It must be the same for all nodes in a mesh.

Figure 27. Setting the mesh prefix

8.6 Internal and External Subnets

The EnRoute500s in a mesh neighborhood must be aware of which addresses are located within the mesh and which are external to the mesh. The addresses that fall within the mesh are considered internal, and those that are located on the WAN-side of the mesh neighborhood’s gateway(s) are considered external.

The internal subnets include by default the mesh subnet, the client access interface subnets, and, if centralized DHCP server mode is enabled, the DHCP client address space subnet. These subnets are automatically listed as internal without requiring the user to specifically identify them as such. It is possible to manually add other subnets to the list of subnets that should be considered internal to the mesh.

The external subnets are all possible subnets that have not been defined as internal subnets. The gateway will automatically add the subnet of the gateway interface to the list of external addresses, even if it would normally be considered internal. Any external hosts that are explicitly defined, such as the DNS servers, will be added to the list of external IP addresses, even if their addresses would normally be considered to fall in internal subnets.

Repeater nodes will inform the gateway what subnets their client access interfaces are using, and the gateway will then redistribute the combined internal/external subnet lists to the repeaters so every device in the mesh neighborhood is consistent. This happens automatically, without requiring user intervention or a reboot.

8.7 DNS / Domain Settings

At least one DNS server, accessible from the EnRoute500, must be specified for the device to be able to resolve host names. This DNS server is also provided to client devices that acquire an IP address from the local DHCP server on an EnRoute500.

INFO

> DNS settings are automatically propagated from gateways to repeaters. Unless the EnRoute500s are being used in a stand-alone network without any gateway, it is not necessary to set the DNS server parameter on repeaters. They will get overwritten by the values from the gateway(s) in the mesh neighborhood.

If a gateway device acquires DNS server information through DHCP on its wired interface, this DNS server information will overwrite any manually set DNS server setting. The current DNS settings will be passed to repeater devices that are in the mesh neighborhood that the gateway is serving.

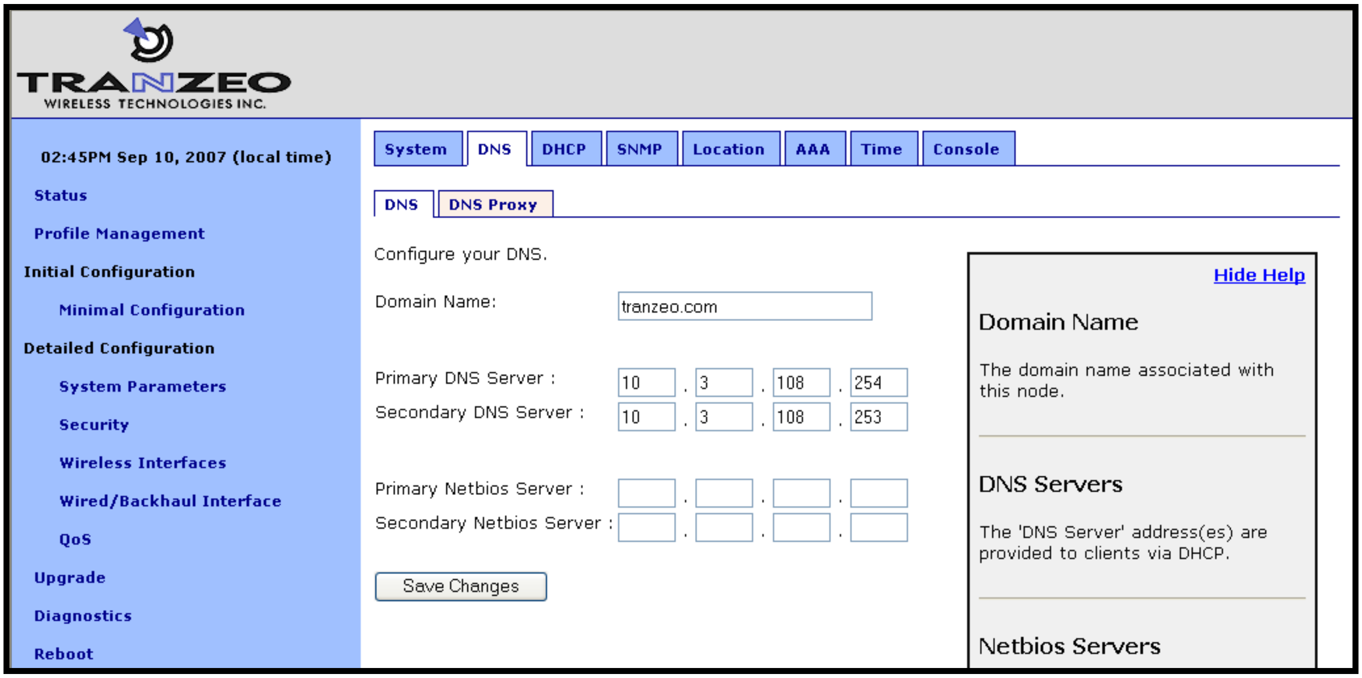
CLI

The DNS server(s) used by an EnRoute500 are specified with the ‘dns.servers’ parameter in the ‘sys’ interface. To specify multiple DNS servers, list them as a space-delimited string enclosed by quotes as shown in the example below

```
> use sys
sys> set dns.servers =”10.5.0.5 192.168.5.5”
```

Web GUI

A primary and secondary DNS server can be set via the web interface using the “DNS” tab on the “System Parameters” page.



Configure your DNS.

Domain Name: tranzeo.com

Primary DNS Server : 10 . 3 . 108 . 254

Secondary DNS Server : 10 . 3 . 108 . 253

Primary Netbios Server : . . .

Secondary Netbios Server : . . .

Domain Name

The domain name associated with this node.

DNS Servers

The 'DNS Server' address(es) are provided to clients via DHCP.

Netbios Servers

Figure 28. Setting the DNS and Netbios server(s)

8.8 DNS Proxy Configuration

DNS proxy entries can be added to an EnRoute500 to force local resolution of host names to IP addresses for the hosts in the proxy list. Use of a DNS proxy list on the EnRoute500 is a two step process, first populating the host name/IP address pairs, and then enabling DNS proxy.

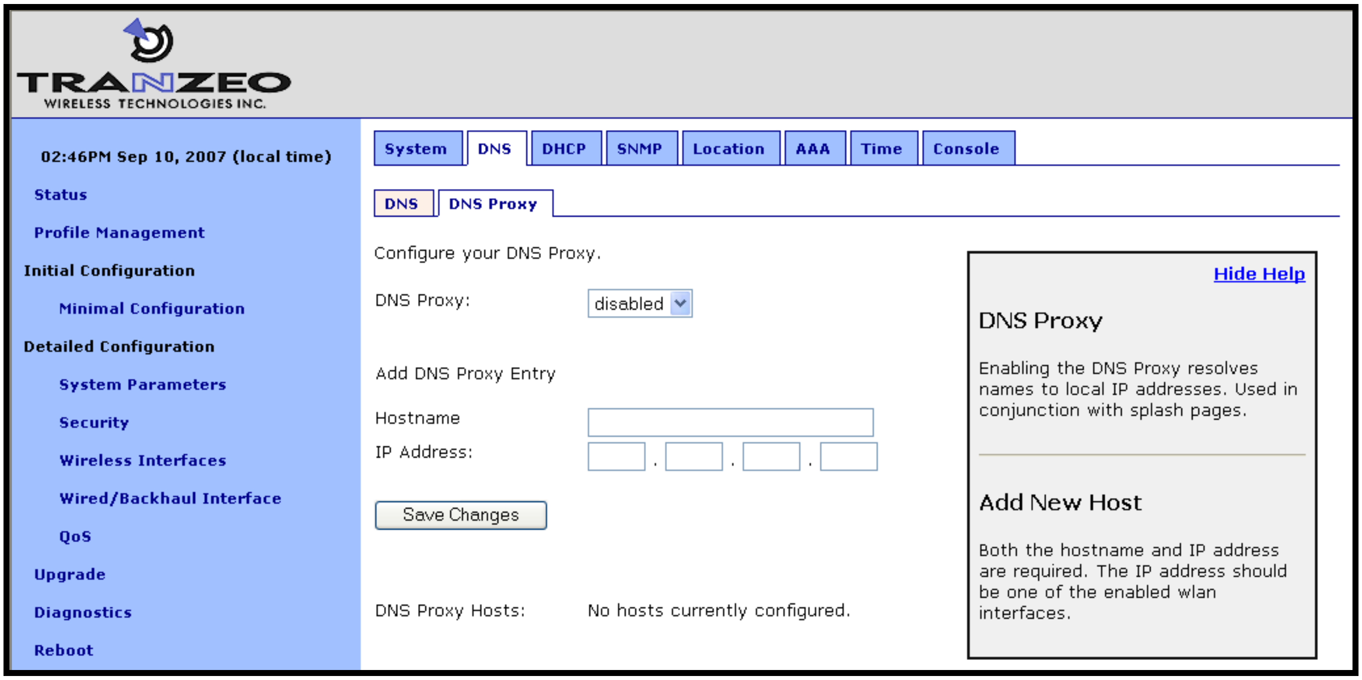
CLI

A list of hostname/IP address to be resolved locally can be specified using the ‘dnsproxy.hosts’ parameter in the ‘sys’ interface. If multiple hostname/IP address entries are specified, they must be separated by semi-colons, as shown in the example below. DNS proxy must be explicitly enabled using the ‘dnsproxy.enable’ parameter in the ‘sys’ interface after the list of hosts has been specified.

```
> use sys
sys> set dnsproxy.enable=yes
sys> set dnsproxy.hosts=”server1.domain.com=10.0.0.1;server2.domain.com=10.0.0.129”
```

Web GUI

DNS proxy can be enabled on the “DNS Proxy” sub-tab on the “DNS” tab on the “System Parameters” page as shown in Figure 29. Hostname/IP address pairs can be added on this page as well.



02:46PM Sep 10, 2007 (local time)

Configure your DNS Proxy.

DNS Proxy: disabled

Add DNS Proxy Entry

Hostname

IP Address: . . .

DNS Proxy Hosts: No hosts currently configured.

DNS Proxy

Enabling the DNS Proxy resolves names to local IP addresses. Used in conjunction with splash pages.

Add New Host

Both the hostname and IP address are required. The IP address should be one of the enabled wlan interfaces.

Figure 29. Configuring DNS proxy

8.9 NetBIOS Server

The NetBIOS server parameter is used to define a NetBIOS server’s IP address that is provided to client devices when they connect to the EnRoute500’s local DHCP server.

CLI

The NetBIOS server is set with the ‘netbios.servers’ parameter in the ‘sys’ interface. To specify multiple NetBIOS servers, list them as a space-delimited string enclosed by quotes as shown in the example below

```
> use sys
sys> set netbios.servers =”10.6.0.5 192.168.6.5”
```

Web GUI

A primary and secondary NetBIOS server can be set via the web interface using the “DNS” tab on the “System Parameters” page (see Figure 28).

8.10 SNMP

The EnRoute500 supports SNMP.

The read-only and read-write passwords and the port that SNMP uses can be configured. A contact person and device location can also be specified as part of the SNMP configuration.

CLI

The SNMP read-only and read/write passwords are set with the ‘snmp.community.ro’ and ‘snmp.community.rw’ parameters in the ‘sys’ interface. The example below shows how to set these parameters.

```
> use sys
sys> set snmp.community.ro=”read-only_password”
sys> set snmp.community.rw=”read-write_password”
```

The SNMP port is set with the ‘snmp.port’ parameter in the ‘sys’ interface as shown below. By default this parameter is set to “161”.

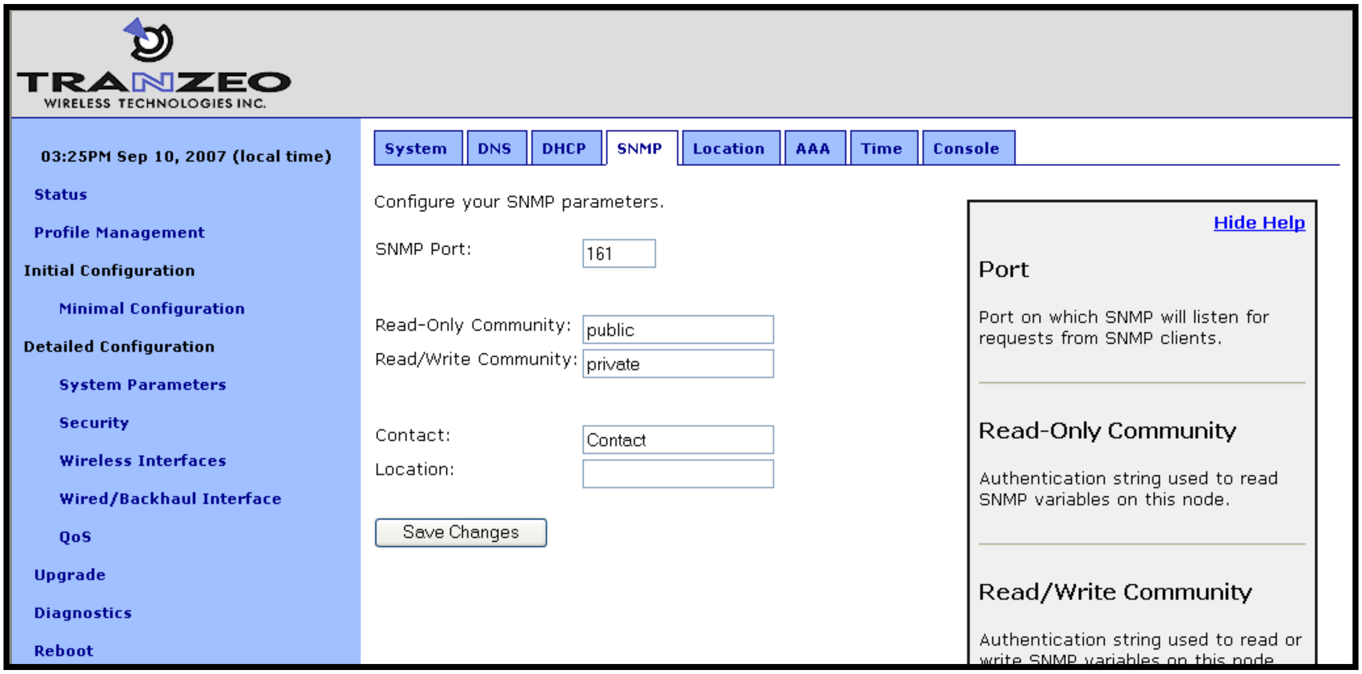
```
> use sys
sys> set snmp.port=161
```

The contact person and location of the device located via SNMP are set with the ‘snmp.contact. and ‘snmp.location’ parameters in the ‘sys’ interface as shown below.

```
> use sys
sys> set snmp.contact=”Joe Smith”
sys> set snmp.location=”123 Main St., Anytown, USA”
```

Web GUI

The SNMP-related parameters can be set on the “SNMP” tab on the “System” page (see Figure 30).



Configure your SNMP parameters.

SNMP Port: 161

Read-Only Community: public

Read/Write Community: private

Contact: Contact

Location:

Port

Port on which SNMP will listen for requests from SNMP clients.

Read-Only Community

Authentication string used to read SNMP variables on this node.

Read/Write Community

Authentication string used to read or write SNMP variables on this node

Figure 30. SNMP configuration

8.11 Location

Two types of device location information can be stored:

- Latitude/longitude/altitude
- Postal address or description a device's location

Note that these values are not automatically updated and must be entered after a device has been installed. Altitude is in meters. Latitude and longitude must be given as geographic coordinates in decimal degrees, with latitude ranging from -90 to 90 (with negative being south, positive being north) and longitude ranging from -180 to 180 (with negative being west, positive being east).

CLI

The geographic location of the EnRoute500 can be stored in the following fields in the 'sys' interface:

- sys.location.gps.altitude
- sys.location.gps.latitude
- sys.location.gps.longitude

For example, you can set the latitude value as follows.

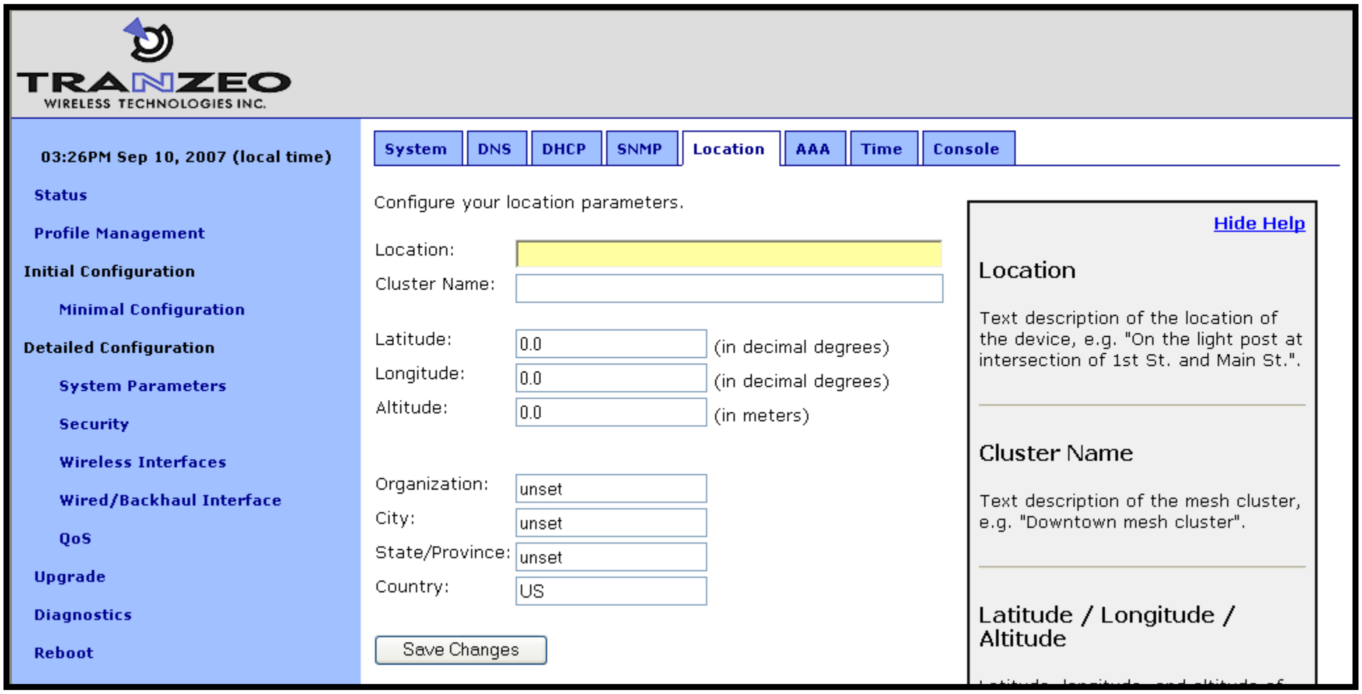
```
> use sys
sys> set location.gps.latitude=”34.01”
```

A description of the EnRoute500’s location can be stored in the ‘location.postal’ field in the ‘sys’ interface. For example, you can set the location value as shown below.

```
> use sys
sys> set location.postal=”Light post near 123 Main St., Anytown, CA”
```

Web GUI

The location information can be set via the web interface using the “Location” tab on the “System Parameters” page.



Configure your location parameters.

Location:

Cluster Name:

Latitude: 0.0 (in decimal degrees)

Longitude: 0.0 (in decimal degrees)

Altitude: 0.0 (in meters)

Organization: unset

City: unset

State/Province: unset

Country: US

Location

Text description of the location of the device, e.g. "On the light post at intersection of 1st St. and Main St.".

Cluster Name

Text description of the mesh cluster, e.g. "Downtown mesh cluster".

Latitude / Longitude / Altitude

Figure 31. Setting location and certificate information

8.12 Cluster Name

A name can be assigned to the mesh neighborhood, or cluster. This name will be displayed in the upper right-hand corner of the web interface on all web interface pages. This name can be used to easily identify which device or mesh neighborhood is being accessed with a particular instance of the web interface. This name does not have any effect on the formation of the mesh and can be different for devices in a mesh neighborhood.

CLI

The cluster name is set with ‘info.cluster’ parameter in the ‘sys’ interface. This parameter can be set as shown in the example below.

```
> use sys
sys> set info.cluster=”Campus network”
```

Web GUI

The cluster name can be set via the web interface using the “Location” tab on the “System Parameters” page (see Figure 31). Use the “Cluster Name” field to set the cluster name.

8.13 Certificate Information

A certificate for use with splash pages and the web interface is locally generated on the EnRoute500. The information embedded in this certificate can be defined by the user. A new certificate is automatically generated when the parameters describing the EnRoute500’s location are changed. The specific location parameters to which the certificate is tied to are listed in the sections below.

CLI

The information used in certificate generation can be set using the ‘organization’ parameters in the ‘sys’ interface. These parameters are:

- sys.organization.name –name of organization (must be enclosed in quotes if it contains spaces)
- sys.organization.city – city name (must be enclosed in quotes if it contains spaces)
- sys.organization.state – state name
- sys.organization.country – two-letter country abbreviation

Web GUI

The certificate information can be set via the web interface using the “Location” tab on the “System Parameters” page (see Figure 31). Changing any of the Organization, City, State/Province, or Country parameters will cause the certificate information to be recalculated.

8.14 Time Synchronization

An EnRoute500 configured as a gateway can be configured to synchronize its internal clock with an external RFC-868-compliant time server. Devices configured as repeaters will automatically synchronize their clocks with the mesh gateway. The delay between following completion of booting and when a repeater synchronizes its clock can be configured. This delay is designed so that if the entire mesh network is rebooted at the same time, the gateway can first synchronize to the external time server, then each repeater, following the delay, will synchronize with the gateway.

The time synchronization will ensure that proper time stamps are displayed for entries in the event logs that are available on the web GUI's "Status" page.

CLI

The time synchronization server for a gateway is set with the 'time.rfc868.server' in the 'sys' interface. The example below shows how to set the time synchronization server.

```
> use sys
sys> set time.rfc858.server="your.time.server.here"
```

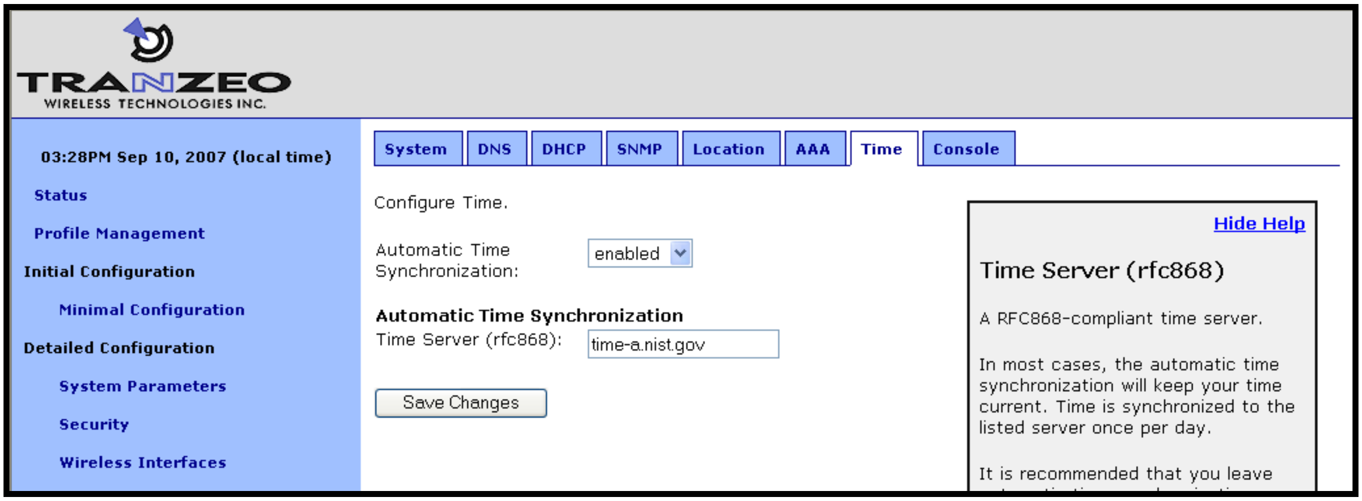
The 'time.sync_delay' parameter in the 'sys' interface sets the delay used by repeaters before they synchronize their clocks with a gateway device.

```
> use sys
sys> set time.sync_delay=600
```

It is not possible to manually adjust the device time through the CLI. Please use the web GUI to adjust it.

Web GUI

The synchronization mode and server can be set on the "Time" tab on the "System" page when the device is configured as a gateway (Figure 32)



03:28PM Sep 10, 2007 (local time)

Configure Time.

Automatic Time Synchronization: enabled

Automatic Time Synchronization

Time Server (rfc868): time-a.nist.gov

Time Server (rfc868)

A RFC868-compliant time server.

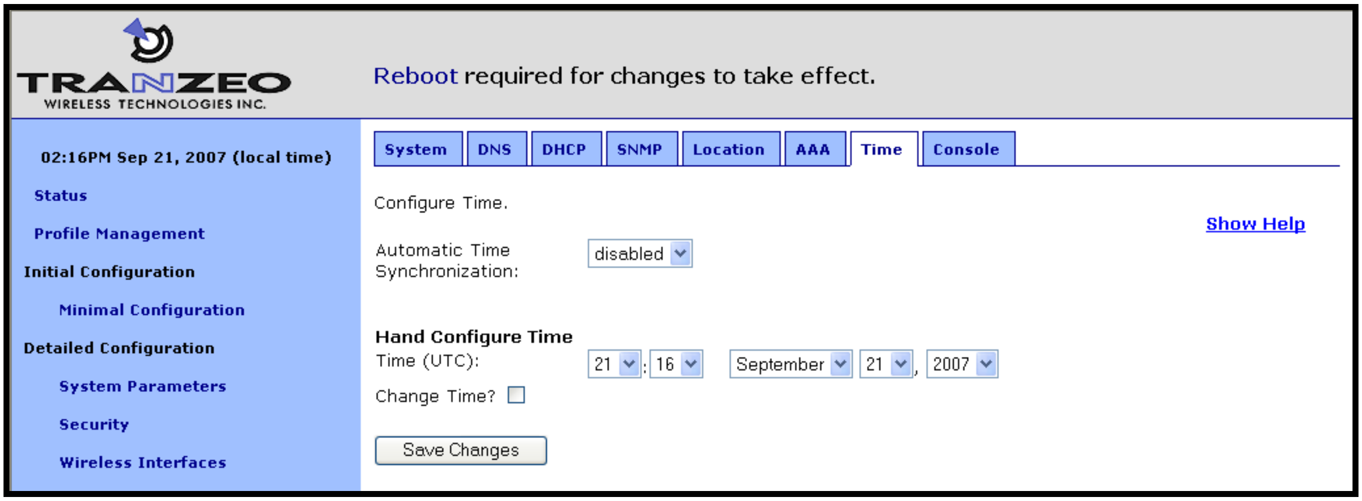
In most cases, the automatic time synchronization will keep your time current. Time is synchronized to the listed server once per day.

It is recommended that you leave

Figure 32. Automatic time synchronization

The synchronization delay and server can be set on the “Time” tab on the “System” page when the device is configured as a repeater.

When automatic synchronization is disabled, the user can set the EnRoute500’s UTC time (Figure 33). Enter the time using the available drop-down menus and check the “Change Time” checkbox.



Reboot required for changes to take effect.

Configure Time.

Automatic Time Synchronization: disabled

Hand Configure Time

Time (UTC): 21 : 16 September 21 , 2007

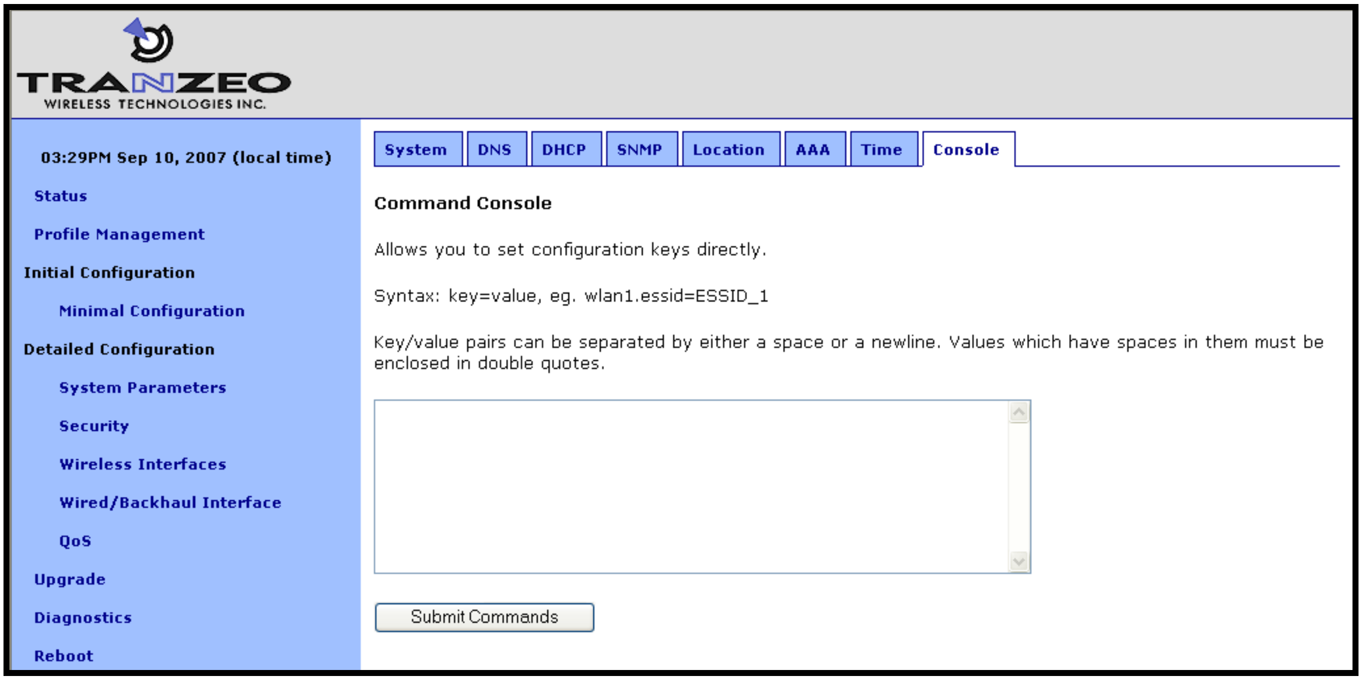
Change Time? □

Figure 33. Setting the time manually

8.15 Web GUI Console

The web interface allows the user to set parameters that are not otherwise settable through the web interface using a console interface. The console is available on the “Console” tab on the “System” page.

CLI key/value pairs can be entered through the console. The key format used is “<interface name>.<key>”. For example, “wlan1.channel” is the key to set the channel used by virtual AP wlan1. To use the console, enter one or more key/value pairs in the large text box on the page, either separating each pair with a space or placing each pair on its own line. Click on the “Submit Commands” button to set the values entered in the text box.



Command Console

Allows you to set configuration keys directly.

Syntax: key=value, eg. wlan1.essid=ESSID_1

Key/value pairs can be separated by either a space or a newline. Values which have spaces in them must be enclosed in double quotes.

Figure 34. Web interface console

8.16 OnRamp Configuration Access

ONRAMP IS A PC-BASED TOOL THAT WILL BECOME AVAILABLE TO SUPPORT INITIAL CONFIGURATION OF THE ENROUTE500. IT HAS NOT BEEN RELEASED AT THE TIME OF THE WRITING OF THIS DOCUMENT. CHECK WWW.TRANZEO.COM/ONRAMP FOR ONRAMP STATUS.

IT IS RECOMMENDED THAT ONRAMP CONFIGURATION ACCESS IS DISABLED UNTIL THE TOOL IS MADE AVAILABLE.

The OnRamp utility provides network detection and configuration capabilities for EnRoute500s. The configuration capabilities are only intended for initial configuration and for security reasons, it is strongly recommended that OnRamp configuration capability is disabled after initial configuration.

You can use the CLI, the web interface, or OnRamp to determine whether a device can be configured from OnRamp. In OnRamp, the “Prog” column displays the programming capability from OnRamp. A ‘Y” in this column indicates that OnRamp can configure the device, an ‘N’ indicates that it cannot.

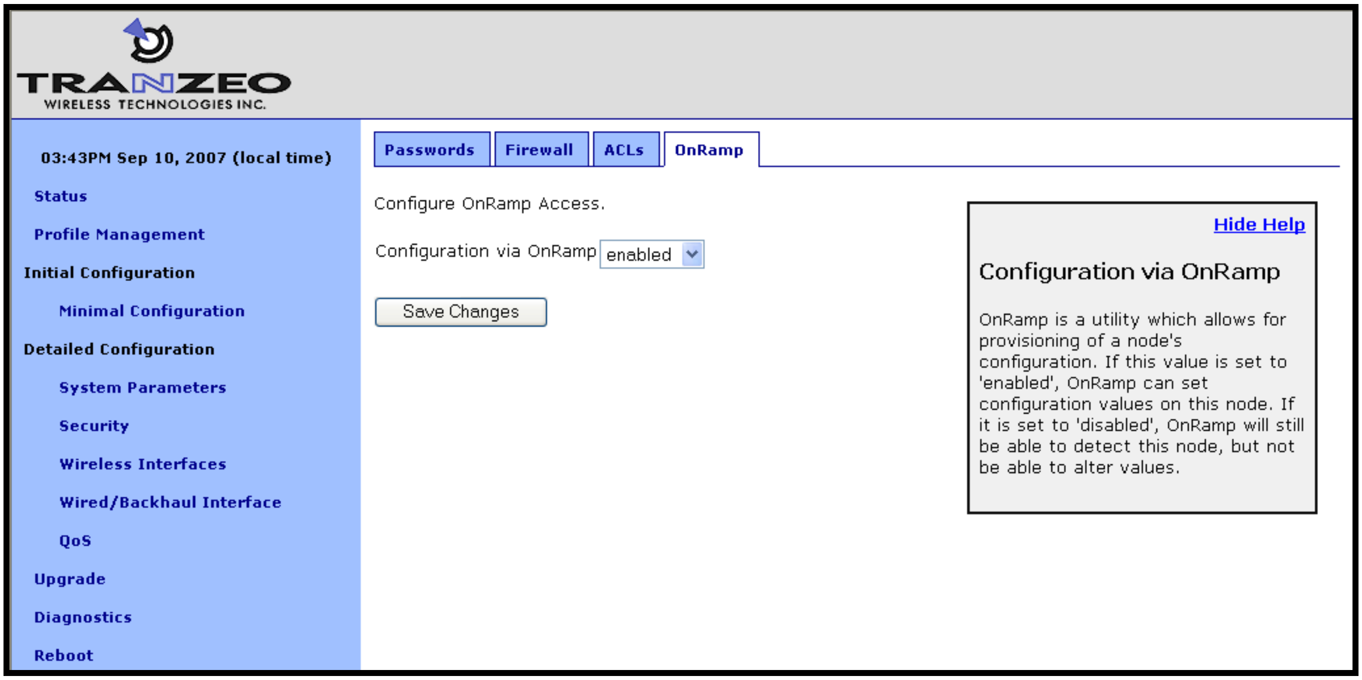
CLI

The OnRamp configuration capability is controlled by the ‘provisioning.enable’ parameter in the ‘sys’ interface. Set this parameter to ‘0’ to disable configuration through OnRamp, as shown in the example below.

```
> use sys
sys> set provisioning.enable=0
```

Web GUI

The OnRamp configuration capability is set on the “OnRamp” tab on the “Security” page (see Figure 35).



03:43PM Sep 10, 2007 (local time)

Configure OnRamp Access.

Configuration via OnRamp: enabled

Configuration via OnRamp

OnRamp is a utility which allows for provisioning of a node's configuration. If this value is set to 'enabled', OnRamp can set configuration values on this node. If it is set to 'disabled', OnRamp will still be able to detect this node, but not be able to alter values.

Figure 35. OnRamp configuration access

8.17 CLI Timeout

The CLI will automatically log out a user if the interface has remained inactive for a certain length of time. The time, in seconds, that a shell must remain inactive before a user is automatically logged out is set with the ‘shell.timeout’ parameter in the ‘sys’ interface, as shown in the example below. The maximum idle time that can be set is 21600 seconds (6 hours).

```
> use sys
sys> set shell.timeout=300
```

9 Client Addressing Schemes

The choice of client addressing scheme affects how EnRoute500 client access interface addresses are assigned. The EnRoute500 can be configured to use an implicit addressing scheme for its client access interfaces, or explicit addresses can be assigned to each client access interface. The addressing scheme choice also affects what the addresses of clients will be when the device is not operating in centralized DHCP server mode.

⚠ **It is not possible to mix devices with implicit and explicit addressing schemes in a common mesh neighborhood.**

Table 6 compares how the behavior of the device differs depending upon the addressing scheme that is chosen.

Feature	Implicit addressing scheme	Explicit addressing scheme
Client access interface addresses	Derived from mesh ID, node ID, and LAN prefix settings. They cannot be directly set.	Can be set to arbitrary values, with a few reserved address ranges that cannot be used.
Size of client address space	Each of the active client access interfaces must share a class C address space.	The address space size for each client access interface can be set independently and can be of arbitrary size.
Default internal subnets	Mesh subnet (typically 172.29.0.0/16), client subnet (10.<mesh ID>.0.0/16, and DHCP client address space subnet	Mesh subnet (typically 172.29.0.0/16), 10.0.0.0/8, and DHCP client address space subnet

Table 6. Differences between explicit and implicit addressing schemes

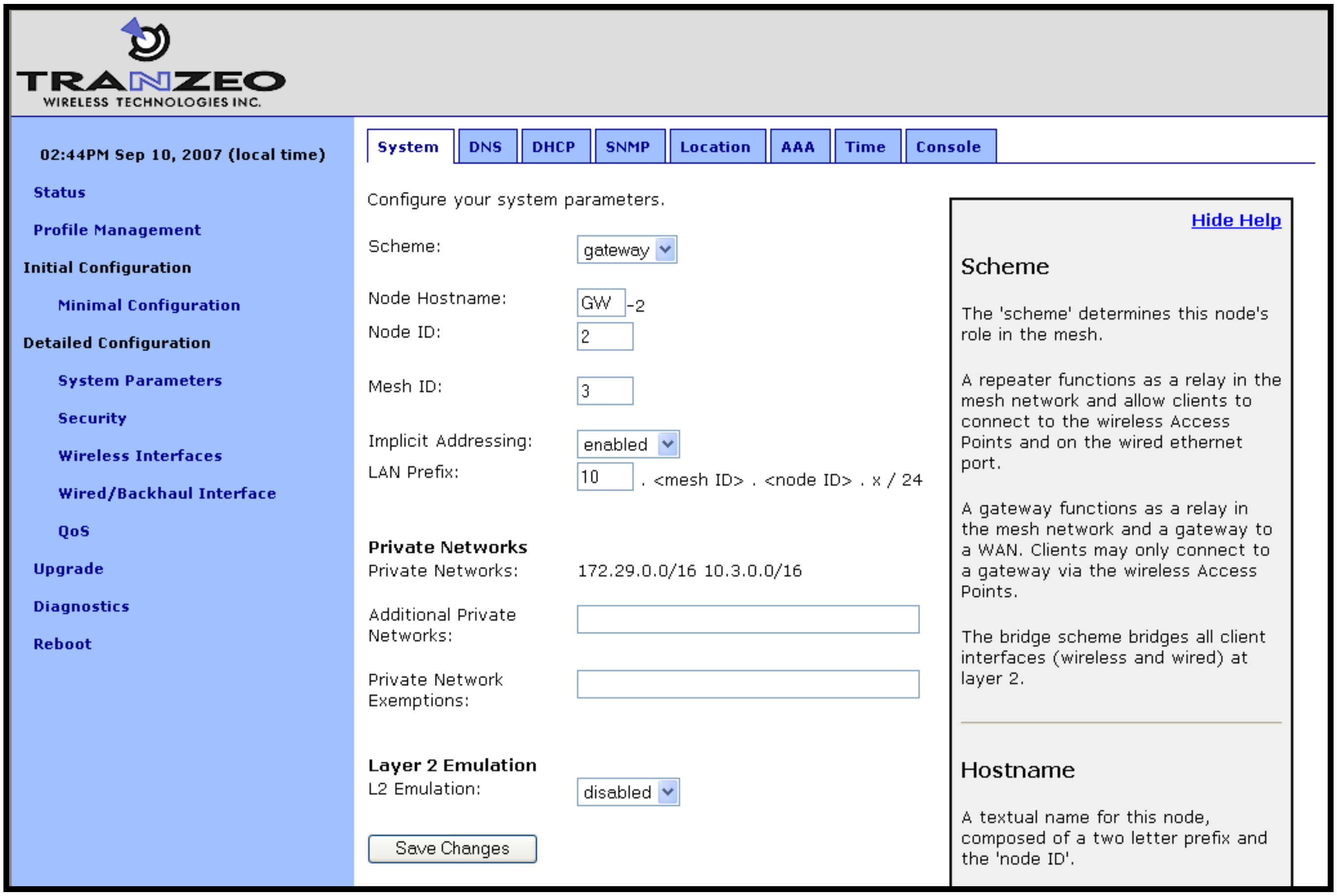
CLI

The choice of implicit or explicit addressing scheme is controlled by the ‘implicit.enable’ parameter in the ‘mesh’ interface. Set this parameter to ‘yes’ to select implicit addressing and to ‘no’ to select explicit addressing. The example below demonstrates how to select the implicit addressing scheme.

```
> use mesh0
sys> set implicit.enable=yes
```

Web GUI

The addressing scheme is set with the “Implicit Addressing” drop-down menu on the “System” tab of the “System” page. Set this to disabled to choose the explicit addressing scheme.



Configure your system parameters.

Scheme: gateway

Node Hostname: GW -2

Node ID: 2

Mesh ID: 3

Implicit Addressing: enabled

LAN Prefix: 10 . <mesh ID> . <node ID> . x / 24

Private Networks

Private Networks: 172.29.0.0/16 10.3.0.0/16

Additional Private Networks:

Private Network Exemptions:

Layer 2 Emulation

L2 Emulation: disabled

Scheme

The 'scheme' determines this node's role in the mesh.

A repeater functions as a relay in the mesh network and allow clients to connect to the wireless Access Points and on the wired ethernet port.

A gateway functions as a relay in the mesh network and a gateway to a WAN. Clients may only connect to a gateway via the wireless Access Points.

The bridge scheme bridges all client interfaces (wireless and wired) at layer 2.

Hostname

A textual name for this node, composed of a two letter prefix and the 'node ID'.

Figure 36. Setting the addressing scheme

9.1 Implicit Addressing Scheme

The implicit addressing scheme requires a class C network, which has a unique address within a mesh, to be shared between all active client access interfaces. The subnet address space is based on the mesh ID, node ID, and LAN prefix as shown in Figure 37.

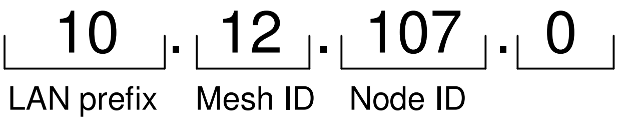


Figure 37. Subnet address structure

INFO

> If the EnRoute500 is operating in centralized DHCP server mode, the addresses used for the implicit addressing scheme have no bearing on the addresses that are assigned to client devices through DHCP.

The default division of the class C address space is shown in Table 7. It is possible to change this configuration, assigning larger address spaces to certain interfaces if not all interfaces are enabled.

Interface	Interface address	Broadcast address	Client device address range
wlan1	subnet.1	subnet.127	subnet.2-126
wlan2	subnet.129	subnet.159	subnet.130-158
wlan3	subnet.161	subnet.191	subnet.162-190
wlan4	subnet.193	subnet.223	subnet.194-222
eth0	subnet.225	subnet.255	subnet.226-254

subnet = <id.lanprefix>.<id.mesh>.<id.node>

Table 7. Default subnet segmentation between interfaces

9.1.1 LAN Prefix

The LAN prefix parameter sets the first octet of the client access interface IP address. The suggested values for the LAN prefix are 10 and 192. The LAN prefix must be the same for all devices in a mesh neighborhood.

The LAN prefix parameter has no effect when an EnRoute500 is using the explicit addressing scheme.

CLI

The LAN prefix is set with the ‘id.lanprefix’ parameter in the ‘sys’ interface as shown in the example below.

```
> use sys
sys> id.lanprefix=10
```

Web GUI

The LAN prefix can be set via the web interface using the “System” tab on the “System Parameters” page (see Figure 36).

9.1.2 Client Address Space Segmentation in Implicit Addressing Mode

As mentioned above, the client access interfaces must share a class C address space when the EnRoute500 is using the implicit addressing scheme. The start address of each address segment and its size can be set. The following restrictions are placed on the address segment configuration:

- Each active client access interface must be assigned an address segment.

- The IP address range start address (‘ip.implicit.start.requested’ in the CLI) must be one of the following values: 1, 33, 65, 97, 129, 161, 193, 225.
- The IP address range size (‘ip.implicit.size.requested’ in the CLI) must be one of the following values: 31, 63, 127, 255.
- The IP address range size and start address must be chosen such that the address segment does not cross a netmask boundary. Table 8 lists allowed combinations.
- The address spaces for enabled interfaces must start at different addresses.
- The address spaces for enabled interfaces should not overlap.

Address range start (ip.implicit.start.requested)	IP address range size (ip.implicit.size.requested)			
	31	63	127	255
1	Yes	Yes	Yes	Yes
33	Yes	No	No	No
65	Yes	Yes	No	No
97	Yes	No	No	No
129	Yes	Yes	Yes	No
161	Yes	No	No	No
193	Yes	Yes	No	No
225	Yes	No	No	No

Table 8. Allowed address segment start address and size combinations

Each of the enabled interfaces’ address segments should be configured to avoid overlap with the other interfaces’ address segments. In the case where an EnRoute500 is not configured such that this requirement is met, address spaces will be automatically reduced in size to prevent overlap.

CLI

The start and size of client address spaces are set with the ‘ip.implicit.start.requested’ and ‘ip.implicit.size.requested’ parameters in the ‘eth0’, ‘wlan1’, ‘wlan2’, ‘wlan3’, and ‘wlan4’ interfaces. Refer to Table 8 for allowed values for these parameters.

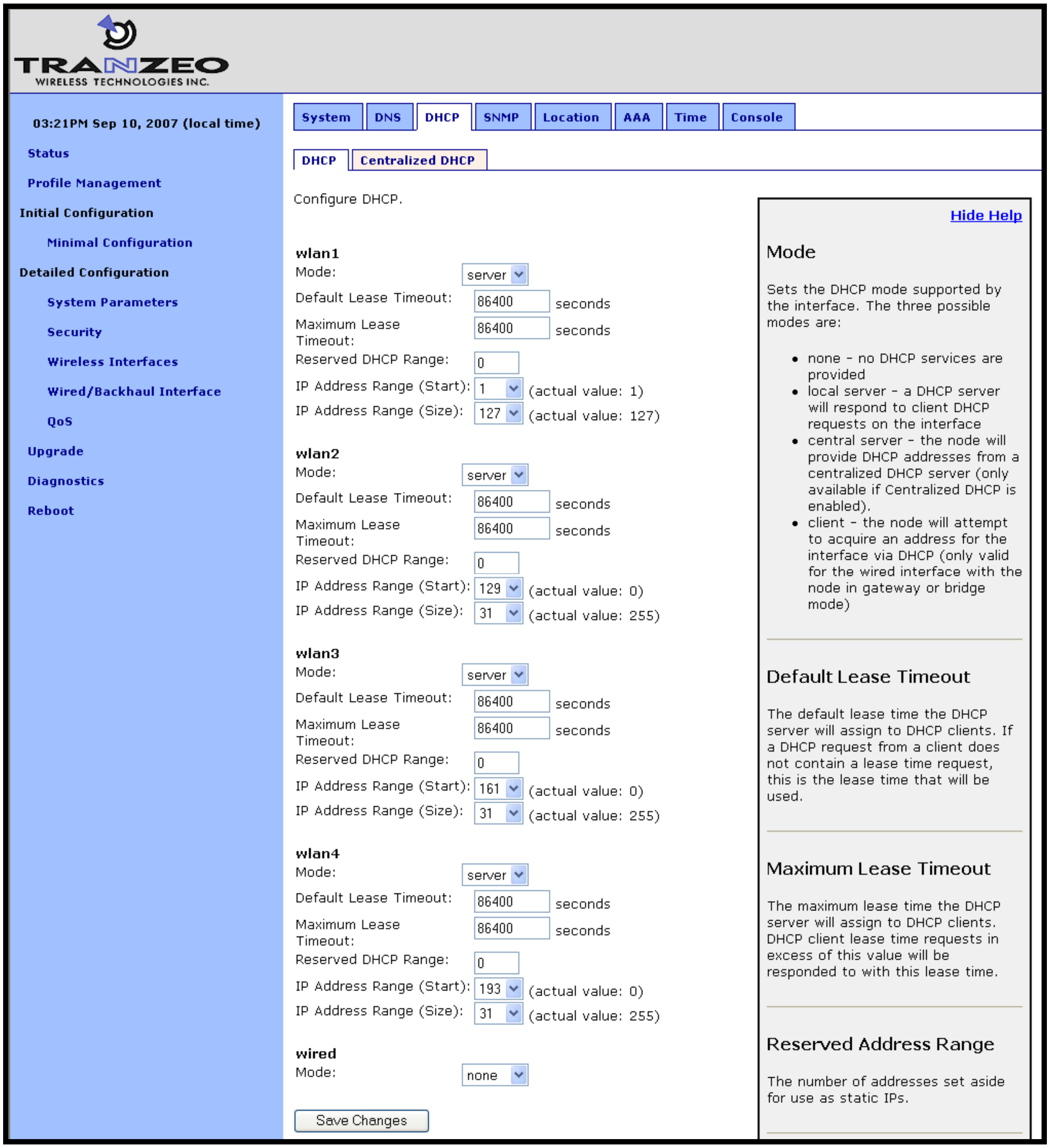
In the first example below, the Ethernet interface is set to use the entire class C address space (this requires that all the other client access interfaces, wlan1-4, are disabled). In the second example, the Ethernet interface is set to use the upper half of the class C address space.

```
> use eth0
eth0> set ip.implicit.start.requested=1
eth0> set ip.implicit.size.requested=255

> use eth0
eth0> set ip.implicit.start.requested=129
eth0> set ip.implicit.size.requested=127
```

The actual start address and size of a segment are accessible via the ‘ip.implicit.start.actual’ and ‘ip.implicit.size.actual’ parameters. These may values may differ from the requested values if the rules for setting these parameters were not abided by.

Web GUI

The address space segments’ start addresses and sizes can be set via the web interface using the “DHCP” sub-tab on the “DHCP” tab on the “System Parameters” page (see Figure 38).



Configure DHCP.

wlan1
Mode: server
Default Lease Timeout: 86400 seconds
Maximum Lease Timeout: 86400 seconds
Reserved DHCP Range: 0
IP Address Range (Start): 1 (actual value: 1)
IP Address Range (Size): 127 (actual value: 127)

wlan2
Mode: server
Default Lease Timeout: 86400 seconds
Maximum Lease Timeout: 86400 seconds
Reserved DHCP Range: 0
IP Address Range (Start): 129 (actual value: 0)
IP Address Range (Size): 31 (actual value: 255)

wlan3
Mode: server
Default Lease Timeout: 86400 seconds
Maximum Lease Timeout: 86400 seconds
Reserved DHCP Range: 0
IP Address Range (Start): 161 (actual value: 0)
IP Address Range (Size): 31 (actual value: 255)

wlan4
Mode: server
Default Lease Timeout: 86400 seconds
Maximum Lease Timeout: 86400 seconds
Reserved DHCP Range: 0
IP Address Range (Start): 193 (actual value: 0)
IP Address Range (Size): 31 (actual value: 255)

wired
Mode: none

Mode

Sets the DHCP mode supported by the interface. The three possible modes are:

- none - no DHCP services are provided
- local server - a DHCP server will respond to client DHCP requests on the interface
- central server - the node will provide DHCP addresses from a centralized DHCP server (only available if Centralized DHCP is enabled).
- client - the node will attempt to acquire an address for the interface via DHCP (only valid for the wired interface with the node in gateway or bridge mode)

Default Lease Timeout

The default lease time the DHCP server will assign to DHCP clients. If a DHCP request from a client does not contain a lease time request, this is the lease time that will be used.

Maximum Lease Timeout

The maximum lease time the DHCP server will assign to DHCP clients. DHCP client lease time requests in excess of this value will be responded to with this lease time.

Reserved Address Range

The number of addresses set aside for use as static IPs.

Figure 38. Address space settings when using the implicit addressing scheme

9.2 Explicit Addressing Scheme

When using explicit addressing scheme, the IP parameters for each interface must be specified manually on the “Wireless Interface” and “Wired/Backhaul Interface” pages.

When specifying the IP addresses and subnet sizes for the client access interfaces, the following rules should be followed:

- Specify IP address and subnet combinations that do not lead to misalignment, e.g. 10.0.0.4/24 is not a properly aligned address/subnet size combination.
- Do not specify subnets that are in the following ranges:
  - 169.254.0.0/16
  - 127.0.0.0/8
  - The class B network used by the mesh (typically 172.29.0.0/16)
- Each subnet specified for a client access interface must not overlap with that of any other client access interface in the mesh neighborhood.
- Do not specify any subnets for client access interfaces that overlap with subnets outside the mesh neighborhood that you want mesh clients to be able to connect to.

⚠ **Do not specify a gateway IP address for any of the client access interfaces when operating using the explicit addressing scheme. This field should be left blank for each interface.**

CLI

Set the ‘implicit.enable’ parameter in the ‘mesh0’ interface to ‘no’ to select the explicit addressing scheme. The example below demonstrates this.

```
> use mesh0
sys> set implicit.enable=no
```

See sections 11.1.2 and 12.4 for instructions on how to set the IP addresses for the wired and wireless client access interfaces when using the explicit addressing scheme.

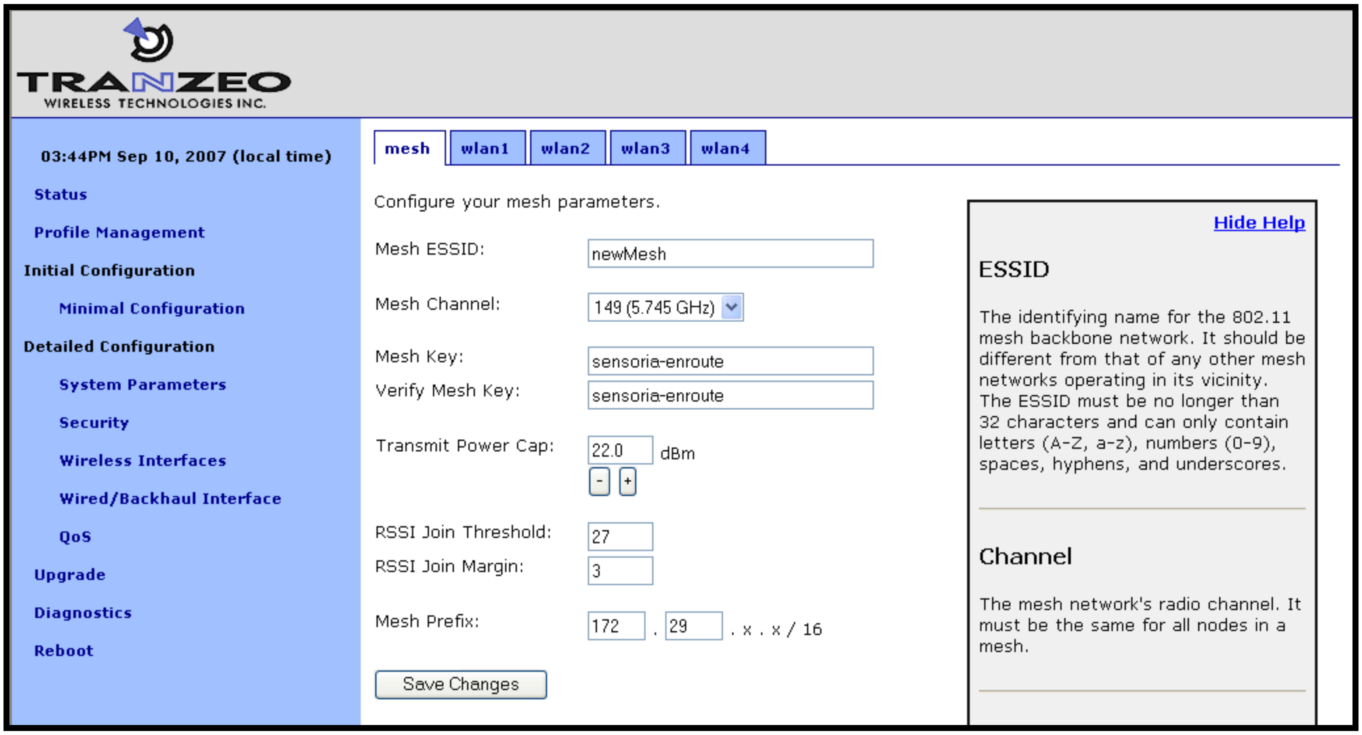
Web GUI

The addressing scheme is set with the “Implicit Addressing” drop-down menu on the “System” tab of the “System” page (see Figure 36). Set this to “disabled” to use the explicit addressing scheme.

See sections 11.1.2 and 12.4 for instructions on how to set the IP addresses for the wired and wireless client access interfaces when using the explicit addressing scheme.

10 Mesh Radio Configuration

The EnRoute500 has an 802.11a radio dedicated to mesh backhaul traffic. The settings for this radio are independent of any settings for the radio used for the EnRoute500's built-in virtual access points. The channel, SSID< and encryption settings for the mesh radio must be the same on all EnRoute500s in a given mesh neighborhood for them to be able to communicate.



Configure your mesh parameters.

Mesh ESSID: newMesh

Mesh Channel: 149 (5.745 GHz)

Mesh Key: sensoria-enroute

Verify Mesh Key: sensoria-enroute

Transmit Power Cap: 22.0 dBm

RSSI Join Threshold: 27

RSSI Join Margin: 3

Mesh Prefix: 172 . 29 . x . x / 16

ESSID

The identifying name for the 802.11 mesh backbone network. It should be different from that of any other mesh networks operating in its vicinity. The ESSID must be no longer than 32 characters and can only contain letters (A-Z, a-z), numbers (0-9), spaces, hyphens, and underscores.

Channel

The mesh network's radio channel. It must be the same for all nodes in a mesh.

Figure 39. Mesh interface parameters

10.1 Channel

The 802.11a radio can be set to operate in the channels listed in Table 9. All these channels are non-overlapping.

Channel	Center Frequency (GHz)
149	5.745
153	5.765
157	5.785
161	5.805
165	5.825

Table 9. Mesh radio channels and frequencies

All the devices in a mesh neighborhood need to be configured to use the same 802.11a channel.

CLI

The mesh radio channel is set with the 'channel' parameter in the 'mesh0' interface as shown in the example below.

```
> use mesh0
mesh0> set channel=157
```

Web GUI

The mesh radio channel can be set via the web interface using the "Mesh" tab on the "Wireless Interfaces" page (see Figure 39).

10.2 Service Set Identifier (SSID)

The Service Set Identifier, or SSID, is used in 802.11 communication to identify a particular network. It differentiates logical networks that operate on the same radio channel. The mesh radio SSID for all the devices in a mesh neighborhood must be the same. If you have adjacent mesh neighborhoods where one or more devices from each neighborhood are within communication range of each other, the SSID for the neighborhoods must be different if you wish to preclude mesh communication between these neighborhoods and preventing repeaters from autonomously deciding which neighborhood to be part of.

The SSID value must be a text string that has a maximum length of 32 characters. It must only contain alphanumeric characters, spaces, dashes ("-"), and underscores ("_"). The SSID setting is case sensitive.

CLI

The mesh radio SSID is set as shown in the example below. When setting an ESSID that contains spaces, the SSID value must be enclosed by quotes. The quotes are optional otherwise.

```
> use mesh0
mesh0> set essid=”enroute500_mesh”
```

Web GUI

The mesh radio SSID can be set via the web interface using the "Mesh" tab on the "Wireless Interfaces" page (see Figure 39).

10.3 Encryption

The mesh radio link can be protected with an encryption key to prevent unauthorized users from intercepting or spoofing mesh traffic. Each EnRoute500 in a mesh neighborhood must have the same mesh radio encryption key.

CLI

To enable encryption, set the ‘key’ parameter in the ‘mesh0’ interface. The examples below illustrate how to set the encryption key. The ‘key’ parameter can either be specified as a 16-character ASCII string preceded by “s:” or a 32-character hexadecimal string.

Encryption can be enabled using an ASCII key with

```
> use mesh0
mesh0> set key=”s:abcdefghijklmnop”
```

or using a hexadecimal key with

```
> use mesh0
mesh0> set key=”0123456789abcdef0123456789abcdef”
```

Encryption can be disabled by specifying a blank value as shown below.

```
> use mesh0
mesh0> set key=
```

Web GUI

The mesh radio encryption key can be set via the web interface using the “Mesh” tab on the “Wireless Interfaces” page (see Figure 39). The same encryption key must be entered in both the “Mesh Key” and “Verify Mesh Key” text boxes for the new key to be accepted.

⚠ **Only ASCII keys can be entered using the web interface. Unlike the CLI, an ASCII key should not be preceded by “s:” when entered via the web GUI.**

10.4 Transmit Power Cap

The maximum transmit power cap of the mesh radio is configurable. Increased output power will improve communication range, but will also extend the interference range of the radios. It is suggested that the transmit power cap is initially set to the maximum level for an installation and is then reduced if it is determined that the transmit power far exceeds the level required to maintain links. It is also recommended that a common transmit power cap value is used for all devices in a mesh to reduce the likelihood of asymmetric links. The default transmit power is 21 dBm.

⚠ **If the transmit power is set to a value in excess of what can be supported by the mesh radio, the actual radio output power will be the highest power supported by the mesh radio.**

CLI

The example below shows how to set the mesh radio’s transmit power cap with the ‘txpower’ parameter in the ‘mesh0’ interface. The txpower parameter is specified in dBm, with a minimum granularity of 0.5 dBm.

```
> use mesh0
mesh0> set txpower=20
```

Web GUI

The mesh radio’s transmit power cap can be set via the web interface using the “Mesh” tab on the “Wireless Interfaces” page (see Figure 39). The “+” and “-“ buttons can be used to increase or decrease the power cap setting in 0.5 dBm steps, or a value can be entered in the text box.

10.5 RSSI Threshold Levels

The mesh networking algorithm evaluates link qualities to neighboring mesh devices and only considers links with a received signal strength indicator (RSSI) value equal to or greater than the ‘RSSI Join’ value specified to be usable. The ‘RSSI Join’ value is set to 27 by default. This value reflects the lowest RSSI that will allow the mesh radio to operate reliably at its highest data rate. It is possible to achieve longer link ranges, at the cost of reduced throughput, by reducing the ‘RSSI Join’ value.

In combination with the ‘RSSI Join’ value, the ‘RSSI Margin’ value is used to set the RSSI level at which links are dropped. A link will be considered broken when its RSSI drops below the ‘RSSI Join’ level by the amount specified with ‘RSSI Margin’. For example, with an ‘RSSI Join’ value of 27 and an ‘RSSI Margin’ value of 3, the link will be dropped if the RSSI goes below 24. The ‘RSSI Margin’ protects the links from the fluctuation in link strengths due to fading. Based on empirical testing of the EnRoute500, a value of 3-5 is recommended for outdoor deployments of the EnRoute500.

CLI

The example below shows how to set the mesh radio’s RSSI thresholds with the ‘fabric.rssi.join’ and ‘fabric.rssi.margin’ parameters in the ‘mesh0’ interface .

```
> use mesh0
mesh0> set fabric.rssi.join=27
> use mesh0
mesh0> set fabric.rssi.margin=3
```

Web GUI

The mesh radio RSSI thresholds can be set via the web interface using the “Mesh” tab on the “Wireless Interfaces” page (see Figure 39).

10.6 IP Configuration

The IP address, broadcast address, and netmask associated with the mesh radio interface can be viewed through the CLI and web interfaces. It is not possible to directly set these values though. To change the mesh interface IP settings, mesh prefix and the node and mesh ID settings must be changed (see sections 8.3 and 8.5).

CLI

In the CLI, the mesh IP settings can be viewed with

```
> use mesh0
mesh0> get ip.address
 ip.address = 172.29.2.4   [read-only]
mesh0> get ip.broadcast
 ip.broadcast = 172.29.255.255   [read-only]
mesh0> get ip.gateway
 ip.gateway =    [read-only]
mesh0> get ip.netmask
 ip.netmask = 255.255.0.0   [read-only]
```

Web GUI

The mesh radio IP settings are available through the web interface on the “Config Overview” tab on the “Status’ page under the heading “Wireless Fabric$^{\text{TM}}$ (mesh)”.

10.7 Neighbor Status

For a mesh device to be considered a neighbor, a minimum SNR threshold must be met. The minimum SNR required for a link to be established and maintained are set with the ‘RSSI Join’ and ‘RSSI Margin’ parameters (see section 10.5).

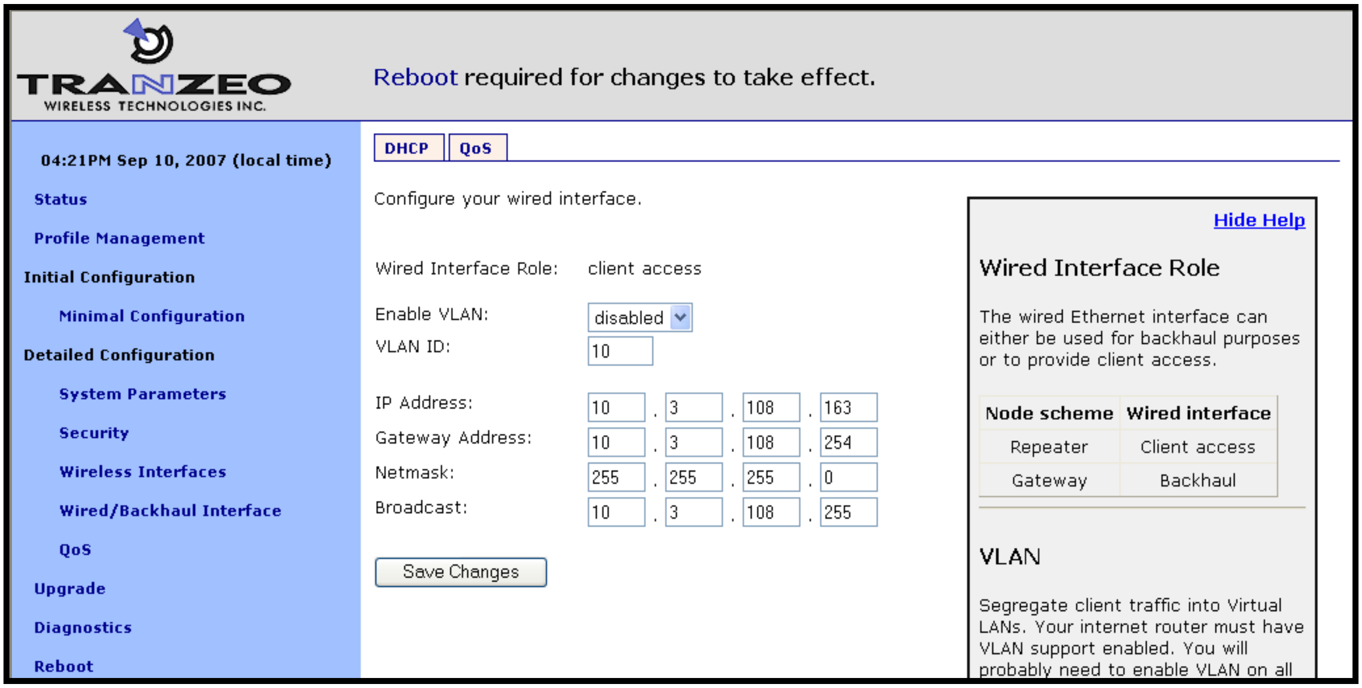
See section 6.2.1 for how to access information, including RSSI and SNR, about mesh neighbors.

11 Ethernet Interface Configuration

The function of the Ethernet interface (eth0) depends on the operating scheme that has been selected (see section 8.2). In repeater mode, the Ethernet interface can be used to connect client devices to the mesh neighborhood. In gateway mode, the Ethernet interface is used as a backhaul interface that connects the mesh neighborhood to a WAN. Client devices cannot connect through the Ethernet interface in this mode.

11.1 IP Configuration for Repeater Devices and Their Clients

When an EnRoute500 is configured as a repeater, client devices can connect to it via the Ethernet interface to access the mesh network. These client devices can either be assigned their IP configuration using DHCP, either by a centralized server or a local one on the EnRoute500, or be manually configured.



Reboot required for changes to take effect.

Configure your wired interface.

Wired Interface Role:	client access
Enable VLAN:	disabled
VLAN ID:	10
IP Address:	10 . 3 . 108 . 163
Gateway Address:	10 . 3 . 108 . 254
Netmask:	255 . 255 . 255 . 0
Broadcast:	10 . 3 . 108 . 255

Wired Interface Role

The wired Ethernet interface can either be used for backhaul purposes or to provide client access.

Node scheme	Wired interface
Repeater	Client access
Gateway	Backhaul

VLAN

Segregate client traffic into Virtual LANs. Your internet router must have VLAN support enabled. You will probably need to enable VLAN on all

Figure 40. Wired interface parameters with EnRoute500 in repeater mode

11.1.1 Ethernet Client Device Address Space

When an EnRoute500 is in repeater mode, the Ethernet interface is either assigned a segment of the EnRoute500's class C client address space, if the EnRoute500 is using the implicit addressing scheme, or an arbitrary address space can be set for the interface when using the explicit addressing scheme. See section 9 for more information on client addressing schemes.

11.1.2 Ethernet Interface IP Configuration

The EnRoute500's Ethernet interface IP configuration can be changed directly when it is in repeater mode and using the explicit addressing scheme. It should not be changed directly when the device is in repeater mode and using the implicit addressing scheme.

When an EnRoute500 is configured to use the implicit addressing scheme, set the IP address to the desired value by modifying the node ID, mesh ID, and LAN prefix parameters (see sections 8.3 and 9.1.1). Set the netmask by changing the client address space segments as described in 9.1.2.

When using the explicit addressing scheme, the IP configuration can be set directly. Care must be taken to avoid using the same or overlapping address spaces on different devices in a mesh neighborhood.

CLI

You can view the IP settings for the Ethernet interface with the 'ip.*' parameters in the 'eth0' interface as shown in the example below.

```
> use eth0
eth0> get ip.*
 ip.address = 10.2.4.225   [read-only]
 ip.address_force =
 ip.broadcast = 10.2.4.255   [read-only]
 ip.broadcast_force =
 ip.gateway =    [read-only]
 ip.gateway_force =
 ip.netmask = 255.255.255.0   [read-only]
 ip.netmask_force =
 ip.implicit.size.actual =    [read-only]
 ip.implicit.size.requested = 31
 ip.implicit.start.actual =    [read-only]
 ip.implicit.start.requested = 225
```

When an EnRoute500 is in repeater mode and using the implicit addressing scheme, the Ethernet IP settings can be changed by altering the 'id.node', 'id.mesh', and 'id.lanprefix' parameters in the 'sys' interface and the 'ip.implicit.start.requested' parameter in the 'eth0' interface.

When an EnRoute500 is configured as a repeater, but is using the explicit addressing scheme, the IP address, netmask, gateway address, and broadcast address can be set using the 'ip.address_force', 'ip.netmask_force', 'ip.gateway_force', and 'ip.broadcast_force' parameters in the 'eth0' interface as shown in the example below.

```
> use eth0
eth0> set ip.address_force= 10.12.7.1
ip.broadcast_force= 10.12.7.255
ip.gateway_force=
ip.netmask_force=255.255.255.0
```

Web GUI

The current Ethernet IP settings can be viewed through the web interface on the “Config Overview” tab on the “Status” page. When using the implicit addressing scheme, the Ethernet IP settings can be changed by altering the node ID, mesh ID, and LAN prefix settings on the “System” parameters tab on the “System Parameters” page. When using the explicit addressing scheme, the IP parameters can be set on the “Wired/Backhaul Interface” page.

11.1.3 IP Configuration of Client Devices via DHCP

When configured as a repeater, the EnRoute500 can be set to serve IP addresses to clients on the Ethernet interface using DHCP. DHCP-provided addresses can be served either from a local server on the EnRoute500 or from an external server. The two DHCP modes are described in detail in section 13.

11.1.4 Manual IP Configuration of Client Devices

The client devices connected via the Ethernet interface that use static IP addresses must have addresses that are within the subnet of the Ethernet interface.

If the local DHCP server is enabled for the Ethernet interface, IP addresses must be reserved for statically-configured devices by setting the DHCP reserve parameter. This will reserve the specified number of IP addresses at the low end of the IP range for the interface. For example, if the interface has been assigned the IP address 10.2.4.225, the netmask 255.255.255.224, and the DHCP reserve value 5, the IP addresses 10.2.4.226 through 10.2.4.230 will be available for use by statically configured devices. The remaining IP addresses in the interfaces address space can be assigned by the DHCP server to other client devices.

CLI

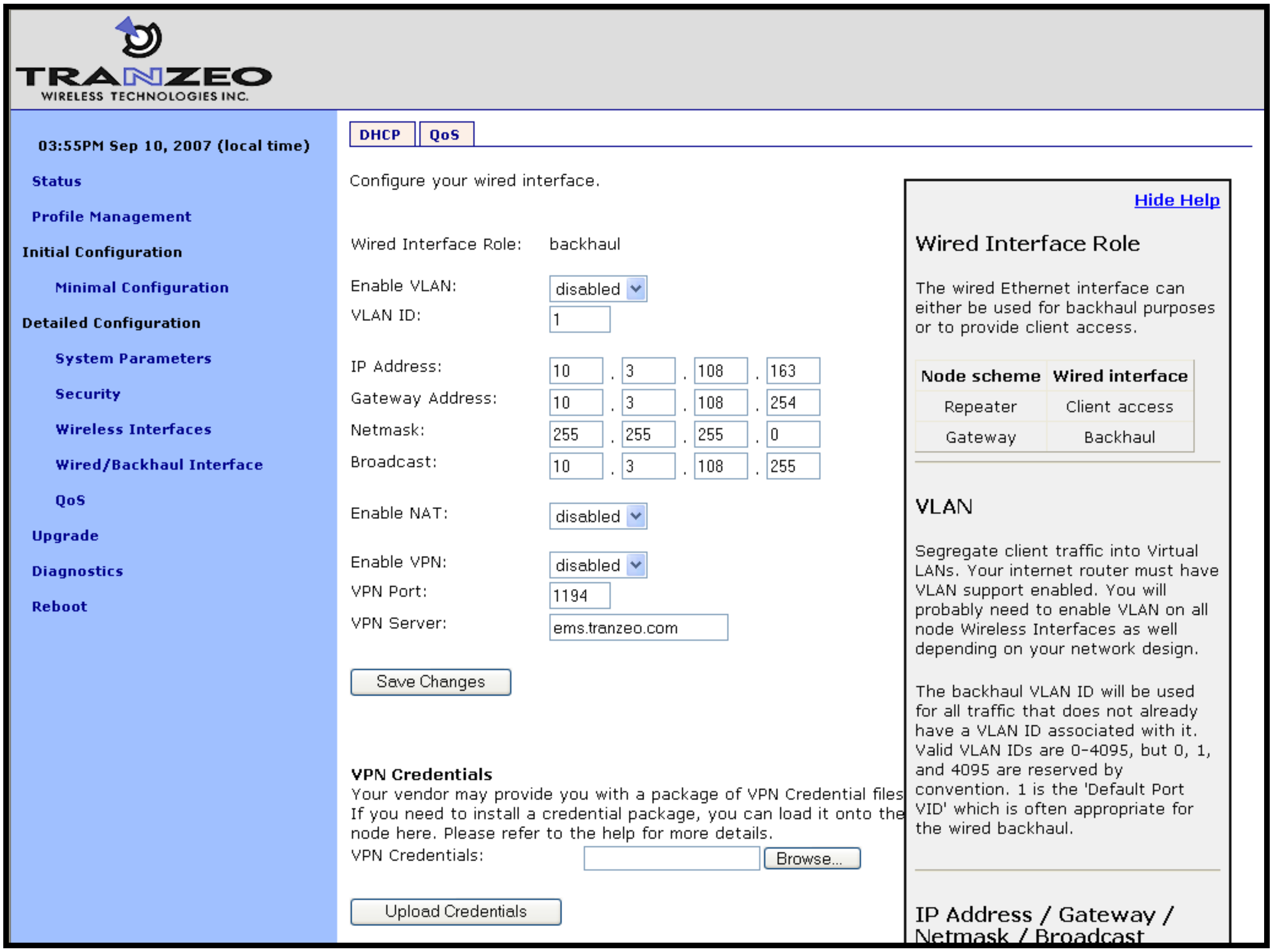
The number of IP addresses reserved for statically-configured devices connected to the Ethernet interface is set with the ‘dhcp.reserve’ parameter in the ‘eth0’ interface.

Web GUI

The DHCP reserve value can be set via the web interface using the “DHCP” sub-tab on the “DHCP” tab on the “System Parameters” page (see Figure 43).

11.2 IP Configuration for Gateway Devices

When an EnRoute500 is configured as a gateway, the Ethernet interface is used to provide backhaul capability by connecting it to a WAN or directly to the Internet. Clients cannot connect to the EnRoute500 through the Ethernet interface when operating in this mode. The Ethernet interface IP address can either be acquired from a DHCP server on the WAN or be set manually.



Configure your wired interface.

Wired Interface Role: backhaul

Enable VLAN: disabled

VLAN ID: 1

IP Address: 10 . 3 . 108 . 163

Gateway Address: 10 . 3 . 108 . 254

Netmask: 255 . 255 . 255 . 0

Broadcast: 10 . 3 . 108 . 255

Enable NAT: disabled

Enable VPN: disabled

VPN Port: 1194

VPN Server: ems.tranzeo.com

VPN Credentials
Your vendor may provide you with a package of VPN Credential files If you need to install a credential package, you can load it onto the node here. Please refer to the help for more details.
VPN Credentials:

Wired Interface Role

The wired Ethernet interface can either be used for backhaul purposes or to provide client access.

Node scheme	Wired interface
Repeater	Client access
Gateway	Backhaul

VLAN

Segregate client traffic into Virtual LANs. Your internet router must have VLAN support enabled. You will probably need to enable VLAN on all node Wireless Interfaces as well depending on your network design.

The backhaul VLAN ID will be used for all traffic that does not already have a VLAN ID associated with it. Valid VLAN IDs are 0-4095, but 0, 1, and 4095 are reserved by convention. 1 is the 'Default Port VID' which is often appropriate for the wired backhaul.

IP Address / Gateway / Netmask / Broadcast

Figure 41. Wired interface parameters with EnRoute500 using wired interface for backhaul

11.2.1 DHCP

When configured as a gateway, the EnRoute500 can be set to obtain an obtain an IP address for its Ethernet interface using DHCP. To enable the DHCP client mode on the Ethernet interface, set the Ethernet DHCP mode to ‘client’. When configured as a DHCP client, the EnRoute500 will continually attempt to contact a DHCP server until it is successful.

INFO

> The DHCP reserve parameter (described in section 13.1) has no effect when the DHCP mode parameter is set to ‘client’.

To disable Ethernet DHCP client mode, set the DHCP mode to ‘none’. If DHCP client mode is disabled, the IP configuration must be carried out manually, as described in the next section.

CLI

To set the DHCP mode to ‘client’ on the Ethernet interface, set the value of the ‘dhcp.role’ parameter in the ‘eth0’ interface to ‘client’, as shown in the example below.

```
> use eth0
eth0> set dhcp.role=client
```

To disable Ethernet DHCP client mode, set the DHCP mode parameter to ‘none’ as shown below.

```
> use eth0
eth0> set dhcp.role=none
```

Web GUI

The Ethernet DHCP mode value can be set via the web interface using the “DHCP” sub-tab on the “DHCP” tab on the “System Parameters” page (see Figure 43).

11.2.2 Manual IP Configuration

When an EnRoute500 is configured as a gateway, there are no limitations imposed by the EnRoute500 on the IP address assigned to the Ethernet interface. If the Ethernet DHCP mode is set to ‘none’, the manually configured IP address will be used. The default IP configuration that is assigned to the interface based on the node and mesh ID settings is available through the CLI and the web GUI.

Note that for the manually configured IP address to be used, the Ethernet DHCP mode setting must be set to ‘none’ if the EnRoute500 is connected to a network which provides access to a DHCP server.

The IP configuration settings shown in the ‘eth0’ interface in the CLI and on the “Wired/Backhaul Interface” page of the web interface do not necessarily reflect the current settings of the interface. They are the requested settings and do not take into account whether the interface has been configured via DHCP. If the Ethernet DHCP mode is set to ‘client’, the ‘ip.address’, ip.broadcast’, ‘ip.gateway’, and ‘ip.netmask’ parameters will respond to a ‘get’ command with ‘<dhcp>’ to indicate that the parameters will be assigned by a DHCP server instead of any values assigned via the CLI. Use the ‘ifconfig eth0’ command in the CLI or access the “Status” page in the web interface to get current interface settings.

CLI

The Ethernet default IP configuration is available through the following read-only parameters:

- ip.address – IP address
- ip.broadcast – IP broadcast address
- ip.gateway – default gateway
- ip.netmask – netmask

These parameters cannot be set though. These default parameters can be overridden with the parameters listed below.

- ip.address_force
- ip.broadcast_force
- ip.gateway_force
- ip.netmask_force

The example below, shows how a custom IP address can be set for the Ethernet interface

```
> use eth0
eth0> set dhcp=none
eth0> set ip.address_force=192.168.1.2
eth0> set ip.broadcast_force=192.168.1.255
eth0> set ip.gateway_force=192.168.1.1
eth0> set ip.netmask_force=255.255.255.0
```

Web GUI

When an EnRoute500 is in gateway mode, the Ethernet IP address, gateway, netmask, and broadcast address parameters can be set via the web interface using the “Wired/Backhaul Interface” page (see Figure 41). The current IP values can be viewed on the “Status” page.

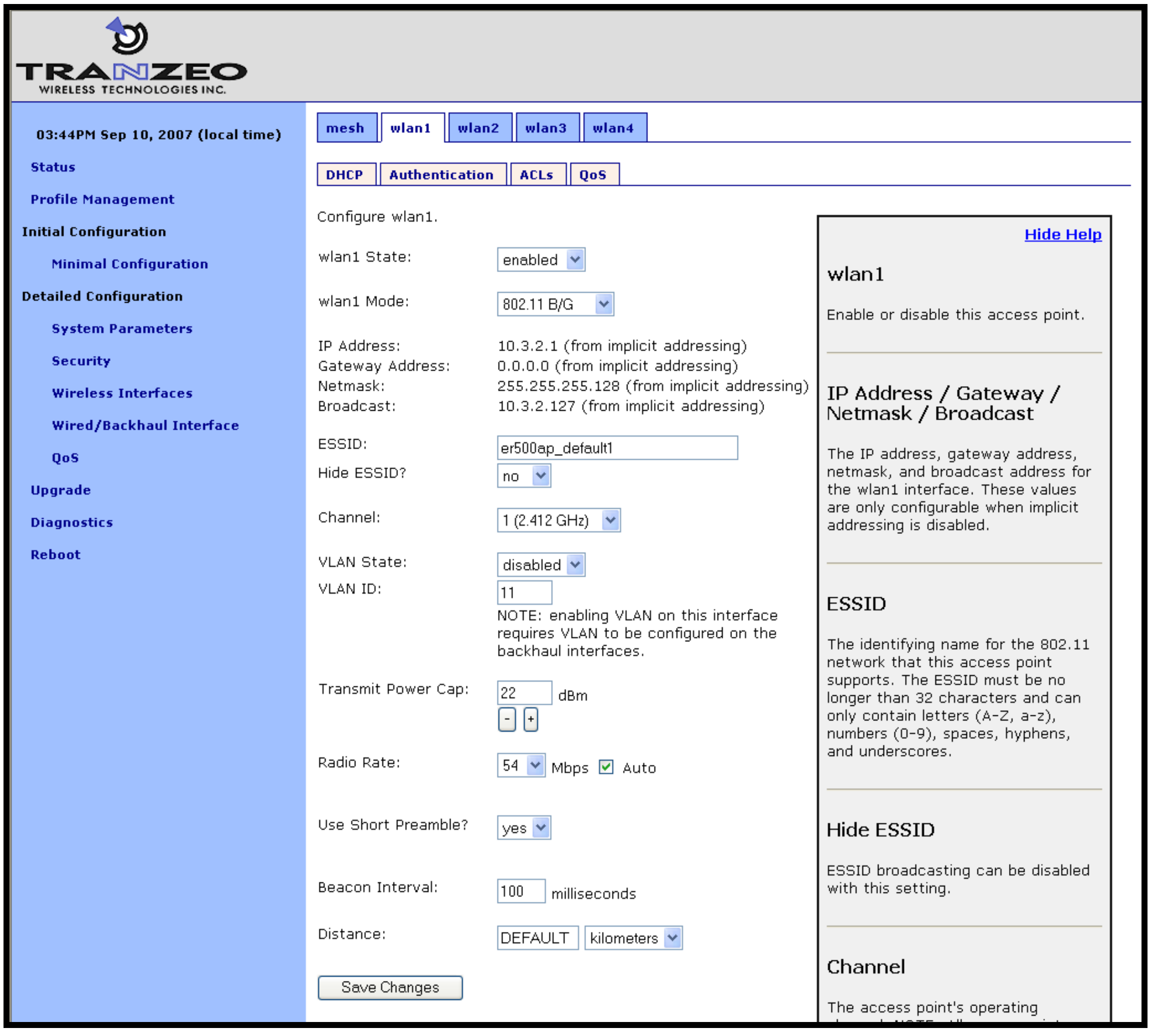
12 Virtual Access Point (VAP) Configuration

The EnRoute500 has an 802.11b/g radio dedicated to access point traffic. The settings for this radio are independent of any settings for the radio used for the mesh backhaul traffic. The settings for the four virtual access points supported by this radio can vary from device to device in the mesh, but typically it is desirable to set certain parameters to the same value for all the access points in a mesh to allow clients to roam seamlessly within the mesh network.

The EnRoute500's four virtual access points (VAPs) can be configured to suit different application needs. These VAPs share a common radio, but, with a few exceptions noted in this chapter, can be configured independently. The availability of the four VAPs provides more flexibility in configuration and catering to different user classes than a single AP does.

INFO

The interfaces for the VAPs will be referred to as 'wlan*N*' when it applies to any of the four VAPs. 'wlan1' will be used in all examples.



Configure wlan1.

wlan1 State: enabled

wlan1 Mode: 802.11 B/G

IP Address: 10.3.2.1 (from implicit addressing)
Gateway Address: 0.0.0.0 (from implicit addressing)
Netmask: 255.255.255.128 (from implicit addressing)
Broadcast: 10.3.2.127 (from implicit addressing)

ESSID: er500ap_default1
Hide ESSID? no

Channel: 1 (2.412 GHz)

VLAN State: disabled
VLAN ID: 11
NOTE: enabling VLAN on this interface requires VLAN to be configured on the backhaul interfaces.

Transmit Power Cap: 22 dBm [-] [+]

Radio Rate: 54 Mbps ☑ Auto

Use Short Preamble? yes

Beacon Interval: 100 milliseconds

Distance: DEFAULT kilometers

wlan1

Enable or disable this access point.

IP Address / Gateway / Netmask / Broadcast

The IP address, gateway address, netmask, and broadcast address for the wlan1 interface. These values are only configurable when implicit addressing is disabled.

ESSID

The identifying name for the 802.11 network that this access point supports. The ESSID must be no longer than 32 characters and can only contain letters (A-Z, a-z), numbers (0-9), spaces, hyphens, and underscores.

Hide ESSID

ESSID broadcasting can be disabled with this setting.

Channel

The access point's operating

Figure 42. Access point interfaces

12.1 Access Point Interfaces

There are four interfaces that are used to configure the VAPs: wlan1, wlan2, wlan3, and wlan4. The VAPs have equivalent configuration capabilities and there is no inherent prioritization or preference for one VAP. The section on quality-of-service settings (section 16) describes how prioritization on a per-VAP basis can be configured.

12.2 Enabling and Disabling Access Points

Access points can be individually enabled or disabled. A VAP can be configured when it is disabled and parameter settings are retained when it is disabled.

CLI

A VAP can be enabled with the ‘enable’ parameter in the ‘wlan*N*’ interface as shown below.

```
> use wlan1
wlan1> set enable=yes
```

A VAP can be disabled with the following commands.

```
> use wlan1
wlan1> set enable=no
```

Web GUI

Each VAP can be enabled or disabled by setting the “State” parameter via the web interface using the appropriate “wlan*N*” tab on the “Wireless Interfaces” page (see Figure 42).

12.3 Virtual Access Point Client Types

The VAPs can be set to support both 802.11b and 802.11g clients, or just 802.11b clients.

CLI

A VAP’s client type mode can be set with the ‘iwpriv.mode’ parameter in the ‘wlan*N*’ interface as shown below. See Table 10 for the mapping between valid values for this parameter and operating modes.

```
> use wlan1
wlan1> set iwpriv.mode=2
```

Mode value	Mode
2	802.11b
3	802.11b/g

Table 10. VAP mode value/mode mapping

Web GUI

The VAP's client type mode can be set via the web interface using the appropriate "wlan*N*" tab on the "Wireless Interfaces" page (see Figure 42). Two client type options are available: "802.11b only" and "802.11b/g".

12.4 Access Point Client Device Address Space

Each VAP interface is either assigned a segment of the EnRoute500's class C client address space, if the device is using the implicit addressing scheme, or an arbitrary address space can be set for the interface when using the explicit addressing scheme. See section 9 for more information on client addressing schemes.

The EnRoute500 VAPs' interface IP configurations can be changed directly when it is using the explicit addressing scheme. They cannot be changed directly when the device is using the implicit addressing scheme.

When an EnRoute500 is configured to use the implicit addressing scheme, set the IP address to the desired value by modifying the node ID, mesh ID, and LAN prefix parameters (see sections 8.3 and 9.1.1). Set the netmask by changing the client address space segments as described in 9.1.2.

When using the explicit addressing scheme, the IP configuration can be set directly. Care must be taken to avoid using the same or overlapping address spaces on different devices in a common mesh.

CLI

You can view the IP settings for the VAP interfaces with the 'ip.*' parameters in the appropriate 'wlan*N*' interface as shown in the example below.

```
> use wlan1
wlan1> get ip.*
 ip.address = 10.2.4.1   [read-only]
 ip.address_force =
 ip.broadcast = 10.2.4.127   [read-only]
 ip.broadcast_force =
 ip.gateway =    [read-only]
 ip.gateway_force =
 ip.netmask = 255.255.255.0   [read-only]
 ip.netmask_force =
 ip.implicit.size.actual =    [read-only]
 ip.implicit.size.requested = 31
 ip.implicit.start.actual =    [read-only]
 ip.implicit.start.requested = 1
```

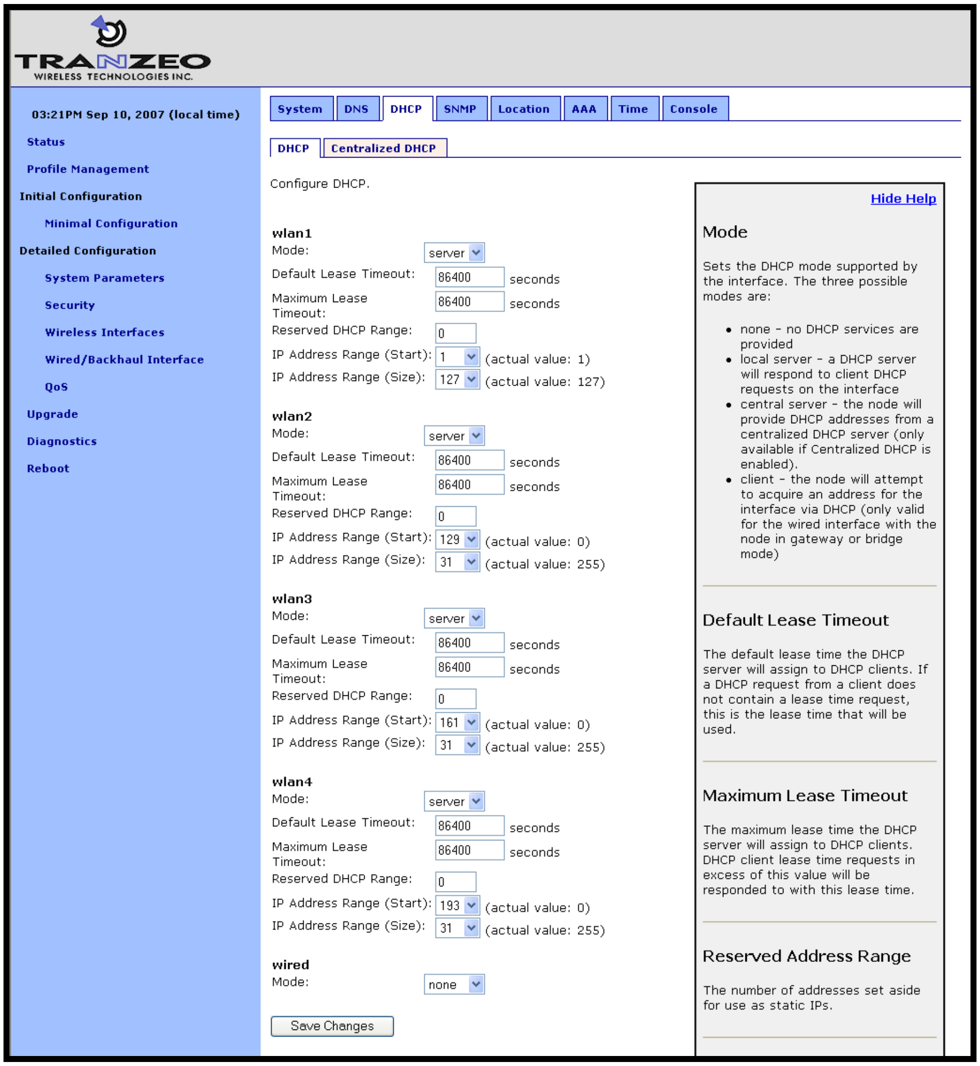
When an EnRoute500 is using the implicit addressing scheme, the VAP IP settings can be changed by altering the ‘id.node’, ‘id.mesh’, and ‘id.lanprefix’ parameters in the ‘sys’ interface and the ‘ip.implicit.start.requested’ parameter in the appropriate ‘wlan*N*’ interface.

When an EnRoute500 is using the explicit addressing scheme, the IP address, netmask, gateway address, and broadcast address can be set using the ‘ip.address_force’, ‘ip.netmask_force’, ‘ip.gateway_force’, and ‘ip.broadcast_force’ parameters in the appropriate ‘wlan*N*’ interface as shown in the example below.

```
> use wlan1
wlan1> set ip.address_force=10.12.8.1
wlan1> set ip.broadcast_force=10.12.8.255
wlan1> set ip.gateway_force=
wlan1> set ip.netmask_force=255.255.255.0
```

Web GUI

The current VAP IP settings can be viewed through the web interface on the “Config Overview” tab on the “Status” page. When using the implicit addressing scheme, the VAP IP settings can be changed by altering the node ID, mesh ID, and LAN prefix settings on the “System” parameters tab on the “System Parameters” page. When using the explicit addressing scheme, the IP parameters can be set on the appropriate tab on the “Wireless Interface” page.



Configure DHCP.

wlan1
Mode: server
Default Lease Timeout: 86400 seconds
Maximum Lease Timeout: 86400 seconds
Reserved DHCP Range: 0
IP Address Range (Start): 1 (actual value: 1)
IP Address Range (Size): 127 (actual value: 127)

wlan2
Mode: server
Default Lease Timeout: 86400 seconds
Maximum Lease Timeout: 86400 seconds
Reserved DHCP Range: 0
IP Address Range (Start): 129 (actual value: 0)
IP Address Range (Size): 31 (actual value: 255)

wlan3
Mode: server
Default Lease Timeout: 86400 seconds
Maximum Lease Timeout: 86400 seconds
Reserved DHCP Range: 0
IP Address Range (Start): 161 (actual value: 0)
IP Address Range (Size): 31 (actual value: 255)

wlan4
Mode: server
Default Lease Timeout: 86400 seconds
Maximum Lease Timeout: 86400 seconds
Reserved DHCP Range: 0
IP Address Range (Start): 193 (actual value: 0)
IP Address Range (Size): 31 (actual value: 255)

wired
Mode: none

Mode

Sets the DHCP mode supported by the interface. The three possible modes are:

- none - no DHCP services are provided
- local server - a DHCP server will respond to client DHCP requests on the interface
- central server - the node will provide DHCP addresses from a centralized DHCP server (only available if Centralized DHCP is enabled).
- client - the node will attempt to acquire an address for the interface via DHCP (only valid for the wired interface with the node in gateway or bridge mode)

Default Lease Timeout

The default lease time the DHCP server will assign to DHCP clients. If a DHCP request from a client does not contain a lease time request, this is the lease time that will be used.

Maximum Lease Timeout

The maximum lease time the DHCP server will assign to DHCP clients. DHCP client lease time requests in excess of this value will be responded to with this lease time.

Reserved Address Range

The number of addresses set aside for use as static IPs.

Figure 43. Access point and wired DHCP and address space settings

12.5 Channel

The 802.11b/g radio can be set to operate in the channels listed in Table 11.

Channel	Center Frequency (GHz)
1	2.412
2	2.417
3	2.422
4	2.427
5	2.432
6	2.437
7	2.442
8	2.447
9	2.452
10	2.457
11	2.462

Table 11. Access point channels and associated center frequencies

Note that only channels 1, 6, and 11 are non-overlapping.

It is not possible to configure VAPs to use different channels. If the channel for wlan2 is changed, the channel will be changed for wlan1, wlan3, and wlan4. However, different devices in a mesh neighborhood can be set to use different VAP channels in order to reduce co-channel interference.

CLI

The AP channel is set with the ‘channel’ parameter in the ‘wlan*N*’ interfaces. The example below shows how to set the AP channel to 6.

```
> use wlan1
wlan1> set channel=6
```

Web GUI

The VAP channel can be set via the web interface using the appropriate “wlan*N*” tab on the “Wireless Interfaces” page (see Figure 42).

12.6 ESSID

The ESSID, or Extended Service Set Identifier, is used in 802.11 infrastructure networks to identify a particular network consisting of one or more Basic Service Sets. It is used to differentiate logical networks that operate on the same channel.

INFO

Each VAP can be configured with a different ESSID. This allows network traffic to be separated based on ESSID. Assigning unique ESSIDs to the VAPs in a mesh has the benefit of allowing a user to configure a client device to connect to a specific device in the mesh. Typically a mesh will be deployed with the VAP ESSIDs having the same set of values for each EnRoute500 in order to support seamless roaming.

The ESSID value must be a text string that has a maximum length of 32 characters. It must only contain alphanumeric characters, spaces, dashes ("-"), and underscores ("_").The ESSID setting is case sensitive.

It is possible to hide an AP ESSID by restricting it from broadcasting advertisements for that ESSID. Whether it is appropriate for an AP ESSID to be hidden depends on the application.

CLI

The VAP ESSID is set as shown in the example below. When setting an ESSID that contains spaces, the ESSID value must be enclosed by quotes – the quotes are optional otherwise.

```
> use wlan1
wlan1> set essid=”wlan1_ap”
```

The broadcast of the ESSID can be controlled with the 'hide_essid' parameter in the 'wlan*N*' interface. The example below shows how hiding of the ESSID can be enabled.

```
> use wlan1
wlan1> set hide_essid=yes
```

Web GUI

The VAP ESSIDs and their broadcast state can be set via the web interface using the appropriate "wlan*N*" tab on the "Wireless Interfaces" page (see Figure 42).

12.7 IP Configuration of Client Devices

The VAP interfaces allow client devices to connect to access the mesh network. The client devices can either be assigned their IP configuration in one of three ways:

- Via DHCP from a centralized server
- Via DHCP from a local server on the mesh device that the client device is connected to
- Be manually configured

12.7.1 IP Configuration of Clients Devices via DHCP

The EnRoute500 can be set to serve IP addresses to clients on the VAP interfaces using DHCP. DHCP-provided addresses can be served either from a local server on the EnRoute500 or from an external server. The two DHCP modes are described in detail in section 13.

12.7.2 Manual IP Configuration of Client Devices

Client devices that use static IP addresses must have an IP address that is within the subnet of the VAP interface that they connect to.

If the local DHCP server is enabled for a VAP interface, IP addresses must be reserved for statically configured devices by setting the DHCP reserve parameter. This will reserve the specified number of IP addresses at the bottom of the IP range for the interface. For example, if the interface has the IP address 10.2.4.1, the netmask 255.255.255.128, and the DHCP reserve value 5, the IP addresses 10.2.4.2 through 10.2.4.6 will be available for use by statically configured devices. The remaining IP addresses in the interface's address space can be assigned by the DHCP server to other client devices.

CLI

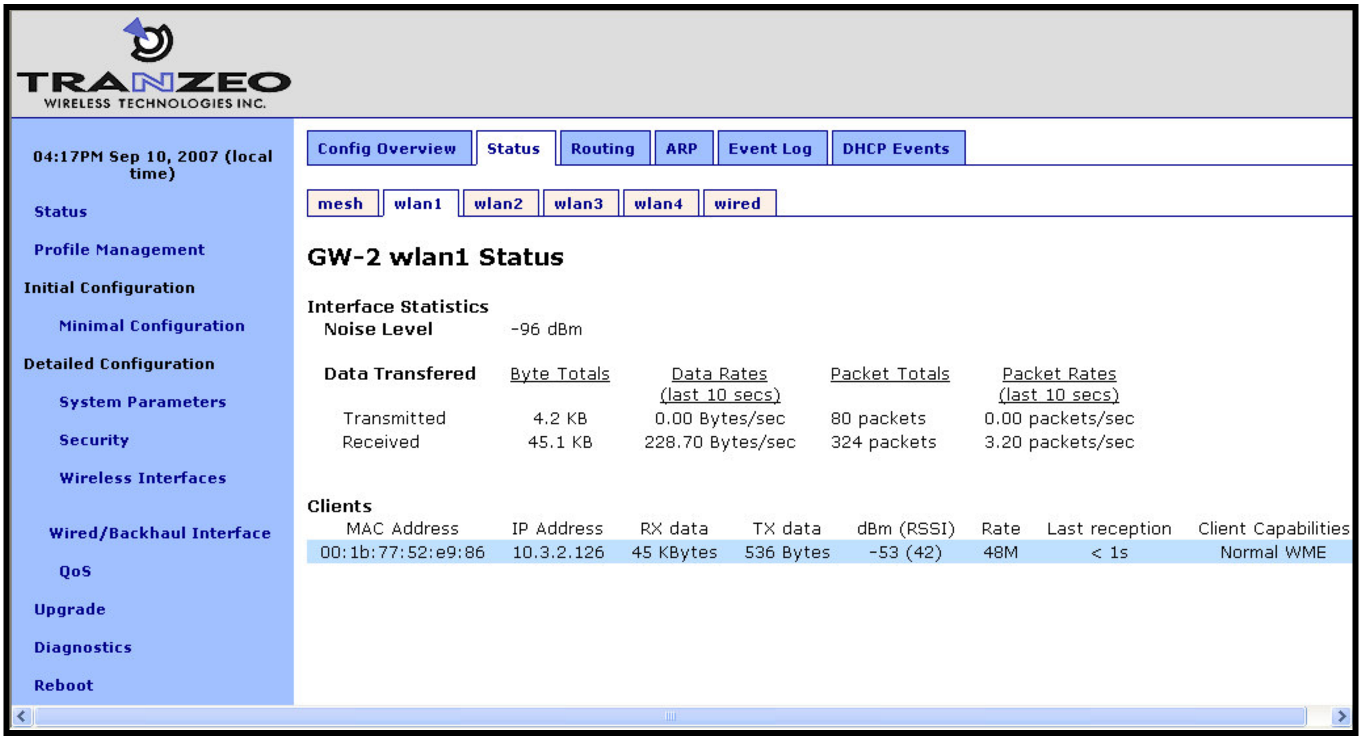
The number of IP addresses reserved for statically-configured devices connected to the Ethernet interface is set with the 'dhcp.reserve' parameter in the 'eth0' interface.

Web GUI

The 'dhcp.reserve' value can be set via the web interface using the "DHCP" sub-tab on the "DHCP" tab on the "System Parameters" page (see Figure 43).

12.8 Client Devices

Each VAP has a status page that displays information about attached client devices and total throughput through the VAP. The signal strength of each client device, its MAC address, its IP address, and the time since data was last received from it are listed. The status pages can be accessed under the 'Status' tab on the 'Status' page, as shown in Figure 44.



04:17PM Sep 10, 2007 (local time)

GW-2 wlan1 Status

Interface Statistics

Noise Level -96 dBm

Data Transfered	Byte Totals	Data Rates (last 10 secs)	Packet Totals	Packet Rates (last 10 secs)
Transmitted	4.2 KB	0.00 Bytes/sec	80 packets	0.00 packets/sec
Received	45.1 KB	228.70 Bytes/sec	324 packets	3.20 packets/sec

Clients

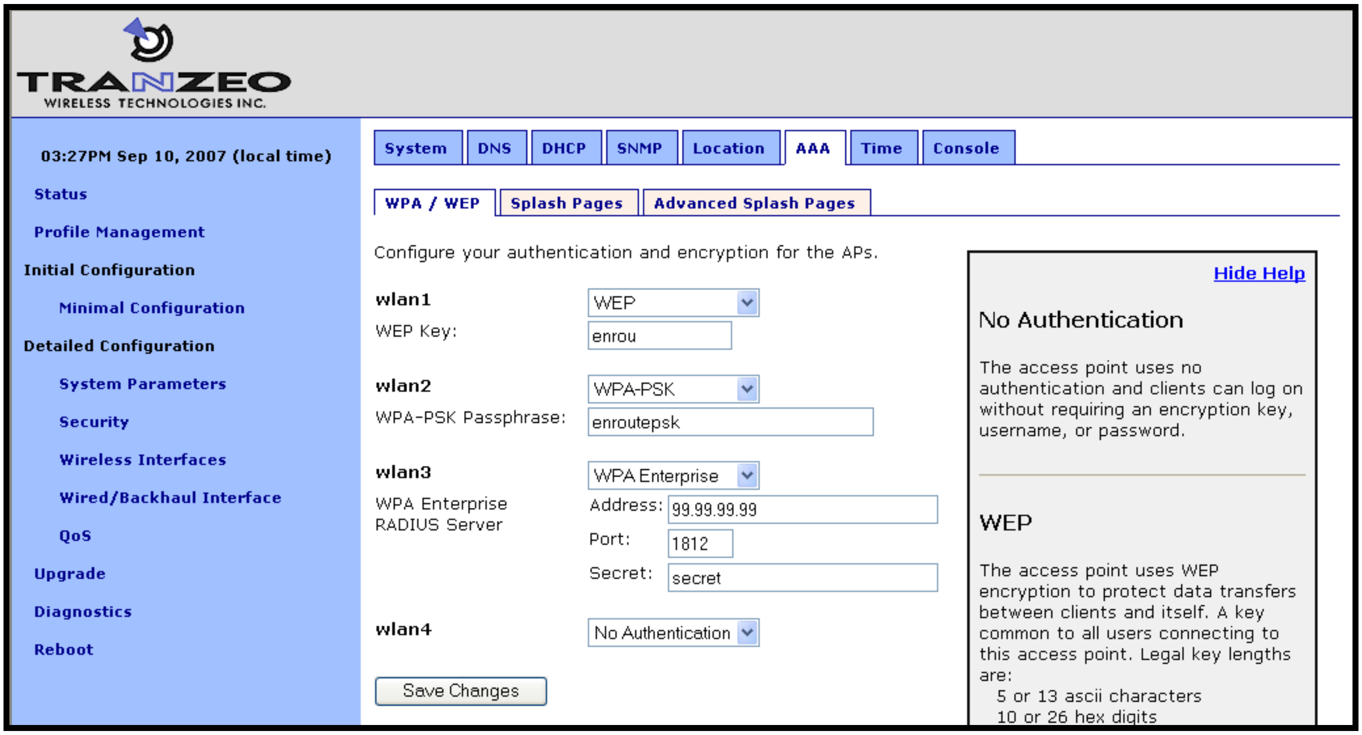
MAC Address	IP Address	RX data	TX data	dBm (RSSI)	Rate	Last reception	Client Capabilities
00:1b:77:52:e9:86	10.3.2.126	45 KBytes	536 Bytes	-53 (42)	48M	< 1s	Normal WME

Figure 44. Virtual access point client status information

12.9 Encryption and Authentication

The EnRoute500 supports several common encryption/authentication schemes, including WEP, WPA, and WPA2, to provide secure wireless access for client devices. WEP keys with 40-bit or 104-bit lengths, pre-shared WPA keys, and multiple WPA-EAP modes.

The WEP and WPA configuration settings for each VAP are independent. An VAP can only support one of the encryption/authentication modes at a time, but the APs in the EnRoute500 do not all have to use the same encryption/authentication scheme.



Configure your authentication and encryption for the APs.

wlan1: WEP
WEP Key: enrou

wlan2: WPA-PSK
WPA-PSK Passphrase: enroutepsk

wlan3: WPA Enterprise
WPA Enterprise RADIUS Server
Address: 99.99.99.99
Port: 1812
Secret: secret

wlan4: No Authentication

No Authentication

The access point uses no authentication and clients can log on without requiring an encryption key, username, or password.

WEP

The access point uses WEP encryption to protect data transfers between clients and itself. A key common to all users connecting to this access point. Legal key lengths are:
5 or 13 ascii characters
10 or 26 hex digits

Figure 45. Access point authentication and encryption settings

12.9.1 WEP Encryption

The VAPs can be protected with a WEP-based encryption key to prevent unauthorized users from intercepting or spoofing traffic.

CLI

To enable WEP-based encryption, set the ‘key’ parameter in the ‘wlan*N*’ interface. The length of the encryption key is determined by the format used to specify the ‘key’ value. Valid key formats and the corresponding encryption type and key length are listed in Table 12.

If WPA is enabled for an interface (‘wpa.enable’ CLI parameter in the ‘wlan*N*’ interfaces), the WPA settings will be used for encryption and authentication and the ‘key’ value used to enable WEP will be ignored.

Key format	Encryption format	Encryption key length
s:<5 ASCII characters> <10 hex values>	WEP	40 bits
s:<13 ASCII characters> <26 hex values>	WEP	104 bits
<blank>	None	N/A

Table 12. WEP encryption key formats

For example, 104-bit WEP encryption can be enabled using an ASCII key with

```
> use wlan1
wlan1> set key=”s:abcdefghijklm”
```

or using a hexadecimal key with

```
> use wlan1
wlan1> set key=”0123456789abcdef0123456789”
```

WEP encryption can be disabled by specifying a blank value as shown below.

```
> use wlan1
wlan1> set key=
```

Web GUI

WEP encryption can be enabled and the key can be set via the web interface using the “WPA/WEP” sub-tab under the “AAA” tab on the “System Parameters” page (see Figure 45). Select “WEP” as the type of encryption from the drop-down menu for the VAP you wish to configure and set the WEP key in the text box below the drop-down menu. In the example in Figure 45, ‘wlan1’ has been configured to use WEP.

12.9.2 WPA Pre-Shared Key Mode (WPA-PSK)

In WPA pre-shared key (PSK) mode, a common passphrase is used for client devices connecting to an EnRoute500 AP. To set the WPA-PSK mode, enable WPA for the interface and set the pre-shared key value as shown below. The passphrase must be between 8 and 63 characters in length.

INFO

> The minimum number of characters required for the WPA passphrase is 8. However, it is recommended that a longer passphrase, with at least 15 characters, is used. This will increase the strength of the encryption used for the wireless link.

CLI

The example below shows how to enable WPA-PSK mode for wlan1. The ‘wpa.key_mgmt’ parameter must also be set to indicate that PSK mode is being used, as shown below.

```
> use wlan1
wlan1> set wpa.enable=yes
wlan1> set wpa.key_mgmt=”WPA-PSK”
wlan1> set wpa.passphrase=long_passphrases_improve_encryption_effectiveness
```

Web GUI

WPA-PSK can be enabled and the pre-shared key can be set via the web interface using the “WPA/WEP” sub-tab under the “AAA” tab on the “System Parameters” page (see Figure 45). Select “WPA-PSK” as the type of encryption/authentication from the drop-down menu for the VAP you wish to configure and enter the WPA-PSK key in the text box below the drop-down menu. In the example in Figure 45, ‘wlan2’ has been configured to use WPA-PSK.

12.9.3 WPA EAP Mode

In WPA-EAP mode, a client device is authenticated using an 802.1x authentication server, which is typically a RADIUS server.

The supported EAP modes are:

• TLS	(X509v3 server & client certificates)
• PEAP-TLS	(X509v3 server & client certificates)
• TTLS	(X509v3 server certificate)
• PEAP-MSCHAPv2	(X509v3 server certificate)

The following information must be provided about the RADIUS server:

- address – the IP address of the 802.1x server that will be used for authentication
- port – the port that the authentication server is listening on (UDP port 1812 by default)
- secret – the shared secret for the authentication server. The secret must be a string that is no longer than 32 characters in length.

See section 19.5 for instructions on how to test the RADIUS configuration and a specific set of credentials.

CLI

To configure the EnRoute500 to support 802.1x authentication, the following parameters in a ‘wlan*N*’ interface must be set:

- wpa.enable
- wpa.key_mgmt
- wpa.auth.server.addr
- wpa.auth.server.port
- wpa.auth.server.shared_secret

The ‘wpa.key_mgmt’ parameter must be set to indicate that both PSK and EAP modes can be supported, as shown in the example below.

The example below shows how to enable WPA EAP mode.

```
> use wlan1
wlan1> set wpa.enable=yes
wlan1> set wpa.key_mgmt=”WPA-PSK WPA-EAP”
wlan1> set wpa.auth.server.addr=1.2.3.4
wlan1> set wpa.auth.server.port=1812
wlan1> set wpa.auth.shared_secret=enroute500_radius_secret
```

Web GUI

WPA-EAP can be enabled and the authentication server parameters can be set via the web interface using the “WPA/WEP” sub-tab under the “AAA” tab on the “System Parameters” page (see Figure 45). Select “WPA-EAP” as the type of encryption/authentication from the drop-down menu for the VAP you wish to configure and set the authentication server IP address, port, and secret in the text boxes below the drop-down menu. In the example in Figure 45, ‘wlan3’ has been configured to use WPA-EAP.

12.10 Transmit Power Cap

The transmit power cap of the AP radio is configurable. Increased output power will improve communication range, but will also extend the interference range of the radios. The default power level is 22 dBm.

⚠ **If the transmit power is set to a value in excess of what can be supported by the AP radio, the actual radio output power will be the highest power supported by the AP radio.**

INFO When setting the output power for a VAP, consider the output power of the client devices that will be communicating the VAP. If these devices have output power levels that are far lower than that of the VAP, an asymmetric link may result. Such a link exists when the received signal strength at client device is sufficient for a downlink to the client device to be established, but the received signal level at the VAP is not sufficient for an uplink from the client device to be established.

CLI

The example below shows how to set the VAP radio's maximum transmit power using the CLI. The Tx power is specified in dBm, with a granularity of 0.5 dBm.

```
> use wlan1
wlan1> set txpower=20
```

Web GUI

The VAPs' maximum transmit power can be set via the web interface using the appropriate "wlan*N*" tab on the "Wireless Interfaces" page (see Figure 42). The "+" and "-" buttons can be used to increase or decrease the power setting in 0.5 dBm steps.

12.11 Radio Rate

The APs can be set to communicate at a specific rate or to automatically select the best rate available. For most applications, choosing automatic rate selection will be the best choice.

CLI

It is not currently possible to set this through the CLI. Please use the web GUI to set this parameter.

Web GUI

The VAPs' communication rate can be set via the web interface using the appropriate "wlan*N*" tab on the "Wireless Interfaces" page (see Figure 42). To limit communication to a specific rate, use the drop-down menu to select the appropriate rate and verify that the "Auto" checkbox is not selected. To set the device to automatically select the most appropriate rate, click on the "Auto" checkbox to select it.

12.12 Preamble Length

The APs can be configured to use short preambles when there are no client devices present that only support long preambles. Alternatively, the device can be forced to always use long preambles. Using short preambles reduces communication overhead, but may not be supported by older 802.11 client devices.

⚠ **The preamble length setting is uniform across all VAPs. Changing it for one will automatically change it for all others as well.**

CLI

The example below shows how to set the preamble type used by a VAP using the CLI. The preamble type is set with the 'iwpriv.short_preamble' parameter in the 'wlan*N*' interfaces. To enable short preambles, set this parameter to '1'. To force use of long preambles, set this parameter to '0'.

```
> use wlan1
wlan1> set iwpriv.short_preamble=1
```

Web GUI

The preamble types supported by the VAPs can be set via the web interface using the appropriate "wlan*N*" tab on the "Wireless Interfaces" page (see Figure 42). To allow support for short preambles, set the "Use Short Preamble" drop-down menu to "Yes". To limit preambles to long ones, set the drop-down menu to "No".

12.13 Beacon Interval

The APs' beacon intervals are configurable. The beacon interval must fall in the range from 20 to 500 ms. The beacon interval is set to 100 ms by default.

CLI

The example below shows how to set the beacon interval for a VAP using the CLI. The beacon interval is set with the 'iwpriv.beacon_interval' parameter in the 'wlan*N*' interfaces and is specified in milliseconds.

```
> use wlan1
wlan1> set iwpriv.beacon_interval=100
```

Web GUI

The beacon interval for an AP can be set via the web interface using the appropriate "wlan*N*" tab on the "Wireless Interfaces" page (see Figure 42). Enter a value specified in milliseconds in the "Beacon Interval" field.

12.14 Maximum Link Distance

The 802.11 standard defines delay values in the communication between devices that affect the maximum communication distance that can be supported. By default, the communication distance is limited to approximately 4 km (2.5 mi). The maximum communication distance can be increased by setting a custom maximum link distance value. This value can be specified in either metric or imperial units.

The maximum link distance setting is uniform across all VAPs. Changing it for one will automatically change it for all others as well.

CLI

The example below shows how to set the maximum link distance supported by a VAP using the CLI. The maximum link distance is set with the ‘distance’ parameter in the ‘wlan*N*’ interfaces and is specified in either kilometers or miles. The ‘units’ parameter in the ‘sys’ interface determines whether the distance units are entered in kilometers or miles. Set ‘units’ to “metric” for kilometers, and to “imperial” for miles.

Set the ‘distance’ parameter to “DEFAULT” or leave it blank to use the default maximum link range.

```
> use sys
sys> set units=”metric”
> use wlan1
wlan1> set distance=10
```

Web GUI

The maximum link distance supported by an AP can be set via the web interface using the appropriate “wlan*N*” tab on the “Wireless Interfaces” page (see Figure 42). Enter a value and specify whether it is in kilometers of miles using the adjacent drop-down menu.

Set the ‘distance’ parameter to “DEFAULT” or leave it blank to use the default maximum link range.

13 Client IP Configuration via DHCP

Two configuration options exist for assigning IP addresses to client devices using DHCP:

- Each EnRoute500 hosts a local DHCP server and supplies IP addresses to devices attaching to any of the client access interfaces
- A centralized DHCP server supplies IP addresses to client devices, with the EnRoute500s relaying DHCP messages between client devices and the centralized server.

The DHCP modes for client access interfaces in a mesh neighborhood can be set individually to use a local server, a centralized server, or be disabled. This allows a mesh to contain devices with client access interfaces supporting a combination of centralized and localized DHCP.

13.1 Using the Local DHCP Server

The EnRoute500 can be set to serve IP addresses to client devices on enabled VAP interfaces and the Ethernet interface on repeater devices using DHCP.

The IP addresses provided by the local DHCP server will be in the subnet defined by the LAN prefix, mesh ID, node ID, and the IP address range start address and size parameters in the appropriate client access interface. For example, for the ‘wlan1’ interface, the start and end of the address range are:

Start address = <LAN prefix>.
<Mesh ID>.
<Node ID>.
<wlan1 IP address range start address> + 1
End address = <LAN prefix>.
<Mesh ID>.
<Node ID>.
< wlan1 IP address range start address > -
< wlan1 IP address range size > - 2

The EnRoute500 can be configured to set aside a number of IP addresses for client devices that will use a static IP address. These IP addresses are taken from the pool that DHCP assigns IP addresses from. Thus, increasing the number of IP addresses set aside for devices with static IP addresses will reduce the size of the DHCP address pool. The DHCP reserve parameter controls the number of IP addresses that will be reserved for static use. By default, this parameter is set to zero, assigning the maximum possible number of IP addresses to the DHCP pool. You may reserve the entire range of IP addresses, but the EnRoute500 will use at least the highest address in the range for DHCP.

If the ‘dhcp.reserve’ value is non-zero, the DHCP range start address will be affected as shown below

Start address = <LAN prefix>.
<Mesh ID>.
<Node ID>.
<wlan1 IP address range start address> + 1 - < wlan1 DHCP reserve>

CLI

The DHCP mode parameters in the ‘wlan*N*’ and ‘eth0’ interfaces control DHCP behavior. When the role is set to ‘server’, the EnRoute500 will respond to DHCP requests received from client devices connected to the interface.

The examples below show how to set the DHCP server state for the ‘wlan1’ interface.

```
> use wlan1
wlan1> set dhcp.role=server
wlan1> set dhcp.relay.enable=no
```

To disable the DHCP server, set the ‘dhcp.role’ parameter to ‘none’

```
> use wlan1
wlan1> set dhcp.role=none
```

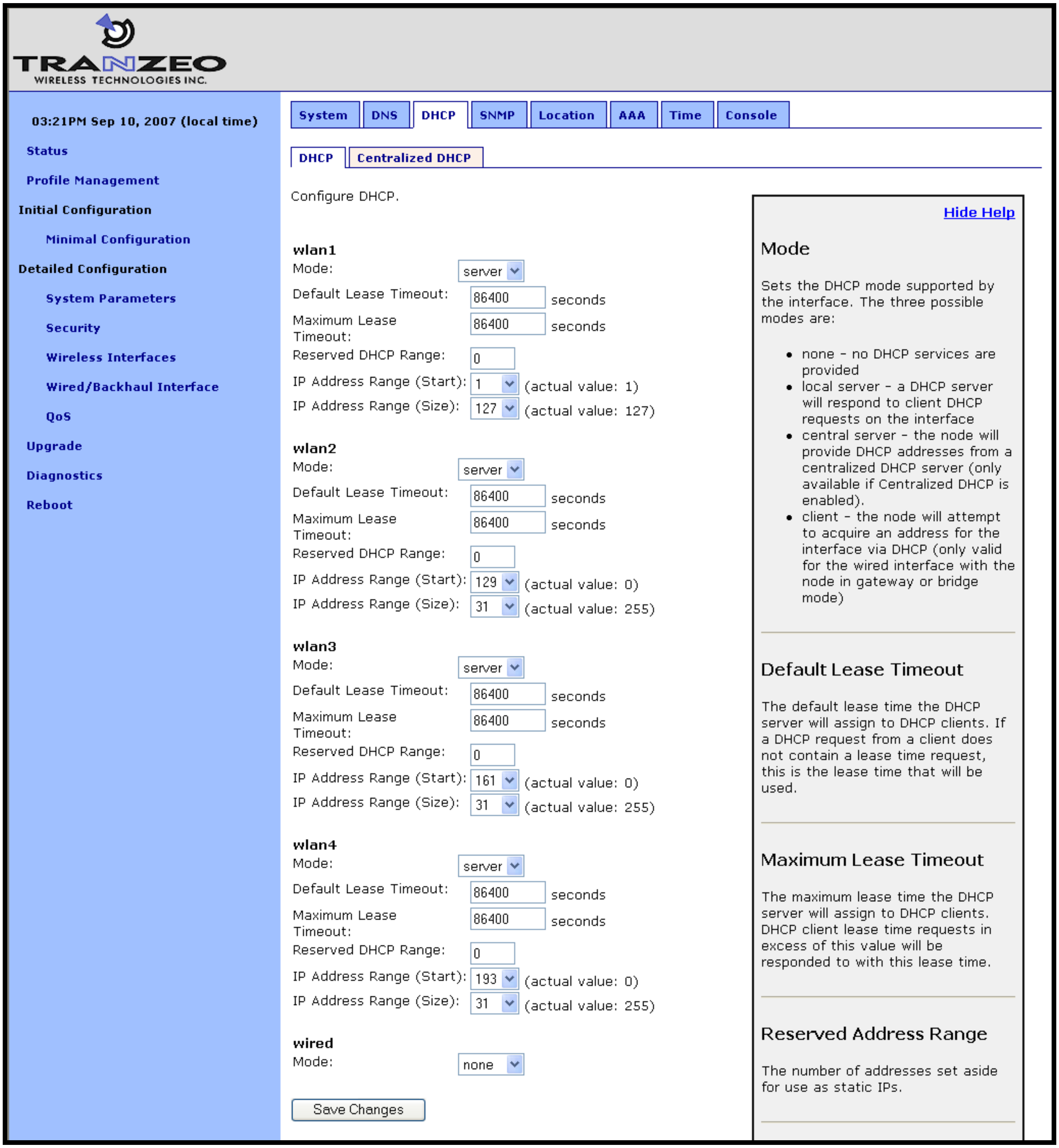
The example below shows how to set the DHCP reserve parameter

```
> use wlan1
wlan1> set dhcp.reserve=5
```

Web GUI

The VAP and wired interface DHCP servers’ state can be set via the web interface using the “DHCP” sub-tab under the “DHCP” tab on the “System Parameters” page (see Figure 46). All of the interfaces’ DHCP settings can be configured on this page. Set the “Mode” field to “Server” to set the DHCP mode for a client access interface to be the local server.

The DHCP reserve setting for all VAPs and the wired interface can be set via the web interface using the “DHCP” sub-tab under the “DHCP” tab on the “System Parameters” page (see Figure 46).



Configure DHCP.

wlan1

Mode: server

Default Lease Timeout: 86400 seconds

Maximum Lease Timeout: 86400 seconds

Reserved DHCP Range: 0

IP Address Range (Start): 1 (actual value: 1)

IP Address Range (Size): 127 (actual value: 127)

wlan2

Mode: server

Default Lease Timeout: 86400 seconds

Maximum Lease Timeout: 86400 seconds

Reserved DHCP Range: 0

IP Address Range (Start): 129 (actual value: 0)

IP Address Range (Size): 31 (actual value: 255)

wlan3

Mode: server

Default Lease Timeout: 86400 seconds

Maximum Lease Timeout: 86400 seconds

Reserved DHCP Range: 0

IP Address Range (Start): 161 (actual value: 0)

IP Address Range (Size): 31 (actual value: 255)

wlan4

Mode: server

Default Lease Timeout: 86400 seconds

Maximum Lease Timeout: 86400 seconds

Reserved DHCP Range: 0

IP Address Range (Start): 193 (actual value: 0)

IP Address Range (Size): 31 (actual value: 255)

wired

Mode: none

Mode

Sets the DHCP mode supported by the interface. The three possible modes are:

- none - no DHCP services are provided
- local server - a DHCP server will respond to client DHCP requests on the interface
- central server - the node will provide DHCP addresses from a centralized DHCP server (only available if Centralized DHCP is enabled).
- client - the node will attempt to acquire an address for the interface via DHCP (only valid for the wired interface with the node in gateway or bridge mode)

Default Lease Timeout

The default lease time the DHCP server will assign to DHCP clients. If a DHCP request from a client does not contain a lease time request, this is the lease time that will be used.

Maximum Lease Timeout

The maximum lease time the DHCP server will assign to DHCP clients. DHCP client lease time requests in excess of this value will be responded to with this lease time.

Reserved Address Range

The number of addresses set aside for use as static IPs.

Figure 46. Virtual access point DHCP configuration

13.2 Using a Centralized DHCP Server

Centralized DHCP server mode uses DHCP relaying to enable assignment of IP addresses to wireless client devices from a common remote DHCP server. The remote DHCP server may reside either on a host connected to the mesh gateway's wired segment, or on a server that is beyond one or more routers. When using a common DHCP server, wireless client devices are assigned IP addresses from a single address pool, and will roam seamlessly from AP to AP, assuming sufficiently overlapping AP coverage. In addition, wired clients can also have their IP addresses assigned by a centralized server.

INFO

DHCP relay as a client IP configuration method is needed to facilitate seamless roaming within a mesh neighborhood. When enabled together with Layer 2 emulation mode, it facilitates delivery of IP traffic regardless of a client's point of attachment to the network. It also puts the mesh network into a mode that makes it behave like a layer 2 distribution and access network expected by most access controllers. In this mode, subsequently called "layer 2 mesh emulation mode", seamless roaming to and from 3rd party bridged access points is also supported.

There are three classes of entities that must be configured when using this DHCP mode:

1. The individual EnRoute500s, including the repeaters and the gateway device
2. The central DHCP server
3. Any intermediate router(s) in the path between the DHCP server and the mesh neighborhood gateway device

When using a centralized DHCP server, a Client Address Space (CAS) from which client device IP addresses are assigned must be defined. The active client access interfaces on the EnRoute500s (there can be up to 5 per EnRoute500) must also have IP addresses that fall within the CAS. This is to facilitate DHCP relay and selection of client device IP addresses from the correct DHCP scope on servers that serve hosts connected to different subnets. The client access interface IP addresses need to be configured statically and must be contiguous. It is recommended that a contiguous range of IP addresses at either the beginning or the end of the CAS be set aside, one for each client access interface on the mesh devices.

⚠ **The Client Address Space (CAS) is not equivalent to the range of addresses served by the DHCP server. The DHCP-served address range is a subset of the CAS. The CAS must also include the addresses for the client access interfaces and the address of the EnRoute1000's Ethernet interface when the device is configured as a gateway.**

Consider the example where a mesh neighborhood consists of 3 EnRoute500s, including the gateway device. The DHCP server resides on a host that also acts as the WAN router and is connected to the mesh gateway's wired segment. We will set aside 15 IP addresses for the mesh devices' client access interfaces (3 devices, up to 5 interfaces per device). Assuming the client address space is 192.168.5.0/24, with available addresses from 192.168.5.1 to 192.168.5.255, we will use 192.168.5.1 for the server hosting the DHCP server, 192.168.5.2 for the mesh gateway's backhaul interface, set aside 192.168.5.3 to 192.168.5.18 for the mesh AP interfaces, and configure the remote DHCP server to serve IP addresses in the range of 192.168.5.19 to 192.168.5.254 to wireless client devices. We will keep 192.168.5.255 as the broadcast address for the mesh neighborhood.

13.2.1 Support for Clients with Static IP Addresses

When using centralized DHCP server mode for a client access interface, client devices connected to that interface can be assigned static addresses within the client address space. However, for these client devices to roam successfully, they must employ duplicate address detection by sending out ARP requests for their own IP address. Windows-based devices typically support this requirement. Please contact the client device manufacturer if you are unsure if your client device meets this requirement.

13.2.2 Configuring the EnRoute500s

When operating in centralized DHCP server mode, each EnRoute500 client access interface that is to serve DHCP addresses from the centralized server must be explicitly configured to use centralized DHCP server mode. The EnRoute500s with client access interfaces in centralized DHCP server mode must also use the same centralized DHCP server. The IP address of the central DHCP server is set with the DHCP relay server parameter. The server must be reachable through the mesh neighborhood gateway's wired backhaul interface.

A gateway router IP address must be entered. This will be supplied to DHCP client devices as their gateway. This IP address can be the same as for the DHCP server, but need not be.

Each client access interface on the EnRoute500 that is to support centralized DHCP server mode must have its DHCP mode set to "server" (CLI) or "centralized server" (web GUI) for it to support relay of IP addresses to client devices from a central DHCP server. This configuration is set with the DHCP mode parameter for each of the client access interfaces (eth0, wlan1-4).

It is possible to disable DHCP address assignments to client devices on a per-interface basis and have them use static IP addresses instead. To disable DHCP for an interface, set the DHCP mode parameter associated with the interface to 'none'.

The address space that is to be used for the wireless clients is a subnet specified with the Client Address Space parameter. The value must be specified in CIDR notation (a subnet and its size separated by a '/'), e.g. '192.168.5.0/24'

The IP addresses of the client access interfaces (eth0, wlan1-4) need to be manually assigned to each of the EnRoute500s in the mesh neighborhood. This is done by setting the Address Base parameter for the interfaces, which is assigned to the first enabled client access interface. Addresses for the remaining client access interfaces are determined by successively incrementing the Base Address by 1. It is recommended that the gateway in a mesh neighborhood be assigned the lowest available value (3 in the example in the CLI section below) and the repeaters in the mesh neighborhood are given successively higher values, with an increment of 5 between them (5 is the maximum number of client access interfaces available on each mesh device, including the Ethernet interface on mesh repeaters).

Layer 2 emulation must also be enabled when operating in centralized DHCP server mode. This setting is located on the “System” tab of the “System” page of the web interface. See section 18.2 for more information on layer 2 emulation mode.

CLI

Centralized DHCP server mode is enabled using the ‘dhcp.relay.enable’ and ‘l2.client_mac_fwd’ parameters in the ‘sys’ interface as shown in the example below.

```
> use sys
sys> set dhcp.relay.enable=yes
sys> set l2.client_mac_fwd=yes
```

In the example below, the central DHCP server and next WAN router reside on the same segment to which the mesh gateway’s wired interface is connected.

```
> use sys
sys> set dhcp.relay.server=192.168.5.2
sys> set dhcp.relay.gateway=192.168.5.1
```

The example below shows how to set the DHCP mode parameters for the wlan1 and wlan2 interfaces.

```
> use wlan1
wlan1> set dhcp=server
wlan1> set wlan1.dhcp.relay.enable=yes
> use wlan2
wlan2> set dhcp=server
wlan1> set wlan2.dhcp.relay.enable=yes
```

To disable distribution of centralized DHCP addresses on an interface, set the interface’s ‘dhcp.role’ parameter to ‘none’ as shown below.

```
> use wlan3
wlan3> set dhcp=none
```

The Client Address Space value is set with the ‘dhcp.relay.dhcp_subnet’ parameter in the ‘sys’ interface. This value should be a class A, B, or, C subnet specified using CIDR notation as shown in the example below.

```
> use sys
sys> set dhcp.relay.dhcp_subnet=192.168.5.0/24
```

The Base Value, which sets the IP address of client access interfaces on an EnRoute500, is set through the 'dhcp.relay.base' parameter in the 'sys' interface. The example below shows the configuration for a mesh neighborhood consisting of 3 devices.

On the gateway:

```
> use sys
sys> set dhcp.relay.base=192.168.5.3
```

on the first repeater device:

```
> use sys
sys> set dhcp.relay.base=192.168.5.8
```

and on the second repeater device:

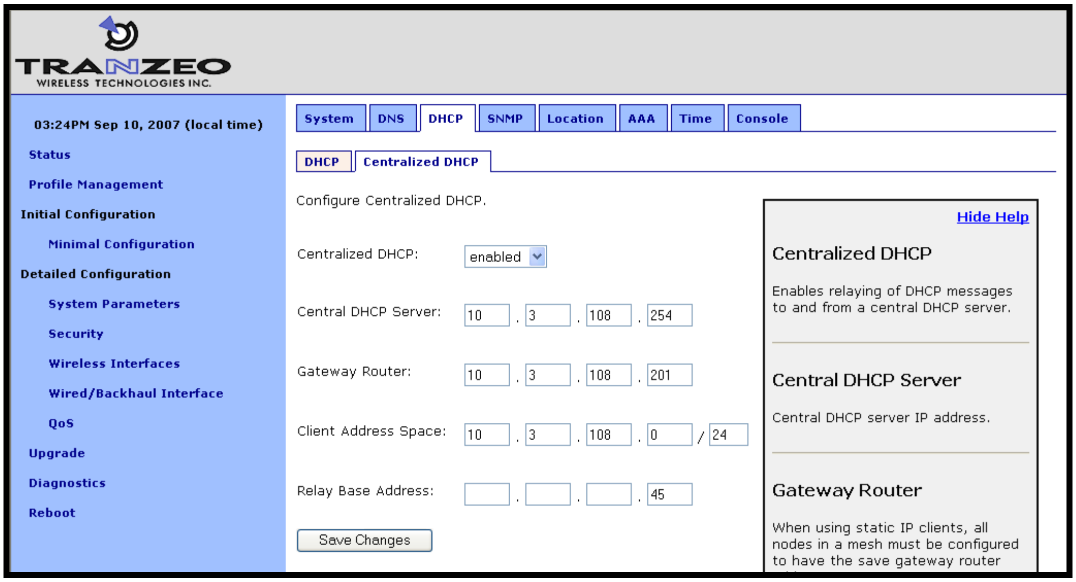
```
> use sys
sys> set dhcp.relay.base=192.168.5.13
```

Note that the value of the fourth octet increases by 5 for each device since that is the number of client access interfaces that each device has, and each interface requires one IP address.

Web GUI

Centralized DHCP server mode can be enabled via the web interface on the "DHCP Relay" sub-tab under the "DHCP" tab on the "System Parameters" page (see Figure 47). The external DHCP server IP address, the gateway router address, the Client Address Space parameter, and the Base Value can also be set on this page. The DHCP mode parameters for all client access interfaces can be set on the "DHCP" sub-tab under the "DHCP" tab on the "System Parameters" page. Set the DHCP mode to "central server" for all interfaces whose client devices should receive addresses from the central DHCP server.

On the "System" tab of the "System" page, set the "L2 Emulation" to "enabled".



Configure Centralized DHCP.

Centralized DHCP: enabled

Central DHCP Server: 10 . 3 . 108 . 254

Gateway Router: 10 . 3 . 108 . 201

Client Address Space: 10 . 3 . 108 . 0 / 24

Relay Base Address: . . . 45

Centralized DHCP

Enables relaying of DHCP messages to and from a central DHCP server.

Central DHCP Server

Central DHCP server IP address.

Gateway Router

When using static IP clients, all nodes in a mesh must be configured to have the save gateway router

Figure 47. Centralized DHCP server mode settings for use with a centralized DHCP server

13.2.3 Configuring the Central DHCP Server

Guidelines for configuring the central DHCP server are provided below. The full configuration of the central DHCP server will depend on the type of DHCP server that is used and is beyond the scope of this document.

Typically the following information must be available in order to configure the server:

1. The local interface (to the DHCP server) over which the DHCP-related messages from the mesh neighborhood arrive
2. The parameter(s) that define the address lease time
3. Whether DNS and domain names are to be provided by the DHCP server to client devices
4. The range of the flat IP address that is used for assigning IP addresses to client devices. The range must not include the IP addresses set aside for the client access interfaces on each mesh device.

The following is a segment of the dhcpd.conf file for a Linux DHCP server (ISC DHCP server) that illustrates the scope settings for the mesh network:

```
subnet 192.168.5.0 netmask 255.255.255.0
{
        option broadcast-address        192.168.5.255;
        option subnet-mask              255.255.255.0;
        option domain-name              "domain.com";
        range                           192.168.5.18 192.168.5.254;
}
```

Note that in this definition no “routers” option is needed. If a global “routers” option is defined, the EnRoute500s in a mesh neighborhood will automatically change it to an appropriate value in DHCP responses to clients based on the centralized DHCP server settings on the EnRoute500s. In this example, the mesh network includes 3 mesh devices, 2 IP addresses are set aside for the DHCP server and the mesh gateway, and therefore the address pool starts from 192.168.5.18.

14 Connecting an EnRoute500 Mesh Network to a WAN

The options for connecting an EnRoute500 gateway to a WAN and establishing layer 3 IP routing include:

- Static route configuration on the WAN router
- Source network address translation (NAT) on the mesh gateways
- Layer 2 mesh emulation as part of DHCP relay mode.

Table 13 shows compatibility of single vs. multiple mesh gateways with the use of implicit vs. explicit addressing for the first two configuration options. Note that different options and requirements exist depending on whether a single or multiple gateways devices are used.

	Static Route Configuration on WAN Router		NAT on Mesh Gateway	
	Supported?	**Requirements**	**Supported?**	**Requirements**
Single gateway, implicit addressing	Yes	Define EnRoute500 mesh gateways as next hop gateway in WAN router or enable L2 emulation mode on mesh gateway	Yes	No client access interface can be in central DHCP mode
Single gateway, explicit addressing	Yes	Define EnRoute500 mesh gateway as next hop gateway in WAN router	Yes	
Multiple gateways, implicit addressing	Yes	Enable L2 mode on all mesh gateways	Yes	
Multiple gateways, explicit addressing	No	N/A	Yes	

Table 13. Supported WAN connection options for single and multi-gateway mesh neighborhoods using implicit or explicit client addressing schemes

14.1 Static Routing Configuration on WAN Router

14.1.1 "Single Gateway, Implicit Addressing Scheme" Option

A single EnRoute500 gateway can be directly connected to a WAN without using Network Address Translation. With this gateway configuration and with the implicit addressing scheme in use, the router on the network that the gateway is attached to must be configured to forward the mesh subnet and the LAN subnets to the gateway's Ethernet interface. The subnets that need to be forwarded are:

Class B subnet:	<LAN prefix>.<Mesh ID>.0.0
Class C subnet:	<Mesh prefix >.<Mesh ID>.0

In the case where the LAN prefix is 10 and the mesh prefix is 172.29, the subnets the router would need to forward to the gateway are 10.2.0.0/255.255.0.0 and 172.29.0.0/255.255.0.0.

Alternatively, to avoid any configuration of the WAN router, enable L2 emulation mode on the mesh gateway. This will automatically direct traffic destined for the mesh neighborhood's mesh devices and clients to the mesh gateway. See section 18.2 for instructions on how to enable L2 emulation mode.

CLI

The subnet information can be retrieved from the 'sys' interface as shown below.

```
> use sys
sys> get id.*
 sys.id.lanprefix = 10
 sys.id.mesh = 2
 sys.id.meshprefix = 172.29
 sys.id.node = 4
```

Web GUI

The LAN prefix and mesh prefix can be obtained by inspecting the IP addresses available on the "Status" page. Alternatively, the mesh ID can be obtained from the "Mesh" tab on the "Wireless Interfaces" page and the LAN prefix can be obtained from the "System" tab on the "System" page.

14.1.2 "Single Gateway, Explicit Addressing Scheme" Option

A single EnRoute500 gateway can be directly connected to a WAN without using Network Address Translation. With this gateway configuration and the explicit addressing scheme in use, the router on the network that the gateway is attached to must be configured to forward the mesh subnet and all explicitly defined client subnets used in the mesh to the gateway's Ethernet interface.

14.1.3 "Multiple Gateway, Implicit Addressing Scheme" Option

Multiple EnRoute500 gateways can be directly connected to a WAN without using Network Address Translation. With this gateway configuration and the implicit addressing scheme in use, the router on the network that the gateway is attached to must be configured to use L2 emulation mode on all mesh gateways. This will automatically direct traffic destined for the mesh neighborhood's mesh devices and clients to the appropriate mesh gateway, avoiding any configuration of the WAN router.

See section 18.2 for instructions on how to enable L2 emulation mode.

14.1.4 “Multiple Gateway, Explicit Addressing Scheme” Option

This mode of operation is not supported.

14.2 Network Address Translation (NAT) on Mesh Gateways

Network Address Translation (NAT) provides a simple method for connecting a mesh neighborhood to a WAN router and also prevents hosts that are located on external networks from initiating connections with client devices and individual mesh repeaters. However, the mesh devices, as well as their client devices, are able to establish connections and communicate with hosts connected to networks external to the mesh.

⚠ **NAT cannot be used if any of the mesh devices in a mesh neighborhood are using centralized DHCP server mode.**

The advantages of using NAT are:

- You can easily attach a mesh neighborhood to an existing network. You do not need to modify any settings on the WAN router on your existing network to forward IP packets to client devices within your mesh neighborhood.
- The devices in the mesh neighborhood are shielded from the network that the gateway is attached to.
- You only consume a single IP address on your existing network when connecting the mesh neighborhood to it.

The main disadvantages of using NAT is

- You are not able to initiate connections into the EnRoute500s in the mesh neighborhood or their clients from outside the mesh neighborhood.
- It is not compatible with centralized DHCP server mode.

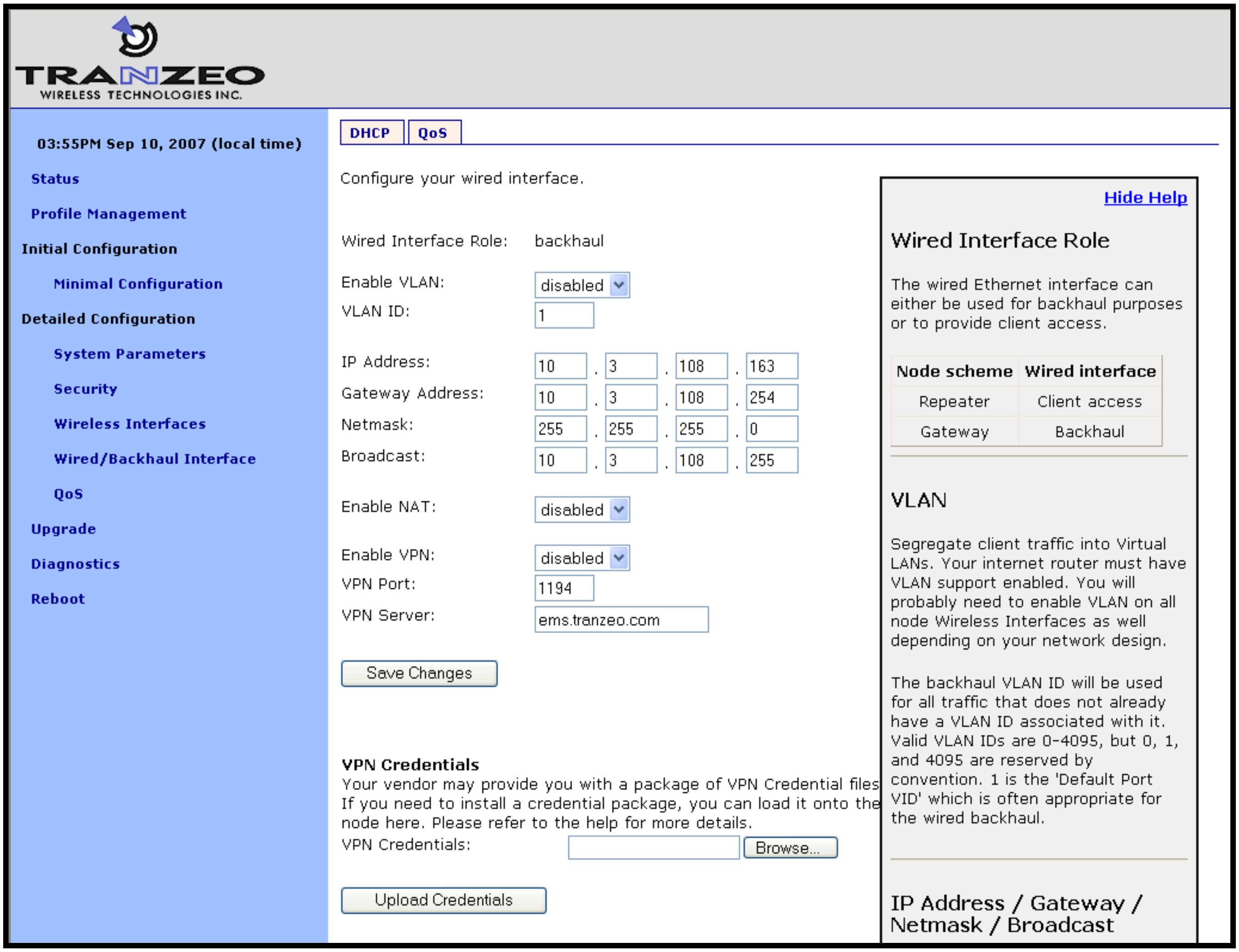
CLI

To set the NAT state, use the commands

```
> use sys
sys> set nat.enable=<yes|no>
```

Web GUI

The NAT state can be set via the web interface on the “Wired/Backhaul Interface” page (Figure 48).



Configure your wired interface.

Wired Interface Role:	backhaul
Enable VLAN:	disabled
VLAN ID:	1
IP Address:	10 . 3 . 108 . 163
Gateway Address:	10 . 3 . 108 . 254
Netmask:	255 . 255 . 255 . 0
Broadcast:	10 . 3 . 108 . 255
Enable NAT:	disabled
Enable VPN:	disabled
VPN Port:	1194
VPN Server:	ems.tranzeo.com

VPN Credentials
Your vendor may provide you with a package of VPN Credential files If you need to install a credential package, you can load it onto the node here. Please refer to the help for more details.
VPN Credentials:

Wired Interface Role

The wired Ethernet interface can either be used for backhaul purposes or to provide client access.

Node scheme	Wired interface
Repeater	Client access
Gateway	Backhaul

VLAN

Segregate client traffic into Virtual LANs. Your internet router must have VLAN support enabled. You will probably need to enable VLAN on all node Wireless Interfaces as well depending on your network design.

The backhaul VLAN ID will be used for all traffic that does not already have a VLAN ID associated with it. Valid VLAN IDs are 0-4095, but 0, 1, and 4095 are reserved by convention. 1 is the 'Default Port VID' which is often appropriate for the wired backhaul.

IP Address / Gateway / Netmask / Broadcast

Figure 48. NAT and VPN settings

14.3 Layer 2 Mesh Emulation in DHCP Relay Mode

When DHCP relay and layer 2 emulation mode are both enabled, the mesh network emulates a layer 2 distribution and access network. In this case the WAN router configuration is limited to setting up a static route without a designated next-hop gateway via the router’s LAN interface. In this configuration, additional static routes to the mesh address space as well as implicit and or explicit address spaces served by the mesh neighborhood may be added, without the need for specifying a next hop gateway.

14.4 VPN Access to a Mesh Gateway

An EnRoute500 configured as a gateway can establish a VPN connection to an OpenVPN server. This VPN connection provides the following capabilities:

- Any EnRoute500 in the mesh can be contacted directly from a remote host, even when NAT is enabled on the gateway device. This allows remote access to devices to monitor their behavior or reconfigure them
- A secure path between the mesh and a host, which can be used to monitor and reconfigure the mesh, is established. The control and status traffic passing between the mesh and the host is protected if it passes over a public network at any point.

The state of the VPN client on the EnRoute500 is set with the Enable VPN parameter. The IP address of the VPN server and its port are specified with the VPN Server and VPN Port parameters. Note that the VPN server parameter can either be an IP address or a resolvable host name.

To allow a connection to be established to an OpenVPN server, appropriate credentials must also be uploaded to the EnRoute500. Contact Tranzeo for information on how to create VPN credentials.

CLI

The example below shows how to enable the VPN connection (‘vpn.enable’ in the ‘sys’ interface) and set the server and port parameters (‘vpn.server’ and ‘vpn.port’ in the ‘sys’ interface).

```
> use eth0
sys> set vpn.enable=yes
sys> set vpn.server=192.168.0.1
sys> set vpn.port=1194
```

It is not possible to upload VPN credentials with the CLI. Please use the web interface to do this.

Web GUI

These parameters can be set via the web interface on the “Wired/Backhaul Interface” page when the device scheme is set to ‘gateway’ as illustrated in Figure 48.

15 Controlling Access to the EnRoute500

The EnRoute500 supports the following features for restricting access to it, restricting inter-client device communication and access to mesh devices, and shielding client devices from an external network:

- Firewall
- Client-to-client communication blocking
- Gateway firewall

It further supports controlled network access by client devices through MAC address black lists and mesh association through MAC white lists.

15.1 Firewall

The EnRoute500 has a firewall that blocks certain types of traffic destined for the EnRoute500. This prevents client devices attached to an EnRoute500 and devices on the mesh gateway WAN from connecting to the gateway.

INFO

> The default firewall rules only affect packets destined for the EnRoute500, and have no effect on packets forwarded by the device. The firewall should typically be enabled on all EnRoute500s since it prevents undesired access to the mesh devices.

By default, the ports listed in Table 14 are set to be allowed for connection to the EnRoute500.

Function	Port(s)	Type	Protocol
SSH	22	Source & destination	TCP
DNS	53	Source & destination	UDP
DHCP	67, 68	Destination	UDP
HTTP	80	Destination	TCP
SNMP	161	Source & destination	UDP
HTTPS	443	Destination	TCP
HTTP redirect (if splash pages are enabled)	3060	Destination	TCP
Roaming support	7202 – 7205, 7207	Destination	UDP
OnRamp	20123	Source & destination	UDP

Table 14. Source and destination ports allowed by default

CLI

The firewall is enabled by selecting the ‘firewall’ interface and setting the ‘node.enable’ parameter.

```
> use firewall
firewall> set node.enable=yes
```

Lists of allowed source and destination ports for inbound TCP and UDP traffic can be specified. These lists can be set with the following parameters in the ‘firewall’ interface:

- node.tcp.allow.dest
- node.tcp.allow.source
- node.udp.allow.dest
- node.udp.allow.source

The list of allowed ports must be a space-delimited string enclosed by quotes. The example below shows how to set the TCP source ports parameters.

```
> use firewall
firewall> set node.tcp.allow.dest=”22 23 80 5280”
```

Web GUI

It is not possible to configure the state of the firewall and the open firewall ports via the web interface. It is enabled by default.

15.2 Gateway Firewall

The gateway firewall blocks connections originating outside the mesh neighborhood from entering the mesh via the gateway, protecting mesh devices and their clients from unwanted traffic. The gateway firewall will permit return traffic for connections that originate inside the mesh neighborhood or on mesh clients.

The gateway firewall should only be enabled on EnRoute500s that are configured as gateways. It is possible to enable the gateway firewall on a repeater device, but it does not have any effect on the flow of traffic through the device’s Ethernet interface.

INFO

> If you have enabled NAT (see section 14.2) on the Ethernet interface ‘eth0’, you will have an implicit firewall that limits the type of inbound connections that are possible.

CLI

The state of the gateway firewall is controlled with the ‘gateway’ parameter in the ‘firewall’ interface. Enable the gateway firewall with

```
> use firewall
firewall> set gateway=yes
```

disable it with

```
> use firewall
firewall> set gateway=no
```

Web GUI

It is not possible to configure the state of the gateway firewall via the web interface.

15.3 Blocking Client-to-Client Traffic

Client-to-client traffic can be blocked or permitted on a per-interface basis. By enabling client-to-client traffic blocking for one or more of an EnRoute500’s client access interfaces, the client devices that attach to that particular interface will not be able to communicate with any client devices attached to that or any other client access interface in the mesh. Client-to-client traffic can be controlled for interfaces wlan1, wlan2, wlan3, wlan4, and eth0.

CLI

The parameters that control client-to-client access are all in the ‘firewall’ interface. They are:

- node.allowc2c.eth0
- node.allowc2c.wlan1
- node.allowc2c.wlan2
- node.allowc2c.wlan3
- node.allowc2c.wlan4

To block client-to-client traffic, select the ‘firewall’ interface and set the parameter for the appropriate interface to ‘no’, To allow traffic between client devices, set the parameter to ‘yes’. The examples below illustrate how to configure these parameters.

To block client-to-client traffic for client devices attached to wlan1:

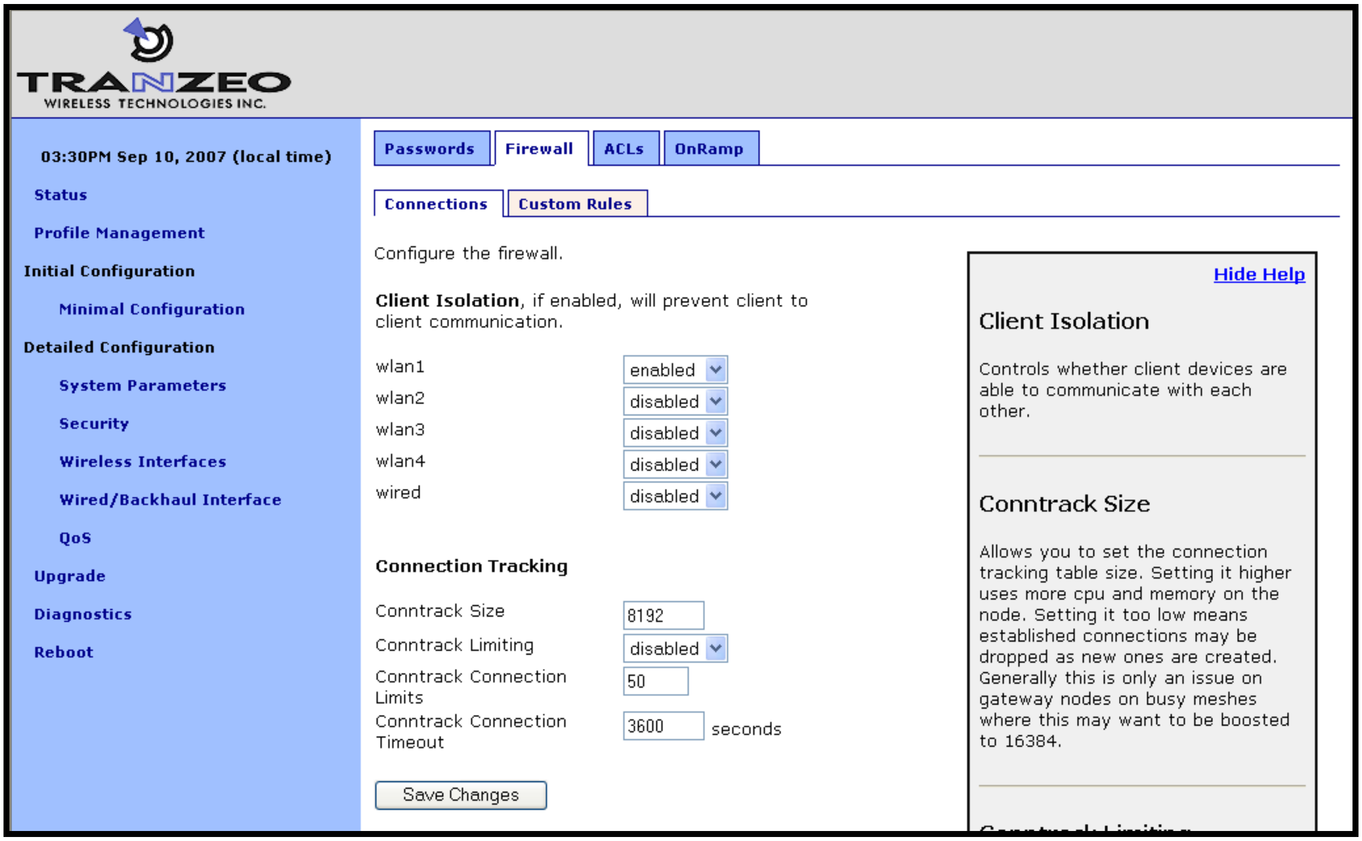
```
> use firewall
firewall> set node.allowc2c.wlan1=no
```

To allow client-to-client traffic for client devices attached to eth0:

```
> use firewall
firewall> set node.allowc2c.eth0=yes
```

Web GUI

The client isolation parameters can be set via the web interface using the “Connections” sub-tab under the “Firewall” tab on the “Security” page (see Figure 49). By setting an interface’s client isolation parameter to ‘yes’, client devices connecting to that interface will not be able to communicate with any other client devices in the mesh.



Configure the firewall.

Client Isolation, if enabled, will prevent client to client communication.

wlan1 enabled
wlan2 disabled
wlan3 disabled
wlan4 disabled
wired disabled

Connection Tracking

Conntrack Size 8192
Conntrack Limiting disabled
Conntrack Connection Limits 50
Conntrack Connection Timeout 3600 seconds

Client Isolation

Controls whether client devices are able to communicate with each other.

Conntrack Size

Allows you to set the connection tracking table size. Setting it higher uses more cpu and memory on the node. Setting it too low means established connections may be dropped as new ones are created. Generally this is only an issue on gateway nodes on busy meshes where this may want to be boosted to 16384.

Figure 49. Connection-related firewall settings

Note that devices connected to different interfaces can only communicate with each other if client-to-client isolation is disabled for both interfaces.

Client-to-client isolation is only enabled if the EnRoute500 firewall (firewall.node.enable) is enabled (section 15.1).

15.4 Connection Tracking

The firewall keeps track of existing TCP connections. It is advisable to enable connection tracking for public networks that can have large numbers of users. In particular, it is important to enable connection tracking if your network is heavily loaded or if it has users running file sharing applications. A number of parameters are available for tuning how connection tracking is handled.

15.4.1 Limiting Number of TCP Connections Per Client Device

The number of TCP connections allowed per client device can be limited. For most use cases, setting the connection limit to 30 is sufficient.

INFO

> Users running file sharing applications may have difficulties establishing connections when TCP connection limiting is enabled since the file sharing application may be consuming the maximum number of TCP connections allowed.

CLI

The ‘conntrack.connlimit.enable’ parameter in the ‘firewall’ interface is used to set the state of TCP connection limiting. The ‘conntrack.connlimit.connections’ parameter is used to set the maximum number of connections allowed per client device.

```
> use firewall
firewall> set conntrack.connlimit.enable=yes
firewall> set conntrack.connlimit.connections=30
```

Web GUI

The TCP connection limit-related settings are set on the “Connections” sub-tab on the “Firewall” tab of the “Security” page (see Figure 49). The “Conntrack Limiting” drop-down box sets the state of TCP connection limiting and the “Conntrack Connection Limits” sets the maximum number of TCP connections allowed per client device.

15.4.2 Connection Tracking Table Size

The size of the connection tracking table can be set. This sets maximum aggregate number of connections that can be supported for all users on all mesh devices in the mesh neighborhood the gateway is servicing. Allowed values are in the range from 4096 to 16384. A larger connection tracking table allows more connections to be maintained without dropping older connections. Typically, the default size of 8192 is adequate for normal operation and the setting should only be increased on gateway devices with high levels of traffic since they need to track the connections for all client devices connected to any of the mesh devices in the gateway's mesh neighborhood.

CLI

The connection tracking table size is set by selecting the 'firewall' interface and setting the 'conntrack.table_size' parameter.

```
> use firewall
firewall> set conntrack.table_size=16384
```

Web GUI

The connection tracking table size is set with the "Conntrack Size" field on the "Connections" sub-tab on the "Firewall" tab of the "Security" page (see Figure 49). This field is located under the "Connection Tracking" heading.

15.4.3 Connection Tracking Timeout

The connection tracking timeout parameter allows you to flush connections that have been idle for an extended period of time from the connection tracking table. This will help limit the maximum required size of the connection tracking table. By default, this parameter is set to 3600 seconds (1 hour).

CLI

The connection tracking timeout is set by selecting the 'firewall' interface and setting the 'conntrack.tcp_timeout_established' parameter. The timeout is specified in seconds.

```
> use firewall
firewall> set conntrack.tcp_timeout_established=3600
```

Web GUI

The connection tracking timeout is set with the "Conntrack Connection Timeout" field on the "Connections" sub-tab on the "Firewall" tab of the "Security" page (see Figure 49). This field is located under the "Connection Tracking" heading. Specify the timeout limit in seconds.

15.5 Custom Firewall Rules

Custom firewall rules can be added that control how traffic forwarded by an EnRoute500 is handled. For example, rules can be added to:

- Block client traffic on certain ports
- Block traffic from a given client access interface to a certain subnet

The custom firewall rules can be added on the “Custom Rules” sub-tab on the “Firewall” tab on the “Security” page as shown in Figure 50. These rules are specified as you would specify rules for iptables, with the exception of the chain that they are to be added to cannot be specified. All rules will be applied to the iptables forwarding chain.

List one rule per line in the text box on the “Custom Rules” tab and click on the “Save and Apply Changes” button when all rules have been entered. The following examples of custom rules illustrate how to use the custom firewall interface.

Blocking SMTP traffic 25

This rule will block all SMTP traffic, which uses port 25.

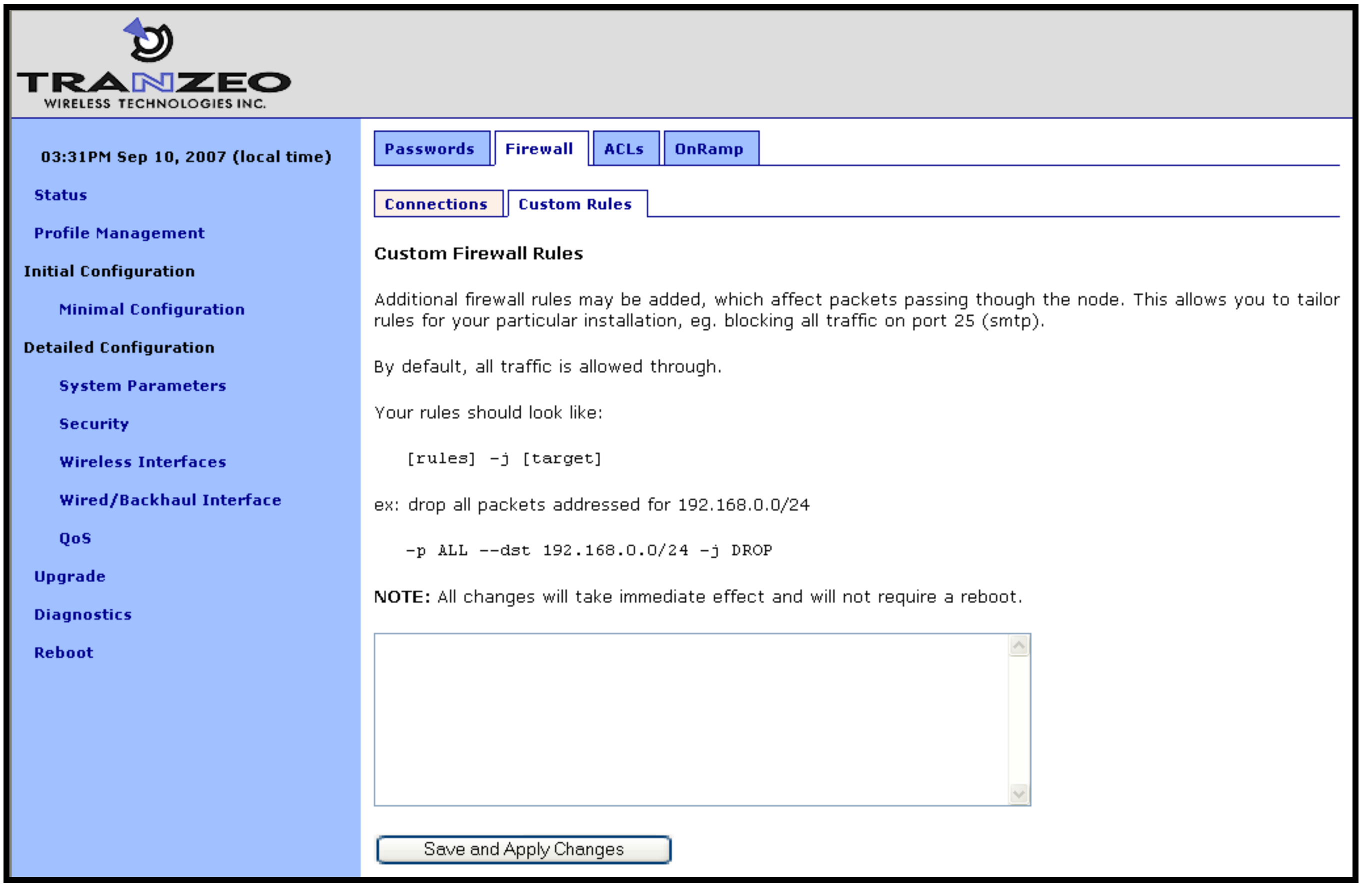
```
-dport 25 -j DROP
```

Limiting Access Based on Client Access Interface

Packets can be filtered based upon which interface they were received through. For example, wlan1 and wlan2 can be used to provide users with access to two different, private subnets, while wlan3 users have access to neither of these subnets. Users of all wlans would have access to the Internet though. The following rules will:

- Drop traffic from wlan1 destined for the 192.168.2.0 subnet
- Drop traffic from wlan2 destined for the 192.168.1.0 subnet
- Drop traffic from wlan3 destined for the 192.168.1.0 and 192.168.2.0 subnets

```
-i wlan1 --dst 192.168.2.0/24 -j DROP
-i wlan2 --dst 192.168.1.0/24 -j DROP
-i wlan3 --dst 192.168.1.0/24 -j DROP
-i wlan3 --dst 192.168.2.0/24 -j DROP
```



Custom Firewall Rules

Additional firewall rules may be added, which affect packets passing though the node. This allows you to tailor rules for your particular installation, eg. blocking all traffic on port 25 (smtp).

By default, all traffic is allowed through.

Your rules should look like:

```
   [rules] -j [target]
```

ex: drop all packets addressed for 192.168.0.0/24

```
   -p ALL --dst 192.168.0.0/24 -j DROP
```

NOTE: All changes will take immediate effect and will not require a reboot.

Figure 50. Custom firewall settings

15.6 Access Control Lists (ACLs)

Access control lists can be created for each of the VAP interfaces and the mesh interface.

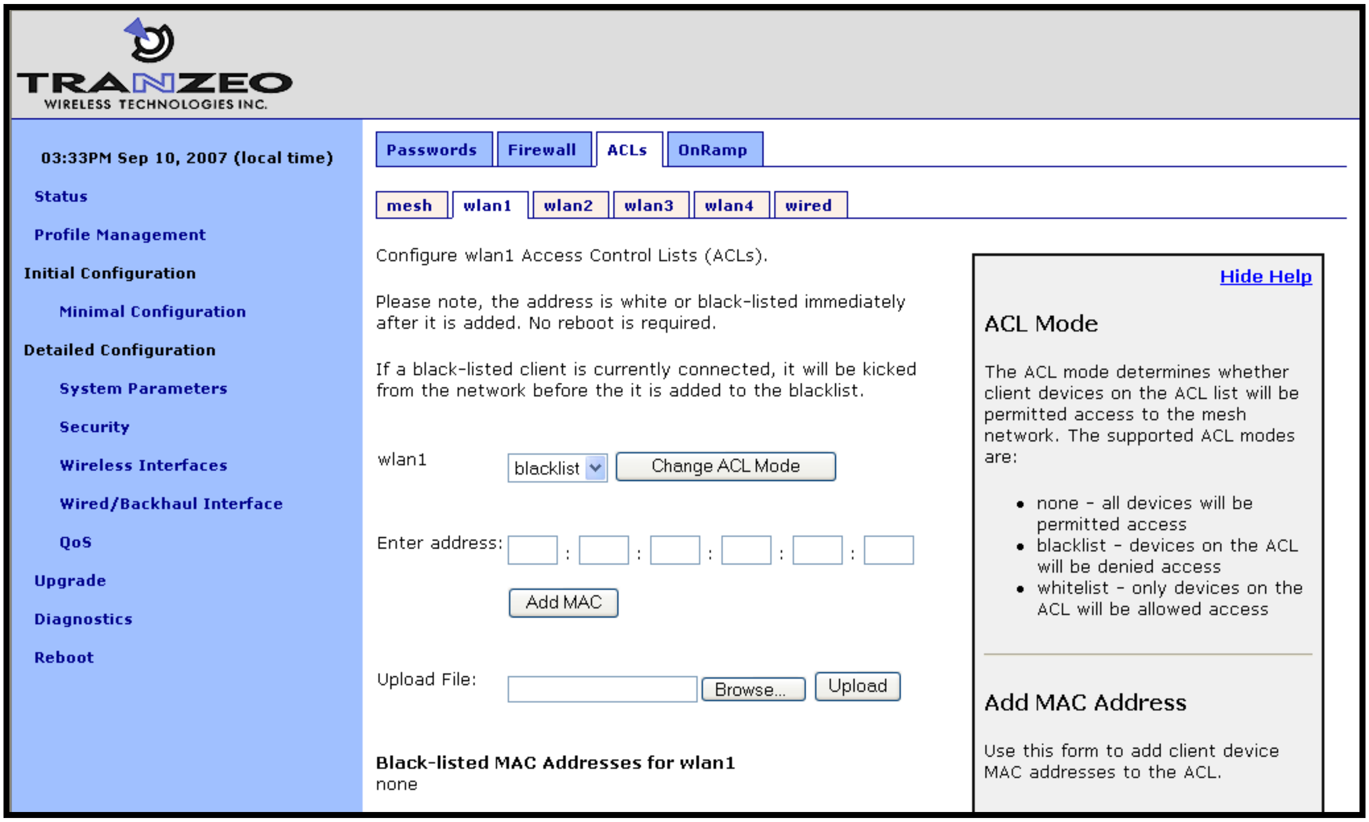
15.6.1 Access Point Access Control Lists (ACLs)

The access control lists (ACLs) for the VAP interfaces (wlan1-wlan4) block access to any device with a MAC address matching those on the list. Individual ACLs can be defined for each VAP.

Web GUI

The ACLs can be defined via the web interface on the appropriate “wlan*N*” sub-tab under the “ACL” tab on the “Security” page as shown in Figure 51. Enter a MAC address and click on the “Add MAC” button to add the address to the ACL for that VAP. Once an address has been added, it will appear at the bottom of the page. To delete a MAC address in an ACL, click on the “Delete MAC” button next to the address.

The ACL for a VAP must be enabled after it has been created. Choose “blacklist” from the drop-down menu and click on “Change ACL Mode” to enable the list. Choose “none” from the drop-down menu and click on “Change ACL Mode” to disable the ACL.



Configure wlan1 Access Control Lists (ACLs).

Please note, the address is white or black-listed immediately after it is added. No reboot is required.

If a black-listed client is currently connected, it will be kicked from the network before the it is added to the blacklist.

wlan1 blacklist

Enter address: __ : __ : __ : __ : __ : __

Upload File:

Black-listed MAC Addresses for wlan1
none

ACL Mode

The ACL mode determines whether client devices on the ACL list will be permitted access to the mesh network. The supported ACL modes are:

- none - all devices will be permitted access
- blacklist - devices on the ACL will be denied access
- whitelist - only devices on the ACL will be allowed access

Add MAC Address

Use this form to add client device MAC addresses to the ACL.

Figure 51. AP ACL configuration

15.6.2 Mesh ACL

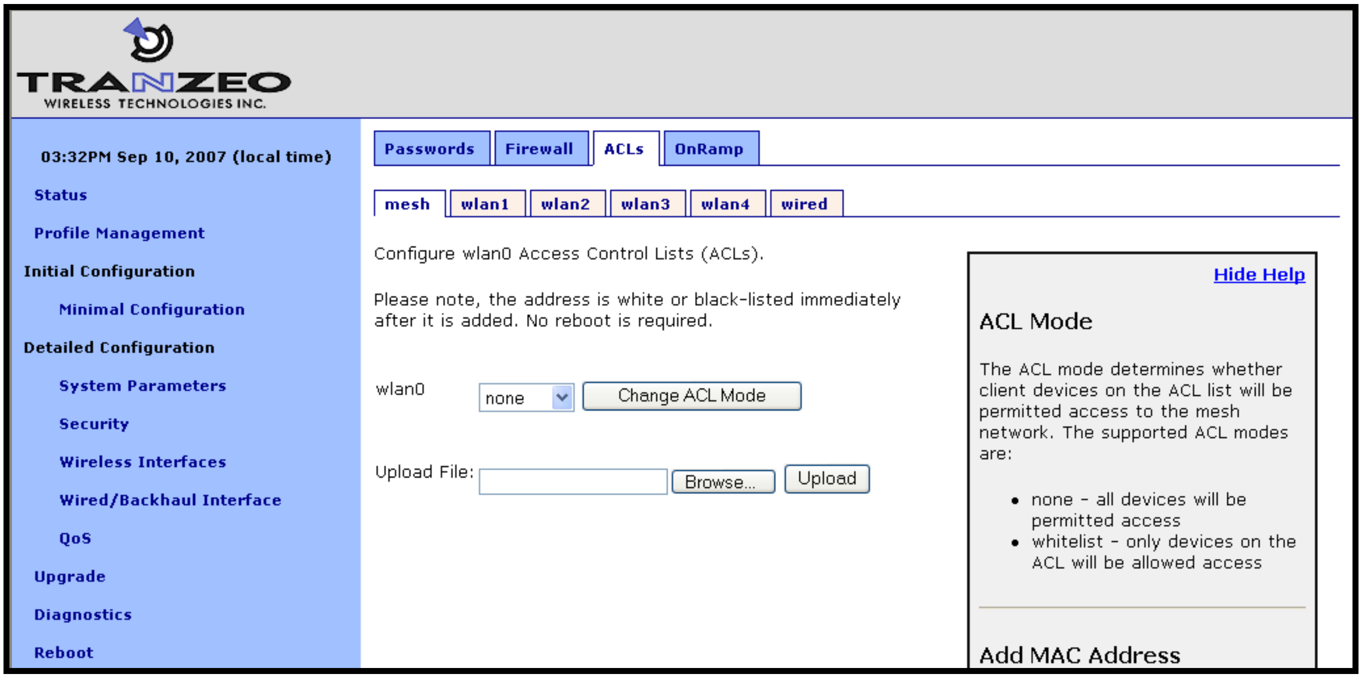
The access control list (ACL) for the mesh interface blocks access to the EnRoute500 via the mesh interface for any mesh device whose mesh MAC address is not listed in the ACL.

⚠ **It is possible to isolate a mesh device from other devices in the mesh if the mesh ACL is incorrectly configured. If the mesh ACL is enabled and no MAC addresses are present on the list, or the wrong addresses are present, it will not be possible for other mesh devices to communicate with the device.**

Web GUI

The mesh ACL can be defined via the web interface on the “Mesh” sub-tab under the “ACL” tab on the “Security” page as shown in Figure 52. Enter a MAC address and click on the “Add MAC” button to add the address to the ACL for that VAP. Once an address has been added, it will appear at the bottom of the page. To delete a MAC address in an ACL, click on the “Delete MAC” button next to the address.

The ACL for a VAP must be enabled after it has been created. Choose “whitelist” from the drop-down menu and click on “Change ACL Mode” to enable the list. Choose “none” from the drop-down menu and click on “Change ACL Mode” to disable the use of the ACL for the mesh interface.



Configure wlan0 Access Control Lists (ACLs).

Please note, the address is white or black-listed immediately after it is added. No reboot is required.

wlan0 none

ACL Mode

The ACL mode determines whether client devices on the ACL list will be permitted access to the mesh network. The supported ACL modes are:

- none - all devices will be permitted access
- whitelist - only devices on the ACL will be allowed access

Add MAC Address

Figure 52. Mesh ACL configuration

16 Quality of Service (QoS) Configuration

The EnRoute500 has extensive support for quality of service settings that allow traffic to be prioritized based on the source interface, destination interface, and type of traffic. The EnRoute500 QoS scheme allows both rate limiting and rate reservation for all interfaces.

16.1 Priority Levels

The Flow Priority parameters set the relative priority of outbound traffic based on the source interface. These parameters can be set to an integer value in the range from 0 to 99, with a higher number indicating a higher priority. If a flow priority level parameter is set to ‘inherit’, the associated interface will assume the default priority level set. The default flow priority is the flow priority ‘inherited’ by each interface if another flow priority setting is not applied. The default flow priority is configurable.

Traffic originating from an interface with a higher priority will take priority over traffic from all interfaces with a lower priority value until the higher-priority interface has no more data to send. If multiple interfaces have the same priority level, their traffic will be given equal access to the outbound interface. Rate reservation and rate limiting, described in the following sections, can be used to avoid one interface dominating the use of the mesh interface bandwidth.

INFO

As a rule, locally generated traffic should **always** have the highest priority so that EnRoute500 control traffic has precedence over client traffic and the mesh can be maintained.

INFO

The absolute values of the flow priority settings do not have any weighting effect. If a flow priority is higher for one interface than another, the former will always be prioritized with any remaining bandwidth allocated to the other one.

The Max/Min Hardware Priority parameters can be used to limit the hardware priority queues that traffic from a particular interface can use for outbound traffic. Valid values for these parameters are from 1 to 4, which are the priority levels listed in Table 15.

Abbreviation	Description	Priority level
VO	Voice	4 (highest)
VI	Video	3
BE	Best Effort	2
BK	Background	1 (lowest)

Table 15. Hardware flow priority levels

When sending data out through any of the wireless interfaces (wlan*N*, mesh0), these hardware priorities map directly to the 802.11e hardware priority output queues on the wireless card. The default level for all traffic is Best Effort.

To increase the hardware priority of all traffic originating from a particular interface, set the value of Min Hardware Priority to a value larger than 1. This will force all traffic from the chosen interface to use a hardware queue equal to or greater than the Min Hardware Priority value set. To reduce the maximum hardware priority of traffic from an interface, set the Max Hardware Priority parameter to a value less than 4. To disable hardware prioritization, set the Min/Max Hardware Priority parameters to ‘0’.

INFO

> Setting an interface’s flow priority above that of another interface results in all traffic originating on the higher flow priority interface blocking traffic on the lower priority interface until all traffic from the prioritized interface has been sent. In comparison, elevating the Min Hardware Priority associated with an interface will prioritize, but not fully block traffic tagged with a lower hardware priority. Instead the medium access delay will be reduced (as dictated by the IEEE 802.11e standard) for the traffic with the elevated hardware priority. Thus, these two priority types provide different gradations of quality control, even when applied en mass to an interface, although further refinements can be set using the EnRoute500 rate limiting features discussed below.

Changing hardware priorities does **not** affect the rate limiting and reservation (section 16.2), it only affects which output hardware queues that provide the required support for the 802.11e standard.

CLI

Flow priority levels are set with the ‘in.<intf>.flow_priority’ parameters in the ‘qos’ interface, where <intf> is one of the following: default, local, eth0, mesh0, wlan1, wlan2, wlan3, wlan4. ‘local’ refers to traffic originating on the device itself, not from its client devices (in practice this means mesh network control traffic). The example below sets locally generated traffic to have top priority and wlan1 to have priority over all other interfaces.

```
> use qos
qos> set in.default.flow_priority=10
qos> set in.local.flow_priority=90
qos> set in.wlan1.flow_priority=20
qos> set in.wlan2.flow_priority=inherit
qos> set in.wlan3.flow_priority=inherit
qos> set in.wlan4.flow_priority=inherit
qos> set in.eth0.flow_priority=inherit
```

Hardware priority levels are set with ‘in.<intf>.hwpri{max,min}’ in the ‘qos’ interface, where <intf> is one of the following: default, local, eth0, mesh0, wlan1, wlan2, wlan3, wlan4.

The example below shows how to configure the system such that all traffic from ‘wlan1’ with a ‘Voice’ or ‘Video’ priority will be reduced to a ‘Best Effort’ priority. Traffic with ‘Best Effort’ and ‘Background’ priorities will not be affected.

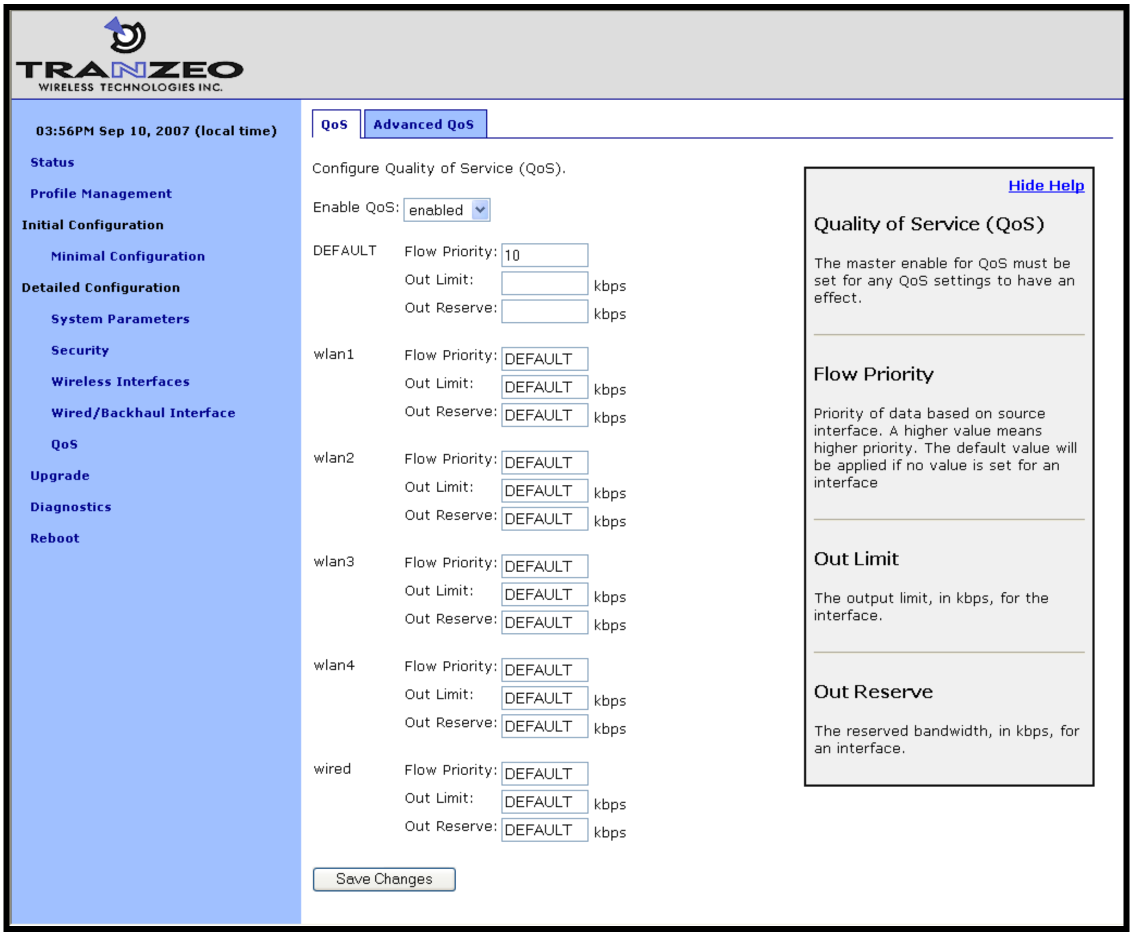
```
> use qos
qos> set in.wlan1.hwpri.max=2
```

The example below shows how to configure the system such that all traffic from ‘wlan2’ with a ‘Background’ or ‘Best Effort’ priority will be increased to a ‘Video’ priority. Traffic with ‘Video’ and ‘Voice’ priorities will not be affected.

```
> use qos
qos> set in.wlan2.hwpri.min=2
```

Web GUI

Flow priorities can be set via the web interface under the “QoS” tab on the “QoS” page (see Figure 53). The hardware priority levels can be set for each interface under the “Advanced QoS” tab on the “QoS” page (see Figure 54).



Configure Quality of Service (QoS).

Enable QoS: enabled

DEFAULT	Flow Priority:	10	
	Out Limit:		kbps
	Out Reserve:		kbps
wlan1	Flow Priority:	DEFAULT	
	Out Limit:	DEFAULT	kbps
	Out Reserve:	DEFAULT	kbps
wlan2	Flow Priority:	DEFAULT	
	Out Limit:	DEFAULT	kbps
	Out Reserve:	DEFAULT	kbps
wlan3	Flow Priority:	DEFAULT	
	Out Limit:	DEFAULT	kbps
	Out Reserve:	DEFAULT	kbps
wlan4	Flow Priority:	DEFAULT	
	Out Limit:	DEFAULT	kbps
	Out Reserve:	DEFAULT	kbps
wired	Flow Priority:	DEFAULT	
	Out Limit:	DEFAULT	kbps
	Out Reserve:	DEFAULT	kbps

Quality of Service (QoS)

The master enable for QoS must be set for any QoS settings to have an effect.

Flow Priority

Priority of data based on source interface. A higher value means higher priority. The default value will be applied if no value is set for an interface

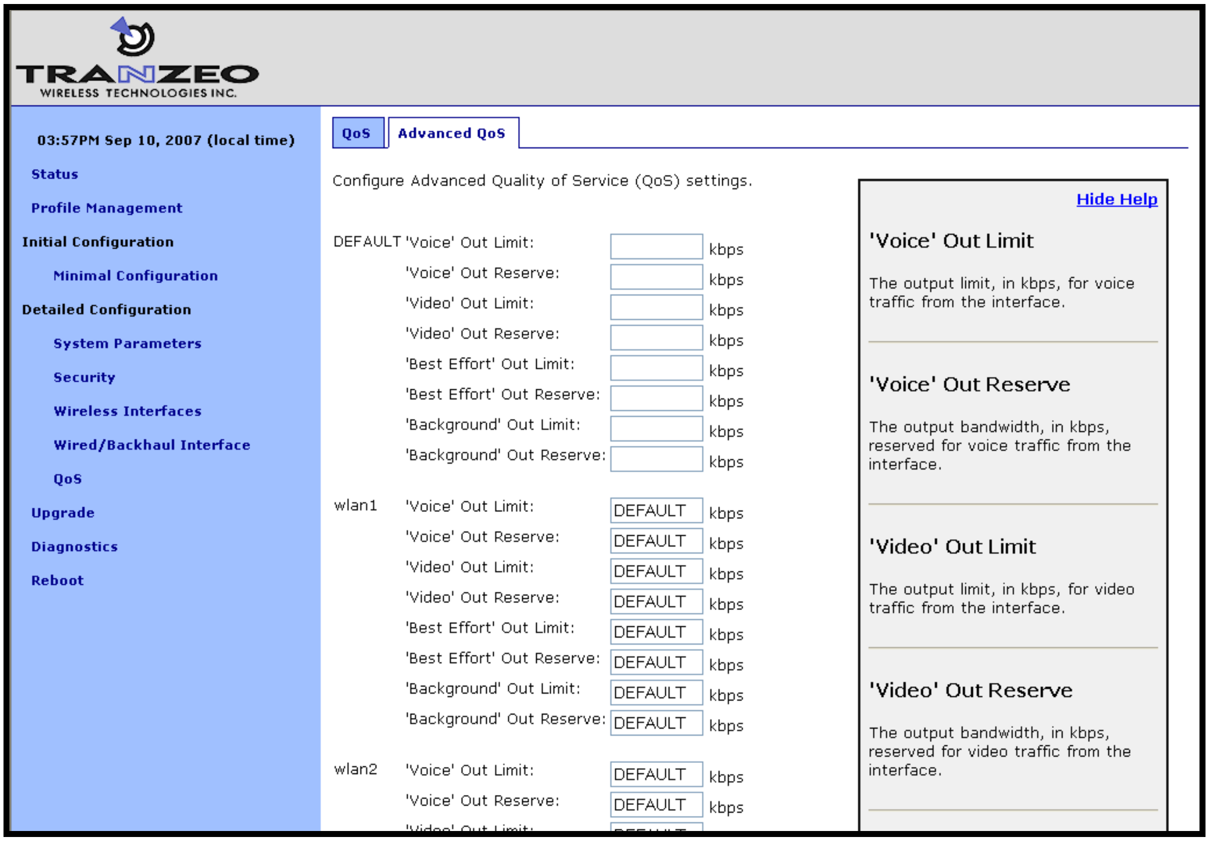
Out Limit

The output limit, in kbps, for the interface.

Out Reserve

The reserved bandwidth, in kbps, for an interface.

Figure 53. QoS settings



Configure Advanced Quality of Service (QoS) settings.

DEFAULT	'Voice' Out Limit:		kbps
	'Voice' Out Reserve:		kbps
	'Video' Out Limit:		kbps
	'Video' Out Reserve:		kbps
	'Best Effort' Out Limit:		kbps
	'Best Effort' Out Reserve:		kbps
	'Background' Out Limit:		kbps
	'Background' Out Reserve:		kbps
wlan1	'Voice' Out Limit:	DEFAULT	kbps
	'Voice' Out Reserve:	DEFAULT	kbps
	'Video' Out Limit:	DEFAULT	kbps
	'Video' Out Reserve:	DEFAULT	kbps
	'Best Effort' Out Limit:	DEFAULT	kbps
	'Best Effort' Out Reserve:	DEFAULT	kbps
	'Background' Out Limit:	DEFAULT	kbps
	'Background' Out Reserve:	DEFAULT	kbps
wlan2	'Voice' Out Limit:	DEFAULT	kbps
	'Voice' Out Reserve:	DEFAULT	kbps
	'Video' Out Limit:		

'Voice' Out Limit

The output limit, in kbps, for voice traffic from the interface.

'Voice' Out Reserve

The output bandwidth, in kbps, reserved for voice traffic from the interface.

'Video' Out Limit

The output limit, in kbps, for video traffic from the interface.

'Video' Out Reserve

The output bandwidth, in kbps, reserved for video traffic from the interface.

Figure 54. Advanced QoS configuration (only settings for some interfaces are shown)

16.2 Rate Limiting

A rate limit can be set at each QoS Control Point shown in Figure 55. The Control Points can be split into three groups, listed below in decreasing order of importance:

- Interface output limit
- Interface output limit of traffic from a particular interface
- Interface output limit of traffic of a certain type from a particular interface

INFO All rate limit parameter values are in kbps. If no rate limit parameter is set, rate limiting will be disabled for that interface or interface and traffic combination.

The maximum output data rate for interfaces can be limited with the Output Limit parameters for each client access interface. The default output limit value is applied to interfaces that have the Output Limit parameter set to 'inherit'.

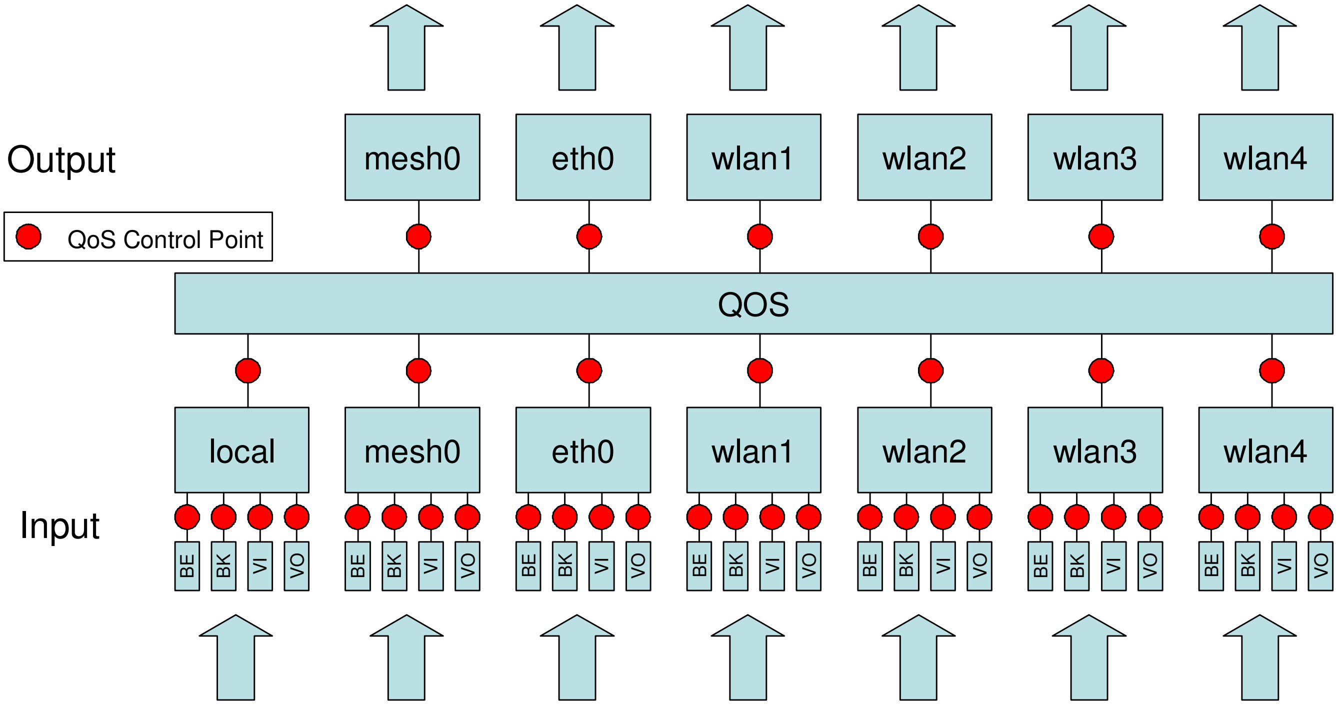


Figure 55. Quality of Service rate limit control points

Data rate limits can also be imposed based on traffic type through an interface. The maximum data rate for a certain type of traffic that enters the EnRoute500 through a particular interface and exits it through another interface can be limited.

INFO

> There is no standalone input rate limiting. Limiting the input rate of an interface on the EnRoute500 only makes sense in the context of the output for another interface(s). In most cases you are concerned with mesh0 as the output interface.

CLI

The example below shows how to limit the maximum output rate of the mesh0 interface to 8 Mbps and the maximum output rates of all four wlan*N* interfaces to 2 Mbps each.

```
> use qos
qos> set out.mesh0.limit=8192
qos> set out.wlan1.limit=2048
qos> set out.wlan2.limit=2048
qos> set out.wlan3.limit=2048
qos> set out.wlan4.limit=2048
```

The maximum data rate for traffic that enters the EnRoute500 through a particular interface and exits it through another interface can be limited with the ‘out.<output intf>.<input intf>.limit’ parameters in the ‘qos’ interface, where <output intf> is one of the following: default, eth0, mesh0, wlan1, wlan2, wlan3, wlan4; and <input intf> is one of the following: default, eth0, local, mesh0, wlan1, wlan2, wlan3, wlan4. The ‘out.default.default.limit’ value is applied to interfaces that have the ‘out.<output intf>.<input intf>.limit’ parameter set to ‘inherit’ or is left blank.

The example below shows how to limit the maximum output rate of data from wlan1, wlan2, wlan3, and wlan4 through the mesh0 interface to 2 Mbps, 1 Mbps, 512 kbps, and 256 kbps, respectively.

```
> use qos
qos> set out.mesh0.wlan1.limit=2048
qos> set out.mesh0.wlan2.limit=1024
qos> set out.mesh0.wlan3.limit=512
qos> set out.mesh0.wlan4.limit=256
```

Traffic type limits can be set with the ‘out.<output intf>.<input intf>.<traffic type>.limit.’ parameters in the ‘qos’ interface, where <output intf> is one of the following: default, eth0, mesh0, wlan1, wlan2, wlan3, wlan4; <input intf> is one of the following: default, eth0, local, mesh0, wlan1, wlan2, wlan3, wlan4; <traffic type> is one of the following: ‘vo’, ‘vi’, ‘be’, ‘bk’ (see Table 15 for description of traffic types).

The example below shows how to limit the maximum output rate of voice, video, best effort, and background traffic from wlan1 through the mesh0 interface to 256 kbps, 1 Mbps, 256 kbps, and 256 kbps, respectively.

```
> use qos
qos> set out.mesh0.wlan1.vo.limit=256
qos> set out.mesh0.wlan1.vi.limit=1024
qos> set out.mesh0.wlan1.be.limit=256
qos> set out.mesh0.wlan1.bk.limit=256
```

Web GUI

The interface- and traffic-based Output Limit parameters can be set via the web interface under the “QoS” and “Advanced QoS” tabs on the “QoS” page (see Figure 53 and Figure 54).

16.3 Rate Reservation

Rate reservation is used to guarantee bandwidth for certain types of traffic. Rate reservations can be made for traffic based on:

- The traffic input and output interfaces
- The traffic type, input interface, and output interface

For rate reservations to be enforced, a rate limit must be set for the traffic type that the reservation is made for. Setting a rate limit for a broader traffic type, of which the one the reservation is made for is a subset, is also acceptable. For example, when making a rate reservation for voice traffic from wlan1 to mesh0 ('out.mesh0.wlan1.vo.reserve'), a limit must be set with 'out.mesh0.limit', 'out.mesh0.wlan1.limit', or 'out.mesh0.wlan1.vo.limit'.

Rate reservations guarantee bandwidth for a particular traffic type, but if no such traffic is present, the bandwidth reserved will be returned to the pool of available bandwidth for other traffic types to use. The points at which rate reservations can be made are shown in Figure 56. These points are similar to where rate limits can be placed, except that rate reservations require both an input and output interface, whereas rate limits can be made without specifying an input interface.

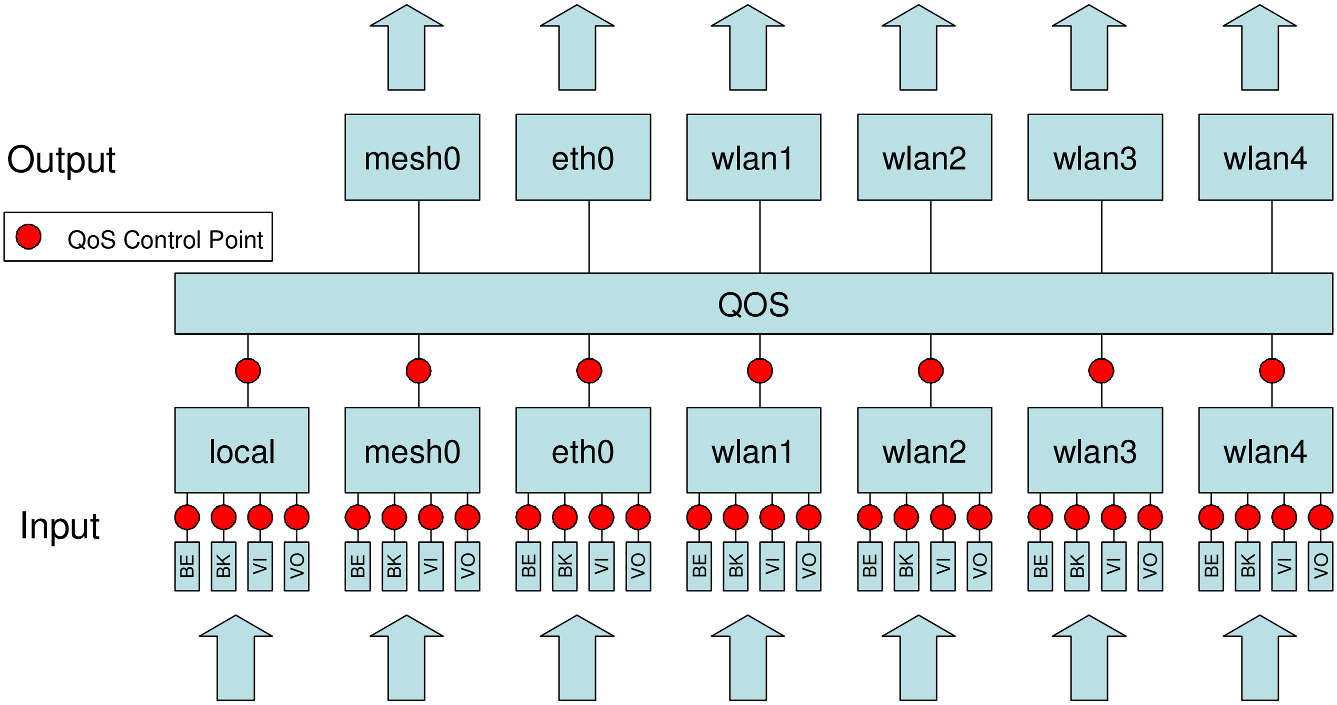


Figure 56. Quality of Service rate reservation control points

INFO

All rate reservation parameter values are in kbps. If no rate reservation parameter is set, rate reservation will be disabled for that interface or interface and traffic combination.

A rate reservation, which guarantees a certain amount of bandwidth, can be made for traffic that enters the EnRoute500 through a particular interface and exits it through another interface. Rate reservations can also be set based on traffic type through an interface. The default value set for the EnRoute500 rate reservation is applied to interfaces that have their bandwidth reservation parameters set to 'inherit' or are left blank.

CLI

The parameters that are used to set these rate reservations are in the 'qos' interface and are of the form 'out.<output intf>.<input intf>.reserve', where <output intf> is one of the following: default, eth0, mesh0, wlan1, wlan2, wlan3, wlan4; and <input intf> is one of the following: default, eth0, local, mesh0, wlan1, wlan2, wlan3, wlan4.

Typically, most rate reservations will involve reserving bandwidth for traffic from a particular client access interface to the mesh0 interface. The example below shows how to reserve differing amount of bandwidth on mesh0 for traffic originating from the wlan1, wlan2, wlan3, and wlan4 interfaces.

```
> use qos
qos> set out.mesh0.wlan1.reserve=2048
qos> set out.mesh0.wlan2.limit=1024
qos> set out.mesh0.wlan3.limit=512
qos> set out.mesh0.wlan4.limit=256
```

A rate reservation for a certain type of traffic that enters the EnRoute500 through a particular interface and exits it through another interface can be set with the 'out.<output intf>.<input intf>.<traffic type>.reserve.' parameters in the 'qos' interface, where <output intf> is one of the following: default, eth0, mesh0, wlan1, wlan2, wlan3, wlan4; <input intf> is one of the following: default, eth0, local, mesh0, wlan1, wlan2, wlan3, wlan4; <traffic type> is one of the following: 'vo', 'vi', 'be', 'bk' (see Table 15 for description of traffic types).

The 'out.default.default.limit' value is applied to interfaces that have the 'out.<output intf>.<input intf>.reserve' parameter set to 'inherit' or is left blank.

The example below shows how to reserve bandwidth for voice, video, best effort, and background traffic from wlan1 through the mesh0 interface to 512 kbps, 1 Mbps, 256 kbps, and 128 kbps, respectively.

```
> use qos
qos> set out.mesh0.wlan1.vo.reserve=512
qos> set out.mesh0.wlan1.vi.reserve=1024
qos> set out.mesh0.wlan1.be.reserve=256
qos> set out.mesh0.wlan1.bk.reserve=128
```

Web GUI

The rate reservation parameters can be set via the web interface under the "QoS" and "Advanced QoS" tabs on the "QoS" page (see Figure 53 and Figure 54).

17 Enabling VLAN Tagging

The EnRoute500 supports VLAN tagging, with each client access interface capable of supporting a different VLAN tag.

17.1 Client Access Interface Configuration

VLAN tagging can be independently controlled on each client access interface (eth0, wlan1-4). The Enable VLAN parameters for the 'eth0', 'wlan1', 'wlan2', 'wlan3', and 'wlan4' interfaces controls the state of VLAN tagging.

> ⚠ **VLAN tagging must be enabled on the backhaul Ethernet interface on a mesh neighborhood's gateway for VLAN tags to be included in data frames sent to the WAN. See section 17.2 for more details.**

The VLAN ID value for each client access interface is set with the VLAN ID parameter for each interface. The VLAN ID must be in the range from 0 to 4095. Note that 0 and 4095 are reserved values and 1 is the default VLAN ID. There are no restrictions on VLAN IDs for different interfaces or mesh devices having to match or be different.

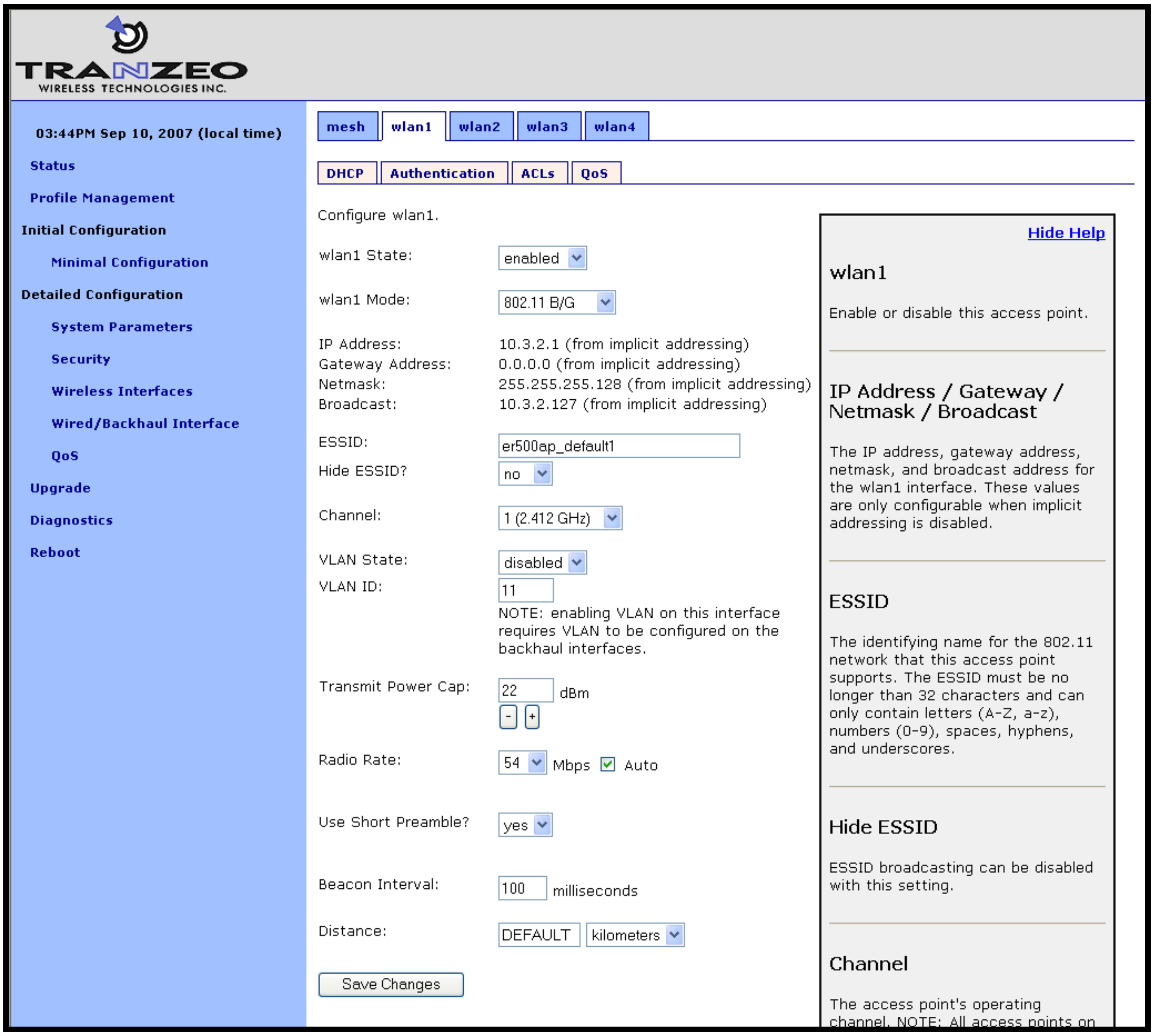
CLI

The example below shows how to enable VLAN tagging on the 'wlan1' interface and set the VLAN ID to 12 using the parameters 'vlan.enable' and 'vlan.id' in the 'wlan1' interface.

```
> use wlan1
wlan1> set vlan.enable=yes
> use wlan1
wlan1> set vlan.id=12
```

Web GUI

The VLAN Enable and VLAN ID parameters can be set via the web interface under the "wlan*N*" tabs on the "Wireless Interfaces" page and on the "Wired/Backhaul Interface" page (see Figure 57).



Configure wlan1.

wlan1 State: enabled

wlan1 Mode: 802.11 B/G

IP Address: 10.3.2.1 (from implicit addressing)
Gateway Address: 0.0.0.0 (from implicit addressing)
Netmask: 255.255.255.128 (from implicit addressing)
Broadcast: 10.3.2.127 (from implicit addressing)

ESSID: er500ap_default1
Hide ESSID? no

Channel: 1 (2.412 GHz)

VLAN State: disabled
VLAN ID: 11
NOTE: enabling VLAN on this interface requires VLAN to be configured on the backhaul interfaces.

Transmit Power Cap: 22 dBm

Radio Rate: 54 Mbps ☑ Auto

Use Short Preamble? yes

Beacon Interval: 100 milliseconds

Distance: DEFAULT kilometers

wlan1

Enable or disable this access point.

IP Address / Gateway / Netmask / Broadcast

The IP address, gateway address, netmask, and broadcast address for the wlan1 interface. These values are only configurable when implicit addressing is disabled.

ESSID

The identifying name for the 802.11 network that this access point supports. The ESSID must be no longer than 32 characters and can only contain letters (A-Z, a-z), numbers (0-9), spaces, hyphens, and underscores.

Hide ESSID

ESSID broadcasting can be disabled with this setting.

Channel

The access point's operating channel. NOTE: All access points on

Figure 57. Configuring VLAN for VAP interfaces

17.2 Gateway Configuration

For VLAN tags to be preserved on traffic that exits a mesh neighborhood, VLAN support must be enabled for the Ethernet interface on the mesh neighborhood's gateway device (the backhaul interface). The "Enable VLAN" parameter for the Wired/Backhaul interface controls the state of VLAN tagging. If VLAN tagging is enabled on the gateway's interface to the WAN, all outbound traffic will have its VLAN tags preserved. If VLAN tagging is disabled for the backhaul interface, all VLAN tags will be stripped from frames entering the mesh neighborhood.

When VLAN is enabled for the backhaul interface, data frames forwarded by the gateway to the WAN will preserve their existing VLAN tag, if they have one. Frames that do not have a tag will be tagged with the default VLAN ID for the gateway's Ethernet interface. The VLAN ID must be in the range from 0 to 4095. Note that 0 and 4095 are reserved values and 1 is the default VLAN ID.

CLI

The example below shows how to enable VLAN tagging on the backhaul interface on a gateway device using the ‘vlan.enable’ parameter in the ‘eth0’ interface.

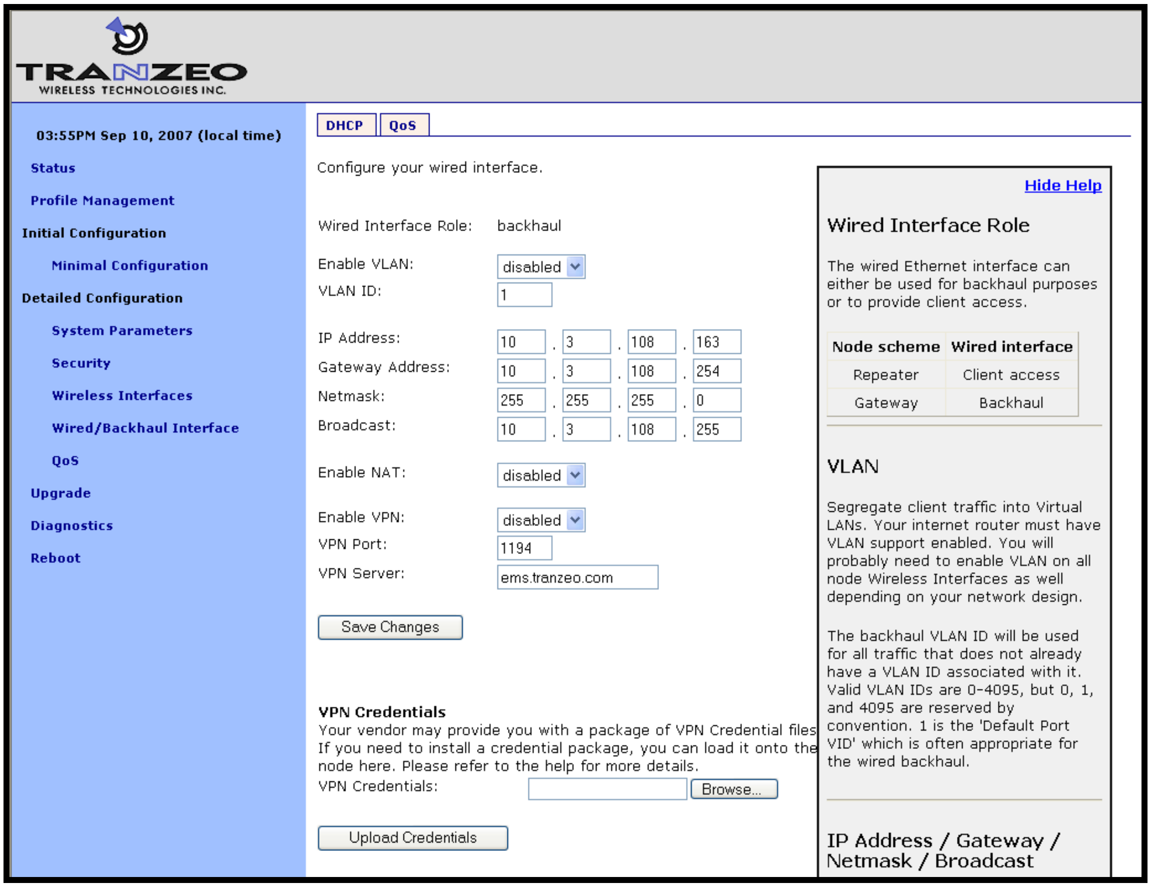
```
> use eth0
eth0> set vlan.enable=yes
```

The example below shows how to set the VLAN ID for the backhaul Ethernet interface using the ‘vlan.id’ parameter in the ‘eth0’ interface.

```
> use eth0
eth0> set vlan.id=1
```

Web GUI

The backhaul VLAN parameters are set on the “Wired/Backhaul Interface” page as shown in Figure 58.



Configure your wired interface.

Wired Interface Role: backhaul

Enable VLAN: disabled

VLAN ID: 1

IP Address: 10 . 3 . 108 . 163

Gateway Address: 10 . 3 . 108 . 254

Netmask: 255 . 255 . 255 . 0

Broadcast: 10 . 3 . 108 . 255

Enable NAT: disabled

Enable VPN: disabled

VPN Port: 1194

VPN Server: ems.tranzeo.com

VPN Credentials
Your vendor may provide you with a package of VPN Credential files If you need to install a credential package, you can load it onto the node here. Please refer to the help for more details.

VPN Credentials:

Wired Interface Role

The wired Ethernet interface can either be used for backhaul purposes or to provide client access.

Node scheme	Wired interface
Repeater	Client access
Gateway	Backhaul

VLAN

Segregate client traffic into Virtual LANs. Your internet router must have VLAN support enabled. You will probably need to enable VLAN on all node Wireless Interfaces as well depending on your network design.

The backhaul VLAN ID will be used for all traffic that does not already have a VLAN ID associated with it. Valid VLAN IDs are 0-4095, but 0, 1, and 4095 are reserved by convention. 1 is the 'Default Port VID' which is often appropriate for the wired backhaul.

IP Address / Gateway / Netmask / Broadcast

Figure 58. Configuring VLAN for backhaul interface

18 Integration with Enterprise Equipment

The EnRoute500 supports authentication, accounting, and monitoring services that easily integrate with enterprise equipment. In this section the following topics are described:

- Splash pages
- Backhaul health monitoring
- Layer 2 client emulation

18.1 Configuring Splash Pages

The EnRoute500 supports splash pages, which can be used to restrict access to the mesh network and provide information to users that connect to the mesh. When a user connects through a client access interface to an EnRoute500 with splash page support enabled, the splash page for the appropriate interface will be displayed and the user will be restricted from accessing other destinations on the Internet until they have logged in. The splash page can require the user to enter logon credentials or simply click a button to complete the login process.

To use splash pages, a number of URLs for login, successful login, and failed login must be specified. A RADIUS server that provides authentication services may also need to be specified.

18.1.1 Enabling Splash Pages

The enabling of splash pages can be controlled on a per-interface basis. Two splash page mode are supported – one which requires client device users to login in to gain access to the network and another which requires them to simply click on a button on the web page to proceed.

CLI

Enable or disable splash pages with the 'splash.enable.wlan*N*' parameters in the 'sys' interface. For a splash page to be displayed on an interface, the appropriate parameter must be set to 'yes'. The example below illustrates how to set the 'splash.enable.wlan1' parameter in the 'sys' interface to enable splash pages for the wlan1 interface.

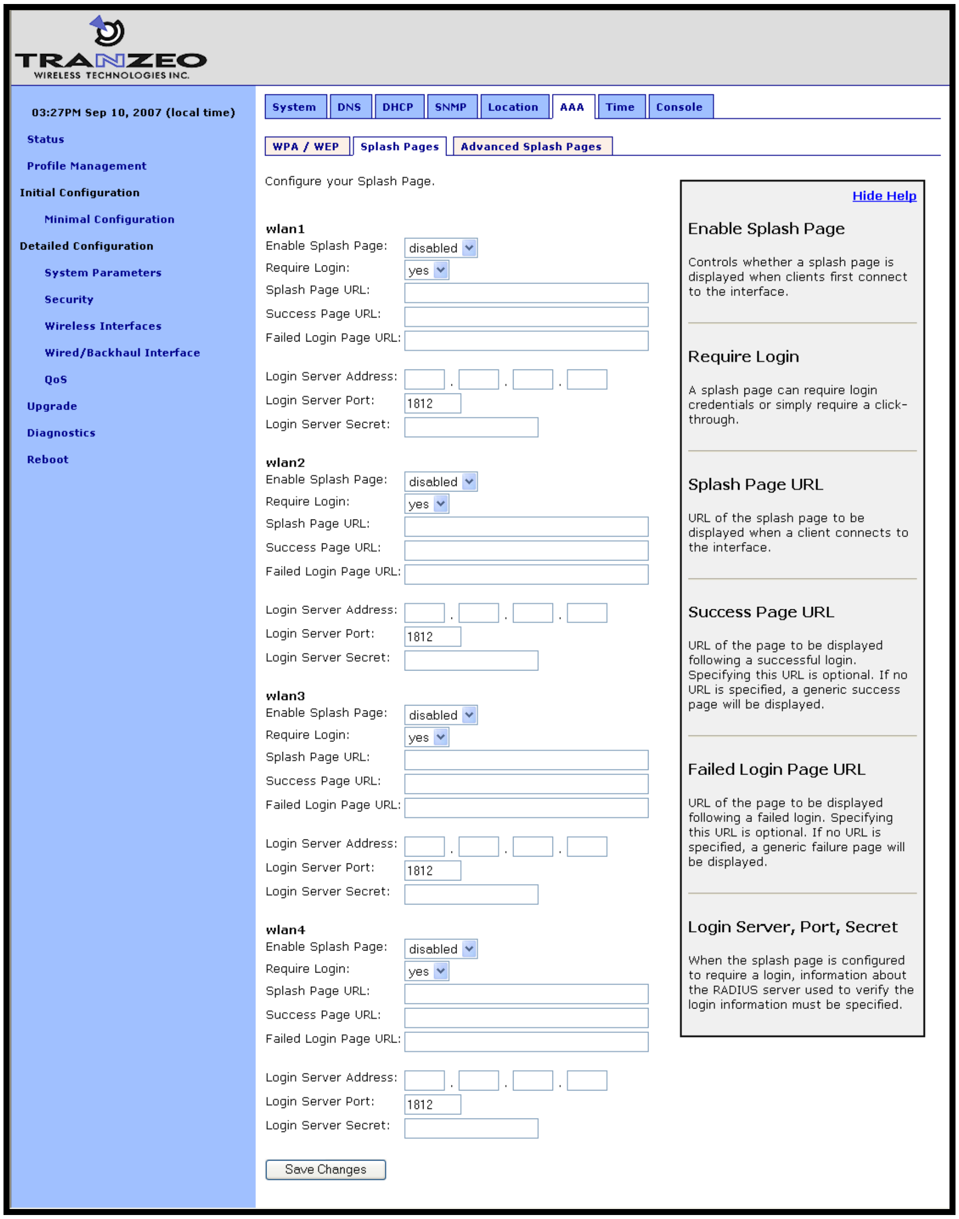
```
> use sys
sys> set splash.enable.wlan1=yes
```

Use the 'splash.auth.server.wlan*N*.enable' parameters in the 'sys' interface to select whether a user is required to provide login credentials for a particular interface. The example below illustrates how to set the parameter for the wlan1 interface such that a user will be required to login to access the network.

```
> use sys
sys> set splash.auth.server.enable.wlan1=yes
```

Web GUI

Splash pages can be enabled on a per-interface basis on the “Splash Pages” sub-tab under the “AAA” tab on the “System Parameters” page of the web interface (see Figure 59). Setting whether client login is required can also be set on this page with the “Require Login” parameter.



Configure your Splash Page.

wlan1
Enable Splash Page: disabled
Require Login: yes
Splash Page URL:
Success Page URL:
Failed Login Page URL:
Login Server Address: . . .
Login Server Port: 1812
Login Server Secret:

wlan2
Enable Splash Page: disabled
Require Login: yes
Splash Page URL:
Success Page URL:
Failed Login Page URL:
Login Server Address: . . .
Login Server Port: 1812
Login Server Secret:

wlan3
Enable Splash Page: disabled
Require Login: yes
Splash Page URL:
Success Page URL:
Failed Login Page URL:
Login Server Address: . . .
Login Server Port: 1812
Login Server Secret:

wlan4
Enable Splash Page: disabled
Require Login: yes
Splash Page URL:
Success Page URL:
Failed Login Page URL:
Login Server Address: . . .
Login Server Port: 1812
Login Server Secret:

Enable Splash Page

Controls whether a splash page is displayed when clients first connect to the interface.

Require Login

A splash page can require login credentials or simply require a click-through.

Splash Page URL

URL of the splash page to be displayed when a client connects to the interface.

Success Page URL

URL of the page to be displayed following a successful login. Specifying this URL is optional. If no URL is specified, a generic success page will be displayed.

Failed Login Page URL

URL of the page to be displayed following a failed login. Specifying this URL is optional. If no URL is specified, a generic failure page will be displayed.

Login Server, Port, Secret

When the splash page is configured to require a login, information about the RADIUS server used to verify the login information must be specified.

Figure 59. Splash page configuration

18.1.2 Configuring Splash URLs

The URL that a user is redirected to for login purposes can be individually configured for each client access interface that supports splash pages (wlan1-4). URLs for successful login, failed login, and error conditions can also be specified for each interface.

The 'login URL' parameter sets the URL that a user is redirected to when they attach to the interface and have not yet been authenticated. This parameter should not be left blank if splash pages are enabled for the interface. No client would be able to access the network through the interface if splash pages are enabled and the login URL parameter does not point to a valid URL.

The 'success URL' parameter sets the URL that a user is redirected to when they have successfully logged in. If this variable is left blank, a default page that indicates login success will be displayed.

The 'fail URL' parameter sets the URL that a user is redirected to when a login attempt fails. If this variable is left blank, a default page that indicates login failure will be displayed.

The 'error URL' parameter sets the URL that a user is redirected to when a login error has occurred. For example, this page would be displayed if a valid authentication server could not be reached. If this variable is left blank, a default page that indicates an error has occurred will be displayed.

CLI

In the examples that follow, <intf> represents any of the client access interfaces 'wlan1', 'wlan2', 'wlan3', or 'wlan4'. The 'splash.url.<intf>.login' parameters in the 'sys' interface set the login URLs. The 'splash.url.<intf>.success' parameters in the 'sys' interface set the success URLs. The 'splash.url.<intf>.fail' parameters in the 'sys' interface set the fail URLs. The 'splash.url.<intf>.error' parameters in the 'sys' interface set the error URLs

The example below shows how the 'wlan1' and 'wlan2' interfaces can be set to use different URLs for the login process.

```
> use sys
sys> set splash.url.wlan1.login=http://server.domain.com/wlan1_login.htm
sys> set splash.url.wlan1.success=http://server.domain.com/wlan1_success.htm
sys> set splash.url.wlan1.fail=http://server.domain.com/wlan1_fail.htm
sys> set splash.url.wlan1.error=http://server.domain.com/wlan1_error.htm
sys> set splash.url.wlan2.login=http://server.domain.com/wlan2_login.htm
sys> set splash.url.wlan2.success=http://server.domain.com/wlan2_success.htm
sys> set splash.url.wlan2.fail=http://server.domain.com/wlan2_fail.htm
sys> set splash.url.wlan2.error=http://server.domain.com/wlan2_error.htm
```

Web GUI

All of the splash page-related URLs can be set on the “Splash Pages” sub-tab under the “AAA” tab on the “System Parameters” page of the web interface (see Figure 59).

18.1.3 Sample HTML Code for Splash Pages

The login HTML page must contain specific form information as shown in the sample code in Figure 60 and Figure 61. Figure 60 contains the code required for an interface that requires a login. Figure 61 contains code for a login page that the user just clicks through to unlock network access.

The critical lines in Figure 60 are 6, 12, 15, and 19. The ‘action’ value in line 6 of Figure 60 must point to a server name for which there is a DNS proxy entry on the local mesh device and the last part of it must be ‘/radius/login.cgi’. The DNS proxy entry, which will be different for each mesh device in the network, must be mapped to one of the EnRoute500’s IP addresses (see section 8.8 for more information on how to set the DNS proxy configuration).

The example below shows how to configure the DNS proxy assuming the login page redirects to the host ‘redirect.domain.com’ and the IP address of the wlan1 interface is 10.1.2.1.

```
> use sys
sys> set dnsproxy.enable=yes
sys> set dnsproxy.hosts=”dns.proxy.name.here=10.1.2.1”
```

INFO

> The DNS proxy setting is used in conjunction with the splash pages to ensure that a common login URL can be used on all mesh devices. The DNS proxy entry directs the results of the login process to the right location – that is, the EnRoute500 that the client device is connected to.

The login page must also contain the ‘input’ fields on lines 12, 15, and 19. These are used to allow a user logging in to provide their username and password, and to submit them. The names of these input fields, ‘username’, ‘password’, and ‘login’, must not be changed.

```
<html>
<head>
  <title>Test Login Page</title>
</head>
<body>
  <form method="POST" action="https://dns.proxy.name.here/radius/login.cgi">
  Welcoming text or 'Terms of Service' could go here. <br />

  <table border="0">
  <tr>
    <td> Username: </td>
    <td> <input name="username" type="text"><br /> </td>
  </tr><tr>
    <td> Password: </td>
    <td> <input name="password" type="password"> </td>
  </tr>
  </table>

    <input name="login" type="submit" value="Submit">
  </form>
</body>
</html>
```

Figure 60. Sample HTML code for login web page with password authentication

If the splash page is not configured to require a user to provide login credentials, the requirements for the login page are slightly different, as shown in Figure 61. The page must still contain a form definition similar to that on line 6 in Figure 61. The ‘action’ value must be set to point to a proxied server name, just as for the case where a user is required to provide login credentials. The last part of the ‘action’ value must be ‘/splash/nologin.cgi’. Also, a button with the name ‘login’ must be defined, as shown on line 8 of Figure 61.

```
 1  <html>
 2  <head>
 3    <title>Test Login Page</title>
 4  </head>
 5  <body>
 6    <form method="POST" action="https://dns.proxy.name.here/splash/nologin.cgi">
 7    Welcoming text or 'Terms of Service' could go here.<br />
 8      <input name="login" type="submit" value="Continue">
 9    </form>
10  </body>
11  </html>
```

Figure 61. Sample HTML code for web page when authentication is disabled

18.1.4 Configuring the Authentication Server

A RADIUS authentication server must be specified when the splash page is enabled for an interface and login is required. The following parameters must be specified:

- the server address – can be either a hostname or and IP address

- the port on the server that the RADIUS server is listening on
- the shared secret – must be a string of alphanumeric characters that is 32 characters or less in length.

CLI

The ‘splash.auth.server.<intf>.host’, ‘splash.auth.server.<intf>.port’, and ‘splash.auth.server.<intf>.secret’ parameters in the ‘sys’ interface, where <intf> is either ‘wlan1’, ‘wlan2’, ‘wlan3’, or ‘wlan4’, specify the authentication server to use. The example below shows how to configure the authentication server for interfaces ‘wlan1’ and ‘wlan2’.

```
> use sys
sys> set splash.auth.server.wlan1.host=auth1.yourserverhere.com
sys> set splash.auth.server.wlan1.port=1812
sys> set splash.auth.server.wlan1.secret=authsecret
sys> set splash.auth.server.wlan2.host=auth2.yourserverhere.com
sys> set splash.auth.server.wlan2.port=1812
sys> set splash.auth.server.wlan2.secret=authsecret
```

Web GUI

The authentication server parameters can be set on the “Splash Pages” sub-tab under the “AAA” tab on the “System Parameters” page of the web interface (see Figure 59) using the fields for “Login Server Address”, “Login Server Port”, and “Login Server Secret”.

18.1.5 Trusted MAC Addresses

A list of trusted MAC addresses, which do not require splash page authentication, can be defined. When a device with one of these MAC addresses connects to an EnRoute500, it will automatically have full access to the WAN.

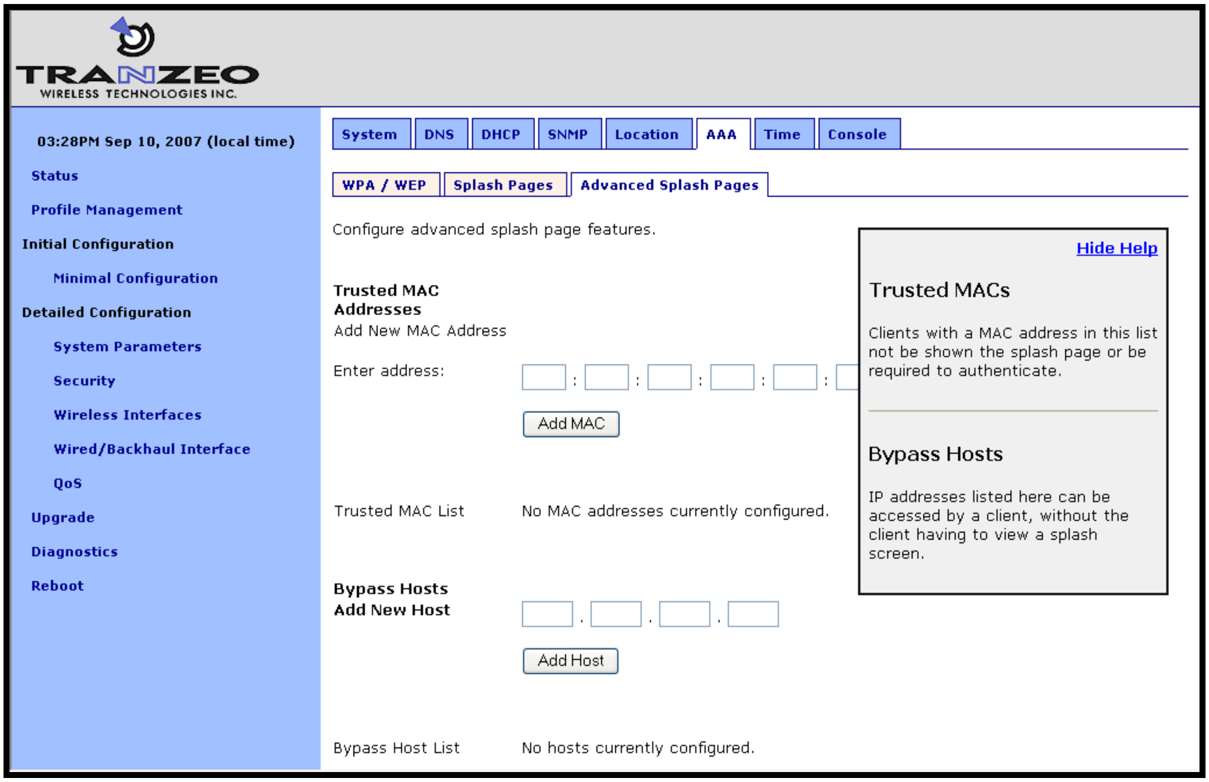
CLI

The list of trusted MAC addresses is set with the ‘splash.trusted_macs’ parameter in the ‘sys’ interface. The MAC addresses are specified as a list of 48-bit addresses separated by commas. An example of setting this parameter is shown below.

```
> use sys
sys> set splash.trusted_macs="aa:bb:cc:00:00:01,aa:bb:cc:00:00:02"
```

Web GUI

The authentication server parameters can be set on the “Advanced Splash Pages” sub-tab under the “AAA” tab on the “System Parameters” page of the web interface (see Figure 62). The list of trusted MAC addresses is displayed on this page. To delete a trusted MAC from the list, click on the “Delete MAC” button next to the MAC address.



Configure advanced splash page features.

Trusted MAC Addresses
Add New MAC Address

Enter address: ☐ : ☐ : ☐ : ☐ : ☐ : ☐

Trusted MAC List — No MAC addresses currently configured.

Bypass Hosts
Add New Host ☐ . ☐ . ☐ . ☐

Bypass Host List — No hosts currently configured.

Trusted MACs

Clients with a MAC address in this list not be shown the splash page or be required to authenticate.

Bypass Hosts

IP addresses listed here can be accessed by a client, without the client having to view a splash screen.

Figure 62. Adding trusted MAC addresses and accessible hosts

18.1.6 Bypass Splash Pages for Access to Specific Hosts

It is possible to specify a list of IP addresses that client devices can access without the client devices having to view a splash screen.

CLI

The list of hosts that can be accessed without having to view a splash screen is set with the 'splash.bypass_hosts' parameter in the 'sys' interface. The hosts are specified by their IP addresses and must be separated by commas. An example of setting this parameter is shown below.

```
> use sys
sys> set splash.bypass_hosts="1.1.1.1,2.2.2.2"
```

Web GUI

The IP addresses of hosts that can be accessed without having to view a splash screen can be set on the "Advanced Splash Pages" sub-tab under the "AAA" tab on the "System Parameters" page of the web interface (see Figure 62). The list of IP addresses of bypassed hosts is displayed on this page. To delete an IP address from the list, click on the “Delete Host” button next to the IP address.

18.2 Layer 2 Emulation

Certain back-end systems (e.g. Internet gateways) use the MAC addresses of client devices for authentication and accounting purposes. The EnRoute500 uses a layer 3 approach to mesh routing, which means that the client device MAC addresses are typically not provided to the back-end servers. A layer 2 emulation mode can be enabled on the EnRoute500 to provide the client device MAC address information to back-end systems. Note that layer 2 emulation must be enabled to support seamless roaming

When layer 2 emulation is enabled, a mesh neighborhood gateway will send Ethernet (layer 2) frames to the WAN using the MAC address of the client device the packet originated from as the source address. Mesh gateways will act as proxies for incoming client traffic, as well as forward packets with MAC destination addresses of client devices that are in the mesh neighborhood they service.

In layer 2 emulation mode, a mesh gateway will respond to ARP requests if it has a route to the target IP address contained in the ARP request. If central DHCP mode is enabled, the source MAC address will be set to the client device’s MAC address for which a request has been received, thereby facilitating the emulation of the mesh as a layer 2 network. The list of subnets for which a mesh gateway has routes includes the mesh and implicit/explicit network addresses. If central DHCP mode is enabled, the mesh gateway routing table also includes host routes to addresses in the client address space. Thus care must be taken that these subnets are not used elsewhere in the network.

In order to reduce the amount of address space consumed by the mesh, the ARP responses can be limited to a subset of the mesh’s address space. The EnRoute500 can be configured to:

- Disregard ARP requests for mesh IP addresses (typically in the 172.29.0.0/16 subnet)
- Disregard all ARP requests except for IP addresses within the client address space (if centralized DHCP server mode is enabled). Note that this is a superset of the previous case.

CLI

Layer 2 emulation is enabled with the ‘l2.client_mac_fwd’ parameter in the ‘sys’ interface. This parameter should be set to the same value for all devices in a given mesh neighborhood. The example below shows how to enable layer 2 emulation.

```
> use sys
sys> set l2.client_mac_fwd=yes
```

To limit the range of addresses for ARP requests that the gateway will respond to, set the ‘l2.hide_internal.enable’ parameter in the ‘sys’ interface to ‘yes’. Set the ‘l2.hide_internal.gateway.deny.mesh’ in the ‘sys’ interface to ‘yes’ to disregard ARP requests for IP addresses within the mesh subnet (typically 172.29.0.0/16). Set ‘l2.hide_internal.gateway.deny.all’ in the ‘sys’ interface to ‘yes’ to disregard all ARP requests (except for addresses within the client address space if centralized DHCP server mode is enabled).

The example below shows how to disregard all ARP requests except for those for addresses within the client address space.

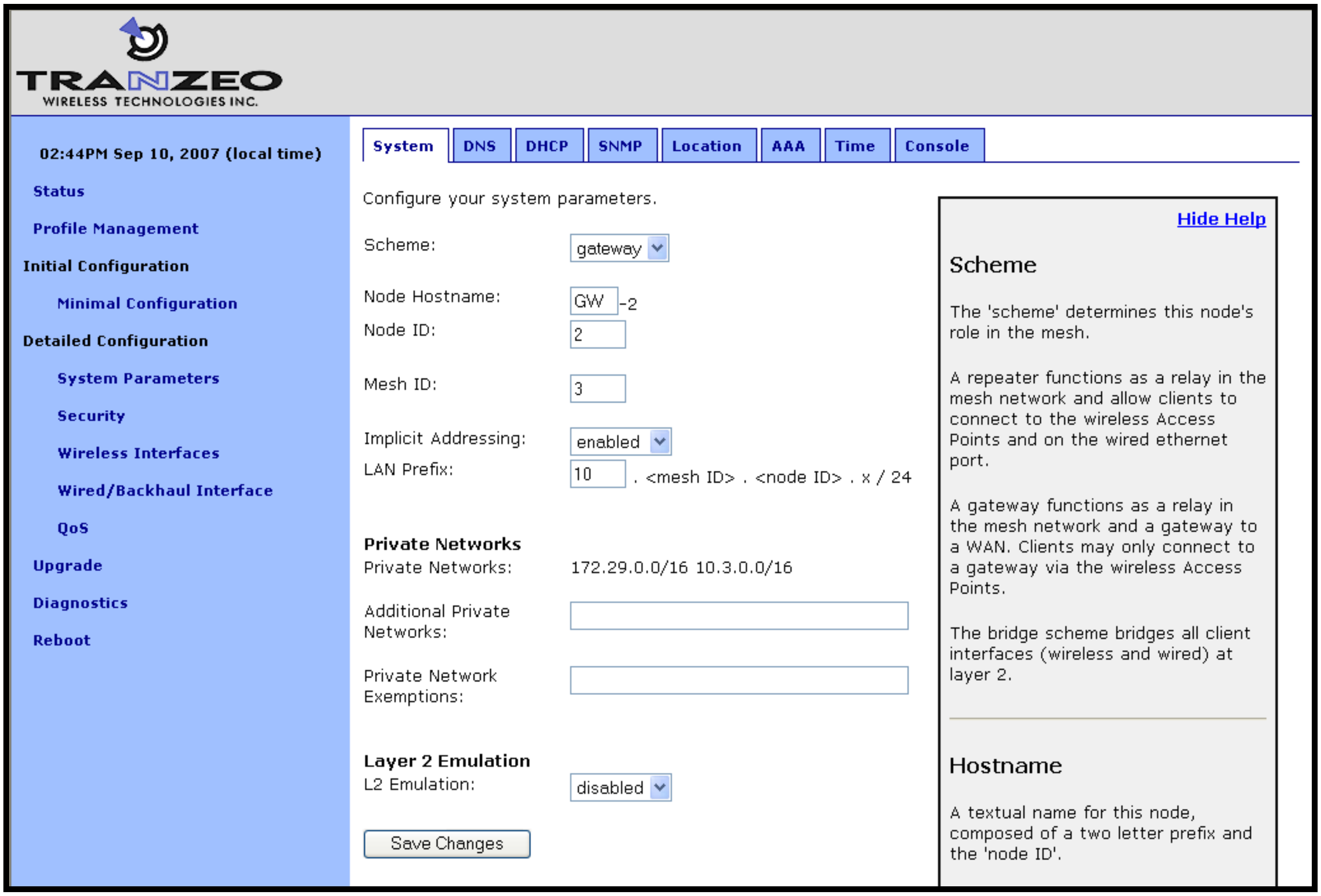
```
> use sys
sys> set l2.hide_internal.enable=yes
sys> set l2.hide_internal.gateway.deny.all=yes
```

The example below shows how to disregard all ARP except for addresses within the mesh address space.

```
> use sys
sys> set l2.hide_internal.enable=yes
sys> set l2.hide_internal.deny.mesh=yes
sys> set l2.hide_internal.deny.all=no
```

Web GUI

The state of layer 2 emulation is set on the “System” tab of the “System” page (see Figure 63). The console interface in the web GUI must be used to configure which address ranges the gateway responds to ARP requests for. See the CLI section above for parameter names and set these using the console interface (see section 8.15).



Configure your system parameters.

Scheme: gateway

Node Hostname: GW -2

Node ID: 2

Mesh ID: 3

Implicit Addressing: enabled

LAN Prefix: 10 . <mesh ID> . <node ID> . x / 24

Private Networks

Private Networks: 172.29.0.0/16 10.3.0.0/16

Additional Private Networks:

Private Network Exemptions:

Layer 2 Emulation

L2 Emulation: disabled

Scheme

The 'scheme' determines this node's role in the mesh.

A repeater functions as a relay in the mesh network and allow clients to connect to the wireless Access Points and on the wired ethernet port.

A gateway functions as a relay in the mesh network and a gateway to a WAN. Clients may only connect to a gateway via the wireless Access Points.

The bridge scheme bridges all client interfaces (wireless and wired) at layer 2.

Hostname

A textual name for this node, composed of a two letter prefix and the 'node ID'.

Figure 63. Enabling/disabling layer 2 emulation

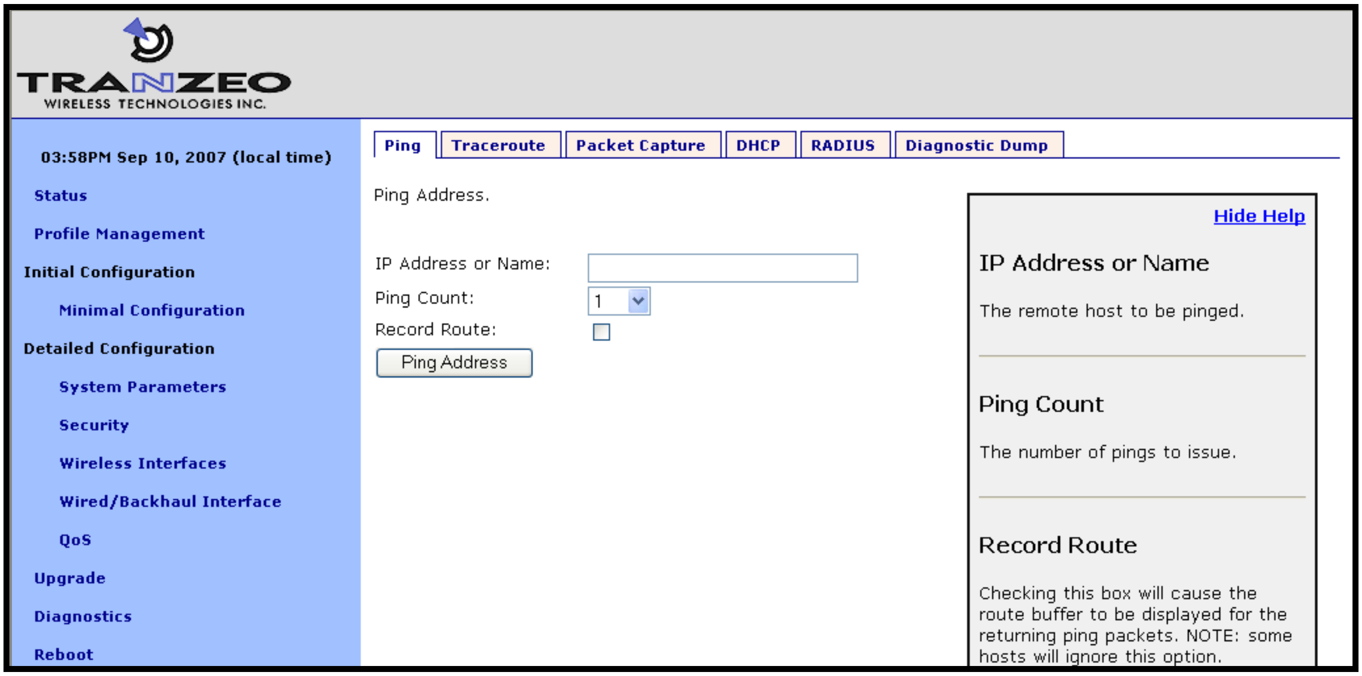
19 Diagnostics Tools

The EnRoute500 has a number of diagnostics tools to help the user diagnose and correct configuration issues. These tools are available on the “Diagnostics” page, accessible from the navigation bar. The individual diagnostics tools are accessible from the row of tabs shown on the “Diagnostics” page.

19.1 Ping

The “Ping” tab on the “Diagnostics” page allows the user to check for network connectivity by pinging a remote device (see Figure 64). Either an IP address, e.g. 10.1.2.3, or a hostname, e.g. www.yahoo.com, can be specified. The number of pings to send can be set to 1, 10, or 100.

Click on “Ping Address” to start pinging the device. The results of the pings will appear on the bottom half of the page shortly after clicking on the button. There may be a delay of a few seconds to display the ping results if the ping destination is not responsive.



Ping Address.

IP Address or Name:

Ping Count: 1

Record Route: □

IP Address or Name

The remote host to be pinged.

Ping Count

The number of pings to issue.

Record Route

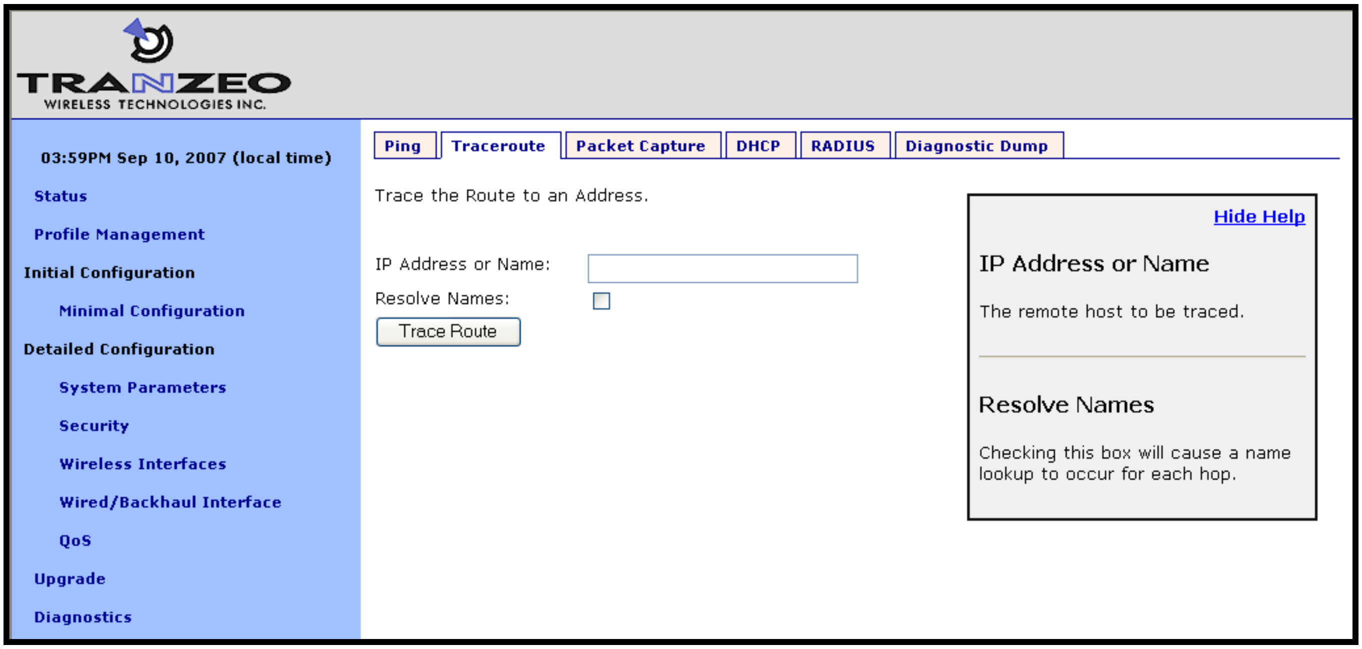
Checking this box will cause the route buffer to be displayed for the returning ping packets. NOTE: some hosts will ignore this option.

Figure 64. Pinging a remote device

19.2 Traceroute

The “Traceroute” tab on the “Diagnostics” page allows the user to determine the individual intermediary devices used to route traffic from the EnRoute500 to a remote device (see Figure 65).

Enter the IP address, e.g. 10.1.2.3, or hostname, e.g. www.yahoo.com, of the device you wish to find the route path to. Check the “Resolve Names” box if traceroute should show device names, when available, instead of just IP addresses. Click on the “Trace Route” button to begin tracing the route. The intermediary nodes will be displayed on the bottom half of the page. Click on “Stop Trace” to stop the tracing process.



03:59PM Sep 10, 2007 (local time)

Trace the Route to an Address.

IP Address or Name:

Resolve Names: □

IP Address or Name

The remote host to be traced.

Resolve Names

Checking this box will cause a name lookup to occur for each hop.

Figure 65. Determining the route from the EnRoute500 to a remote device using traceroute

19.3 Packet Capture

The “Packet Capture” tab on the “Diagnostics” page allows the user to capture traffic on the EnRoute500’s network interfaces (see Figure 66). The captured data can either be displayed in the web interface or saved to a file that can be downloaded and analyzed using 3rd-party tools, such as Wireshark (http://www.wireshark.org/). At most, 10 captured files can be saved on the EnRoute500 at any given time.

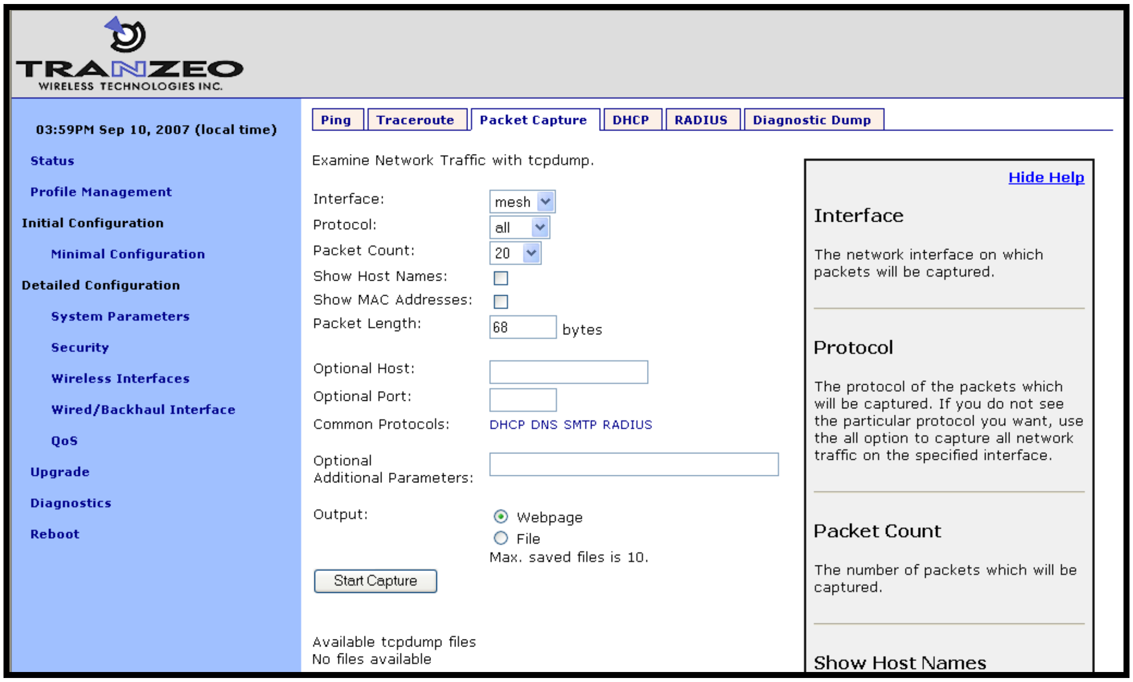
The full array of options available for packet capture is described in Table 16. A number of examples of common packet capture scenarios are also presented below.

Capturing DHCP Traffic From Client Device on wlan1

1. Set “Interface” to “wlan1”
2. Set “Protocol” to “all”
3. Set “Packet Count” to “20”
4. Set “Packet length” to 500
5. Click on “DHCP” next to “Common Protocols”
6. Set “Output” to “File”
7. Click on “Start Capture”
8. Allow the capture to complete automatically when the prescribed number of packets has been captured or click on “Stop Capture” to halt the capture
9. The captured data is accessible by clicking on the link at the bottom of the page under the heading “Available tcpdump files”. The file name format used is “<file prefix>_MMDDYYY.HHMM. Click on this link to save it to your computer. The downloaded file can be parsed by packet analyzers such as Wireshark.
10. Click the checkbox next to the filename in the “Available tcpdump list” and click on the “Delete Selected” button. This will delete the file from the EnRoute500 and free up space for other capture files.

Capturing All Traffic From a Specific Client Device

1. Set “Interface” to the one that the client device is attached to
2. Set “Protocol” to “all”
3. Set “Packet Count” to “500”
4. Set “Packet Length” to 500
5. Set the “Optional Host” to the IP address of the client device of interest
6. Set “Output” to “File”
7. Click on “Start Capture”
8. Allow the capture to complete automatically when the prescribed number of packets has been captured or click on “Stop Capture” to halt the capture
9. The captured data is accessible by clicking on the link at the bottom of the page under the heading “Available tcpdump files”. The file name format used is “<file prefix>_MMDDYYY.HHMM. Click on this link to save it to your computer. The downloaded file can be parsed by packet analyzers such as Wireshark.
10. Click the checkbox next to the filename in the “Available tcpdump list” and click on the “Delete Selected” button. This will delete the file from the EnRoute500 and free up space for other capture files.



03:59PM Sep 10, 2007 (local time)

Examine Network Traffic with tcpdump.

Interface: mesh
Protocol: all
Packet Count: 20
Show Host Names: □
Show MAC Addresses: □
Packet Length: 68 bytes

Optional Host:
Optional Port:
Common Protocols: DHCP DNS SMTP RADIUS

Optional Additional Parameters:

Output: ● Webpage ○ File
Max. saved files is 10.

Available tcpdump files
No files available

Interface

The network interface on which packets will be captured.

Protocol

The protocol of the packets which will be captured. If you do not see the particular protocol you want, use the all option to capture all network traffic on the specified interface.

Packet Count

The number of packets which will be captured.

Show Host Names

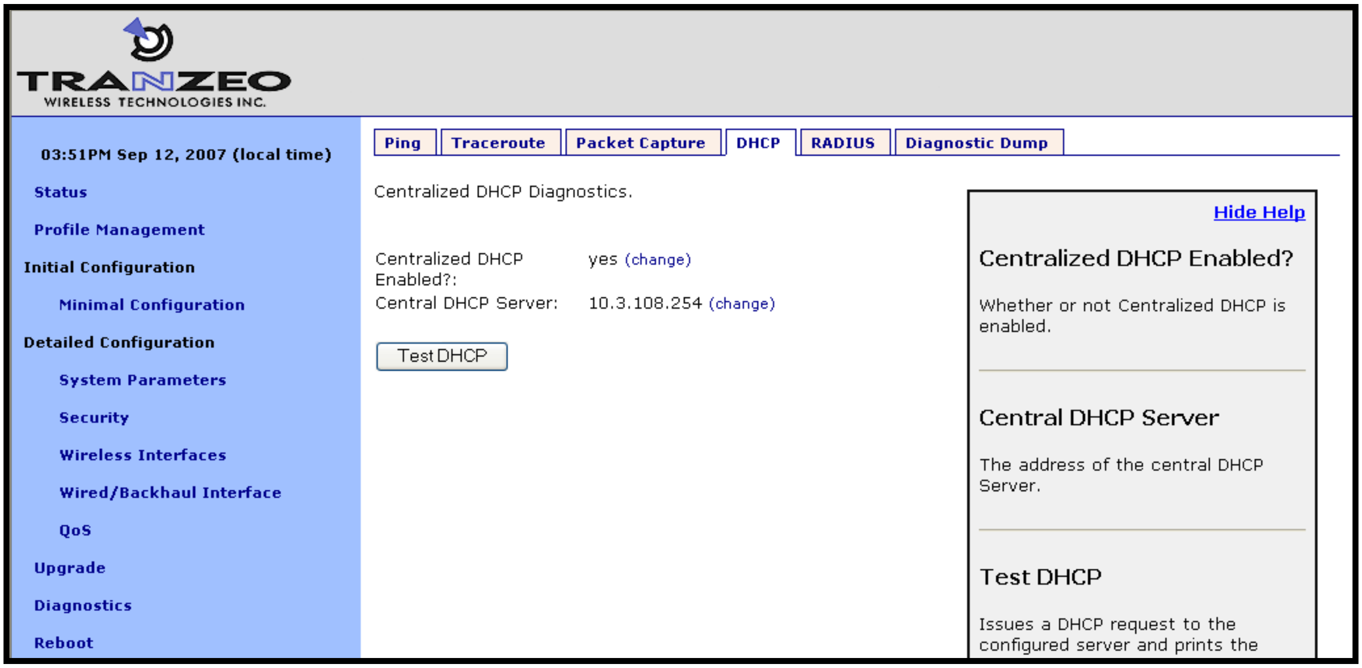
Figure 66. Capturing network traffic

Option	Description
Interface	Selects the interface from which packets are captured. Note that some packets may be available on multiple interfaces. For example, data from a client device connected to wlan1 destined for a device on the Internet will pass through wlan1 and either the wired interface on a gateway device or the mesh interface on a repeater device
Protocol	Data can be captured for the following protocols: TCP, UDP, ICMP, and ARP. Set the value to “all” if you do not wish to filter out packets based on protocol type.
Packet Count	Sets the number of packets to capture. The provided settings are 20, 50, 100, and 500.
Show Host Names	Captured data will show resolved host names instead of IP addresses when this option is selected.
Show MAC addresses	In addition to IP address or hostnames, source and destination MAC addresses will be displayed for each packet when this option is selected.
Packet Length	Sets the length of each packet that should be captured. If you are only interested in the header contents of a packet, this value can be lowered to reduce the size of the data capture file. If it is set to too low of a value, critical data may be not be captured though.
Optional Host	Sets a host name or IP address to use for filtering purposes. All packets with this host as their source OR destination address will be captured.
Optional Port	Sets a port to use for filtering purposes. All packets with this port as their source OR destination port will be captured. NOTE: this setting only has an effect on capture of TCP or UDP packets.
Common Protocols	Click on the protocol names listed to add filtering parameters for them in the “Additional Parameters” text box. It is possible to select more than one protocol to filter on.
Optional Additional Parameters	The underlying application used to capture packets is tcpdump. Use this field to specify additional parameters to tcpdump that are not made available through the GUI.
Output	Select whether to display the data on the webpage or to save it to a file, which can be downloaded from the device. The file name format used is “<file prefix>_MMDDYYY.HHMM.
Output File Prefix	Sets an optional file prefix for saved files.

Table 16. Packet capture options

19.4 Centralized DHCP Testing

The “DHCP” tab on the “Diagnostics” page can be used to test access to an external DHCP server when the EnRoute500 is in centralized DHCP server mode (see Figure 67). Click on the “Test DHCP” button to initiate a test. The results of the test will be displayed at the bottom of the page.



Centralized DHCP Diagnostics.

Centralized DHCP Enabled?: yes (change)
Central DHCP Server: 10.3.108.254 (change)

Centralized DHCP Enabled?

Whether or not Centralized DHCP is enabled.

Central DHCP Server

The address of the central DHCP Server.

Test DHCP

Issues a DHCP request to the configured server and prints the

Figure 67. Testing the connection to an external DHCP server

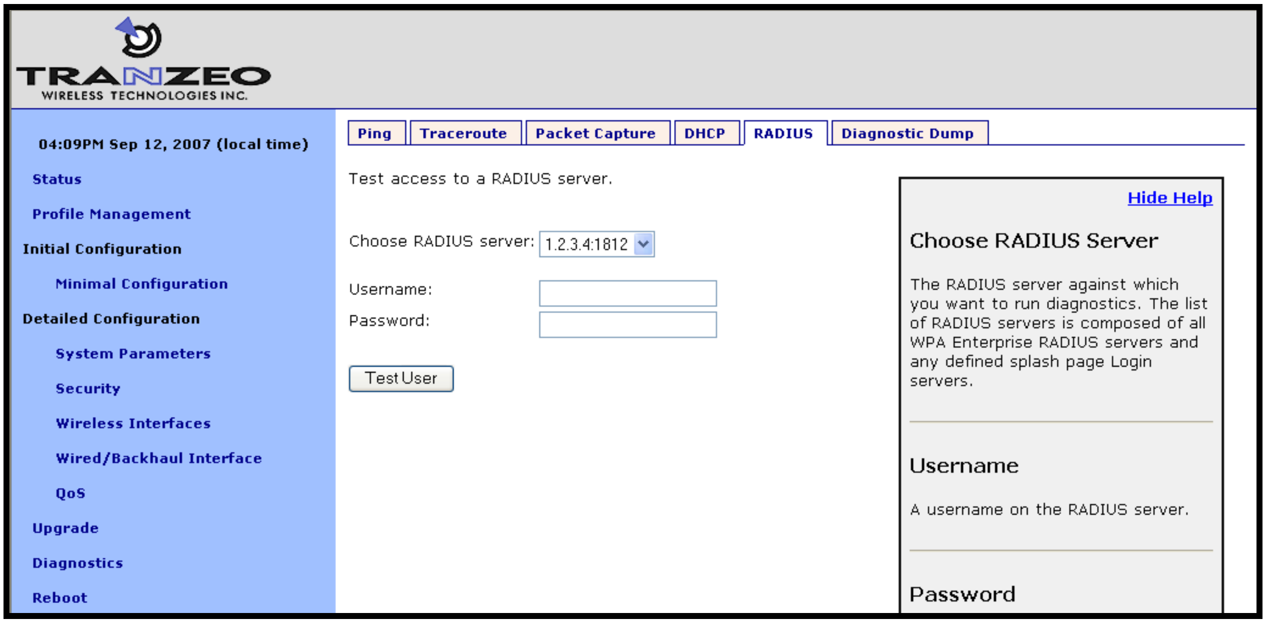
19.5 RADIUS Server Testing

The “RADIUS” tab on the “Diagnostics” page can be used to test authentication of credentials by a RADIUS servers used for splash page or WPA authentication (see Figure 68). Use the procedure below to test the validity of credentials with a RADIUS server.

1. Select the RADIUS server you want to use for the test from the drop-down menu
2. Enter the credentials you want to test in the “Username” and “Password” fields
3. Click on the “Test User” button

The results of the test will be displayed at the bottom of the page. Three outcomes are possible:

- The credentials were authenticated by the server
- Communication was established with the server, but the credentials were not valid
- It was not possible to establish communication with the server



Test access to a RADIUS server.

Choose RADIUS server: 1.2.3.4:1812

Username:

Password:

Choose RADIUS Server

The RADIUS server against which you want to run diagnostics. The list of RADIUS servers is composed of all WPA Enterprise RADIUS servers and any defined splash page Login servers.

Username

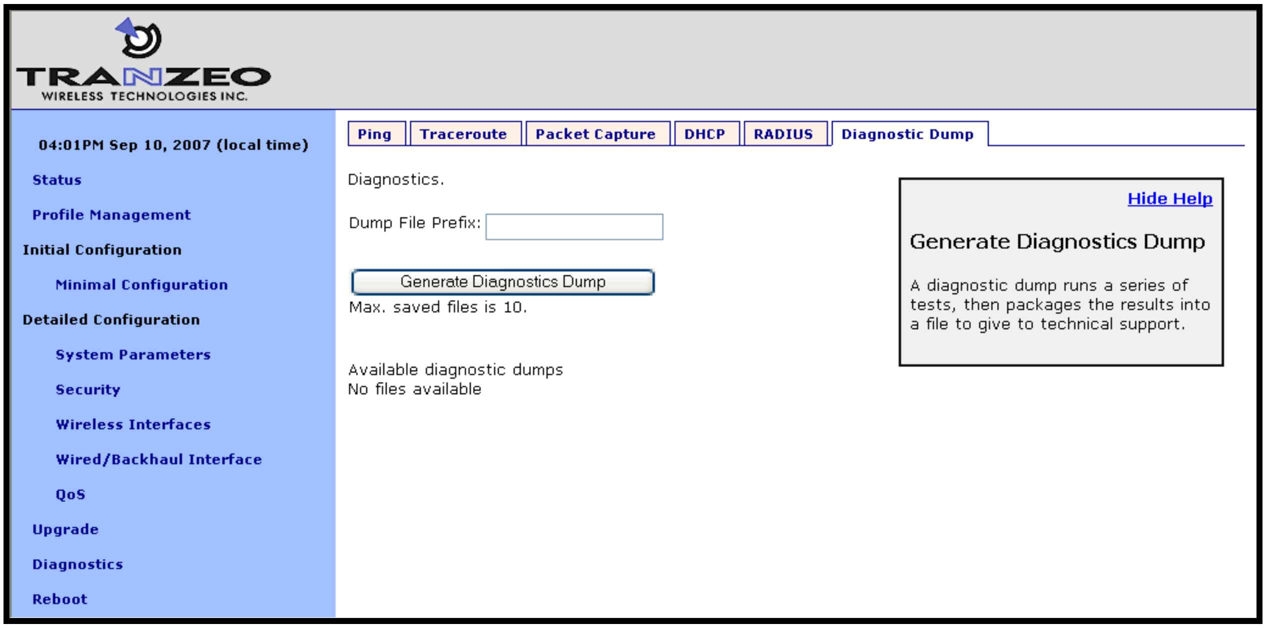
A username on the RADIUS server.

Password

Figure 68. Testing credentials with a RADIUS server

19.6 Diagnostic Dump

The “Diagnostic Dump” tab on the “Diagnostics” page allows the user to create a snapshot of diagnostic data that can be downloaded to a PC and sent to Tranzeo technical support for analysis (see Figure 69).



Diagnostics.

Dump File Prefix:

Max. saved files is 10.

Available diagnostic dumps
No files available

Generate Diagnostics Dump

A diagnostic dump runs a series of tests, then packages the results into a file to give to technical support.

Figure 69. Generating a diagnostic dump

The list of diagnostic dumps available for download is displayed at the bottom of the page. The diagnostic dumps can be downloaded by clicking on the filenames. To delete one or more diagnostic dumps, select the check boxes next to the ones you wish to delete and then click on the “Delete Selected” button.

20 Firmware Management

20.1 Displaying the Firmware Version

The firmware version string contains the following information:

- Build date
- Major version number
- Minor version number
- Build number

These values are embedded in the version string as follows:

enroute500_< Build date >_< Major version >_< Minor version >_< Build number>

CLI

Firmware version information is available in the ‘version’ interface. The example below shows how to display the current firmware version.

```
> use version
version> get release
 release = ENROUTE500_20060419_00_00_0133
```

Web GUI

The firmware version is displayed at the top of the “Status” page accessible via the web interface.

20.2 Upgrading the Firmware

The EnRoute500 supports secure remote firmware upgrade.

⚠ **When upgrading the firmware, it is important to upgrade the firmware on all devices in a mesh neighborhood.**

⚠ **Prior to upgrading firmware, please contact Tranzeo technical support to find out if there are any version-specific instructions for upgrading from the firmware version you are currently using.**

There are two approaches for upgrading the firmware of a number of devices in a mesh neighborhood:

- Upgrade the firmware on each device individually
- Upgrade the firmware for the entire mesh neighborhood from the mesh gateway

The latter method is the recommended approach.

INFO

> The primary benefit of using the mesh neighborhood upgrade approach is that the gateway will determine the order in which it should start the upgrades of devices in the mesh based on their relative connectivity. If each device is upgraded manually, the user must determine the connectivity between devices to ensure that they are upgraded in an order such that connectivity to devices isn't broken. For example, consider the following scenario:
>
> - Device 1 is a gateway
> - Device 2 is a repeater connected to device 1
> - Device 3 is a repeater connected to device 2
>
> If the upgrade of device 2 is started before the upgrade of device 3, the connection to device 3 from the gateway will be lost, preventing the user from connecting to that device.

⚠

> **At least the gateway device must have access to the Internet, and specifically the Tranzeo upgrade server, to complete an upgrade unless the upgrade image has already been downloaded to the device's non-volatile memory.**

⚠

> **If power to the EnRoute500 is lost during the upgrade process, it is possible that the device will become inoperable.**

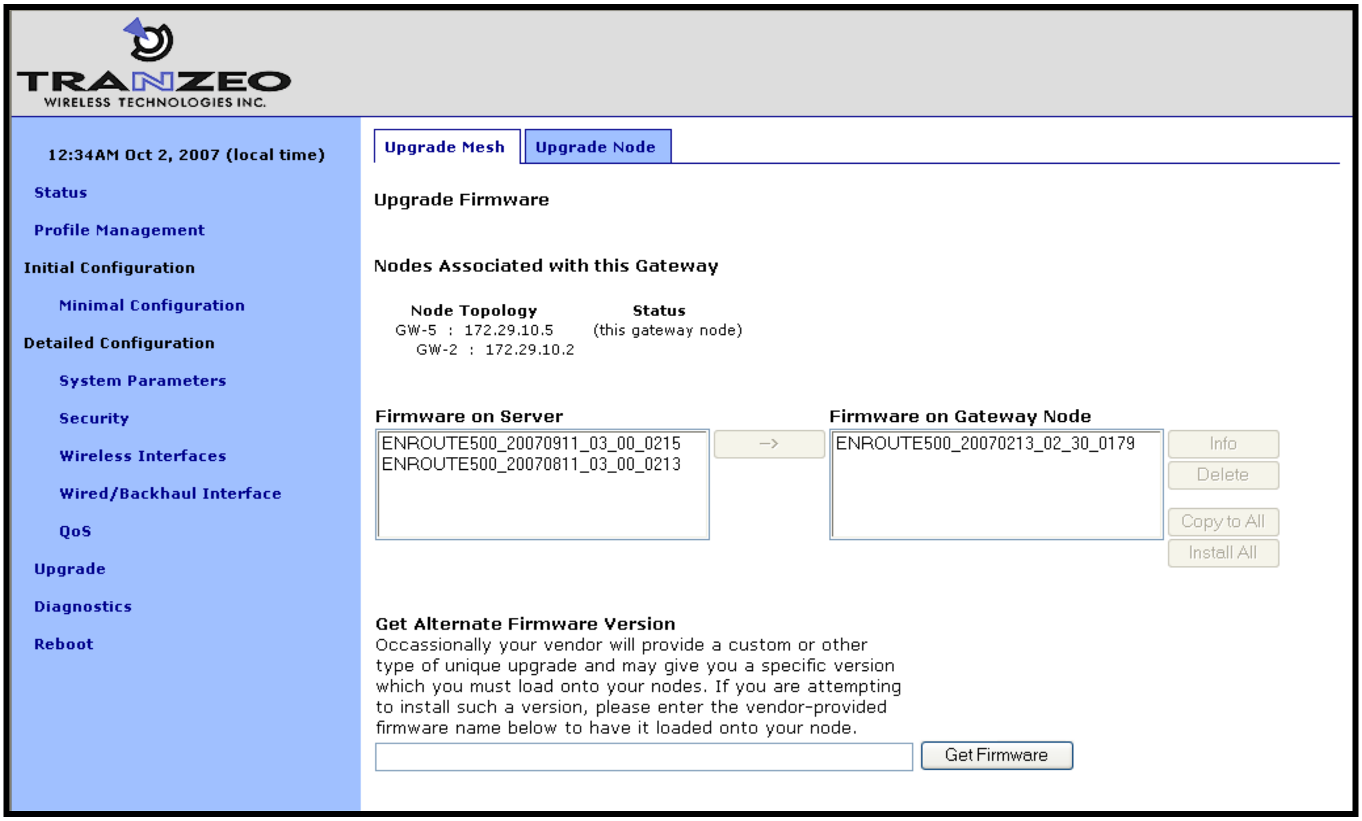
20.2.1 Upgrading the Firmware on all Devices in a Mesh Neighborhood

INFO

> The web GUI page for upgrading all devices in a mesh neighborhood is only available on devices configured as gateways.

It is possible to control the firmware upgrade of all devices in a mesh neighborhood from the "Upgrade Mesh" tab on the "Upgrade" page. This page displays the following information:

- Firmware available on the remote upgrade server
- Firmware available in the non-volatile memory of the EnRoute500
- Devices in the mesh neighborhood



Upgrade Firmware

Nodes Associated with this Gateway

Node Topology	Status
GW-5 : 172.29.10.5	(this gateway node)
GW-2 : 172.29.10.2	

Firmware on Server

ENROUTE500_20070911_03_00_0215
ENROUTE500_20070811_03_00_0213

Firmware on Gateway Node

ENROUTE500_20070213_02_30_0179

Get Alternate Firmware Version

Occassionally your vendor will provide a custom or other type of unique upgrade and may give you a specific version which you must load onto your nodes. If you are attempting to install such a version, please enter the vendor-provided firmware name below to have it loaded onto your node.

Figure 70. Updating firmware on all devices in a mesh neighborhood

Follow the procedure below to upgrade the devices in a mesh neighborhood:

1. Select the firmware version you want to upgrade to from the “Firmware on Server” box
2. Click on the button with the arrow to the right of the “Firmware on Server” box. This will begin the download process of the firmware from the Tranzeo upgrade server to the non-volatile memory on the EnRoute500. While the firmware is downloading, it will be shown in blue in the “Firmware on Gateway Node” box.

INFO

> If the completion percentage does not update, click on the “Upgrade Node” tab to update it.

3. When the download has been completed, verify that all the devices you wish to update are listed under the “Nodes Associated with this Gateway” heading. If they are proceed to the next step.
4. Select the firmware you wish to upgrade to from the “Firmware on Gateway Node” box.
5. Click on the “Copy to All” button. The upgrade image will be copied to the devices in the mesh that do not already have it. Text indicating progress will be displayed next to the device IP address under the “Nodes Associated with this Gateway” heading (“files being copied”, “copy completed”, and finally “READY TO BE UPGRADED”).
6. Again, select the firmware you wish to upgrade to from the “Firmware on Gateway Node” box.

7. Click on “Install All”. Text indicating that the node is being upgraded will be displayed next to the device IP address under the “Nodes Associated with this Gateway” heading.
8. Wait for the upgrade to complete (approximately 20 minutes).

20.2.2 Upgrading the Firmware on an Individual Device

The firmware can be upgraded on an individual device using the “Upgrade Node” tab on the “Upgrade” page. This is the only tab that is available on devices configured as repeaters. This page displays the following information:

- Firmware currently installed on the EnRoute500
- Firmware available on the remote upgrade server
- Firmware available in the non-volatile memory of the EnRoute500
- Space used/available in non-volatile memory for storing upgrade images

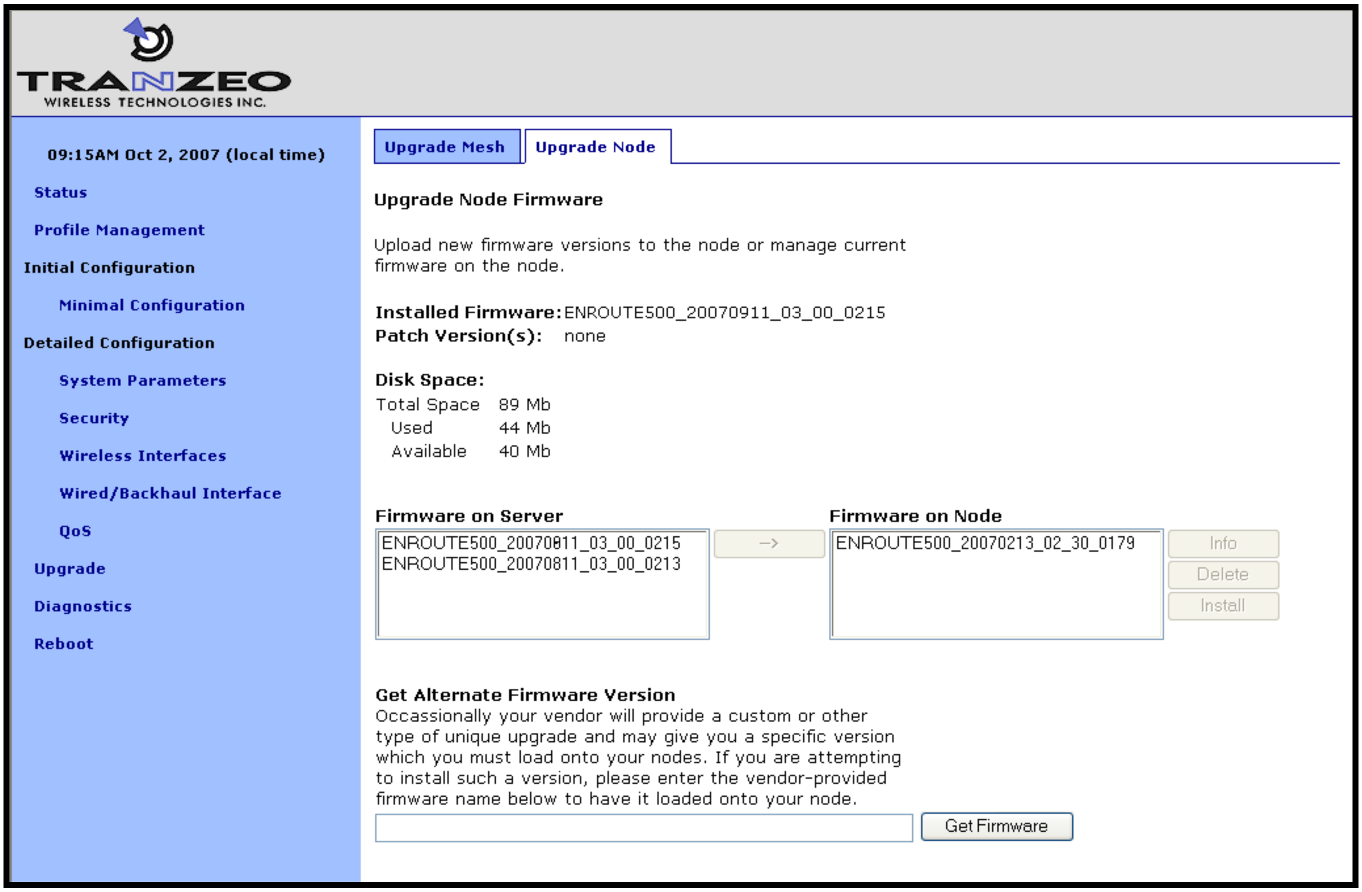
⚠ **Caution should be used when updating the firmware on a single device in a mesh neighborhood. It is advisable to upgrade the devices that are the most hops away from a gateway first and keep upgrading devices that are successively closer to the gateway, upgrading the gateway firmware last.**

Follow the procedure below to upgrade the firmware on a device:

1. Select the firmware version you want to upgrade to from the “Firmware on Server” box
2. Click on the button with the arrow to the right of the “Firmware on Server” box. This will begin the download process of the firmware from the Tranzeo upgrade server to the non-volatile memory on the EnRoute500. While the firmware is downloading, it will be shown in blue in the “Firmware on Gateway Node” box.

INFO If the completion percentage does not update, click on the “Upgrade Node” tab to update it.

3. When the download has been completed, select the firmware you wish to upgrade to from the “Firmware on Node” box.
4. Click on the “Install” button.
5. Wait for the install to complete. The EnRoute500 will reboot automatically when the upgrade has been completed.



09:15AM Oct 2, 2007 (local time)

Upgrade Node Firmware

Upload new firmware versions to the node or manage current firmware on the node.

Installed Firmware: ENROUTE500_20070911_03_00_0215
Patch Version(s): none

Disk Space:

Total Space	89 Mb
Used	44 Mb
Available	40 Mb

Firmware on Server

ENROUTE500_20070811_03_00_0215
ENROUTE500_20070811_03_00_0213

Firmware on Node

ENROUTE500_20070213_02_30_0179

Get Alternate Firmware Version

Occassionally your vendor will provide a custom or other type of unique upgrade and may give you a specific version which you must load onto your nodes. If you are attempting to install such a version, please enter the vendor-provided firmware name below to have it loaded onto your node.

Figure 71. Updating firmware on a single device

Glossary

Client access interface

An interface on the EnRoute500 used by a client device, such as an 802.11-enabled laptop, to connect to the EnRoute500. The client access interfaces are the virtual APs wlan1 – wlan4 and, on devices configured as repeaters, the eth0 Ethernet interface.

Client address scheme

The method used to assign address spaces to client address interfaces. The two supported client address schemes are implicit and explicit.

Client device

A device that is connected to one of the EnRoute500's client access interfaces, e.g. a laptop

Mesh neighborhood

A group of two or more EnRoute500 nodes with at least one configured as a gateway

Mesh gateway

A mesh node that, in addition to relaying traffic between neighboring mesh nodes and supporting wireless clients through its built-in APs, acts as the layer 3 gateway for a mesh neighborhood

Mesh node

A single EnRoute500 that is part of a mesh neighborhood

Mesh repeater

A mesh node that relays traffic to neighboring mesh nodes and supports wireless and wired clients.

Virtual access point

An access point that shares a single AP radio with one or more access points.

Abbreviations

ACL	Access Control List
AP	Access Point
CLI	Command line interface
ESSID	Extended Service Set Identifier
LAN	Local-Area Network
NAT	Network Address Translation
PoE	Power over Ethernet
QoS	Quality of Service
RSSI	Received signal strength indicator
VAP	Virtual Access Point
VLAN	Virtual Local-Area Network
VPN	Virtual Private Network
WAN	Wide-Area Network
WLAN	Wireless Local-Area Network
WPA	Wi-Fi Protected Access
WPA-PSK	Wi-Fi Protected Access Pre-Shared Key