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EnRoute500

User's Guide

Rev. C5

TRANZEO
WIRELESS TECHNOLOGIES INC.

Next Generation Mesh Networks, Today™

Tranzeo Confidential

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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

⚠ 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 little 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 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 nodes. 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 (APs), each with different access and performance settings. It is also possible to connect devices to an EnRoute500 using an Ethernet connection.

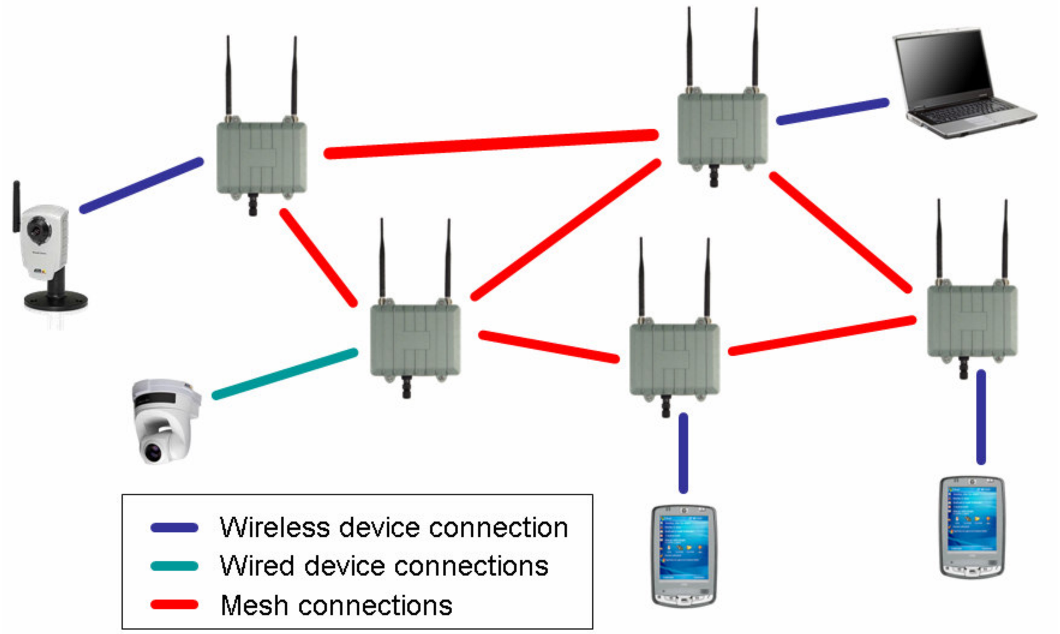


Figure 1. EnRoute500 sample network – devices attach to the EnRoute500 through both wired and wireless connections

1.2 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.

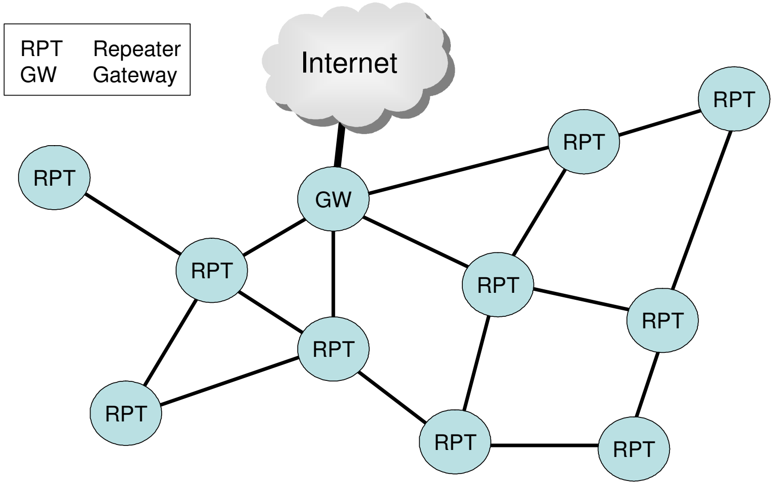


Figure 2. Internet extension network

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 at least one gateway node that provides access from the mesh network to an external network.

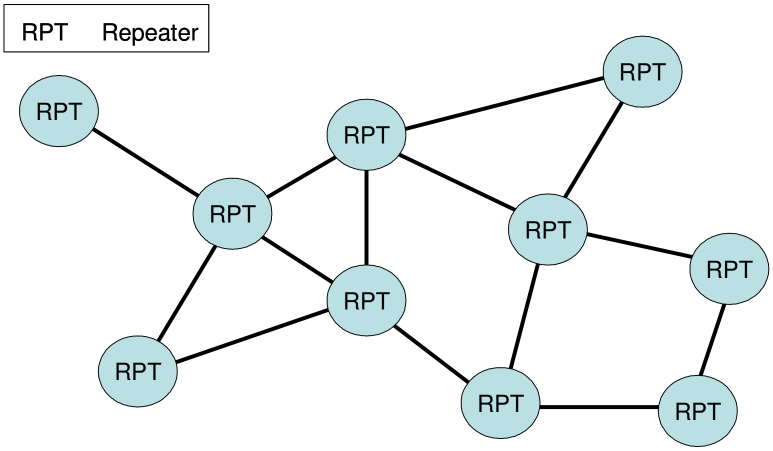


Figure 3. Stand-alone network

In a stand-alone network, as shown in Figure 3, all nodes are configured to operate in the same 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.

1.3 Network Terminology

The following terms will be referred to throughout this manual.

Mesh cloud – a group of nodes configured as one or more clusters

Mesh cluster – a group of two or more EnRoute500s with at least one configured as a gateway

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

1.4 EnRoute500 Interfaces

The EnRoute500 has four external interfaces: power, Ethernet and two radio ports.

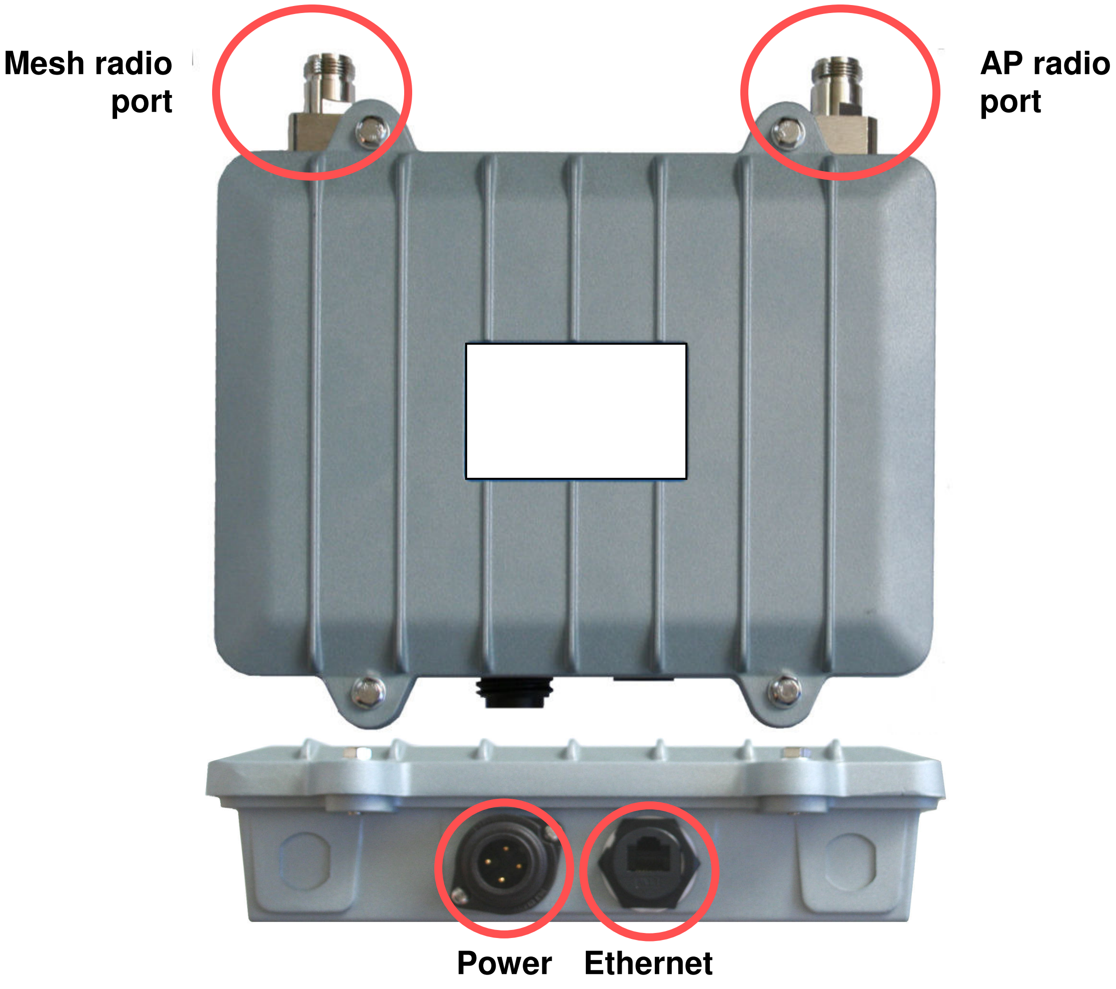


Figure 4. EnRoute500 interfaces

Interface	Description
Power	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 secondary power input (9-28VDC, 12W) *Not compatible with IEEE 802.3af*

Table 1. EnRoute500 Interfaces

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 2. Ethernet port pinout

The EnRoute500 Ethernet port 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 2.

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

The mesh antenna should be attached to the mesh radio port and the access point antenna should be attached to the AP antenna port, as shown in Figure 5.

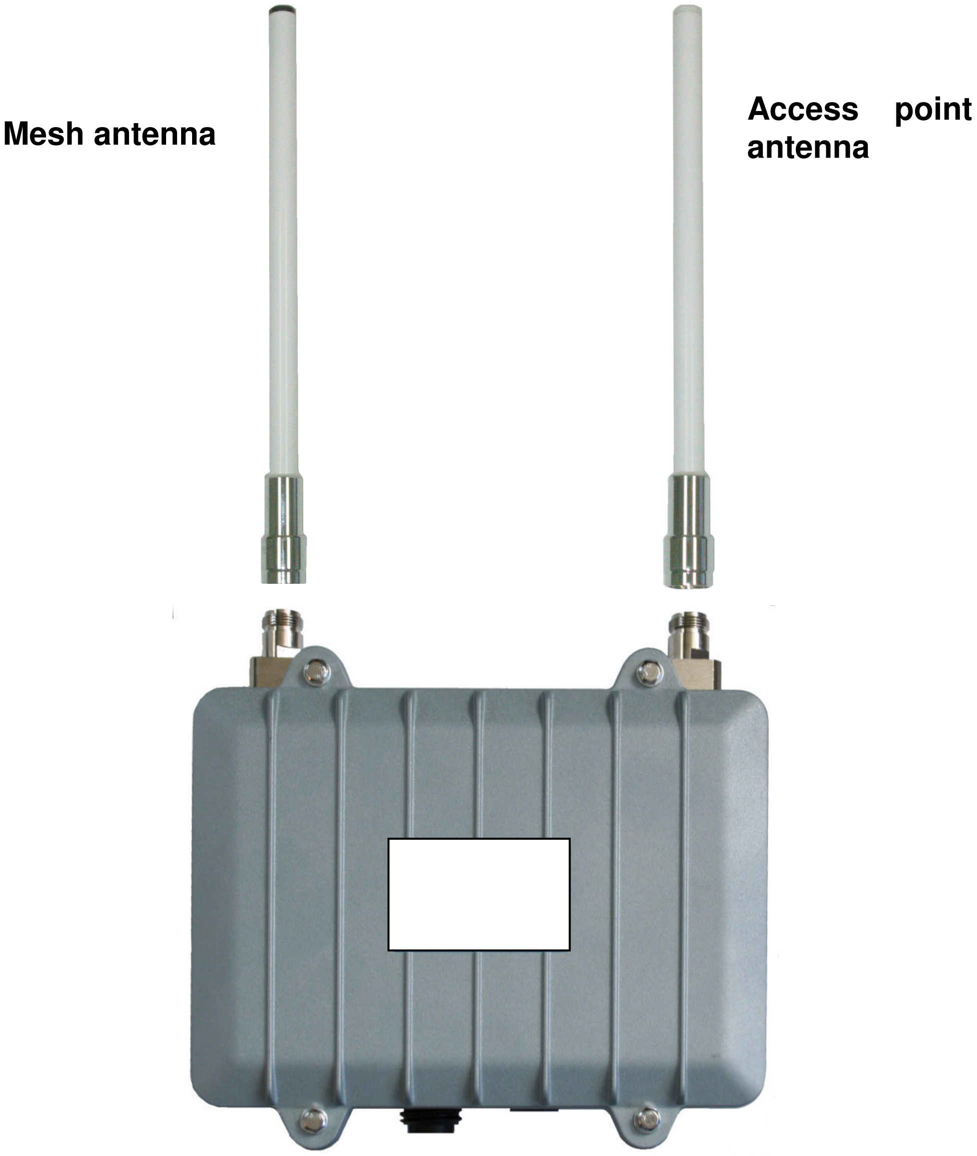


Figure 5. Connecting the mesh and access point antennas

1.5 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.

1.5.1 Mesh channel selection

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

1.5.2 AP channel selection

The access point radio channels used by the EnRoute500s in a mesh cluster can differ. It is advisable to use different access point channels for adjacent mesh nodes 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 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

2.1 Accessing the CLI

The EnRoute500's command-line interface (CLI) is accessible through the device's 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 recommended for devices that have not previously been configured.

The EnRoute500 has a dedicated configuration interface that is accessible via the Ethernet port. This interface is present regardless of the EnRoute500's standard Ethernet interface configuration. The address and netmask of this interface are provided in Table 3.

⚠ Since the configuration IP address (shown in Table 3) is the same for all EnRoute500s, you should not simultaneously connect multiple EnRoute500s to a common LAN and attempt to access them using the configuration IP address.

Parameter	Setting
IP address	169.254.253.253
Netmask	255.255.0.0
Protocol	SSH v2
User name	admin
Default password	mesh

Table 3. EnRoute500 Ethernet configuration interface settings

To use this interface:

1. Configure a computer with an IP address on the 169.254.0.0 subnet
2. Connect the PC to the EnRoute500 using an Ethernet cable. A standard or cross-over cable will work.

3. Login to the node using an SSHv2-capable client application with the credentials provided in Table 3.

> 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.

> 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
> ```

When you log in to the node, 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 6.10 describes how to change the timeout period.

```
Shell timeout: 3 minutes.

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

2.2 User Accounts

There are two user accounts for accessing the EnRoute500: 'admin' and 'monitor'. With the 'admin' account all parameters can be set and viewed. The 'monitor' account only allows users to view a subset of the parameters available. Parameters that affect access to the network, such as encryption keys, are not viewable by the 'monitor' user. The only parameter that can be set by the 'monitor' user is the shell timeout (see section 6.10). The passwords for both users can only be set by the 'admin' user. The procedure for changing passwords is described in section 6.1.

2.3 CLI Interfaces

The CLI provides the user with a number of interfaces that contain related parameters and controls. Some of these interfaces are actual 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 access through the EnRoute500's network interfaces
- 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.

2.4 CLI Features

The CLI has a number of features to simplify the configuration of the EnRoute500.

2.4.1 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.

2.4.2 Cancel a Command

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

2.4.3 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.

2.4.4 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.

2.5 CLI Commands

The usage of all CLI commands is explained below. The command syntax used is

```
command <mandatory argument>
```

```
command [optional argument]
```

2.5.1 '?' 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 '?'.

2.5.2 'whoami' command

Syntax `whoami`

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

2.5.3 'help' command

Syntax

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

where [command] is one of the CLI commands or [parameter] is a parameter in the currently selected interface.

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
```

2.5.4 'show' command

Syntax

```
show
```

Description

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

2.5.5 ‘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.

2.5.6 '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 node 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.

2.5.7 '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
```

2.5.8 '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
```

2.5.9 '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
```

2.5.10 ‘ifconfig’ command

Syntax

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

Description

Displays information, such as IP address and MAC address, for a particular 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)
```

2.5.11 ‘route’ command

Syntax

```
route
```

Description

Displays the current route table.

2.5.12 ‘clear’ command

Syntax

```
clear
```

Description

Clears the screen

2.5.13 ‘history’ command

Syntax

```
history
```

Description

Shows the command history since the node 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=er500ap
```

2.5.14 '!' 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=er500ap1
4: use wlan2
5: set essid=er500ap2
```

the command

```
!1
```

will execute

```
use wlan1
```

The command

```
!use
```

will execute

```
use wlan2
```

2.5.15 'exit' command

Syntax `exit`

Description Terminates the current CLI session and logs out the user

2.5.16 'quit' command

Syntax `quit`

Description Terminates the current CLI session and logs out the user

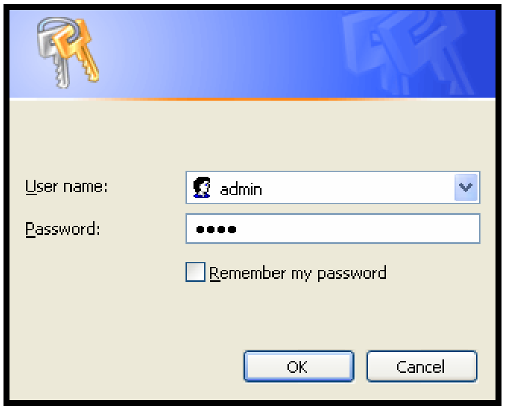
3 Using the Web Interface

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

3.1 Accessing the Web Interface

You can access the web interface by entering one of the node's IP addresses preceded by "https://" in the URL field of a web browser (see section 2.1 for a description of how to access an unconfigured node using its Ethernet interface). When you enter this URL, you will be prompted for a login and password. The login and password used for the web interface is the same as for the CLI (see Table 3 in section 2.1).

The node IP must be preceded by "https://", not "http://", to access the web interface



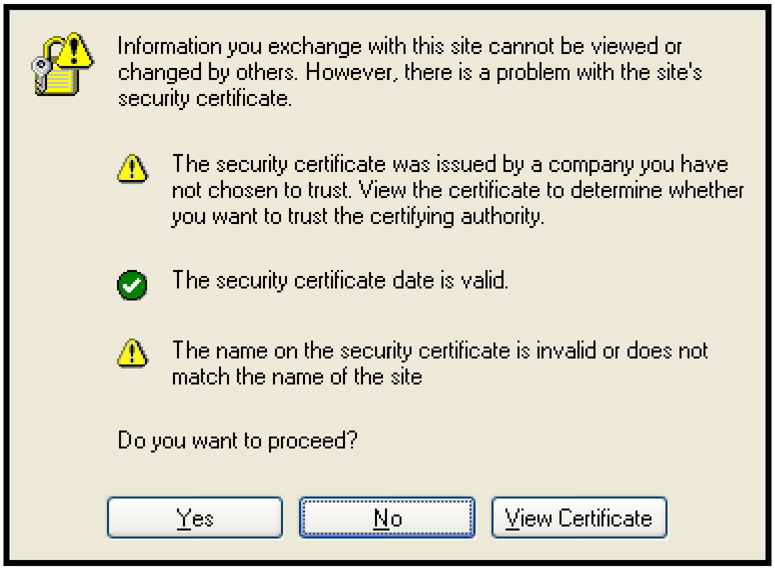
User name: admin

Password: ●●●●

□ Remember my password

Figure 6. Login window for web interface

Since the certificate used in establishing the secure link to the node has not been signed by a Central 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?

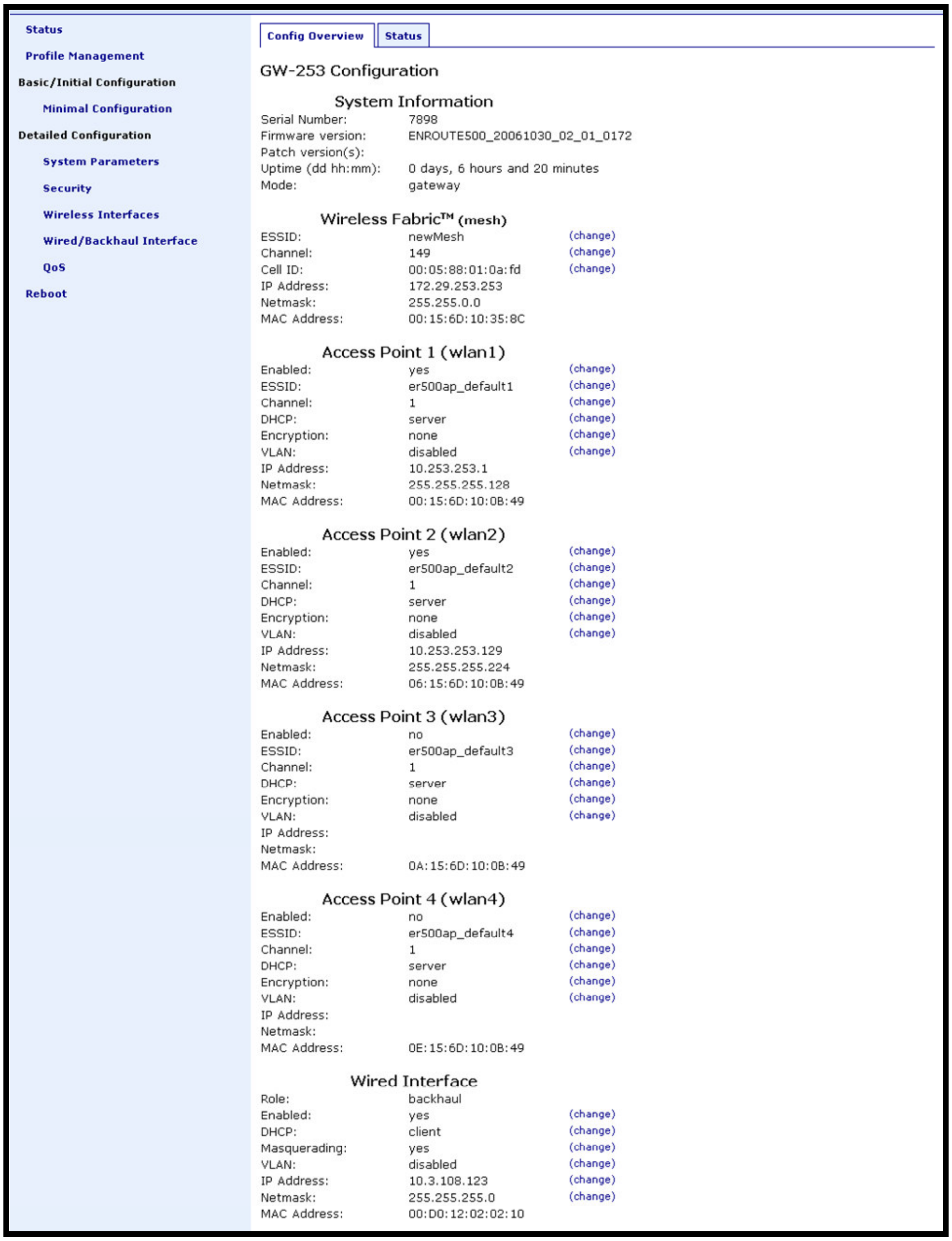
Figure 7. Certificate warning

3.2 Status Page

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

- System type (gateway or repeater)
- System uptime
- Interface IP addresses
- VLAN status and ID for all interfaces
- Mesh interface channel and ESSID
- Access point status, channel, ESSID, and encryption type
- Ethernet interface use (client access or backhaul)
- Firmware version

To access the status page from any other page in the web interface, click on the "Status" button on the left side of the page.



GW-253 Configuration

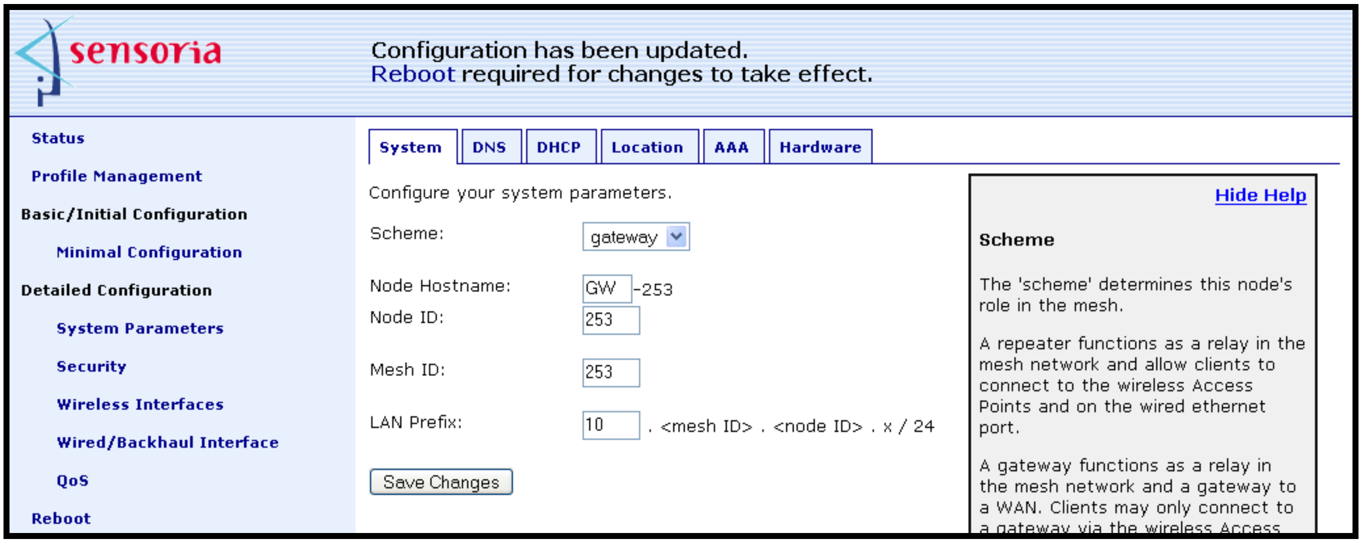
```
System Information
Serial Number:          7898
Firmware version:       ENROUTE500_20061030_02_01_0172
Patch version(s):
Uptime (dd hh:mm):      0 days, 6 hours and 20 minutes
Mode:                   gateway

Wireless Fabric™ (mesh)
ESSID:                  newMesh                 (change)
Channel:                149                     (change)
Cell ID:                00:05:88:01:0a:fd       (change)
IP Address:             172.29.253.253
Netmask:                255.255.0.0
MAC Address:            00:15:6D:10:35:8C

Access Point 1 (wlan1)
Enabled:                yes                     (change)
ESSID:                  er500ap_default1        (change)
Channel:                1                       (change)
DHCP:                   server                  (change)
Encryption:             none                    (change)
VLAN:                   disabled                (change)
IP Address:             10.253.253.1
Netmask:                255.255.255.128
MAC Address:            00:15:6D:10:0B:49

Access Point 2 (wlan2)
Enabled:                yes                     (change)
ESSID:                  er500ap_default2        (change)
Channel:                1                       (change)
DHCP:                   server                  (change)
Encryption:             none                    (change)
VLAN:                   disabled                (change)
IP Address:             10.253.253.129
Netmask:                255.255.255.224
MAC Address:            06:15:6D:10:0B:49

Access Point 3 (wlan3)
Enabled:                no                      (change)
ESSID:                  er500ap_default3        (change)
Channel:                1                       (change)
DHCP:                   server                  (change)
Encryption:             none                    (change)
VLAN:                   disabled                (change)
IP Address:
Netmask:
MAC Address:            0A:15:6D:10:0B:49

Access Point 4 (wlan4)
Enabled:                no                      (change)
ESSID:                  er500ap_default4        (change)
Channel:                1                       (change)
DHCP:                   server                  (change)
Encryption:             none                    (change)
VLAN:                   disabled                (change)
IP Address:
Netmask:
MAC Address:            0E:15:6D:10:0B:49

Wired Interface
Role:                   backhaul
Enabled:                yes                     (change)
DHCP:                   client                  (change)
Masquerading:           yes                     (change)
VLAN:                   disabled                (change)
IP Address:             10.3.108.123            (change)
Netmask:                255.255.255.0           (change)
MAC Address:            00:D0:12:02:02:10
```

Figure 8. Sample status page

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 node must be rebooted. After a change has been committed, a message reminding the user to reboot the node will be displayed at the top of the screen.



Configuration has been updated.
Reboot required for changes to take effect.

Configure your system parameters.

Scheme: gateway

Node Hostname: GW -253

Node ID: 253

Mesh ID: 253

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

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

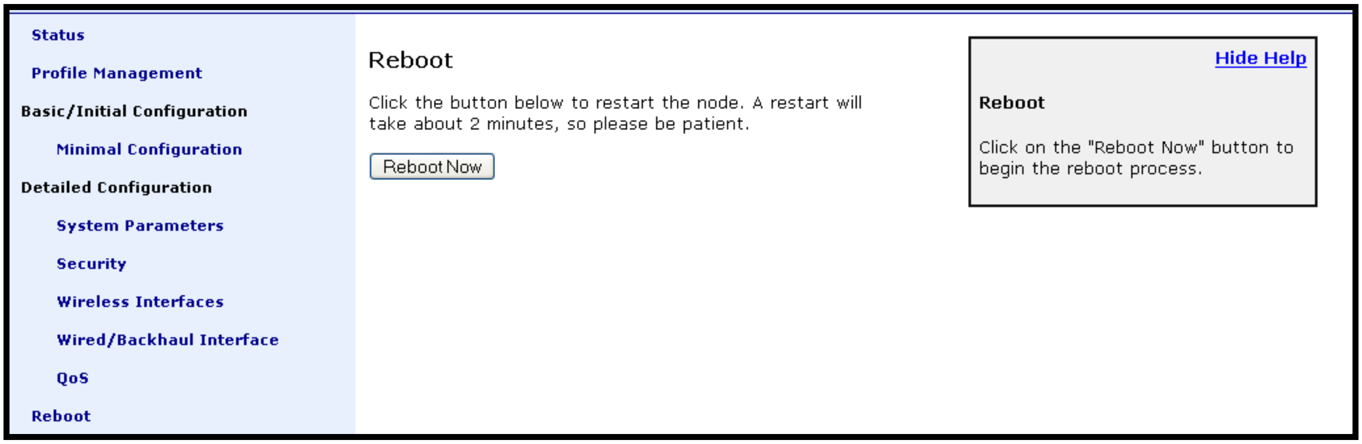
Figure 9. Sample page showing "Save Changes" button and message prompting the user to reboot

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 node.



Reboot

Click the button below to restart the node. A restart will take about 2 minutes, so please be patient.

Reboot

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

Figure 10. Rebooting the node

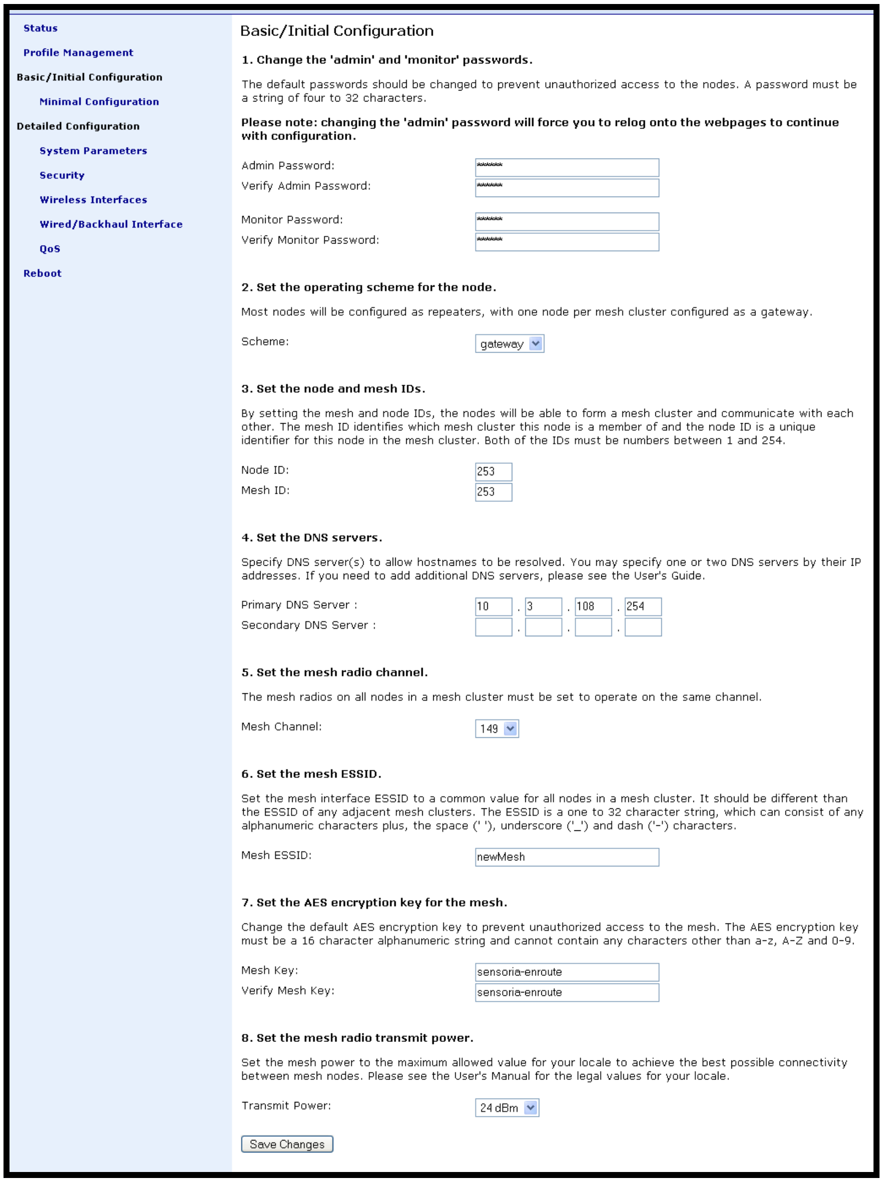
4 Initial Configuration of an EnRoute500

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 the settable parameters. The list below will guide you through a minimal configuration procedure that prepares a network of EnRoute500s for deployment.

1	**Change the 'admin' and 'monitor' passwords.** The default passwords should be changed to prevent unauthorized access to the node.	See section 6.1
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.	See section 6.2
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.	See section 6.3
4	**Set the DNS servers** Specify DNS servers to allow hostnames to be resolved.	See section 6.6
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.	See section 7.1
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 for any adjacent mesh clusters.	See section 7.2
7	**Set the AES encryption key for the mesh** Change the default AES encryption key to prevent unauthorized access to the mesh.	See section 7.3
8	**Set the mesh radio transmit power** Set the mesh power to the maximum allowed value to achieve the best possible connectivity between mesh nodes.	See section 7.4

After these settings have been changed, the EnRoute500s will be able to form a mesh cluster and you will be able to configure the nodes from a central location. 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 that is present on the left-hand side of all web GUI pages.



Basic/Initial Configuration

1. Change the 'admin' and 'monitor' passwords.

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: ******

Monitor Password: ******
Verify Monitor 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: 253
Mesh ID: 253

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 : 10 . 3 . 108 . 254
Secondary DNS Server : . . .

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

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: 24 dBm

Figure 11. Initial configuration web page

5 Configuration Profile Management

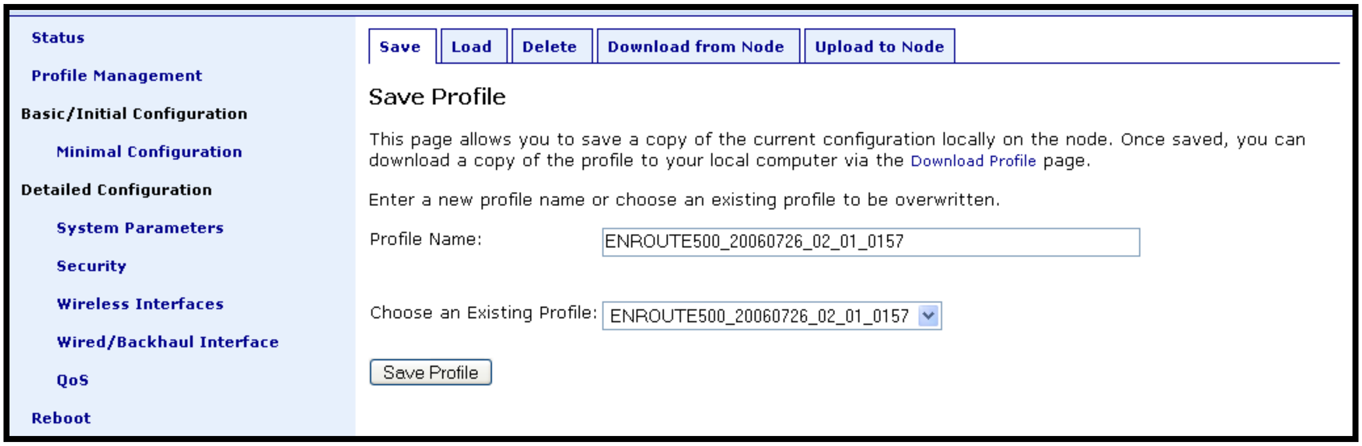
Configuration profiles describe an EnRoute500's configuration state and can be created to simplify the provisioning and management of nodes. The EnRoute500 supports the following configuration profile-related tasks:

- Saving the current configuration as a configuration profile
- Applying a configuration profile stored on the node
- Downloading a configuration profile stored on the node to a computer
- Uploading a configuration profile from a computer to the node
- Deleting a configuration profile stored on the node

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

5.1 Saving the Current Configuration

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



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.

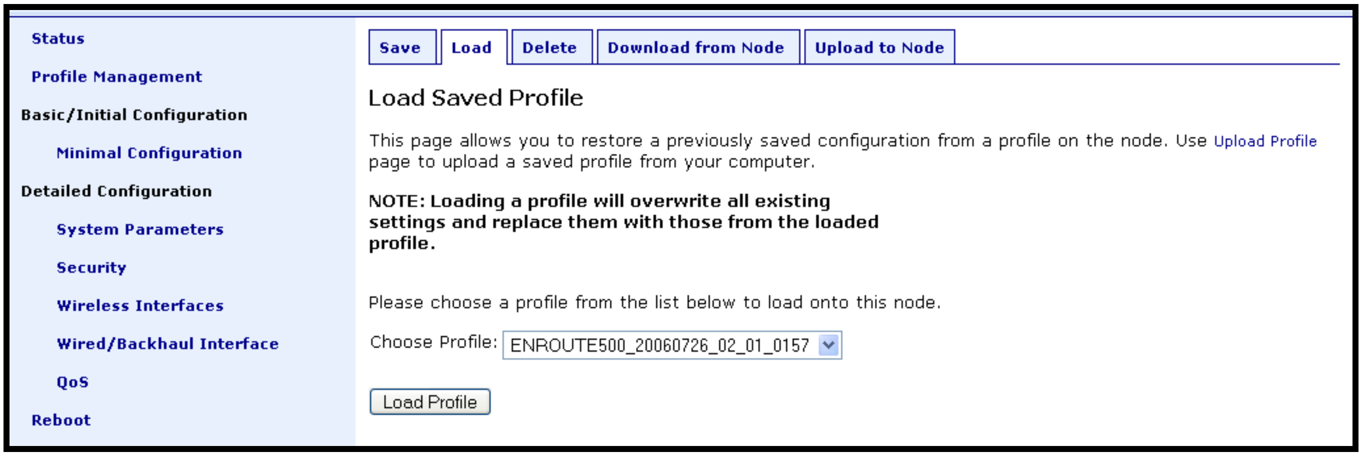
Profile Name: ENROUTE500_20060726_02_01_0157

Choose an Existing Profile: ENROUTE500_20060726_02_01_0157

Figure 12. Save a configuration profile

5.2 Load a Configuration Profile

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



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.

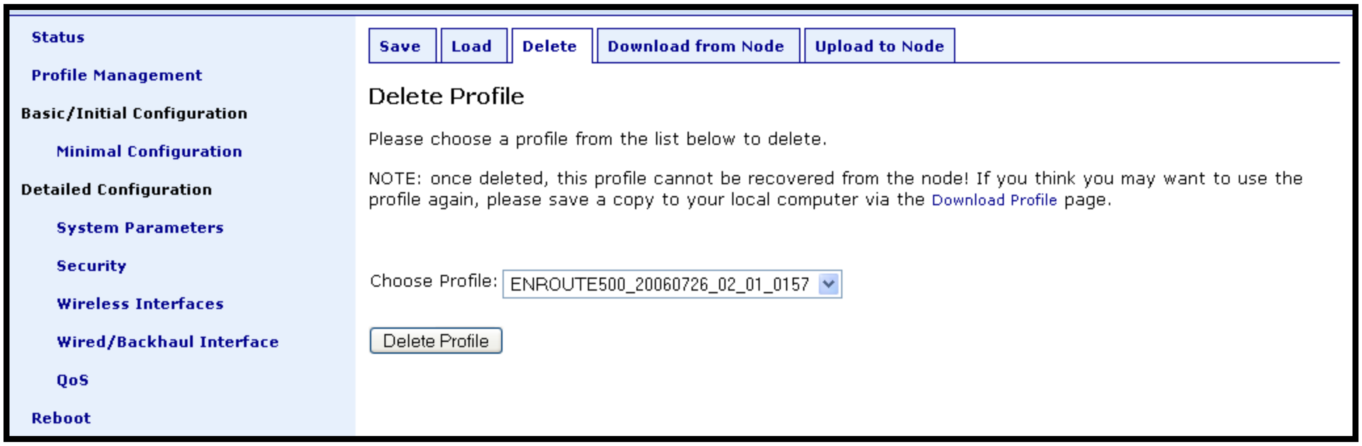
Please choose a profile from the list below to load onto this node.

Choose Profile: ENROUTE500_20060726_02_01_0157

Figure 13. Load a configuration profile

5.3 Delete a Configuration Profile

A locally-stored configuration profile can be deleted using the "Delete" tab on the "Profile Management" page of the web interface. 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.

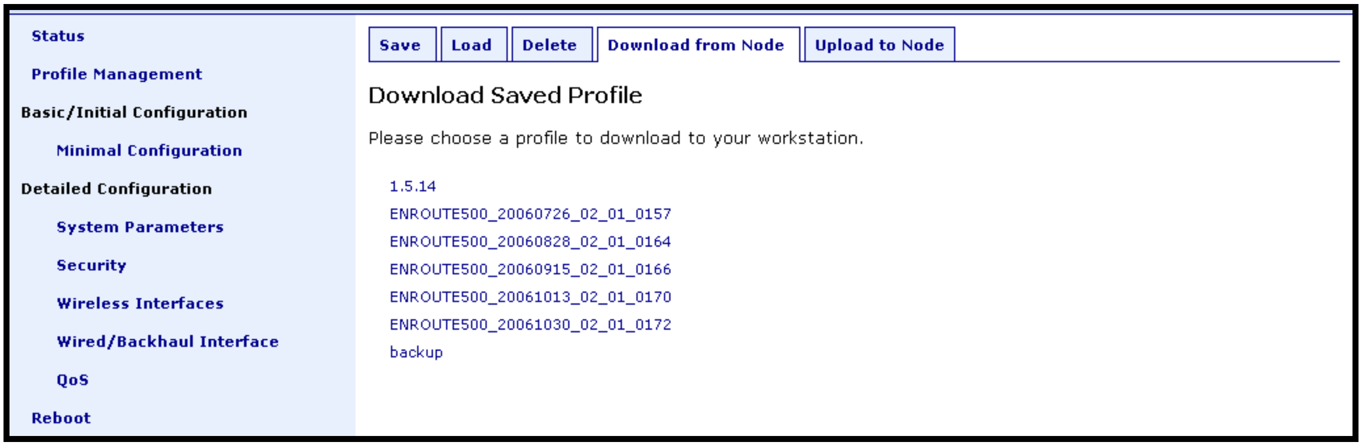
NOTE: once deleted, this profile cannot be recovered from the node! If you think you may want to use the profile again, please save a copy to your local computer via the Download Profile page.

Choose Profile: ENROUTE500_20060726_02_01_0157

Figure 14. Deleting a configuration profile

5.4 Downloading a Configuration Profile from a Node

A configuration profile can be download from a node using the "Download from node" tab on the "Profile Management" page of the web interface. The existing configuration profiles are listed on this page. Click on the one that is to be downloaded to a computer and you will be given the option to specify where the profile should be save on the host computer.



Download Saved Profile

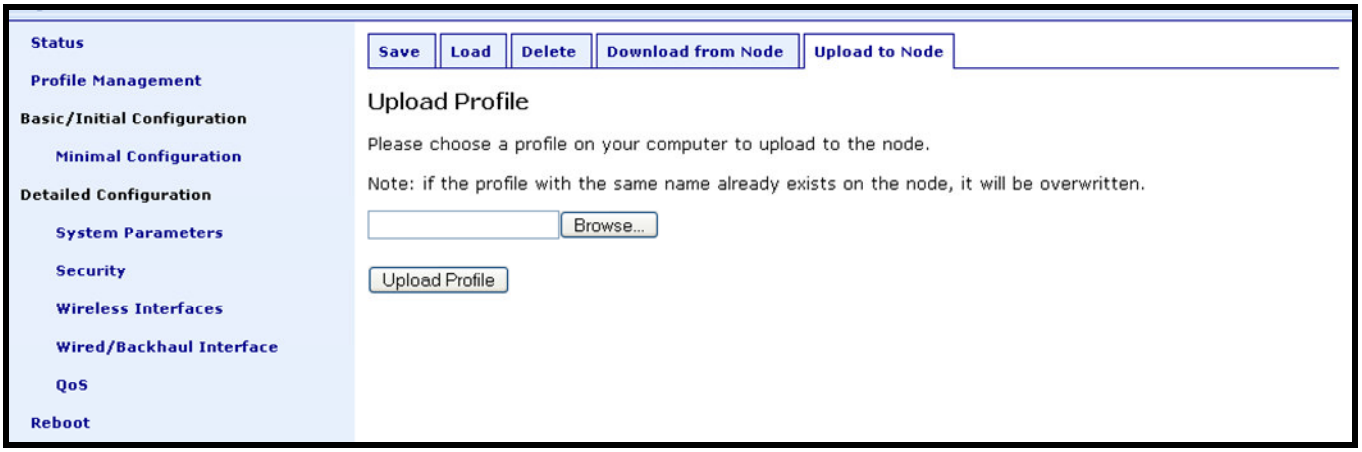
Please choose a profile to download to your workstation.

1.5.14
ENROUTE500_20060726_02_01_0157
ENROUTE500_20060828_02_01_0164
ENROUTE500_20060915_02_01_0166
ENROUTE500_20061013_02_01_0170
ENROUTE500_20061030_02_01_0172
backup

Figure 15. Downloading a configuration profile from a node

5.5 Uploading a Configuration Profile to a Node

A configuration profile can be uploaded to a node using the "Upload to node" tab on the "Profile Management" page of the web interface. Use the "Browse" button to select a profile file on your host computer for upload to the node. 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 node.



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 16. Uploading a configuration profile to a node

6 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.

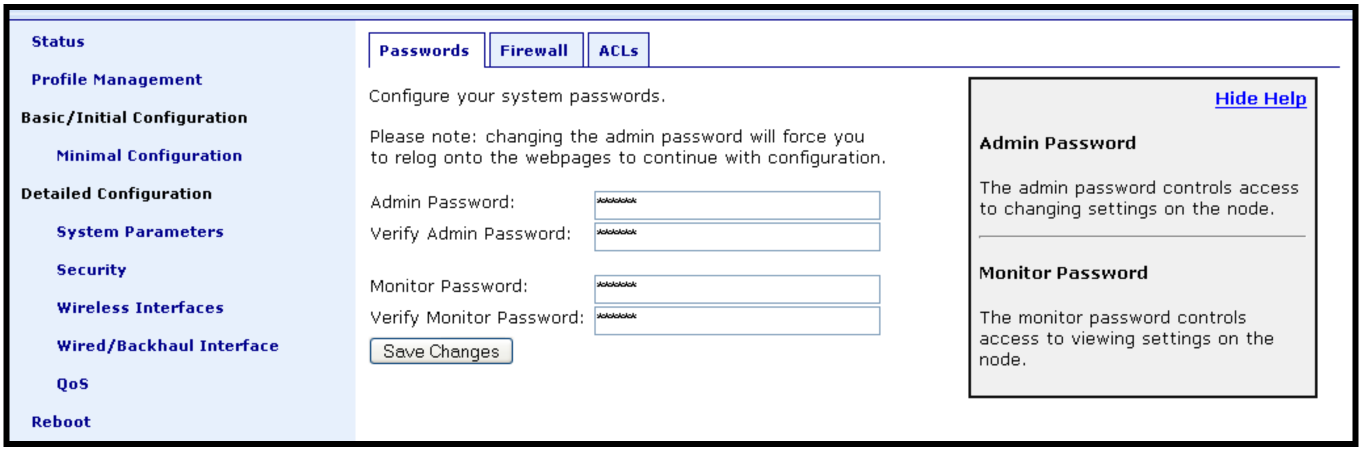
6.1 User Passwords

The passwords for the 'admin' and 'monitor' users can be set using the 'password.admin' and 'password.monitor' parameters in the 'sys' interface. By default, both user accounts have the password 'mesh'. The passwords will not be displayed when using the 'get' command with these parameters. Note that the 'monitor' account password can only be changed by an 'admin' user.

The example below shows how to set the 'admin' password using the CLI.

```
> use sys
sys> set password.admin=er500
```

The passwords can be changed via the web interface using the "Passwords" tab on the "System Parameters" page. The passwords can be changed independently – if only one password is modified, the other password will remain unchanged.



Configure your system passwords.

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

Admin Password: ******
Verify Admin Password: ******

Monitor Password: ******
Verify Monitor Password: ******

Admin Password

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

Monitor Password

The monitor password controls access to viewing settings on the node.

Figure 17. Setting passwords page

6.2 Operating Scheme

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

- All ER500s will be configured as 'aprepeater' nodes to create a stand-alone mesh cluster
- All but one of the ER500s in a mesh cluster will be configured as 'aprepeater' nodes, with one node configured as an 'apgateway'. The 'apgateway' node is connected to an external network using the node's Ethernet interface. This network configuration will create an Internet extension network.

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

Table 4. EnRoute500 operating schemes

Ensure that only one node in a mesh cluster is configured as an 'apgateway'.

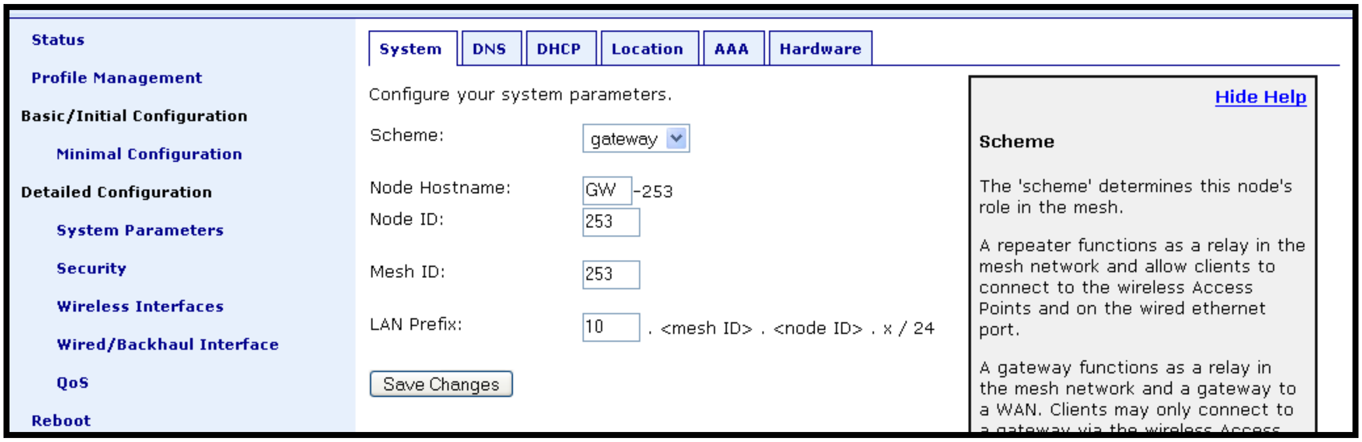
To set the EnRoute500's operating scheme with the CLI, use the commands

```
> use sys
sys> set scheme=<operating scheme>
```

For example, to set the operating scheme to 'apgateway' mode use:

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

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 -253

Node ID: 253

Mesh ID: 253

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

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

Figure 18. Setting the operating scheme

6.3 Mesh / Node ID

An EnRoute500 must be assigned a mesh ID and a node ID before it is deployed as part of a mesh cluster. The mesh ID identifies nodes that are members of the same mesh cluster and the node ID uniquely identifies a node within a mesh cluster.

The mesh ID must be the same for all nodes in a mesh cluster. Each mesh that is connected to a common WAN network must have a different mesh ID since it is a component of the mesh nodes' IP addresses. The mesh ID is set with the 'id.mesh' parameter in the 'sys' interface as shown below. The range of valid mesh IDs is 0 through 254.

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

A node in a mesh cluster must be given a unique node ID. This node ID is part of the node's IP address as shown in Figure 19. The allowable range for node IDs is 1 through 254. The node ID is set as shown below.

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

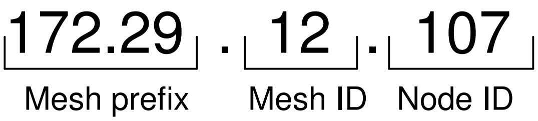
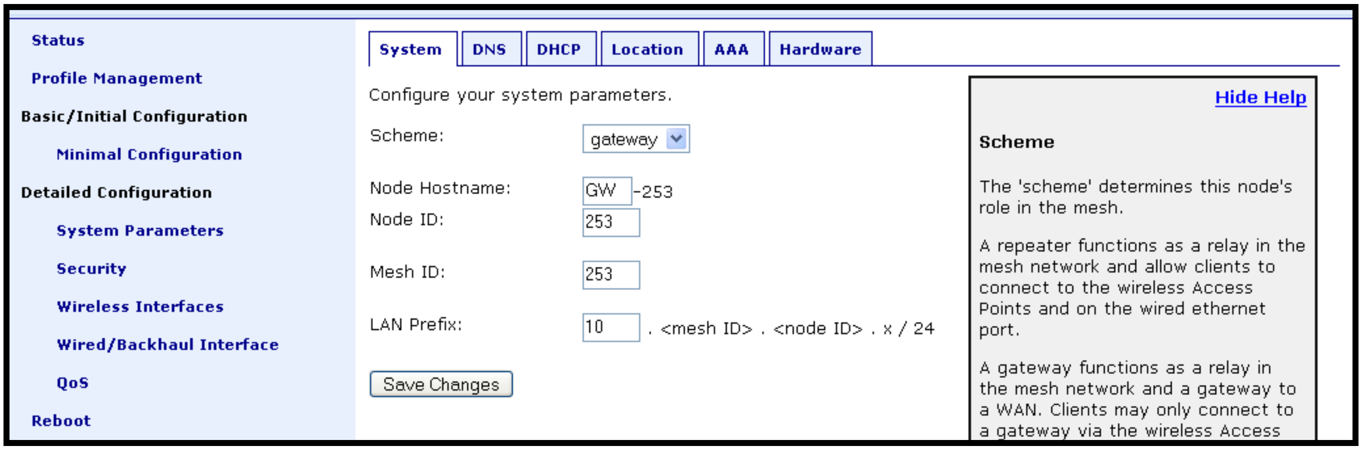


Figure 19. EnRoute500 mesh interface IP address

The mesh and node IDs 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 -253

Node ID: 253

Mesh ID: 253

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

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

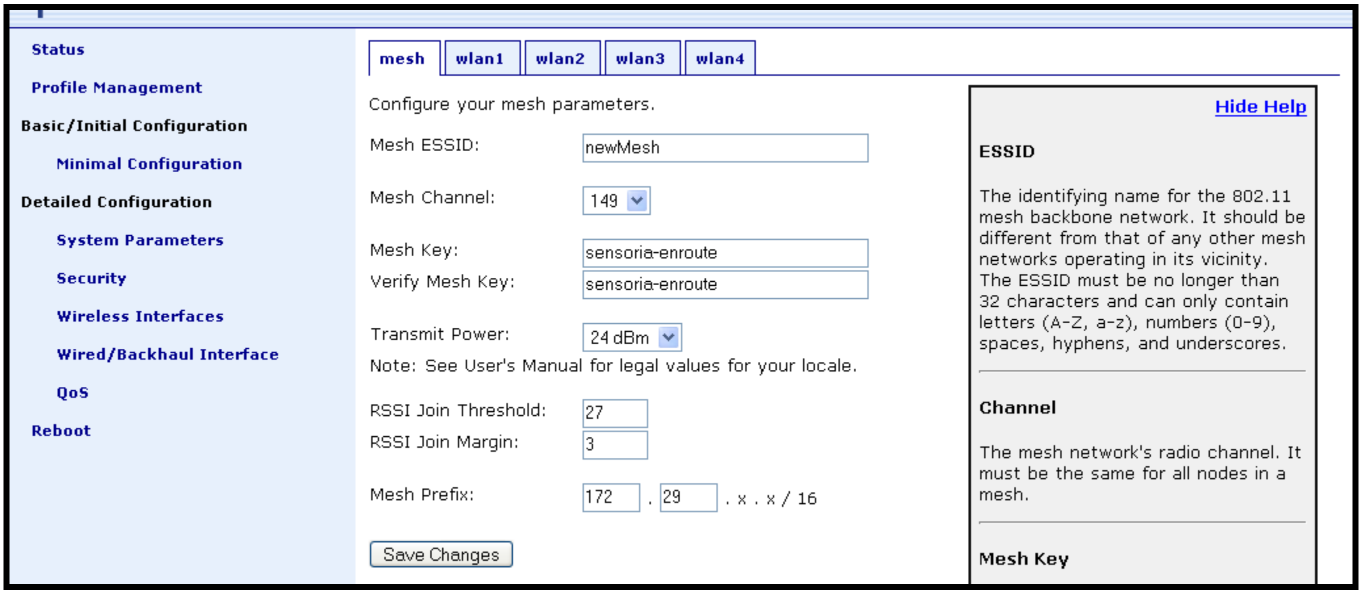
Figure 20. Setting the mesh and node IDs

6.4 Mesh Prefix

The mesh prefix parameter sets the first two octets of a node's mesh interface IP address. The mesh prefix is set with the 'id.meshprefix' parameter in the 'sys' interface as shown in the example below. The mesh prefix must be set the same for all nodes in a given mesh cluster. The recommended range of values is 172.16 through 172.30.

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

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

Mesh Key: sensoria-enroute

Verify Mesh Key: sensoria-enroute

Transmit Power: 24 dBm

Note: See User's Manual for legal values for your locale.

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.

Mesh Key

Figure 21. Setting the mesh prefix

6.5 LAN Prefix

Class C subnets are created for an EnRoute500's access point and Ethernet interfaces. The subnet address space is based on the mesh ID, node ID, and LAN prefix. The LAN prefix is set with the 'id.lanprefix' parameter in the 'sys' interface as shown in the example below. The suggested values for the LAN prefix are 10 and 192. The LAN prefix must be the same for all nodes in a mesh cluster.

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

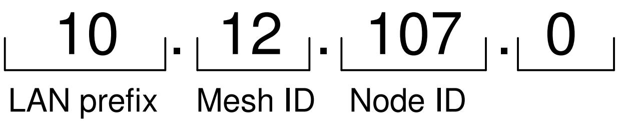


Figure 22. Subnet address structure

A node’s subnet is split up between its different client interfaces (eth0, wlan1-4). By default the subnet is split as shown in Table 5. See sections 8.1.4 and 9.6.3 for instructions on how to adjust how the subnet is segmented between interfaces.

Interface	Interface address	Broadcast address	Client 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 5. Default subnet segmentation between interfaces

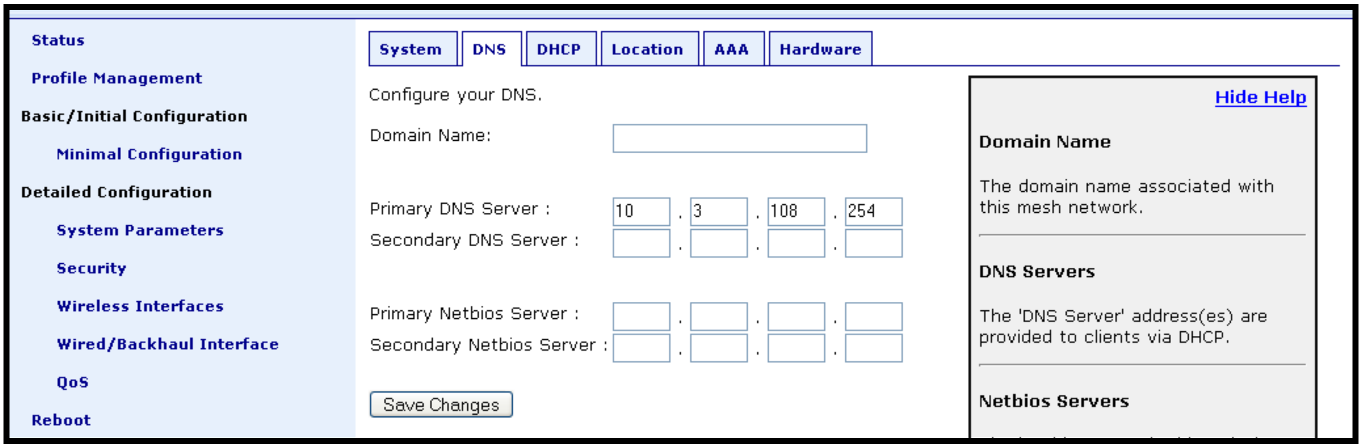
6.6 DNS / Domain Settings

The DNS server(s) used by the node 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”
```

If a gateway node acquires DNS server information through DHCP, this DNS server information will overwrite the ‘dns.servers’ setting. Note that the DNS server settings will not be passed to repeater nodes that are in the same mesh cluster that the gateway is serving – you will need to set this on each of the repeater nodes.

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:

Primary DNS Server : 10 . 3 . 108 . 254

Secondary DNS Server : . . .

Primary Netbios Server : . . .

Secondary Netbios Server : . . .

Domain Name

The domain name associated with this mesh network.

DNS Servers

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

Netbios Servers

Figure 23. Setting the DNS server(s)

6.7 DNS Proxy Configuration

DNS proxy entries can be added to an EnRoute500 to force local resolution of host names to IP addresses. 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 proxying must be explicitly enabled using the 'dnsproxy.enable' parameter in the 'sys' interface after the list of hosts has been specified.

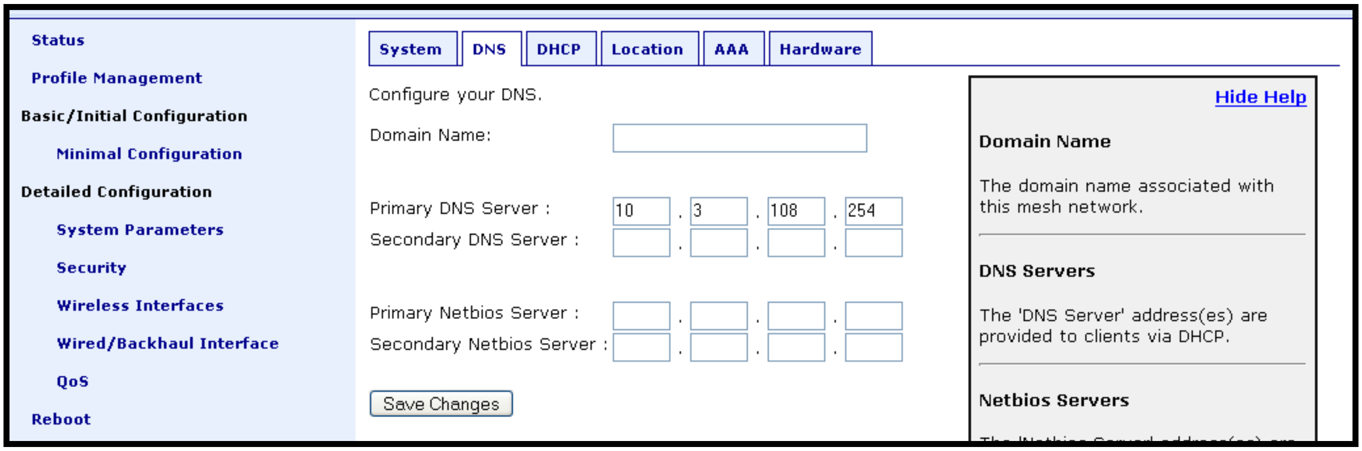
```
> use sys
sys> set dnsproxy.hosts=”server1.domain.com=10.0.0.1;server2.domain.com=10.0.0.129”
```

6.8 Netbios Server

The Netbios server parameter is used to define a Netbios server address that is provided to client devices via the local DHCP server. 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”
```

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



Configure your DNS.

Domain Name:

Primary DNS Server : 10 . 3 . 108 . 254

Secondary DNS Server : . . .

Primary Netbios Server : . . .

Secondary Netbios Server : . . .

Domain Name

The domain name associated with this mesh network.

DNS Servers

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

Netbios Servers

The 'Netbios Server' address(es) are

Figure 24. Setting the Netbios server(s)

6.9 Location

Two types of node location information can be stored:

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

The GPS location of the node can be stored in the following fields in the 'sys' interface:

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

Note that these values are not automatically updated and must be entered after a node has been installed. Altitude is in meters. Latitude ranges from -90 to 90 (with negative being south, positive being north). Longitude ranges from -180 to 180 (with negative being west, positive being east).

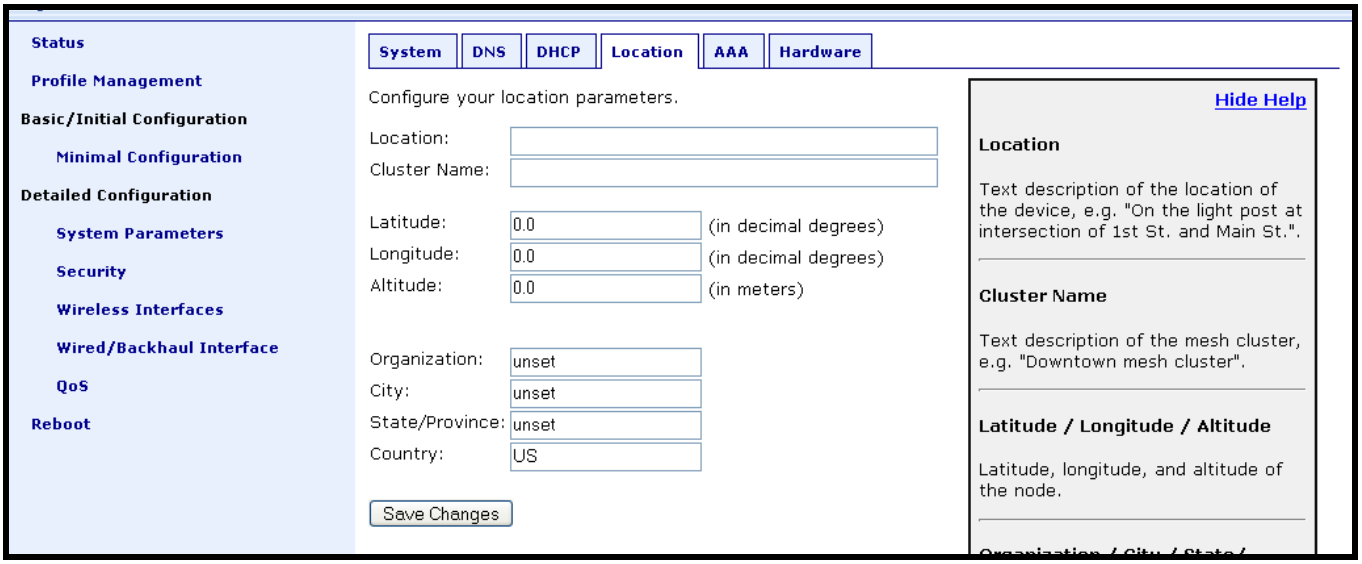
For example, you can set the latitude value as follows.

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

A description of the node'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"
```

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

Latitude, longitude, and altitude of the node.

Organization / City / State /

Figure 25. Setting location information

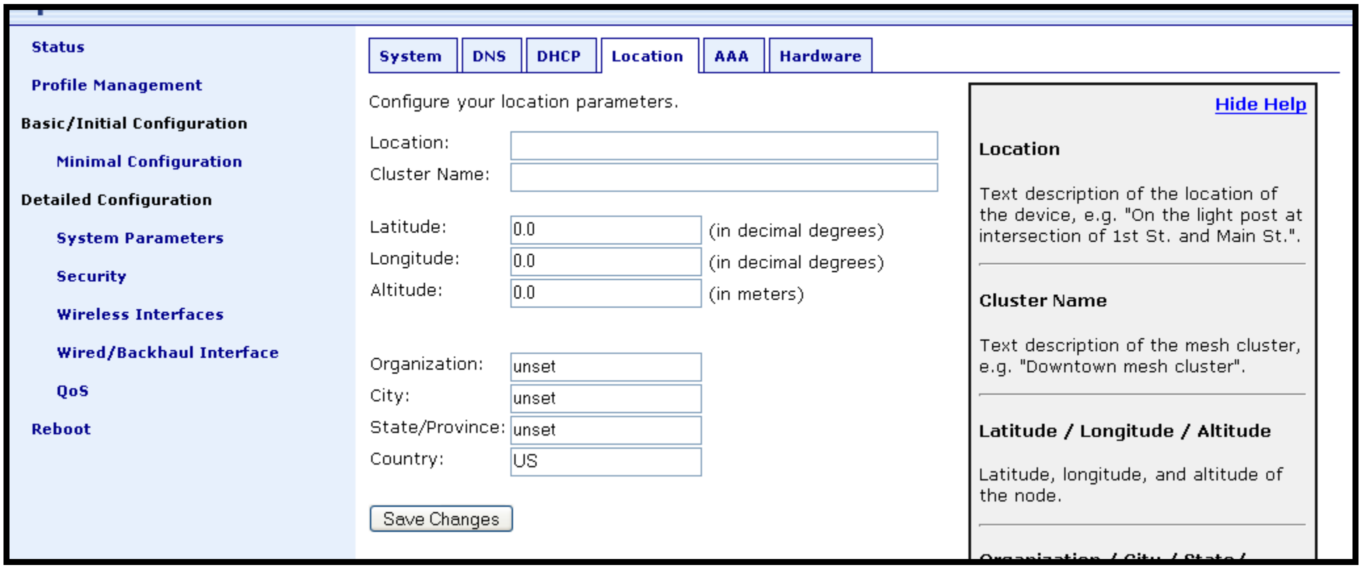
6.10 Certificate Information

A certificate for use with splash pages and the web interface is locally generated on the node. The information embedded in this certificate 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

A new certificate is automatically generated whenever any of these parameters are changed.

The certificate 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

Latitude, longitude, and altitude of the node.

Organization / City / State /

Figure 26. Setting certificate information

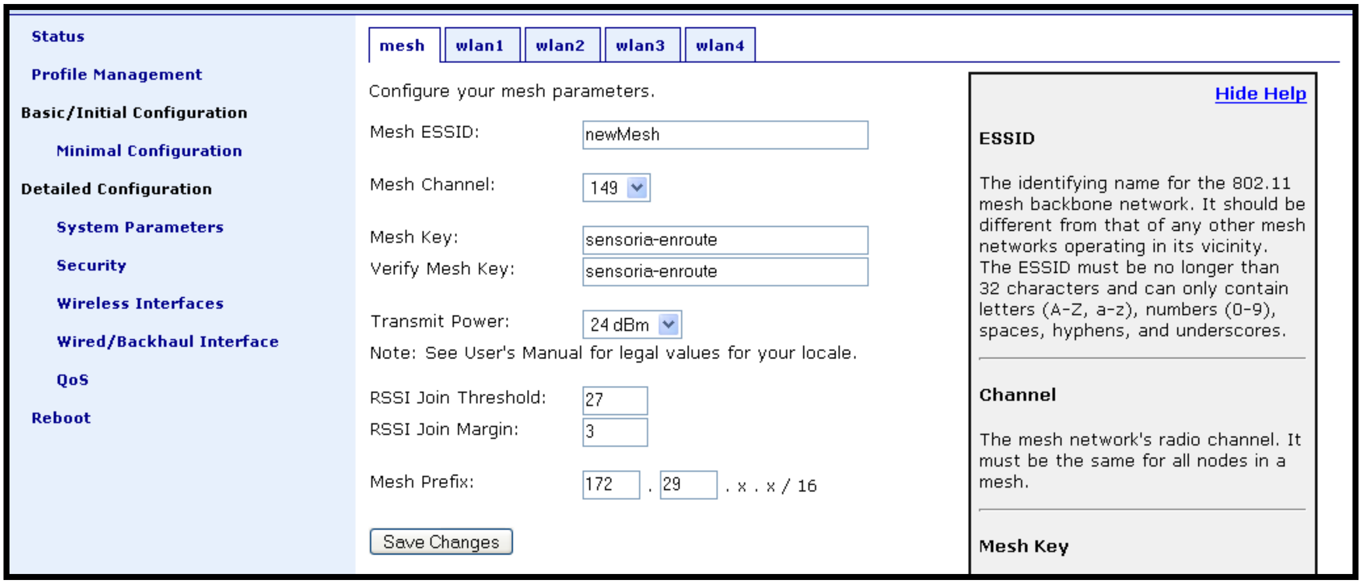
6.11 CLI timeout

The CLI will automatically log out a user if the interface has remained inactive for a certain length of time. The time, in minutes, 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 360 minutes.

```
> use sys
sys> set shell.timeout=15
```

7 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 access points. The majority of the mesh radio settings must be the same on all nodes in a given mesh cluster for the nodes to be able to communicate.



Configure your mesh parameters.

Mesh ESSID: newMesh

Mesh Channel: 149

Mesh Key: sensoria-enroute

Verify Mesh Key: sensoria-enroute

Transmit Power: 24 dBm

Note: See User's Manual for legal values for your locale.

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.

Mesh Key

Figure 27. Mesh interface parameters

7.1 Channel

The 802.11a radio can be set to operate in the channels listed in Table 6. 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 6. Mesh radio channels and frequencies

All the nodes in a mesh cluster need to be configured to use the same 802.11a channel. The mesh radio channel is set as shown in the example below.

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

The mesh radio channel can be set via the web interface using the “Mesh” tab on the “Wireless Interfaces” page (see Figure 27).

7.2 ESSID

The ESSID, or Extended Service Set Identifier, 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 ESSID for all the nodes in a mesh cluster must be the same. If you have adjacent mesh clusters where one or more nodes from each cluster are within communication range of each other, the ESSID for the clusters must be different.

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

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

The broadcast of the ESSID can be controlled with the ‘hide_essid’ parameter in the ‘mesh0’ interface. The example below shows how hiding of the ESSID can be enabled. You will generally want the ESSID to be hidden, and it is hidden by default.

```
> use mesh0
mesh0> set hide_essid=yes
```

The mesh radio ESSID can be set via the web interface using the “Mesh” tab on the “Wireless Interfaces” page (see Figure 27).

7.3 Encryption

The mesh radio link can be protected with an encryption key to prevent unauthorized users from intercepting or spoofing mesh traffic. To enable encryption, set the ‘key’ parameter in the ‘mesh0’ interface. The ‘key’ parameter can either be specified as a 16-character ASCII string preceded by “s:” or a 32-character hexadecimal string. Each node in a mesh cluster must have the same encryption key. The examples below illustrate how to set the encryption key.

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=
```

The mesh radio encryption key can be set via the web interface using the "Mesh" tab on the "Wireless Interfaces" page (see Figure 27). 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:"

7.4 Transmit Power

The transmit power 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 is initially set to the maximum 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 value is used for all nodes in a mesh to reduce the likelihood of asymmetric links. The default transmit power is 24dBm.

⚠ **The mesh radio's transmit power value must be in the range from 1 to 60 to be in compliance with FCC regulations.**

The example below shows how to set the mesh radio's transmit power.

```
> use mesh0
mesh0> set txpower=60
```

The mesh radio transmit power can be set via the web interface using the "Mesh" tab on the "Wireless Interfaces" page (see Figure 27).

txpower	Output Power (dBm)
1	9
9	10
14	12
18	14
22	16
26	18
29	20
33	22
60	24

Table 7. Mesh radio output power settings

7.5 IP Configuration

The IP address, broadcast address, and netmask associated with the mesh radio interface can be viewed, but not directly changed through the 'mesh' interface. To change the IP settings, the 'id' settings in the 'sys' interface, from which the IP settings are derived, must be changed (see sections 6.3 and 6.4).

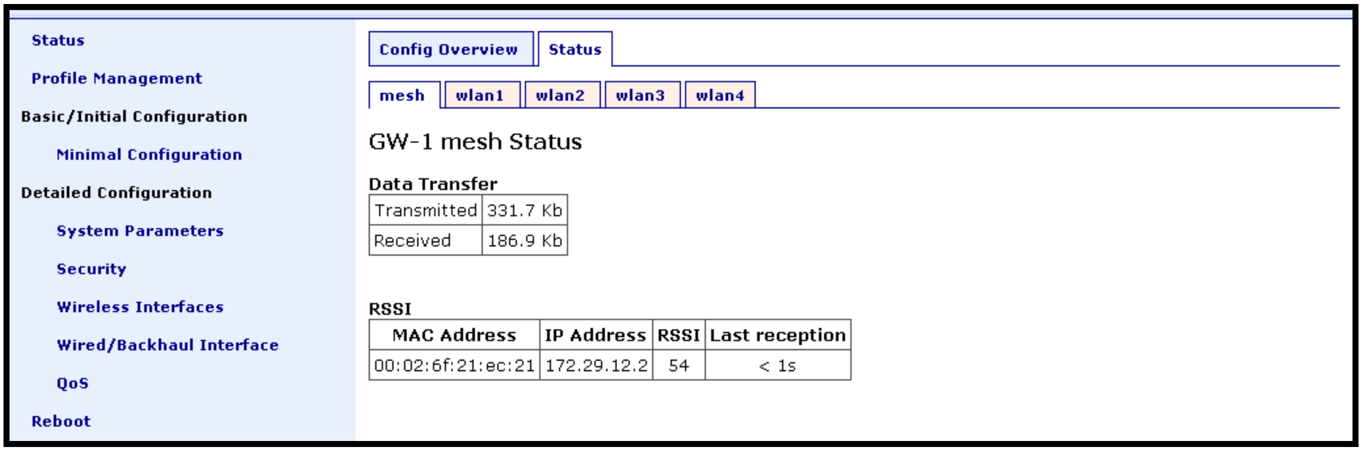
The IP settings can be viewed with

```
> 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]
```

The mesh radio IP settings are also available through the web interface on the "Status" page.

7.6 Neighbor Status

Information on mesh neighbors is provided on the mesh status page, accessible under the 'Status' tab on the 'Status' page. The signal strength of each neighbor device, it's MAC address, its IP address, and the time since data was last received from it are listed. A sample of the mesh neighbor status page is shown in Figure 28.



GW-1 mesh Status

Data Transfer

Transmitted	331.7 Kb
Received	186.9 Kb

RSSI

MAC Address	IP Address	RSSI	Last reception
00:02:6f:21:ec:21	172.29.12.2	54	< 1s

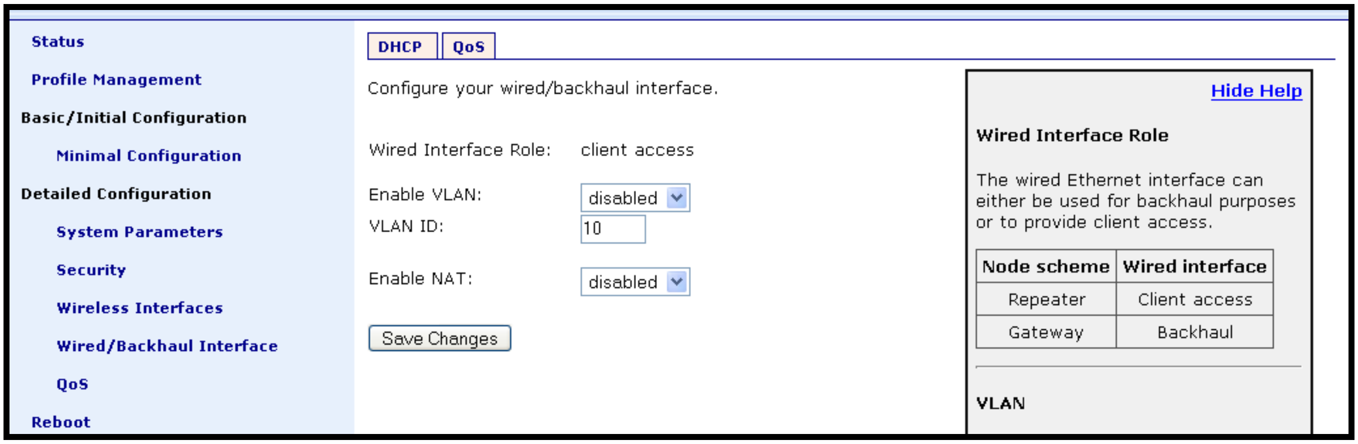
Figure 28. Mesh neighbor status information

8 Ethernet Interface Configuration

The function of the Ethernet interface (eth0) depends on the operating scheme that has been selected (see section 6.2). In 'aprepeater' mode, the Ethernet interface can be used to connect client devices to the mesh cluster. In 'apgateway' mode, the Ethernet interface is used as a backhaul link that connects the mesh cluster to a WAN. Client devices cannot connect through the Ethernet interface in this mode.

8.1 IP Configuration for Repeater Nodes 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 or be manually configured.



Configure your wired/backhaul interface.

Wired Interface Role: client access

Enable VLAN: disabled

VLAN ID: 10

Enable NAT: disabled

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

Figure 29. Wired interface parameters with EnRoute500 in repeater mode

8.1.1 Ethernet Client Device Address Space

The Ethernet interface, when the node is in repeater mode, is assigned a segment of the class C address space that each node has to share between its client interfaces, which include eth0, wlan1, wlan2, wlan3, and wlan4. The start address of the address segment and its size can be set with the 'ip.size.requested' and 'ip.start.requested' variables. The following restrictions are placed on the address segment configuration:

- Each active client interface must be assigned an address segment.
- The address segment start address, 'ip.start.requested', must be one of the following values: 1, 33, 65, 97, 129, 161, 193, 225.
- The address segment size, 'ip.size.requested', must be one of the following values: 31, 63, 127, 255.

- The address segment 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.

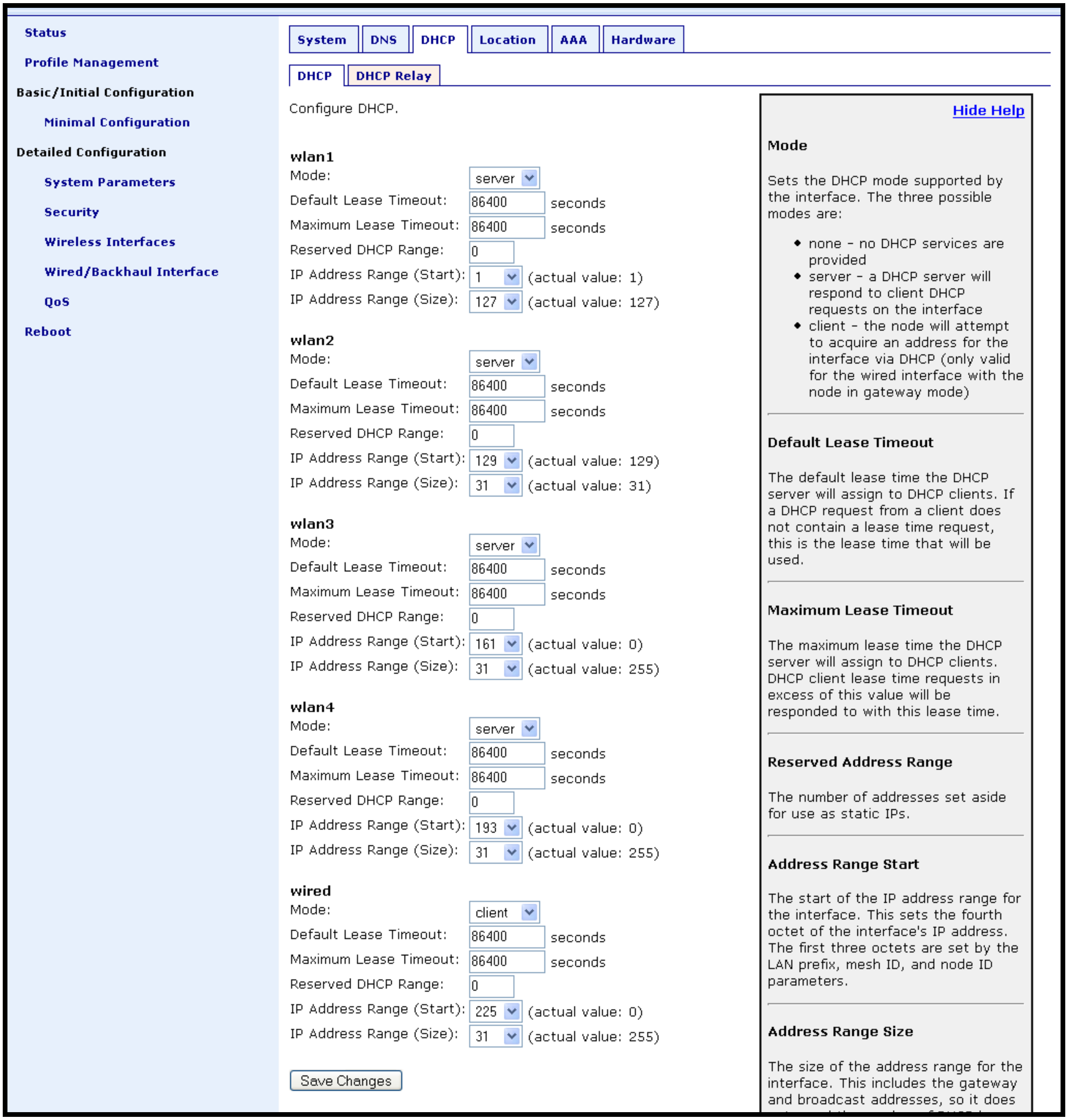
ip.start.requested	ip.size.requested 31	63	127	255
1	Yes	Yes	Yes	Yes
33	Yes	No	No	No
65	Yes	Yes	No	No
97	Yes	No	No	No
129	Yes	Yes	Yes	No
161	Yes	No	No	No
193	Yes	Yes	No	No
225	Yes	No	No	No

Table 8. Allowed 'ip.start.requested'/'ip.size.requested' combinations

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 interfaces, wlan1-4, are disabled). In the second example, the Ethernet interface is set to use the top half of the class C address space.

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

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

The eth0 'ip.start.requested' and 'ip.size.requested' values can be set via the web interface using the "DHCP" sub-tab on the "DHCP" tab on the "System Parameters" page (see Figure 30).



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: 129)
IP Address Range (Size): 31 (actual value: 31)

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: client
Default Lease Timeout: 86400 seconds
Maximum Lease Timeout: 86400 seconds
Reserved DHCP Range: 0
IP Address Range (Start): 225 (actual value: 0)
IP Address Range (Size): 31 (actual value: 255)

Mode

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

- none - no DHCP services are provided
- server - a DHCP server will respond to client DHCP requests on the interface
- 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 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.

Address Range Start

The start of the IP address range for the interface. This sets the fourth octet of the interface's IP address. The first three octets are set by the LAN prefix, mesh ID, and node ID parameters.

Address Range Size

The size of the address range for the interface. This includes the gateway and broadcast addresses, so it does

Figure 30. ‘eth0’ DHCP and address space settings

Each of the enabled interfaces’ address segments should be configured to avoid overlap with the other interfaces’ address segments. In the case where a node is not configured such that this requirement is met, address spaces will be automatically reduced in size to prevent overlap. The actual start address and size of a segment are accessible via the ‘ip.start.actual’ and ‘ip.size.actual’ parameters.

8.1.2 Ethernet Interface IP Address

The EnRoute500's Ethernet interface address should not be changed directly using the 'ip.*' parameters in the 'eth0' interface when it is in repeater mode. To set the IP address to the desired value, modify the 'id.node', 'id.mesh', and 'id.lanprefix' parameters in the 'sys' interface and the 'ip.start.requested' parameter in the 'eth0' interface (see sections 6.3 and 6.5). You can view the resulting 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.size.actual =    [read-only]
 ip.size.requested = 31
 ip.start.actual =    [read-only]
 ip.start.requested = 225
```

The Ethernet IP settings are also available through the web interface on the "Status" page.

It is strongly recommended that all the 'ip.*_force' variables are cleared when the EnRoute500 is configured as a repeater. This ensures that the Ethernet interfaces settings are inherited from the 'id.*' settings in the 'sys' interface and client devices will get addresses that the mesh can route to.

8.1.3 IP Configuration of Clients Devices via DHCP

When configured as a repeater, the EnRoute500 can be set to serve DHCP addresses to clients on the Ethernet interface. Two distinct modes for providing addresses via DHCP exist. These are described in depth in section 10.

8.1.4 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. The IP address and subnet of the Ethernet interface can viewed with

```
> use eth0
eth0> get ip.address ip.netmask
 eth0.ip.address = 10.2.4.225   [read-only]
```

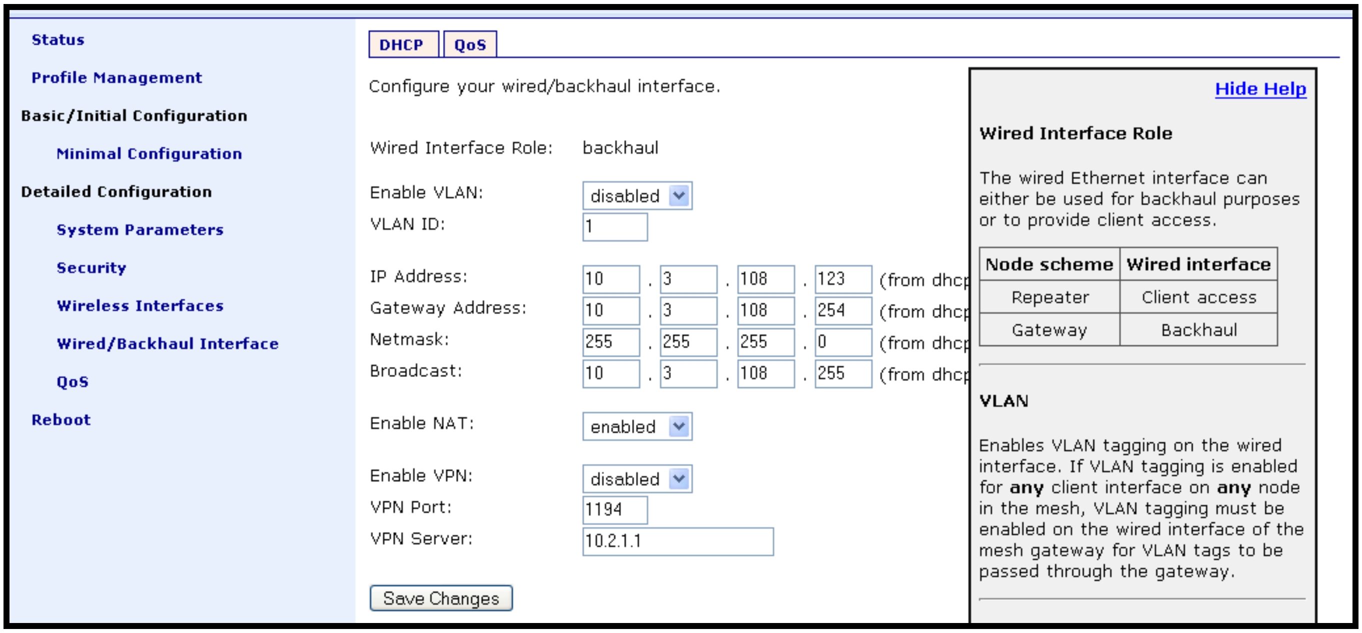
```
eth0.ip.netmask = 255.255.255.224   [read-only]
```

If the local DHCP server is enabled for the Ethernet interface, addresses must be reserved for statically-configured devices by setting the 'dhcp.reserve' parameter in the 'eth0' interface. This will reserve the specified number of addresses at the bottom of the IP range for the interface. For example, if the interface has been assigned the address 10.2.4.225, the netmask 255.255.255.224, and the 'dhcp.reserve' value 5, the addresses 10.2.4.226 through 10.2.4.230 will be available for use by statically configured devices. The remaining addresses in the interfaces address space can be assigned by the DHCP server to other client devices.

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 30).

8.2 IP Configuration for Gateway Nodes

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 address can either be acquired from a DHCP server on the WAN or be set manually.



Configure your wired/backhaul interface.

Wired Interface Role: backhaul

Enable VLAN: disabled
VLAN ID: 1

IP Address: 10 . 3 . 108 . 123 (from dhcp
Gateway Address: 10 . 3 . 108 . 254 (from dhcp
Netmask: 255 . 255 . 255 . 0 (from dhcp
Broadcast: 10 . 3 . 108 . 255 (from dhcp

Enable NAT: enabled

Enable VPN: disabled
VPN Port: 1194
VPN Server: 10.2.1.1

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

Enables VLAN tagging on the wired interface. If VLAN tagging is enabled for **any** client interface on **any** node in the mesh, VLAN tagging must be enabled on the wired interface of the mesh gateway for VLAN tags to be passed through the gateway.

Figure 31. Wired interface parameters with EnRoute500 using wired interface for backhaul

8.2.1 DHCP

When configured as a gateway, the EnRoute500 can be set to obtain an obtain an address for its Ethernet interface using DHCP. To enable the DHCP client mode on the Ethernet interface, set the value of the 'dhcp.role' parameter in the 'eth0' interface to 'client', as shown in the example below. When configured as a DHCP client, the EnRoute500 will continually attempt to contact a DHCP server until it is successful.

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

INFO

> The 'dhcp.reserve' parameter (described in section 6.1.1) has no effect when the 'dhcp.role' parameter is set to 'client'.

To disable DHCP client mode, set the 'dhcp.role' parameter to 'none'. If DHCP client mode is disabled, the IP configuration must be carried out manually, as described in the next section.

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

The 'dhcp.role' value can be set via the web interface using the "DHCP" sub-tab on the "DHCP" tab on the "System Parameters" page (see Figure 30).

8.2.2 Manual IP Configuration

When a node is configured as a gateway, there are no limitations imposed by the EnRoute500 on the IP address assigned to the Ethernet interface. If the 'dhcp.role' parameter in the 'eth0' interface 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 'id' settings in the 'sys' interface is visible 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 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
```

The 'ip.address_force', 'ip.gateway_force', and 'ip.netmask_force' parameters can be set via the web interface using the "Wired/Backhaul Interface" page (see Figure 31).

Note that for the manually configured address to be used, the 'dhcp.role' setting must be set to 'none' if the node is connected to a network which provides access to a DHCP server.

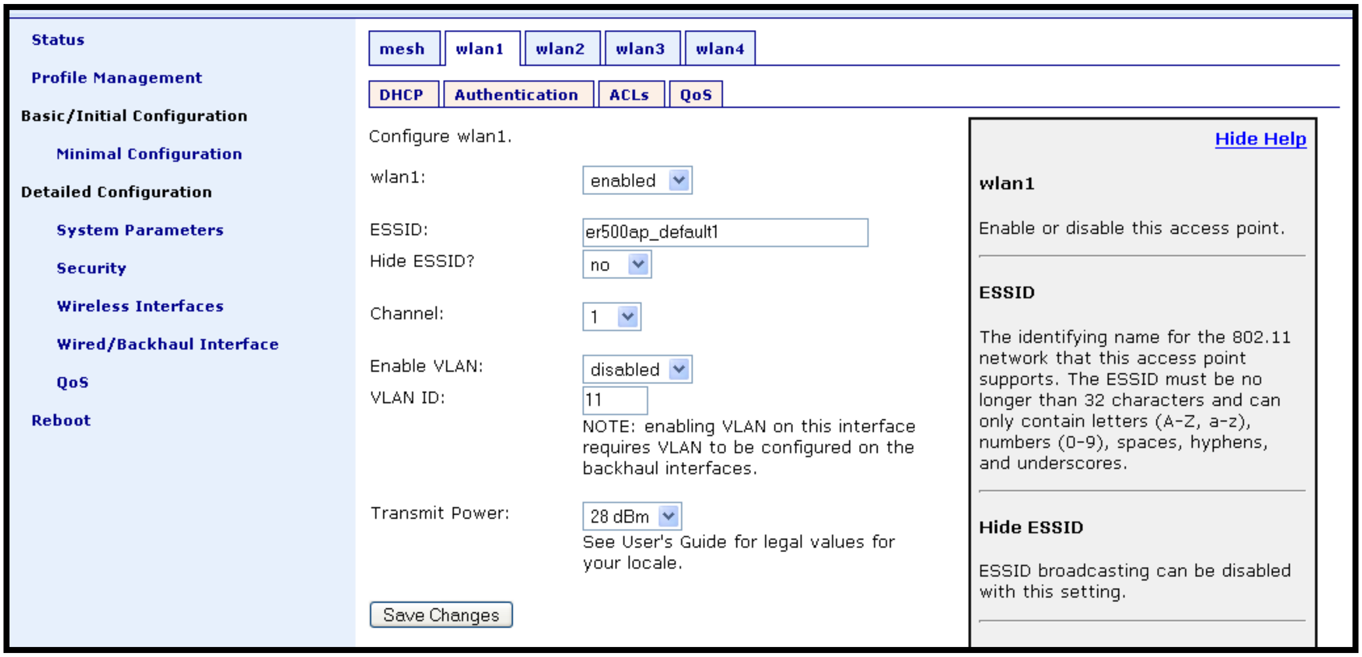
> ⚠ The IP configuration settings shown in the 'eth0' interface in the CLI and on the "Wired/Backhaul Interface" page of the web interface do not necessarily reflect the current settings of the interface. They are the requested settings and do not take into account whether the interface has been configured via DHCP. If the 'dhcp.role' parameter 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.

9 Access Point (AP) 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 access points can vary from node to node 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 in the network.

An EnRoute500 has four access points that can be configured to suit different application needs. With the exception of the 'wlanN.channel' parameter, all access point parameters can be configured independently of each other.

INFO The interfaces for the access points will be referred to as 'wlanN' when it applies to all four access points. 'wlan1' will be used in all examples.



Configure wlan1.

wlan1: enabled

ESSID: er500ap_default1

Hide ESSID? no

Channel: 1

Enable VLAN: disabled

VLAN ID: 11

NOTE: enabling VLAN on this interface requires VLAN to be configured on the backhaul interfaces.

Transmit Power: 28 dBm

See User's Guide for legal values for your locale.

wlan1

Enable or disable this access point.

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.

Figure 32. Access point interfaces

9.1 Access Point Interfaces

There are four access point interfaces that are used to configure the access points: wlan1, wlan2, wlan3, and wlan4. The access points have equivalent configuration capabilities and there is no inherent prioritization or preference for one access point. The section on quality-of-service settings (section 13) describes how prioritization on a per-access point basis can be configured.

9.2 Access Point Client Device Address Space

The enabled wlanN interfaces are assigned segments of the class C address space that each node has to share between its client interfaces, which include eth0, wlan1, wlan2, wlan3, and wlan4. The start address of the address segment and its size can be set with the 'ip.size.requested' and 'ip.start.requested' variables. The following restrictions are placed on the address segment configuration:

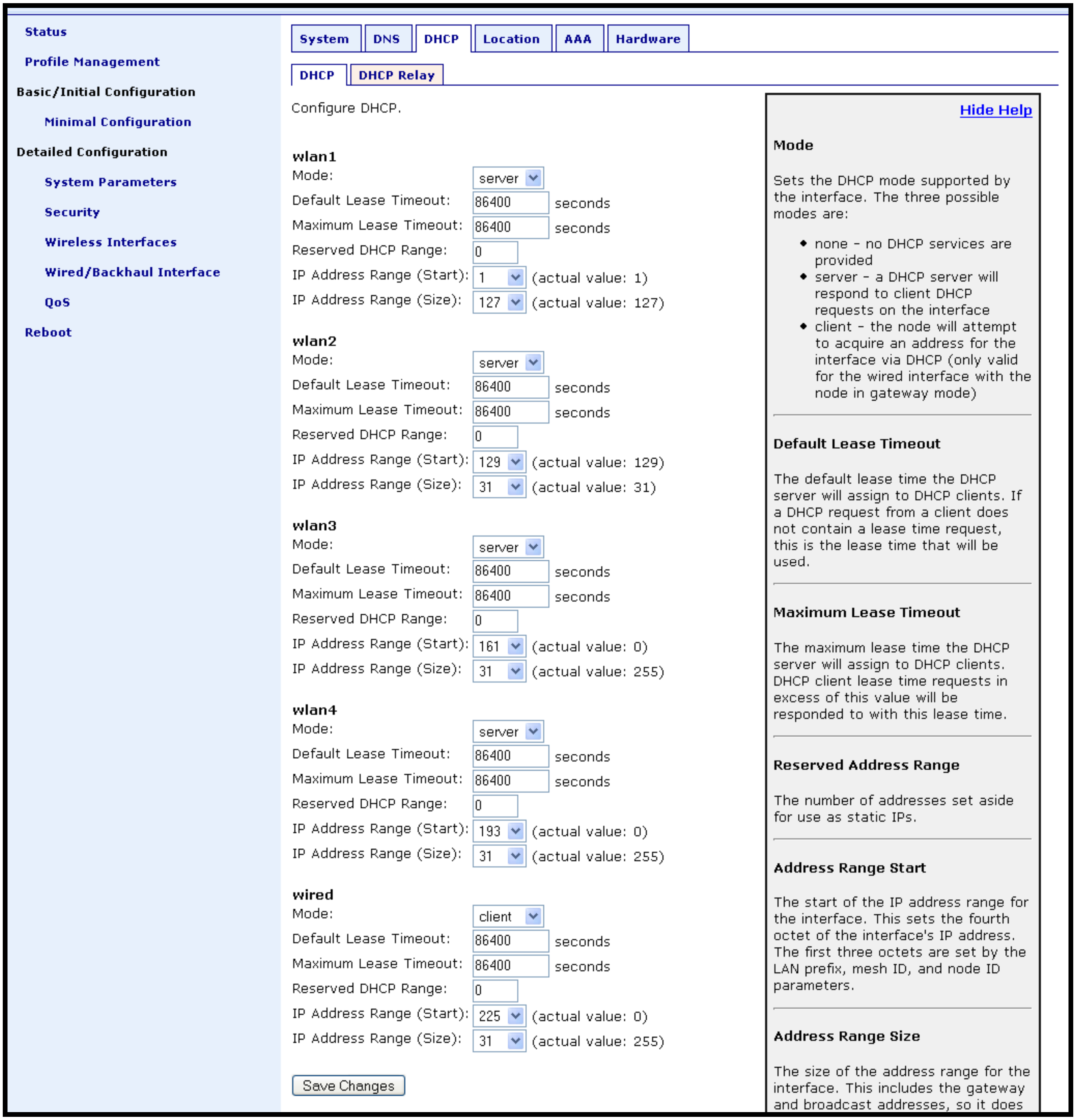
- Each active interface must be assigned an address segment.
- The address segment start address, 'ip.start.requested', must be one of the following values: 1, 33, 65, 97, 129, 161, 193, 225.
- The address segment size, 'ip.size.requested', must be one of the following values: 31, 63, 127, 255.
- The address segment size and start address must be chosen such that the address segment does not cross a netmask boundary. See Table 8 in section 8.1.4 for a list of allowed combinations.
- The address spaces for enabled interfaces must start at different addresses.
- The address spaces for enabled interfaces should not overlap.

In the example below, the WLAN interfaces are set up to use the lower half of the class C address space. This assumes that the Ethernet interface is either used for gateway purposes or is assigned to an address segment in the upper half of the class C network.

```
> use wlan1
wlan1> set ip.start.requested=1
wlan1> set ip.size.requested=31
wlan1> use wlan2
wlan2> set ip.start.requested=33
wlan2> set ip.size.requested=31
wlan2> use wlan3
wlan3> set ip.start.requested=65
wlan3> set ip.size.requested=31
wlan3> use wlan4
wlan4> set ip.start.requested=97
wlan4> set ip.size.requested=31
```

Each of the enabled interfaces' address segments should be configured to avoid overlap with the other interfaces' address segments. In the case where a node is configured such that this requirement is not met, address spaces will be automatically reduced in size to prevent overlap. The actual start address and size of a segment are accessible via the 'ip.start.actual' and 'ip.size.actual' parameters.

The wlanN 'ip.start.requested' and 'ip.size.requested' values can be set via the web interface using the "DHCP" sub-tab on the "DHCP" tab on the "System Parameters" page (see Figure 33).



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: 129)
IP Address Range (Size): 31 (actual value: 31)

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: client
Default Lease Timeout: 86400 seconds
Maximum Lease Timeout: 86400 seconds
Reserved DHCP Range: 0
IP Address Range (Start): 225 (actual value: 0)
IP Address Range (Size): 31 (actual value: 255)

Mode

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

- none - no DHCP services are provided
- server - a DHCP server will respond to client DHCP requests on the interface
- 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 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.

Address Range Start

The start of the IP address range for the interface. This sets the fourth octet of the interface's IP address. The first three octets are set by the LAN prefix, mesh ID, and node ID parameters.

Address Range Size

The size of the address range for the interface. This includes the gateway and broadcast addresses, so it does

Figure 33. 'wlanN' DHCP and address space settings

9.3 Enabling and Disabling Access Points

An access point can be enabled with the 'enable' parameter in the 'wlanN' interface as shown below.

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

An access point can be disabled with the following commands.

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

The access point status can be set via the web interface using the appropriate "wlanN" tab on the "Wireless Interfaces" page (see Figure 32).

An access point can be configured when it is disabled and parameters are maintained when it is disabled.

9.4 Channel

The 802.11b/g radio can be set to operate in the channels listed in Table 9.

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 9. Access point channels and frequencies

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

It is not possible to configure access points to use different channels. If 'channel' in the 'wlan2' interface is changed, the same change will be made to 'channel' in 'wlan1', 'wlan3', and 'wlan4' interfaces. The nodes in a mesh cluster can be set to use different access point channels though.

The example below shows how to set the AP channel to 6.

```
> use wlan1
```

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

The access point channel can be set via the web interface using the appropriate “wlanN” tab on the “Wireless Interfaces” page (see Figure 32).

9.5 ESSID

The ESSID, or Extended Service Set Identifier, is used in 802.11 communication to identify a particular network. It is used to differentiate logical networks that operate on the same channel.

INFO

> Each access point can be configured with a different ESSID. This allows network traffic to be separated based on ESSID. Assigning unique ESSIDs to the access points in a mesh has the benefit of allowing a user to configure a client device to connect to a specific node in the mesh. Typically a mesh will be deployed with the access point ESSIDs having the same set of values for each EnRoute500 though. This has the benefit of allowing client devices to connect to any node in the network without having to be reconfigured.

The access point ESSID is set as shown in the example below. 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. 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 ‘wlanN’ interface. The example below shows how hiding of the ESSID can be enabled.

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

The access point ESSIDs can be set via the web interface using the appropriate “wlanN” tab on the “Wireless Interfaces” page (see Figure 32).

9.6 IP Configuration for Nodes and Their Clients

When an EnRoute500 is configured as a repeater, the access point interfaces allow client devices to connect to it to access the mesh network. These client devices can either be assigned their IP configuration using DHCP or be manually configured.

9.6.1 Access Point IP Address

The IP address, broadcast address, and netmask associated with an access point interface can be viewed, but not directly changed through the 'wlanN' interface. To set the IP address to the desired value, modify the 'id.node', 'id.mesh', and 'id.lanprefix' parameters in the 'sys' interface. You can view the resulting settings for the AP interface with the 'ip.*' parameters in the 'wlanN' interface as shown in the example below (see sections 6.3 and 6.5).

```
> use wlan1
wlan1> get ip.address
 ip.address = 10.2.4.1
wlan1> get ip.broadcast
 ip.broadcast = 10.2.4.127
wlan1> get ip.gateway
 ip.gateway =
wlan1> get ip.netmask
 ip.netmask = 255.255.255.128
```

The access points' IP settings are also available through the web interface on the "Status" page.

9.6.2 IP Configuration of Clients Devices via DHCP

The EnRoute500 can be set to serve DHCP addresses to clients on the access point interfaces. Two distinct modes for providing addresses via DHCP exist. These are described in depth in section 10.

9.6.3 Manual IP Configuration of Client Devices

The client devices that use static IP addresses must have an address that is within the subnet of the access point interface that they connect to. The IP address and subnet of the access point interface can viewed with

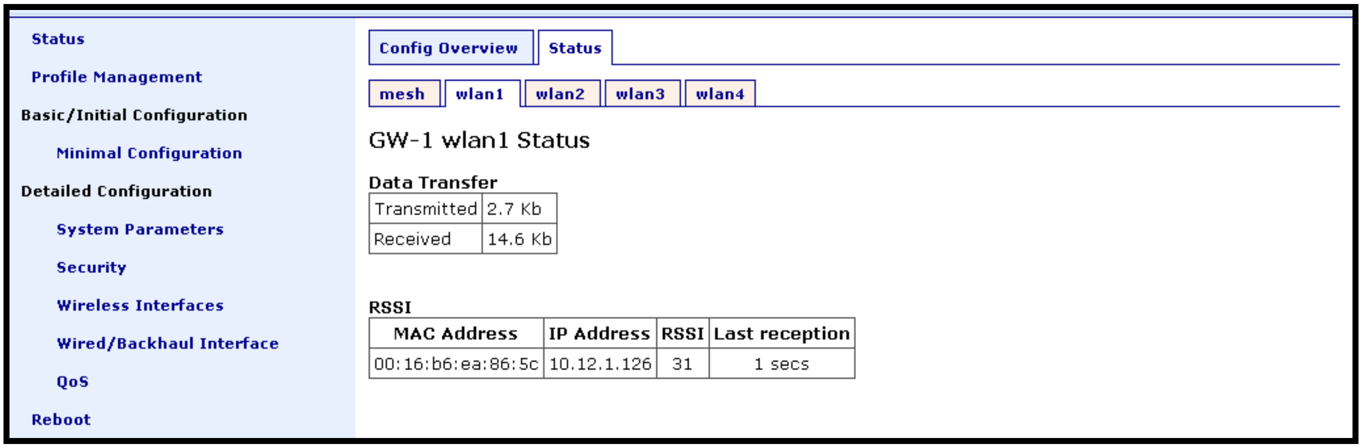
```
> use wlan1
wlan1> get ip.address ip.netmask
 ip.address = 10.2.4.1
 ip.netmask = 255.255.255.128
```

If the local DHCP server is enabled for an access point interface, addresses must be reserved for statically configured devices by setting the 'dhcp.reserve' parameter. This will reserve the specified number of addresses at the bottom of the IP range for the interface. For example, if the interface has the address 10.2.4.1, the netmask 255.255.255.128, and the 'dhcp.reserve' value 5, the addresses 10.2.4.2 through 10.2.4.6 will be available for use by statically configured devices.

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 33).

9.7 Client Devices

Each access point has a status page that displays information about attached clients and total throughput through the access point. The signal strength of each client device, it's 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 34.



GW-1 wlan1 Status

Data Transfer

Transmitted	2.7 Kb
Received	14.6 Kb

RSSI

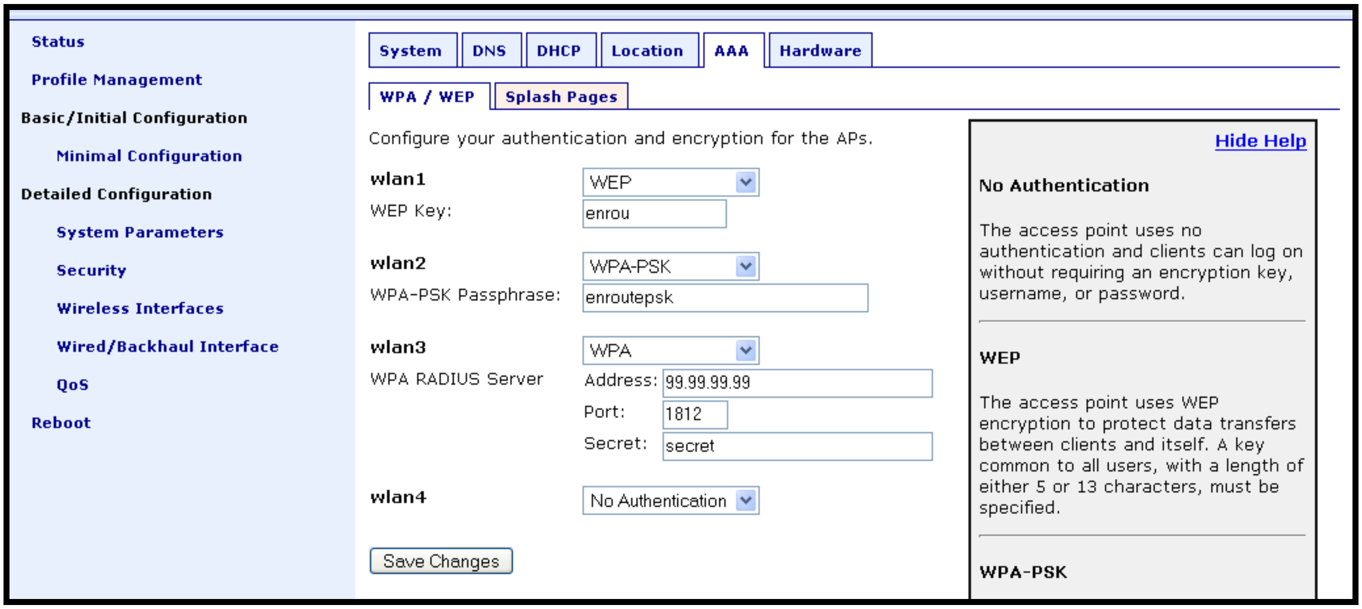
MAC Address	IP Address	RSSI	Last reception
00:16:b6:ea:86:5c	10.12.1.126	31	1 secs

Figure 34. Access point client status information

9.8 Encryption and Authentication

The EnRoute500 has 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 are supported.

The WEP and WPA configuration settings for each access point are independent. An access point 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
WPA 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, with a length of either 5 or 13 characters, must be specified.

WPA-PSK

Figure 35. Access point authentication and encryption settings

9.8.1 WEP Encryption

The access points can be protected with a WEP-based encryption key to prevent unauthorized users from intercepting or spoofing traffic. To enable WEP-based encryption, set the 'key' parameter in the 'wlanN' 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 10.

> If WPA is enabled for an interface ('wpa.enable' parameter in the 'wlanN' 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 10. 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=
```

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 35). Select "WEP" as the type of encryption from the drop-down menu for the access point you wish to configure and set the WEP key in the text box below the drop-down menu. In the example in Figure 35, 'wlan1' has been configured to use WEP.

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

In WPA pre-shared key (PSK) mode, a common passphrase is used for clients 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. It is suggested that the passphrase is 14 characters or longer to achieve an adequate level of security from the encryption algorithm. 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
```

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 35). Select "WPA-PSK" as the type of encryption/authentication from the drop-down menu for the access point you wish to configure and enter the WPA-PSK key in the text box below the drop-down menu. The correct 'wpa.key_mgmt' value for WPA-PSK is automatically set by the web interface. In the example in Figure 35, 'wlan2' has been configured to use WPA-PSK.

9.8.3 WPA EAP Mode

In WPA-EAP mode, a client device is authenticated using an 802.1x authentication server, which is typically a RADIUS server. To configure the EnRoute500 to support 802.1x authentication, the following parameters in a 'wlanN' interface must be set:

- wpa.enable
- wpa.key_mgmt

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

The supported EAP modes are:

- TLS
- TTLS
- PEAP

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 'wpa.auth.server.addr' parameter is the IP address of the 802.1x server that will be used for authentication and the 'wpa.auth.server.port' is the port that the authentication server is listening on (typically UDP port 1812 for a RADIUS server).

The parameter 'wpa.auth.server.shared_secret' is the shared secret for the authentication server. The secret must be a string that is no longer than 32 characters in length.

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
```

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 35). Select "WPA-EAP" as the type of encryption/authentication from the drop-down menu for the access point you wish to configure and set the authentication server address, port, and secret in the text boxes below the drop-down menu. The correct 'wpa.key_mgmt' value for WPA-EAP is automatically set by the web interface. In the example in Figure 35, 'wlan3' has been configured to use WPA-EAP.

9.9 Transmit Power

The transmit power of the access point 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 25 dBm.

⚠ **The values for 'txpower' in the 'wlanN' interfaces must be no greater than the values listed in Table 11 to be in compliance with FCC regulations. Note that the power limit is dependent on the channel selected.**

The example below shows how to set the access point radio's transmit power.

```
> use wlan1
wlan1> set txpower=25
```

The access points transmit power can be set via the web interface using the appropriate "wlanN" tab on the "Wireless Interfaces" page (see Figure 32).

INFO To determine the currently selected channel for the access point, use the command 'show channel' when the appropriate 'wlanN' interface has been selected.

Channel	txpower setting
1	13
2 – 10	25
11	05

Table 11. Access point transmit power limits

txpower	Output Power (dBm)
1	18
10	20
13	22
17	24
21	26
25	28
28	30

Table 12. AP radio output power settings

10 Client DHCP Configuration

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

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

All client interfaces in a mesh cluster must use the same DHCP option or have DHCP disabled.

10.1 Using Local DHCP Servers

The EnRoute500 can be set to serve DHCP addresses to clients on enabled access point interfaces and the Ethernet interface on repeater nodes. The 'dhcp.role' parameters in the 'wlanN' and 'eth0' interfaces control DHCP behavior. When 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
```

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

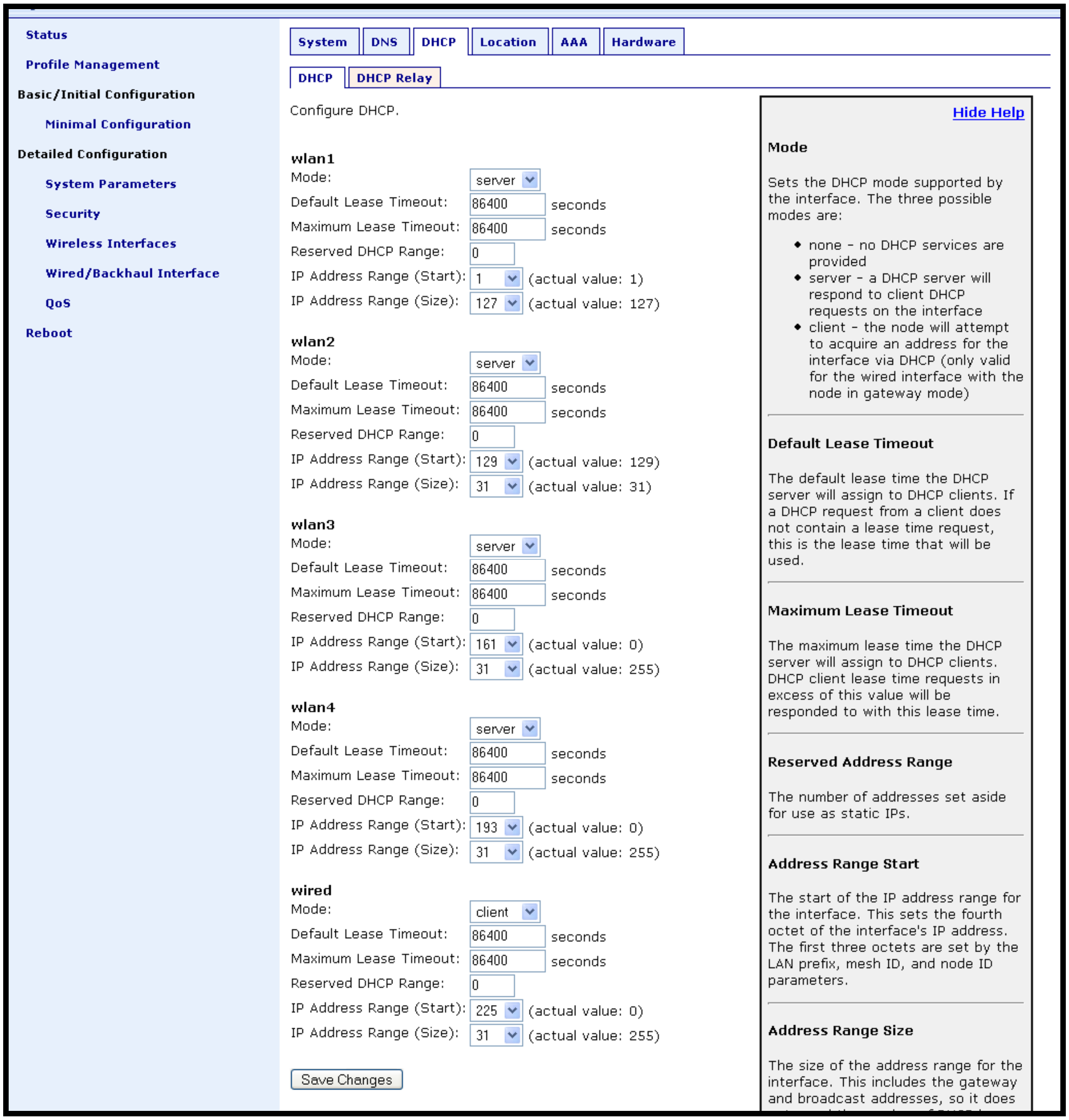
```
> use wlan1
wlan1> set dhcp.role=none
```

The access point 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 36). All of the access points' DHCP settings can be configured on this page.

The addresses provided by the DHCP server will be in the subnet defined by the 'id.lanprefix', 'id.mesh', 'id.node' in the 'sys' interface and the 'ip.start.actual' and 'ip.size.actual' parameters in the appropriate client interface. For example, for the 'wlan1' interface, the start and end of the address range are:

Start address = <sys.id.lanprefix>.
<sys.id.mesh>.
<sys.id.node>.
<wlan1.ip.start.actual> + 1

End address = <sys.id.lanprefix>.
<sys.id.mesh>.
<sys.id.node>.
<wlan1.ip.start.actual> - <wlanN.ip.size.actual> - 2



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: 129)
IP Address Range (Size): 31 (actual value: 31)

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: client
Default Lease Timeout: 86400 seconds
Maximum Lease Timeout: 86400 seconds
Reserved DHCP Range: 0
IP Address Range (Start): 225 (actual value: 0)
IP Address Range (Size): 31 (actual value: 255)

Mode

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

- none - no DHCP services are provided
- server - a DHCP server will respond to client DHCP requests on the interface
- 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 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.

Address Range Start

The start of the IP address range for the interface. This sets the fourth octet of the interface's IP address. The first three octets are set by the LAN prefix, mesh ID, and node ID parameters.

Address Range Size

The size of the address range for the interface. This includes the gateway and broadcast addresses, so it does

Figure 36. Access point DHCP configuration

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

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

The 'dhcp.reserve' setting for all access points 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 36).

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

Start address = <sys.id.lanprefix>.
<sys.id.mesh>.
<sys.id.node>.
<wlan1.ip.start.actual> + 1 - <wlan1.dhcp.reserve>

10.2 Using a Centralized DHCP Server

DHCP relay enables assignment of IP addresses to wireless clients from of 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 clients are assigned IP addresses from a single address pool, and are allowed to keep their address while roaming seamlessly from AP to AP. Even though they will not move seamlessly from one node to another, wired clients can also have their addresses assigned by a centralized server.

INFO

Seamless roaming denotes roaming from AP to AP with the same ESSID, while maintaining Layer 4 session persistence. Certain wireless utility / card combos will, instead of resetting the network adapter, re-request their currently assigned IP address from the DHCP server when connecting to a new AP with the same ESSID as the last one it was connected to. This behavior will leave existing Layer 4 (TCP/UDP) sessions intact.

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 node
2. The central DHCP server
3. Any intermediate router(s) in the path between the DHCP server and the mesh cluster gateway node

When using a centralized DHCP server, an address space, from which client addresses are assigned, must be defined. The client interfaces on the EnRoute500s (there can be up to 5 per node) must also have addresses that belong to this address space in order to facilitate DHCP relay and selection of client addresses from the correct DHCP scope on servers that serve hosts connected to different subnets. The client interface addresses need to be configured statically. It is recommended that a contiguous range of addresses at the lower end of the address space be set aside, one for each client interface on the mesh nodes.

Consider the example where a mesh cluster consists of 3 nodes, including the gateway node. The DHCP server resides on a host that also acts as the upstream router and is connected to the mesh gateway's wired segment. We will set aside 15 addresses for the mesh nodes' client interfaces (3 nodes, up to 5 interfaces per node). 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 addresses in the range of 192.168.5.19 to 192.168.5.254 to wireless clients. We will keep 192.168.5.255 as the broadcast address for the mesh cluster.

10.2.1 Configuring the EnRoute500s

Each EnRoute500 in a mesh cluster must be configured to use the same centralized DHCP server. This is set using the 'dhcp.relay.enable' parameter in the 'sys' interface as shown in the example below.

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

DHCP relay 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 37).

Each client interface on the EnRoute500 must be configured to be in server mode for it to support relay of addresses to clients from a central DHCP server. This configuration is set with the 'dhcp.role' parameter in each of the client interfaces (eth0,wlan1-4). The example below shows how to set this parameter for the wlan1 and wlan2 interfaces.

```
> use wlan1
wlan1> set dhcp=server
> use wlan2
wlan2> set dhcp=server
```

It is possible to disable DHCP address assignments to clients on a per-client interface basis and have them use static addresses instead. To disable DHCP for an interface, set the 'dhcp.role' parameter in the interface to 'none', as shown below

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

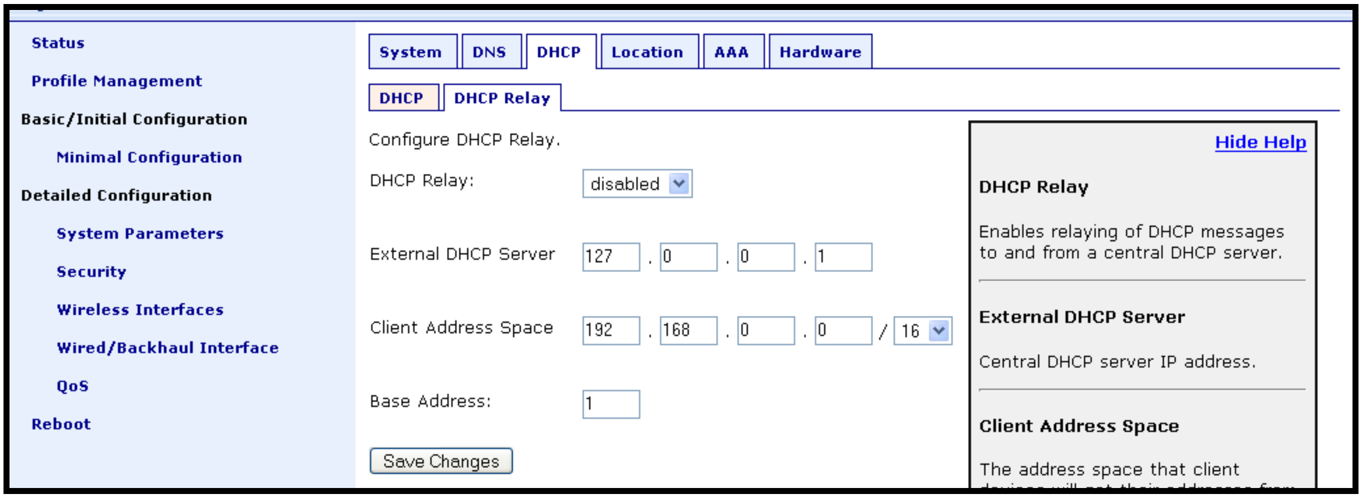
The IP address of the central DHCP server is set with the 'dhcp.relay.server' parameter in the 'sys' interface. The server must be reachable through the mesh gateway's wired backhaul interface. In the example below, the central DHCP server resides on a host on the same segment to which the mesh gateway's wired interface is connected.

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

The external DHCP server address can be set via the web interface on the "DHCP Relay" sub-tab under the "DHCP" tab on the "System Parameters" page (see Figure 37).

The address space that is to be used for the wireless clients is set with the 'dhcp.relay.dhcp_subnet' parameter in the 'sys' interface. This subnet can either be a class A (/8), class B (/16), or class C (/24) network. The value must be specified in CIDR notatation (a subnet and its size separated by a '/') as shown in the example below.

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



Configure DHCP Relay.

DHCP Relay: disabled

External DHCP Server 127 . 0 . 0 . 1

Client Address Space 192 . 168 . 0 . 0 / 16

Base Address: 1

DHCP Relay

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

External DHCP Server

Central DHCP server IP address.

Client Address Space

The address space that client

Figure 37. DHCP relay settings for use with a centralized DHCP server

The address space used for the nodes' DHCP clients can be set via the web interface on the "DHCP Relay" sub-tab under the "DHCP" tab on the "System Parameters" page (see Figure 37).

The IP addresses of the client interfaces (eth0, wlan1-4) need to be assigned to each of the nodes in the mesh cluster. This is done by defining a base value for the interfaces using the 'dhcp.relay.base' parameter in the 'sys' interface, which determines the address offset for each individual node. The value must be in the range from 0 to 255 and is used to derive the per-client relay agent address by OR-ing it with the value of the dhcp_subnet parameter. It is recommended that the gateway in a mesh cluster be assigned the lowest available value (3 in the example above) and the repeaters in the mesh cluster are given successively higher values, with an increment of 5 between them. The example below shows the configuration for a mesh cluster consisting of 3 nodes.

On the gateway:

```
> use sys
sys> set dhcp.relay.base=3
```

on the first repeater node:

```
> use sys
sys> set dhcp.relay.base=8
```

and on the second repeater node:

```
> use sys
sys> set dhcp.relay.base=13
```

The 'dhcp.relay.base' parameter can be set via the web interface on the "DHCP Relay" sub-tab under the "DHCP" tab on the "System Parameters" page (see Figure 37).

10.2.2 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 cluster 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 clients
4. The range of the flat IP address that is used for assigning addresses to clients. The range must not include the addresses set aside for the client interfaces on each mesh node.

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

```
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, it will be set to the correct value for proper operation inside the mesh segment. In this example, the mesh segment includes 3 mesh nodes, 2 addresses are set aside for the DHCP server and the mesh gateway, and therefore the address pool starts from 192.168.5.18.

11 Connecting an EnRoute500 Gateway to a WAN

The options for connecting an EnRoute500 gateway to a WAN are described below.

11.1 Manual Configuration

An EnRoute500 gateway can be directly connected to a WAN without using Network Address Translation. With this gateway configuration, 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 IP address. The subnets that need to be forwarded are:

Class B subnet:	<sys.id.lanprefix>.<sys.id.mesh>.0.0
Class C subnet:	<sys.id.meshprefix>.<sys.id.mesh>.0

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
```

With this configuration, the subnets the router would need to forward to the gateway are 10.2.0.0/255.255.0.0 and 172.29.2.0/255.255.255.0.

11.2 Network Address Translation (NAT)

Network Address Translation (NAT) isolates a mesh cluster from the WAN network that its gateway is connected to. The mesh nodes and their client devices are able to communicate with devices connected to the external network that the mesh gateway is connected to. However, devices on the external network cannot initiate communication with any nodes in the mesh cluster, or their clients, other than the mesh cluster gateway.

The advantages of using NAT are:

- You can easily attach a mesh cluster to an existing network. You do not need to modify any settings on the router on your existing network to forward packets to the addresses used in your mesh cluster.
- The nodes in the mesh cluster 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 cluster to it.

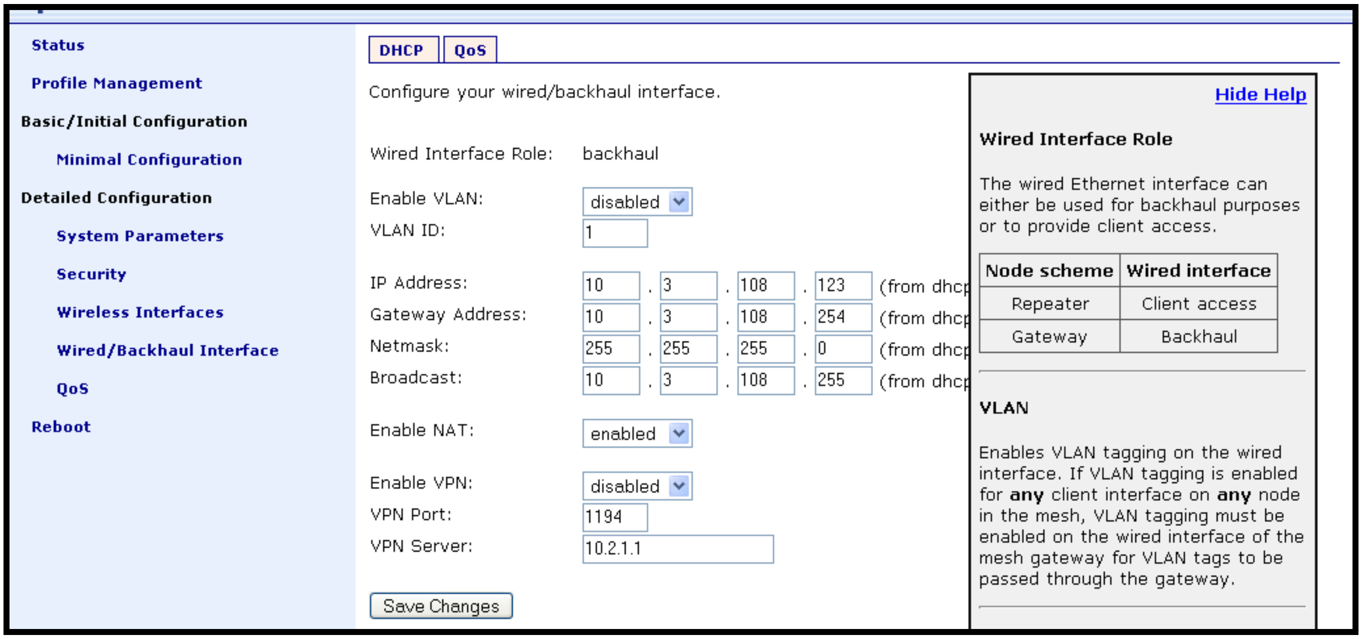
The main disadvantage of using NAT is

- You are not able to initiate connections with nodes in the mesh cluster or their clients from outside the mesh cluster.

To set the NAT state, use the commands

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

The NAT state can be set via the web interface on the "Wired/Backhaul Interface" page (Figure 38).



Configure your wired/backhaul interface.

Wired Interface Role: backhaul

Enable VLAN: disabled
VLAN ID: 1

IP Address: 10 . 3 . 108 . 123 (from dhcp
Gateway Address: 10 . 3 . 108 . 254 (from dhcp
Netmask: 255 . 255 . 255 . 0 (from dhcp
Broadcast: 10 . 3 . 108 . 255 (from dhcp

Enable NAT: enabled

Enable VPN: disabled
VPN Port: 1194
VPN Server: 10.2.1.1

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

Enables VLAN tagging on the wired interface. If VLAN tagging is enabled for **any** client interface on **any** node in the mesh, VLAN tagging must be enabled on the wired interface of the mesh gateway for VLAN tags to be passed through the gateway.

Figure 38. NAT setting

11.3 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:

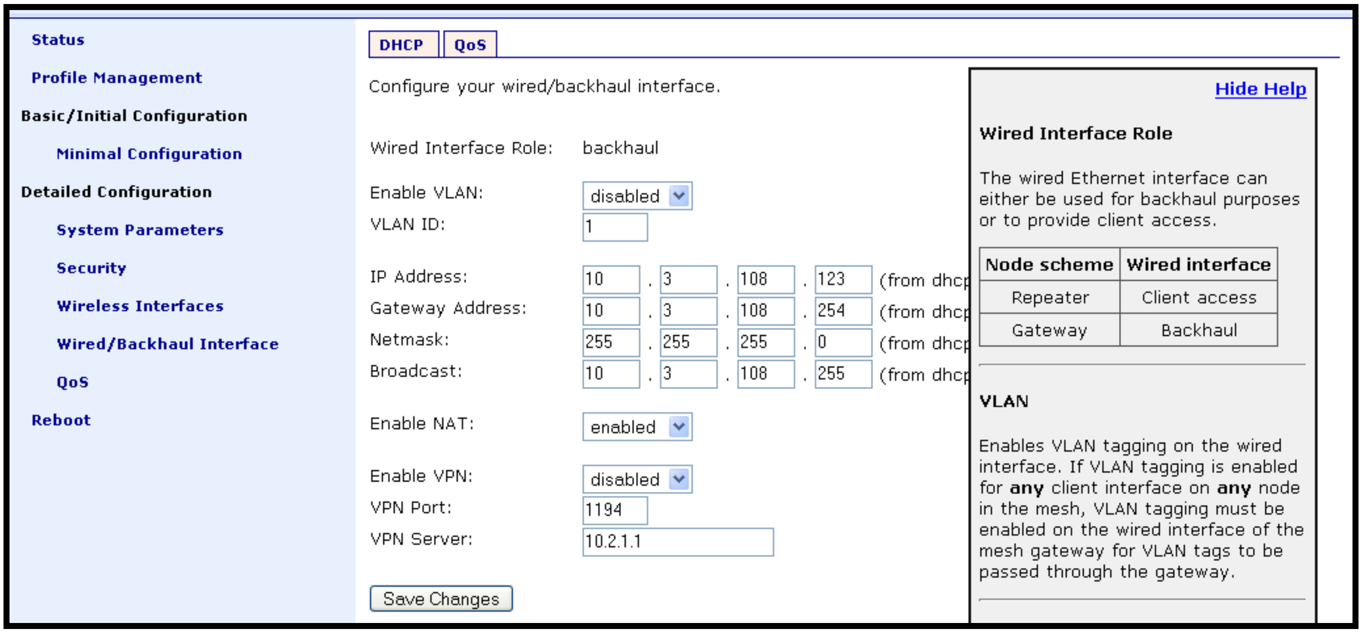
- Any node in the mesh can be contacted directly from a remote host, even when NAT is enabled on the gateway node. This allows remote access to nodes to monitor their behavior or reconfigure them

- A secure path between the mesh and a host, which can 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 'vpn.enable' parameter in the 'eth0' interface. The address of the VPN server and port are specified with the 'vpn.server' and 'vpn.port' parameters in the 'eth0' interface. Note that the 'vpn.server' parameter can either be an IP address or a resolvable host name. The example below shows how to configure the VPN client to talk to a VPN server.

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

These parameters can be set via the web interface on the "Wired/Backhaul Interface" page when the node scheme is set to 'gateway'.



Configure your wired/backhaul interface.

Wired Interface Role: backhaul

Enable VLAN: disabled

VLAN ID: 1

IP Address: 10 . 3 . 108 . 123 (from dhcp

Gateway Address: 10 . 3 . 108 . 254 (from dhcp

Netmask: 255 . 255 . 255 . 0 (from dhcp

Broadcast: 10 . 3 . 108 . 255 (from dhcp

Enable NAT: enabled

Enable VPN: disabled

VPN Port: 1194

VPN Server: 10.2.1.1

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

Enables VLAN tagging on the wired interface. If VLAN tagging is enabled for **any** client interface on **any** node in the mesh, VLAN tagging must be enabled on the wired interface of the mesh gateway for VLAN tags to be passed through the gateway.

Figure 39. VPN client settings

12 Controlling Access to the EnRoute500

The EnRoute500 supports the following methods for restricting access to the node and the network that it is connected to:

- Firewall
- Gateway firewall
- Client-to-client communication blocking
- White lists / black lists

12.1 Firewall

The EnRoute500 has a firewall that blocks traffic to the EnRoute500. This prevents client devices attached to a node and devices on the mesh gateway WAN from connecting to the node.

INFO

> The firewall only affects packets destined for the EnRoute500. All traffic destined for devices 'past' the EnRoute500 is not affected by the firewall. This means the firewall needs to be enabled on every EnRoute500 or connected clients will have full access to the EnRoute500's private ports.

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"
```

By default, the ports listed in Table 13 are set to be allowed.

Function	Port	Type	Protocol
SSH	22	Source & destination	TCP
HTTPS	443	Destination	TCP
HTTP redirect	3060	Destination	TCP
DNS	53	Source & destination	UDP
DHCP	67	Destination	UDP
DHCP	68	Destination	UDP
Roaming support	7202	Destination	UDP
Roaming support	7203	Destination	UDP

Table 13. Source and destination ports allowed by default

⚠ If ports that are open by default are reconfigured to be closed, certain EnRoute500 functions will be affected. It is strongly recommended that all of the ports listed in Table 13 be kept open.

12.2 Gateway Firewall

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

The gateway firewall should only be enabled on EnRoute500's that are configured as gateways. It is possible to have the gateway firewall set to be enabled on a repeater node, but it does not have any effect on the flow of traffic through the node's Ethernet interface.

INFO If you have enabled NAT (see section 11.2) on the Ethernet interface 'eth0', you will have an implicit firewall that limits the type of inbound connections that are possible.

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
```

12.3 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 interfaces, the clients that attach to that particular interface will not be able to communicate with any clients attached to that or any other client interface in the mesh. Client-to-client traffic can be controlled for interfaces wlan1, wlan2, wlan3, wlan4, and eth0.

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 clients, set the parameter to 'yes'. The examples below illustrate the how to configure these parameters.

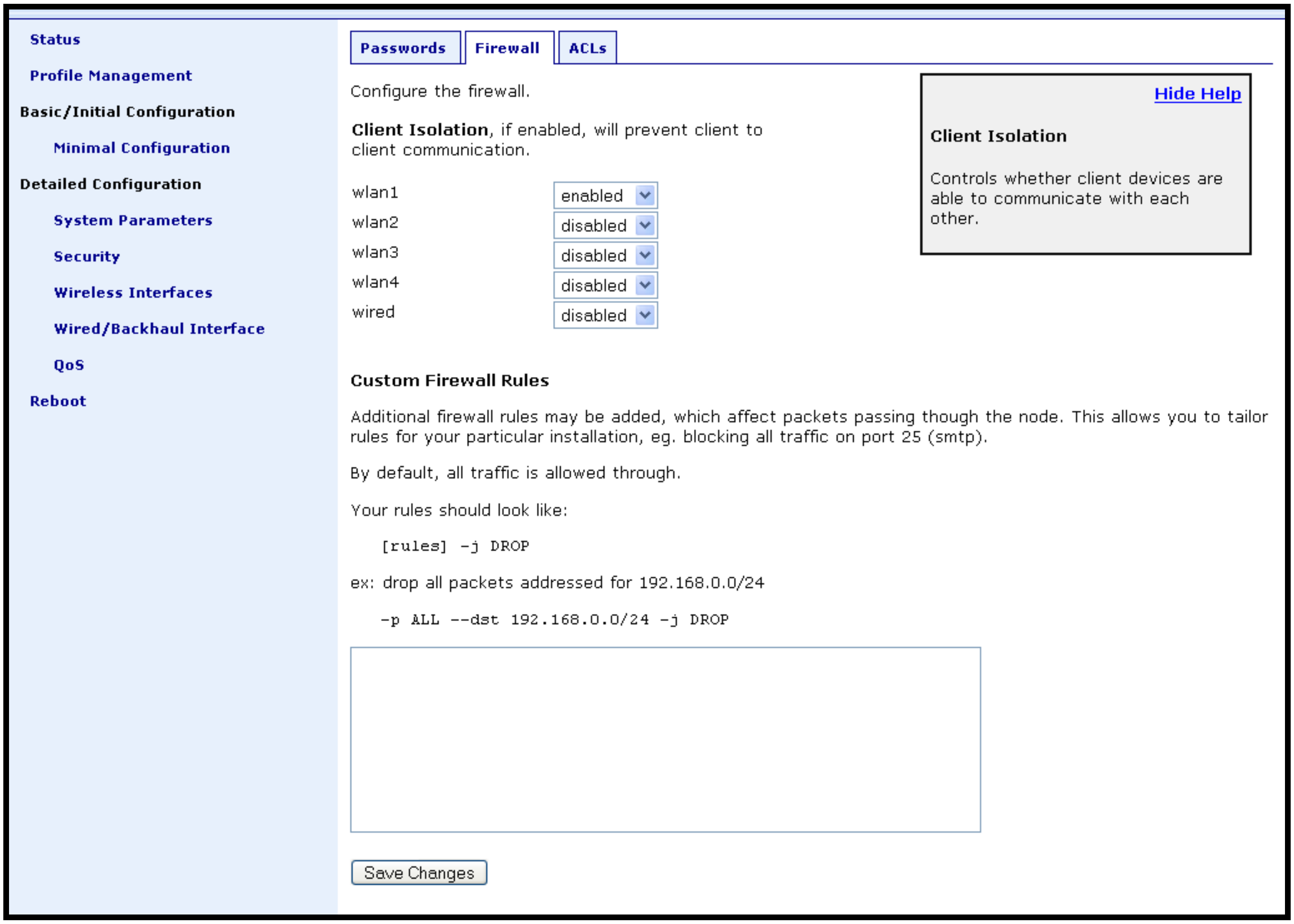
To block client-to-client traffic for clients attached to wlan1:

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

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

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

The 'node.allow_c2c' parameters can be set via the web interface using the "Firewall" tab on the "Security" page (see Figure 40).



Configure the firewall.

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

wlan1	enabled
wlan2	disabled
wlan3	disabled
wlan4	disabled
wired	disabled

Client Isolation

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

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 DROP
```

ex: drop all packets addressed for 192.168.0.0/24

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

Figure 40. Client-to-client 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 node firewall (firewall.node.enable) is enabled (section 12.1).

12.4 Access Control Lists (ACLs)

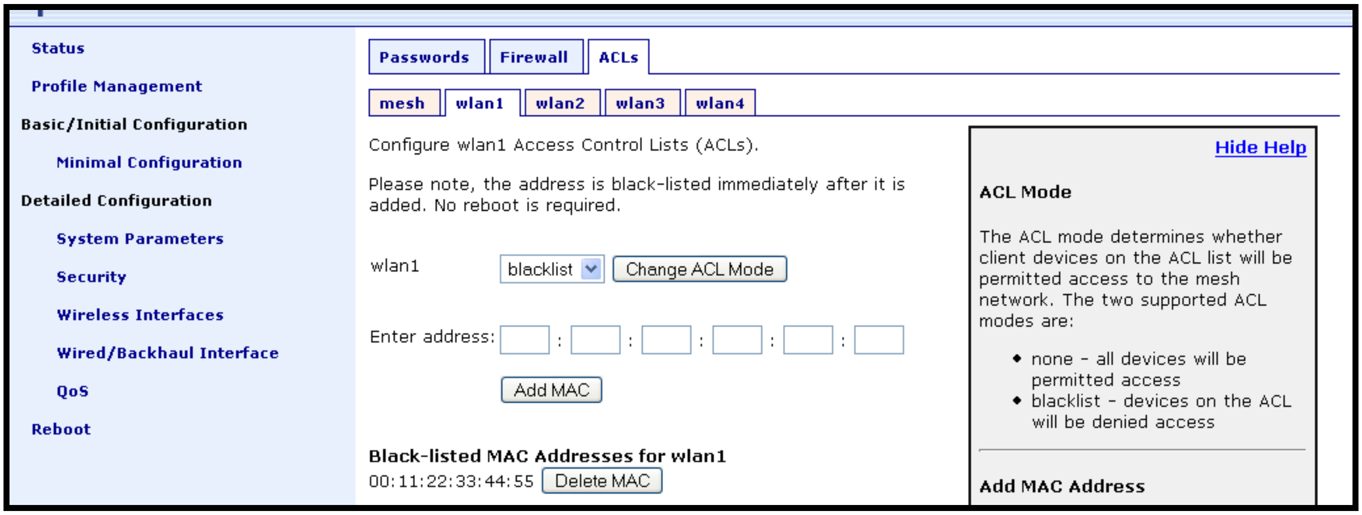
Access control lists can be created for each of the access point interfaces and the mesh interface.

12.4.1 Access Point Access Control Lists (ACLs)

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

The ACLs can be defined via the web interface on the appropriate "wlanN" sub-tab under the "ACL" tab on the "Security" page. Enter a MAC address and click on the "Add MAC" button to add the address to the ACL for that access point. 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 an access point 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 black-listed immediately after it is added. No reboot is required.

wlan1 blacklist

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

Black-listed MAC Addresses for wlan1

00:11:22:33:44:55

ACL Mode

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

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

Add MAC Address

Figure 41. AP ACL configuration

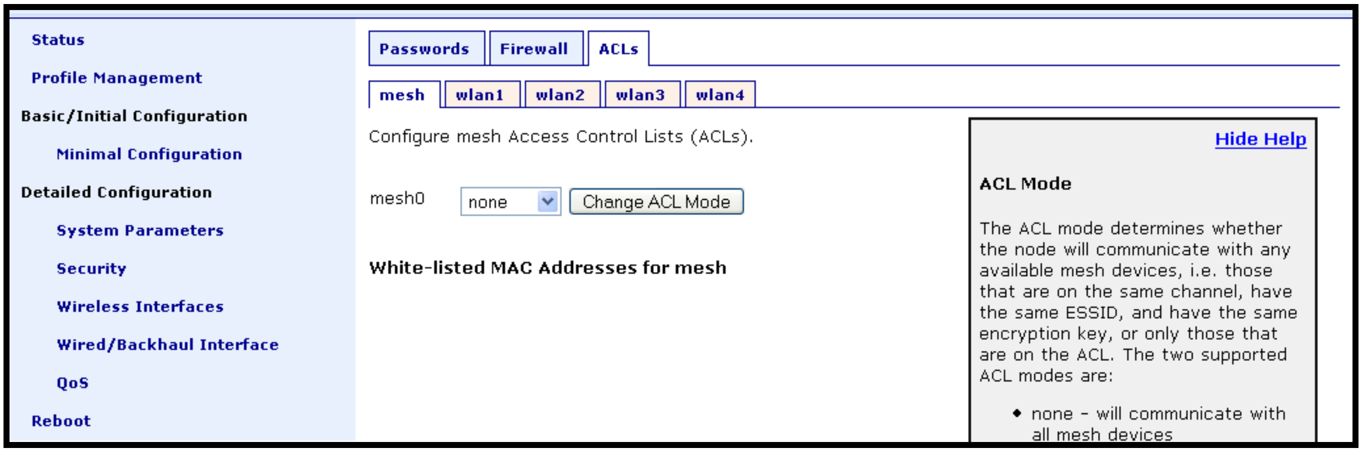
12.4.2 Mesh ACL

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

> It is possible to isolate a mesh node from other nodes 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 nodes to communicate with the node.

The mesh ACL can be defined via the web interface on the "Mesh" sub-tab under the "ACL" tab on the "Security" page. Enter a MAC address and click on the "Add MAC" button to add the address to the ACL for that access point. 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 an access point 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 mesh Access Control Lists (ACLs).

mesh0 none

White-listed MAC Addresses for mesh

ACL Mode

The ACL mode determines whether the node will communicate with any available mesh devices, i.e. those that are on the same channel, have the same ESSID, and have the same encryption key, or only those that are on the ACL. The two supported ACL modes are:

- none - will communicate with all mesh devices

Figure 42. Mesh ACL configuration

13 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.

13.1 Priority Levels

The available priority levels are listed in Table 14.

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

Table 14. Priority levels

When sending data out through any of the wireless interfaces (wlanN, mesh0), these priorities map directly to the hardware priority output queues on the wireless card if the receiver has 802.11e support, as the EnRoute500 does. The default level is Best Effort.

Priority levels are set with the following CLI parameters in the 'qos' interface:

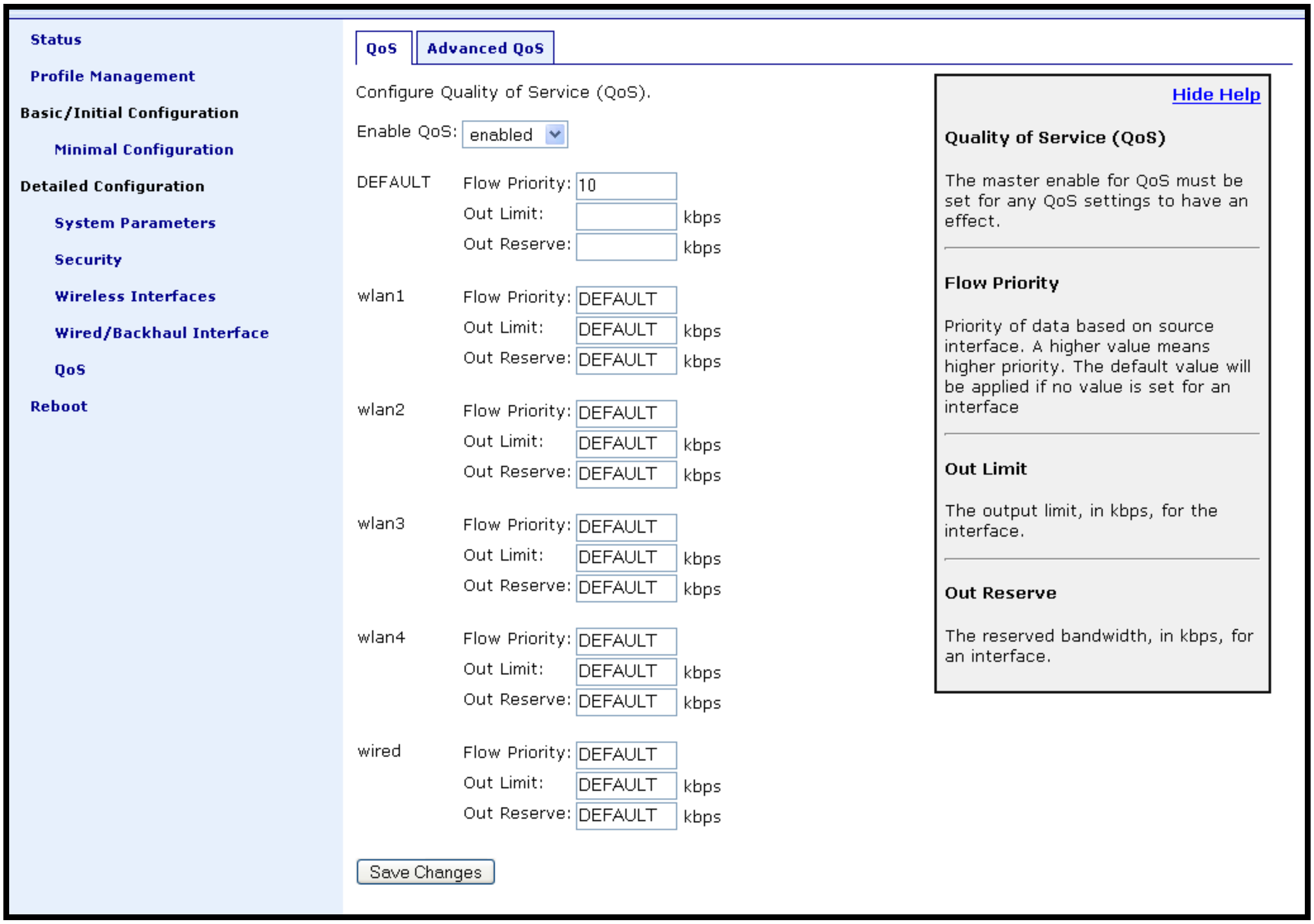
```
in.<intf>.hwpri{max,min}
in.<intf>.flow_priority
```

where <intf> is one of the following: default, local, eth0, mesh0, wlan1, wlan2, wlan3, wlan4. 'local' refers to traffic originating on the node itself, not from its clients (in practice this means mesh network control traffic).

Flow priorities can be set via the web interface under the "QoS" tab on the "QoS" page (see Figure 43).

The 'in.<intf>.flow_priority' parameters set the relative priority of outbound traffic based on the source interface. These parameters can be set to a value in the range from 0 to 99, with a higher number indicating a higher priority. If a priority level parameter is set to 'inherit', the interface will assume the default priority level of 'in.default.flow_priority'.

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.



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 43. QoS settings

INFO

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

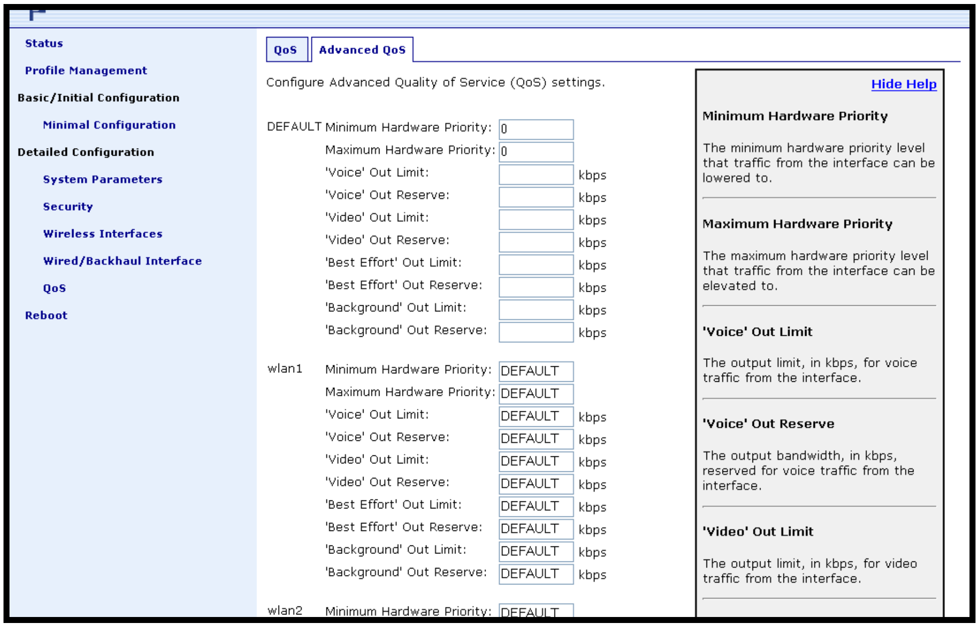
The example below sets locally generated traffic to have top priority and wlan1 to have priority over all other interfaces.

```
> 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
```

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.

The 'in.<intf>.hwpri.max' and 'in.<intf>.hwpri.min' 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 14. These parameters can be set via the web interface under the "Advanced QoS" tab on the "QoS" page (see Figure 44).



Configure Advanced Quality of Service (QoS) settings.

DEFAULT	Minimum Hardware Priority:	0	
	Maximum Hardware Priority:	0	
	'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	Minimum Hardware Priority:	DEFAULT	
	Maximum Hardware Priority:	DEFAULT	
	'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	Minimum Hardware Priority:	DEFAULT	

Minimum Hardware Priority

The minimum hardware priority level that traffic from the interface can be lowered to.

Maximum Hardware Priority

The maximum hardware priority level that traffic from the interface can be elevated to.

'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.

Figure 44. Advanced QoS configuration (only settings for some interfaces are shown)

To increase the hardware priority of traffic from a particular interface, set the value of 'in.<intf>.hwpri.min' 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 'in.<intf>.hwpri.min' value set. To reduce the maximum hardware priority of traffic from an interface, set the 'in.<intf>.hwpri.max' parameter to a value less than 4. To disable hardware prioritization, set the 'in.<intf>.hwpri.max' and 'in.<intf>.hwpri.min' parameters to '0'.

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
```

This does **not** affect the rate limiting and reservation (section 13.2), it only affects which output hardware queues are used.

13.2 Rate Limiting

A rate limit can be set at each QoS Control Point shown in Figure 45. 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

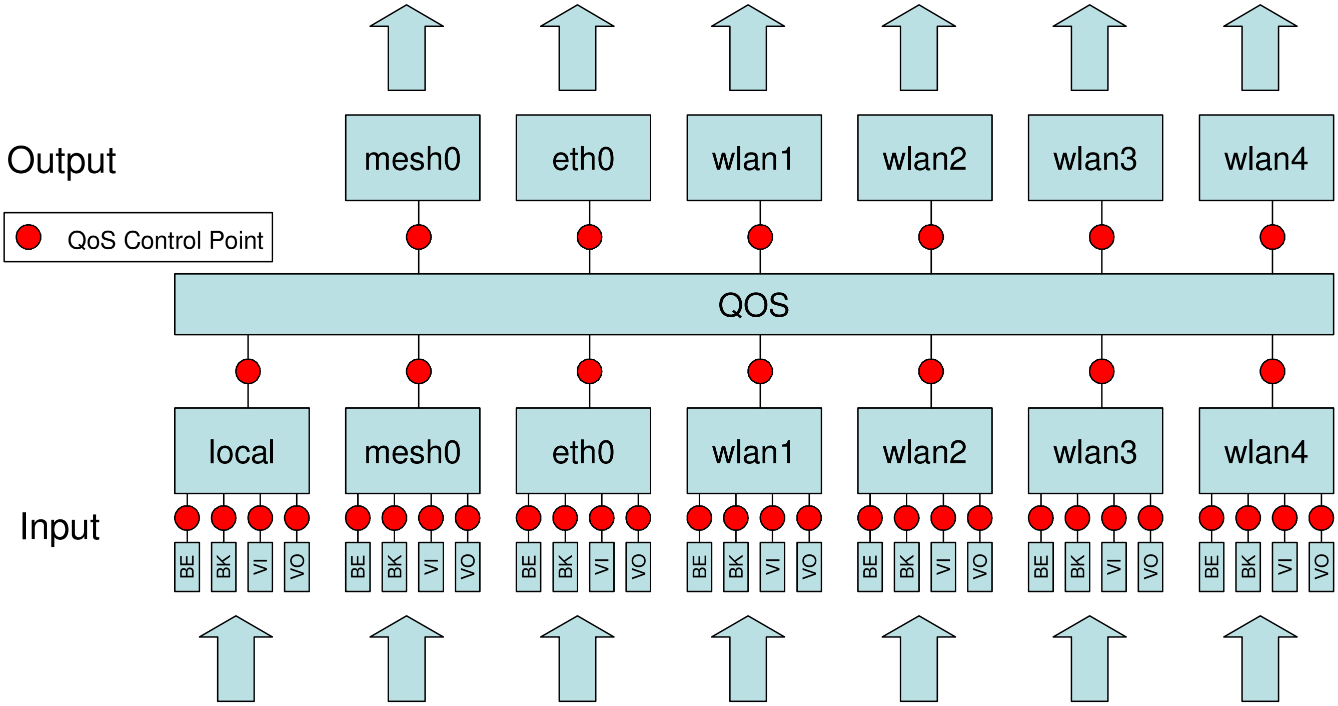


Figure 45. Quality of Service rate limit control points

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 'out.<intf>.limit' parameters in the 'qos' interface, where <intf> is one of the following: default, eth0, mesh0, wlan1, wlan2, wlan3, wlan4. The 'out.default.limit' value is applied to interfaces that have the 'out.<intf>.limit' parameter set to 'inherit'. These parameters can be set via the web interface under the "QoS" tab on the "QoS" page (see Figure 43).

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 wlanN 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. These parameters can be set via the web interface under the "Advanced QoS" tab on the "QoS" page (see Figure 44).

INFO

> There is no standalone input rate limiting. Limiting the input rate of an interface 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.

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
```

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 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 14 for description of traffic types). These parameters can be set via the web interface under the "Advanced QoS" tab on the "QoS" page (see Figure 44).

The 'out.default.default.limit' value is applied to interfaces that have the 'out.<output intf>.<input intf>.limit' parameter set to 'inherit'.

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
```

13.3 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 46. 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.

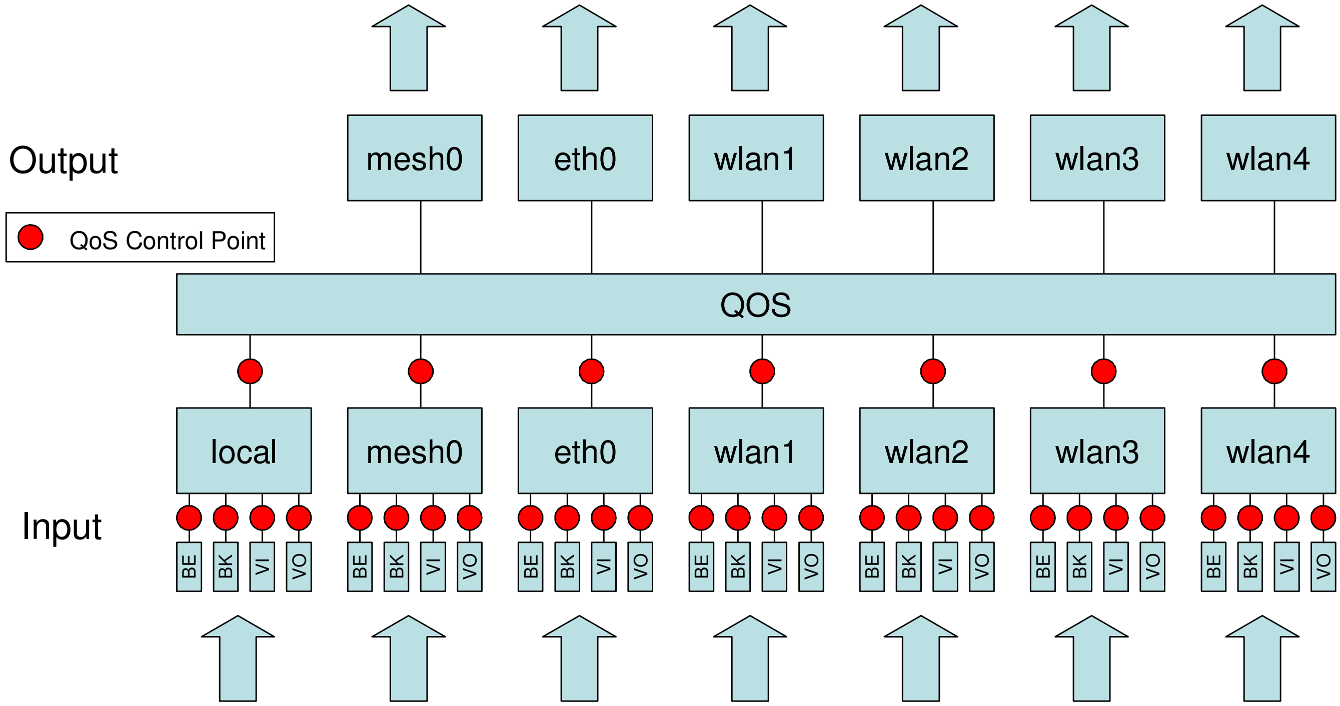


Figure 46. Quality of Service rate reservation control points

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. 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. The 'out.default.default.reserve' value is applied to interfaces that have the 'out.<output intf>.<input intf>.reserve' parameter set to 'inherit' or is left blank. These parameters can be set via the web interface under the "Advanced QoS" tab on the "QoS" page (see Figure 44).

Typically, most rate reservations will involve reserving bandwidth for traffic from a particular client 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
```

Rate reservations can also be set based on traffic type through an interface. 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 14 for description of traffic types). These parameters can be set via the web interface under the "Advanced QoS" tab on the "QoS" page (see Figure 44).

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
```

14 Enabling VLAN Tagging

The EnRoute500 supports VLAN tagging, with each client interface capable of supporting a different VLAN tag. If VLAN tagging is enabled for an interface, client devices that connect to the interface must be capable of receiving VLAN-tagged frames.

14.1 Client Interface Configuration

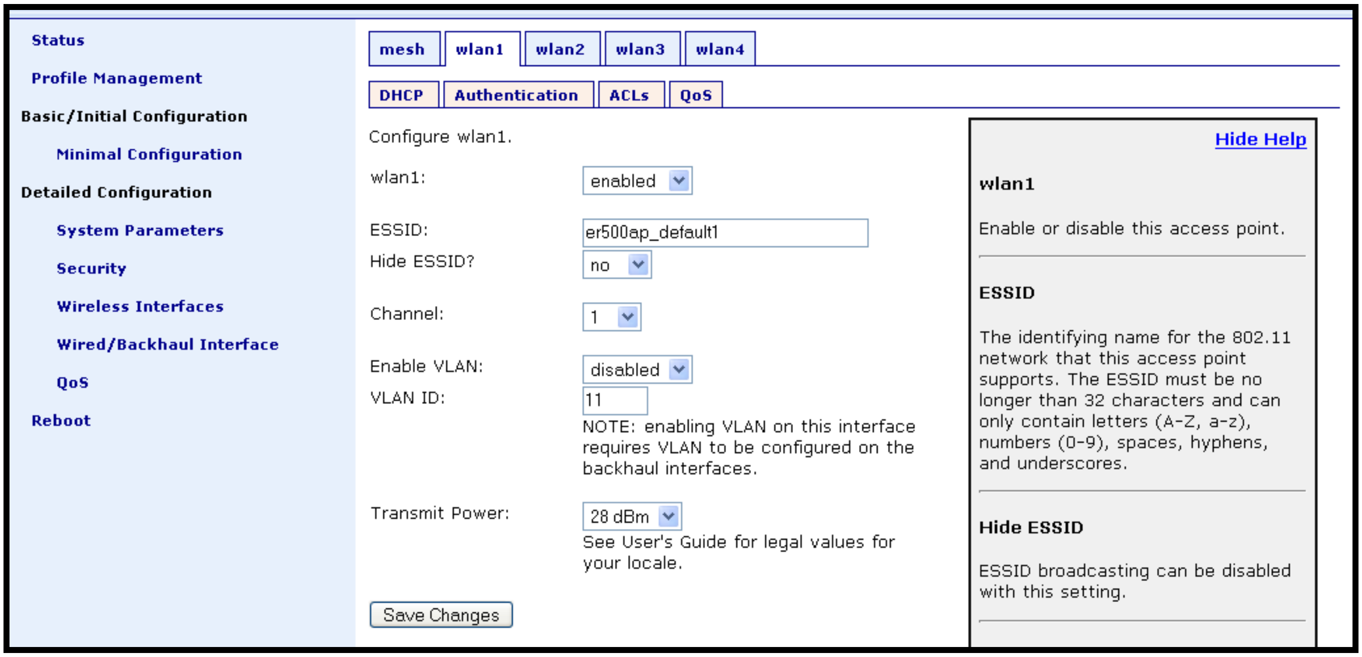
VLAN tagging can be independently controlled on each client interface (eth0, wlan1-4). The 'vlan.enable' parameter in the 'eth0', 'wlan1', 'wlan2', 'wlan3', and 'wlan4' interfaces controls the state of VLAN tagging. The example below shows how to enable VLAN tagging on the 'wlan1' interface. The VLAN-related parameters can be set via the web interface under the "wlanN" tags on the "Wireless Interfaces" page and on the "Wired/Backhaul Interface" page (see Figure 47).

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

⚠ VLAN tagging must be enabled on the backhaul Ethernet interface on a mesh cluster's gateway for VLAN tags to be included in data frames sent to the WAN. See section 14.2 for more details.

The VLAN ID is set with the 'vlan.id' parameter in the respective interfaces that support VLAN tagging. 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 nodes having to match or be different.

The VLAN-related parameters for the backhaul interface can be set via the web interface on the "Wireless Interfaces" page and on the "Wired/Backhaul Interface" page (see Figure 47).



Configure wlan1.

wlan1: enabled

ESSID: er500ap_default1

Hide ESSID? no

Channel: 1

Enable VLAN: disabled

VLAN ID: 11

NOTE: enabling VLAN on this interface requires VLAN to be configured on the backhaul interfaces.

Transmit Power: 28 dBm

See User's Guide for legal values for your locale.

wlan1

Enable or disable this access point.

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.

Figure 47. Configuring VLAN for access point interfaces

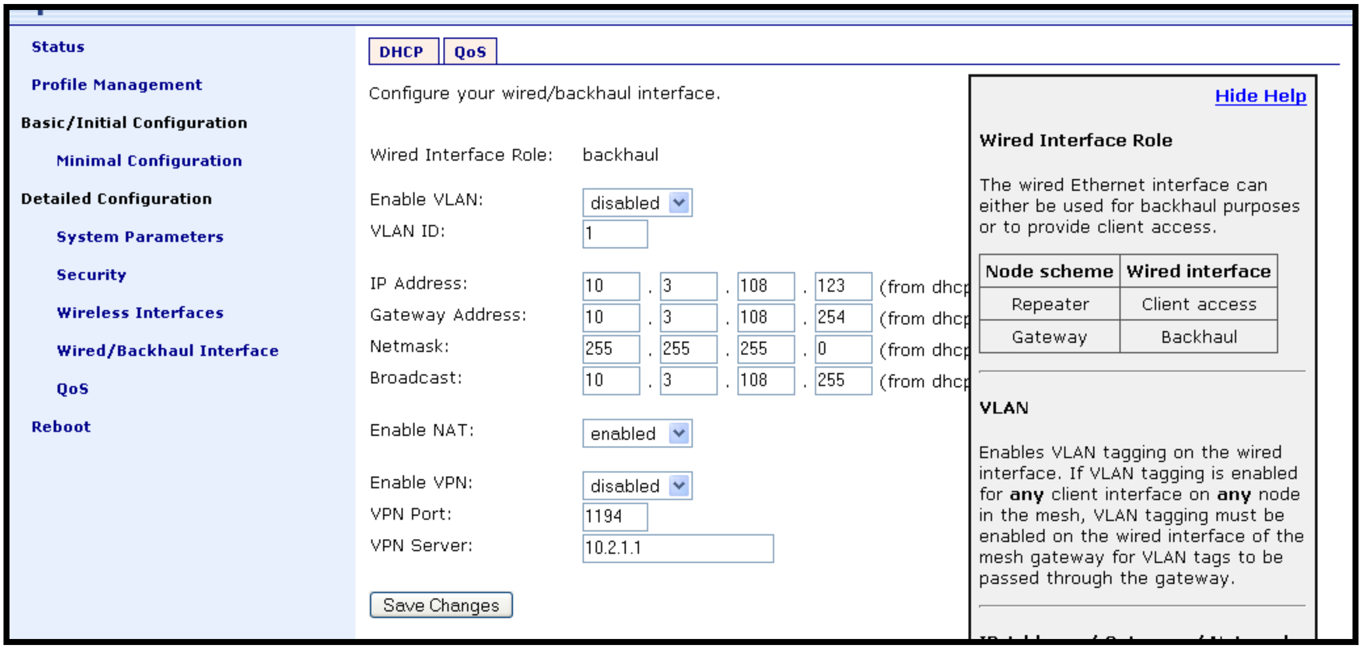
14.2 Gateway Configuration

For VLAN tags to be preserved on traffic that exits a mesh cluster, VLAN support must be enabled for the Ethernet interface on the mesh cluster's gateway node. The 'vlan.enable' parameter in the 'eth0' interface controls the state of VLAN tagging. The example below shows how to enable VLAN tagging on a gateway node. If VLAN tagging is enabled on the gateway's interface to the WAN, all inbound traffic will have their VLAN tags preserved. If VLAN tagging is disabled for this interface, all VLAN tags will be stripped from frames entering the mesh cluster.

```
> use eth0
eth0> set vlan.enable=yes
```

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, defined by the 'vlan.id.' parameter in the 'eth0' interface. The example below shows how to set the VLAN ID for the 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.

```
> use eth0
eth0> set vlan.id=1
```



Configure your wired/backhaul interface.

Wired Interface Role: backhaul

Enable VLAN: disabled

VLAN ID: 1

IP Address: 10 . 3 . 108 . 123 (from dhcp

Gateway Address: 10 . 3 . 108 . 254 (from dhcp

Netmask: 255 . 255 . 255 . 0 (from dhcp

Broadcast: 10 . 3 . 108 . 255 (from dhcp

Enable NAT: enabled

Enable VPN: disabled

VPN Port: 1194

VPN Server: 10.2.1.1

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

Enables VLAN tagging on the wired interface. If VLAN tagging is enabled for **any** client interface on **any** node in the mesh, VLAN tagging must be enabled on the wired interface of the mesh gateway for VLAN tags to be passed through the gateway.

Figure 48. Configuring VLAN for backhaul interface

15 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

15.1 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 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 having 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 must also be specified.

15.1.1 Enabling Splash Pages

The enabling of splash pages can be controlled on a per-interface basis with the 'splash.enable.wlanN' 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 this parameter for the wlan1 interface.

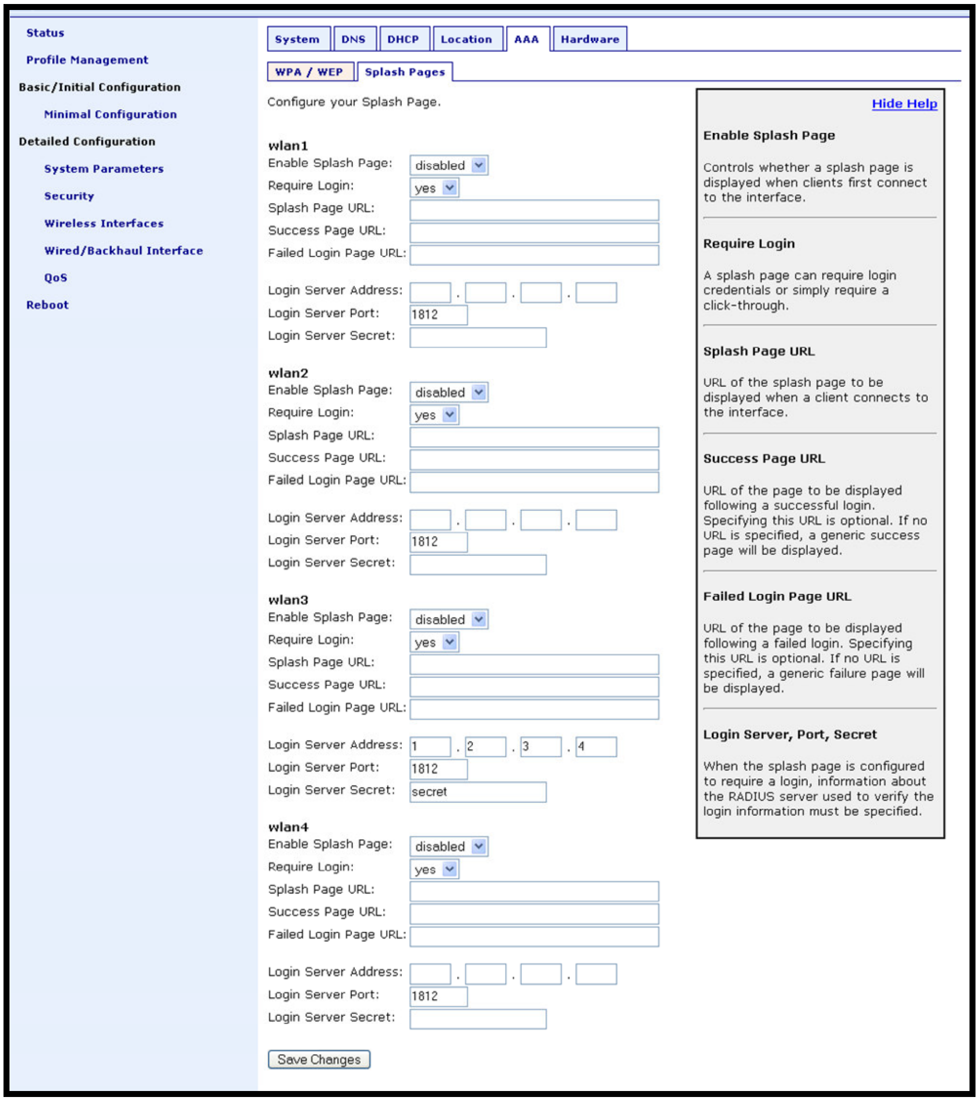
```
> use sys
sys> set splash.enable.wlan1=yes
```

Splash pages can be enabled on the "Splash Pages" sub-tab under the "AAA" tab on the "System Parameters" page of the web interface (see
Figure 49).

Two splash page mode are supported – one which requires clients 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. Use the 'splash.auth.server.wlanN.enable' parameters in the 'sys' interface to select which mode is used for an 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
```

The “Require Login” settings on the “Splash Pages” sub-tab under the “AAA” tab on the “System Parameters” page (see
Figure 49) is used to configure this parameter via the web interface.



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: 1 . 2 . 3 . 4
Login Server Port: 1812
Login Server Secret: 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 49. Splash page configuration

15.1.2 Configuring Splash URLs

The URL that a user is redirected to for login purposes can be individually configured for each client interface that supports splash pages (wlan1-4). URLs for successful login, failed login, and error conditions can also be specified for each interface.

The 'splash.url.<intf>.login' parameter in the 'sys' interface, where <intf> is either 'wlan1', 'wlan2', 'wlan3', or 'wlan4', 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 since no client would be able to access the network through the interface if it does not point to a valid URL.

The 'splash.url.<intf>.success' parameter in the 'sys' interface, where <intf> is either 'wlan1', 'wlan2', 'wlan3', or 'wlan4', 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 'splash.url.<intf>.fail' parameter in the 'sys' interface, where <intf> is either 'wlan1', 'wlan2', 'wlan3', or 'wlan4', 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 'splash.url.<intf>.error' parameter in the 'sys' interface, where <intf> is either 'wlan1', 'wlan2', 'wlan3', or 'wlan4', 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.

All of these 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 49).

The example below shows how the 'wlan1' and 'wlan2' interfaces can be used to 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
```

The login page must contain specific form information as shown in the sample code in Figure 50 and Figure 51. Figure 50 contains the code required for an interface that requires a login ('splash.auth.server.enable.wlanN' is set to 'yes'). Figure 51 contains code for a login page that the user just clicks through to unlock network access. The critical lines in Figure 50 are 6, 9, 10, and 12.

The 'action' value in line 6 of Figure 50 must point to a server name for which there is a DNS proxy entry on the local node and the last part of it must be '/radius/login.cgi'. The DNS proxy entry, which will be different for each node in the network, must be mapped to one of the node's IP addresses (see section 6.7 for more information on 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 nodes. 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 following '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.

```
 1  <html>
 2  <head>
 3    <title>Test Login Page</title>
 4  </head>
 5  <body>
 6    <form method="POST" action="https://dns.proxy.name.here/radius/login.cgi">
 7    Welcoming text or 'Terms of Service' could go here. <br />
 8
 9    <table border="0">
10    <tr>
11      <td> Username: </td>
12      <td> <input name="username" type="text"><br /> </td>
13    </tr><tr>
14      <td> Password: </td>
15      <td> <input name="password" type="password"> </td>
16    </tr>
17    </table>
18
19      <input name="login" type="submit" value="Submit">
20    </form>
21  </body>
22  </html>
```

Figure 50. Sample HTML code for login web page

If the splash page is not configured to require a user to provide login credentials ('splash.auth.server.enable.wlanN' is set to 'no'), the requirements for the login page are slightly different, as shown in Figure 51. The page must still contain a form definition similar to that on line 6 in Figure 51. 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 51.

```
<html>
<head>
  <title>Test Login Page</title>
</head>
<body>
  <form method="POST" action="https://dns.proxy.name.here/splash/nologin.cgi">
  Welcoming text or 'Terms of Service' could go here.<br />
    <input name="login" type="submit" value="Continue">
  </form>
</body>
</html>
```

Figure 51. Sample HTML code for web page when authentication is disabled

15.1.3 Configuring the Authentication Server

A RADIUS authentication server must be specified when the splash page is enabled for an interface. 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 ‘splash.auth.server.<intf>.host’ parameter can be either a hostname or and IP address. ‘splash.auth.server.<intf>.port’ is the port that the authentication server is listening on. ‘splash.auth.server.<intf>.secret’ is the shared secret that must be provided to the RADIUS authentication server. This parameter must be a string of alphanumeric characters that is 32 characters or less in length.

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 49).

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
```

15.1.4 Trusted MAC Addresses

A list of trusted MAC addresses that do not require splash page authentication can be defined. When a device with one of these MAC addresses connects to a node, it will automatically have full access to the WAN. 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"
```

15.2 Backhaul Health Monitoring

A gateway node can monitor its connectivity to a remote device to ensure that its backhaul connection is functioning properly. If a gateway determines that it has lost connectivity over its backhaul link, it will stop advertising its gateway capability to nodes in the mesh cluster. If the backhaul connection is re-established, the gateway will revert to advertising its gateway services. While the backhaul link is down the gateway will switch to repeater mode and will forward traffic from other mesh nodes and its clients.

INFO

> The backhaul health monitoring function has no effect on a node configured as a repeater.

Backhaul health monitoring is enabled with the 'monitor.health.enable' parameter in the 'sys' interface as shown in the example below.

```
> use sys
sys> set monitor.health.enable=yes
```

⚠

> The health monitoring scheme, if configured incorrectly, can incapacitate a mesh cluster. If the device that is used to check the state of the backhaul link fails or if an address that the gateway cannot reach is specified, the gateway will not function properly and it will not be possible to communicate with it over the backhaul link.

The host that the gateway uses to test backhaul health is specified with the 'monitor.health.host' parameter in the 'sys' interface. The device specified with this parameter must be capable of responding to ping, or ICMP echo, packets from the gateway for the health monitoring to function properly. The example below shows how to set this parameter.

```
> use sys
sys> set monitor.health.host=10.0.1.1
```

INFO

> It is recommended that an IP address, rather than a hostname, is specified for the 'monitor.health.host' parameter to avoid a DNS failure from causing the gateway to believe that its backhaul link is down. The IP address of the closest backhaul router would be an appropriate host to specify.

15.3 Layer 2 Emulation

Certain back-end systems (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 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 MAC address information to back-end systems.

When the layer 2 emulation mode is enabled, a mesh cluster gateway will send Ethernet (layer 2) frames to the WAN using the MAC address of the device the packet originated from as the source address. Mesh gateways will also act as proxies and forward packets with MAC destination addresses of clients that are in the mesh cluster they service.

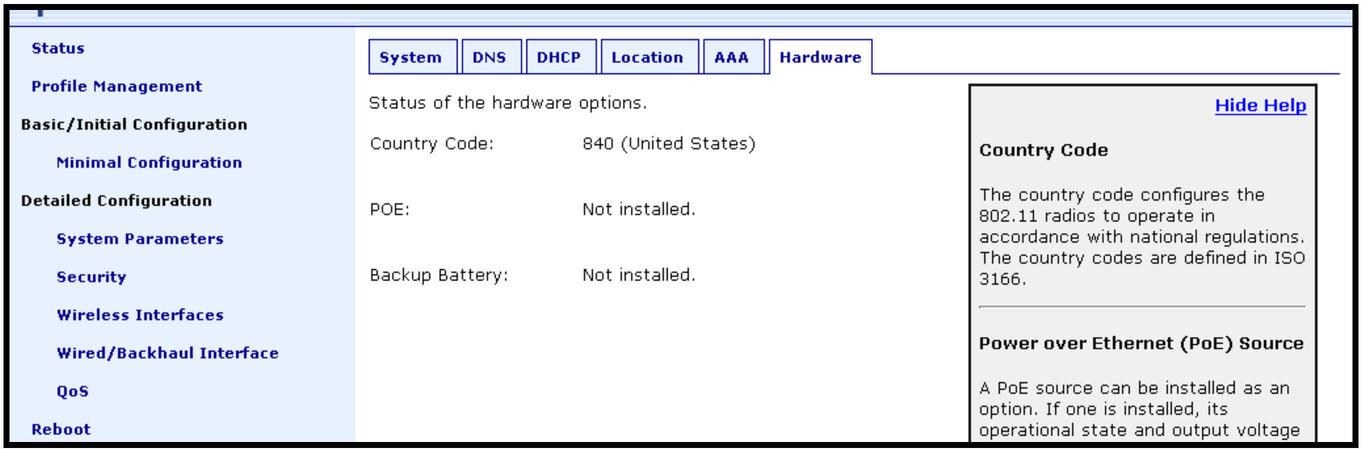
Layer 2 emulation is enabled with the 'l2_client_mac_fwd' parameter in the 'sys' interface. This parameter should be set to the same value for all devices in a given mesh cluster. The example below shows how to enable layer 2 emulation.

```
> use sys
sys> set l2_client_mac_fwd=yes
```

In combination with a centralized DHCP server, layer 2 emulation allows the EnRoute500 mesh network to behave like a series of access point bridges, a mode which is required by certain Internet gateways to successfully forward IP packets to clients. For more information on setting up a centralized DHCP server, see section 10.2.

16 Hardware Configuration

An EnRoute500 can be equipped with a number of optional hardware components, such as a Power-over-Ethernet (PoE) source and a back-up battery. The "Hardware" tab on the "System" page in the web interface displays whether these optional hardware components are installed or not. If they are installed, their current operational state will be displayed.



Status of the hardware options.

Country Code: 840 (United States)

POE: Not installed.

Backup Battery: Not installed.

Country Code

The country code configures the 802.11 radios to operate in accordance with national regulations. The country codes are defined in ISO 3166.

Power over Ethernet (PoE) Source

A PoE source can be installed as an option. If one is installed, its operational state and output voltage

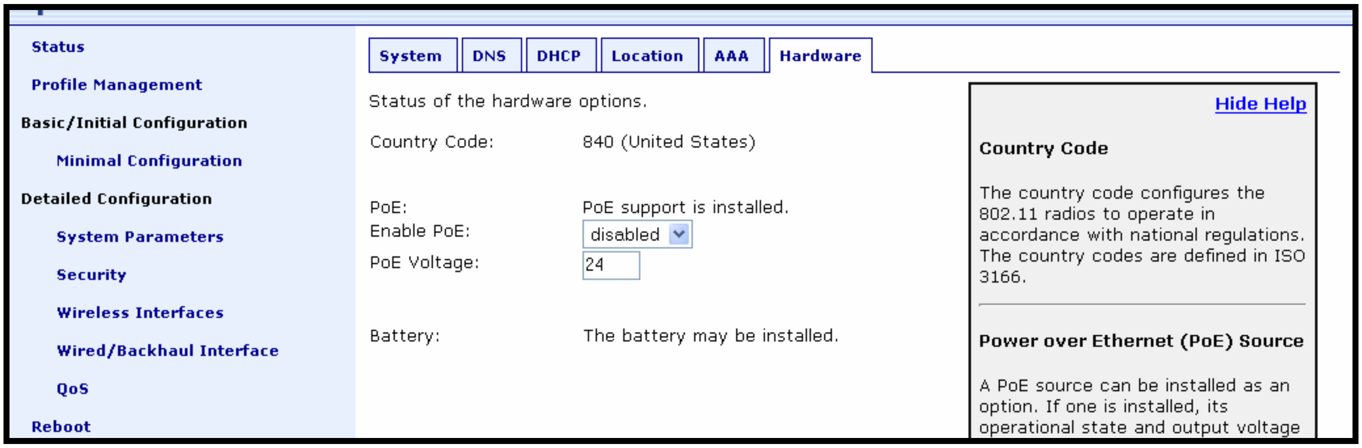
Figure 52. Node hardware configuration on node without PoE source capability

16.1 Power Over Ethernet Source

An EnRoute500 may optionally be equipped with a Power over Ethernet (PoE) source. If the PoE source is installed, the 'dev.poe.installed' parameter in the 'sys' interface will be set to 'yes'. The state of the PoE source is controlled through the 'dev.poe.enable' parameter in the 'sys' interface. The PoE source voltage can be set to either 24 or 48V with the 'dev.poe.voltage' parameter in the 'sys' interface.

The PoE-related parameters can be set via the web interface on the "Hardware" tab on the "System Parameters" page (see Figure 53). This page will indicate whether a PoE source option is installed and will only display the PoE parameters if it is installed.

PoE parameter changes will take effect when the node is rebooted.



Status of the hardware options.

Country Code: 840 (United States)

PoE: PoE support is installed.
Enable PoE: disabled
PoE Voltage: 24

Battery: The battery may be installed.

Country Code

The country code configures the 802.11 radios to operate in accordance with national regulations. The country codes are defined in ISO 3166.

Power over Ethernet (PoE) Source

A PoE source can be installed as an option. If one is installed, its operational state and output voltage

Figure 53. Node hardware configuration on node with PoE source capability

17 Firmware Management

The EnRoute500 supports secure remote firmware upgrade.

17.1 Displaying the Firmware Version

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
```

The firmware version is also displayed at the top of the "Status" page accessible via the web interface.

17.2 Upgrading the Firmware

Contact Tranzeo for instructions on upgrading the EnRoute500's firmware.