Altum AC 600

600 Mbps Wireless Bridge with Hotspot

User Manual

Notice

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Contents

Chapter 1: Overview

1.1 Introduction

This user manual covers the operation of the Altum AC wireless radio user interface. The radio can be operated as a point-to-point (PtP) system, a point to multipoint (PmP) system, or a point to point with 2.4 GHz Wifi hotspot. The radio settings and mode of operation are controlled with a web based user interface that is run from any standard web browser.

This manual is organized the same way as presented on the radio web interface. After the *Login* and *Language* sections, the following sections correspond to the top-level tabs: *Status*, *System*, *Services*, and *Network*. The last section contains the Final Notes which include troubleshooting information.

The Figure below shows the access panel of the unit with the various user interfaces annotated for reference.

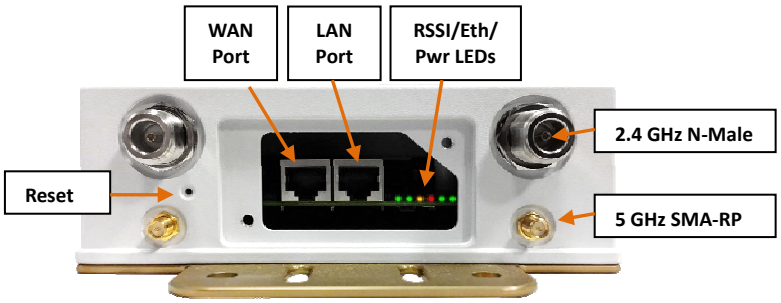

Figure 1 : Altum AC Interfaces and Indicators

1.2 Language

To change the language, please navigate to the *System* page, look for the *System Properties* section, click the *Language and Style* tab, and click the drop-down list for *Language*. You can change the language from *English* to another language e.g. Chinese (中文).

1.3 Supported Products

This manual covers the following Altum AC models:

A600-EXT-US (External Connectors)
A600-19-US (Internal 19 dBi Antenna)
A600-25-US (Internal 25 dBi Antenna)

1.4 System Requirements

Operating System: Microsoft Windows XP, Windows Vista, Windows 7, Windows 8, Linux, or Mac OS X.

Web Browser: Mozilla Firefox, Google Chrome, Apple Safari, or Microsoft Internet Explorer 8 or above.

1.5 Getting Started

Before establishing a link several parameters must be configured using the web interface. To access the web interface, perform the following steps:

1. Connect the local area network (LAN) port of the radio to the PoE port of the PoE Injector using a Cat5e Ethernet cable. Plug the PoE into the AC power source. The rightmost LED on the radio should illuminate, indicating the unit is booting up.

2. Connect the network port of your computer to the PoE injector network port using a Cat5e Ethernet cable.

3. Assign the Ethernet adapter on your computer with a static IP address on the 192.168.1.x network, e.g. 192.168.1.10 and with a subnet mask 255.255.255.0.

4. Launch a web browser and enter the default IP address of the radio, 192.168.1.1, into the address bar. The radio's configuration web page should be presented.

The first page that you see is the login page. The words on the top left denote the Radio host name and firmware build version e.g. A600 v1.51_b141027.

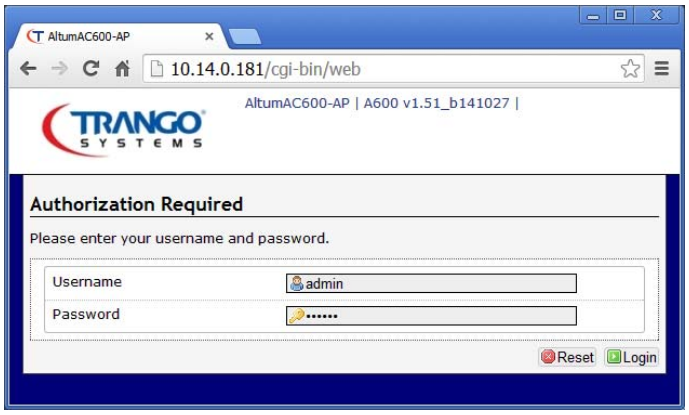

Figure 2: The login page is presented upon requesting the radio's IP address.

The default credentials are:
Username: **admin**
Password: **trango**

1.6 Operating Modes

The radio can operate in the following modes:

1. Access Point / Master.
2. Station / Client.
3. Access Point WDS.
4. Station WDS.

A wide area network (WAN) is a network that covers a broad area. The world's most popular WAN is the Internet.

In a commonly used setup, the WAN port of an access point connects to a modem via an Ethernet cable. A modem can be a cable, digital subscriber line (DSL), or fiber optic modem. A modem translates the signal from the internet service provider (ISP) to Ethernet signals that the access point can understand. This allows the access point to have internet connection.

Other devices called stations connect wirelessly to this access point. These devices can be other Altum radios, mobile phones, printers, IP cameras, laptops. The stations obtain internet connection from the access point.

An access point WDS and a station WDS together extend the wireless coverage, like a repeater. More information on the setup can be found on page 31.

1.7 Buttons and Changes

The buttons are described below.

Reset: Undo the changes.

Save: Saves the changes. Currently please do not use this button.

Save & Apply: Saves and applies the changes. Please use this button instead of the 'Save' button so that the changes would be applied immediately. It is recommended to click this button before moving to a different page.

Logout: Logs out of the radio's web page.

Note: At the top right corner of the radio's configuration web page, there may be either of the following texts displayed.

Changes: 0: Means that all changes on the configuration web page have been applied to the radio.

Unsaved Changes: Shows the number of changes that have not yet been implemented in FLASH via the *Save & Apply* button.

1.8 Physical Hardware Button

Please refer to Section 3.6 .

1.9 LEDs

The light emitting diodes (LEDs) on the board are described in Section 3.5 .

Chapter 2: Status Tab

After login, when you click on the *Status* top-level tab, you can see the second-level tabs of *Overview*, *Routes*, *System Log*, *Realtime Graphs, and Hotspot Users*. This is shown in Figure 2.

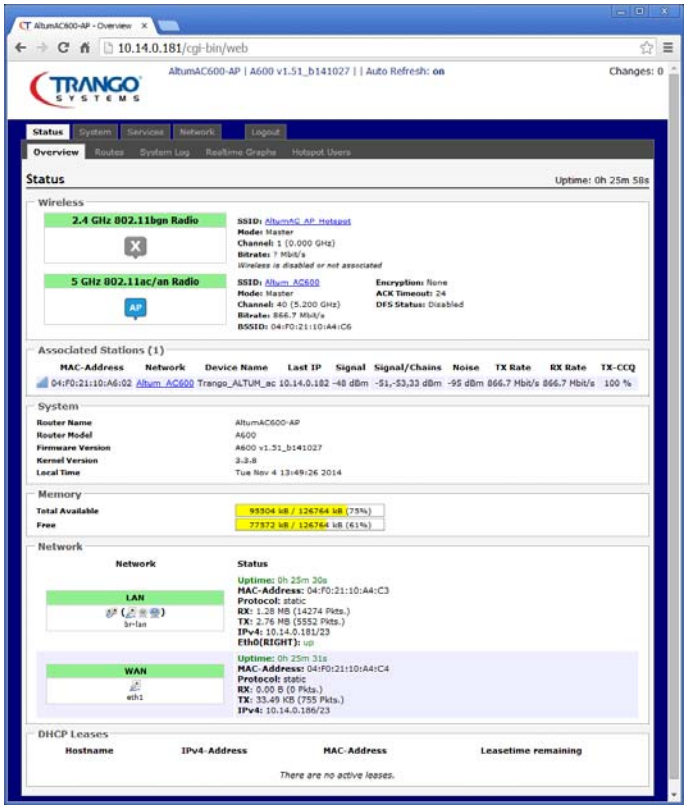

Figure 3: The *Status* → *Overview* page.

Notice in the figure that the radio is using the latest and fastest 11ac wireless standard that supports a data rate of up to 866.7 Mbit/s over the air, which translates to over 600 Mbps Layer 2 Ethernet capacity.

2.1 Overview

The *Status* → *Overview* page is divided into the sections *Wireless*, *Associated Stations*, *System*, *Memory*, *Network*, and *DHCP Leases*.

Uptime: Displays the duration of time since the radio was last rebooted.

2.1.1 Wireless Radio Mode

The wireless radio frequency band, supported modes, and current mode are shown in the box on the left e.g. "*5 GHz 802.11ac/an Radio*". The mode can be AP or CPE and is set based on the Wifi Configuration. For all models the 5 GHz radio refers to SMA RP connectors. The "*2.4 GHz 802.11bgn Radio*" refers to the N connectors on the unit.

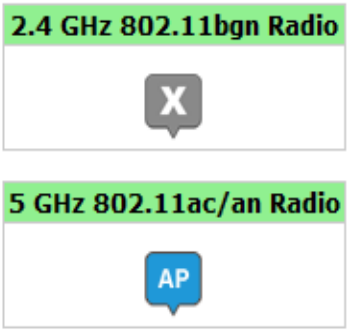

Figure 4: Wireless Radio Mode

The word *AP* in the small callout box means that the radio is operating in the Access Point (AP) mode. If the callout is *CPE*, it means that the radio is operating as customer-premises equipment (CPE) i.e. a station. The Letter *X* is shown if the radio is disabled.

2.1.2 Wireless (for AP Mode)

The *Wireless* section in the *Status* → *Overview* page shows a summary of the wireless parameters. The following describes the parameters when the device is in the *AP* mode.

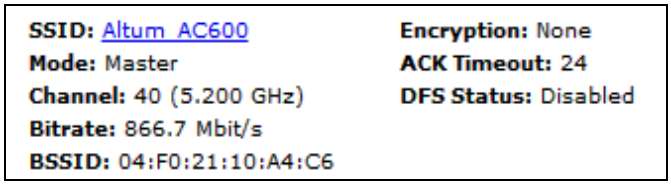

Figure 5: A summary in the *Wireless* section for a device operating as an 802.11ac access point.

SSID: Displays the name of the wireless network that this access point (AP) is offering, the Service Set Identifier (SSID).

Mode: This is *'Master'* if the device is in AP mode or AP WDS mode.

Channel: Shows the channel number and frequency that this AP is using.

Bitrate: This is the maximum bitrate supported by the radio in the current configuration.

BSSID: This is the MAC address of the AP's radio. This MAC should be used for PTP modes on the peer radio.

Encryption: Displays the wireless encryption used.

ACK Timeout: Shows the maximum acknowledgment time in microseconds.

DFS Status: If DFS is enabled, the AP automatically switches channel if radar is detected on the current channel.

2.1.3 Wireless (for Station Mode)

The following describes the parameters for a device operating in *Station* mode.

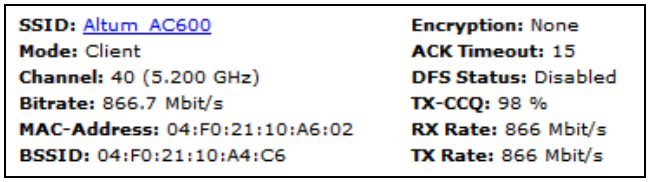

Figure 6: A summary in the *Wireless* section for a device operating as an 802.11 station.

SSID: Displays the name of the wireless network that this station should be associated with.

Mode: This is *'Client'* if the device is in Station mode or in Station WDS mode.

Channel: Shows the channel number and frequency that this station is using. Normally, it would automatically select the same channel as the AP.

Bitrate: This is the maximum bitrate supported by the radio in the current configuration.

MAC-Address: States the MAC address of the device's radio.

BSSID: This is the MAC address of the AP's radio.

Encryption: Displays the wireless encryption used.

ACK Timeout: Shows the maximum acknowledgment time in microseconds.

DFS Status: If DFS is enabled, the AP automatically switches channel if radar is detected on the current channel.

TX-CCQ: Displays the transmission quality in %. A higher percentage means a better wireless connection quality.

RX Rate: Shows the receive bit rate of this station.

TX Rate: Shows the transmit bit rate of this station.

2.1.4 Associated Stations (for AP Mode)

This section shows the connected devices, if the radio is in the AP mode.

Figure 7: List of Associated Stations.

If there are no associated stations, the text “No information available” is displayed. The parameters shown are as follows:

MAC-Address: Displays the MAC address of the station's radio.

Network: States the name of the wireless network.

Device Name: Shows the name of the station. (Does not show for WDS mode)

Last IP: States the most recent IP address of the station as seen by the AP (does not show for WDS mode).

Signal: Displays the received signal strength from the station e.g. -31 dBm.

Signal/Chains: Shows the received signal strengths from the station on each antenna port e.g. -51, -52

dBm. The value of 33 dBm is taken to mean “no antenna” if the radio has only 2 antennas.

Noise: Displays the received noise power at the AP.

TX Rate: Shows the transmit bit rate from the AP towards this station.

RX Rate: Shows the receive bit rate at the AP from this station.

TX-CCQ: Indicates the wireless connection quality.

2.1.5 System

This section shows the *(Radio Unit) Name*, *Model*, *Firmware Version*, *Kernel Version*, and *Local Time*.

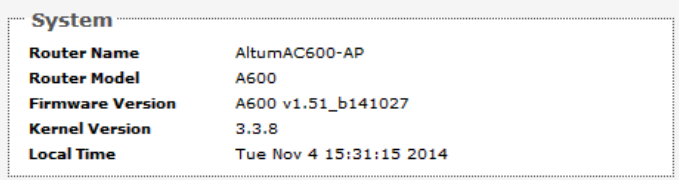

Figure 8: System parameters.

2.1.6 Memory

Here, the *Total Available* and *Free* memory are shown.

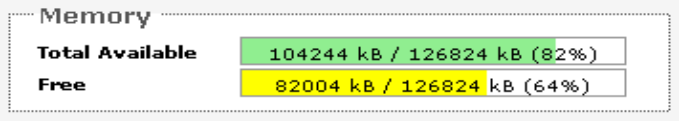

Figure 9: *Total Available* and *Free* Memory.

2.1.7 Network

This section displays the status of the *LAN* and *WAN* networks.

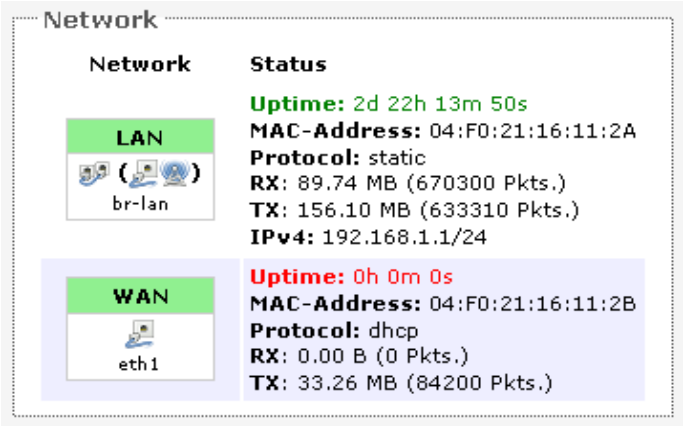

Figure 10: Network summary.

Status: Shows summaries of the interfaces for the LAN and WAN zones. This may include uptime, MAC address, protocol, bytes and packets received by the device, bytes and packets transmitted by the device, and its IPv4 address.

2.1.8 DHCP Leases

This section shows a table of MAC and IP addresses of connected computers with static DHCP leases. They are specified in the *Network* → *Interfaces* → *LAN* → *Static Leases* section of the device's configuration web page. More explanation is given in the *Network* section of this user manual on page 26.

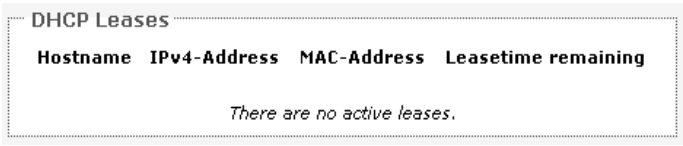

Figure 11: Currently active static DHCP leases.

2.1.9 Link Status (for Station Mode)

This section only applies if the device operates as an 802.11 station.

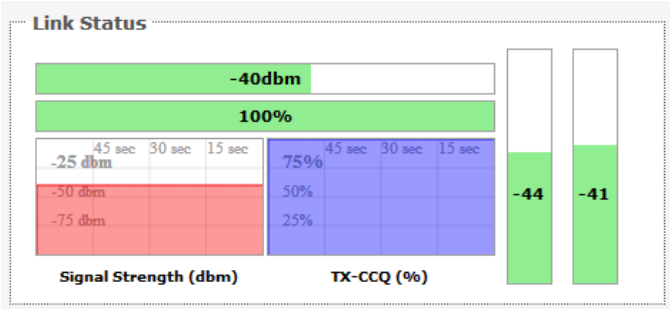

Figure 12: The *Link Status* section.

In the *Link Status* section on the *Status* → *Overview* web page, the value in the top left box denotes the current received signal strength e.g. -40 dBm. The box directly below it shows the current TX-CCQ (transmission client connection quality) e.g. 100 %. The bottom left box shows a realtime graph of the received signal strength over the last 60 seconds. The box directly to its right shows a realtime graph of the TX-CCQ over the past 60 seconds.

On the right of this section, there are 2 vertical bars. Each bar shows the current received signal strength of each antenna e.g. -44 dBm, and -41 dBm. These represent the H and V antenna polarizations for streams 1 and 2.

2.2 Routes

When you click on the *Status* → *Routes* tab, you will see the page that shows the routing rules that are currently active on the device.

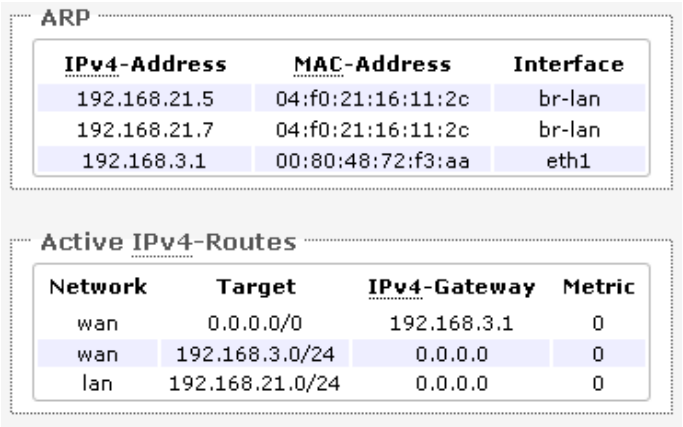

Figure 13: The *Status* → *Routes* page.

ARP: This address resolution protocol (ARP) table shows the IP address and corresponding MAC address of each device on the network.

Active IPv4-Routes: This table shows the IPv4 gateway and network ID (Target) for each subnet.

2.3 System Log

When you click on this tab, you can see the log of system messages.

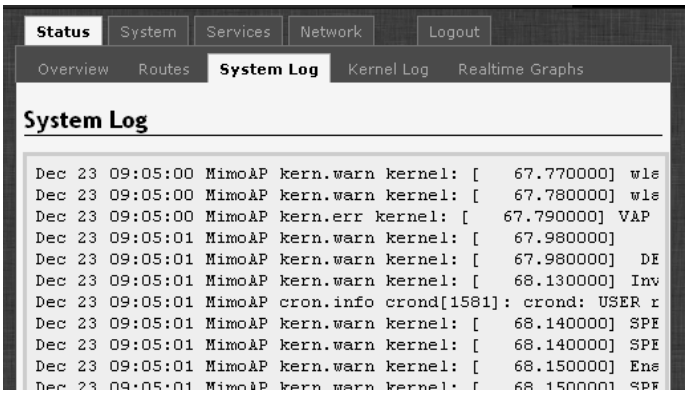

Figure 14: The *Status* → *System Log* page.

2.4 Realtime Graphs

Under the tab for *Realtime Graphs*, there are four tabs titled *Load*, *Traffic*, *Wireless*, and *Connection*.

2.4.1 Load

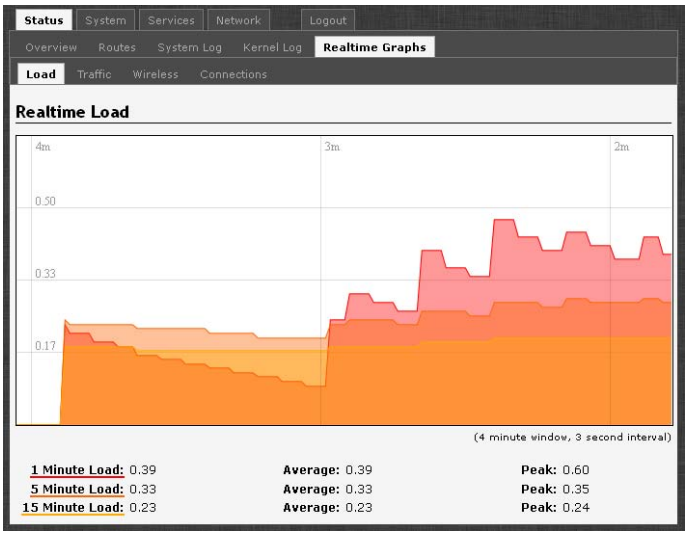

Figure 15: The graph for *Realtime Load*.

2.4.2 Traffic

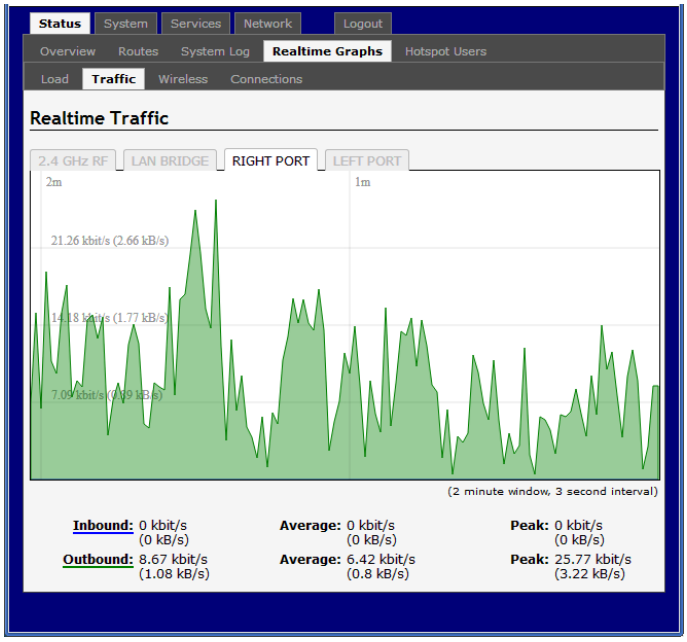

Figure 16: The graph for *Realtime Traffic*.

Note: that Right Port is the LAN port, and the Left Port is the WAN Port.

2.4.3 Wireless

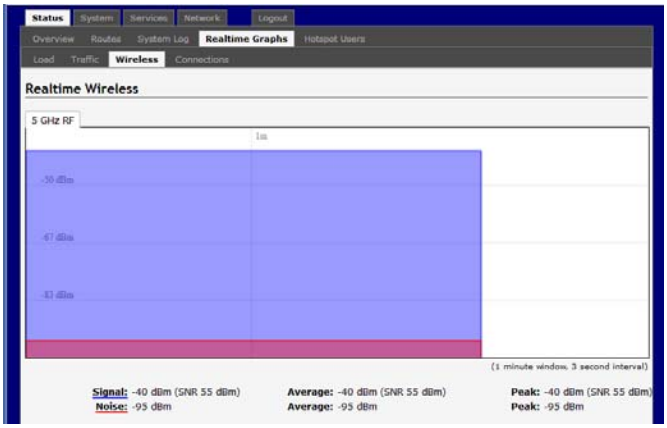

Figure 17: The graph for *Realtime Wireless*.

2.4.4 Connections

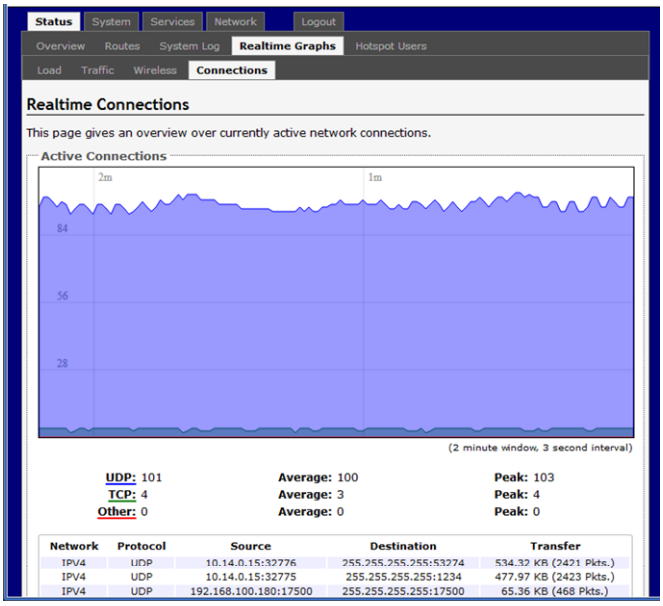

Figure 18: The graph for *Realtime Connections*.

Chapter 3: System Tab

This section is about the *System* top-level tab. Under this tab, there is a row of tabs for *Administration*, *Services*, *SNMP*, *LED Configuration*, *Backup/Flash Firmware*, and *Reboot*. This can be seen in Figure 19.

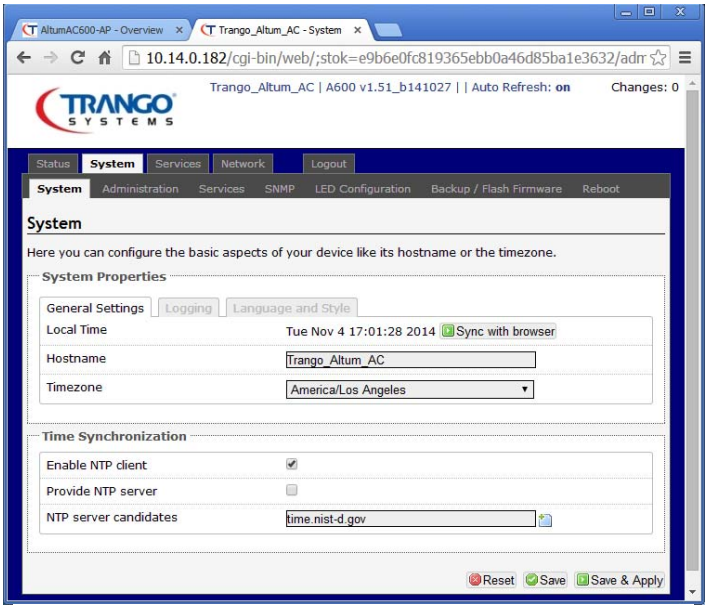

Figure 19: The *System* top-level tab.

Within the *System* page, you can configure the device parameters such as the hostname and timezone.

3.1.1 System Properties

Within the section on *System Properties*, there are tabs corresponding to *General Settings*, *Logging*, and *Language* and *Style*.

General Settings

Local Time: Displays the local time according to the Timezone.

Hostname: Configures the name of the device.

Timezone: Sets the timezone.

Logging

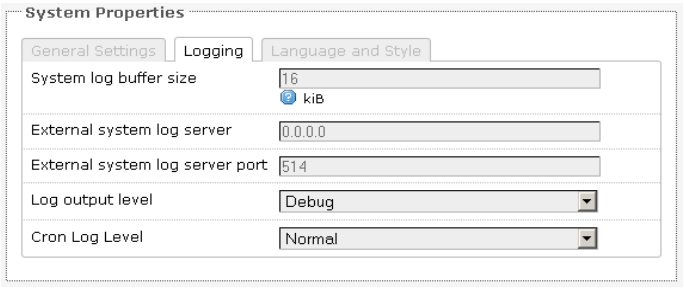

Figure 20: Changing the system properties for *Logging*.

Logging: Specifies parameters used for the system log, such as *System log buffer size*, *External system log server*, *External system log server port*, *Log output level*, and *Cron Log Level*.

Language

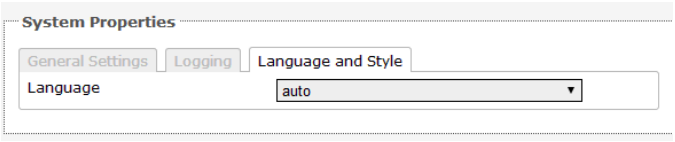

Figure 21: Modifying the *Language*

Language and Style: Lets you choose the language of the radio's web pages.

3.1.2 Time Synchronization

Enable NTP client: Obtains the date and time from specified Network Time Protocol (NTP) servers.

NTP server candidates: These are the sources of the time information. At least three are recommended for accurate time synchronization.

Figure 22: *Time Synchronization* settings.

3.2 Administration

Within the *System* → *Administration* page, you can configure the radio *Password*, *SSH*, *Telnet*, *Web*, and *FTP settings*.

3.2.1 Password

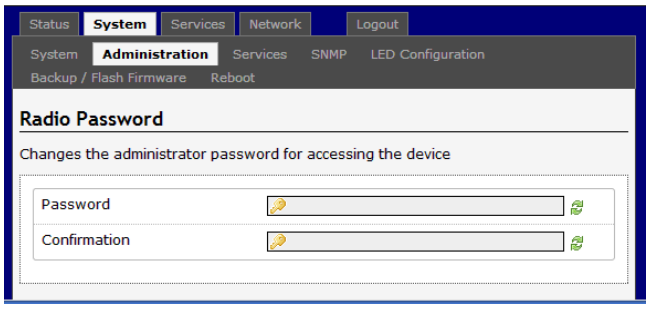

Figure 23: Setting the radio password.

Password: Allows changing the password, the default being *trango*.

Confirmation: Requires you to re-enter the password.

3.2.2 SSH

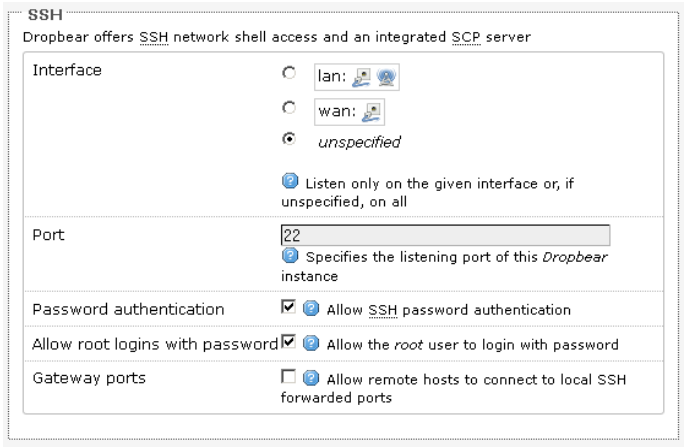

Figure 24: *SSH* settings in the *System* → *Administration* page.

SSH: Allows access the radio's Linux shell and file system using the *Secure Shell* protocol. For example, the programs *PuTTY* and *WinSCP* can be used. It is recommended to use the web interface for normal setup and monitoring operations, and use SSH only for debugging if needed.

Interface: Lets the radio listen on a given interface or all interfaces.

Port: Specifies the listening port, the default being *22*.

Password authentication: Allows *SSH* password authentication.

Allow root logins with password: This is enabled by default.

Gateway ports: Allow remote hosts to connect to local *SSH* forwarded ports.

3.2.3 Telnet

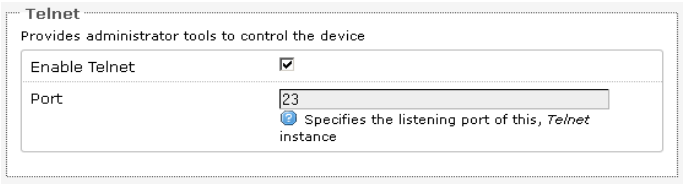

Figure 25: *Telnet* settings in the *System* → *Administration* page.

Telnet: Provides administrator tools for controlling the device or network debugging, over an unencrypted connection. It is recommended to use the web interface for normal setup and monitoring operations, and use Telnet only for debugging if needed.

Port: Specifies the listening port, the default being *23*.

3.2.4 Web

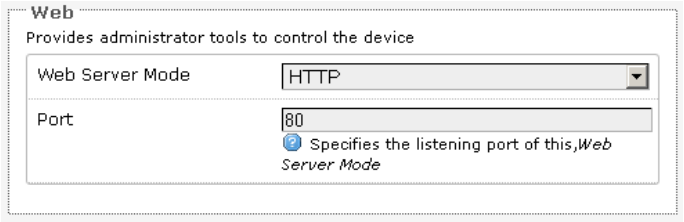

Figure 26: The radio's web server mode and port.

Web Server Mode: This can be set to Hypertext Transfer Protocol (*HTTP)* or Hypertext Transfer Protocol Secure (*HTTPS)*. For *HTTPS*, if you see the warning, "The certificate is not trusted because it is self-signed". Click "Add Exception", "Confirm Security Exception" and proceed.

Port: Specifies the listening port, the default being *80* for *HTTP* and *443* for *HTTPS*.

3.3 Services

In the *System* → *Services* page, you can configure the *Ping Watchdog* and the *Auto Reboot*.

3.3.1 Ping Watchdog

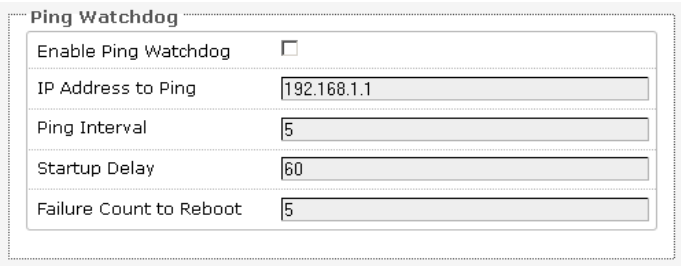

Figure 27: *Ping Watchdog* settings in the *System* → *Services* page.

Ping Watchdog: Configures the device to ping to a remote IP address and reboot if the connection is lost. It is disabled by default.

IP Address to Ping: Sets the remote IP address to ping e.g. 192.168.1.10 or 8.8.8.8.

Ping Interval: Specifies the time between successive pings, the default being 5 seconds.

Startup Delay: Sets the time delay in seconds after the radio finishes rebooting, before running the Ping Watchdog, the default being 60 seconds.

Failure Count to Reboot: Specifies the number of failed pings before the radio reboots automatically.

3.3.2 Auto Reboot

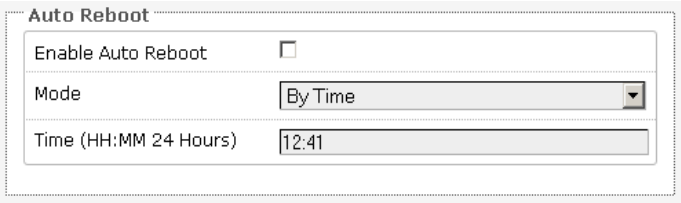

Figure 28: *Auto Reboot* settings in the *System* → *Services* page.

Auto Reboot: Allows the radio to reboot itself automatically, disabled by default.

Mode: Chooses the *Auto Reboot* mode *By Time* or *By Number of Hours*.

Time: Sets the time of day to reboot if the *Mode* is *By Time*.

Number of Hours: Sets the delay as an integer number of hours after each reboot, if the *Mode* is *By Number of Hours*.

3.4 SNMP

The Simple Network Management Protocol (SNMP) is an Internet-standard protocol for managing devices on IP networks. It consists of a set of standards for network management, including an application layer protocol, a database schema, and a set of data objects. SNMP exposes management data in the form of variables on the managed systems, which describe the system configuration. These variables can then be queried (and sometimes set) by managing applications.

In the *System* → *SNMP* Page, you can configure SNMP V2c and SNMP V3.

A MIB file with detailed information is available from the Trango Website that can be loaded on the SNMP Manager.

3.4.1 SNMP Information

In the *SNMP Information* section, the text fields for the *SNMP Enterprise ID*, *Contact*, and *Location* information are shown.

3.4.2 SNMP Configuration

General Settings

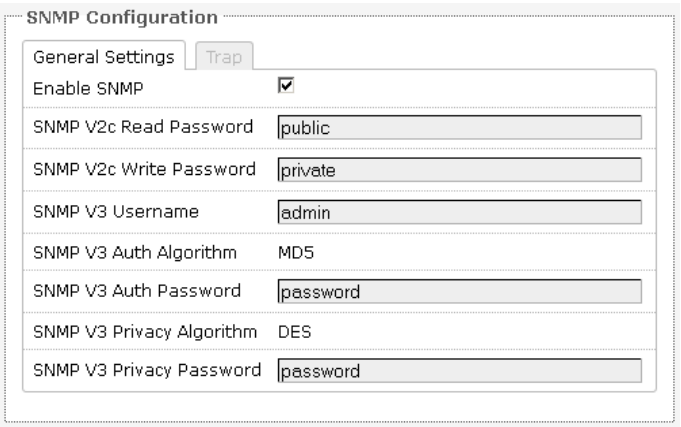

Figure 29: General settings for SNMP.

Enable SNMP: Enables SNMP.

SNMP V2c Read Password: Sets the community string for read-only access (to the variables on the SNMP agent) by the network management system (NMS). The NMS is the software which runs on the SNMP manager. (default: public)

SNMP V2c Write Password: Sets the community string for read-write access by the SNMP manager. (default: private)

A community string identifies a group of SNMP agents. It is sent in clear text. It should be changed from the default string "public" or "private". The variables on the SNMP agent can be classified into read-only or read-write variables.

SNMP V3 Username: Sets the username for authentication. (default: admin)

SNMP V3 Auth Algorithm: Shows the authentication algorithm used e.g. MD5.

SNMP V3 Auth Password: Configures the password for user authentication. (default: password)

SNMP V3 Privacy Algorithm: Shows the data encryption algorithm used e.g. DES.

SNMP V3 Privacy Password: Sets the password for data encryption. (default: password)

Trap

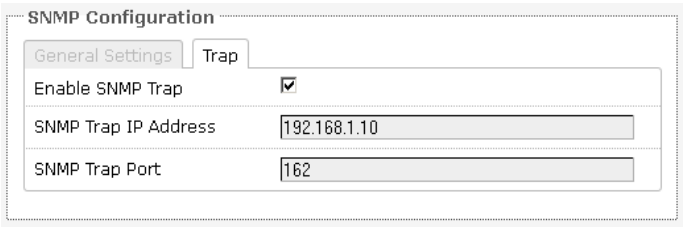

Figure 30: SNMP trap configuration.

Enable SNMP Trap: Allows the SNMP agent to notify the SNMP manager of events.

SNMP Trap IP Address: Sets the IP address of the SNMP manager which receives the trap messages.

SNMP Trap Port: Sets the port number.

3.5 LED Configuration

The *System* → *LED Configuration* page customizes the behaviour of the LEDs.

Signal strength indicator interface: Chooses the Wireless radio to use based on the wireless network name.

Signal strength indicator LEDs: Sets the received signal strength thresholds (in dBm) above which LEDs #1 to #4 would light up.

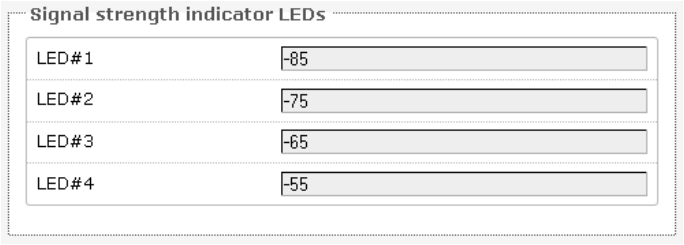

Figure 31: Signal strength indicator LEDs and their default threshold values in dBm.

Note: The physical arrangement of LEDs on the radio is as follows starting from the furthest to the right of the Access Port and moving left are: Power (green), Diagnostics (green), LED#1 (red), LED#2 (orange), LED#3 (green), and LED#4 (green). LEDs 1-4 are used for RSSI typically.

3.6 Physical Hardware Button

There is a physical button on the radio unit which is located to the left of the access port through a tiny hole. Use a paperclip to set the action desired. Depending on how long the button is pressed, you can reboot the board or reset it to factory default. First make sure then power is on. The following table shows the duration of the button press and the corresponding action.

Duration of button press	Action
0 - 3 seconds	reboot
4 - 30 seconds	reset to factory default
more than 30 seconds	do nothing

3.7 Backup/Flash Firmware

The *System* → *Backup/Flash Firmware* page lets you perform backup and restore, or flash a new firmware.

3.7.1 Backup/Restore

Download backup: Generate archive: Downloads a tar archive of the current configuration files.

Note: The backup archive file should be stored in a safe place because it contains the wireless password in clear text.

Reset to defaults: Perform reset: Resets the firmware to its initial state.

Restore backup: Upload archive: Lets you upload a previously generated backup archive to restore configuration files.

3.7.2 Flash new firmware

You can upload a new firmware to replace the currently running firmware.

Keep settings: Retains the current configuration.

Firmware: Shows the current version of the firmware and allows you to upload a new firmware.

3.8 Reboot

Perform reboot: Reboots the operating system of your device. This is similar to the power-off and power-on cycle. The system configuration remains the same. Any changes that are not applied are lost.

Chapter 4: Services Tab

The *Services* top-level tab contains the configuration pages for *Dynamic DNS*, *Hotspot*, and *Discovery*.

4.1 Dynamic DNS

The domain name system (DNS) translates a URL like www.yahoo.com to an IP address like 206.190.36.45. Dynamic DNS (DDNS) allows the with the public IP address to be reached from the internet via a URL even if its IP address is dynamically changing.

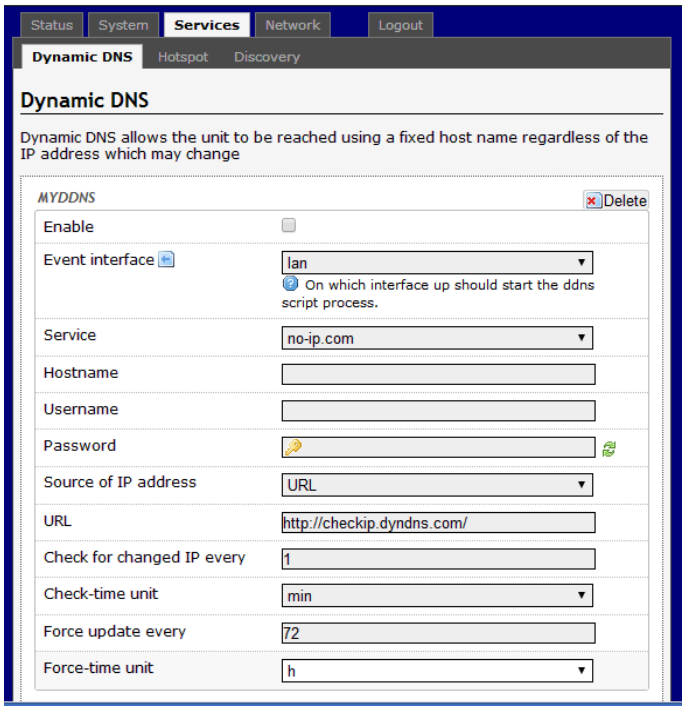

Figure 32: The *Services* → *Dynamic DNS* page.

Enable: Enables the dynamic DNS.

Event interface: Chooses the interface, e.g. LAN or WAN, for which "interface up" would run the DDNS script process.

Service: Chooses the DDNS service provider e.g. no-ip.com.

Hostname: Specifies the hostname e.g. y0033.no-ip.biz.

Username: Sets the username registered for the DDNS service.

Password: Sets the password registered for the DDNS service.

Source of IP Address: Configures the source of the IP address information. The default is URL.

URL: Sets the URL of the source of the IP address information e.g. http://checkip.dyndns.com/.

Check for changed IP every: The default is to check the IP address every 1 minute.

Force update every: The default is to force update every 72 hours.

4.2 Hotspot

The Hotspot service allows you to control the access and usage of the Internet by connected devices.

4.2.1 Setting up the Connections

The following subsections contain advice on configuring the 2.4 GHz radio to implement the hotspot. It is recommended to configure the LAN, Wifi, and WAN, then test it before enabling the hotspot setting.

LAN Interface: DHCP Server

It is recommended to enable the DHCP server, because network address translation (NAT) occurs between the WAN zone and the LAN zone. To do this, you may go to the *Network* → *Interfaces* → *LAN (Edit)* → *Physical Settings* → *DHCP Server* section, then uncheck the option *Ignore interface (Disable DHCP for this interface)*.

Devices or computers that connect to the hotspot radio can then obtain their IP addresses automatically. In addition, the default gateway IP address and the DNS server IP address are automatically configured for these connected devices.

If the DHCP server is left disabled, it is still possible for devices to connect to the hotspot. Each device would need a unique static IP address on the same subnet as this hotspot . Set the default gateway and DNS server for the device both to be the IP address of this hotspot .

It is not necessary to set the hotspot radio's default gateway and DNS server in the *Network* → *Interfaces* → *LAN* page. This information is obtained automatically from the WAN interface.

Wifi Settings

The wireless networks should be set up to allow any user to access the Internet, assuming that the hotspot is not yet enabled.

WAN Interface: Physical Settings

The hotspot has no effect if there is no WAN interface. To use the hotspot, please set the WAN interface in the *Network* → *Interfaces* → *WAN (Edit)* → *Physical Settings*. The WAN interface should be the zone where the Internet access is available. It could be one of the Ethernet adapters or one of the wireless networks. All interfaces other than the WAN interface are considered as in the LAN zone. Any user in the LAN zone would see the hotspot login page after the hotspot is set up.

Test Internet Connection

At this point, before setting up the hotspot, it is good to test the Internet connection by connecting a mobile phone to a wireless network in the LAN zone of the hotspot .

The Internet browser may cache web pages, so to be sure, one may perform an Internet search of a random string of numbers. If the search results are returned, this means that the Internet connection is working fine.

4.2.2 Setting up the Hotspot

The hotspot can then be set up and enabled either by using the AP itself or by using a Compex Access Point Controller (APc).

The following sections show the Hotspot settings available in the AP's web page.

4.2.3 General Settings

By clicking on the *Services* → *Hotspot* tab, you can see the general settings.

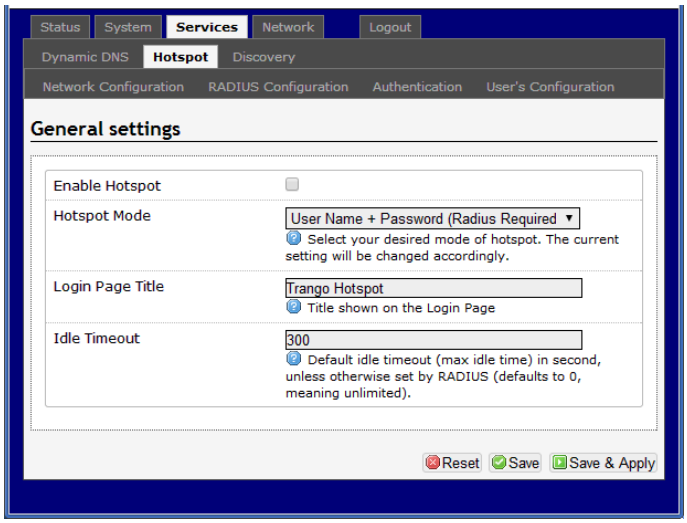

Figure 33: The *Services* → *Hotspot* page.

Enable Hotspot: Turns on the hotspot service. You may wish to enable the hotspot after all the settings are completed.

Hotspot Mode: Selects your desired mode of hotspot. You can choose to use the hotspot together with a third party or external RADIUS authentication server.

Note: Remote Authentication Dial-In User Service (RADIUS) is a networking protocol that provides centralized Authentication, Authorization, and Accounting (AAA) management for users that connect and use a network service.

The choices for the *Hotspot Mode* are:

- User Name + Password (Radius Required)

- Agreement (Radius Required)
- Password (Radius Required)
- Agreement (Radius not Required)
- Password (Radius not Required)

Login Page Title: Sets the title shown on the Login Page e.g. “Trango HotSpot”.

Idle Timeout: Configures the default idle timeout (max idle time) in seconds unless otherwise set by RADIUS (Set as 0 to mean unlimited time).

4.2.4 Network Configuration

Network Parameters: Auto Config: Automatically configures the network parameters. It is recommended to keep this enabled.

4.2.5 RADIUS Configuration

Here you can set the RADIUS parameters.

Radius Server 1: Sets the IP address of Radius server 1 e.g. 127.0.0.1.

Radius Server 2: Sets the IP address of Radius server 2 e.g. 127.0.0.1.

Radius Secret: Sets the Radius shared secret for both servers. This secret should be changed in order not to compromise security.

4.2.6 Authentication

Here you can set the Universal Access Method (UAM) parameters.

UAM Server: Sets the URL of the web server to use for authenticating clients. For example:

- http://1.0.0.1/www/login.html

UAM Secret: Configures the shared secret between uamserver and chilli. This secret should be set in order not to compromise security.

Walled Garden (Domain): Shows a comma separated list of resources the client can access without first authenticating. Each entry in the list is a domain name. Do not put www in the domain name. For example, “google.com” is a good domain name, “www.google.com” is not acceptable. The default is “coova.org”.

Walled Garden (IP Address): Shows a comma separated list of resources the client can access without first authenticating. Each entry in the list is a IP Address. The AP's web page is always accessible.

4.2.7 User's Configuration

Here you can configure the users' network access and bandwidth limitations.

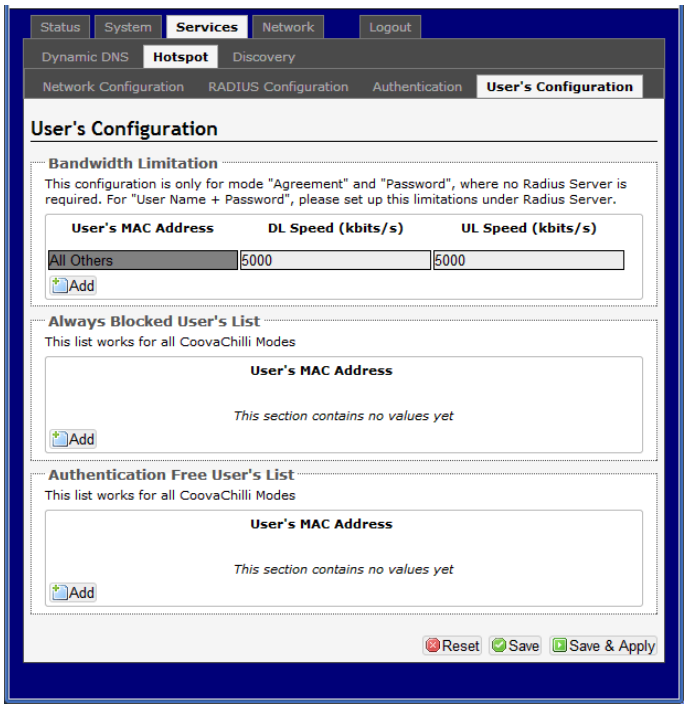

Figure 34: The *Services* → *Hotspot* → *User's Configuration* page.

Bandwidth Limitation

This section only applies if the Radius Server is not required. If the Radius Server is required, this section is ignored.

You may add entries consisting of the following three fields:

- User's MAC Address
- Download (DL) Speed (kbits/s)
- Upload (UL) Speed (kbits/s)

By default, there is an entry:

- User MAC Address
  - All Others
- Download (DL) Speed (kbits/s)
  - 5000
- Upload (UL) Speed (kbits/s)
  - 5000

This means that all hotspot users are subjected to 5000 kbits/s bandwidth limitation. To prevent any limitation, it may be set to a high value like 5000000 kbits/s.

Always Blocked User's List

You may add entries for: User's MAC Address.

These users would be blocked from accessing the network.

This list works for all Hotspot Modes.

Authentication Free User's List

You may add entries for: User's MAC Address.

These users would not need any authentication at all and can get immediate access to the network. For example, the boss of the company could be in the authentication free list.

This list works for all Hotspot Modes.

4.2.8 Logging in to the Hotspot

When a hotspot user opens an Internet browser on his/her computer, it would automatically show the hotspot login page. To quickly see the hotspot login page, he/she could enter a simple URL in the Internet browser e.g.

- 1.0.0.1
- 8.8.8.8
- bing.com

When a user connects his/her mobile/smart phone to the hotspot wireless network, the hotspot login page should automatically appear. Otherwise, he/she could open the default Internet browser app or Chrome app on their mobile phone to see the login page.

4.2.9 Possible Hotspot Scenarios

The WAN interface could be set as one of the Ethernet ports. This means that the wireless networks provided by the hotspot would be in the LAN zone. Users can connect within the LAN zone to see the hotspot login page.

The wireless distribution system (WDS) can also be used to increase the coverage. More information is found in Section .

4.3 Discovery

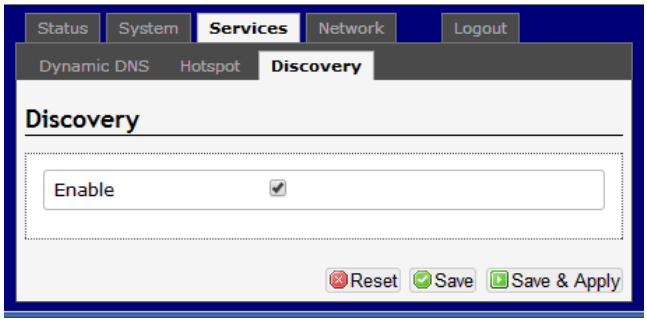

Figure 35: The *Services* → *Discovery* page.

Enable: Allows the Device Name and Last IP address of the wireless station to be discovered by the wireless access point. The functionality is similar to the Cisco Discovery Protocol. Discovery is enabled by default.

Chapter 5: Network Tab

The *Network* → *Interfaces* tab shows an overview of the network interfaces. You can view and configure the interfaces of the local area network (LAN) zone as well as the wide area network (WAN) zone. Network address translation (NAT) occurs between these two network zones. The radio that performs the NAT is called a gateway. A gateway is a network point that acts as an entrance to another network.

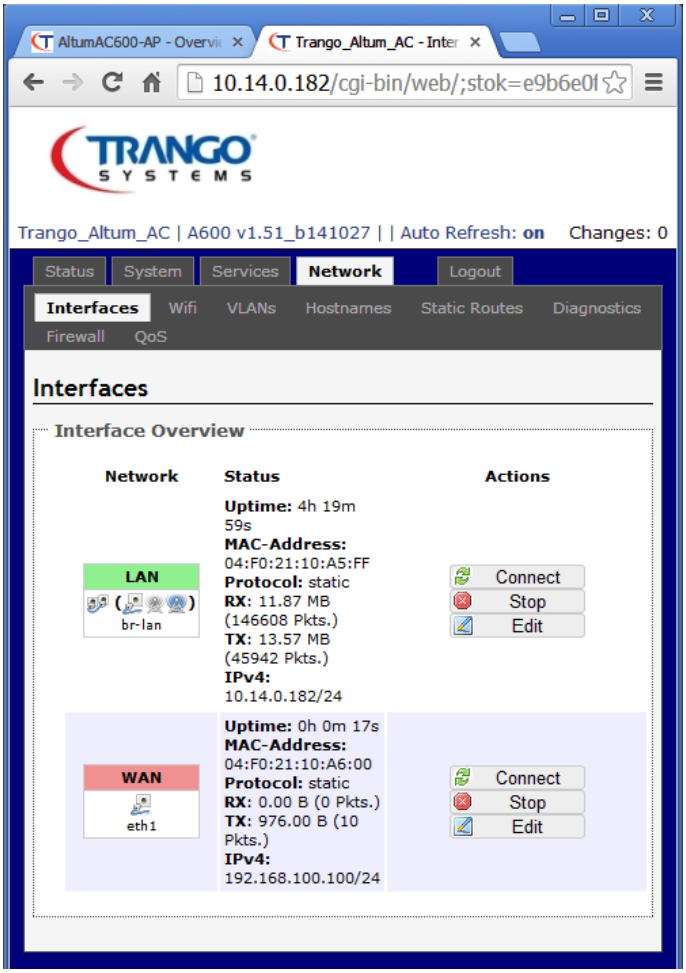

Figure 37: The *Interface Overview* on the *Network* → *Interfaces* page.

The *Network* column shows that the WAN zone has the physical port "eth1" as its interface.

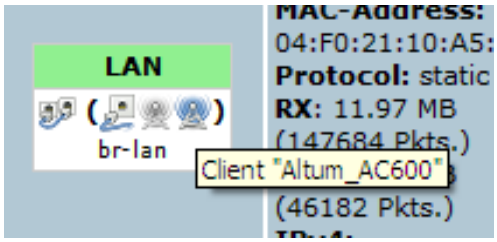

Figure 38: An infotip appears when hovering the mouse over an icon.

In Figure 38, the LAN zone (icon with two Ethernet ports) has the bridged interface "br-lan" which consists of one physical port (icon with one Ethernet port) and two wireless networks (tower icons) on the device. Hovering the mouse over each icon would give the name of the interface it represents. In this example, the infotip shows that there is a (virtual) client on the device with "Altum_AC600" as its network name.

5.1 Interfaces – WAN

The *Network* → *Interfaces* → *WAN* page configures the interface for the WAN zone.

5.1.1 Common Configuration

General Setup

Status: Shows a summary of the interface for the WAN zone. This includes uptime, MAC address, bytes and packets received by the device, bytes and packets transmitted by the device, and its IPv4 address.

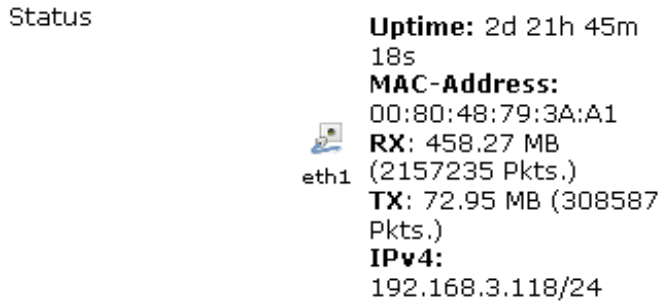

Figure 39: Status of the "eth1" interface of the WAN zone.

Protocol: Chooses between *DHCP client* (default), where the device obtains it IP address automatically,

or *Static address*, where you can specify the device IP address. Other protocols are *PPTP*, *PPPoE*, and *L2TP*.

Protocol – Static address

IPv4 address: Sets the IP address of the device as seen from the WAN zone.

IPv4 netmask: Sets the subnet mask e.g. 255.255.255.0. The IP address and netmask together determine the subnet or network ID e.g. 192.168.3.0/24. Two devices must be in the same subnet in order to establish a (Layer 2) link between them.

IPv4 gateway: Specifies the IP address of the remote server that allows the device's shell to gain internet access.

IPv4 broadcast: Specifies the IPv4 broadcast address, optional.

Use custom DNS servers: Configures the IP address of the DNS servers e.g. 165.21.100.88 for the SingNet DNS server in Singapore or 8.8.8.8 for the Google DNS server in the USA. The computers in the same subnet as this device can then set this device's IP address as their preferred DNS server to obtain the same DNS service.

Protocol – DHCP client

The Dynamic Host Configuration Protocol (DHCP) is a standardized networking protocol used by servers on an IP network to allocate IP addresses automatically to client devices.

Hostname to send when requesting DHCP: Specifies the name of this device as seen by the remote DHCP server.

Protocol – PPTP

The Point-to-Point Tunneling Protocol (PPTP) is a method for implementing virtual private networks. PPTP uses a control channel over Transmission Control Protocol (TCP) and a Generic Routing Encapsulation (GRE) tunnel operating to encapsulate Point-to-Point Protocol (PPP) packets.

VPN Server: Specifies the IP address of the remote PPTP server for the virtual private network (VPN).

PAP/CHAP username: Sets the username for the Password Authentication Protocol (PAP) or the Challenge-Handshake Authentication Protocol (CHAP).

PAP/CHAP password: Sets the password for the PAP or CHAP.

Configure PPTP IP settings: Upon clicking the "Configure..." button, the PPTP *Common Configuration* page would be displayed. The protocol DHCP client or Static address can be selected. The corresponding options are explained within this section (*5.1.1 Common Configuration*).

Protocol – PPPoE

The Point-to-Point Protocol over Ethernet (PPPoE) is a network protocol for encapsulating PPP frames inside Ethernet frames. Most DSL providers use PPPoE, which provides authentication, encryption, and compression.

The options *PAP/CHAP username* and *PAP/CHAP password* have been explained earlier.

Access Concentrator: Identifies the PPPoE server. Leave empty to autodetect.

Service Name: Specifies the PPPoE service name. The server will accept clients which send an initialization message with the service name that matches the server's configuration. Leave empty to autodetect.

Protocol – L2TP

The Layer 2 Tunneling Protocol (L2TP) is a tunneling protocol used to support virtual private networks (VPNs) or as part of the delivery of services by ISPs. It does not provide any encryption or confidentiality by itself. Rather, it relies on an encryption protocol that it passes within the tunnel to provide privacy.

The options *PAP/CHAP username* and *PAP/CHAP password* have been explained earlier.

L2TP Server: Specifies the IP address of the remote L2TP server.

Configure L2TP IP settings: Upon clicking the "Configure..." button, the L2TP *Common Configuration* page would be displayed. The protocol DHCP client or Static address can be selected. The corresponding options are explained within this section (*5.1.1 Common Configuration*).

Advanced Settings

The following are options in the *Advanced Settings* section tab. Some of these options are shown, depending on the protocol being used.

Override MAC address: Allows you to specify a different MAC address other than the radio's original MAC address. This is useful if the ISP uses the MAC address of a radio to identify a customer. Suppose that the radio needs to be replaced. The new radio can take on the MAC address of the previous radio in order to continue having internet access.

Override MTU: Sets the maximum transmission unit (MTU), the default being 1500 bytes. Unless, your ISP requires, it is not recommended to change this setting.

Use gateway metric: Allows you to specify a gateway metric. This acts as a cost for choosing the gateway when a connected device has to select between multiple available gateways. The gateway with the smallest metric is chosen.

Use broadcast flag: When sending DHCP requests, a client can indicate if it wants an answer in unicast or broadcast, by setting the broadcast flag. This is required for certain ISPs. Unchecked by default.

Use default gateway: Configures a default route. Checked by default.

Use DNS servers advertised by peer: Uses the DNS settings advertised by the DHCP server. Checked by default.

Client ID to send when requesting DHCP: Sets the identifier that may be required by the ISP or network administrator. If not stated, the MAC address of the client will be sent.

Vendor Class to send when requesting DHCP: Identifies the vendor of a DHCP client for the enhancement of vendor-specific DHCP functionality.

The following three options are specific to the PPTP and PPPoE protocols:

LCP echo failure threshold: Sets the number of link control protocol (LCP) echo failures before the peer is presumed to be dead. Use 0 to ignore failures.

LCP echo interval: Specifies the interval in seconds to send LCP echo requests. This is only effective in conjunction with failure threshold.

Inactivity timeout: Sets the number of seconds of inactivity, after which the connection is closed. Use 0 to persist connection.

Physical Settings

Interface: Chooses which physical interface to use for the WAN zone. This can be the *Ethernet Adapter* "eth0" or "eth1" that corresponds to each of the two ports on the device for example. It could also be set as the *Wireless Network*. If *No Interface* is selected, all interfaces would be within the LAN zone.

Note: For boards with 2 ethernet ports, both ports would be LAN ports in the default configuration. You can still designate the WAN port in the firmware. For s with power over Ethernet (PoE), only the port further away from the DC Jack (right port) would be the PoE input port (ethY). The port nearer to the DC Jack (left port) would be the PoE output port (ethX).

5.2 Interfaces – LAN

5.2.1 Common Configuration

General Setup

Status: Shows a summary of the current LAN port status, which includes uptime, MAC address, received

bytes and packets, transmitted bytes and packets, and IPv4 address.

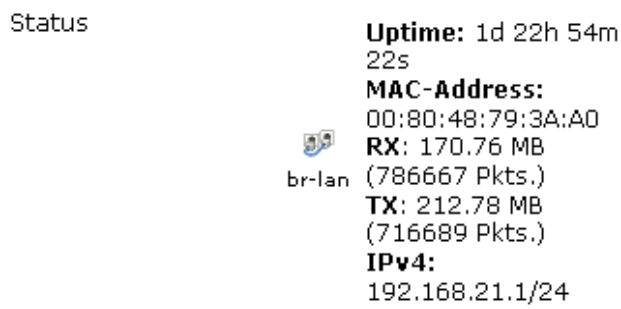

Figure 40: Status of the "br-lan" interface of the LAN zone.

Protocol: Chooses between *Static address*, where you can specify the device IP address, or *DHCP client*, where the device obtains it IP address automatically. *Static address* is necessary if other devices obtain internet connection through this device. *Static address* is also recommended if you wish to configure the device via the web interface.

Protocol – Static address

IPv4 address: Sets the IP address of the device e.g. 192.168.21.1, where you can access the radio's configuration web page.

IPv4 netmask: Sets the subnet mask e.g. 255.255.255.0. The IP address and netmask together determine the subnet or network ID e.g. 192.168.21.0/24. Two devices must be in the same subnet in order to establish a (Layer 2) link between them.

IPv4 gateway: Specifies the IP address of the remote server that allows the device's shell to gain internet access.

IPv4 broadcast: Specifies the IPv4 broadcast address, optional.

Use custom DNS servers: Configures the IP address of the DNS servers e.g. 165.21.100.88 for the SingNet DNS server in Singapore or 8.8.8.8 for the Google DNS server in the USA. The computers in the same subnet as this device can then set this device's IP address as their preferred DNS server to obtain the same DNS service.

Protocol – DHCP client

The Dynamic Host Configuration Protocol (DHCP) is a standardized networking protocol used by servers on an IP network to allocate IP addresses automatically to client devices.

Hostname to send when requesting DHCP: Specifies the name of this device as seen by the remote DHCP server.

Advanced Settings

The following are options in the *Advanced Settings* section tab. Some of these options are shown, depending on the protocol being used.

Override MAC address: Allows you to specify a different MAC address other than the radio's original MAC address. This is useful if the ISP uses the MAC address of a radio to identify a customer. Suppose that the radio needs to be replaced. The new radio can take on the MAC address of the previous radio in order to continue having internet access.

Override MTU: Sets the maximum transmission unit (MTU), the default being 1500 bytes. Unless, your ISP requires, it is not recommended to change this setting.

Use gateway metric: Allows you to specify a gateway metric. This acts as a cost for choosing the gateway when a connected device has to select between multiple available gateways. The gateway with the smallest metric is chosen.

Use broadcast flag: When sending DHCP requests, a client can indicate if it wants an answer in unicast or broadcast, by setting the broadcast flag. This is required for certain ISPs. Unchecked by default.

Use default gateway: Configures a default route. Checked by default.

Use DNS servers advertised by peer: Uses the DNS settings advertised by the DHCP server. Checked by default.

Client ID to send when requesting DHCP: Sets the identifier that may be required by the ISP or network

administrator. If not stated, the MAC address of the client will be sent.

Vendor Class to send when requesting DHCP: Identifies the vendor of a DHCP client for the enhancement of vendor-specific DHCP functionality.

Physical Settings

Enable STP: Enables the Spanning Tree Protocol on this bridge. It is unchecked by default.

5.2.2 DHCP Server

This section allows you to configure the device as a DHCP server.

General Setup

Ignore interface: Disables DHCP for this interface. You should uncheck this to enable DHCP.

Note: All the following options in this *DHCP Server* section depend on DHCP being enabled.

Start: Specifies the lowest leased address as offset from the network address, the default being *100*.

Limit: Sets the maximum number of leased addresses, the default being *150*.

Leasetime: States the expiry time of leased addresses, the default being *12h*.

Advanced Settings

Dynamic DHCP: Dynamically allocates DHCP addresses for clients. If disabled, only clients having static leases will be served. Checked by default.

Force: Forces DHCP on this network even if another server is detected, unchecked by default.

IPv4-Netmask: Overrides the netmask sent to clients. Normally it is calculated from the subnet that is served.

DHCP-Options: Defines additional DHCP options, for example "6,192.168.2.1,192.168.2.2" which advertises different DNS servers to clients. Normally, connected devices would take this board's IP address as the default gateway. To set an alternative default gateway, add the DHCP option "3,192.168.2.3" for example. More information can be found in this link: http://wiki.openwrt.org/doc/uci/dhcp.

5.2.3 Static Leases

In this section, you can specify that a particular DHCP client obtain an IP address that you define. The MAC address of the client is required. Click the *Add* button to add a static DHCP lease, then click *Save & Apply* to apply the changes.

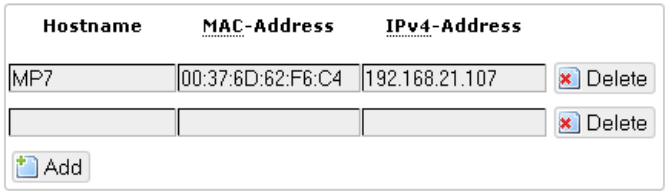

Figure 41: Adding a static DHCP lease.

The static DHCP lease shows up on the Status → Overview page if the client is active.

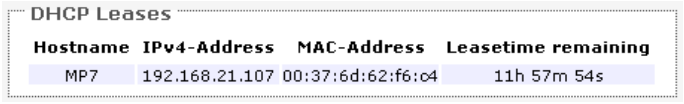

Figure 42: The static DHCP leases on the *Status* → *Overview* page.

5.3 Wifi – Overview

Clicking on the *Network* → *Wifi* tab would bring you to the *Wireless Overview* page. This page shows the radios present on the device. These may include the on-board radio and the miniPCI/miniPCIe radio card. The wireless local area networks (WLANs) are displayed under each radio.

Figure 43: The *Wireless Overview* page showing two radios.

In Figure 43, two tabs are shown at the top, wifi0: Master “A600-2” and wifi1: Client “Altum_AC600”. These correspond to the two radios in the window below.

The buttons are explained as follows.

Spectrum: Shows the Channel Scan Report and allows you to run the Interference Analyzer.

Add: Allows you to add virtual access points (VAPs) to the radio. By default, there is only one VAP on the radio. Each VAP corresponds to one network.

Enable: Enables the radio.

Disable: Disables the radio.

Edit: Brings you to the configuration page of the network. Clicking this button is equivalent to clicking the corresponding tab above

5.3.1 Radio in AP Mode

When a radio is operating as an AP, the section for *Associated Stations* shows a list of stations connected to this device.

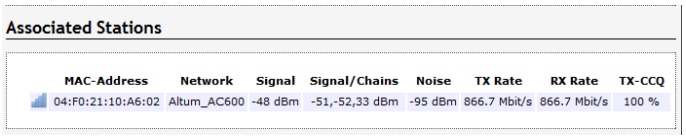

Figure 44: The *Associated Stations* are also shown on the *Wireless Overview* page.

The MAC address, network name, received signal strength, noise power, transmit rate, receive rate, and transmission quality for each station are displayed.

5.3.2 Spectrum: Interference Analyzer for AP

For a radio in AP mode, clicking the *Spectrum* button would bring up the Channel Scan Report page. Only the radios that are enabled will be available for scanning, and only the frequency band currently in use will be scanned for each enabled radio (2.4-2.48, 5.15-5.25, 5.725-5.85, etc.)

Press the Radio 2 Scan button to look at the spectrum for the 5 GHz Radio and Radio 1 Scan for 2.4 GHz.

You can click 'Radio 1 Scan' to do the full channel scan again and get the latest results.

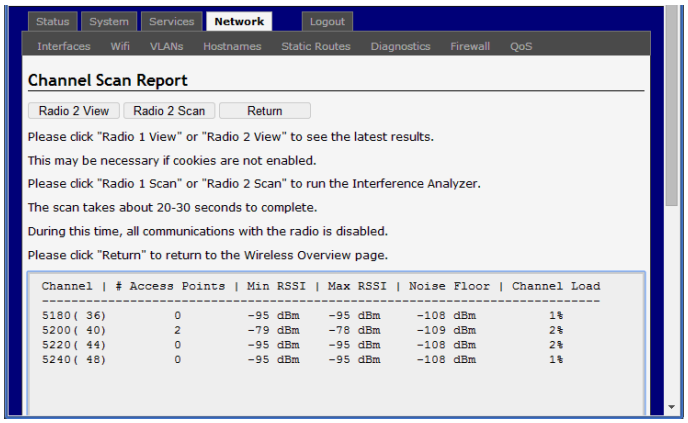

Figure 45: The Channel Scan Report.

The results show the RF Channel and number of neighbouring access points (not including the Altum AC) along with the Min RSSI, Max RSSI, Noise Floor, and Channel Load.

Min RSSI: Shows the minimum received signal strength indicator due to the neighbouring access points.

Max RSSI: Shows the maximum received signal strength indicator due to the neighbouring access points.

Noise Floor: Shows the level of the noise on the channel.

Channel Load: Shows how much the channel is utilized. A lower channel load denotes a channel with less interference.

Return: Brings you back to the *Wireless Overview* page.

5.3.3 Radio in Station Mode

A radio can operate as a Station. This can be set in the *Interface Configuration* → *General Setup* → *Mode* option, after clicking on the *Edit* button.

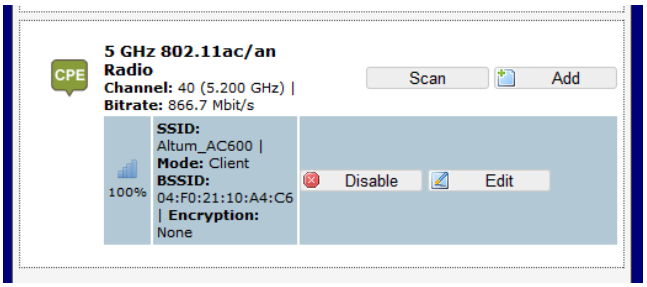

Figure 46: The Wireless Overview page showing a radio as a Client (station).

The following buttons are for a radio operating as a station.

Scan: Scans for available wireless networks. This button is available if the device is operating as a Station. You can then select the network to connect to.

Join Network: Associates this device with the selected wireless network.

5.4 Wifi – Wireless Network

As mentioned earlier, clicking on the *Edit* button for a network would bring up the configuration page. This page contains the sections *Device Configuration* and *Interface Configuration*.

The *Device Configuration* section covers the physical settings of the radio hardware such as Country Code, Wireles Profile, channel width, operating channel and transmit power. These are shared among all defined wireless networks of the radio. Per network settings like encryption or operation mode are grouped in the *Interface Configuration*.

5.4.1 Device Configuration

The *Device Configuration* section consists of the section tabs for *General Setup* and *Advanced Settings*.

General Setup

Status: Shows a summary of the wireless network.

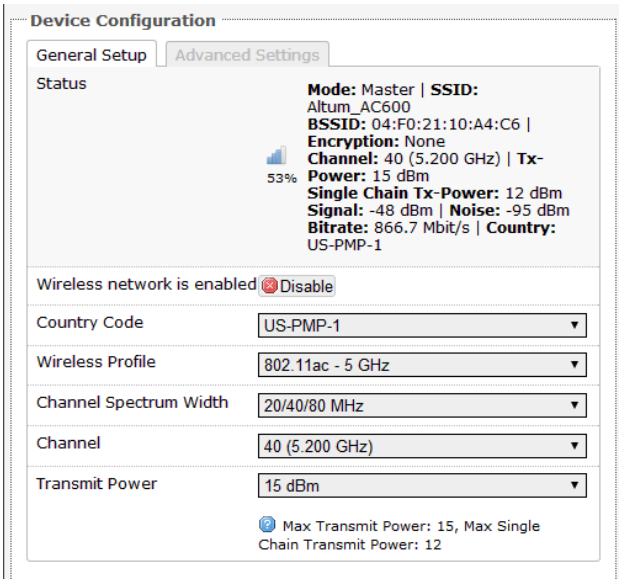

Figure 47: The Wifi *Device Configuration* section.

Enable: Enables the wireless network.

Disable: Disables the wireless network.

Country Code: Selects the country. Each country has its own transmit power and frequency regulations. To ensure regulatory compliance, you must select the

country where the device is operating in. The transmit power levels for each channel are tuned accordingly.

The country codes should match for all radios on the network.

For US, models there are sub categories which are explained below:

US-PTP-1 – Point to Point Mode 5.15-5.25 GHz
US-PTP-2– Point to Point Mode 5.725-5.85 GHz
US-PMP-1– Point to Multipoint Mode 5.15-5.25 GHz
US-PMP-2– Point to Multipoint Mode 5.725-5.85 GHz

NOTE: When PTP modes are selected, a box will appear in the Interface Configuration Section labelled PTP-MAC which the user should enter the other end of the links MAC address (BSSID for AP). This should be done on both ends of the link to prevent any other radios from linking to the PTP link. The Mode must be set to Access Point (WDS) at one end and Station (WDS) at the other end for this feature to work.

Wireless Profile: Chooses the wireless standard used. 802.11a and 802.11g are older standards while 802.11n is a newer standard that offers higher data rates. The choice of *802.11g+n* is a combination of 802.11g and 802.11n, and operates in the 2.4 GHz frequency band. The choice of *802.11a+n* is a combination of 802.11a and 802.11n, and operates in the 5 GHz frequency band. The *802.11ac* is the latest standard that offers even higher data rates (up to 866 Mbps OTA) and it also operates in the 5 GHz frequency bands

Channel Spectrum Width: Selects whether *20 MHz* or *20/40 MHz* bands are used. A 40 MHz band has twice the throughput of a 20 MHz band. A smaller bandwidth may allow more devices to be connected. The *20/40 MHz* option allows both 20 and 40 MHz bands to be used. When the *802.11ac* wireless standard is used, the *20/40/80 MHz* band can be selected. An 80 MHz band can carry twice the amount of data of a 40 MHz band.

Channel: Chooses the frequency channel. The default setting of *Auto* is may be used. For an AP, it would select the channel with the least interference from other APs. For a station, *Auto* will automatically select the same channel as its AP. The frequency channel may also be manually selected. An AP and its station must have the same channel in order to communicate.

Obey Regulatory Power: Obeys the power regulations specified by each country. This would satisfy the legally permitted maximum for the equivalent isotropically radiated power (EIRP) limits of the selected country, based on the specified *Antenna Gain (dBi)*. The result is that the maximum transmit power may be less than the capability of the radio. Once activated, a refresh of the webpage may be needed to show the settings correctly.

Transmit Power: Chooses the transmit power of the radio e.g. 4 dBm, 5 dBm, …, 22 dBm or Max. This is the total power supplied to the antennas of the radio. The maximum power also depends on the frequency channel used.

Allowable Antenna Gain

Due to FCC restrictions the professional installer must use antennas of similar type and gain not exceeding the following limits.

Point to Point Operation:
5.15-5.25 GHz: Max Gain 25 dBi including cable losses. Max EIRP of +40 dBm.

5.725-5.85 GHz: Max Gain 34 dBi including cable losses. Maximum EIRP not limited.

Point to Multipoint Operation:
5.15-5.25 GHz: Max Gain 25 dBi including cable losses. Max EIRP of +36 dBm.

5.725-5.85 GHz: Max Gain 25 dBi including cable losses. Maximum EIRP of +36 dBm.

2.4-2.48 GHz: Max Gain = ?? dBi including cable losses.

Outdoor Channels: Limits the available channel frequency selections to 5500-5700 MHz if the country is in the European Union (EU). Based on the EU-Rule

2005/513/EC regulation, only this frequency band is allowed for outdoor use.

Advanced Settings

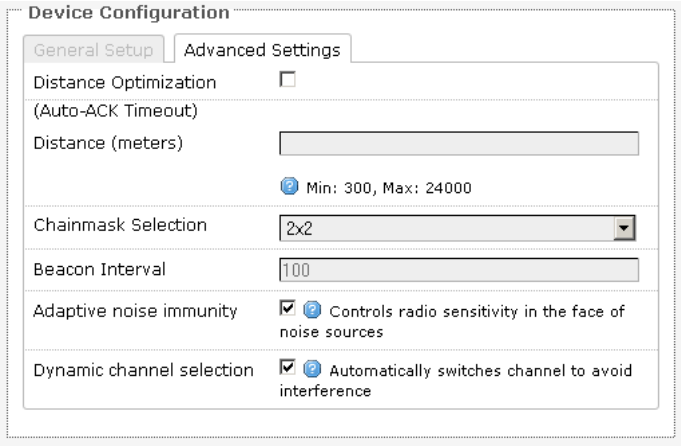

Figure 48: *Advanced Settings* for the Wifi *Device Configuration*.

Distance Optimization (Auto-ACK Timeout): Determines the distance of the connected station from the AP and automatically adjusts the ACK timeout. This is disabled(unchecked) by default. If the stations are positioned over a wide area at different distances from the AP (typically in PmP), it is recommended to disable this option to prevent the ACK timeout from fluctuating widely.

For Point to Point (PtP) links it is recommended to check the box to optimize the timeout period

Distance (meters): Specifies the distance between the AP and the station, if the previous option is unchecked. Min: 300, Max: 12000 (80MHz), 24000 (40MHz), 48000 (20MHz). This value may be set to slightly more than the physical distance between the AP and the farthest station.

Chainmask Selection: Sets the antenna port selection on the radio. For example, *2x2* means that 2 antennas are being used for transmit and receive.

Note: The following options are for the device operating as an access point (AP).

Beacon Interval: Specifies the interval between beacon transmissions by the AP, in milliseconds. A beacon is a frame broadcast by the AP to synchronize the wireless network. For the multiple VAP case, the beacons are transmitted evenly within this interval. Thus, if four VAPs are created and the beacon interval is 200 ms, a beacon will be transmitted from the radio portion every 50 ms, from each VAP in a round-robin fashion. The default value of the interval is 100 ms.

Adaptive noise immunity: Controls radio sensitivity in the face of noise sources. Adaptive noise immunity allows the AP to reject spurs and non-WLAN noise. An advantage is that the AP would have to spend less time decoding the signal, resulting in lower packet loss rate.

Dynamic channel selection: Automatically switches channel to avoid interference. Dynamic channel selection is feature to detect and avoid continuous wave (CW) interference. CW interference or spurs cause the noise floor to be high. This stops transmissions as well as causes a high dropped packet rate. The noise floor is monitored by the calibration logic. When the noise floor is above a threshold, the AP is performs an automatic channel selection. It would disconnect from the stations (it would already have due to the interference) and move to a new channel. The stations are expected to re-associate with the AP on their own.

5.4.2 Interface Configuration

The *Interface Configuration* section contains the section tabs for *General Setup*, *Wireless Security*, *MAC-Filter*, and *Advanced Settings*.

General Setup

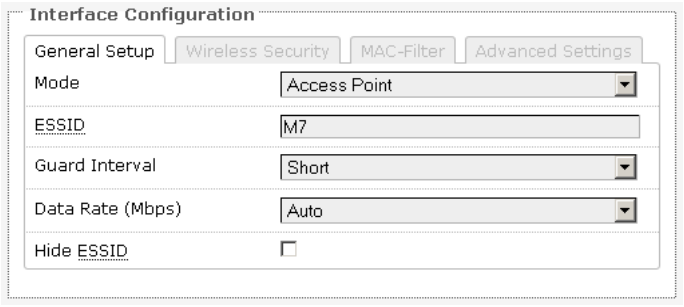

Figure 49: The Wifi *Interface Configuration* section.

Mode: Selects whether the device is operating as an *Access Point* (AP) or a *Station*. Other options are *Access Point WDS* and *Station WDS*.

Note: **Setting more than 1 station on a board is not supported because there can only be one default gateway. Both 2.4 and 5 GHz radios cannot be in *Station* mode at the same time.**

ESSID: Specifies the name or extended service set identifier (ESSID) of the wireless network as it is provided in the beacon message. The network name can be up to 32 characters in length and can contain spaces. When running in AP mode, it is the name of the network as advertised in the beacon message. In Station mode, it is the network name that the station associates with.

BSSID: Sets the MAC address of the AP. This option is available for a device operating as a station. This is useful because there can be multiple APs with the same ESSID. Setting the MAC address would prevent the station from roaming to other APs.

Guard Interval: Chooses between *Short* and *Long* guard intervals. Guard intervals are used to ensure that distinct transmissions do not interfere with one another. Data rate is improved in downlink and uplink if both AP and station use the Short Guard Interval. Long Guard Intervals can improve performance in high multipath environments with a small reduction in maximum data rate.

Data Rate (Mbps): Selects the data rate or the modulation and coding scheme (MCS). The default setting of *Auto* is recommended for all profiles. The MCS and data rates are adjusted automatically depending on the wireless channel conditions.

Hide ESSID: Hides the network name (ESSID) from being broadcast publicly. (This option is for a device operating as an AP.)

Note: If the goal is securing your network, use WPA or preferably WPA2-PSK encryption. Hiding the ESSID does not provide complete security.

WDS

A Wireless Distribution System (WDS) is a system enabling the wireless interconnection of access points in an IEEE 802.11 network. It allows a wireless network to be expanded using multiple access points without the traditional requirement for a wired backbone to link them. The notable advantage of WDS over other solutions is it preserves the MAC addresses of client frames across links between access points.

WDS may also be considered a repeater mode because it appears to bridge and accept wireless clients at the same time (unlike traditional bridging). However, with this method, throughput is halved for all clients connected wirelessly.

Setup for the WDS Modes

The wireless distribution system (WDS) allows the *Station WDS* to bridge wireless traffic transparently, providing the functionality of a repeater. The *Station WDS* is a transparent client and would need to associate with an *AP WDS*. The WDS protocol is not defined as a standard so there may be compatibility issues between devices from different vendors. The following figures show an example of a setup.

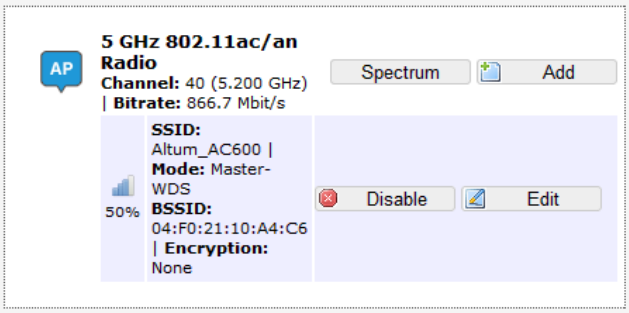

Figure 50: The first Radio is set to the *AP WDS* mode.

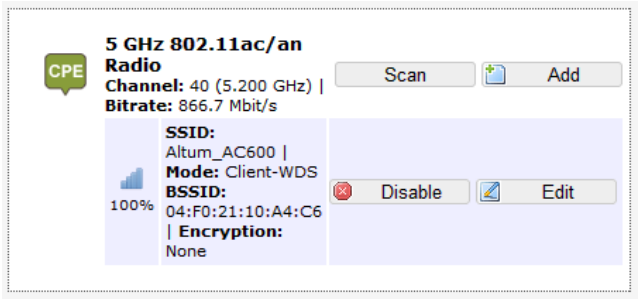

Figure 51: The second Radio is set to the Station WDS mode.

Multiple stations or *Stations WDS* can connect to an *AP WDS* (unless the PTP Country code is used *and* the PTP-MAC of the peer radio is entered) In Figure 52, the *Add* button creates a virtual access point (VAP) on the second . You should choose *AP WDS* mode for the VAP's wireless network e.g. “M8” so that devices in *Station WDS* mode can connect to this network. The pair of *Station WDS* and *AP WDS* on the same board extends the wireless coverage. If the board has two radios, one onboard and one card radio, one radio can be the *Station WDS* and the other radio can be the *AP WDS*. Therefore the *Station WDS* with *AP WDS* on the same board functions as a repeater.

In the non-WDS mode, the *Station* translates all the packets that pass through it to its own MAC address, thus resulting in a lack of transparency. A consequence is that the ARP table of the access point would show the MAC address of the *Station* assigned to IP addresses of both the *Station* and the computer connected to it.

Wireless Security

Figure 52: Setting the *Wireless Security* for the Wifi Interface.

Encryption: Chooses between *No Encryption* (open) and the following encryptions: *WEP Open System*, *WEP Shared Key*, *WPA-PSK*, *WPA2-PSK*, *WPA-PSK/WPA2-PSK Mixed Mode*, *WPA-EAP*, and *WPA2-EAP*.

WEP

Wired Equivalent Privacy (WEP) is the oldest and least secure encryption algorithm. Stronger encryption using WPA or WPA2 should be used where possible.

For the *WEP Open System* and *WEP Shared Key* encryptions, you can specify up to 4 keys and only 1 would be used at a time. We have the following options:

Used Key Slot: Chooses between Key #1 to Key #4.

Key #1: Specifies a string of characters to be used as the password. It may consist of 5 ASCII characters or 10 HEX characters, implying a 64-bit WEP key length. Otherwise, it may consist of **13 ASCII or 26 HEX** characters, implying a 128-bit key length.

Key #2, #3, and #4: Similar to Key #1.

Note: Valid HEX characters are numbers 0-9 and letters A-F, case insensitive. Valid ASCII characters are numbers and the letters of the English alphabet, case sensitive. Based on the number of characters, the key is automatically checked for validity. Invalid keys are represented by red dots while valid keys are represented by black dots. Click the green arrows icon beside the text field to reveal/hide the password.

WPA or WPA2 with PSK

Wifi protected access (WPA) is a stronger encryption than WEP.

Furthermore, WPA2 was developed to strengthen the security of WPA and is stronger than WPA and WEP.

For *WPA-PSK*, *WPA2-PSK*, *WPA-PSK/WPA2-PSK Mixed Mode* encryptions, we have the following options.

Cipher: Can be set to *Auto*, *CCMP (AES)*, or *TKIP and CCMP (AES)*. The Temporal Key Integrity Protocol (TKIP) was developed as a temporary replacement for WEP. The Counter Mode Cipher Block Chaining Message Authentication Code Protocol (CCMP) is

based on the Advanced Encryption Standard (AES) and is the most secure protocol.

Key: The pre-shared key (PSK) is the password for the wireless network. This may consist of **8 to 63 ASCII** characters.

WPA or WPA2 with EAP

The Extensible Authentication Protocol (EAP) is encapsulated by the IEEE 802.1X authentication method. IEEE 802.1X is equivalent to EAP over LAN or WLAN. Enterprise networks commonly use this authentication method.

WPA or WPA2 with EAP (AP Mode)

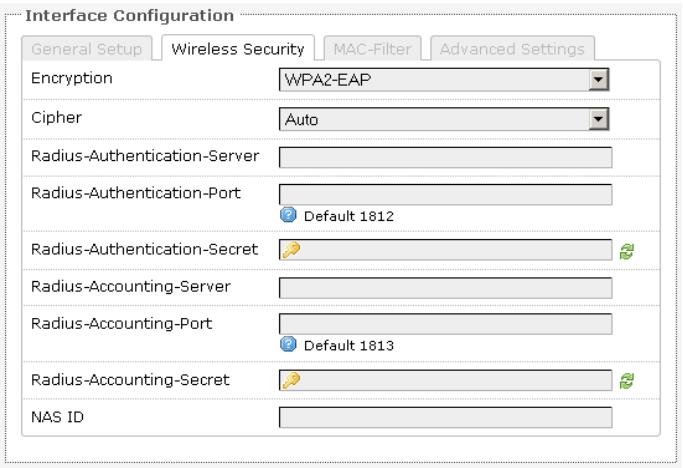

Figure 53: Encryption options for WPA-EAP or WPA2-EAP in AP mode.

Cipher: Can be set to *Auto*, *CCMP (AES)*, or *TKIP and CCMP (AES)*.

Radius-Authentication-Server: Specifies the IP address of the RADIUS authentication server.

Note: Remote Authentication Dial In User Service (RADIUS) is a networking protocol that provides centralized Authentication, Authorization, and Accounting (AAA) management for users that connect and use a network service.

Radius-Authentication-Port: Sets the port number for the RADIUS authentication server. Normally, the port number is 1812.

Radius-Authentication-Secret: Configures the password for the authentication transaction.

Radius-Accounting-Server: Specifies the IP address of the RADIUS accounting server.

Radius-Accounting-Port: Sets the port number for the RADIUS accounting server. Normally, the port number is 1813.

Radius-Accounting-Secret: Configures the password for the accounting transaction.

NAS ID: Specifies the identity of the network access server (NAS).

WPA or WPA2 with EAP (Station Mode)

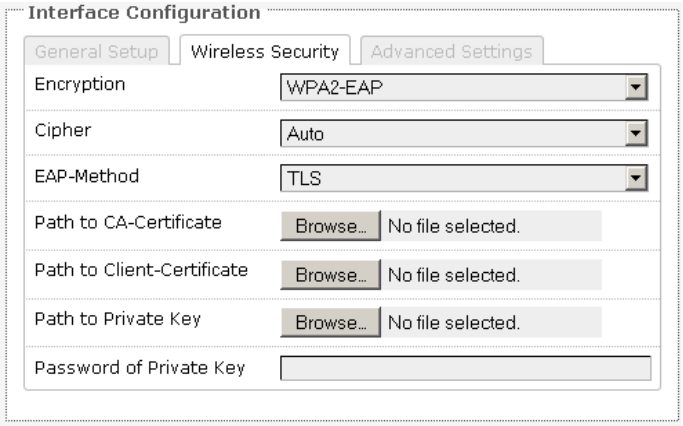

Figure 54: Encryption options for WPA-EAP or WPA2-EAP in Station mode.

Cipher: Can be set to *Auto*, *CCMP (AES)*, or *TKIP and CCMP (AES)*.

EAP-Method: The authentication protocol can be set to Transport Layer Security (*TLS*), Tunneled TLS (*TTLS*), or Protected EAP (*PEAP*).

Path to CA-Certificate: Selects the file for the CA certificate.

Note: The certificate authority (CA) is a trusted third party that issues digital certificates. In a public key infrastructure scheme, a digital certificate certifies the ownership of a public key by the named subject of the certificate.

Path to Client-Certificate: Selects the file for the client certificate.

Options for TLS as the EAP method

Path to Private Key: Selects the file for the private key.

Password of Private Key: Configures the password for the private key.

Options for TTLS or PEAP as the EAP method

Authentication: Selects the authentication method used by the AP, e.g. PAP, CHAP, MSCHAP, or MSCHAPV2.

Identity: Sets the identity used by the supplicant for EAP authentication.

Password: Sets the password used by the supplicant for EAP authentication.

MAC-Filter

This section tab is only available for a device operating as an AP.

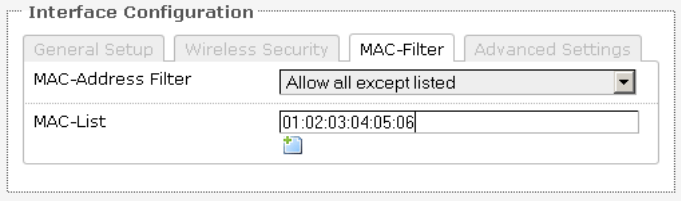

Figure 55: Configuring the *MAC-Filter* for a Wifi AP.

MAC-Address Filter: Lets you allow only devices with the listed MAC address to associate with this AP, or lets you block devices with the listed MAC address.

MAC-List: Adds the MAC address of the remote device to either block or allow.

Advanced Settings

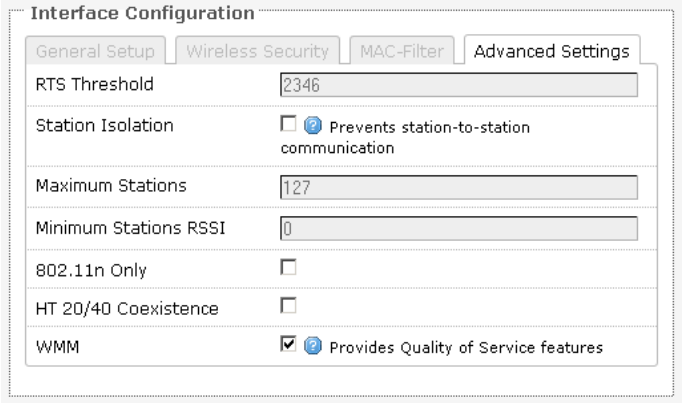

Figure 56: *Advanced Settings* for the Wifi Interface.

RTS Threshold: Sets the threshold for the packet size above which the request to send (RTS) mechanism is used. The default is 2346 octets. There is a trade-off to consider when setting this parameter. On the one hand, using a small value causes RTS packets to be sent more often, consuming more of the available bandwidth, and therefore reducing the throughput of the network packet. On the other hand, when more RTS packets are sent, the system recovers faster from interference or collisions. This is useful in a heavily loaded network, or a wireless network with high electromagnetic interference.

Note: The following options for *Station Isolation*, *Maximum Stations*, *Minimum Stations RSSI*, and *802.11n Only* are available only for a device operating as an AP.

Station Isolation: Prevents station-to-station communication, unchecked by default. When Station Isolation is disabled, wireless clients can communicate with one another normally by sending traffic through the AP. When Station Isolation is enabled, the AP blocks communication between wireless clients on the same AP.

Maximum Stations: Specifies the maximum number of associated stations, the default being 127.

Minimum Stations RSSI: Sets the minimum received signal strength indicator for a station to be associated. The default value of 0 means that the AP would allow a station to associate independent of its RSSI.

802.11n Only: Forces the device to use only the IEEE802.11n standard, unchecked by default.

WMM: Provides Quality of Service (QoS) features, checked by default. Wireless multimedia enables the classification of the network traffic into 4 main types, voice, video, best effort, and background, in decreasing order of priority. Higher priority traffic has a higher transmission opportunity and would have to wait less time to transmit. As a result, an existing video stream would not be interrupted by additional background processes.

5.5 VLANs

A local area network (LAN) can be divided into multiple distinct virtual LANs (VLANs) with the use of VLAN switches. This improves the management and security of the network. The broadcast domain of a device on a VLAN is confined to all devices on the same VLAN.

The *Network* → *VLAN* page contains the sections for *VLAN Management* and *VLAN Ethernet Trunk*.

5.5.1 VLAN Management

The *VLAN Management* section controls individual VLANs according to the IEEE802.1Q standards. Within the subsection for VLAN entries, each row represents one VLAN ID.

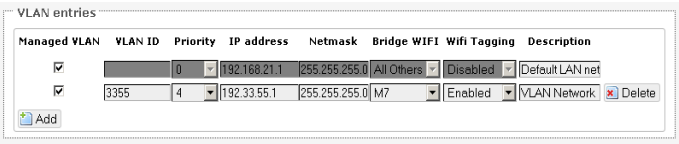

Figure 57: *VLAN entries* in the *VLAN Management* section.

The first row is given by default. It is the native or untagged VLAN.

Add: Inserts a new row corresponding to a new VLAN. The *IP address* field should be distinct for different devices.

Managed VLAN: Allows computers on this VLAN to access the device's configuration web page.

VLAN ID: Specifies the identifier for the VLAN. It is an integer from 2 to 4094. Let *VID* be this number. The "eth0" port is tagged with *VID* to give "eth0.*VID*". This port can have multiple tags corresponding to different VLANs. An "eth0.*VID*" port would only accept frames that have been tagged with the VLAN ID *VID*.

Priority: Chooses the priority for transmitting packets. This is a number from 0 to 7. The number 7 represents the highest priority.

IP address: Sets the IP address of the radio as seen by other devices on this VLAN.

Netmask: States the netmask of the subnet defined by this VLAN.

Bridge WIFI: Selects the wireless network for which its interface would be bridged to the "eth0.*VID*" port. The choice *All Others* would select all other wireless networks that are currently not selected.

Wifi Tagging: Should be set to Enabled. This tags the Ethernet frames sent over Wifi. This does not add a second tag (QinQ). The wireless interface "ath0" of this VLAN would be tagged to give "ath0.*VID*" for example.

Description: Provides a short description of the VLAN.

5.5.2 VLAN Ethernet Trunk

The VLAN Ethernet Trunk uses a wireless network as a trunk link to connect physically separate VLANs having the same VLAN ID.

Within the subsection for the VLAN Ethernet Trunk Entries, each row represents one VLAN ID.

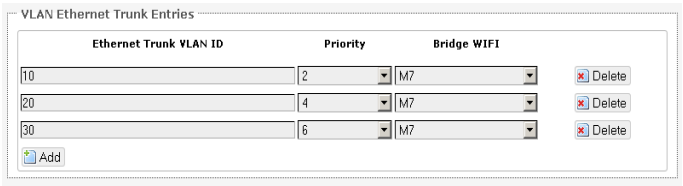

Figure 58: *VLAN entries* in the *VLAN Ethernet Trunk* section.

Ethernet Trunk VLAN ID: Sets the VLAN ID of the separate VLANs to connect.

Priority: Chooses the priority for transmitting packets. This is a number from 0 to 7. The number 7 represents the highest priority.

Bridge WIFI: Selects the wireless network that would act as a trunk link.

5.6 Hostnames

In the *Network* → *Hostnames* page, you can specify custom hostnames (URLs) with their respective IP addresses. This is an additional local DNS.

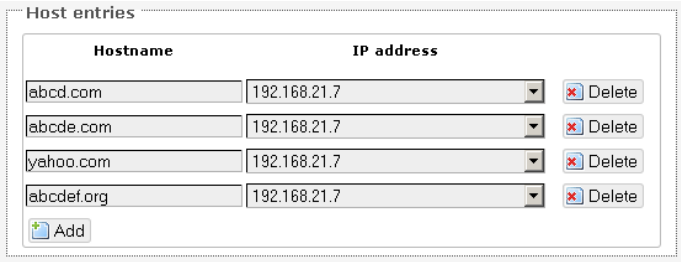

Figure 59: Custom hostname entries.

Note: The computers in the same subnet need to set the IP address of this device as their preferred DNS server in order to interpret these custom hostnames.

5.7 Static Routes

The *Network* → *Static Routes* page shows the static IPv4 routes.

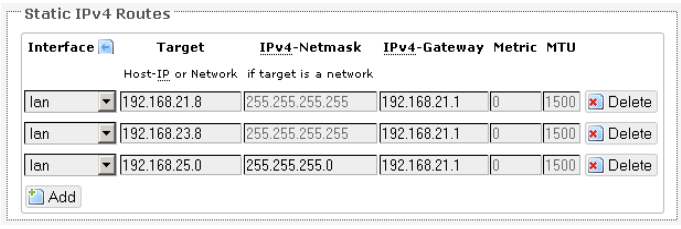

Figure 60: *Static IPv4 Routes*.

Each row shows the interface and gateway over which a certain host or network can be reached.

5.8 Firewall

The *Network* → *Firewall* page contains the subpages for *General Settings*, *Port Forwards*, and *Traffic Rules*.

5.8.1 General Settings

The firewall creates zones over the network interfaces to control network traffic flow.

The *Network* → *Firewall* → *General Settings* page contains the zone settings.

Zone Settings

Figure 61: *General Settings* for the *Firewall Zones*.

Enable SYN-flood protection: Checked by default.

Drop invalid packets: Unchecked by default.

Input: To *accept* by default.

Output: To *accept* by default.

Forward: To *reject* by default.

Zones

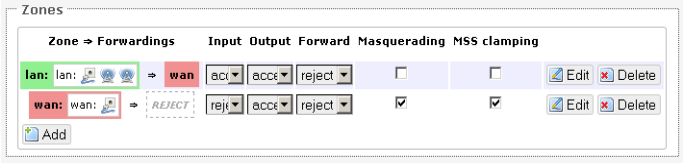

Figure 62: The *Zones* section showing the default settings for the firewall zones.

5.8.2 Port Forwards

Port forwarding allows remote computers on the Internet to connect to a specific computer or service within the private LAN.

The *Network* → *Firewall* → *Port Forwards* page lets you define the protocol and port number to access an internal IP address.

Figure 63: Adding a port forwarding rule.

5.8.3 Traffic Rules

The *Network* → *Firewall* → *Traffic Rules* page configures the traffic rules and source NAT.

Traffic Rules

Traffic rules define policies for packets travelling between different zones, for example to reject traffic between certain hosts or to open WAN ports on the .

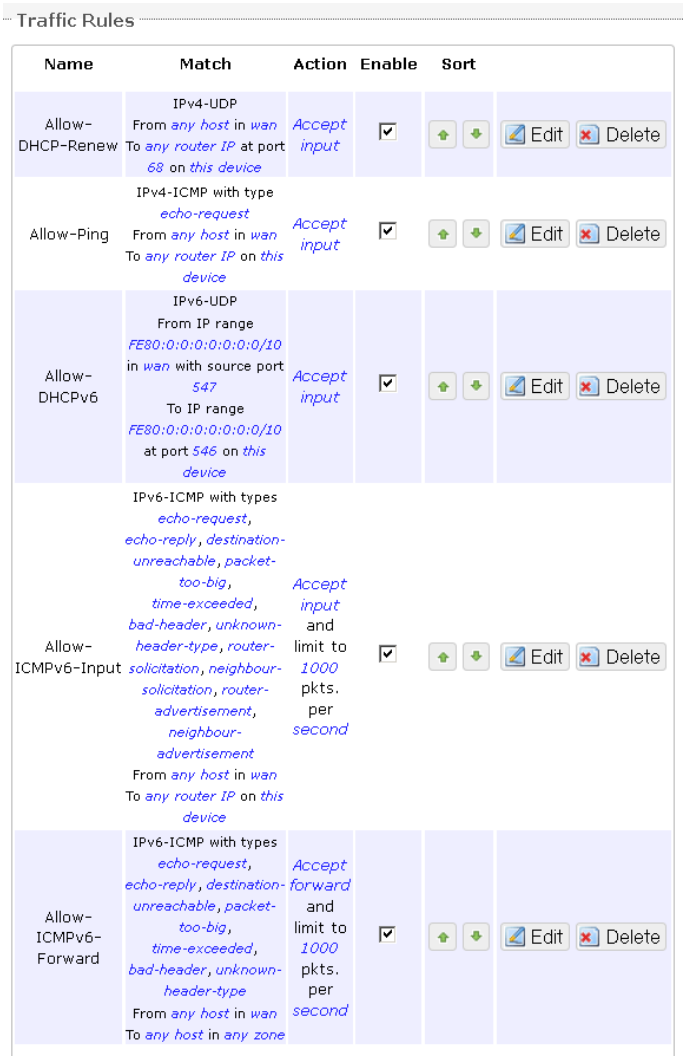

Figure 64: Firewall Traffic Rules with the default settings.

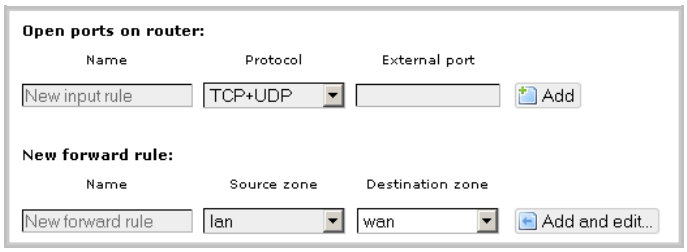

Figure 65: You can choose to open ports on the or add new forwarding rules.

Source NAT

Source NAT is a specific form of masquerading which allows fine grained control over the source IP used for outgoing traffic, for example to map multiple WAN addresses to internal subnets.

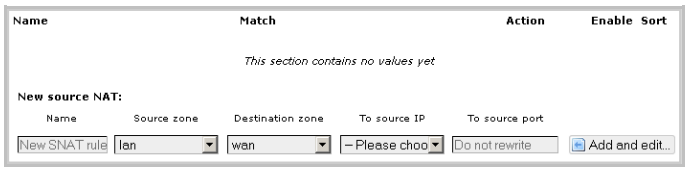

Figure 66: *Source NAT*.

5.9 Diagnostics

5.9.1 Network Utilities

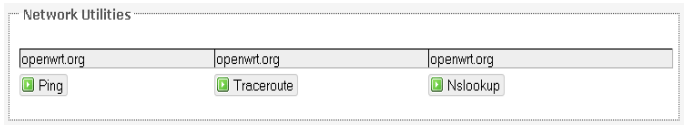

Figure 67: *Network Utilities* consist of *Ping*, *Traceroute*, and *Nslookup*.

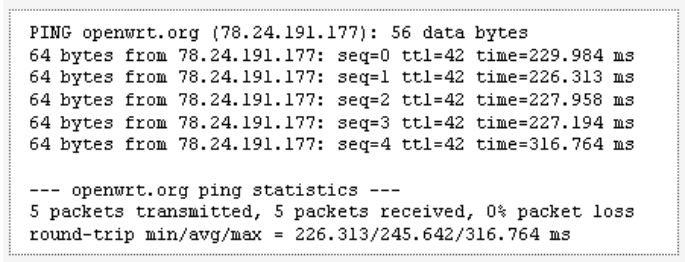

Figure 68: Result of *Ping*.

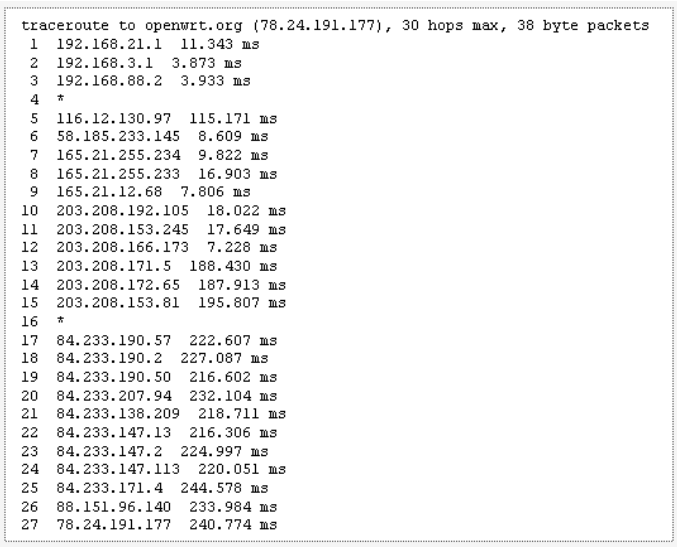

Figure 69: Result of *Traceroute*.

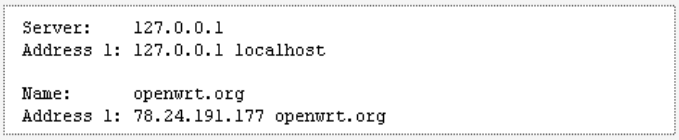

Figure 70: Result of *Nslookup*.

5.10 Quality of Service

The *Network* → *QoS* page configures the quality of service (QoS). With QoS, you can shape network traffic selected by addresses, ports, or services. You can limit the download and upload speeds. Network QoS is disabled by default.

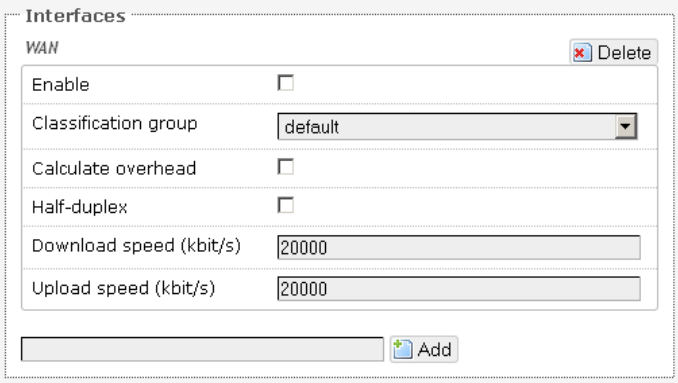

Figure 71: *Network QoS* settings.

Chapter 6: Final Notes

Logout: Logs out of the radio's web page.

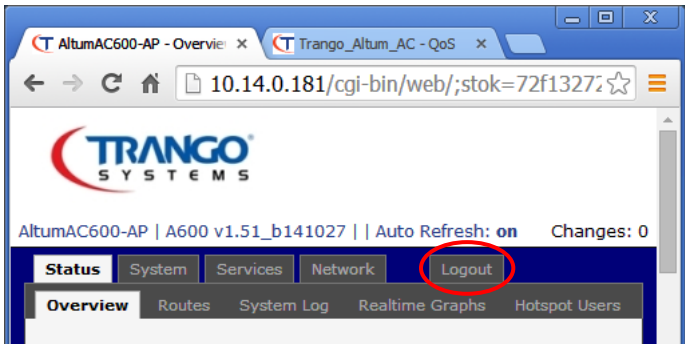

Figure 72: The *Logout* button is circled.

6.1 Troubleshooting steps

6.1.1 PC cannot connect to the radio

The configuration web page for the radio will not be able to show up if the radio and your computer are not connected.

If the PC and the radio are joined to the network by LAN cables, they will not be able to connect if any of the network cable connections are loose. A possible indicator is that there is no light at the LAN port of the PC. In Windows, if you click the network icon and click to "View network connections", the LAN port shows "Disconnected". Please ensure that all the connections are tight.

Sometimes, disconnecting and reconnecting the LAN cable solves connection problems if DHCP is used, because the DHCP server and DNS server are reset.

The radio, the computer, and the gateway must have IP addresses on the same network. For example, if you use a subnet mask of 255.255.255.0 and the gateway IP address is 192.168.3.1, all the IP addresses must be unique and be of the form 192.168.3.X.

Check whether the radio and computer are connected on the same network by running the ping command to ping the IP address of the radio. Alternatively, type the following in the radio's Linux terminal:

- **`ping 192.168.3.77`** (if your computer's IP address is 192.168.3.77 for example.)

They should be able to give the ping responses.

An IP address conflict would cause unstable pings. Switch to another address and ping the conflicting address to check.

If using a Windows computer, you should run the command **`arp -d *`** if the network configuration has changed. This is to delete the address resolution protocol (ARP) table in Windows as it may not update fast enough. This also applies if multiple radio units with the factory default IP address are being set up all at the same time. After configuring each radio, run the arp –d command from your PC.

If the ping still cannot get responses, try disabling the firewall on your Windows computer. The Windows Firewall on your computer may prevent it from sending back a ping response. Disabling the firewall may be a security risk, so you should take the precaution of disconnecting the Internet first.

6.1.2 PC Ethernet and Wifi adapters

If your PC has both Ethernet and Wifi adapters, they must not have the same subnet. Otherwise, packets from the PC may not be directed to the correct network.

6.1.3 Mobile phone cannot connect

A mobile phone or any Wifi user would not be able to connect to a wireless network if there does not exist a DHCP server on the network. Please make sure that there is one, and only one, DHCP server to assign IP addresses automatically to users.

You may refer to Section 5.2.2 to enable the DHCP server for a . The option is found in *Network* → *Interfaces* → *LAN* → *DHCP Server*.

6.1.4 Mobile phone connects but cannot access Internet

A mobile phone or any connected Wifi user would not be able to access the Internet if the default gateway is not set correctly on the radio.

The option for the default gateway is found in *Network → Interfaces → LAN → Common Configuration → General Setup → IPv4 gateway*.

If this radio has enabled a DHCP server but the gateway is at a different IP address please add a DHCP option according to Section 5.2.2 .

The DNS server should also be set. This option is found in *Network → Interfaces → LAN → Common Configuration → General Setup → Use custom DNS servers*.

6.1.5 Unresponsive web page

Symptom: The 'XML Parsing Error' may occur if a certain option was changed and the web page did not update in time.

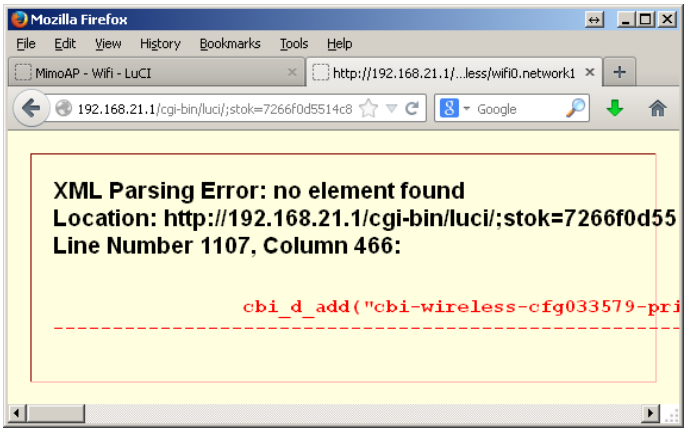

Figure 73: XML Parsing Error.

Solution: Re-enter the IP address into the browser. This would bring you back to the login page of the device.

6.1.6 Unresponsive

Symptom: The radio does not respond.

Solution: Turn off the radio for 10 seconds and then turn it on again.

6.2 Resetting to factory default

To reset the radio to the factory default settings, while the power is on, hold down the reset button for 8 seconds and then release.

Another method is to enter the following command into the radio's Linux terminal:

- `mtd -r erase rootfs_data`

After a while, the flash would be erased and the radio would reboot into its factory default state. The firmware version remains the same as the latest firmware loaded onto the board.

Glossary

Term	Definition
Access Point (AP)	A device that provides network access to associated stations (connected wireless devices). Altum AC can function as an AP.
ACK	Acknowledgment. This is a response to a transmission to indicate that the data packet was received correctly.
ARP	Address Resolution Protocol. This is a broadcast protocol for mapping IP addresses to MAC addresses.
CHAP	Challenge-Handshake Authentication Protocol. This is a protocol for authenticating users to an ISP.
CPE	Customer-Premises Equipment. This is also known as a station.
dB	Decibels. This is a measure of intensity.
dBm	Decibel-milliwatts. This is a measure of power relative to 1 mW. This is commonly used to measure wireless signal power. A higher power leads to better signal quality.
DDNS	Dynamic DNS. This is a system for updating domain names in real time. It allows a domain name to be assigned to a device with a dynamic IP address.
DHCP	Dynamic Host Configuration Protocol. This is a protocol for allocating IP addresses dynamically so that addresses can be reused when hosts (e.g. computers) no longer need them.
DNS	Domain Name System. This is a distributed and hierarchical naming system for computers, services, or any resource connected to the Internet or a

Term	Definition
	private network.
EIRP	Equivalent Isotropic Radiated Power. Each country sets the legally permitted maximum for the EIRP limits on each channel.
ESSID	Extended Service Set Identifier. This is the name of the wireless network. It is case-sensitive and up to 32 alphanumeric characters in length. The ESSID differentiates one wireless network from another. All access points and devices trying to connect to a specific wireless network should use the same ESSID (and password) to enable effective roaming.
FTP	File Transfer Protocol. This is a protocol for transferring files between network nodes.
HTTP	Hypertext Transfer Protocol. This is a protocol used by web browsers and web servers to transfer files.
IP	Internet Protocol. This is the primary communications protocol used for relaying network packets (also known as datagrams) across an internetwork using the Internet Protocol Suite. IP is responsible for routing packets across network boundaries. It is the principle protocol that establishes the Internet.
ISP	Internet Service Provider.
L2TP	Layer 2 Tunneling Protocol. This is a tunneling protocol used to support virtual private networks (VPNs) or as part of the delivery of services by ISPs. It does not provide any encryption or confidentiality by itself. Rather, it relies on an encryption protocol that it passes within the tunnel to provide privacy.
LAN	Local Area Network.

Term	Definition
Layer 2	Data link layer of the Open Systems Interconnection (OSI) model. This corresponds to the Link layer of the Internet protocol suite.
MAC Address	Media Access Control Address. This is a globally unique identifier attached to a network adapter. It also identifies the hardware manufacturer.
Mbps	Megabits per second. Also Mbit/s. This is a measure of the data rate.
MiniPCIe	Mini Peripheral Component Interconnect Express. A miniPCIe radio is a radio card that can be inserted into a unit's circuit board.
MTU	Maximum transmission unit. This is the size, in bytes, of the largest packet that can be passed on. The MTU for Ethernet is a 1500-byte packet.
NAT	Network Address Translation. This is the process of rewriting IP addresses as a packet passes through a controller or firewall. NAT enables multiple computers (or hosts) on a LAN to access the Internet using the single public IP address of the LAN's gateway controller.
NMS	Network Management Station. This is a software which runs on the SNMP manager. It is sometimes simply referred to as an SNMP manager.
NTP	Network Time Protocol. This is a protocol for synchronizing a controller to a single clock on the network, known as the clock master.
PAP	Password Authentication Protocol. This is a protocol for authenticating users to a remote access server or ISP.
PPPoE	Point-to-Point Protocol over Ethernet. This is a protocol for connecting a network of hosts to an ISP without the ISP having to manage the allocation of IP addresses.
PPTP	Point-to-Point Tunneling Protocol. This is a protocol for the creation of VPNs for the secure transfer of data from remote clients to private servers over the Internet.
QoS	Quality of Service. This is the prioritization of network traffic. Voice traffic gets the highest priority, followed by video, best effort, and background traffic, in this order.
RADIUS	Remote Authentication Dial In User Service. This is a networking protocol that provides Authentication, Authorization, and Accounting (AAA) management for remote users. The RADIUS provides centralized management of usernames and passwords.
SNMP	Simple Network Management Protocol. This is an Internet-standard protocol for managing devices on IP networks. It consists of a set of standards for network management, including an application layer protocol, a database schema, and a set of data objects. SNMP exposes management data in the form of variables on the managed systems, which describe the system configuration. These variables can then be queried (and sometimes set) by managing applications.
SSID	Service Set Identifier. This is also known as the ESSID or the wireless network name.
Station	A device that connects wirelessly to an access point.

Term	Definition
Subnet	A portion of a network that shares a common address component. On TCP/IP networks, subnets are defined as all devices whose IP addresses have the same prefix. For example, all devices with IP addresses that start with 192.168.7 belong to the same subnet.
TCP	Transmission Control Protocol. This is a protocol for transmitting data over the Internet with guaranteed reliability and in-order delivery.
UDP	User Datagram Protocol. This is a protocol for transmitting data over the Internet quickly but with no guarantee of reliability or in-order delivery.
VAP	Virtual Access Point. A VAP simulates a physical access point. A VAP is configured on a per-radio basis. By default, only one VAP is enabled. Up to 16 VAPs can be created for each radio, each with its own SSID.
VPN	Virtual Private Network. This is a network that enables IP traffic to travel securely over a public TCP/IP network by encrypting all traffic from one network to another. The VPN uses tunneling to encrypt all information at the IP level.
WAN	Wide Area Network. This is a network that covers a broad area. The world's most popular WAN is the Internet.
Web Browser	A software that allows the user to surf the Internet.
WDS	Wireless Distribution System. This is a system enabling the wireless interconnection of access points in an IEEE 802.11 network. It allows a wireless network to be expanded using multiple access points without the traditional requirement for a wired backbone to link them.
WLAN	Wireless Local Area Network.

FCC Information

FCC ID: NCY-A600

The Altum AC600 System can be used for point-to-point or Point to Multipoint operation.

NOTE: All Altum AC600 models require professional installation due to FCC limits on output power settings when operating in the UNII bands.

This device complies with Part 15 of the FCC Rules and Regulations. 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 a 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, uses, and can radiate radio-frequency energy and, if not installed and used in accordance with these instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in any 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 correct the interference by one of more of the following measures:

1) Reorient the antenna.
2) Increase the separation between the affected equipment and the unit.
3) Connect the affected equipment to a power outlet on a different circuit from that which the receiver is connected to.
4) Consult the dealer and/or experienced radio/TV technician for help.

WARNING:

Intentional or unintentional changes or modifications must not be made unless under the express consent of the party responsible for compliance. Any such modifications could void the user's authority to operate the equipment and will void the manufacturer's warranty. To comply with RF exposure requirements, the following antenna installation and device operating configurations must be satisfied. The antenna for this unit must be fixed and mounted on outdoor permanent structures with a separation distance of at least two meters from all persons. Furthermore, it must not be co- located or operating in conjunction with any other antenna or transmitter.

Warranty Information

Radios from Trango Systems are warranted for one year from date of purchase. Please see www.trangosys.com for a complete description of warranty coverage and limitations