SATEL XPRS IP RADIO ROUTER
CENTRAL UNIT
USER GUIDE VERSION 2.1

CU

USER GUIDE

SATEL

Mission-Critical Connectivity

Contents

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Salo, Finland 2019

Product conformity

SATELLAR CU

SATEL Oy hereby declares that SATELLAR Central Unit is in compliance with the essential requirements (electromagnetic compatibility and electrical safety) and other relevant provisions of Directive 1999/5/EC. Therefore the equipment is labelled with the following CE-marking.

Warranty and safety instructions

Read these safety instructions carefully before using the product:

- The warranty will be void if the product is used in any way that is in contradiction with the instructions given in this manual, or if the housing of the radio modem has been opened or tampered with.
- The devices mentioned in this manual are to be used only according to the instructions described in this manual. Faultless and safe operation of the devices can be guaranteed only if the transport, storage, operation and handling of the device is appropriate. This also applies to the maintenance of the products.
- To prevent damage the Central Unit (referred to in this user guide as CU) must always be switched OFF before connecting or disconnecting the serial connection cable. It should be ascertained that different devices used have the same ground potential. Before connecting any power cables the output voltage of the power supply should be checked.
- To be protected against all verified adverse effects the separation distance of at least 44 cm must be maintained between the antenna of SATELLAR radio modems and all persons.

1. Introduction to the SATEL XPRS radio router product family

SATEL XPRS radio router is a new generation narrow band radio router that consists of separate units:

- Central Unit (CU)
- Radio Unit (RU)

Figure 1.1 SATEL XPRS radio router product family:

1. SATELLAR XT 5RC with display:
   Central unit (CU) with display and keypad + radio unit (RU)
2. SATELLAR XT 5RC without display:
   Central unit (CU) w/o display and keypad + radio unit (RU)
3. SATELLAR XT 5R: Radio unit (RU)

Using SATELLAR the customer builds an own independent radio data communication network. This document presents the specifications and usage of the CU. The properties of other units are described in the extent, which is necessary to read in order to understand the operation of the CU.

Data communication

SATELLAR operates either as a transparent radio link, essentially replacing a wire, for classic RS-232, RS-485 or RS-422 based protocols, or as a wireless router in an IP-based network. Using SATELLAR many network topologies are possible, everything from a point-to-point connection to a nationwide chain with multiple branches.

Security

Data security is often a concern when using radio communication. In SATELLAR there are 128-bit and 256-bit encryptions available on the air-interface ensures privacy in the radio network.

Display and keypad

The CU is available with or without a display and keypad. The size of the display is 2.4 “, resolution is 320 x 240 pixels, and the amount of colors is 65k. The keypad has seven buttons: left, right, up, and down arrows, OK button, and two software defined buttons.

Diagnostics and configuration

Radio modems are often used in applications where reliability and independence are key properties. To support this demand, SATELLAR has built-in diagnostic and remote configuration features.

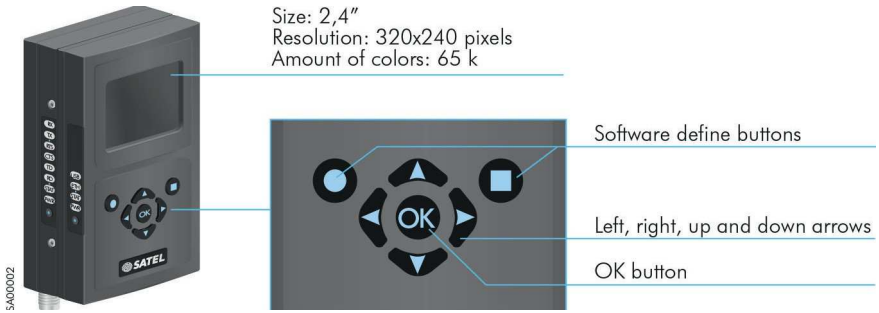


Figure 1.2 Display and keypad

Local use

The status of the CU can be seen from the LED indicators, which are located on the other narrow side of the unit. More detailed information is available using the graphical user interface with a QVGA display and 7 pushbuttons.

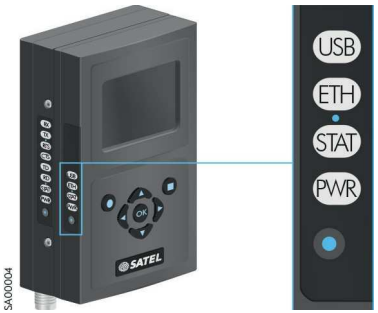


Figure 1.3 The status of the CU can be seen from the LED indicators

Remote use

Once deployed, status monitoring and configuration can be performed using one of the following methods:

1. The SATELLAR CU provides WWW pages for configuration and diagnostic, accessible using IP connectivity (the Ethernet interface of the CU)

2. Using the Windows based SATEL NMS PC software through the serial data interface of the RU, the USB device port of the CU, or TCP/IP port 55555 of the CU. (Check SW availability from SATEL)

SATELLAR can also be accessed over the air by the methods described above.

Flexible and expandable

SATELLAR concept has been designed to be flexible and expandable both in terms of hardware and software functions.

Software

In the RU the modulation method, channel spacing (i.e. air interface data rate), and forward error correction can be selected by changing the modem settings by software. Also the RF output power can be set.

Hardware

Due to the modular mechanical structure of SATELLAR, it is possible to add hardware expansion units. The idea is that this could be done as an update after the initial deployment. At the moment, however, the RU does not support the update. Schedule for this will be informed later.

USB host and device connectors offer a possibility to connect commercially available USB devices like Bluetooth and WLAN modules to the modem or e.g. to show the modem as an external memory device to the PC.

Ruggedized

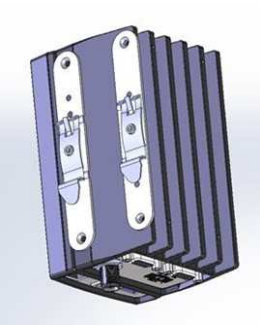
SATELLAR is constructed of die-cast aluminum to withstand the abuse typical to rough industrial environments. It operates over a wide temperature range and under severe vibration conditions to meet the requirements of vehicular and process industry applications.

1.1 Mounting

The SATELLAR XT 5R and 5RC can be mounted as follows:

- On a DIN-rail using SATELLAR specific DIN rail adapters (two pieces needed) connected at the other edge or at the bottom of the unit.
- On a flat surface using SATELLAR specific wall mounting brackets (two pieces needed) connected at the other edge or at the bottom of the unit.
- NOTE! The DIN rail adapters have to be ordered separately.

Wall mount Wall mount parts, 2 pcs, WP0019



DIN SATELLAR XT 5RX Installation parts for DIN rail, 2 pcs, WP0020

Please contact manufacturer to get more information regarding mounting of the units.

NOTE!

1. The equipment must be installed in restricted access location due to high touch temperatures of metal enclosure.
2. The screen of coaxial antenna cable must be grounded to protect from over voltages from outdoor antenna.

1.2 Configuration quick steps

SATELLAR XT 5RC radio has WEB user interface available for the manual configuration (also models with LCD UI available). Software tool called NETCO has been created to ease up and automate the configuration steps for the radio network.

In this tool it is possible to draw the radio network along with the connected IP devices into the view, let the SW tool to assist to create some necessary settings for the setup and set the configuration to the radios in physical connection to the device. After the network build, it is also possible to change the device settings remotely.

The network configuration file can be saved into a separate file from the SW, containing all the critical parameters for the system setup. Thus also replacing radios in the setup and replicating radio networks can be done easily. NETCO saves valuable time and thus also money when building a radio network or even when just adding more radios into the network.

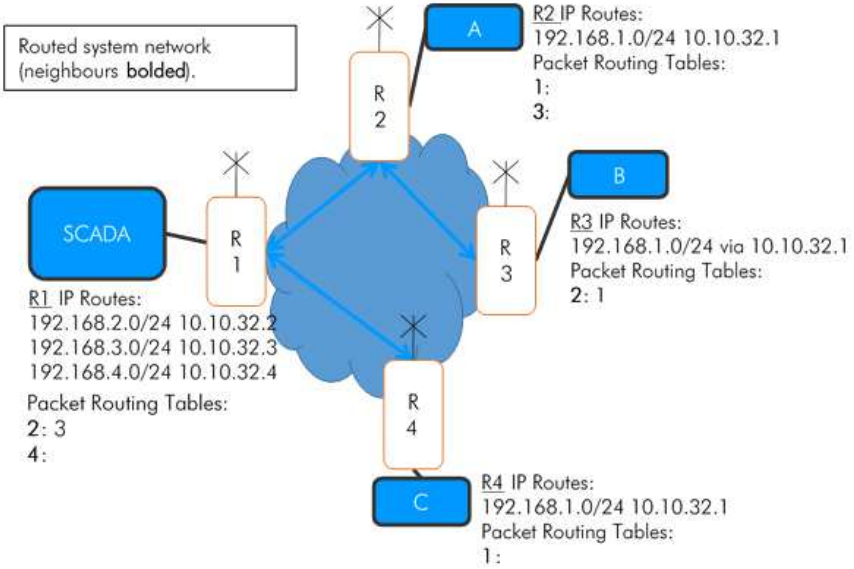
Please contact SATEL to receive the SW package along with your company specific NETCO installation license key.

Manual configuration quick steps for IP radio network

1. Enter to the WEB/LCD user interface of the device
    - Default IP address: 192.168.1.1/24 (set PC connecting PC to the same subnet, unique IP address)
        - Administrator entry:
            - Username: admin
            - Password: Satel456
2. Enter Modem Settings → Network Protocol Mode –tab
    - Set unique Address (RMAC) -setting to each radio in the network according to your network design plan
    - Press “Apply Settings” button to save the changed settings (needs to be committed separately, after all required parameters are changed)
3. Enter Modem Settings → Radio –tab
    - Adjust the radio parameters according to your network design plan (set similarly to all radios in the network if no detailed plans):
        - TX Frequency
        - RX Frequency
        - RF Output Power
        - Channel Spacing
        - Modulation (see modulation levels for air rates requirements, high modulation for high data rate)
    - Press “Apply Settings” button to save the changed settings (needs to be committed separately, after all required parameters are changed)
4. Enter Modem Settings → Packet Mode Radio Access Control –tab
    - Adjust settings:
        - Handshake/Network Topology
        - Retransmissions
            - …according to network design plan. Leave to factory settings if no detailed plans. To make radio network as fast as possible, set Handshake-, and Retransmissions –settings to OFF –state
    - Press “Apply Settings” button to save the changed settings (needs to be committed separately, after all required parameters are changed)

5. Enter Routing → Packet Routing Tables –tab
    - Set the Packet Routing Tables according to your network design plan:
        - Neighbor: the RMAC address of a direct neighbor radio
        - Remotes: RMAC that can be reached behind certain RMAC
    - Press “Apply Settings” button to save the changed settings (needs to be committed separately, after all required parameters are changed)
6. Enter Routing → IP Routes –tab
    - Set the IP routes according to your network design plan
        - Route to the destination IP subnet or specific IP address (mask /32) via defined radio address (10.10.32.x).
            - NOTE! If radio network devices in the same subnet, Proxy ARP –setting needs to be enabled (Routing → IP → Proxy ARP)
    - Press “Apply Settings” button to save the changed settings (needs to be committed separately, after all required parameters are changed)
7. Enter Routing → IP –tab
    - Set the IP Address 0 for the IP radio
    - Press “Apply Settings” button to save the changed settings (needs to be committed separately, after all required parameters are changed)
8. Press “Commit Changes” button. The changed parameters listed in the view under “Uncommitted changes” text are taken into use. Note that connection to the PC might require changes to the PC IP settings if the IP radio IP address is changed).

Example network 1:



“IP Routes” example:
IP route 192.168.2.0/24 10.10.32.2
In order to reach 192.168.2.0 subnet, consisting of host address range 192.168.2.1 – 192.168.2.254, route 10.10.32.2 (=RMAC address 2) must be used.

2. Technical specifications

Electrical

CPU	ARM 9 @ approx. 200 MHz
RAM	64 MB
ROM	128 MB
Display	2.4", 320 x 240 pixel resolution, 65 k colors
Keypad	up, down, left, right, OK (select), and two SW defined keys
Power consumption	No USB device connected: 2.0 W with the display 1.4 W W/O display USB connected: +max. 2.5W
USB interfaces	USB-host & USB-device USB2.0 high speed
Ethernet interface	10/100 Mbps Ethernet RJ-45 with Auto-MDIX
Start time from power on	For CU/RU combination: 65 s until IP communication works (locally and over the air). 130 s until LCD/GUI works.

Power consumption values (W)**, no USB device connected

Radio model (***UHF**)	@RX	@TX, 5W power	@TX, 2W power	@TX, 1W power	@TX, 0.5W power	@TX, 0.2W power	@TX, 0.1W power	Notes
SATELLAR XT 5R, FSK*	2.8	22.8	16	12.8	10.9	9.2	8.4	Radio Unit only
SATELLAR XT 5RC, FSK*	4.2	24.4	17.4	14.2	12.3	10.6	9.4	Radio Unit + Central Unit
SATELLAR XT 5RC, FSK*	4.8	24.8	18	14.8	12.9	11.2	10.4	Radio Unit + Central Unit with LCD
SATELLAR XT 5R, QAM*	3.8	14.4	12	11.6	9.1	7.8	7.6	Radio Unit only
SATELLAR XT 5RC, QAM*	5.2	15.8	13.4	13	10.5	9.2	9	Radio Unit + Central Unit
SATELLAR XT 5RC, QAM*	5.8	16.4	14	13.6	11.1	9.8	9.6	Radio Unit + Central Unit with LCD
XPRS Optimum, QAM*	5.2	15.8	13.4	13	10.5	9.2	9	Radio Unit + Central Unit
SATELLAR XT 5R, QAM	4.4	16	12.2	10.2	9.7	9	8.4	Radio Unit only
SATELLAR XT 5RC, QAM	5.8	17.4	13.6	11.6	11.1	10.4	9.8	Radio Unit + Central Unit
SATELLAR XT 5RC, QAM	6.4	18	14.2	12.2	11.7	11	10.2	Radio Unit + Central Unit with LCD

**Measured with V_{max} (+30Vdc), PRBS (Pseudorandom Binary Sequence). NOTE! Power consumption with QAM models in Carrier Test –mode (transmission) can raise up to +30% from the given values.

Mechanical and environmental

Mechanical dimensions	130 x 21.7 x 76.5 mm (RU+CU 130 x 77.2 x 76.5 mm)
Weight	260 g (RU+CU 940 g)
Temperature ranges	-25 - +55 deg °C, complies with the standards -30 - +75 deg °C, functional -40 - +85 deg °C, storage
Humidity	< 95 % @ 25 deg °C, non-condensing
Vibration	At least 10 – 500 Hz/5g without degradation in data transfer capability
Shock resistivity	Dropping height 1 m, all directions
IP rating	IP 52
Mounting:	DIN rail (side or back), two piece mounting clip, or directly on flat surface

Standards compliance

Emissions	IEC 61600-6-4
Immunity	IEC 61000-6-2
ESD	IEC 61000-4-2 level 4 for external connections EIC 61000-4-2 level 2 for internal unit-to-unit connector
RoHS	2002/95/EC

Table 2.1 SATELLAR Central Unit technical specifications

3. Typical setup

The figure below shows a typical setup when transferring IP data through the CU. When using the RU together with the CU the recommended minimum distance between the antenna and CU is 2 m in order to avoid degradation of the receiver sensitivity due to interference from the CU.

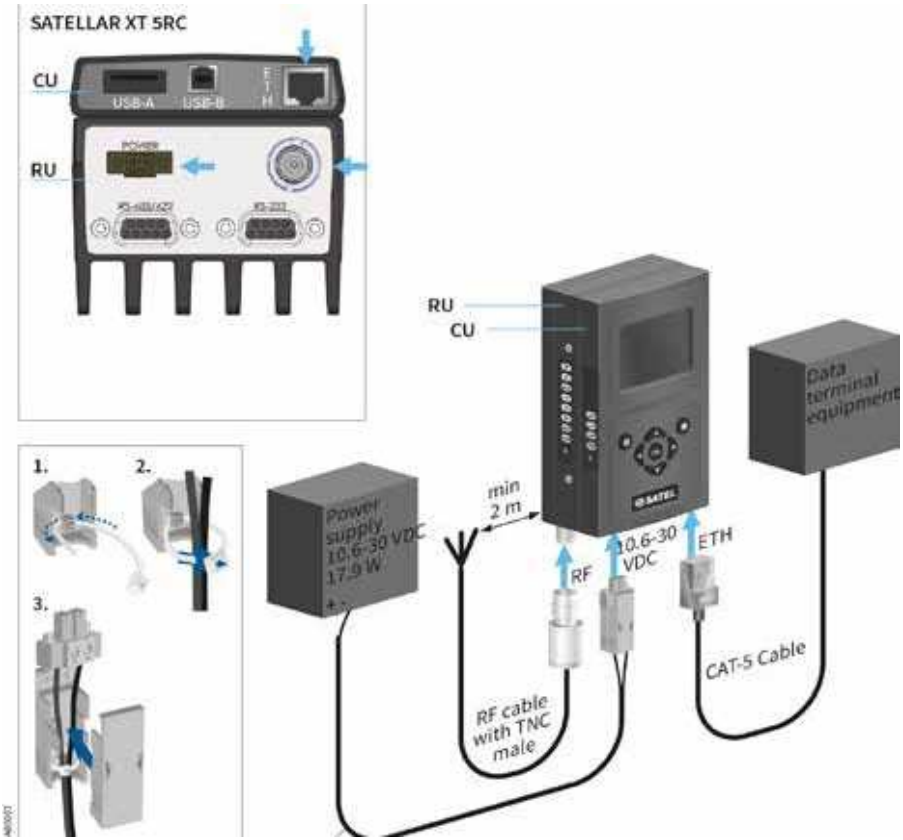


Figure 3.1 Transferring IP data through the CU, cabling

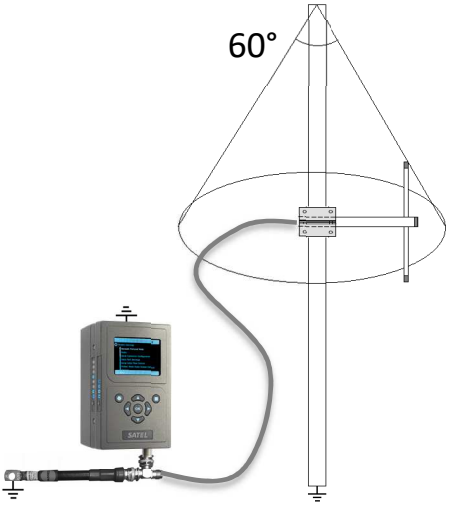


Figure 3.2 Grounding

Proper grounding together with surge protection components should be installed on site to protect the hardware against possible surge spikes and power transients caused by lightning, ESD or other electrical systems. RF surge protector models available where the ground potential is handled by the RF surge protector. Ground connection in the antenna mast, antenna installed inside 60 degree “invisible cone” improves the possibility for the RF setup not to get direct hit from a lightning strike.

General installation guidelines for grounding:

- Perform grounding of the system in accordance with local and national regulations
- Check the grounding related information of other products in the system
- Use short low impedance cables. Although DC resistance of a ground cable may be a fraction of an ohm, its impedance may be thousands of ohms on the radio frequency. Wide copper straps are the best
- The ground connection should be connected directly to the power supply, not the ground connection of the load, in order to isolate the radio from voltage drops across the ground return for the load
- Equipment of the radio system should be grounded in a star ground configuration. The center of the star should be usually connected directly to a good external earth ground scheme
- The mast installations require special measures in the construction of ground electrodes and equipotential bonding – consult professional installation providers

Contact SATEL Technical support for more details: Please visit http://www.satel.com

5. Interfaces

The CU offers three data interfaces: Ethernet, USB host and USB device. LED indicator shows the status of the unit and graphical user interface can be used to check and change device settings and to see the diagnostics data.

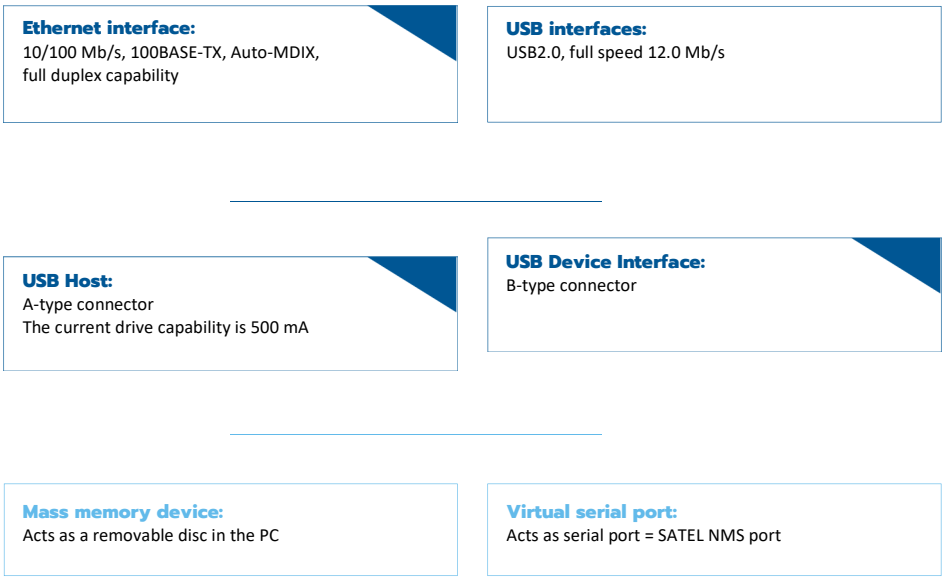


Figure 5.1 Three data interfaces: Ethernet, USB host and USB device

5.1 Ethernet

Ethernet interface is 10/100 Mb/s 100BASE-TX with Auto-MDIX and full-duplex capability.

5.2 USB

The USB interfaces support USB2.0 Full Speed (12.0 Mb/s) data rates. Both USB host and device interfaces are available. For USB host the A type connector is used and for USB device the connector is B type. The current drive capability of the USB host interface is 500 mA. The USB device interface has two modes: Mass memory device and Virtual serial port. The mode can be selected in Modem Settings, General category and in addition by the function button as described in chapter 5.5.

In the Mass memory device -mode a PC can be connected to the USB device interface and SATELLAR acts as a Removable Disc in the PC. The removable disk contains copies of system log files, which can be copied to the PC. Update files can be copied to the removable disk and be used in the Firmware Updater (see chapter 8.3). Any other files copied to the removable disk are removed when the cable is disconnected.

In Virtual serial port -mode, the USB port acts as a serial port. When the USB port is connected to a PC, the virtual serial port device is created in the PC. This virtual port appears to windows as a normal serial port: the only difference is that an actual D9 connector is not used. This allows programs to connect to serial ports in order to access the CU via the USB connection.

Windows PC requires a special driver, available from SATEL. The Virtual Serial port acts as a SATEL NMS port, allowing a program such as SATEL NETCO Design stack or NETCO to be used to change the settings of SATELLAR. The driver can be found in the WWW UI under the Administration tab. It can be downloaded by following the “Download USB Drivers” link.

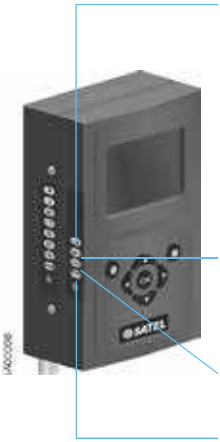
5.3 Diagnostics, monitoring, changing settings

Figure 5.2 Display and keypad

CU equipped with a display and keypad offers an easy way to check or change device settings and see diagnostics information. The same is possible using the Web interface of the CU. Graphical user interface is explained more in chapter 5.6.

5.4 LED indicators

The CU provides four LED indicators that are located on one of the narrow sides of the unit. They are listed and described in the table below.



LED Label	Status	Description
USB	OFF	USB host disabled
	ON	USB host enabled, USB device detected
	Blinking (0.25 s interval)	USB host enabled, no USB device detected
	Blinking (0.50 s interval)	USB device setting override using function button, see chapter 5.5
	Blinking (1.0 s interval)	USB is a mass memory device
ETH	OFF	Ethernet port disabled
	ON	Ethernet port enabled and connected
	Blinking (0.25 s interval) or	Ethernet port enabled but not connected operational
	Blinking (0.50 s interval)	Ethernet port setting override using function button, see chapter 5.5
STAT	ON	Normal operation mode
	Blinking (0.25 s interval)	Device is starting up
PWR	OFF	Device is powered off
	ON	Device is powered on

Table 5.1 LED indicators

NOTE: In normal operation the USB LED indicates the status of the USB host interface. When operating with the function button (chapter 5.5), the USB LED refers to the state changes in the USB device interface.

5.5 Function button

The function button is located below the LED indicators. It is used to control the operation of the USB device and Ethernet interfaces as described below. The CU must be allowed to boot up completely before the button will work.

Figure 5.3 Location of the Function button

When the button is pressed for more than a second, all the LEDs turn on indicating the start of the process. The effect depends on how long the button is kept depressed, and is indicated by turning the LEDs off one by one. When the LEDs indicate the desired function, release the button. After the button has been released, press the button once more quickly (less than a second) to finish the operation.

Figure 5.4 LED indications, see the Table 5.2

Action	Length of press [seconds]	LED indication	Effect
	1 to 2	All LEDs ON.	The USB device and Ethernet interface settings are reset to states defined by user settings.
	2 to 4	The uppermost LED (USB) is switched off.	The USB device setting is changed so that if the user setting is Mass memory device, the setting changes to Virtual serial port and vice versa. Thereafter the USB LED starts to blink until the setting is reset to the original value. Blinking interval is 0.5 seconds if the new device setting is Virtual serial port and 1.0 seconds if the setting is Mass memory device.
	4 to 6	The next lower LED (ETH) is switched off.	The CU IP address settings are changed. Thereafter the IP address is 192.168.1.1, the net mask is 255.255.255.0, and DHCP is switched to off mode. All firewall rules preventing access to the WWW UI are removed. The ETH LED blinks until the settings is reset to the original value. Blinking interval is 0.5 seconds.
	6 to 8	The next lower LED (STAT) is switched off.	No specific operation defined.
	8 to 10	The fourth LED (PWR) is switched off.	All the LEDs start to blink rapidly until the MCU restarts. SATELLAR CU then reboots.
	> 10	All LEDs ON.	
	> 20	All LEDs turn ON and remain on even if the button is kept down.	The selection process starts from the beginning (11 to 12 seconds counts as 1 to 2 seconds etc.).

Table 5.2 Function button operation

5.6 Graphical user interface

In SATELLAR device equipped with LCD display and keypad, GUI can be used to change settings and access the various applications.

Figure 5.5 Central Unit equipped with LCD display and keypad

5.6.1 Booting screen

This screen is visible while the CU is starting up.

5.6.2 LCD display, information and button menu areas

Figure 5.6 Information and button menu areas

Figure 5.7 Red font indicating a value lower than the defined threshold

The top of the screen is the Information area. The following information is available (From left to right).

- Modem name: Default value is “SATELLAR”. It can be changed in Modem Settings, General category (see chapter 7.1.2).
- Current date and time, if enabled (see chapter 7.1.6)
- RSSI value: The signal level of the last received message. If no message has been received in the last 5 seconds, the value is set to -128. If the reading is lower than the defined minimum threshold value, this value is shown with red font. The threshold can be set in Modems Settings, General category (see chapter 7.1.2).
- Voltage reading. A numeric value or a voltage bar depending on the setting in Modem Settings, General category (see chapter 7.1.2).

On the bottom of the screen is the button menu area operated by software defined keypad buttons. The left (round) button command is displayed on the left bottom corner of the screen and the right (square) button command on the bottom right corner of the screen.

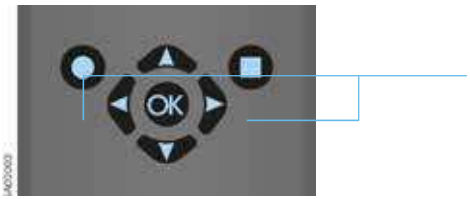


Figure 5.8 Software defined buttons on keypad

5.6.3 Main menu

Figure 5.9 Main menu view

This menu screen contains icons which can be used to start the different applications.

- Modem Settings: See chapter 7.1
- Modem Info: See chapter 7.2
- Routing: See chapter 7.3
- Diagnostics: See chapter 8.1
- Admin Tools: See chapter 8.8
- Remote settings: See chapter 8.4
- Firmware updater: See chapter 8.3

To start an application, use the cursor keys to select the icon and press the round button or OK button.

5.6.4 Status screen

Figure 5.10 Status screen view

If “Lock Screen” command is given in main menu, or the defined time passes without keyboard input, the screen goes to the status/lock screen mode.

In this screen some basic status values are displayed.

- RX Frequency
- TX Frequency
- RF Output Power
- Tun0 IP Address
- Eth0 IP Address
- Forward Error Correction (FEC) mode (with FSK-product)

No input is allowed in this screen, except to unlock the screen. To do this, follow the instruction on screen. If PIN code has been enabled, the correct code must be entered to unlock.

5.6.5 Screen save mode

After a timeout set in Modem Settings, General category (see chapter 7.1.2), the display is turned off. When any button is pressed, the Status screen is displayed and the UI can be unlocked as normal.

5.7 WWW User interface

This interface can be used with a web browser application, such as Mozilla Firefox. The URL to access the WWW -page is *http://<modem's IP address>*. By default this is *http://192.168.1.1.* If the current IP address is unknown, it can be forced to 192.168.1.1 by using the function button as explained in chapter 5.5, or using the Graphical user interface, if present. The WWW interface can also be used across the radio link, once routes have been set (see chapter 6). In this case either of the IP addresses defined can be used (both the eth0 and tun0 addresses work).

5.7.1 Login

The first screen of the WWW interface is the login screen. The user name is *satellar* and the default password is *Satel123*. (The password can be changed in settings, see chapter 7.1.2)

You can also log in using the name *admin* and default password is *Satel456*. In this case an additional application called Administration is available, see chapter 8.8.

5.7.2 Main menu

The main menu lists all the "applications" available in the WWW interface. An additional Administration tab is available when logged in with user name *admin* as explained in chapter 5.7.1.

5.7.3 Status area

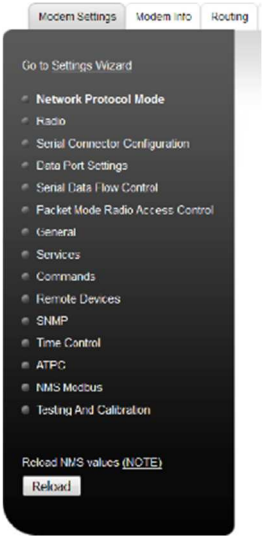
The area immediately below the main menu shows the name of the radio station (settable in the General Settings category, see chapter 7.1.2). Current status information is also available:

- Voltage
- Received signal strength (RSSI)
- Current system time

More status information may be visible depending on the firmware versions installed.

5.7.4 Categories list

Once a Main menu application (see chapter 5.7.2) is selected, the categories related to that application are listed in the dark grey area on the left. The category labels can be clicked to open the category page, which contain settings and information related to that category. More details about categories can be found beginning from chapter 7.



There is also one button in the category area: Reload NMS values. It can be used to force a reload of settings from the RU and CU settings databases to be displayed on the WWW User Interface.

Loading operation takes several minutes, so it should only be used if some of the settings seems to be incorrectly displayed.

5.7.5 Category page

This area to the right of Categories list shows the contents of the currently selected category. It contains settings or other information.

FSK-model

QAM-model

5.7.6 Changing settings

When changing settings in the WWW interface, select first the correct application and category, then change the desired settings found on the category page. Finally click the Apply Changes button.

Some settings are text or numbers which can be changed by typing, while others are drop down lists, allowing you to select from a few choices. Any changes you make are lost if you change the category or application without clicking the Apply Changes -button.

When the Apply Changes button is clicked, all changes on the current page are added to the list of uncommitted changes. You can then navigate to another page and Apply more changes, which are also added to the list. When you have finished making changes, store and take the new settings into use by clicking the Commit Changes button. You can also discard all applied changes by clicking the Cancel applied changes

button. In this case all settings are removed from the list of uncommitted changes and all settings of all units remain as they were.

When Commit Changes is clicked, the CU will store settings into the settings database and the Radio Unit, and restart all necessary Linux processes. Therefore the committing process may take a relatively long time, sometimes up to a minute.

NOTE: If the IP Address has been changed, the browser will be automatically redirected to the new address, but in case the network address part of the IP address has changed, you'll need to modify your computer's IP settings so that it is again in the same LAN as the modem to be able to continue using the WWW interface.

5.8 SATEL NMS

SATEL NMS is a Network Management System. Devices that support SATEL NMS can be configured and monitored using external software provided by SATEL. One such program is SATEL NETCO Design stack. Configuration and monitoring can be performed either locally using a cable, or remotely via a radio link. Other option is NETCO, WEB-based tool that can be used for configuration either locally using a USB or Ethernet cable, or remotely via a radio link.

The SATELLAR Central Unit supports SATEL NMS, and provides the following features.
Connection options:

- Connect via TCP/IP Port 55555
- Connect via USB Device port when the USB port is in Virtual Serial port mode. (See chapters 5.2 and 7.1.2 for details)
- Remote connection via radio network is available when the routing settings are correctly defined.

Most settings available via the User Interfaces of the CU are also accessible using SATEL NMS. For this purpose, the NMSID (Network Management System Identifier) as well as Sub-Unit number of each setting is listed in this manual, see chapter 7. The NMSIDs are also used by the NMS Import application (see chapter 8.5).

Note that the NMS Address of the CU is the same as the RMAC Address of the attached Radio Unit. See the Radio Unit user manual for details.

5.9 SSH

SATELLAR's Linux command line can be accessed using the SSH protocol. To do this you need a SSH client, such as putty.exe. The user name is *satellar* and the password is *Satel123*.

6. Data transmission

The CU is used to transfer data over the IP protocol. Multiple IP protocols are supported, such as TCP/IP, UDP and ICMP. A prerequisite for wireless IP transmission is that the RU is configured to packet routing protocol mode as explained in the RU user manual.

6.1 Internet protocol

Each CU has an IP address belonging to the Local Area Network (LAN) to which they are connected via their Ethernet interface. Each CU also has another IP address belonging to a second LAN, the SATELLAR RU LAN. This LAN is formed by the radio protocol. These two interfaces are called eth0 and tun0 according to stand- ard Linux naming conventions. The CU acts as an IP router device, routing IP packets between its Ethernet interface (eth0) and the radio network provided by SATELLAR RUs (tun0).

6.1.1 Example

In the Figure 6.1 shown on the next page is presented a network which has three (3) data terminal equipment devices (DTEs) connected to CU through Ethernet. Each CU is connected to a RU, together forming a SATELLAR XT 5RC Radio Station (in this case RU type is: 1 W, with display and keypad). In addition there are two standalone RUs acting as repeater stations. Each of the stations has a unique station address (RMAC) which is a number freely selectable in the range of 1 … 4094. The station addresses are used at the radio protocol level when sending messages through the radio path. (The radio protocol is explained in the RU user manual.)

Each DTE belongs to a LAN on the eth0 interface of a SATELLAR. To be able to communicate with each other, IP routing must be correctly configured in each DTE and each SATELLAR.

How the station addresses are used for routing the data through the radio path, is explained in the RU user manual. This is called Packet Routing. For the network topology seen on Figure 6.1 the Packet Routes routing table looks like the following:

Radio unit	Next hop (neighbor)	Addresses behind (remotes)
A	2	3, 4, 5
B	3	1, 2, 5
C	3	1, 2, 4
D	1	-
	3	4, 5
E	2	1
	4	-
	5	-

Table 6.1 Packet Routes routing table for Figure 6.1

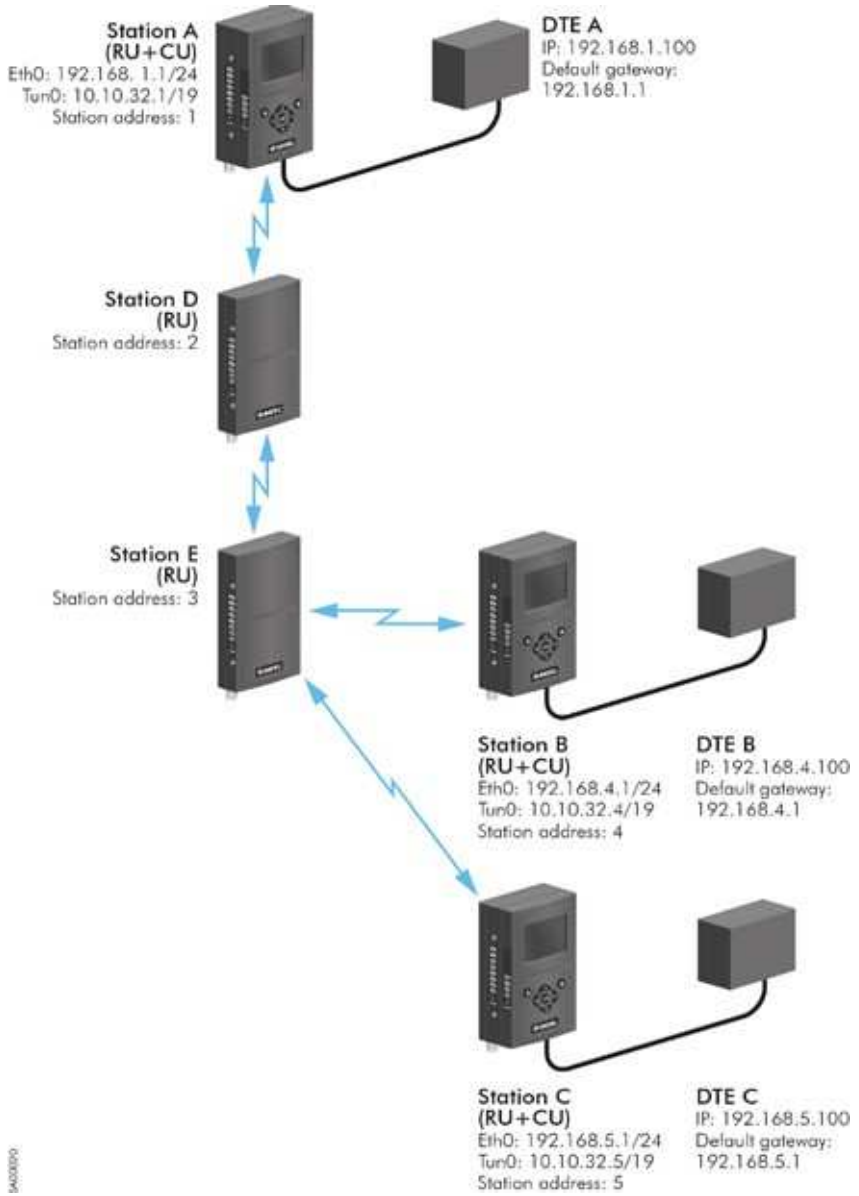


Figure 6.1 Routing example

6.1.2 Forming the tun0 IP address

Whenever the station address (RMAC) of a SATELLAR is changed, the IP address for the tun0 interface is automatically determined: If the station address is X, the tun0 IP address is set to 10.10.32.X, netmask 19.

In case the station address (X) is larger than 254, the tun0 address is of the form 10.10.A.B, where A = 32 + (X / 254), rounded down and B = 1 + (X % 254) [% being the modulus operator]. For example, RMAC 500 translates to tun0 address 10.10.33.247.

In case a subnet with network address 10.10.32.0/19 is already in use in a system, a SATELLAR radio network can be configured to use another tun0 network Base Address. To do this, use the Admin Settings application (see chapter 8.8.2). All modems MUST use the same tun0 Base Address.

6.1.3 Choosing the eth0 IP address

The picture examples in this chapter are made by utilizing the Routing –mode of the radio router. To set the radio router into same subnet with connected devices, see chapter 6.2 for Proxy ARP –mode (recommended mode for radio routers in the same subnet) or Bridge –mode details from chapter 7.10.

Eth0 IP addresses must be selected according to two rules.

- The IP address is not used by another device in the LAN.
- The CU and the corresponding DTE must belong to the same subnet.

Additionally

- The default gateway for the DTE should be the corresponding CU, unless there is another gateway present in the LAN. In this case the routing tables of the gateway must be modified accordingly.

The rules can be clarified with the help of Figure 6.1: Routing example.

The station A has

- Station address (RMAC) 1 à tun0 address is 10.10.32.1
- Eth0 address 192.168.1.1/24 (i.e. subnet mask is 255.255.255.0)
- Therefore DTE A must have an address 192.168.1.X, e.g. 192.168.1.100 and its default gateway must be 192.168.1.1

The station B has

- Station address (RMAC) 4 à tun0 address is 10.10.32.4
- Eth0 address must be chosen so that it belongs to a subnet different from station A, e.g. 192.168.4.1/24
- Therefore DTE B must have an address 192.168.4.X, e.g. 192.168.4.100 and its default gateway must be 192.168.4.1

The station C has

- Station address (RMAC) 5 à tun0 address is 10.10.32.5
- Eth0 address must be chosen so that it belongs to a subnet different from stations A and B, e.g. 192.168.5.1/24
- Therefore DTE C must have an address 192.168.5.X, e.g. 192.168.5.100 and its default gateway must be 192.168.5.1

Stations D and E act only as repeaters without a CU and therefore no local Ethernet connection. So they have no IP addresses – just station addresses.

6.1.4 Setting IP routes

After all the addresses have been set it is still required to define IP routes for each of the CU. Routing data must include the address and net mask of each of the destination subnets (LANs) that need to be reached and the gateway it can be reached through. The gateway address is the tun0 address of the target CU.

For the network in the Figure 6.1 the IP routing tables of each CU equipped station are:

Station	Destination/net mask	Gateway
A	192.168.4.0/24	10.10.32.4
	192.168.5.0/24	10.10.32.5
B	192.168.1.0/24	10.10.32.1
	192.168.5.0/24	10.10.32.5
C	192.168.1.0/24	10.10.32.1
	192.168.4.0/24	10.10.32.4

Table 6.2 IP routing tables for each CU in Figure 6.1

The usage of different addresses and routing tables can be clarified by an example where DTE A wants to send a message to DTE B.

1. The destination IP address, 192.168.4.100, belongs to a subnet different from the source address, 192.168.1.100. The message is therefore routed to the default gateway of DTE A, i.e. to CU of station A.
2. CU of station A recognizes that the destination address belongs to sub network 192.168.4.0 which is reachable through gateway 10.10.32.4. The message is therefore forwarded to tun0 interface which translates the gateway address to the RMAC address, 4 in this case.
3. At this point the packet routing protocol of the RU enters the picture: it reads the destination RMAC address and consults the packet routing table to find out that a message to address 4 must be sent to address 2. (Address of station D).
4. Station A's RU now reserves the radio path using the CSMA/CA algorithm to send the data to station D.
5. Station D receives the data and recognizes that the final destination address is 4. Station D consults its packet routing table and sees that the message to address 4 must be sent to address 3 (station E) and then reserves the radio path to send the message.
6. Station E receives the message and then forwards it to station B (as above) which is the final destination station.
7. The packet routing protocol in station B recognizes that the received data is intended for this station and therefore forwards the data to the CU/tun0 interface.
8. The IP router software component of the CU of station B recognizes that the destination IP address differs from its own IP address but belongs to the same sub network. Therefore it forwards the message to eth0 interface and then the message finally reaches the destination, i.e. DTE B.

6.2 Proxy Arp

Proxy ARP option enables SATELLAR to act as a "Pseudo-bridge" or a hidden router. When this option is enabled, SATELLAR responses with its own MAC address to all ARP (Address Resolution Protocol) requests addressed to a remote network. This causes the other hosts in the same local network to send their packets to the SATELLAR, which then routes those packets according to its configured IP Routes. This behavior makes it look like the hosts on each side of the bridge belong to the same physical network segment (Default=OFF).

7. Settings

The CU has several settings, which affect the operation of the IP routing and other things. The CU can also be used to change the settings of the RU as well as any other units present. There are several interfaces to use when viewing info and changing settings (see chapter 5.6)

The settings are grouped into categories used in the LCD and WWW GUIs. Each setting is also listed with the sub-unit number and NMSID for use with NMS Protocol and NMS Import features. See chapter 5.8 for information about NMSIDs and chapter 8.5 for information about NMS Import.

NOTE: See the settings selection quide at the end of the manual.

7.1 Modem Settings

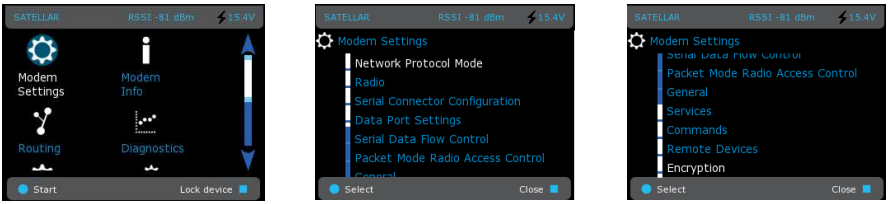


Figure 7.1 Modem Settings by CU: Graphical user interface (GUI/LCD)

7.1.1 Radio Unit Settings categories

For explanation of categories Network Protocol Mode, Radio, Serial Connector Configuration, Data Port Settings, Serial Data Flow Control and Packet Mode Radio Access Control, see the RU user manual chapter 7, subchapters 7.1 through 7.3 respectively.

7.1.2 General

These are general and miscellaneous settings of the radio station and CU.

Attribute	Explanation	Sub unit	NMSID
Name	Name of the radio station. This is freely selectable by the user, up to a maximum length of 32 characters. The name can be used to identify the radio station. It is shown in the WWW interface and GUI/LCD screen, for example.	0	1.769
PIN Code	Code to unlock the GUI/LCD Screen of the C (if present).	1	1.3200

Attribute	Explanation	Sub unit	NMSID
Temperature unit	Fahrenheit, Kelvin or Celsius. Used by the Diagnostics graph for modem temperature.	1	1.3201
UI Voltage Critical Level	When the Voltage reading drops to this level, it is displayed in red in the GUI/LCD and WWW interfaces.	1	1.3202
UI RSSI Critical Level	When RSSI drops to this level it is displayed in red.	1	1.3203
UI Voltage Display mode	Select the way to display voltage in the GUI/LCD: either numeric or as a bar	1	1.3204
UI Voltage Bar Min	If display mode is set to Bar, this Voltage level corresponds to the minimum level of the voltage indicator, i.e. no bars. Value is also used as a minimum threshold for SNMP Voltage. See chapter 8.2 for more details.	1	1.3205
UI Voltage Bar Max	If display mode is Bar, this Voltage level corresponds to Maximum bars	1	1.3206
PIN Code Required	If set to Yes, user must enter PIN code to unlock the GUI/LCD and keyboard.	1	1.3224
USB Device Mode	Choose how the CU will act when connected to a PC: Mass memory or Serial port. See also chapter 7.3.	1	1.3225
Display Brightness	A value from 0 to 255, this setting controls the brightness of the LCD screen's backlight.	1	1.3258
Web GUI Password	Set the password of user "satellar". This affects the WWW password and linux command line login password for this user. The password is case-sensitive. Default password is "Satel123".	1	1.3259
GUI Color profile	Choose a color profile for the GUI/LCD. Default is "Black"	1	1.3261
LCD Timeout	The time in seconds without keys pressed before the LCD (if present) of the CU is powered off.	1	1.3275

Table 7.1 Modem settings, General

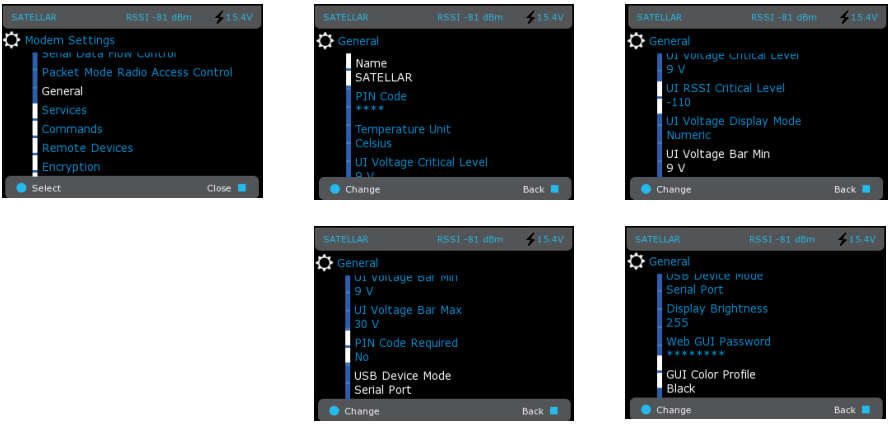


Figure 7.2 Modem Settings, General by CU: Graphical user interface (GUI/LCD)

7.1.3 Services

This category can be used to disable unused features of the CU and fine-tune some operational parameters. Usually these settings should not be modified, as some of the settings disable essential services of the device.

Attribute	Explanation	Sub unit	NMSID
SSHD State	Turn the SSH server ON or OFF	1	1.3230
HTTPD State	Turn the Web server ON or OFF. WARNING: If this is turned off, the WWW interface becomes unavailable. It can be turned back on using the GUI/ LCD (if present) or SATEL NMS protocol.	1	1.3231
NMSBluetoothd State	Turn ON or OFF the possibility of giving SATEL NMS commands to the device using a wireless Bluetooth serial connection. A supported USB Bluetooth dongle must be connected to the CU. (List of supported devices available separately)	1	1.3232
NMSTcpsocketd State	Turn ON or OFF the possibility of using SATEL NMS commands over a TCP/IP connection to the device. The default TCP port is 55555.	1	1.3233
NMSLoggerd State	This service is required by the diagnostics features. It monitors diagnostic values and stores them in a database, where they can be viewed using the Diagnostics application. If this service is disabled, the status bar RSSI and Voltage readings are also disabled.	1	1.3234
Linklayer State	This feature is required by IP data transfer. WARNING: IF THIS IS DISABLED, NO IP DATA CAN BE TRANSMITTED TO THE RADIO NETWORK. Diagnostics can still be gathered and settings can still be changed.	1	1.3235
NMSGathererd timeout	Time in milliseconds to wait for NMS messages sent to the RU before giving up. It is usually not necessary to modify this value	1	1.3237
NMSLoggerd Interval	How often the Diagnostic values are updated, in milliseconds.	1	1.3238
NMSLoggerd Timeout	Time in milliseconds to wait for diagnostic NMS messages before giving up. In case a CU is set up to monitor other devices in the network (using the “Modem Settings/Remote Devices” settings category), it may become necessary to increase this value if the network is very large.	1	1.3239
NMSLoggerd Retries	Number of times to retry lost diagnostic NMS messages. This value should be kept low to avoid congestion in heavy traffic situations.	1	1.3240
RU Commslogd State	Set logging of NMS messages between the CU and the RU ON or OFF. The log can be viewed in the “Logs” page of the WWW interface.	1	1.3262
USB Host Control	When USB Host Control is OFF, the USB host port power is turned off and no devices can be connected. When the value is ON, the port works normally.	1	1.3269
UI Power Control	When UI Power Control is ON, the GUI/LCD Screen is turned off after the defined timeout (See Modem Settings/General). When the value is OFF, the screen is always turned off and the device uses less power.	1	1.3274

Table 7.2 Modem settings, Services

Attribute	Explanation	Sub unit	NMSID
SNMPD State	Select SNMPD (SNMP Daemon or agent) ON or OFF	1	1.3266
OSPFD State	Turns ON the OSPFD service. See section 7.8 for more information about OSPFD.	1	1.3349
OSPFD Telnet Port	The configuration port for OSPFD. Port 0 turns the Telnet server OFF	1	1.3350
RT Logger	RT Logger collects certain radio specific information into the log file. The log file is collected first to device and can be seen in RT Logger at Logs sheet. Local log is cleared and restarted in certain time periods defined by Query Interval and Backup Interval. In case a USB drive (stick) is attached to device, the current log is copied to a USB drive to the end of the file named as name_address_date_rtlogger.log. E.g. device SATELLAR5 with RMAC address 2 which is having a log started at first day of January 2018 at 10:00 would have a log file SATELLAR5_ RMAC_0002_2018-01-01_00-10-00_rtlogger.log. Default is OFF	1	1.3355
RT Logger Query Interval	Query Interval is the period of time between two log information queries in seconds. Default is 10 s, scope 1...65535.	1	1.3356
RT Logger Backup Interval	Backup interval defines the amount of query rounds before current log in device is copied to end of current log at USB-Stick, after which current log is cleared and restarted. Default is 30 rounds. Together with 10 seconds query interval it means that backup is done in every 10 s x 30 = 300 seconds i.e. in every 5 minutes. Scope 1..65535.	1	1.3357
Automatic Modulation Monitoring	Automatic modulation monitoring is intended for use when automatic modulation is enabled. It enables gathering of automatic modulation states against the neighbors of device. NOTE: If automatic modulation is not enabled for radio (Modem Settings – Radio – Link Specific Modulation -> Auto), this feature does not provide any useful information and is thus not recommended in such case. Modulation state and changes can be seen from Diagnostics sheet (Local Modulation and Remote Modulation) as well as from Automatic QAM Modulations at Logs sheet. Default is OFF.	1	1.3361
Auto-modulation Monitoring Timer	The time between the queries of current modulation states. Default is 10 seconds, scope 0..3600.		
HTTPD IP Address	Binding IP Address for the Web server	1	1.3400
SSHD IP Address	Binding IP Address for the SSH server	1	1.3401
NMSTcpsocketd IP Address	Binding IP Address for the NMS TCP socket	1	1.3402
OSPFD IP Address	Binding IP Address for OSPFD	1	1.3403

Table 7.2 Modem settings, Services

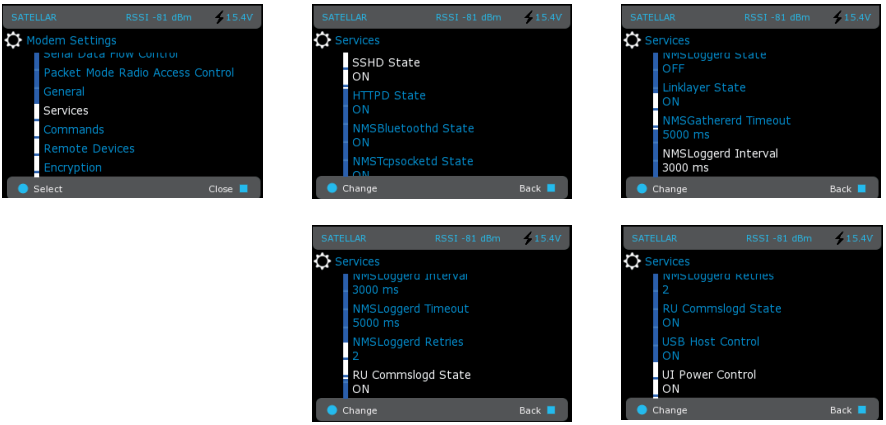


Figure 7.3 Modem Settings, Services by CU: Graphical user interface (GUI/LCD)

7.1.4 Commands

This chapter has commands to reset the unit(s) or restore settings to various states, for example to initialize a device to its original status or reboot device.

Use only one command at the time and do not to save any other settings at the same time.
Also, refresh NMS values after Radio Unit value restore.
To issue a command, select “Reset” or “Reboot”, for example. The command is sent when settings are committed, as detailed in chapter 5.7.6.

Command	Explanation	Sub unit	NMSID
Restore Default Factory Settings Radio Unit	The RU’s settings, including Frequency, Packet routing tables, RMAC etc. are restored to the state they were in when the unit left the factory.	0	1.3085
Restore Default Factory Settings Central Unit	The CU’s settings, including IP, routing etc. are restored to the state they were in when the unit left the factory.	1	1.3085
Reset Radio Unit	Resets the Radio Unit. This command is mostly used by NMS Protocol to discard unsaved changes. It is not usually necessary to use this command when configuring the modem using the WWW or LCD user interfaces.	0	1.3090

Command	Explanation	Sub unit	NMSID
Reset Central Unit	Resets the Central Unit. This command is mostly used by NMS Protocol to discard unsaved changes. It is not usually necessary to use this command when configuring the modem using the WWW or LCD user interfaces. (Note that despite being called the Reset command, the CU is not actually reset. Only unsaved settings are cleared.)	1	1.3090
Reboot Central Unit	Reboot the CU (by resetting the MCU). The reboot lasts approximately one a minute (see technical specification for accurate values)	1	1.3093
Statistical Counters Clear	Clears (resets to zero) all Radio Unit statistical counters. Statistical counters include the variables whose values increase due to some activity. These variables are Bytes to Radio, Bytes from Radio, Transmitted Packet Count and Received Packet Count. Setting of this parameter to value Clear resets those counters to zero. Note that the value is automatically restored back to do not clear after commit. Reset of values can be observed from Modem Info page values (as soon as the counters are updated).	1	1.3109

Table 7.3 Modem settings, Commands

There are also three buttons at the bottom of the WWW interface page: Reboot RU+CU, Reboot CU and Reboot RU. Select the corresponding button to reboot the CU, RU or both. In this case there is no need to select Apply or Commit buttons, but the reboot happens immediately.

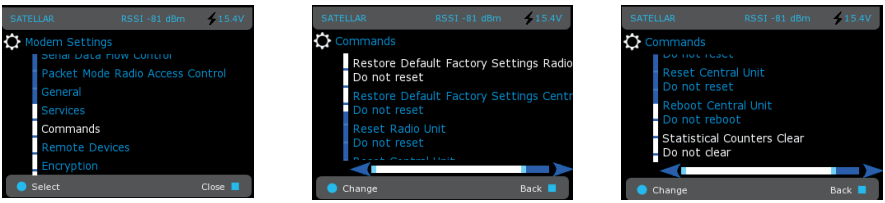


Figure 7.4 Modem Settings, Commands by CU: Graphical user interface (GUI/LCD)

7.1.5 Remote Devices

This controls how the CU diagnostics service (NMSLoggerd) handles remote radio stations. By default, no online remote monitoring is done.

Setting	Explanation	Sub unit	NMSID
Pre-cache All Settings of Device N	(N equals the RMAC address of the radio station). Enable this to have the CU remotely fetch all settings from the remote device. This will cause significant radio traffic. (Not usually recommended)	1	1.3264
Diagnostics Polling of Device N	(N equals the RMAC address of the radio station). Enable this to have the CU monitor the diagnostics values of the remote device. The diagnostics become available in the Diagnostics page. This will cause additional radio traffic which may be significant depending on the size of the network, defined time intervals, timeouts and retries (see chapter 7.1.3) and the number of devices monitored. This setting is not shown, unless at least one Packet Route is defined (see chapter 7.3.1)	1	1.3265

Table 7.4 Modem settings, Remote devices

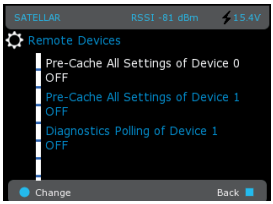


Figure 7.5 Modem Settings, Remote devices by CU: Graphical user interface (GUI/LCD)

7.1.6 SNMP

The usage of SNMP is described in chapter 8.2.

7.1.7 Time Control

Control current date and time, time zone and Network Time Protocol (NTP) settings.
Note that SATELLAR does not have battery-backed real time clock hardware, therefore time is not

accurately preserved during power off and reboot. Using an external NTP server can help mitigate this.

Time is used mainly for logging purposes and accurate real-time is not essential for the operation of SATELLAR.

Setting	Explanation	Sub unit	NMSID
Time Operation Mode	*No time operation* – default. Other time settings have no effect.	1	1.3282
	Manual time operation. Time and time zone settings are used, NTP settings are not used.		
	NTP Time. Time setting is not used; instead the NTP protocol is used.		
NTP Server Address	Current time is fetched from the defined NTP Server Address. Only works if Time operation mode is set to NTP time.	1	1.3283
NTP Interval	Time is refreshed from the NTP server after the interval defined in this settings has passed. Default is 100 seconds. Please be aware this setting will consume some radio bandwidth if used in remote SATELLARs, therefore very small values are not recommended.	1	1.3284
Time	Current time given in *"YYYY-MM-DD hh:mm:ss"* format. This setting is only taken into use if *Time operation mode* is set to Manual time operation.	1	1.3285
Time Zone	Select time zone. Used in both NTP time and Manual time modes.	1	1.3286
NTP Request Source IP Address	Source IP address of the NTP requests	1	1.3347

Table 7.5 Modem settings, Time control

NTP time setup can be verified from System Messages at Logs sheet.
Successful connection to NTP server generates the line:
May 26 08:06:03 (none) user.notice ntpclient: 29279 10391.478 55115.0 20.0 1080364372505324.6 1709.0 0

7.1.8 ATPC

This category controls Automatic TX Power Optimization, a feature that allows the SATELLAR to use the minimum power required to get the wanted signal level and thus optimizing power consumption.

A remote SATELLAR is needed for reference. If there are multiple SATELLARs in range, the one that has the weakest radio link should be selected so that when the transmit power is set based on that device, all other devices should get at least as good signal as well.

The criteria for the correct transmit power are based on RSSI floor and RSSI range. Floor is the minimum allowed RSSI value, and Range depicts how much that value is allowed to vary. If RSSI floor is -100dBm and the allowed range 10dBm, then the transmit power is increased if the measured RSSI drops below -100dBm. If the measured RSSI rises above -90dBm, the transmit power is lowered. The power steps depend on the device, and the values are the same as in the menu Modem Settings -> Radio.
The logic of ATPC goes like this:
Every update period, the RSSI seen by the target device is measured

- If the target device cannot be connected to, do nothing. If there is no reply after 5 periods, increase power
- If the measured RSSI is lower than the lower limit for two queries in a row, increase power
- If the measured RSSI is higher than the upper limit for two queries in a row, decrease power
- Otherwise do nothing

Setting	Explanation	Sub unit	NMSID
Automatic TX Power Control	Turns the feature ON or OFF	0	1.2900
Target RMAC Address	The RMAC address of the device used as reference	1	1.2901
Target RSSI Floor	The lowest allowed RSSI value	1	1.2902
Allowed RSSI Range	How much above the RSSI floor is the measured RSSI allowed to rise	1	1.2903
Update Period	How often is the power level checked	1	1.2904

Table 7.6 Modem Settings, ATPC

Example how to use ATPC can be found from manufacturer's web site (Technical Bulletins):
https://www.satel.com/support-and-services/downloads/

7.1.9 NMS Modbus

This category allows the user to configure the NMS Modbus service, so that NMS values can be queried with Modbus protocols (see section 5.8 for more information about NMS).

The SATELLAR works as a Modbus device that can be queried. The slave id can be changed, as well as the used serial port (with Modbus RTU) and the binding IP address and port (with TCP). The NMS values are stored in holding registers, and the only function that Modbus NMS supports is "Read holding Registers". The response will be a standard Modbus reply, or an exception code if the query is invalid.

The available register space are addresses 40001-49999. By default, registers 1-12 and 4097-8191 are allocated to information that needs to be typically queried:

Register mapping.

The registers are holding registers, which are always 4xxxx. So register 1 is 40001 etc.

Register(s)	NMSID	Format	Name	Unit
1	1.111	INT8	RSSI	Radio Unit
2	1.122	UINT8	SNR	Radio Unit
3	1.32	UINT16	Temperature	Radio Unit
4	1.33	UINT16	Voltage	Radio Unit
5-6	1.38	UINT32	Bytes From Radio	Radio Unit
7-8	1.39	UINT32	Bytes To Radio	Radio Unit
9-10	1.120	UINT32	Transmitted Packet Count	Radio Unit
11-12	1.121	UINT32	Received Packet Count	Radio Unit
4097-8191	1.3086	INT8	RSSI from RMAC 1-4095	Radio Unit

In the WWW UI, any other NMSID from either the Central Unit or Radio unit can be allocated to a register that can then be queried. A list of Central Unit NMSIDs can be found in chapter 12, and a list of Radio Unit NMSIDs can be found in chapter 12 of the Radio Unit user guide. You can also get a full list with NMS Import (see section 8.5.1).

To add a new mapping, select “Add Mapping Row”. Type the Modbus register and NMSID pair. Add as many mappings as you want and finally select “Apply Changes”. The information in the table will be filled automatically. To remove a mapping, select the checkbox on the right of the mapping row and select “Delete Selected”.

NMSIDs are divided into 4 categories based on their type, and it affect how they are mapped into the registers:

- 8- and 16-bit NMSIDS are stored as they are into the register
- 32-bit NMSIDs are stored into two consecutive registers. If a 32-bit NMSID is mapped into register N, no NMSIDs can be mapped into register N+1. If the value needs to be read, both Modbus registers N and N+1 must be read, and the data combined in the application
- RMAC-specific RSSI values (NMSID 1.3087 and 1.55) are a special, hard coded case. Registers 4097-8191 are reserved for queries about the RSSI-levels of RMACs 1-4095. So if for example the RSSI of device 17 is required, register 4113 should be read. The register contains the RSSI value.

All other NMSIDs; 64-bit, String, IP Address and all NMSIDs that take more than 32 bits to store will be truncated and stored into two consecutive registers. For example if the name of the device is SATELLAR, and the name is mapped into a register, the two registers would contain SATE. If the name of the device would be S1, the first register would contain S1 and the second register would be empty.

When sending Modbus queries some thought is required for timeouts and latency. The time it takes to generate a reply message depends quite naturally on how many NMSIDs are queried. When connected locally, the average time it takes to generate a reply is about 10ms + 70ms times the number of NMSIDs to be fetched. So if two NMSIDs are queried, the average response time is 150 milliseconds. This delay naturally increases if the queries are sent over a radio network. Also if the CU is experiencing lots of traffic the latency might be higher. This should be taken into account when defining timeouts for queries, all queries will not get responses if they are sent with a too high frequency.

Setting	Explanation	Sub unit	NMSID
NMS Modbus Service	Turns the service ON or OFF	1	1.2800
Slave ID	The Modbus Slave ID of the device, 0-247	1	1.2801
Protocol	Used Modbus protocol: Modbus RTU, Modbus TCP or Modbus RTU over TCP	1	1.2802
TCP Port	Used TCP port (effective when protocol is TCP or RTU over TCP)	1	1.2803
Binding IP Address	Effective when Modbus is TCP or RTU over TCP	1	1.2804
Serial Port	Used serial port, RS or USB (effective when Modbus RTU is used)	1	1.2805
Register Mapping	Array containing Modbus register/NMSID mapping	1	1.2815

Table 7.7 Modem Settings, NMS Modbus

Example of Custom Modbus NMS mapping can be found from manufacturer's web site(Technical Bulletins): https://www.satel.com/support-and-services/downloads/

7.1.10 Testing and Calibration

This category contains settings that help testing and calibrating the network.

Setting	Explanation	Sub unit	NMSID
Carrier Test	Activates the carrier test in the radio unit. When the test is on, the RU will transmit a carrier signal continuously with no actual data included. It can be used to measure how well other devices can receive the transmissions. All devices in range operating on the same frequency will be able to measure the RSSI. When the test is on, the radio interface is reserved, because of the constant transmission.	0	1.3074
Carrier Test Timeout	Specifies the duration for the carrier test on seconds. This value can be modified either before starting the carrier test or during the test. If the value is zero, the carrier test will stay on until turned off.	1	1.3094
Fast RSSI scan	When this parameter is set to TRUE, RSSI value in the GUI will update about once per second. (If set to FALSE, the update frequency of RSSI value in the GUI is once per 30 seconds by default). Fast RSSI scan increases CPU usage. Also, other statistics like Voltage and Temperature will not be collected, if Fast RSSI scan is enabled. It is recommended to enable Fast RSSI scan only when a fast update is required for example for antenna alignment or troubleshooting.	1	1.330

Setting	Explanation	Sub unit	NMSID
RSSI RMAC Address	By default the RSSI displayed in the GUI and the Diagnostics application will show the RSSI measured from the last signal received. If the device is receiving signals from multiple devices, it may be difficult to match the measured RSSI to the correct transmitting neighbor. This parameter can be used to force the RSSI measurement to be done only for the messages received from the specific modem only. Value expected for this parameter is the remote device RMAC. If the value is 4096, the RSSI will be measured from any device. Note that RMAC specific RSSI monitoring does not work with Carrier Test, because the RMAC information is not included to test signal by the transmitting modem.	1	1.331

Table 7.8 Modem Settings, Testing and Calibration

7.1.10.1 Example: Using carrier timeout and fast RSSI

In this example there is one master device with several neighbors. The user wants to know how well each of the neighbors can hear the master, and adjust the antennas of the devices that have poor reception. The carrier test is used.

The carrier test is activated in the master device. Also, because the device cannot be accessed remotely, the timeout is set to two hours. Carrier test will automatically stop and normal operation can continue after 7200 seconds.
The following values are set from the GUI:

- Carrier test: ON
- Carrier test timeout: 7200

When the test is on, the user accesses all the remote modems to verify measured RSSI from the GUI. If a poor RSSI value is found from any of the remote devices, the user proceeds to adjust the antenna. By default, the RSSI on the screen updates about once per each 30 seconds. This may not be sufficient for antenna adjustment purposes. Therefore the user makes the RSSI measurement faster by changing the following setting:

- Fast RSSI scan: ON

Now the RSSI measurement updates about once per second, and the user can see the results of the antenna adjustment in almost real time. After the antenna has been adjusted, the fast RSSI mode should be turned off:

- Fast RSSI scan: OFF

7.2 Modem Info

This application contains information about the radio station. These values cannot be changed.

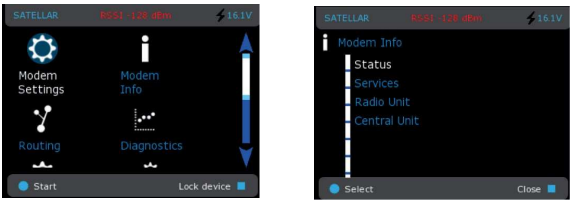


Figure 7.6 Modem Info by CU: Graphical user interface (GUI/LCD)

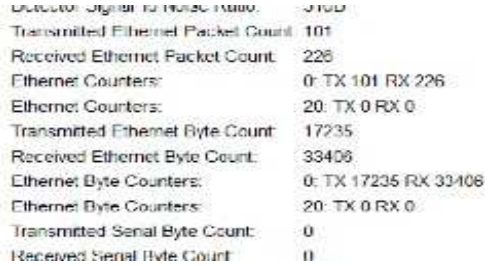
7.2.1 Status

Information about the current general state of the radio station. The values on this page may be refreshed by pressing the F5 Key, or selecting Refresh from a menu, when viewed via the WWW interface on a standard web browser.

Item	Explanation	Sub unit	NMSID
Temperature	Measured inside the RU radio module. See RU user manual for details.	0	1.32
Voltage terminals.	Measured by the RU from the voltage input Precision of the reading is 0.1 Volts, but actual measurement accuracy may vary, see RU user manual for details.	0 0	1.33 1.38
Bytes From Radio	How much data (including NMS messages) has been received by the RU from radio.	0	1.39
Bytes to Radio	How much data (including NMS messages) has been transmitted by the RU to radio.	1	1.45
Watchdog Error Count CU	Number of reboots the CU's Watchdog has performed.		
Last RSSI	Signal strength of the last received radio message.	0	1.111
Alive Timer	Time in seconds the RU has been running since the last reset.	0	1.113
Transmitted Packet Count	Number of Packet Routing packets transmitted by Radio Unit to the radio since last reset of the RU.	0	1.120
Received Packet Count	Number of Packet Routing packets received by Radio Unit from the radio since last reset of the RU.	0	1.121
Detector Signal To Noise Ratio	Signal to Noise Ratio (SNR) measured by the RU from last received data packet, in decibels (dB).	0	1.122

Item	Explanation	Sub unit	NMSID
Ethernet Status	As a result of settings or auto MDI-X negotiation the Ethernet status may change. This item shows the current status. Connected/Not connected, 10 or 100Mb/s, Full or Half duplex.	1	1.3257
Last Boot Reason RU	Reason for the last restart. User command, Watchdog error, Power up etc.	0	9.795
Last Boot Reason CU	Reason for the last restart. User command, Watchdog error, Power up etc.	1	9.795
Temperature Ceiling	Maximum measured temperature since the last reset	0	1.83
Transmitted Ethernet Packet Count	Count of all packets transmitted to Ethernet.	1	1.141
Received Ethernet Packet Count	Count of all packets received from Ethernet.	1	1.142
Ethernet Counters	Count of Ethernet packets per interface. Interface is defined with number i.e. 0 is trunk eth0 and each VLAN is defined by VLAN ID. See picture below.	1	1.143
Transmitted Ethernet Byte Count	Count of all bytes transmitted to Ethernet.	1	1.144
Received Ethernet Byte Count	Count of all bytes received from Ethernet.	1	1.145
Ethernet Byte Counters	Count of Ethernet bytes per interface. Interface is defined with number i.e. 0 is trunk eth0 and each VLAN is defined by VLAN ID. See picture below.	1	1.146
Transmitted Serial Byte Count	Count of all bytes transmitted to serial port.	1	1.147
Received Serial Byte Count	Count of all bytes received from serial port.	1	1.148

Table 7.9 Modem info, Status



View of Ethernet counters having multiple interfaces

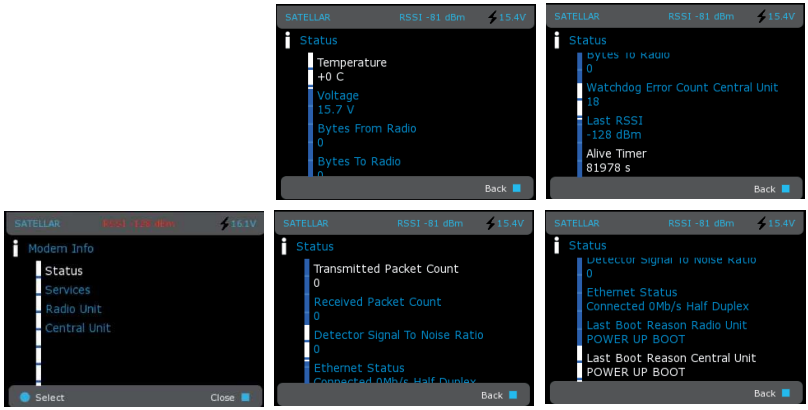


Figure 7.7 Modem info, Status by CU: Graphical user interface (GUI/LCD)

7.2.2 Services

This page shows information on different services running in the CU (see more about the services in chap- ter 7.1.3). In addition to seeing which services are running, it can also be seen which services have been restarted or have caused the device to reboot recently.

7.2.3 Radio Unit

This page shows information about the RU. See the Radio Unit User Guide for details.

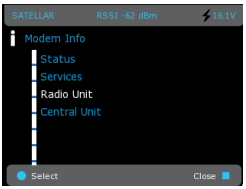


Figure 7.8 Modem info, Radio unit by CU: Graphical user interface (GUI/LCD)

7.2.4 Central Unit

Next page shows information about the CU

Item	Explanation	Sub unit	NMSID
FPGA Watchdog Restarts	Count of restarts the hardware watchdog has performed.	1	1.123
FPGA Total Restarts	Total count of restarts the hardware has performed.	1	1.124

* Exact numbers and names of these items depend on the current HW configuration of the device

Item	Explanation	Sub unit	NMSID
Firmware version	The version of the file system of the CU. This information is needed when updating the firmware using Firmware Updater (see chapter 8.3)	1	1.650
Model	Product model name. Normally this is “Satellar CU”	1	1.772
Ethernet MAC Address	The Media Access Control (MAC) address of the built-in Ethernet interface.	1	1.3210
Kernel version	The version of the Linux kernel of the CU. This information is needed when updating the firmware using Firmware Updater (see chapter 8.3). This is the version of SATELLAR kernel build, not the Linux kernel version it is based on.	1	1.3215
Serial Nbr RW	The serial number of the CU, equal to the one printed on the sticker on the device.	1	9.652
Board 1 *	Hardware information about the PCB.	1	various
Interface board *	Hardware information about the interface board (Ethernet and USB connectors).	1	various

* Exact numbers and names of these items depend on the current HW configuration of the device

Table 7.10 Modem info, Central unit

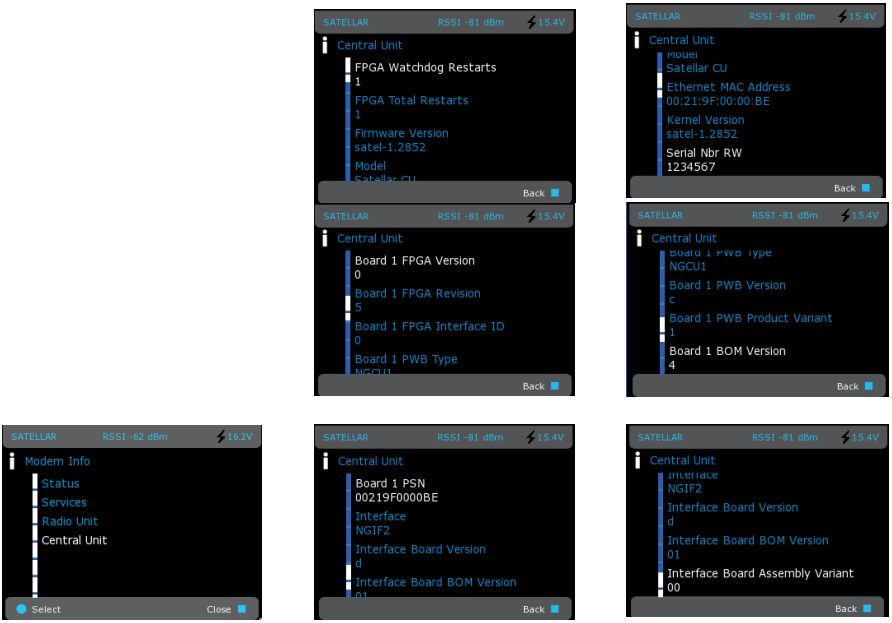


Figure 7.9 Modem info, Central unit by CU: Graphical user interface (GUI/LCD)

7.3 Routing

The routing application allows changing the Packet routing tables, IP settings and routes. This is similar to Modem Settings.

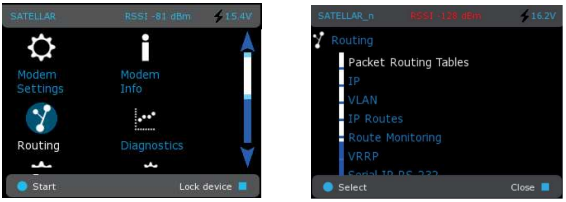


Figure 7.10 Routing by CU: Graphical user interface (GUI/LCD)

7.3.1 Packet Routing Tables

This category controls the packet routing tables of the RU. The interface is a little different on the GUI/ LCD and WWW. In both cases you can:

- Add new packet routes - Delete selected routes - Delete remote stations
- View current routes - Add remote stations to a route from a route

Important terms related to Packet Routing are:
- Neighbor, the RMAC address of a modem behind one radio link
- Remotes, RMAC address of modems behind the specific neighbor

In LCD GUI route management has 4 options: Edit Target, Add Remote RMAC, Delete Target and Add New Neighbor.

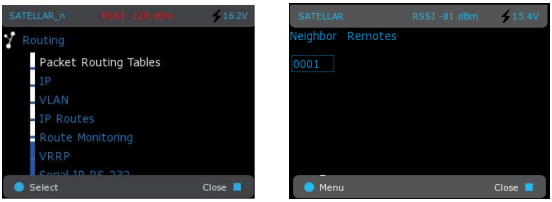
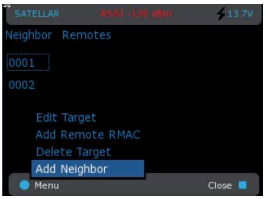
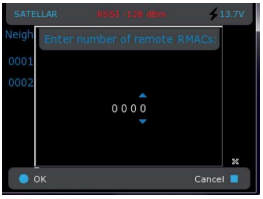


Figure 7.11 Packet routing tables by CU: Graphical user interface (GUI/LCD)

1.



1. Add neighbor



2. Enter number of remotes

3. Enter neighbor RMAC

4. Enter remote RMAC

Figure 7.12 Add new route

It is possible to cancel the procedure at any point and discard the route by selecting Cancel.

Editing of a route is done by highlighting the route that needs to be modified and then selecting Menu -> Edit Target. See the figure “1. Add neighbor”.

Figure 7.13 Edit route

To add a new remote RMAC address to existing route, highlight the neighbor to which the route is added to and then select Menu -> Add Remote RMAC (see figure “1. Add neighbor”). Next, fill in the RMAC address to be added to the route.

Figure 7.14 Set remote RMAC

To delete a route, highlight the neighbor or remote which needs to be deleted and then select Menu -> Delete Target (see Figure “1. Add neighbor”).

Inserted values are pre-validated so in case of invalid input, SATELLAR will show the numbers in red color and proceeding is not allowed until the value is corrected.

Once all needed modifications are done, select Back twice to return to the main menu and you will be prompted to save or discard settings.

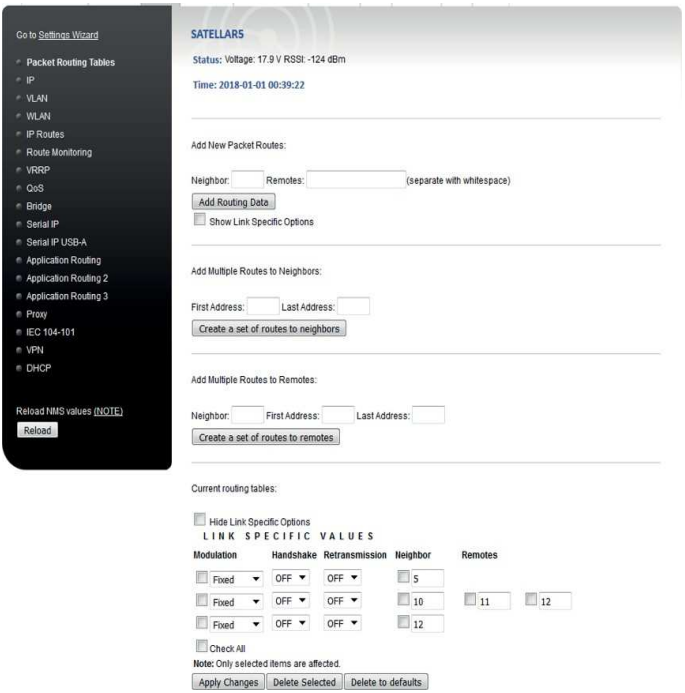


Figure 7.15 Packet routing tables by CU: WWW user interface

With WWW interface, adding new routes is done by entering value for the neighbor RMAC address to Neighbor field and filling in the RMAC addresses of remotes behind this neighbor to the Remotes field. Separate remote RMAC address with whitespace. Apply the defined Packet Route by selecting Add Routing Data. For example, to add a route to neighbor device with RMAC address 2, insert number 2 to Neighbor field and select Add Routing Data button to apply the new packet route.

In case of neighboring modem with RMAC address 3 having modems with RMAC addresses 5 and 6 behind it, add the corresponding route as follows:

- Insert “3” to Neighbor field
- Fill in “6 5” to Remotes field
- Select Add Routing Data to apply changes.

At GUI the same functionality is achieved by:

- Select Add Neighbor
- Setting number of remote RMACs to 2
- Define the neighbor address to 3
- When asked for remote RMAC value, set the remote RMAC number 5
- When asked for next remote RMAC value, set the remote RMAC number 6
- To delete a route, mark the checkbox next to the route entry and select Delete Selected.
- To modify a route, change any of the values on a row and select on the Apply Changes.

In the WWW interface, Packet Routes can also be created automatically. Multiple routes can be configured with one step by defining a range of addresses. For example, setting the First Address to 5 and the Last Address to 10 creates routes to the following neighbors: 5, 6, 7, 8, 9 and 10. The changes are applied by selecting Create a set of routes to neighbors.

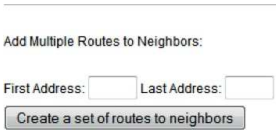


Figure 7.16 Adding multiple routes to neighbors

Multiple remotes can also be added similarly with one step. This is done by setting values to the First Address and Last Address fields. The neighbor that has these addresses behind is defined by setting the correct address to the Neighbor field. The changes are applied by selecting Create a set of routes to
remotes. For example, Packet Routes to remotes 6,7,8,9 and 10 via the neighbor 5, is configured by setting address 5 to Neighbor field, number 6 to First Address and number 10 to Last Address field. Selecting Create a set of routes creates routes to remotes from 6 to 10 via the Neighbor 5.

Figure 7.17 Adding multiple routes to be reachable via one neighbor

Each neighbor packet route link can be specified with a different link specific modulation. If some of the links have better link quality than others, it is possible to define the best possible modulation for those particular links - instead of using one common modulation defined by the weakest link. It is also possible to define a handshake and a retransmission state for each link separately in the same way.

To use link specific values, link specific setting must be set on from either Modem Settings->Radio category (Link specific modulation must be set to Manual) or from Modem Settings->Packet Mode Radio Access Control (Link Specific Handshake and/or Retransmission must be on).

If link specific modulation has been set on but link specific modulation value at packet route is at off-state, then modulation that is used is the common general modulation defined at Modem Settings -> Radio category. Similar to that, the common general handshake and retransmission state are linked to link specific handshake and retransmission state. It should be noticed that the value of link specific modulation should be used so that it is either the same or higher than common general modulation. See RU user manual for more information about link specific modulation.

NOTE:
- It is possible to show link specific options in add section with check box “Show Link Specific Options”
- It is possible to hide link specific options in Current routing tables section with check box “Hide Link Specific Options”
- Link specific options are valid and visible only with QAM-products

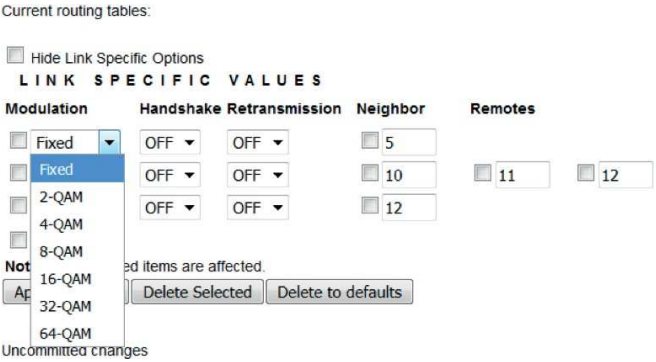


Figure 7.18 Link specific settings

If you have entered an invalid route, SATELLAR will print a red error text and the invalid route is not added. All applied changes are committed and taken into use by selecting Commit Changes button. Applied configurations can be reversed by Cancel applied changes.

See RU user manual for more information about packet routing.

In LCD GUI route management has 4 options: Edit Target, Add Remote RMAC, Delete Target and Add New Neighbor. To add new route:

1. Select Menu -> Add Neighbor
2. Provide the number of remote RMAC addresses for this neighbor. In case adding only neighbor, and no remotes, leave this to zero.
3. Fill in the RMAC address of the neighbor.
4. If number of remotes > 0, then RMAC for each remote is set.

7.3.2 IP

This category contains the Internet Protocol settings.

Setting	Explanation	Sub unit	NMSID
IP Address 0 and 1	One of these is the Tun0 address. This cannot be directly modified. The Eth0 address can be modified.	1	1.3208
Secondary IP Address	List of additional IP addresses	1	1.3328
Ethernet Speed	Auto, 10 Mbps or 100 Mbps. Some Ethernet devices will not work correctly if speed is set to Auto. In this case select the correct speed using this setting.	1	1.3255
Automatic IP State	OFF or ON. Default is OFF. If set to ON, the eth0 address is set to 172.20.X.1/14, where X equals the RMAC address. In this case, the eth0 IP address cannot be modified until Automatic IP State is set to OFF.	1	1.3263
Ethernet Current IP Address	Show the current eth0 address. If the address has been overridden by the function button as detailed in chapter 5.5, this value is 192.168.1.1, even if the setting on this same page has been set to another value.	1	1.3270
Ethernet Current Ethernet mask	As above, shows the actual netmask in use at this time.	1	1.3271
Ethernet Duplex	Settable to FULL or HALF. Some Ethernet devices require this to be set to Half.	1	1.3276
IP Queue Max Time Length	The IP router of the CU buffers the IP packets going to the radio interface. This setting controls how long individual packets are kept in the buffer before being deleted. See below for more information.*	1	1.3280
IP Queue Max Packets	This setting controls the maximum number of packets in the outgoing IP packet buffer.*	1	1.3281
IP MTU Size	MTU=Maximum Transmission Unit. MTU of a communications protocol of a layer is the size (in bytes) of the largest protocol data unit that the layer can pass onwards. The largest number is 1500-byte packet. A larger MTU brings greater efficiency. Large packets increase lag and minimum latency. Corruption of a single bit in a packet requires that the entire packet is retransmitted. Retransmissions of larger packets take longer.	1	1.3317
Proxy ARP	When this option is enabled, SATELLAR responses with its own MAC address to all ARP requests (Address Resolution Protocol) addressed to IP address that actually locates in a remote network. This causes the other hosts in the same local network to send their packets to the SATELLAR, which then routes those packets according to its configured IP Route. Effectively, the Proxy ARP connects to separate physical LAN segments on each side of the radio network to the same IP network. (Default value: OFF).	1	1.3318

Setting	Explanation	Sub unit	NMSID
IP Header Compression	IP Header Compression reduces the size of headers in IP connections. It will reduce latency since the transmitted packets will be smaller. Possible options are off, Van Jacobson and ROHC. Van Jacobson compression algorithm is used to improve TCP/IP performance over slow serial links. It packs the header of 40 bytes to about 3-4 bytes. It must be noticed that Van Jacobson assumes that there is very little packet loss, so the feature should be used only in good-quality point-to-point connections. Lost packets will make the receiver unable to decompress the received packets, causing extra retransmissions. If there are repeaters in the network, or there is noticeable packet loss, Van Jacobson should not be used. ROHC i.e. Robust Header Compression is a method for compressing IP, UDP, TCP and RTP headers in IP packets. ROHC packs 40 bytes or 60 bytes of header typically into only one or three bytes. As ROHC uses a functionality called context which handle compressions per connection. This uses bit more memory than Van Jacobson but can tolerate packet loss much better than Van J. SATELLAR uses O-mode of ROHC.	1	1.3703
USB Ethernet IP Address	IP address of possibly attached USB Ethernet dongle. The address defined here will be set to Ethernet interface (eth1) that is created when dongle is attached. Default is 192.168.10.1/24	1	1.3714
USB Ethernet Secondary IP Address	Possible secondary address(es) of USB Ethernet dongle interface.	1	1.3715
IP Interface Binding	This feature enables bonding or binding of physical Ethernet interfaces. Feature requires USB Ethernet dongle being attached. Feature acts as a redundancy mechanism which uses other interface if another goes somehow out of order or down. Both interfaces are connected to IP interface bond0 which gets the IP interface of eth0 and system acts basically similar to bridge i.e. physical interfaces are not working as IP interfaces but instead as Ethernet ports which of one or the other is being used depending on the case. Default state is OFF. The default master port is native Ethernet port.	1	1.3716

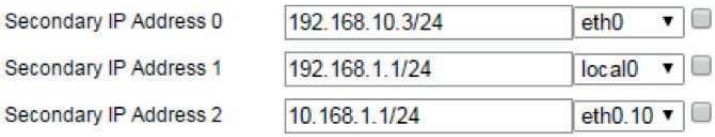
* IP Queue handling: When the radio channel is experiencing heavy traffic, IP packets cannot always be sent immediately. They are placed in a queue waiting for the radio channel to become free. (See RU user manual for more information). Note that the radio queue should not be set to too large values, because the TCP/IP protocol will resend IP packets if it has not received a response in time. Too long IP queue will in this case just cause more duplicate packets to be sent, to no useful effect. Also some real-time or near-real-time applications, typically those using the UDP protocol, require packets to be at most a few seconds old, therefore buffering them for tens of seconds is not useful.

Table 7.11 Routing, Internet protocol settings

Figure 7.19 Routing, IP by CU: Graphical user interface (GUI/LCD)

In the WWW UI, the user can add additional IP addresses to the device by selecting the plus symbol next to the IP address:

New rows will appear on the page. The addresses will consist of two fields: the IP address with mask and the interface:



The interface can be the Ethernet interface (eth0), radio interface (tun0), a virtual interface not connected to any physical connector (local0) or a VLAN interface (eth0.*). VLAN interfaces need to be committed to the device before they appear in the drop-down menu, see more about VLANs in section 7.5.
After the addresses have been set, select Apply changes to store them. To remove an address, check the checkbox next to the address and select Delete Selected.

Addresses cannot be added or removed from the GUI, but existing ones can be viewed and modified.

7.3.3 IP Routes

This category allows adding, modifying and removing IP routes. For examples of typical routes, see chapter 6.1.

Figure 7.20 Routing, IP Routes by CU: Graphical user interface (GUI/LCD)

A short introduction to IP routing

The SATELLAR IP radio network consists of Local Area Networks (LANs) and routers (the SATELLAR CUs). One of the LANs is the radio network, reached through the tun0 interface of each SATELLAR. This LAN is common to all SATELLARs. The other LANs are the Ethernet LANs (reached through the eth0 interface).

A router's defined task is to route IP packets between LANs. To do this, the router needs routing tables which tell it how to reach any other network. Therefore each router must have defined routes to all the LANs.

The task of defining routes is made easier by the concept of default route, also known as default gateway. All IP packets are sent to the default gateway, unless there is a specific route telling otherwise. All IP routes consist of two pieces of information.

- The target network address (including netmask)
- The target gateway address.

Together these two tell the router that an *IP packet belonging to a certain network (i.e. LAN or subnet) must be sent to a certain gateway*. For example a route defined as 192.168.2.0/24 10.10.32.2, tells that all IP packets which have a destination address that falls under the 192.168.2.0/24 network address (for example 192.168.2.7) must be sent to the gateway 10.10.32.2.

Note that there must also be a return route defined in the other end router back to the original LAN. (Sometimes a default route is enough for this). Typically SATELLARs at remote sites will act as the default gateway for the Ethernet LAN they are connected to.

It is also possible to define multiple routes to one network with redundant routing. For more information see chapter 7.6. The rest of this chapter will focus on single routes to a single destination.

Consider the network in the Figure 7.20. There are four Ethernet LANs (1 through 4), connected by SATELLAR radios (R1 through R4). The radios are connected by a fifth LAN, the radio LAN. LAN 1 is also connected to the internet via a gateway (router, ADSL etc.).

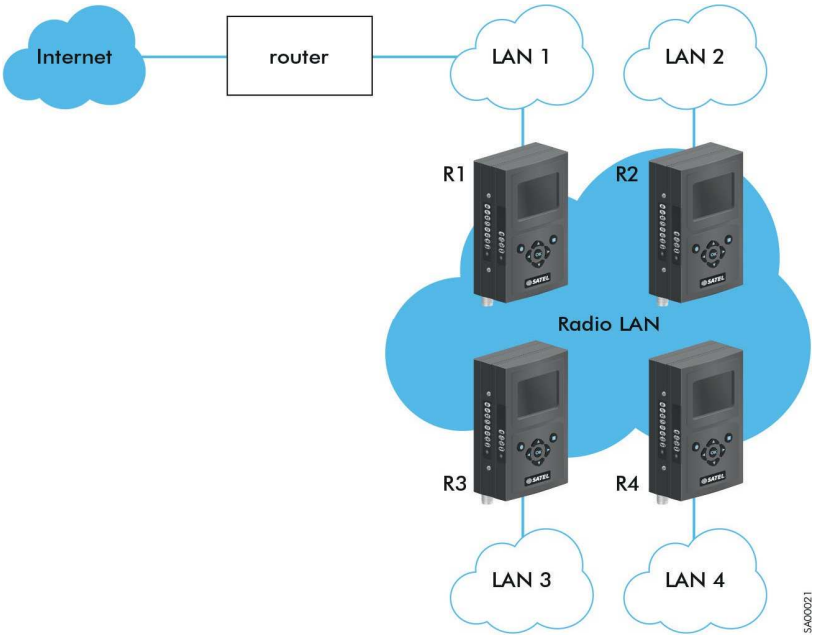


Figure 7.21 IP routing

Before designing the IP routes, we must define the desired connectivity. To keep the amount of routes smaller, we decide that LANs 2, 3 and 4 do not need to have access to each other, because our central station is in LAN 1 and it will receive status messages from sensors connected to the other LANs. The sensors do not need to communicate with each other. LAN 1 must however have access to the internet, so it can be reached from off-site for remote monitoring.

Router	Default gateway	Other routes
router	WAN/internet	LAN 2 via R1
		LAN 3 via R1
		LAN 4 via R1
R1	router	LAN 2 via R2
		LAN 3 via R3
		LAN 4 via R4
R2	R1	none
R3	R1	none
R4	R1	none

(Note that interface routes are omitted for simplicity, as they are automatically added)

Table 7.12 Interface routes, see Figure 7.20

The next step is to decide the actual IP address and netmask for each LAN. You also decide which device will be the default gateway of each LAN.

LAN name	network IP address	Netmask	Default gateway
LAN 1	192.168.1.0	24	router
LAN 2	192.168.2.0	24	R2
LAN 3	192.168.3.0	24	R3
LAN 4	192.168.4.0	24	R4
Radio LAN (Automatic)	10.10.32.0	19	R1

Table 7.13 IP address and net mask, see Figure 7.20

Please remember that the Radio LAN (tun0) addresses of each modem are automatically set based on the RMAC addresses (see chapter 6.1.2). If we assume that each RMAC of radios R1…R4 is the same as their number, we get the following IP addresses for the modems:

Device	RMAC address	tun0 IP address	eth0 IP address (suggestion)
router	-	-	192.168.1.1
R1	1	10.10.32.1	192.168.1.2
R2	2	10.10.32.2	192.168.2.1
R3	3	10.10.32.3	192.168.3.1
R4	4	10.10.32.4	192.168.4.1

Table 7.14 IP address, see Figure 7.20

Now we can define the routing tables with actual addresses:

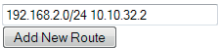
Device	Target network	gateway	notes
router	0.0.0.0/0	<WAN IP address or interface>	Default route is to internet
	192.168.2.0/24	192.168.1.2	LAN 2 via R1
	192.168.3.0/24	192.168.1.2	LAN 3 via R1
	192.168.4.0/24	192.168.1.2	LAN 4 via R1
R1	0.0.0.0/0	192.168.1.1	Default route is via the router to internet
	192.168.2.0/24	10.10.32.2	LAN 2
	192.168.3.0/24	10.10.32.3	LAN 3
	192.168.4.0/24	10.10.32.4	LAN 4
R2	0.0.0.0/0	10.10.32.1	Default route is via the radio network to R1
R3	0.0.0.0/0	10.10.32.1	Default route is via the radio network to R1
R4	0.0.0.0/0	10.10.32.1	Default route is via the radio network to R1
<other devices in the LANs>	0.0.0.0/0	<default gateway of the LAN as defined above>	We omit the details, but in principle each device in LANs 2, 3 and 4 will set the SATELLAR as their default gateway. Devices in LAN 1 use router as their default gateway.

Table 7.15 Routing tables with actual address, see Figure 7.20

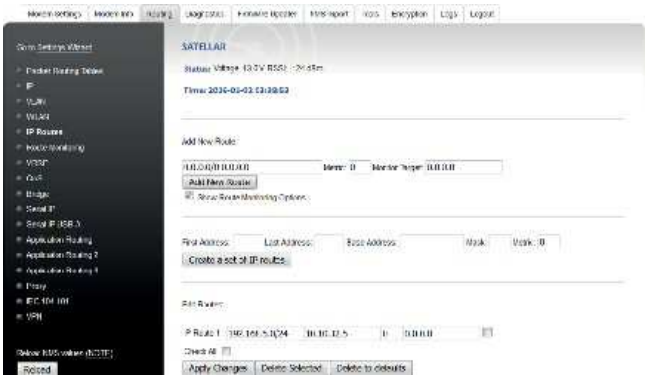
To insert these routing tables to the SATELLAR CUs, use the Routing Application, IP Routes category. Note that you also need to change the routing in your other routers to gain full connectivity. In case of demonstrating and testing, the “router” is usually your PC.

Adding routing tables to SATELLAR

To add a new route with the WWW interface, insert the route in the text area and select Add New Route. For example, to add a route to LAN 192.168.2.0/24 via the radio address 10.10.32.2, insert this:



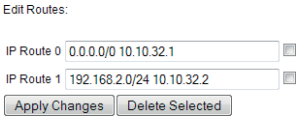
You can also define a Metric for each route for redundant routing. If the checkbox ”Show Route Monitoring Options” is selected, a metric and monitor target can be specified for each route. These are only used
if there are multiple routes to one destination, otherwise they can be ignored. See chapter 7.7 for more information.
In case “Show Route Monitoring Options” is selected, view looks like this:



To add a new route in LCD GUI, select Menu -> Add. Then modify destination Network (upper value) and Gateway (lower value). Changing the editing between upper and lower values, or Network and Gateway, is done with selection in Menu: select either Menu -> Network or Menu -> Gateway. When the route is ready, select Save. Alternatively select Cancel to abandon the route.

Figure 7.22 Add and Save new route

To edit existing routes with WWW interface, use the Edit routes functionality. Select apply to apply changes.



To edit IP routes with GUI: In the IP Routes view, highlight the route to edit and select Menu -> Edit.

Figure 7.23 Edit IP routes

With WWW interface, set of IP Routes can also be created automatically, based on the provided parameters. The parameters are used as follows: the parameter Base address, together with Mask, defines the destination network for the first route. The next hop to this network will be the radio network IP address of the neighboring modem provided to the field First Address. For the next automatically created route, the destination network will be the next available network according to the Mask value.

Figure 7.24 Create a set of IP routes

For example, with the Mask 27, the network size will be 32 addresses. So if the first automatically created route is to network 192.168.0.0/27, the next one will be to 192.168.0.32/27. The next hop for the next route will be the next radio network IP address in sequency. Automatic route creation will be applied further on for the next network and next radio IP address, until the radio network IP address specified in the field Last Address is reached.

Example 1. Setting “Base Address: 192.168.0.0 Mask: 27 First Address: 4 Last Address: 7” creates routes as presented in the following picture.

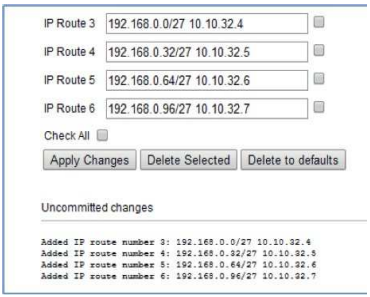


Figure 7.25 Example 1

Example 2: Setting the following “Base Address: 192.168.2.0 Mask: 24 First Address: 2 Last Address: 3” creates routes as presented in the following picture:

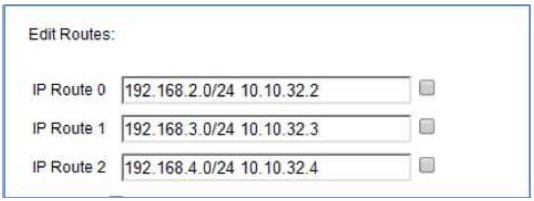


Figure 7.26 Example 2

To delete a route with WWW interface, mark the checkbox and select the Delete Selected button. It is also possible to mark checkbox Check All to select all routes. Deleting all routes at once is not recommended if you have more than 500 routes.

To delete a route with GUI, highlight the correct route and select Menu -> Delete Target.

With the WWW interface, delete to defaults button deletes all routes from device. This is useful especially with large amount of routes. Note that this action does not ask for confirmation, but the routes are removed immediately.

If you have entered an invalid route, SATELLAR will print a red error text and the invalid route is not added. Finally, remember to click on the *Commit Changes* button, or *Cancel* applied changes if you made a mistake.

7.4 Serial IP

Serial IP is a feature where data coming from serial port is converted to IP packets and set to designated IP address. Correspondingly the received IP packets are converted and forwarded to serial interface. Serial IP configuration handling is divided into two sections for two interfaces:

- RS-232 connection in the radio unit (RU) and
- USB-Serial dongle attached to USB-A port of the central unit (CU).

Central Unit handles all the IP related data traffic and the air interface is IP based. Central Unit is needed for stations using the serial IP (CU, router). Central Unit is not required if the station is acting only as a repeater (no terminal connection).

NOTE! IP routing to the destination is not required if the IP data traffic is not entered to the SATELLAR radio modem via RJ45 connector and the sender target address is defined to be TUN0 address (radio address).

- The IP ports are selectable from port 1 to 65535. There are several ports already in use for various applications (NOTE! Application layer), e.g. http 80, https 443, SSH 21 and 22. Typically ports 1024 - 65535 are reserved for general purpose. EXCEPTIONS: Ports 54441, 54442 and 55555 are reserved for SATELLAR use.
- Due to the IP based data transfer, the transmission delays variate. The SCADA system shall be adjusted according to the SATELLAR Serial IP delays.

7.4.1 Serial IP RS-232 / USB-A

This section includes configurations related to both RS-232 and USB-A interface connection / serial IP functionality.

Attribute	Explanation	Sub unit	NMSID
Serial IP Mode	Server – Used in cases where the data transfer is initiated by some remote host. Server cannot open a connection, it can only answer to the request for opening the connection by Client.	1	3287
	Client – Used typically in cases where most of data transfer is initiated by this device. Client sends the request to the Server for the connection to be opened.		
	Send Only - In this mode device is able only to send data to from serial port to defined IP address and port i.e. not able to receive any sending.		
	Receive Only – In this mode device is able to only receive data to defined IP listening port and forward it to serial port.		

Attribute	Explanation	Sub unit	NMSID
	Twoway mode - This mode is meant to be used with TCP. In the other modes TCP can either only originate the connection (Client and Send Only) or listen to incoming connections (Server and Receive Only). In Twoway mode either side can either initiate or listen to connections.		
Port Rate	Rate of serial port – from 1200 to 460800 bps. Default is 19200.	1	3288
Port Data Bits	Serial Port Data Bits - 7 or 8.	1	3289
Port Parity	Serial Port Parity - No Parity, Odd, Even.	1	3290
Port Stop Bits	Serial Port Stop Bits – 1 bit or 2 bits.	1	3291
Protocol	TCP, UDP, Telnet or Bulk Mode. Must be coherent in network.	1	3292
Listening Port	IP Port for listening incoming messages. *	1	3293
Destination Port	IP Port for sending outgoing messages. **	1	3294
Destination IP Address	IP address for sending outgoing messages. **	1	3295
Sender Retry Count	Count for how many times messages are attempted to resent in TCP protocol if send does not succeed. ***	1	3296
Sender Retry Interval	The gap time between resending attempts (in TCP mode) in milliseconds. ***	1	3297
UDP Listener Port Timeout	Timeout for releasing the listener of one connection in UDP mode in seconds. This means that if there is no data received in defined time, connection is closed. New connection can be established at any time again. ****	1	3298
Remote Control Port Mode	Defines whether the RFC 2217 configuration possibility set on or off, default being off.	1	3299
Remote Control Port Rate	Port rate of remote control connection. Default is 115200.	1	3300
Remote Control Port	IP port of configuration.	1	3301
Minimum Packet Characters**	Minimum size of sent IP packets	1	3319
Packet Creation Timeout**	How long to wait for new serial data before creating IP packet	1	3320
Serial Output	Where is the serial output written to: serial port or radio. See section 7.4.3 for more information	1	3327
Local IP Address	This is the address that remote clients will connect to when connecting to this device. It is also the sending address in case of outgoing traffic.	1	3404

* Parameter is effective when message listening is on (Server, Client, Receive Only).
** Parameter is effective when message sending is on (Server, Client, Send Only).
*** Parameter is effective when message sending is on (Server, Client, Send Only) with TCP protocol.
**** Parameter is effective when message listening is on (Server, Client, Receive Only) with UDP protocol.

Table 7.16 The configurations related to both RS-232 and USB-A interface connection / serial IP functionality

NOTE: The connection will be established only by the Client and only to the device acting in Server mode. Once the connection has been established, the data traffic can be both ways. The connection will be kept open as long as the SATELLAR central units are running. The connection is closed by the Client or the connection is opened to another destination by the Client.

Page has also link to check serial connector configuration status e.g. to verify that the serial port is not reserved for NMS usage. Typically Radio Unit Port Assignment should be at state MCU UARTS TO SATBUS WITH CAN.

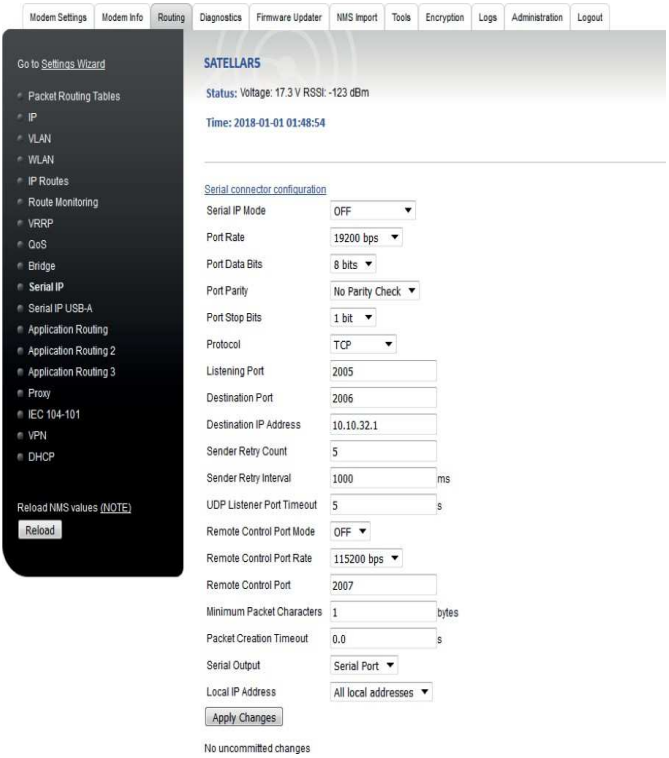


Figure 7.27 Configuration of Serial IP RS-232 via WWW-interface

7.4.2 UDP and TCP protocols

Transmission Control Protocol (TCP) and User Datagram Protocol (UDP) are both based on Internet Protocol (IP) suite. They are used for relaying datagrams - also known as network packets – from the source host to the destination host solely based on the addresses. Packets are structured by Open Systems Interconnection (OSI) model layer principles. OSI model structures packets to different layers and TCP and UDP packets can quite simply be presented with these layers:

- Data link layer: Physical addresses i.e. source and destination MAC addresses
- Internet layer: IPv4 / IPv6 addresses and related header
- Transport Layer: TCP, UDP or similar protocol data (ports etc.) and related header
- Application Layer: Actual user data

Following tables present the structure of data. Data link layer data comes first and in the end there is frame footer. Between the frame data and footer is IP packet data. In IP packet internet layer data is first, then the transport layer i.e. protocol related data and finally actual user data.

Data Link layer

Frame header (8 bytes)	Frame data (14 bytes)	IP + UDP packet (below)	Frame footer i.e. CRC (4 bytes)

IP Packet

bits	0-3	4-7	8-13	14-15	16-18	19-31
0	Version	Internet Header Length	Differentiated Services Code Point	Explicit Congestion Notification	Total Length	
32	Identification				Flags	Fragment Offset
64	Time To Live		Protocol		Header Checksum	
96	Source Address					
128	Destination Address					
160+	Data (UDP Packet)					

UDP Packet

bits	0-7	8 – 15	16 – 23	24 – 31
0	Source Port		Destination Port	
32	Length		Checksum	
64+	Data (actual user data)			

Thus IP + UDP Packet headers are altogether 28 bytes. TCP packet is alike the UDP with some more information in TCP section such as sequence number. TCP header is thus larger (20 bytes) than UDP (8 bytes).

The difference between the protocols is the administration of packets and how the received packets are supposed to be handled. UDP is a not connection based simple transmission model without implicit handshaking dialogues for providing reliability, ordering, or data integrity. Thus, datagrams may arrive out of order, appear duplicated, or go missing without notice. UDP assumes that error checking and correction is either not necessary or performed in the application, avoiding the overhead of such processing at the network interface level. TCP on the other hand is connection based protocol which provides error checking, ordering and general reliability.

Time-sensitive applications often use UDP because dropping packets is preferable to waiting for delayed packets. Also as described above, the size of headers - i.e. packet overhead - is smaller with UDP which may make difference when the size of actual data is always small. Examples of applications using UDP are DHCP, DNS and voice and video applications. On the other hand, if error correction facilities, ordering and general reliability is needed, an application may use the TCP. Examples of using TCP are HTTP, FTP, SMTP and SSH.

7.4.3 Ethernet to serial converter

It is also possible to use Serial IP as an Ethernet/Serial converter with the Radio Unit in either Basic or Source Routing mode. In that configuration, all data received by the TCP/UDP server configured with Serial IP will be sent over the radio, and all data received from the radio will be sent as TCP/UDP packets.

To get the converter working, settings in several menus have to be modified:

- Serial IP settings need to be set correctly. NMSID 1.3327 must be set to “Radio”
- Protocol Mode in Modem Settings -> Network Protocol Mode must be something other than Packet Routing
- Radio Unit Port Assignment in Modem Settings -> Serial Connector Configuration must be MCU UARTS TO SATBUS WITH CAN
- The serial port settings in Modem Settings -> Data Port Settings must match the ones set for Serial IP
- Linklayer state must be OFF in Modem Settings -> Services
- CRC shall be set to OFF state in all radio modems (Modem Settings -> Serial Data Flow Control -> CRC)

The WWW UI will display warning messages if some of these settings do not match:

WARNING: When Serial IP is connected to radio, linklayer must be off. Go to Modem Settings -> Services to disable linklayer.
WARNING: When Serial IP is connected to radio, Modem Settings->Network Protocol Mode->Protocol Mode cannot be Packet Routing
WARNING: When Serial IP is connected to radio, serial port settings in Routing->Serial IP and Modem Settings->Data Port Settings must match

7.4.4 Notes

There are some noticeable issues, which are related to serial IP functionality.

7.4.4.1 USB Serial dongle connection

Availability of USB serial connection is informed with different notes. When USB serial dongle is connected, the following text is shown in the screen: USB serial dongle connected.

Figure 7.28 USB serial dingle connected

If not connected, then note about interface being not available is shown.

Figure 7.29 USB serial dongle not connected

Please make sure that Serial IP Mode is OFF when USB serial dongle is not connected.

7.4.4.2 RS-232 port availability

In some occasions RS-232 is reserved and cannot be used for Serial IP functionality. Following text is displayed in such occasions.

7.4.4.3 Disconnecting USB Serial dongle

When disconnecting the USB Serial dongle the Serial IP Mode must to be set OFF. Detaching the dongle when the mode is not OFF sets the device in to a fault state and may even reboot the device.
If the Serial IP Mode is ON, but the dongle is not connected, following warning text is displayed at web UI: USB serial IP mode is on but dongle is not connected!! Please set the mode off.

7.4.4.4 Incompatible parameter combinations

There are some parameter combination cases that can make the connection ends incompatible:

- Different protocols: It must be verified that both connection ends have the same protocol. When one connection end uses TCP and other UDP, connection cannot work.
- Compatible modes: If both ends have either send only or receive only mode on, connection does not work as assumed. On the other hand, when using send only on one end and receive only on other end, it must be verified that send only is in the end intended to send data.
- Ports and addresses: Ports and addresses must match in the setup. I.e. the sending target address and port must match with IP address of listener and the port that is opened for listening.
- CRC shall be set to OFF state in all radio modems (Modem Settings -> Serial Data Flow Control -> CRC)

7.5 Virtual Local Area Network (VLAN)

Virtual LAN (VLAN) is a feature that allows a physical LAN network to be divided into separate networks. All devices connected to same VLAN can communicate with each other as if they were connected to the same physical LAN.

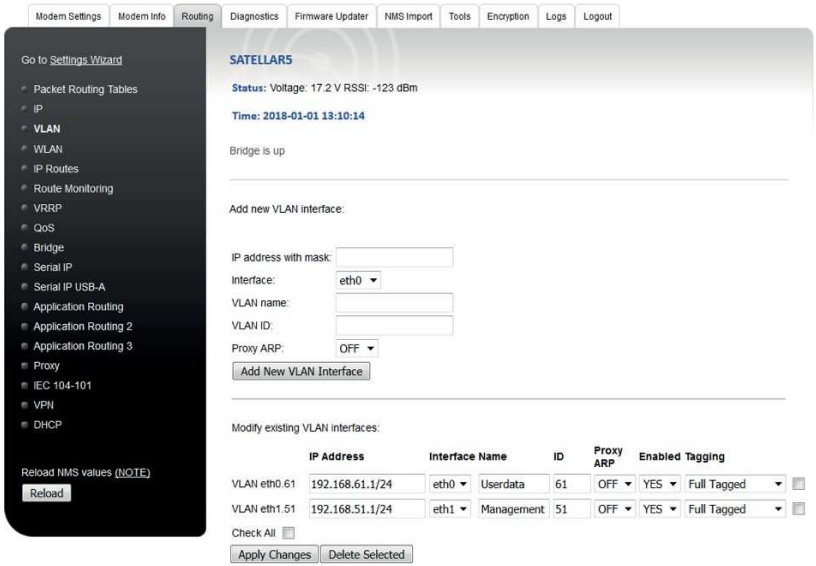
The VLAN operation and functionality is described in the IEEE (Institute of Electrical and Electronics Engineers) standards 802.1q

The SATELLAR supports VLAN in its Ethernet port (eth0). The Ethernet interface accepts those Ethernet frames that have a VLAN tag matching any of the VLAN IDs configured to SATELLAR. SATELLAR removes any VLAN tag from the accepted frames after receiving them and correspondingly adds VLAN tag with a correct ID to the frames sent out from the VLAN interface. The VLAN information is not carried over the radio and cannot be configured to the radio interface.

7.5.1 VLAN settings

The VLAN settings are available under the Routing menu, at the VLAN page. This applies for both, the GUI on the modem display and the WWW user interface. In the VLAN configuration page, VLAN interfaces can be added, modified or removed.

7.5.1.1. WWW user interface



The WWW UI is divided into two sections: add new VLAN interface and modify existing VLAN interfaces. To add a new VLAN interface, fill the empty fields with correct values and then select Add new VLAN. The fields have the following definitions:

To add a new VLAN interface, fill the empty fields with correct values and then select Add new VLAN. The fields have the following definitions:

Name	Explanation
IP address	The IP address and the net mask of the VLAN interface. The IP address should be unique. The address is given in the same format as the eth0 IP address, for example: 192.168.51.1/24
Interface	Master interface for this VLAN, either eth0 or eth1
VLAN name	A descriptive name for VLAN. Must be 1-31 characters long and can contain only alphanumeric symbols. All specified VLANs must have unique names.
VLAN ID	A number from the range 1-4094, identifying the VLAN. Each device connected to the same VLAN network must have the same ID.
Proxy ARP	Enable or Disable Proxy ARP operation for this VLAN interface.
Tagging	The state of tagging related to particular VLAN. NOTE: valid only if bridge mode has been set to some other state than OFF. Full tagged: Messages in both directions (Ethernet and radio interface) are going out as tagged. Untagged radio: Packets from Ethernet are untagged and packets to Ethernet are tagged. Packets from and to radio IP interface are handled as untagged. Untagged Ethernet: Same as previous but vice versa i.e. messages through Ethernet are untagged and radio interface sets VLAN tag to them. It must be noticed that some combinations do not work logically together. E.g. setting one side to Full Tagged and other to Untagged radio does not work. As the tagged message would go over the radio to device having only untagged radio interface, it does not handle tagged VLAN message.

Table 7.17 The configurations related to creating and modifying VLANs

You can add multiple VLANs. When all desired VLANs have been added, select Apply Changes and Commit Changes as when modifying any other parameter. To delete a VLAN, select the checkbox next to it and choose Delete Selected and Commit Changes.
You have the option to disable a VLAN instead of deleting it completely. The last field in every VLAN is Enabled, that can be set to NO. Remember to Apply and Commit changes. Every VLAN will be enabled by default.

7.5.1.2 GUI

Figure 7.30 VLAN configuration screen

The following information is displayed for each VLAN interface: The automatically generated name, the IP address and mask, a descriptive name, the VLAN ID, Proxy ARP status (0 indicates that Proxy ARP is off, 1 indicates that Proxy ARP is on for this interface) and if the interface is enabled or not (1 indicates enabled and 0 disabled).

To add a new VLAN interface, select Menu -> Add, which starts a configuration wizard. The wizard will go through three different editors asking to insert the IP address, VLAN ID, Proxy ARP status and the name of the VLAN interface. Refer to the previous section for more detailed explanation of each parameter. In each stage, after inserting the value, select Next to proceed to next step. After you have set valid values to all fields, the new VLAN interface has been created and it appears in the list.

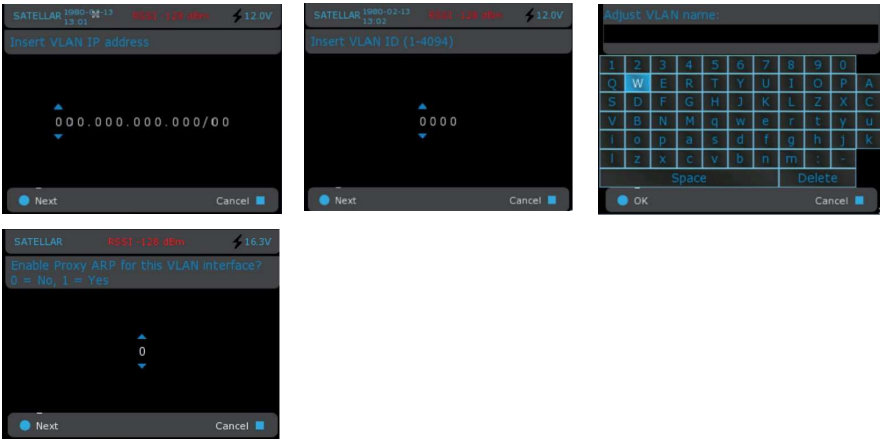


Figure 7.31 Configuring VLAN interface

To edit an existing VLAN interface, navigate to the corresponding interface and select Menu -> Edit. This launches a wizard, which guides you through editing the interface parameters. The wizard is similar to one used when adding a new VLAN interface. To remove a VLAN, navigate to the respective entry to be removed and select Menu - > Delete.

When finished with adding, modifying or removing VLAN interfaces save the settings by pressing the Back button twice to return to the main menu: you will be prompted to save the settings.

7.6 WLAN

WLAN i.e. Wireless Local Area Network – also known as Wi-Fi - is a method for connecting devices using wireless distribution methods. SATELLAR can be used as WLAN device by attaching an USB WLAN adapter (stick) to SATELLAR which then enables the connectivity. SATELLAR acts as a WLAN connection point.

WLAN connection is configurable with parameters available at WLAN view.
Available settings:

Name	Description	Available values	Subunit	NMS ID
SSID	Service Set ID (name) of the WLAN server (network)	Off, On	1	1.3700
WPA-PSK Passphrase	The passphrase for the network	String, SATELLAR	1	1.3701
IP Address	The IP address of SATELLAR in WLAN network. Address with IP Address mask also defines the DHCP scope for WLAN network, see more below.	(192.168.0.248/28)	1	1.3702
Proxy ARP	Enable or Disable Proxy ARP operation for WLAN.	Off, On	1	1.3703

As SATELLAR acts as a network host, there also needs to be some way to define network scope. Defined IP address of SATELLAR with mask defines this. In the example view the address is 192.168.0.242/28.
This means the scope of address 192.168.0.241...192.168.0.254. Now as the SATELLAR is defined to be the address 192.168.0.242, first available address is defined to be 192.168.0.243. Generally, the address of SATELLAR and the scope can be rather freely chosen. If the scope is not clear, one option is to use some of the online subnet calculator sites to have more clarity on this issue.

7.7 Redundant Routing

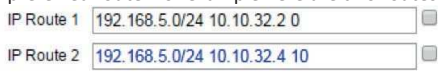
With the SATELLAR it is possible to define multiple routes to one destination, so that if one route fails a secondary route can be used. Redundant routing is required both in the radio interface and Ethernet

interface for the end-to-end connection to be fully redundant. Virtual Router Redundancy Protocol (VRRP) is used for Ethernet redundancy and Route Monitoring for radio redundancy.

This chapter is divided into three sections: Section 7.7.1 describes Route Monitoring and radio redundancy. Section 7.7.2 describes VRRP and Ethernet redundancy. Section 7.7.3 describes how to use the two features together to create redundant networks and contains several examples.

7.7.1 Route monitoring

Route monitoring is used if several IP routes are defined to the same destination (see section 7.3.3 for more information about IP routes). If more than one route is defined to one destination, they must have different metric values. Metric is a parameter describing the cost of the route, so a smaller value means a preferred route. For example here are two routes specified to subnetwork 192.168.5.0/24:



The number seen after the gateway is the metric. The route using gateway 10.10.32.2 has a smaller metric, so it is used by default. The route currently not in use is marked blue in the WWW interface. If the SATELLAR with the address 10.10.32.2 drops off the network, the local device will switch to the alternative route, using the gateway 10.10.32.4.

In those cases, the following warning can also be seen in the WWW UI to inform the user that the primary route is not available:

Also, the following log entry will appear in the Logs -> Service Messages page:

Changing route to 192.168.5.0/24 from 10.10.32.2 to 10.10.32.4

The SATELLAR uses ICMP echo messages to determine is the route usable or not. By default the target of the pings is the gateway. If a monitor target IP address is specified, that will be used to determine if the route works or not. If monitor target is 0.0.0.0, the gateway will be used. The parameters to determine when to switch routes can be seen in table down below:

Item	Explanation	Sub unit	NMSID
Check Interval	How often in seconds a gateway is checked	1	1.2700
Only Check With Traffic	If set to Yes, routes will only be monitored if there is traffic to that network. This will cause less unnecessary traffic in the network, but on the other hand an unusable route will only be detected the next time any traffic is sent. If set to No, routes will be monitored regardless of traffic. This option should not be used if Only Check With Traffic is set to Yes.	1	1.2701
Allowed Fail Count	How many times must a gateway fail to respond before being determined unavailable	1	1.2702
Revert Timer	How often in seconds will a higher priority route be checked to see if it is available again	1	1.2703
Ping Timeout	The allowed timeout for the ICMP query.	1	1.2704
Only Monitor Primary	If set to Yes, only the primary route is monitored. When changed to backup route, the primary route will be monitored based on revert timer, and when it answers again the route will revert to it. The backup route(s) will not be monitored, even if they are in use.	1	1.2705

Table 7.18 Routing, Route monitoring

Every check interval, the local SATELLAR will send a message to the currently used gateway of a network. If the gateway fails to answer more times than the allowed fail count indicates alternative gateways with higher metrics will be pinged. If a working gateway is found, all traffic to the networks will be routed through that gateway.

If the used route is not the primary route, gateways with lower metrics will be contacted regularly. If connection is re-established, traffic is again routed through that device. Revert timer indicates how often routes with lower metrics will be contacted.

Route monitoring quality is a trade-off between time and network traffic. If switching to a secondary route needs to be fast, a lot of extra traffic is generated into the network. Let's say that check interval is 30 seconds and allowed fail count is 3. There are two alternative gateways to one remote network. Then the SATELLAR will notice that a gateway is not working in at most 30 * (3 + 1) = 120 seconds. With those parameters, one monitoring message will be generated every 30 seconds.

If there are multiple remote networks, each with their own alternative gateways, the networks will be checked one at a time every check interval. So if in the previous example there are two remote networks, the SATELLAR will notice that a gateway is not working in at most 30 * (3 + 1) * 2 = 240 seconds. One monitoring message will still be generated every 30 seconds.

7.7.2 VRRP

Virtual Router Redundancy Protocol is a networking protocol that automatically assigns a virtual IP address to one machine in a network. It has been specified in IETF publication RFC 5789 (http://tools.ietf.org/html/rfc5798), VRRP will be described in this section to the extent that is relevant to usage with SATELLAR.

The SATELLAR can use VRRP in its Ethernet interface, either eth0 or any VLAN interface. When multiple SATELLAR devices are in the same Ethernet network, one of them is the master router and the rest of them are backup routers. In addition to its own IP address, the master router has a designated virtual IP address. If the device somehow becomes unusable, if it loses power or radio connectivity for example, the virtual IP address will be assigned to one of the backup routers. Because of this, any other device located in the network can use the virtual IP address as its gateway, and it does not have to know which physical SATELLAR it is using.

The parameters used to control VRRP can be seen in table:

Item	Explanation	Sub unit	NMSID
VRRP State	Is VRRP ON or OFF	1	2710
VRRP Virtual IP Address*	The virtual IP address	1	2711
VRRP Virtual Router ID*	Router ID to identify the router group	1	2712
VRRP Priority	Priority of the SATELLAR. The highest priority device is the master in normal conditions	1	2713
VRRP Advertisement Interval*	How often in seconds is the status of the virtual router checked	1	2714
VRRP Check Target Radio IP	This is an IP address behind the radio interface that the SATELLAR needs to be able to reach in order to be a master	1	2715
VRRP Interface	Which interface is VRRP used with. The Ethernet interface is eth0 and any VLAN interface is eth0.X where X is the VLAN ID	1	2717
VRRP Check Target Local IP	This is an IP address behind the Ethernet interface that the SATELLAR needs to be able to reach in order to be a master	1	2718
VRRP Virtual RMAC Address	Virtual RMAC address stored to the radio unit when in VRRP master state, to make route monitoring in substations unnecessary. See section 7.7.3.5 for more information.	1	2719
RF Link	Sends digital control command to SATEL I-link I/O unit. Can be used for example to control antenna switch between redundant radio units in case of switchover. Functionality requires additional hardware, please contact SATEL for more information.	1	2721

* These parameters must all be the same in one virtual router

Table 7.19 Routing, VRRP

The group of SATELLAR devices in the Ethernet network works as a single virtual router with the virtual IP address as the gateway for every other device. Each device must have the same virtual router ID as well as the advertisement interval.

Each device has a priority, from 2 to 255 (priority 1 is reserved in the SATELLAR for internal use). The active device with the highest priority is the master at any given time. Every advertisement interval the device sends a multicast packet to all other devices in the network.

If a master router fails to send the advertisement packets, the other devices assume that the master has failed and go into an election process to set the device with the largest priority to be the new master. If a device with a higher priority enters the network at some point, it will be elected as the new master.

There are several reasons for the master to fail. The clearest ones are power failure or disconnection from the Ethernet network. In those cases it is clear that the master stops sending advertisements. But there are also other ways it can fail: if it loses connectivity to the radio network or the Ethernet network. For those cases, it is possible to determine check target IP addresses, which will be checked regularly. Rules from route monitoring (see section 7.6.1) will be used to determine when connectivity is lost. By default the IP addresses are 0.0.0.0, in which case no checking is done.

If the device cannot connect to either of the defined IP addresses, it forces itself to be a backup router and signals the rest of the devices in the network to start an election for a new master.

The status of the VRRP can be seen in the WWW interface, one of the following messages is always displayed at the top of the page when VRRP is on:

- INFO: VRRP is in BACKUP state
- INFO: VRRP is in MASTER state
- INFO: VRRP is in BACKUP state, cannot connect to Target Radio IP
- INFO: VRRP is in FAULT state, cannot connect to Target Local IP
- INFO: VRRP is in FAULT state

More information about the VRRP process can be found in the Logs -> System Messages page by searching for entries from process keep alive.

7.7.3 Building a redundant network

7.7.3.1 Example 1: Redundant master station with one substation

This is perhaps the simplest example of a redundant network. Two data terminal equipment (DTE) devices are connected by SATELLARs. DTE A is connected to SATELLARs R1 and R2 via Ethernet; DTE B is connected to SATELLAR R3.

Figure 7.32 Example 1

R1 and R2 have VRRP running. R3 does not have VRRP, but it has two IP routes to DTE A. In this setup, if either R1 or R2 breaks down, traffic will still continue to flow. But if R3 breaks down, traffic will naturally stop.

The devices have the following addresses:

Device	IP Address	RMAC Address
DTE A	192.168.1.100/24	-
R1	192.168.1.1/24	1
R2	192.168.1.2/24	2
R3	192.168.3.1/24	3
DTE B	192.168.3.100/24	-

Both R1 and R2 have radio connectivity to R3. The following VRRP settings will have been changed from their default values:

Setting	R1	R2
VRRP State	On	On
VRRP Virtual IP Address	192.168.1.10/24	192.168.1.10/24
VRRP Virtual Router ID	10	10
VRRP Priority	255	100
VRRP Check Target Radio IP	192.168.3.1	192.168.3.1

R1 has a higher priority, so in normal circumstances it will be the VRRP master and hold the virtual IP address 192.168.1.10/24. Both have defined 192.168.3.1 as the IP address to use, that will determine are radio communications working or not. Other valid IP addresses to use are for example 10.10.32.3 and 192.168.3.100.

DTE A can use the virtual IP address 192.168.1.10 as the gateway to DTE B, it does not need to know which STAELLAR is using the address. DTE B will use 192.168.3.1 as the gateway.

Both R1 and R2 have a normal IP route defined to 192.168.3.0/24 via 10.10.32.3. But R3 will have the following IP routes defined:

- 192.168.1.0/24 via 10.10.32.1, metric 0
- 192.168.1.0/24 via 10.10.32.2, metric 10

So the primary route goes through R1. If something happens to R1, if it is for example powered off or the Ethernet cable is disabled, R2 will become the master and R3 will route all traffic going to DTE A through R2. It uses the default route monitoring parameters, so it will notice if a device is missing in 2-3 minutes. If R1 starts working again, R3 will revert to using R1 again in at most 5 minutes. If R3 stops working traffic will stop, so the network is not fully redundant.

7.7.3.2 Example 1: Redundant master station with multiple substations

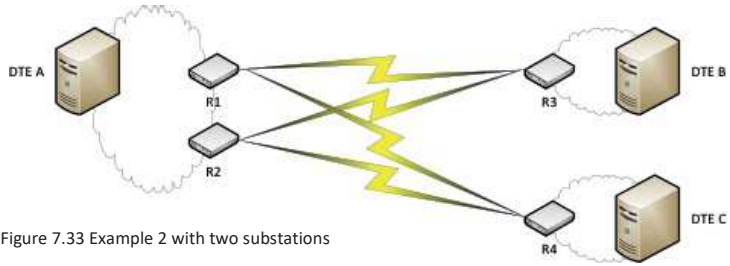


Figure 7.33 Example 2 with two substations

The new devices have the following addresses:

Device	IP Address	RMAC Address
DTE C	192.168.4.100/24	-
R4	192.168.4.1/24	4

This actually changes very little for the other devices. R1 and R2 need to add normal packet and IP routes to R4. The VRRP settings in R1 and R2 can remain unchanged, although there is the option of changing the Check Target Radio IP to that of R4 or DTE C. This will only affect which device will be used to deter- mine if the radio of the VRRP master is working, so generally it is a good idea to select the substation with the best connectivity.

R4 will have the following IP routes defined:

- 192.168.1.0/24 via 10.10.32.1, metric 0
- 192.168.1.0/24 via 10.10.32.2, metric 10

Again, in this setup traffic will continue to flow even if R1 or R2 face some sort of problem.

Using this example, more substations can be added. With every new substation, basically two steps need to be done:

- A route to the new substation needs to be added to R1 and R2
- The new substation needs routes specified to R1 and R2

It should be noted that each new substation adds more extra traffic to the network, since each substation will regularly determine is R1 still usable or not. If the monitoring messages start to hamper the actual traffic in the network, the route monitoring could be made more infrequent. This of course means that the substations will be slower to update the route when needed.

There is also an alternative option: enabling the “Only Check With Traffic” option in Route Monitoring. In those cases the substations will only check the availability of R1 when there is actually any traffic from the substation to 192.168.1.0/24 (this includes replies to messages sent by DTE A, so the substation does not need to generate traffic spontaneously). This will make the network load lighter, but it means that the first time traffic is directed to a substation there will always be a delay before the traffic works.

Note: The device specified to be the Check Target Radio IP for R1 and R2 will always have traffic, because the VRRP master will use it to determine that its radio is working. So in practice the option will have no effect for that substation.

7.7.3.3 Example 3: Two fully redundant routes

In this example there are two alternative routes between DTE A and DTE B.

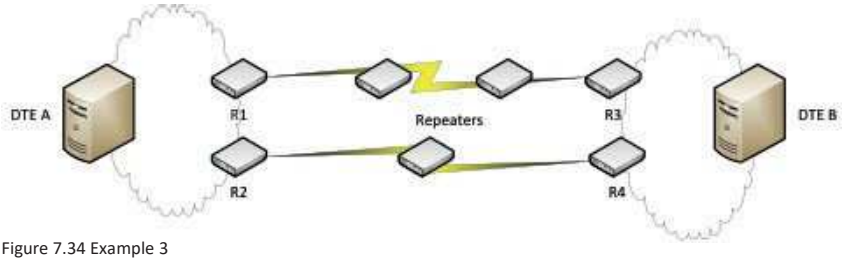


Figure 7.34 Example 3

R1 and R3 will have packet and IP routes defined to each other, as will have R2 and R4. No IP routes with different metric values will be needed. There can be any number of repeaters between either of the two pairs. The two routes should not use common repeaters, because that would cause a single point of failure. The point of this example is to create a network that will work if any one device malfunctions.

The devices have the following addresses:

Device	IP Address	RMAC Address
DTE A	192.168.1.100/24	-
R1	192.168.1.1/24	1
R2	192.168.1.2/24	2
R3	192.168.3.1/24	3
R4	192.168.3.2/24	4
DTE B	192.168.3.100/24	-

All four non-repeater SATELLARs will have VRRP enabled with the following parameters:

Setting	R1	R2	R3	R4
VRRP State	On	On	On	On
VRRP Virtual IP Address	192.168.1.10/24	192.168.1.10/24	192.168.3.10/24	192.168.3.10/24
VRRP Virtual Router ID	10	10	30	30
VRRP Priority	255	100	255	100
VRRP Check Target Radio IP	192.168.3.10	192.168.3.10	192.168.1.10	192.168.1.10

DTE A will have 192.168.1.10 as its gateway and DTE B will have 192.168.3.10. R1 and R3 are the VRRP masters by default.

Now, if R1 or R3 or any repeater between them will stop working, R2 and R4 will become the VRRP masters and traffic will flow through them.

It is possible to add as many networks as one wishes, by adding extra SATELLAR devices.

7.7.3.4 Example 4: Fully redundant network

The problem in Example 3 is that if one device on both routes breaks down, traffic will stop. If the two networks are close enough that they do not require repeaters, it is feasible to build a fully redundant network between DTE A and DTE B.

Figure 7.35 Example 4

The VRRP settings and IP addresses can be used directly from Example 3, but the routing will look significantly different. The packet and IP routes will look like this:

Device	Packet routes	IP route 1	IP route 2
R1	3, 4	192.168.3.0/24 via 10.10.32.3, metric = 0	192.168.3.0/24 via 10.10.32.4, metric = 5
R2	3, 4	192.168.3.0/24 via 10.10.32.3, metric = 0	192.168.3.0/24 via 10.10.32.4, metric = 5
R3	1, 2	192.168.1.0/24 via 10.10.32.1, metric = 0	192.168.1.0/24 via 10.10.32.2, metric = 5
R4	1, 2	192.168.1.0/24 via 10.10.32.1, metric = 0	192.168.1.0/24 via 10.10.32.2, metric = 5

So by default traffic will flow through R1 and R3. But if R1 breaks down, traffic from DTE A to DTE B will be routed through R2 to R3. If R3 then breaks down, traffic will flow through R2 to R4. If R1 then comes back up, traffic will flow through R1 to R4. So as long as there is one possible functional route, it will be used.

Now, it is possible to bring repeaters into this case as well, but it significantly increases the number of devices in the network. Adding only one repeater between DTE A and DTE B would create a single point of failure. Adding a repeater between pairs R1-R3 and R2-R4 would revert the case back to Example 3. So to make this case fully redundant with repeaters would require repeaters between pairs R1-R3, R1-R4, R2-R3 and R2-R4, a total of four repeaters on top of the four devices already in the network.

7.7.3.5 Example 5: Virtual RMAC Address

Virtual RMAC address can be used to change the RMAC address of the modem along with the IP address. Therefore route monitoring is not needed in other devices, making the switchover much faster.

Let's take Example 2 and change it to use Virtual RMAC Address. The setup has a redundant master device and two substations as seen in Figure 7.Y. This time the devices will have the following addresses (the DTE devices will be exactly the same as in Example 2):

Device	IP Address	RMAC Address
R1	192.168.1.1/24	101
R2	192.168.1.2/24	102
R3	192.168.3.1/24	3
R4	192.168.4.1/24	4

R1 and R2 will have exactly the same IP routes and VRRP parameters as in example 2, but with the follow- ing addition:

- Virtual RMAC Address: 1

Both of the substations need only one IP route:

- 192.168.1.0/24 via 10.10.32.1

Route monitoring is not needed, since only the master has tun0 address 10.10.32.1 (RMAC 1) in use. To ensure radio connectivity in all cases, all the substations should have packet routes defined to both the actual RMAC addresses of the master devices, in addition to the virtual RMAC. The packet route tables of the devices would therefore look like this:

Device	PR Neighbors
R1	3, 4
R2	3, 4
R3	1, 101, 102
R4	1, 101, 102

Some restrictions should be kept in mind when configuring a VRMAC address:

- R1 and R2 should not have packet routes to each other
- You should configure and commit all radio settings (RMAC address, PR table etc.) before enabling the VRMAC feature.

7.7.4 Redundancy related SNMP notifications

It is possible to enable sending of notifications for any redundancy related events. Chapter 8.2 presents usage of SNMP in generally and also the functionality of redundancy notification ID at general level. Notifications are sent if this ID has been set to ON and SNMP service is set ON.

Change of the status of VRRP causes different events depending on the case. Simple example is that if backup device notices that master is not present and sets itself as a master, this generates one notification. If the notification has been enabled in both devices, both devices send notification. Route monitoring sends messages simply in case it notices that one device is not responding or that higher priority device responds again. Thus it does not generate several messages for one event.

Both route change and VRRP state change notifications describe the cause of notification and IP of device that has sent it. There are few cases related to these notifications that need to have a clarification.

In case there are radio target IPs defined and master drops to backup since it cannot connect to that device, it generates more notifications. When backup notices that master has changed into backup, it sets itself as a master and then tries to connect to radio target IP (if such has been defined in this device). If the original master is unable to connect to target radio IP since its radio is broken, the new master presumably can connect. But if the remote device has been broken, then either of these two devices cannot connect to it. If notification has been set on at both devices, this case generates 3-4 notifications (master1 is original master and backup1 original backup): master1 to backup2, backup1 to master2, master2 notices that it cannot connect to remote device and sets itself as a backup and then one or the other device sets itself as a master.

In case both VRRP is on and some backup routes are defined, one event may generate several messages. Considering the previously mentioned case where target radio IP device gets broken. Both devices act the same way as in that case but in addition both change to lower priority route which generates one more notification from both. This would mean 6 notifications for this event.

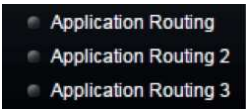
When noticing a bunch of notification in short period (e.g. during one minute) of time, one option is to start from the latest ones since they define the current states of devices. In this case the latest messages are either describing current VRRP states of devices or they are about changing to lower priority route. Nevertheless, these would be the last messages in some order so they would provide the information about current status.

7.8 Application Routing

Application Routing allows the SATELLAR to route packets based on the data itself. When the feature is on, incoming packets will be analyzed and then routed to a specific destination based on the data itself. The following protocols are currently supported:
- DNP3
- Modbus RTU
- Modbus TCP
- Conversion between Modbus RTU and TCP
- NMEA 0183
- IEC101
- Custom protocol
- Sinaut ST1/ST7 FT1.2
- Sinaut ST7 FT2.0

The protocols have some unique features, but the basic logic is the same for all. After choosing the protocol, the transport protocol for the traffic is chosen. TCP and serial port are the supported options. Traffic coming from this source is analyzed and sent forward if a valid target is found.

SATELLAR supports three separate Application Routing instances, seen in the menu as three separate categories:



Each one is independent of each other, and the separate instances cannot use same IP ports or serial ports that another instance is using. Different instances can be used for example when one device needs to route both Modbus RTU and IEC101 traffic.

For the destination, a substation transport protocol must be selected. TCP and UDP are supported, and it is the protocol that usually sends the traffic over the SATELLAR radio network (although there is nothing preventing from selecting IP addresses outside the SATELLAR network). Traffic coming in from the substations is written directly to the main transport protocol (either a serial port or an open TCP connection), without any analysis.

When serial connection is used, serial parameters need to be specified as with Serial IP. Same serial port can- not be used as input in Serial IP and Application Routing. Application routing can also write directly to radio as Serial IP.

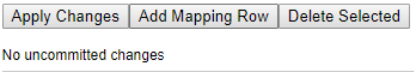
If the TCP connection is used, a listening port needs to be defined. For the substation traffic, two ports need to be defined: destination port and listening port.

The actual routing is based on the destination address used by the protocol. There are three options on how to translate the protocol address to a radio address.

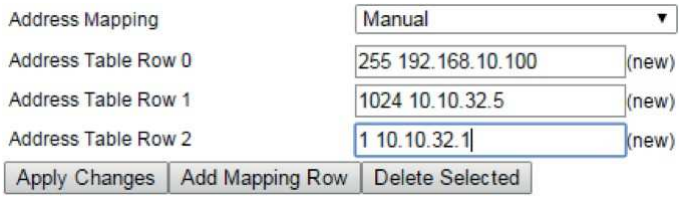
One option is to set Address Mapping to Application Address to RMAC. That means that the destination address will be set directly as the destination RMAC address. So for example if a DNP3 message contains destination address 10, it will be sent to a SATELLAR with RMAC address 10 (IP address 10.10.32.10). So if

possible, the RMAC of each SATELLAR attached to a DTE should have the RMAC address that is same as the protocol address of the DTE it is connected to.

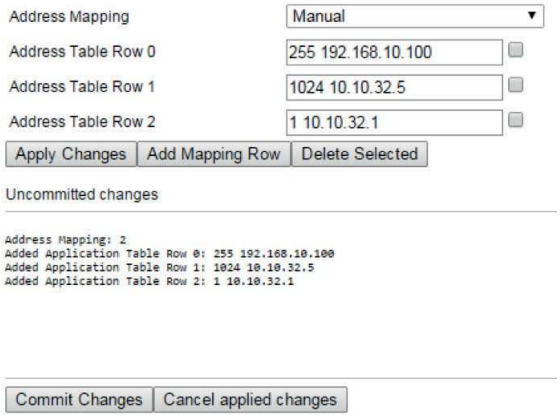
If that setup is not possible, it is also possible to determine the mapping manually by adding address table rows and setting Address Mapping to Manual. Each row contains two elements: first is the protocol address and second is the destination IP address. Rows can be added in the WWW interface with the button Add Mapping Row:



After the rows have been added, each can be edited:



In that example, messages to application address 255 will be routed to 192.168.10.100 etc. After all rows have been edited to be correct, Apply Changes will store the table. Finally selecting Commit Changes will save the table to the device:



To delete a row, select the checkbox next to it and use the button Delete Selected. Commit Changes is required afterwards to finish the removal of the rows.

The third option is point-to-point. In point-to-point, the traffic is written to the first IP address in the map- ping table, regardless of the address. So in other words the traffic contents are not analyzed.

Broadcast messages are supported in Broadcast and Broadcast All –communication modes. When “Point-to-Point” mapping is selected to Address Mapping –selection with the selected protocol (Application Protocol), first row of the Address Table Row defines the sending address for all messages, radio layer broadcast being 10.10.63.255. Thus Address Table Row has to be filled “1 10.10.63.255” for broadcasting the data.

The settings of application routing are seen down below:

Attribute	Explanation	Sub unit	NMSID
Application Protocol	The used protocol of actual data. If the selection is OFF, then no application routing is used.	1	3493
Application Transport Protocol	Origination of data. TCP and Serial Port are supported at the moment.	1	3494
Application Listening Port	If Application Transport Protocol is TCP, this is the listening port	1	3495
Serial Port	If Application Transport Protocol is serial, this variable lets you choose which serial port to use: RS-232 or USB	1	3498
Port Rate	If Application Transport Protocol is serial, this is the rate of the serial port	1	3499
Port Data Bits	If Application Transport Protocol is serial, this sets the serial port data bits	1	3500
Port Parity	If Application Transport Protocol is serial, this sets the serial port parity	1	3501
Port Stop Bits Port Stop Bits	If Application Transport Protocol is serial, this sets the serial port stop bits	1	3502
Transport Protocol For Substation Data	The protocol used to transmit the data to other SATELLAR devices. TCP and UDP are supported	1	3503
Destination Port For Substation Data	Which port will the data be sent to	1	3504
Listening Port For Substation Data	Which port will listen to replies	1	3505
Application Listening IP Address	This is the binding IP address of the device. Incoming packets must be transmitted to this address and outgoing packets will have this as the source address	1	3506
Address Mapping	Select between manual and automatic address mapping and point-to-point mode	1	3507
Custom Address Offset	Address offset used by the custom protocol	1	3508

Custom Address Length	Address length used by the custom protocol and IEC101	1	3509
Maximum Serial Packet Size	If Application Transport Protocol is serial, this value should be set to the longest possible serial packet size. If the maximum packet is less than 255, this value should be left at 255.	1	3510
Address Mapping Row	If manual address mapping is used, this array holds the mapping. New rows can be added in the WWW interface	1	3520

Table 7.20 Application Routing settings

7.8.1 Protocols

7.8.1.1 DNP3

In addition to checking the address of the message, Application Routing checks that the correct starting bytes (0x0564) are used. After detecting that a Modbus message has started, the length byte is read and the whole message is read. This is useful when the data is coming from the serial port, but it is also applied to the IP connection. Therefore multiple DNP3 messages can be contained in one IP packet.

7.8.1.2 Modbus RTU

If Modbus RTU is read from the serial port, the serial port settings are changed so that whole Modbus messages are always read. This is done based on maximum Modbus message length: 255. The message read from the serial port will be seen as whole if it is either 255 bytes long, or a long enough time has passed that the whole message will have been read with the selected serial speed.

The drawback to this method is that the latency of application routing is always as high as it would be with the longest possible Modbus message. This can be optimized with the parameters Minimum Packet Characters and Packet Creation Timeout in the Serial IP menu. So if for example the longest Modbus message in the system is 80 bytes and the serial port speed is 9600, the latency would be smallest with the following parameters:

Minimum Packet Characters: 80
Packet Creation Timeout: (80 bytes·8bits/byte)/(9600 bits/second)=0.07 seconds≈0.1 seconds

If the whole chain is IP, then the serial port settings do not have any effect. In that case, the protocol is in practice Modbus RTU encapsulated over TCP or UDP.

7.8.1.3 Modbus TCP

When Modbus TCP is used, usually Application Routing is needed in one SATELLAR only. The address table should contain the IP addresses of the final destinations, and not the SATELLAR devices connected to them.

The exception is if Modbus TCP/RTU conversion is used. The conversion will taken into use if the selected transport protocol is serial port. So instead of writing the Modbus TCP data directly out of the serial port, it will first be converted into Modbus RTU. Also, if Modbus RTU data is received from the serial port, it will

be written forward as Modbus TCP.

7.8.1.4 NMEA 0183

Fill message are identified with the starting character $ and the ending characters <CR><LF>.

Broadcast NMEA messages are supported in Broadcast and Broadcast All –communication modes. When "Point-to-Point" mapping is selected to Address Mapping –selection with NMEA 0183 –protocol selection, first row of the Address Table Row defines the sending address for all messages, radio layer broadcast being 10.10.63.255. Thus Address Table Row has to be filled "1 10.10.63.255" for broadcasting the data.

7.8.1.5 Custom Protocol

When custom protocol is used, the parameters Custom Address Offset and Custom Address Length become visible. The offset determines which byte contains the address, with 0 meaning the first byte. Address length can be either 8 or 16 bits, determined by the next parameter. See section 7.7.2.4 for an example on creating a custom protocol.

7.8.1.6 IEC101

IEC101 supports two address field lengths: 8 and 16 bits. Depending on which version is being used, the correct one can be chosen with Custom Address Length.

IEC101 messages are identified by a starting byte: 0x10 means a fixed length message and 0x68 a variable length message. In case of a variable length message, the length field will be read as well. The whole message is read, the address is read and the message is routed to its destination.

IEC101 also supports two single character acknowledgement messages: 0xE5 and 0xA2. Since neither of those contain any address information, they will be sent to the last address that sent a message to the device.

7.8.1.7 SINAUT ST1/ST7

Sinaut FT1.2 is almost identical to IEC101 in terms of application routing: It also has starting bytes 0x10 and 0x68, as well as single byte messages 0xE5 and 0xA2. The only difference is, that only 8-bit addresses are supported, and that the address is at a different byte index.

Sinaut FT2.0 has starting bytes 0x27. The protocol requires broadcast messages, which can be executed with QAM modulation variant radios. Maximum Serial Packet Size -setting must be adjusted according to the maximum possible serial data packet size (268).

More information about protocols can be found from manufacturer and manufacturer's web site (Technical Bulletins): https://www.satel.com/support-and-services/downloads/

7.9 OSPF

SATELLAR uses the OSPFv2 daemon from the Quagga Routing Suite to implement OSPF. More information, such as full documentation, can be found on the following web page: http://www.nongnu.org/quagga/

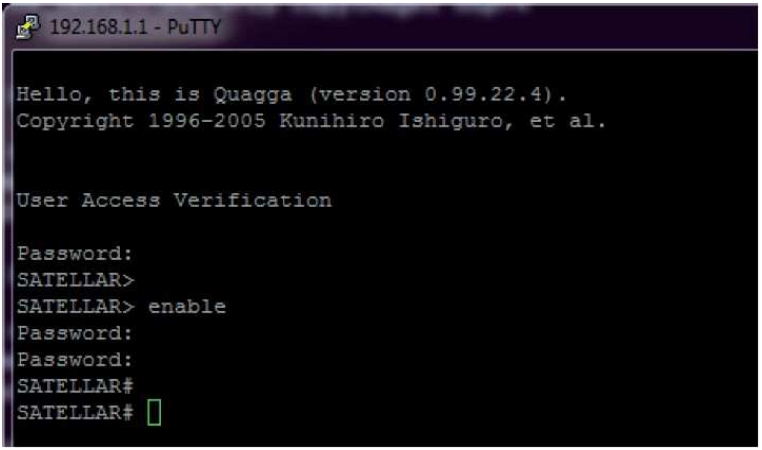
To enable the daemon in SATELLAR, go to Modem Settings -> Services and turn on OSPFD State.

OSPFD is configured through a Telnet connection. You can also change the binding port and IP address of the telnet connection by changing the settings “OSPFD Telnet Port” and “OSPFD IP Address”. Setting the port to 0 will disable the telnet configuration.

Before you turn OSPFD on, you should set up and commit all static network settings, like VLAN interfaces, packet routes and IP routes.

If you want to edit the configuration file, you need to open a SCP connection to the device. The configuration file is located at /etc/ospfd.conf. The file is loaded on OSPFD initialization, so the file should be edited before OSPFD is turned on.

After OSPFD is on, you can open a Telnet connection to the SATELLAR for configuration. You can use software such as PuTTY to open the connection. The default password is “satellar”. After opening the connection, type “enable” to be able to modify OSPF settings:



Then start configuring by typing “configure terminal”: SATELLAR# configure terminal
SATELLAR(config)#

First you should assign a cost to the interface(s) that you plan on using with OSPF. The following commands set cost 10 to the interface eth0:

```
SATELLAR(config)# interface eth0
SATELLAR(config-if)# ip ospf cost 10
SATELLAR(config-if)# exit SATELLAR(config)#
```

Then you should configure the OSPF router instance. In this example the following properties are set:

- Router-id is a unique 32-bit identifier for the OSPF instance, the IP address is a good number to use
- Redistribute connected means that OSPF reports other routers about networks its directly connected to
- Redistribute kernel means that OSPF reports all routes in the Linux kernel to other routers as well
- Passive-interface tun0 turns off OSPF on the radio interface
- Network 192.168.1.0/24 area 0 adds the eth0 network to the OSPF system. OSPF messages will be received and sent to that network

Finally command “exit” stops the OSPF editing. “Write” stores the settings into the configuration file, so that they are not lost after booting the device:

```
SATELLAR(config)# router ospf
SATELLAR(config-router)# ospf router-id 192.168.1.1 SATELLAR(config-
router)# redistribute connected SATELLAR(config-router)# redistribute
kernel SATELLAR(config-router)# passive-interface tun0
SATELLAR(config-router)# network 192.168.1.0/24 area0
SATELLAR(config-router)# exit
SATELLAR(config)# write
Configuration saved to /etc/ospf.conf
SATELLAR(config)#
```

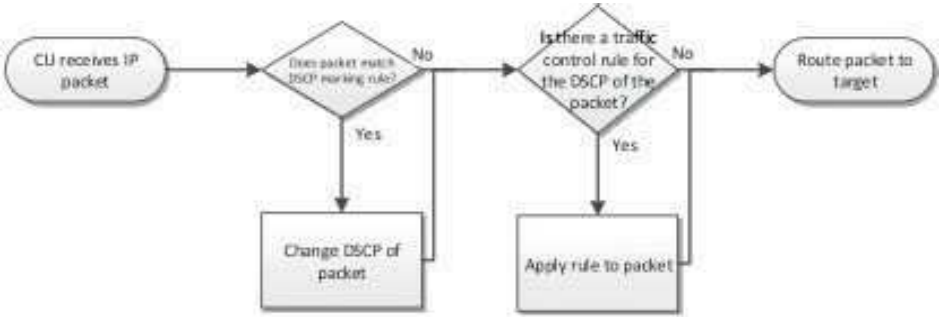
7.10 QoS

Quality of Service (QoS) allows the user to classify and prioritize IP traffic being routed through the SATELLAR. The feature utilizes DSCP marking to rate the traffic, and then prioritize them according to a set of rules created by the user.

So on a high level, QoS in can be divided into two sections:

- DSCP marking
- Traffic control

Both of the features can be used individually or together. The high level functionality goes like this:



To summarize, the traffic routed through the SATELLAR is shaped with traffic control, based on certain rules. To identify which rules are applied to which packets, the DSCP field of the IP header is used. The DSCP marking can be done outside the SATELLAR as well.

The DSCP can be marked with the following criteria:

- Source interface
- Protocol
- Source/Destination IP Address/Port

Additionally each rule has an index that affects the order in which the rules are applied. The smaller indexes are applied first.

The options to shape the traffic are as follows:

- The bandwidth of the traffic can be set to 1-100% of available bandwidth. The limit can be hard or soft, hard limit meaning that the allocated bandwidth is never exceeded and soft limit meaning that the allocated bandwidth can be exceeded if there is no other traffic. Hard limit is usually better, since the CU cannot know how much traffic there is in the network as a whole, and sending low-priority traffic with full bandwidth could take radio resources away from high-priority traffic between other devices.
- The traffic can be dropped entirely
- The traffic can be re-marked with a new DSCP value after traffic control, but before routing it forward

7.10.1 Bandwidth allocation

Limiting the bandwidth in a SATELLAR network is a tricky business. In addition to the radio speed, a lot of other factors affect the available bandwidth. For example packet size, the number of repeaters and/or substations, the network topology and so on.

The bandwidth is set as a percentage, with 100% meaning the bandwidth that is gained by one-directional streaming traffic between two devices with maximum packet size. This is the ideal situation, and if there are factors that limit the available bandwidth in the network, then the percentages need to be scaled accordingly. All the limits need to be hard because the devices cannot know the amount of traffic originating from other devices in the network.

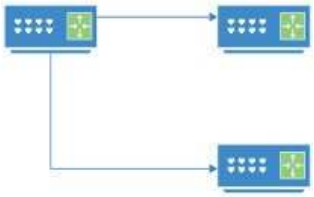
If the traffic is flowing in one direction only, between two devices, then the maximum bandwidth is 100%: If two traffic types are sent and both need a fair share of the bandwidth, 50% should be allocated to both traffic types.

If the traffic is bidirectional, both devices only have 50% bandwidth on average. Some possible setups are:
- If traffic in both directions needs to be distributed evenly, both devices need to limit their traffic to 50%
- If traffic in one direction is more important, the percentages could be for example 75% and 25% - If the bandwidth actually needs to be limited (for example to allow bandwidth for other traffic passing through the network) then setting the allocation to 25% in both devices would mean that they get about half of the total bandwidth.

If the traffic is one-directional and travels over one repeater, the available bandwidth is 50%. So if traffic travelling over one repeater needs to be limited to half,

the bandwidth allocation must be 25%.

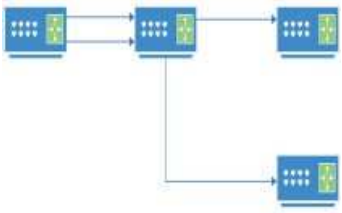
If the traffic is bidirectional over one repeater, the total available bandwidth is 25%. So total traffic from both ends should be limited to 25% to allow balanced traffic in both directions, or 13% to only use half of the available bandwidth.



If the traffic is one-directional to two substations, the available bandwidth is 50% So for a fair division of the traffic, traffic to both substations should be limited to 50%. This goes linearly with adding new substations, and if there are 3 substations then each has on average 33% bandwidth.

If the traffic is bidirectional, the available bandwidth is again halved. So if fair load balancing is required, the traffic limits should be like this:
- Master -> Substation1: 25%
- Master -> Substation2: 25%
- Substation1 -> Master 25%
- Substation2 -> Master 25%

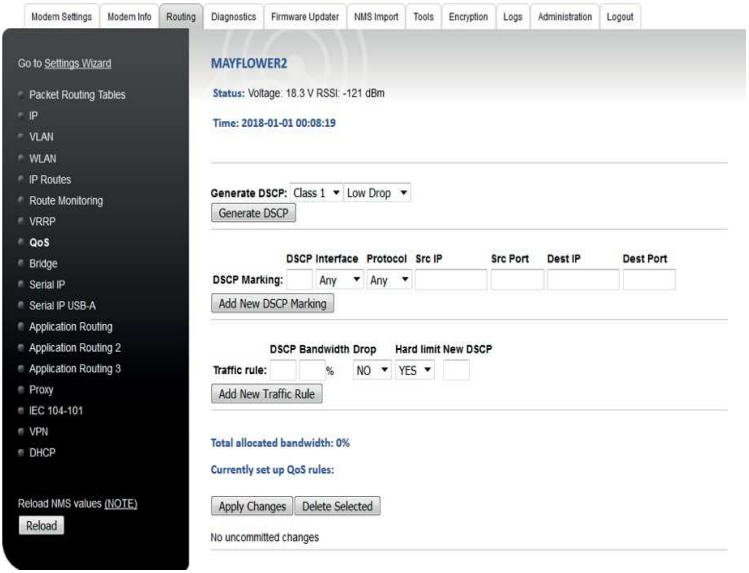
But if for example 75% of available bandwidth should be reserved for traffic going to Substation 1, the rules would look like this:
- Master -> Substation1: 38%
- Master -> Substation2: 12%
- Substation1 -> Master 38%
- Substation2 -> Master 12%



If the network is Y-shaped, traffic going to both of the substations experiences 25% total bandwidth.

7.10.2 Creating QoS rules

QoS rules can be created from the WWW UI only. To start creating the rules, go to the QoS category in the Routing application:



The first row contains a helper function that allows the user to generate some IETF standardized DSCP values. Select the Class and drop precedence from the drop-down menus and select Generate DSCP. The correct value will appear in the two fields below. Note that the DSCP values will not be treated according to any preset rules in the device, only according to those set by the user.

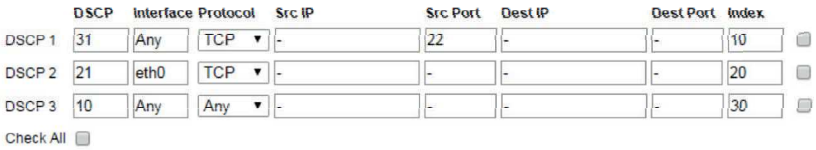
7.5.11 DSCP marking

The next row allows the user to generate DSCP marking rules. The user can set one or more of the following criteria by filling the appropriate fields:

- DSCP: The DSCP value to mark the traffic with
- Interface: Only mark traffic from this interface. Typical interfaces are tun0 (radio network), eth0 (Ethernet interface) or eth0.X (VLAN interface, where X is the ID of the VLAN)
- Protocol: Only mark traffic of a certain protocol. Supported protocols are TCP, UDP and ICMP
- Src/Dst IP/Port: Mark only traffic from/to certain source and destination IP addresses and ports. The IP addresses can be either single addresses (192.168.1.1) or subnets (192.168.1.0/24).

All the set criteria will have to be matched for the traffic to be marked. So if DSCP is set to 21, the interface is set to eth0 and protocol to TCP, all TCP traffic from the Ethernet interface will be marked with DSCP 21. Then again if DSCP is 31, Protocol is TCP and source port is 22, then all TCP traffic to port 22 will be marked with DSCP 31. If no criteria have been set except for DSCP, then all traffic will be marked with that DSCP.

When the criteria have been set, select Add New DSCP Marking and the rule will appear at the bottom of page



The last value is the index of the rule. If a traffic matches multiple criteria, the rule with the smallest index will be applied. If the rules seen in the figure above are in effect, then all TCP traffic going to port 22 will be marked with DSCP 31. All TCP traffic coming from eth0 will be marked with DSCP 21, and all other traffic (for example ICMP or TCP traffic from a VLAN) will be marked with DSCP 10.

You can change the index of the rules (or any other criteria), and select Apply Changes to apply the changes. To remove a rule, select the checkbox next to the rule and select Delete Selected.

After all marking rules have been set, select Commit Changes to store them.

7512 Traffic Rule

The third row allows the user to create traffic rules. The first field sets the DSCP that rules will be applied to. After that the user can set one or more rules to apply to the traffic:

- Bandwidth: A number between 1-100 to set the available bandwidth for that traffic type
- Drop: If this is set to YES, all traffic with the DSCP will be dropped (and the bandwidth is automatically set to 0)
- Hard Limit: If this is set to YES, the traffic will never exceed its set bandwidth even if there is bandwidth available
- New DSCP: If set, the traffic will be marked with this DSCP before being routed forward

After setting the correct rules, select Add New Traffic Rule to add the rule. It will appear at the bottom of the page:

	DSCP	Bw (%)	Drop	Hard Limit	New DSCP
Traffic 1	31	0	YES	YES	
Traffic 2	21	80	NO	YES	
Traffic 3	10	20	NO	YES	0

With the traffic rules seen in the above figure:

- DSCP 31 will be blocked and not routed forward
- DSCP 21 has 80% of the bandwidth allocated to it
- DSCP 10 has 20% of the bandwidth allocated to it, and in addition all packets will be marked with DSCP 0 before routing forward

The total allocated bandwidth can be seen on the page as well. It cannot exceed 100%. If it is less than 100 %, all remaining bandwidth is allocated to other traffic. If the allocation is exactly 100%, there is still always 1% of the bandwidth reserved for all other traffic.

After all the rules have been created, select Commit Changes to take them into use.

Note: With these rules it is possible to block access to the WWW UI (by blocking TCP port 80 for example). If that is done accidentally, it can be undone with the function buttons on the side of the Central Unit (see section 5.5 for more information). If the function button is used to set the IP address to the default (192.168.1.1),

then all firewall rules that prevent access to the WWW UI will be removed as well. So after changing the IP with the function button, the WWW UI is accessible again for as long as the IP address is in use.

7.11 Bridge mode

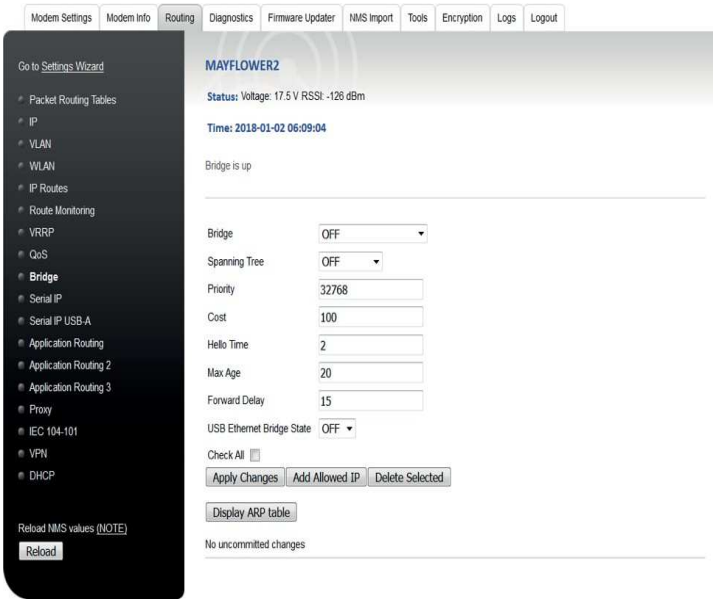
Bridge feature is an option that can be used instead of routing mode and routes.

In general, bridging is a method for aggregating a network from communication networks or segments with some network equipment. Basically bridge in SATELLAR follows that principle and is working similar to all bridges and uses generic configuration tools. It receives the packet from one port and forwards it to another controlled by Ethernet firewall rules. In SATELLAR case the ports are Ethernet and Radio.

IP routes are not needed in bridge mode although they are not restricted nor ignored either as long as they are correctly configured from the general perspective of network configuring.

7.11.1 Bridge configuration

Bridge configuration is done at category Bridge in Routing application.



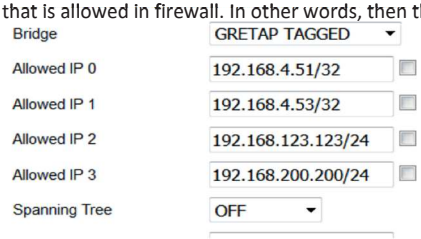
Attribute	Explanation	Sub unit	NMSID
Bridge	State of Bridge. OFF (default), Open (*), Restricted (*), Gretap Tagged, Gretap Untagged, Broadcast (**), Broadcast All (**)	1	1.3524
Allowed IP	Array of IP addresses, each describing one address, allowing the traffic to and from this particular IP.	1	1.3525
Spanning Tree	State of spanning tree protocol. OFF, STP, Rapid STP. Default is OFF.	1	1.3526
Priority	Defining of how downstream switch elects its root port is done by priority. This is only local significant between the two directly connected switches. Highest priority is less preferred. Lower priority values are 'better'. The bridge with the lowest priority will be elected 'root bridge. Default is 32768, can be set between 0..65535. See also cost. When defining the path value, when going away from the root of the tree use priority whereas, when going towards the root of the tree use cost.		1.3527
Cost	Defining of how the local switch elects the root port is done by cost parameter at STP mode. Cost is cumulative throughout the STP domain. These values are used in the computation of the minimal spanning tree and the higher cost is the less preferred. At network based on STP, the bridges always try to send a datagram vie the shortest path (by path cost) i.e. faster interfaces should have lower path costs. Default is 100, can be set between 0...65535. See also priority. When defining the path value, when going away from the root of the tree use priority whereas, when going towards the root of the tree use cost.		1.3528
Hello Time	Hello time is the time between each bridge protocol data unit (BPDU) i.e. interval of BPDU packets that is sent on a port. BPDUs are data messages that are exchanged across the switches within an extended LAN that uses a spanning tree protocol topology. BPDU packets contain information on ports, addresses, priorities and costs and ensure that the data ends up where it was intended to go. BPDU messages are exchanged across bridges to detect loops in a network topology. The loops are then removed by shutting down selected bridge interfaces and placing redundant switch ports in a backup, or blocked, state. Thus it makes possible to prevent loops and on the other hand it makes possible to configure and find out preferring level of different paths. Default values is 2 seconds, can be adjusted between 1 and 10 seconds.		1.3529
Max Age	Controls the maximum length of time that passes before a bridge port saves its configuration BPDU information. Default value is 20 seconds, can be adjusted between 6 and 40 seconds.		1.3530
Forward Delay	The time that is spent in the listening and learning state. Default value is 15 seconds, can be adjusted between 4 and 30 seconds.		1.3531

USB Ethernet Bridge State	Defines is the USB Ethernet interface attached to bridge or not when available. OFF or ON, default is OFF (not attached to bridge).	1.3532

* = Deprecated mode, not available in versions after 1.4785

**=Modes are not available at FSK-devices

Adding allowed IP is generally meant for using in restricted mode. It is a simple way to add one or more IPs that is allowed in firewall. In other words, then the traffic from and to this address is accepted.



Display ARP Table shows the data of current ARP table. This data consists of the IPs located over the radio connected to some other SATELLARs as well as the ones connected to this device via Ethernet.

```
? (192.168.4.12) at 00:21:9f:00:07:4a [ether] PERM on tap0
? (192.168.8.30) at 00:21:9f:00:03:7d [ether] PERM on tap0
? (192.168.4.5) at 00:21:9f:00:03:7d [ether] PERM on tap0
localhost (127.0.0.1) at <incomplete>  on tap0
? (192.168.4.20) at 00:9c:02:18:ad:72 [ether]  on br0
? (10.10.32.2) at 4a:a4:41:e9:62:76 [ether] PERM on br0
? (10.10.32.5) at 00:21:9f:00:03:7d [ether] PERM on tap0
? (10.10.32.12) at 00:21:9f:00:07:4a [ether] PERM on tap0
```

Bridge has (depending on the version) options OFF, OPEN, RESTRICTED, GRETAP TAGGED, GRETAP UNTAGGED, BROADCAST and BROADCAST ALL. OFF is equal to routing mode, others are explained and described in following chapters.

7.11.2 Open and Restricted modes

Open and Restricted modes are deprecated in versions after 1.4785.
OPEN mode means basically the case where all traffic (except certain specified traffic, see chapter Ethernet firewall) is allowed to be forwarded over the radio. Restricted mode on the other hand blocks forwarding of all traffic and allowing of any must be done with adding allowed IP or/and with Ethernet firewall.

In general, restricted mode is suitable for devices which are connected to some network where there is a lot of traffic that is not wanted to be forwarded over the radio. Such can be e.g. device which is connected to some generic office network. Open mode on the other hand is suitable for cases where SATELLAR is connected to e.g. only one end device or generally to a network where exists only such devices that send IP network only messages to that are to be sent over the radio. So in practice e.g. case with one master

station and several substations could be configured with restricted mode in master and open mode in substations and then allowing in master such traffic that is purposed to be sent over the radio.

7.11.2.1 Syncing procedure

As stated before, IP routes are not needed bridge mode but instead system needs to have certain data from other devices to know where the IPs in received packets exists from the radio network point of view. In open and restricted mode device gathers the information from the other devices; it stores the network data from them so that it can form itself a list where different targets locate in radio network. It also sends its own information to other devices. List of these devices is equal to packet routing table list.

The procedure that is done is called data syncing. Whenever some device gets a new entry from its own Ethernet to its ARP table, it sends required information to all devices it has routes in packet routing table. Then other devices may or may not send their data also back to this sending device, depending whether it reports it needs that data. Such need is indicated e.g. when routing mode is set on.

When all devices have sent all their data to all devices in their packet route table, network has been configured. This takes few minutes depending on the size of the network. State of syncing can be obtained from Web UI status bar. If it reports “Bridge is up” constantly about half minute the sync is most probably done.

More detailed status of syncing can be checked with web UI Routing->Bridge Display ARP Table button. In case entry is connected device tap0, it is over the radio and if to br0, it is connected to Ethernet. Own radio IP and Ethernet IP may also be seen and as connected to br0. This list can be used also as a reference for progress of syncing. So, if entry for some IP can be found from this list, traffic can be sent there. When some IP exists at ARP table, it can be connected with even though sync is still ongoing. Ongoing sync may though cause some disturbance and slowdowns.

The general status of bridge sync can be seen from web UI status field. In case it shows the text “Bridge sync ongoing”, some syncing is being done. When text is “Bridge is up” no syncing is done.

7.11.2.3 Scenarios for configuring devices to bridge mode

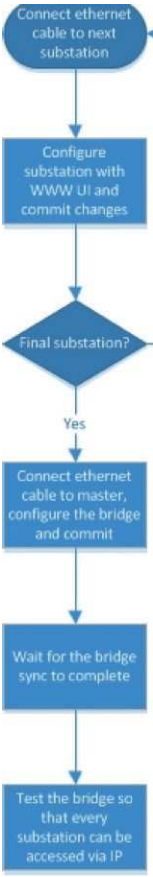
There are different ways to configure all devices to bridge mode and in some cases some things need to pay attention to certain things and it may be good to avoid some procedures.
One rule of thumb is that devices should not be connected to same switch or hub all at once when bridge mode is on but instead only one device at a time. In case the device from which the configuration is done can have several separate hardware Ethernet connections (Wi-Fi, USB-Ethernet dongle etc.), then one device can be connected to one such connection at a time. One important reason is that

as devices are configured as bridges, it may also cause some message loops which will eventually block the network / switch to which the devices are connected.

Another good rule of thumb is that especially in case of one master / several substations where master has routes to substations and substations has only a route to master, it is best to configure the master as last. This way master is not doing unnecessary syncs with substations while configuration is still ongoing and furthermore the syncing goes on correctly easier and effectively.

When the packet routes are configured to device, there must be a route or routes to all SATELLARs that this particular device needs to communicate with. In basic master/substation setup substations have only route to master and master have routes to all substations. It must be avoided to have unnecessary packet routes as this ends up to unnecessary syncing which takes unnecessary time, especially if device with packet route does not exist at all. On the other hand, it is not so significant issue if e.g. in some point of configuration there are routes for devices which do not yet exist but will exist at some point.

When configuring devices so that all devices are located next to each other, they may be connected to each other or not. In either case, setting on the bridge mode can be set via network connection or without it. If devices are configured with network connection (e.g. web user interface), they shouldn't be connected to same switch or hub all at once when bridge mode is on. Instead, all need to
be configured individually with one connection type. This is done to avoid unnecessary and invalid syncing data sending.



If the configuration is done without network e.g. from LCD GUI and they are not connected to each other over Ethernet, there are not too many things to avoid. In such case, it is also most effective to set up master as last.

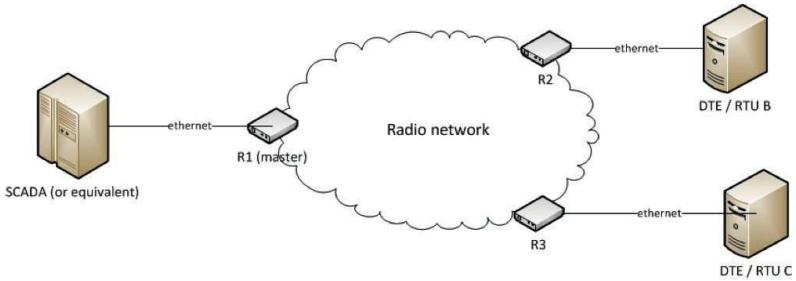
If devices are not connected to each other over the radio when bridge mode is set on, they cannot sync. In this case, devices need to be rebooted when they are connected over the radio.

The status of syncing in device can be found with web user interface Bridge category Display ARP table or getting SSH connection to SATELLAR and giving command ARP. And as a final, in case some ARP information gets somehow mixed up, all data is refreshed at devices boot. So if e.g. some device or devices accidentally gets some data wrong, system can be resynced with restart of devices.

Steps for one basic scenario with one master and several substations, substations have packet route only to master and all devices belong to same subnet:

1. Setup radio hardware connection to all devices (with either cables or antennas).
2. Start configuration of devices from some of the substation. If doing the configuration via web user interface, connect only one SATELLAR at a time to a device from which the configuration is done (laptop etc.). Configure basic settings such as frequency, needed packet route to master device, IP etc.
3. Once done, set bridge mode on as open.
4. Change the Ethernet connection to next substation. Repeat the steps 2 and 3 with that. Then do same with other substations. If the devices belong to same subnet, there is no need to change IP configuration of the device from which the configuration is done. If not, then some IP changes are needed.
5. When all substations have been configured, connect to master device. Do step 2 there as well and create packet routes to all substations. Then set wanted bridge mode on. If this mode is restricted, at least one IP address should be added as an allowed IP. Additional rules can be configured from Ethernet Firewall.
6. Change the Ethernet connection to next substation. Repeat the steps 2 and 3 with that. Then do same with other substations. If the devices belong to same subnet, there is no need to change IP configuration of the device from which the configuration is done. If not, then some IP changes are needed.
7. When all substations have been configured, connect to master device. Do step 2 there as well and create packet routes to all substations. Then set wanted bridge mode on. If this mode is restricted, at least one IP address should be added as an allowed IP. Additional rules can be configured from Ethernet Firewall.

In a simple example firewall may not be needed actually to configure. Let's say there are 2 substations with RTU or DTE and one master connected to some control unit such as SCADA.



Device	IP	RMAC
SCADA	192.168.1.1/24	
R1	192.168.1.11/24	1
R2	192.168.1.22/24	2
R3	192.168.1.33/24	3
DTE/RTU B	192.168.1.2/24	
DTE/RTU C	192.168.1.3/24	

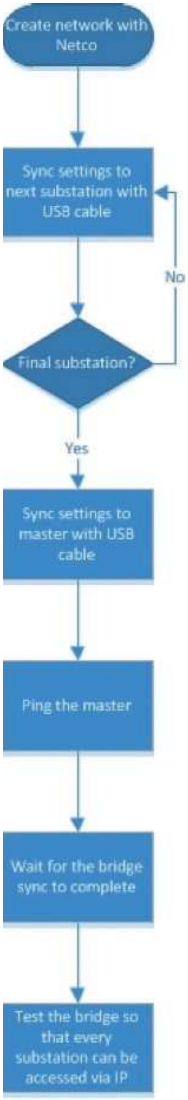
In such case if the substations are in open mode, they would need no configurations to allowing or rejecting. If master device would be in restricted mode, the easiest way would be set allowing of SCADA device IP with web user interface add allowed IP functionality which would automatically set needed rules for allowing traffic to and from that device.

Adding of new device to network in bridge mode can be done basically same way, e.g. with following steps

1. Add packet route to new device to all existing devices that should be communicate with new device.
2. Configure new device and set it to bridge mode. If it is connected to radio network, syncing will start with the devices that it has packet route. Avoid connecting this new device to same device as where the e.g. master is. If such is done, reboot of this new device will fix the case anyway.

This can be done in reversed order as well. Even the syncing will fail at new device when it is connected to radio network when other devices do not have packet route to it, syncing will be completed when these existing devices get a new packet route to this new device. Note also here that only those devices that need to communicate with this new device need a packet route to it.

Other option for creating a network with bridge mode is using PC tool NETCO. This requires a USB-cable connection from the device which the configuration is done to SATELLAR USB-B i.e. USB-serial connection. First the network is created and settings for each device configured. After that, as simplified it goes same way as the web UI configuration so that every device is configured at time but the communication media is this USB-serial.



And same way as in Ethernet network case, if there is a possibility to use several USB ports for connecting several SATELLARs at once, more than one device can be configured simultaneously.

7.11.3 Gretap modes

GRE (Generic Routing Encapsulation) transparent Ethernet bridging i.e. Gretap (GRE Terminal Access Point) tunneling is a way of configuring bridge by sending layer 2 packets over layer 3 tunnels.

When gretap is enabled, it configures SATELLAR Ethernet interfaces so that it has gretap -tunnel to all devices it has a packet route. Gretap-functionality does not require any syncing activity as it is simply based on ARP-queries.
When some device – or SATELLAR itself – does first Ethernet connection attempt to some other device, an ARP (Address Resolution Protocol) message is sent to Ethernet by Internet Standards. When the target is the device over the radio and SATELLAR receives ARP, ARP-query is sent to all tunnels.

At the other end, - depending on the message - SATELLAR either receives the message itself or forwards it to Ethernet. In any case, if and when some device responds to message, it is sent via SATELLAR only to that gretap tunnel and SATELLAR that sent the ARP-query. And when that SATELLAR receives response, it marks up that the IP/MAC that responded to ARP query is located at that tunnel from which ARP reply was received. And when the actual traffic starts to target, they are sent only to that particular tunnel.

In example case network consists in addition of SCADA device (with address 192.168.1.10) from e.g. 3 SATELLAR s: master device 1 (192.168.1.1) having Ethernet connection to SCADA and two substations 2 (192.168.1.2) and 3 (192.168.1.3) with both substations having also some external device connected in Ethernet. SCADA starts pinging address 192.168.1.12 which is behind substation 2. As SCADA has not connected to that device before and
has no ARP entry for it, first thing it does is that it sends ARP message.

When SATELLAR 1 receives ARP, it sends it to both gretap substation tunnels – and thus to SATELLARs. Device 3 forwards it to Ethernet but there will be no response. When device 2 forwards message to

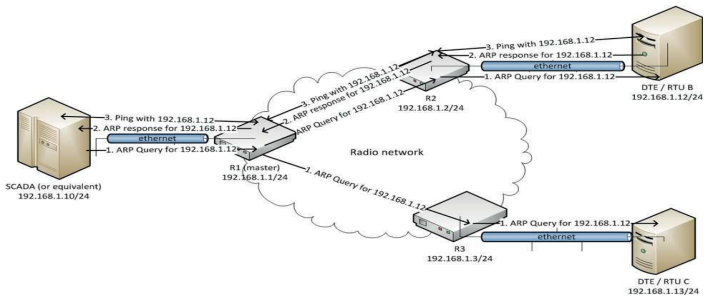
Ethernet, target device responds to it, SATELLAR 2 receives response and sends it back to device 1 which forwards it to Ethernet and furthermore to SCADA. When SCADA receives response, it is able to start actual pinging. When device 1 then receives a ping to 192.168.1.12, it knows that the target is located at gretap tunnel to device 2 and sends packet only there.

If some end device changes location, e.g. in this case 192.168.1.12 would be connected to device 3, the configuration is not ultimately fixed. At some point, if SCADA is not receiving responses, it will resend ARP and thus the tunnel resolution can be rechecked and found out that 192.168.1.12 is located at tunnel to device 3.

GRETAP-modes at SATELLAR do not differ from each other except considering VLAN configuration. However, with new versions (SW version 2.9.0.5151 or newer) VLAN tagging on the other hand is configured at VLAN category. So, for clarity: either mode can be chosen and VLAN tagging is handled in VLAN category.

7.11.3.1 Gretap ethernet default firewall roules

Gretap modes enable certain default firewall rules. These can be seen at Tools-Ethernet Firewall with Current Ethernet Firewall. Most of them are so called helper rules that are there to prevent such traffic that can usually be expected not to be sent over the radio. As gretap enables full bridge and switch functional- ity, it also sends e.g. such messages that are broadcasted. These kind of messages are sent by normal PCs quite regularly and if they are not blocked, they will increase the load of radio network causing at least reduction of network capability from actual payload point of view. One example is Netbios messaging.
This is prevented with following rules:



```
-p IPv4 --ip-proto 17 --ip-dport 137 -j DROP
-p IPv4 --ip-proto 17 --ip-sport 137 -j DROP
```

These rules are at forward chain and describe that packets with IP protocol 17 with target or source port 137 are dropped i.e. they are not sent from Ethernet to radio.

In addition to these, there are also certain rules which are more significant and important from actual device functionality point of view.

```
Bridge chain: FORWARD, entries: 22, policy: ACCEPT
-i gretap12 -o eth0 -j ACCEPT
-i gretap12 -j DROP
-i gretap5 -o eth0 -j ACCEPT
-i gretap5 -j DROP
-p IPv6 -j DROP
-p ARP --arp-ip-dst 192.168.4.11 -j DROP
```

If device with IP 192.168.4.11 has e.g. substations 5 and 12, it will have gretap tunnels gretap12 and gretap5. When device receives the packet from them, they are handled by bridge and all gretap tunnels as well as Ethernet interface are treated as equal ports. To prevent that message arriving from some tunnel is not sent back to radio via other tunnel, it is dropped. Thus, in previous example there is first rule that allows messages from gretap12 to be sent to eth0 but second rule drops any other forwarding. Same is done with gretap5. Also forwarding of ARP messages to devices itself is blocked.
These rules are not absolutely mandatory, but they are strongly recommended. Thus e.g. using of basic drop-allow rule example in following Ethernet Firewall chapter has a different example for the gretap case than for the broadcast case.

7.11.4 Broadcast modes: Broadcast and Broadcast All

Broadcast modes are available since version 2.15.0.5289.

Broadcast modes enable the bridge and switch functionality at the standard mode. This means that similar to open and restricted traffic over radio are OSI layer 2 messages (i.e. contain Ethernet header) and Ethernet and radio interfaces will belong to bridge i.e. they will act as switch ports instead of individual IP interfaces. IP addresses of interfaces belong to bridge interface.

Unlike in open or restricted mode, no syncing procedure is needed in broadcast modes. When SATELLAR receives a broadcast Ethernet packet such as ARP query, it sends it over the radio to all SATELLAR radios. When other end devices receive that packet they forward it to Ethernet and when some device responds to it, it is delivered again over the radio and furthermore to device that sent the ARP query.

Difference between BROADCAST and BROADCAST ALL modes is that first broadcasts only broadcast messages whereas second broadcasts always all messages. BROADCAST ALL mode does not support radio

features such as handshake, retry but it may be useful and beneficial at some cases. BROADCAST mode does not support those radio features either considering actual broadcast messages, but this is rather analog functionality compared to handling of broadcast messages at Ethernet network in general. However, any other messages are handled with configured radio protocol settings e.g. with handshake, if configured.

7.11.5 Ethernet firewall

Ethernet firewall is the functionality for blocking Ethernet level traffic. It can be found from Tools menu.

Here are some examples for using of the feature, the detailed information and usage can be found from http://ebtables.netfilter.org/

Ebtables is quite a like iptables i.e. IP level firewall. Basically the functionality can be divided to INPUT, FORWARD and OUTPUT. Input is the traffic that comes to device and the blocking is done at that level. Output blocks the traffic that is sent out of the device. Forward handles all the traffic that is forwarded through the device i.e. bridge to other side i.e. other port of the bridge. In case of these devices it can be assumed that to avoid any unnecessary traffic to spend the bandwidth, the most relevant thing is to control the traffic to radio i.e. what traffic is allowed to go over the radio. Forwarding covers most of these cases that are wanted to be rejected or accepted.

Rejecting is done with parameter DROP and allowing is done with ACCEPT. In addition to these there several other parameters that are need for each rule. Adding of rule can be done with –I which is insert or –A which is append. Inserted rule is set as the first in (current) list and append is set as last in (current) list. List is checked from first to last and when first match is found, rule is used.

```
ebtables -I FORWARD -p ipv4 --ip-dst 192.168.1.50 -j DROP ebtables -I
FORWARD -p ARP --arp-ip-dst 192.168.1.50 -j DROP
```

This rules configure system so that IP and ARP traffic that is about to be forwarded to radio having target IP 192.168.1.50 will be dropped. Same case for allowing is done with following rules.

```
ebtables -I FORWARD -p ipv4 --ip-src 192.168.1.50 -j ACCEPT ebtables -I
FORWARD -p ARP --arp-ip-src 192.168.1.50 -j ACCEPT
```

Different combinations can be done different options. Following rule rejects forwarding of IPv4 messages with source MAC 00:11:22:33:44:55 and destination 192.168.1.1 when the message is about to be sent to interface tap0 i.e. over the radio.

```
ebtables -A FORWARD -s 00:11:22:33:44:55 --ip-dst 192.168.1.1 -p IPV4 -o tap0 -j DROP
```

This rule is general spoofing rejection rule and could be also applied in more generic mode without destination IP and interface. IPs can be also set with some netmask when it covers a wider set of IPs.

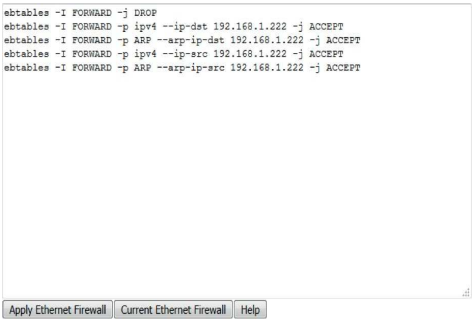
Current Ethernet Firewall displays current set of Ethernet firewall rules. A few rules exist by default in the table. These are mainly related to some typical Windows-based broadcast messages that are very seldom wanted to be forwarded over the radio network. These can be undone by adding a rule with parameter –I that allows such traffic or by –D which deletes the rule. Notice that in case VLANs are used, then some rules for handling them are also visible.

```
Bridge table: filter

Bridge chain: INPUT, entries: 1, policy: ACCEPT
-p ARP -j ACCEPT

Bridge chain: FORWARD, entries: 9, policy: ACCEPT
-p IPv6 -j DROP
-p ARP --arp-ip-dst 192.168.4.11 -j DROP
-p IPv4 --ip-dst 239.255.255.250 -j DROP
-p IPv4 --ip-dst 224.0.0.252 -j DROP
-p IPv4 --ip-dst 224.0.0.251 -j DROP
-p IPv4 --ip-dst 224.0.0.1 -j DROP
-p IPv4 --ip-dst 105.110.100.105 -j DROP
-p IPv4 --ip-dst 255.255.255.255 -j DROP
-p ARP -j ACCEPT

Bridge chain: OUTPUT, entries: 1, policy: ACCEPT
-p ARP -j ACCEPT

Bridge table: broute

Bridge chain: BROUTING, entries: 2, policy: ACCEPT
-p 802_1Q -i eth0 --vlan-id 8 -j DROP
-p 802_1Q -i tap0 --vlan-id 8 -j DROP

Bridge table: nat

Bridge chain: PREROUTING, entries: 0, policy: ACCEPT

Bridge chain: OUTPUT, entries: 0, policy: ACCEPT

Bridge chain: POSTROUTING, entries: 0, policy: ACCEPT
```

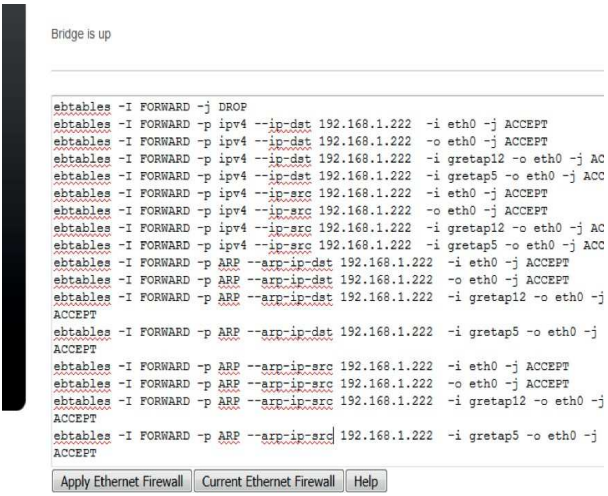
In restricted mode basically all traffic forwarding is blocked. This means that user both has to but also can decide completely what traffic is allowed to be forwarded.

```
Bridge table: filter

Bridge chain: INPUT, entries: 1, policy: ACCEPT
-p ARP -j ACCEPT

Bridge chain: FORWARD, entries: 3, policy: ACCEPT
-p IPv6 -j DROP
-p IPv4 -j DROP
-p ARP -j DROP

Bridge chain: OUTPUT, entries: 1, policy: ACCEPT
-p ARP -j ACCEPT

Bridge table: broute

Bridge chain: BROUTING, entries: 2, policy: ACCEPT
-p 802_1Q -i eth0 --vlan-id 8 -j DROP
-p 802_1Q -i tap0 --vlan-id 8 -j DROP

Bridge table: nat

Bridge chain: PREROUTING, entries: 0, policy: ACCEPT

Bridge chain: OUTPUT, entries: 0, policy: ACCEPT

Bridge chain: POSTROUTING, entries: 0, policy: ACCEPT
```

One of the basic use cases for broadcast modes is to first block all forwarded traffic and then allow it to and from only some dedicated (in this case 192.168.1.222) address. An example of this can be seen in the next figure:



This however is not as simple case with gretap modes. There it must be noticed that if everything is blocked and then accepted, accepting should be done per each gretap and eth0. Allowing of traffic in following way will enable forwarding of messages also between gretap tunnels which would create echoing of at least some broadcast messages back to radio. Thus, more rules are needed to control messaging:



These rules allow now the IP and ARP traffic to and from IP 192.168.1.222. Messages from radio (gretaps) are allowed to be forwarded only to eth0 and messages from eth0 are allowed to all gretaps. Other way of blocking can be done by adding more rules to the end of current list. As the first method bases on the idea of “allowing some, blocking rest” the second bases on the ides of allowing all and blocking some. It is basically a matter of opinion which way to implement different kinds of control mechanisms.

It must be taken into account that order is a relevant factor with these settings. As rules are set from top down order, the first (top) rule appears either before the next ones if they are appended (-A) or after next ones if they are inserted (-I). Thus e.g. in case of second rule, the forwarding block rule is inserted as first and next ones are inserted after that i.e. they will be in top of the blocking rule in actual table. Thus the traffic will be first checked against the filters that accept the forwarding related to this particular IP and only if that does not match, then it is checked against blocking drop rule.
ID description of Ethernet firewall array.

Attribute	Explanation	Sub unit	NMSID
Ethernet Firewall Rule	Array of Ethernet firewall rules. An array of strings, each describing one rule.	1	1.3735

7.11.6 STP

STP i.e. Spanning Tree Protocol is a mechanism for controlling bridged networks. It includes a possibility to rate connections so that connection from one point to other can contain redundant links that have different rates. This means that links are aware of each other and the link that has the biggest priority of available links will be used. In case that is not available for some reason, link with next biggest priority is used and so on. This also prevents bridge loops of parallel and concurrent bridge ports that might cause traffic jam.

STP link selection is based on certain parameters, in SATELLAR case priority and cost. Protocol uses and calculates them to select best link. Configuring the way the protocol handles the communication can be done with hello time, max age and forward delay. These are described in parameter list.
SATELLAR STP includes also possibility for using of Rapid STP i.e. RSTP. It provides significantly faster recovery in response to network changes or failures.

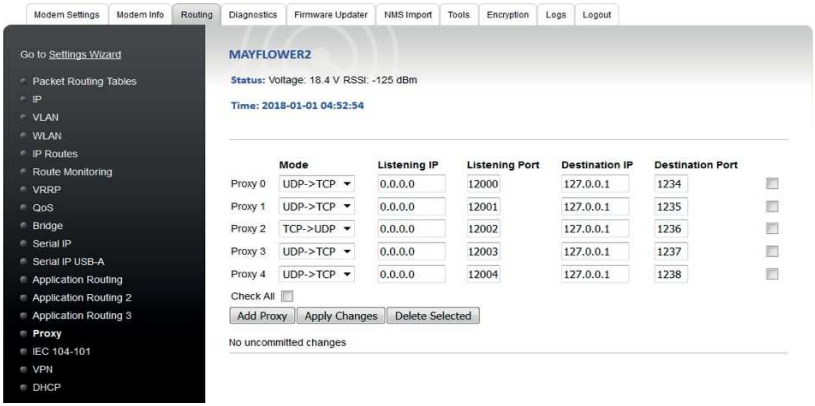
7.11.7 Notes and exceptions

VRRP between SATELLARs cannot be used in bridge mode.

7.12 TCP/UDP Proxy

Using TCP over the radio can be secure, but it can also be quite slow and adds a lot of overhead to the traffic. In some cases it can be beneficial to create a TCP-UDP proxy that just sends the payload data over the radio network. The latency of the connection improves as does the available bandwidth. But on the other hand reception of each sent packet can no longer be guaranteed.

The user can set up the proxy from the WWW UI, on the page Routing -> Proxy. Each proxy is represented by a single row:



New rows can be added with the button “Add Proxy”. Rows can be deleted by selecting the check-boxes on the right and selecting Delete Selected. Each proxy contains the following parameters:

- Mode: Proxy type, either UDP to TCP or TCP to UDP
- Listening IP: IP address there the proxy listens to incoming connections. IP address 0.0.0.0 means that the proxy accepts connection to any of the IP addresses of the device
- Listening Port: The port where the proxy listen to incoming connections
- Destination IP/Port: The destination IP address/port, where a server must be listening for incoming connections

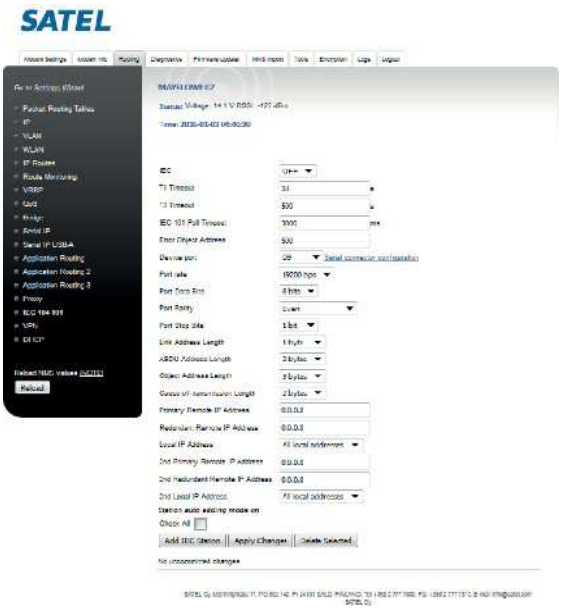
The proxy must be set up in two devices, so that the destination/listening ports match.

A proxy is not suitable for every situation. With a TCP connection ACK messages inform the application that messages have been delivered. But with the proxy, the only way to know that a packet has been lost if that there is no reply. If the traffic is unidirectional, there is no way of knowing if the traffic reaches its target. The proxy is best suited for polling connections.

7.13 IEC 104-101

IEC 60870 part 5 is one of the IEC 60870 set of standards which define systems used for telecontrol (supervisory control and data acquisition) in electrical engineering and power system automation applications.
It includes several categories including 101 and 104 protocols. IEC 101 provides companion standards is a standard for power system monitoring, control & associated communications for telecontrol, teleprotection, and associated telecommunications for electric power systems. IEC 104 is an extension of IEC 101 protocol with the changes in transport, network, link & physical layer services to suit the complete network access for using TCP/IP interface.

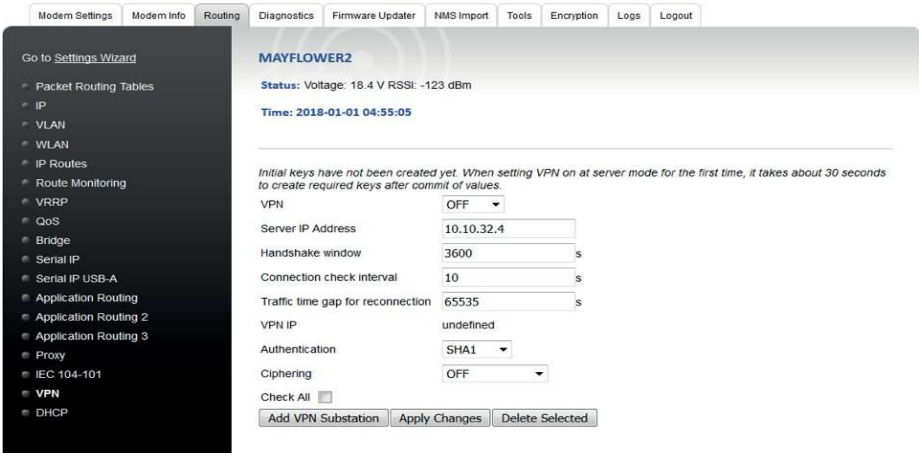
IEC 104-101 includes an interface for enabling IEC 104/101 conversion and 101 and 104 message handling and routing functionality at SATELLAR. When this is set on, CU can receive IEC 104 messages from IP interface and send via defined serial interface as IEC 101 message to their target and correspondingly convert the 101 messages to 104 messages and send them to their target.



More information about IEC 104-101 can be found from manufacturer's web site(Technical Bulletins): https://www.satel.com/support-and-services/downloads/

7.14 VPN

VPN i.e. Virtual Private Network is a method to create an authenticated and in case wanted secured method for communication. When enabled and configured, it is possible to have the SATELLAR radio network communication to go over VPN. VPN can be set to either server or client state. This makes the view of VPN category bit different depending on the mode and this can be seen in pictures below.



More information about VPN can be found from manufacturer's web site(Technical Bulletins): https:// www.satel.com/support-and-services/downloads/

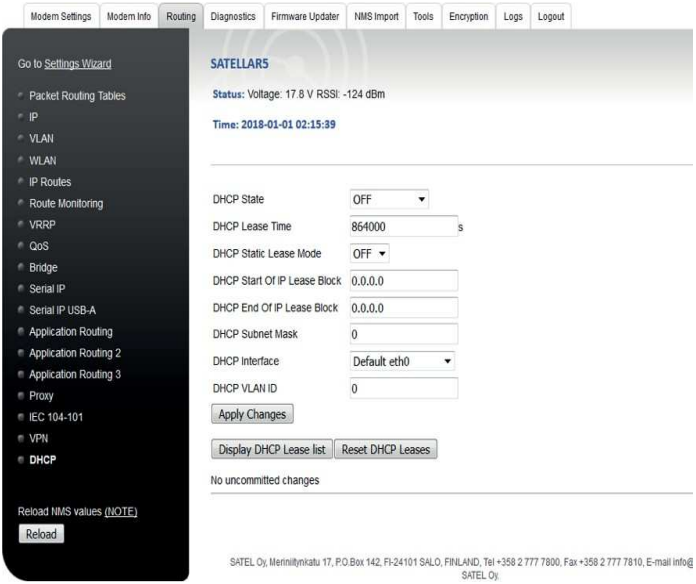
7.15 DHCP

The CU supports the DHCP (Dynamic Host Control Protocol) in either Server or Client mode. DHCP can also be set to off, which is the default setting.

In client mode, the CU attempts to contact a DHCP server in the Ethernet subnet to get the eth0 IP address.

In server mode, the CU provides IP addresses to other devices in the Ethernet subnet. Server mode provides a possibility for both dynamic and automatic DHCP allocation methods by configuration of lease time and static lease mode parameters.

Typicaly SATELLAR networks are configured with DHCP OFF, because static IP addresses are needed to access remote devices reliably.



Display DHCP Lease list shows the current list of leased addresses. Reset DHCP Leases resets all leased addresses – also static ones.

Note: If DHCP state has been set to client, other parameters except state are not used and thus not visible.

Attribute	Explanation	Sub unit	NMSID
DHCP State	State of DHCP, OFF/Server/Client . Default is OFF. Notice that when DHCP client mode is used and device gets a leased IP address, this is stored also to database as a value for ID 1.3208 eth0 IP address (see chapter 7.3.2 IP). If mode will be set to OFF, this IP stays as an IP for the device unless changed.	1	1.3229
DHCP Lease Time	Time of reserving leased address for some particular device (MAC address). Default is 864000 seconds i.e. 10 days. Scope is 10...4294967295 s.	1	1.3719
DHCP Static Lease Mode	If static lease mode is enabled, DHCP process saves leased address permanently. Default is OFF.	1	1.3720

DHCP Start Of IP Lease Block	Start IP address value of DHCP address scope. Default value is 0.0.0.0 which means using of next address of Ethernet interface address in that particular subnet.	1	1.3721
DHCP End Of IP Lease Block	End IP address value of DHCP address scope. Default value is 0.0.0.0. This means using of last address of subnet of Ethernet interface address. Notice that both start and end addresses must be set to something else than 0.0.0.0 to make manual Lease Block setting work.	1	1.3722
DHCP Subnet Mask	Mask of used address scope. Note: It is possible to set IP scope and mask e.g. so that mask does not cover the scope between start and end IP and vice versa. So in general setting of this value reasonably requires knowing of at least basic subnet calculation. Default is 0 which means using of current Ethernet IP address subnet mask. Mask can be set to 0..32.	1	1.3723
DHCP Interface	Defines the interface that is used for DHCP functionality. Default is eth0.	1	1.3724
DHCP VLAN ID	Defines the possible VLAN ID value that is used in DHCP lease procedure. It must be noticed that system allows user to set VLAN ID to normal interface and ID to 0 with VLAN interface but in both cases the result is not quite sensible. VLAN ID 0 is intended for use with trunk interface and correct VLAN ID with particular VLAN interface. Default value is 0 which means that VLAN is not used.	1	1.3725

8. Applications

This chapter explains the additional applications available in the CU.

8.1 Diagnostics

This application is used to view graphs of measured diagnostics.

The following Diagnostics graphs are available:

Diagnostic	Explanation
CU RAM Usage	Memory used by all running processes and kernel in the CU.
CU CPU Load	Shows the percentage of CU CPU (MCU) processing power used.
NMS Timeouts	Local RU NMS message timeouts. Values higher than 0 indicate the RU is busy with data traffic and unable to answer all settings or diagnostics NMS messages sent by the CU.
RSSI	Signal strength of all received radio messages.
SNR	Signal to noise ratio of last received radio message
Temperature	As measured at the RU RF Power Amplifier. See RU User Manual for accuracy and other information.
Voltage	As measured at the RU power in connector. See RU User Manual for accuracy and other information.
Local Modulation	Shows the diagnostics graph of modulation from local device against to selected remote device.
Remote Modulation	Shows the diagnostics graph of modulation from selected remote device to local device.

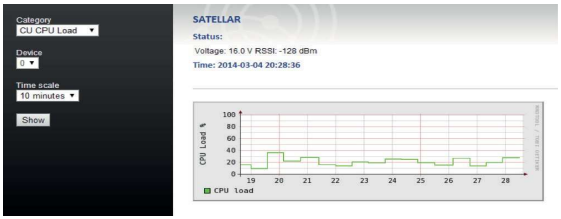
Table 8.1 Diagnostics

The diagnostics graphs can be viewed in several different time scales:

- Previous 10 minutes (scale: minutes)
- Previous 1 hour (scale: five minutes)
- Previous 5 hours (scale: hours)
- Previous 24 hours (scale: 6 hours)
- Previous week (scale: days)
- Previous month (scale: weeks)

Diagnostics, except CU load and MEM usage, from remote devices can also be viewed, if remote diagnostics have been turned on (see section 7.1.5).

8.1.1 Diagnostics application in WWW interface



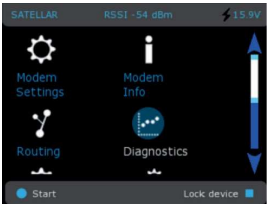
In the WWW UI, the diagnostic category, device and time scale can be selected from the dropdown menus on the left. Selecting Show presents the diagnostic data accordingly.

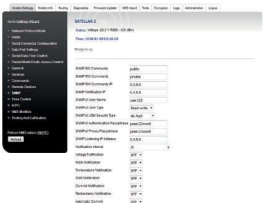
With other graphs except Local and Remote Modulation, the device list is based on the devices having Diagnostics Polling enabled from Modem Settings –> Remote Devices. If none enabled (default), then only the graphs of each local devices are available with device 0.

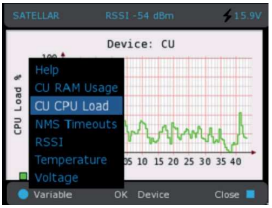
With Modulation graphs the device list is always based on the list of neighbors. Thus, unlike in other graphs, there are no device zero and there is always some other device that can be selected. Modulation graphs are not visible if automatic modulation monitoring is not enabled and the device list is not correct either in that case. NOTE: If automatic modulation monitoring is not enabled in Modem Settings -> Services, diagnostic graphs for modulation are not created. Furthermore, if automatic modulation is not on even if monitoring is enabled, graph does not provide useful information.

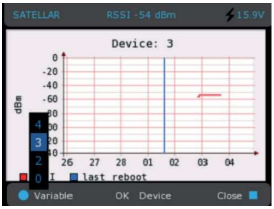
8.1.2 Diagnostics application in the GUI

In the GUI, the diagnostic category is selected by opening the menu item Variable with the left button, and selecting one of the values. A Help text is also available. Similarly, the device menu item is opened with the OK button. The Device menu is used to select which device to show the diagnostics from. The time scale can be changed by pressing the left and right keypad buttons.









8.2 Simple Network Management Protocol (SNMP)

An “Internet-standard protocol for managing devices on IP networks.” It is used mostly in network management systems to monitor network-attached devices for conditions that warrant administrative attention. SNMP is simply a protocol for collecting and organizing information. SNMP itself does not define which information (which variables) a managed system should offer. Rather, SNMP uses an extensible design, where the available information is defined by management information bases.

In typical SNMP uses, one or more administrative computers, called managers, have the task of monitoring or managing devices on a network. Each managed system executes, at all times, a software component called an agent which reports information via SNMP to the manager.

Essentially, SNMP agents expose management data on the managed systems as variables. The protocol also permits active management tasks, such as modifying and applying a new configuration through remote modification of these variables.

An SNMP-managed network consists of three key components:

- Managed device
- Agent — software which runs on managed devices
- Network management system (NMS) — software which runs on the manager

Typical radio modem or system monitoring can be RSSI-values, Voltage or Temperature. Setting type configuration consists of IP- or radio parameters.

Status of SNMP application is set similarly to other CU applications in Services category.

Attribute	Explanation	Sub unit	NMSID
SNMPD State	Enable or disable the SNMP functionality. Options are ON and OFF. Default value is OFF.	1	3266

Table 8.2 The settings of SNMP status

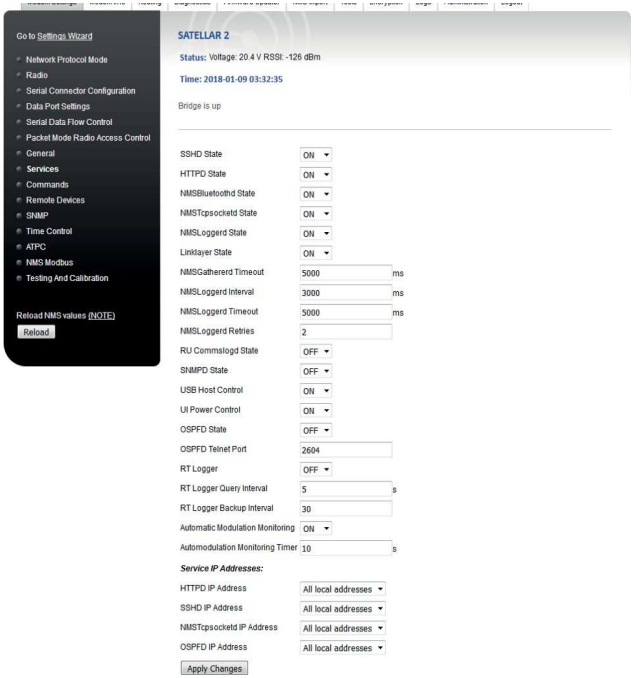


Figure 8.2 Services settings view

8.2.1 SNMP category

SNMP category includes the settings related to SNMP usage.

Attribute	Explanation	Sub unit	NMSID
SNMP RO Community	Read-only community phrase. Expected password in received SNMP request to grant reading of values. Maximum length is 255 characters. Default RO Community phrase is 'public'.	1	3241
SNMP RW Community	Read-write community phrase. Expected password in received SNMP requests to grant reading and writing of values. Maximum length is 255 characters. Default RW Community phrase is 'private'.	1	3242
SNMP RW Community IP	Read-write community IP. Defines the IP address range that is allowed to send read and write requests to this SATELLAR. For example, value 192.168.1.0 allows source addresses from 192.168.1.0 to 192.168.1.1.255. Default value is 0.0.0.0, allowing all addresses.	1	3243
SNMP Notification IP	IP address where the notifications, when available, are sent to.	1	3244
SNMPv3 User Name	Defines the user name of SNMPv3 user. Maximum length is 255 characters and default is 'User123'.	1	3332
SNMPv3 User Type	Defines whether the user has read-only or read-write access.	1	3333
SNMPv3 USM Security Type*	No Auth – No authentication or privacy used with SNMPv3 communication. Also SNMPv2 access is possible MD5 No Priv – MD5 authentication is used in SNMP communication, no privacy protocol is used. SHA No Priv – SHA Authentication is used in SNMP communication, no privacy protocol is used MD5 DES - MD5 authentication and DES ciphering is used in SNMP communication. SHA DES - SHA authentication and DES ciphering is used in SNMP communication. MD5 AES - MD5 authentication and AES128 ciphering is used in SNMP communication. SHA AES - SHA authentication and AES128 ciphering is used in SNMP communication.	1	3334
SNMPv3 Authentication Passphrase	Password for SNMPv3 authentication. This is used to verify that packet with authentication can be used only ones knowing the password.	1	3335
SNMPv3 Privacy Passphrase	Password for SNMPv3 ciphering. This is used to verify that packet with authentication can be used only ones knowing the password	1	3336
SNMP Listening IP Address	IP address that listens any SNMP request at SATELLAR. As a default it is 0.0.0.0 i.e. it listens the requests from any IP that is available at SATELLAR. It can be set to be e.g. VLAN IP so that SNMP cannot be accessed from other IPs.	1	3337

Notification interval	Interval between the checking of values that are observed for notification. This means that the value that is observed is checked in every interval seconds and compared to related threshold values. Notification is send only when threshold limits are exceeded or undershoot	1	3338
Voltage Notification	Defines is the monitoring of voltage and sending of notifications in case the limits are exceeded or undershoot ON or OFF. Default value is OFF.	1	3339
RSSI Notification	Defines is the monitoring of RSSI and sending of notifications in case the limits are undershoot ON or OFF. Default value is OFF.	1	3340
Temperature Notification	Defines is the monitoring of temperature and sending of notifications in case the limits are exceeded or undershoot ON or OFF. Default value is OFF.	1	3341
SNR Notification	Defines is the monitoring of SNR and sending of notifications in case the limits are undershoot ON or OFF. Default value is OFF.	1	3342
Commit Notification	Defines are the notifications send when any values are committed to Radio or Central Unit. Default value is OFF.	1	3343
Redundancy Notification	Defines are the notifications send for any redundancy related events (VRRP state changes or redundancy caused route switches). More details at chapter 7.6	1	3348
Automatic Committ	If ON, parameters changed with Set requests will be taken into use immediately without a separate commit message. Not recommended if a large number of parameters are set at the same time. Default value is OFF.	1	3351
Link Info Collector	This feature enables collecting / querying of device specific RSSI and SNR from RU for every neighbor of particular device. The table (list) of this collecting can be seen by user with SNMP in satelSATELLARLinkSpecificValuesTable table object list. Default OFF.	1	1.3359
Link Info Collector Timer	The time between the collecting rounds i.e. when values for all neighbors have been queried once. Default 10 seconds, scope 0...3600.	1	1.3360

Table 8.3 The settings of SNMP category

* NOTE: This parameter also defines whether the SNMP in generally uses only v3 or both v2 and v3 access. In case any other option than 'No Auth' is selected, only v3 access is allowed. In such case also traps are sent with selected SNMPv3 authentication and privacy.

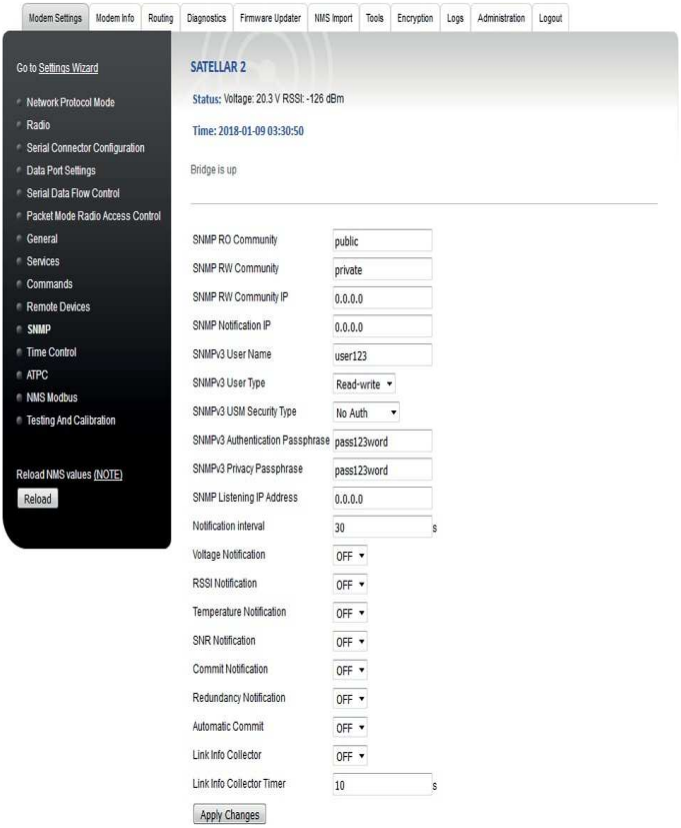


Figure 8.3 SNMP settings view

8.2.2 MIB

Management Information Base, MIB, is a database formed by a collection of description files. The MIB database defines the parameters that are available to the SNMP functionality. In the hierarchical name space of the MIB, each parameter is uniquely identified by OID - Object Identifier.

8.2.2.1 SATELLAR MIB files

External SNMP manager application must have the SATELLAR specific MIB files imported to their MIB, in order to be able to request SATELLAR specific parameters. The SATELLAR specific MIB files are available for download from the SATEL web page www.satel.com. They are also downloadable from the SATELLAR WWW user interface by accessing http://[the SATELLAR IP-address]/mibs. For example http://192.168.1.1/mibs. Parameters available to SNMP are basically the same as in GUI or WWW interface. Also, whether the parameter is read-write or read-only, is identical in the SNMP operation and user interfaces. Any
text editor can be used to view the contents, but the hierarchical presentation of the parameters is best presented by the MIB browser available in many of the external SNMP applications.

Basic level of hierarchical structure of the SATELLAR MIB contents can be presented as follows:

- satelSATELLARNMS
  - satelSATELLARNMSInfo
    - satelSATELLARNMSInfoRU
    - satelSATELLARNMSInfoCU
  - satelSATELLARNMSSettings
    - satelSATELLARNMSSettingsRU
    - satelSATELLARNMSSettingsCU
  - satelSATELLARNMSRouting
  - satelSATELLARNMSAdminTools
  - satelSATELLARNMSCancelCommit
  - satelSATELLARNMSLinkSpecific
- satelSATELLARNotifications

The branch satelSATELLARNMSInfo contains same parameters as Modem Info category in the WWW inter- face, satelSATELLARNMSSettings includes same parameters as Modem Settings category in the WWW interface and similarly the satelSATELLARNMSRouting contains same parameters as Routing category in the WWW interface.

8.2.3 Reading and writing values with SNMP

The SNMP monitoring and management protocol is based on Get and Set requests. The external application sends an SNMP Get request to read values and SNMP Set request to write values to SATELLAR parameters. The available parameters are defined in the MIB and identified uniquely in the MIB and in

the request by OID. SATELLAR responses with the queried value or with result of the writing action, again identified by the OID.

Similarly to the GUI or WWW interface operation, after applying changes the configuration must be committed to save the settings. With SNMP, the committing is executed by sending a SNMP Set request with the OID of the satelSATELLARNMSCancelCommit parameter. To commit changes permanently and make them effective, CancelCommit is set to value 1. To cancel changes that are not yet stored CancelCommit is set to
0. It is also possible to set on Automatic Commit functionality from SNMP settings. In case this is ON, every set is commit and changed permanently and made effective immediately after setting without commit.

SATELLAR SNMP settings define whether the SNMP version 2 or SNMP version 3 is available. SNMPv3 USM Security Type parameter defines what SNMPv3 authentication and ciphering method is used, but it also defines whether the SNMPv2 is available or not. If Security Type is set to NoAuth (default), SNMPv2 is avail- able with defined community words and also SNMPv3 is available without authentication or ciphering.
When the Security Type is set to any other option, only SNMPv3 with defined parameter settings is available.

8.2.4 SNMP Timeout

Some of the reading or writing actions require more time to complete that others. Especially commands related to databases, such as routing tables, take longer than accessing a parameter with a single value. Also, SNMP requests sent over the radio interface have longer delay than the request sent over wired IP connection. This has to be taken into account at the external SNMP application sending the requests: most of the SNMP applications have a SNMP Timeout parameter. Increasing the value for timeout in the external application can be used to avoid SNMP connectivity issues with SATELLAR modems.

8.2.4.1 SNMP application examples

NET-SNMP – Console based application for various SNMP usages, such as scripting.

SNMPB - a simple graphical Windows application.

Dude – a simple graphical Windows application.

Spiceworks – a browser-based application.

8.2.5 Notifications (traps)

SNMP also includes the possibility to get notifications - also known as traps - for different events. These are basically messages with different names and possibly some content. One default trap is information about stop and start of SNMP. When SNMP starts, it sends coldStart trap and when it closes down, it sends notification NotifyShutdown. Notifications are sent to IP address that is defined at parameter SNMP Notification IP.

There are several notifications in SATELLAR that can be enabled. To be able to enable notification, SNMP

must be set ON and then each notification is enabled individually. Each notification has user-definable parameters that define when message for the event is sent.

Notification	Definition	Notification Name	Trigger(s)	Message
Voltage Notification	Notifications in case voltage is above maximum, below minimum or returns back from either state	satelNotifyVoltage	Minimum: Modem Settings – General – UI Voltage Critical Level (1.3202) Maximum: Modem Settings – General – UI Voltage Bar Max (1.3206)	Below minimum: "Voltage has dropped to 9.8, it is below set minimum 10.0" Above maximum: "Voltage is now 28.7, it has peaked over the maximum limit 28" Normalized: "Voltage has returned to an acceptable level 14.7"
RSSI Notification	Notifications in case RSSI below minimum (critical) level or returns back to normal level	satelNotifyRSSI	Minimum: Modem Settings – General – UI RSSI Critical Level (1.3203)	Below minimum: "RSSI has dropped to -128, it is below set minimum -110" Normalized: "RSSI has returned to an acceptable level -58"
	Notifications in case temperature is above maximum level, below minimum level or returns back to normal level from either state	satelNotifyTemperature Modem	Minimum: Settings – General – Temperature Min (1.3344) Maximum: Modem Settings – General – Temperature Max (1.3345)	Below minimum: has dropped to -10, it is below set minimum 0" Above maximum: "Temperature is now 65, it has peaked over the maximum limit 60" Normalized: "Temperature has returned to an acceptable level 40"
SNR Notification	Notifications in case Detector Signal To Noise Ratio value is below minimum (critical) level or returns back to normal level	satelNotifySNR	Minimum: Modem Settings – General – SNR Critical Level (1.3346)	Below minimum: "SNR has dropped to 10, it is below set minimum 20" Normalized: "SNR has returned to an acceptable level 30"
Commit Notification	Notifies when user commits any Radio or Central Unit value.			
	Sends a notification in case the VRRP state (master / backup / fault) changes	satelNotifyCommit		Core of the message: "VRRP of device IPADDRESS has changed into STATE"
		satelNotifyRedundancy	Change of VRRP state	IP Address is the address of the device where change happens, STATE can be one of 5 different options: backup, master, backup cannot connect to radio, fault cannot connect to radio, fault. See chapter 7.7.4

8.3 Firmware updating

The currently installed firmware version numbers are available in the Modem Info Application, RU and CU categories.

There are three different ways to do the firmware updating:

- to use the firmware updater application in CU by the LCD GUI or in the WWW interface
- to use the USB Stick during boot CU update method
- to use the firmware update over-the-air

8.3.1 Firmware updater application

The Firmware updater application can be used to update the firmware of the RU or the CU. This application is available in the WWW interface and the LCD GUI, but the operation is slightly different. When updating the firmware using Firmware Updater, previous settings are NOT lost, unless the release notes for the new firmware specify differently.

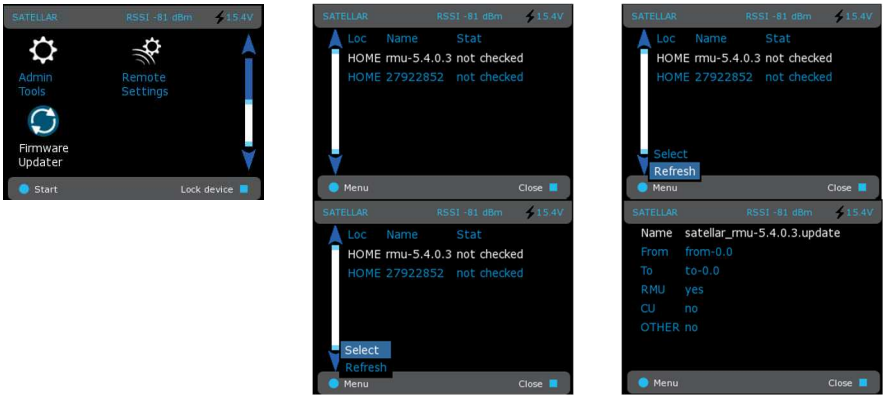


Figure 8.4 Firmware updater by CU: Graphical user interface (GUI/LCD)

8.3.1.1 Choosing the right update file

First you must determine which firmware you are updating. It is possible to update either the RU or the CU firmware.

The RU firmware update file is named “satellar-ru.*x.y.z.w*.update”, where “*x.y.z.w*” is the version number of the new firmware. Simply choose the update file, which has the version number you wish to update to.

The CU firmware update file is named “satellar_xxxxyyyy.update” where xxxx is the old firmware version number and yyyy is the new firmware version number. When updating the CU firmware using Firmware Updater, it is necessary to know the current filesystem version number, so that the correct update file can be chosen. For example, if you need to install a new firmware version satel-2863, and your current filesystem version number is satel-2775, you need an update file named “satellar_27752863.update”. The current firmware version can be seen in Modem Info, CU category.

The CU firmware update file consists of two different files, the kernel image and the filesystem. Due to the relatively large size of the full filesystem image (typically 11 MB), the update includes only the changed parts of the image, so the update file size is kept to a minimum. This is called an incremental, or patch, update.

The following table illustrates the different possibilities.

Update file	Example of update file name	Images contained in the update file	Typical size, approximately	Update method
RU update file	satellar_rmu-5.3.0.2.update	RU firmware image.	300 kB	Firmware Updater
CU update file	satellar_27752863.update (typical total size: 4.3 MB)	CU kernel image.	2.4 MB	Firmware Updater
		CU file system incremental upgrade patch.	1.9	

Table 8.4 Choosing the update file

8.3.1.2 Uploading the update file

When you have the correct update file on your computer, open SATELLAR WWW GUI, and go to the Firmware Updater application. Then click on the Browse... button and then locate the file using the window that opens. Then click on Send to transfer the file to SATELLAR CU.

Note that this step is NOT yet the actual update; it is just a file transfer.

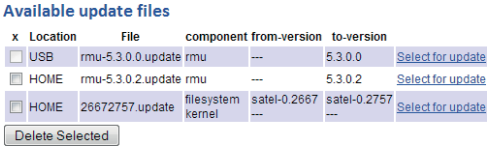
Alternatively, the update file can be placed on an USB memory stick. In the latter case, the file will become visible in the list of Available update files when the memory stick is inserted into SATELLAR's USB port and the web page is reloaded. Allow a few seconds after inserting the stick before reloading the page.

8.3.1.3 Starting the firmware update process

After a file has been uploaded or a USB memory stick containing the file has been inserted, it appears on the list of available update files.

The following image shows that three update files are available:

- A RU update file, eg. version 5.3.0.0, on the USB memory stick
- Another RU update file, eg. version 5.3.0.2, uploaded to the CU
- A CU update file, containing a filesystem patch eg. from version 2667 to 2757 and a kernel image, uploaded to the CU.



When the file is available, click "Select for update" to start the update process using that file (see chapter 8.3.1.4).

Unneeded files can be deleted from the CU by checking the checkbox in the "x" column and clicking "Delete Selected".

8.3.1.4 The firmware update process

The update process is time-consuming, but in case the update is interrupted by a power failure etc., the process can be resumed. The process can also be cancelled at any time.

First the devices to be updated must be selected. Normally choose only device 0 (local device).

Click the Start transfer -button, and you will get this message:

The progress of update is indicated by a progress bar, which is automatically refreshed with 5-second intervals. The transfer may be cancelled at any time by clicking on “Cancel transfer”, and no harm will be done to the target unit.

When transfer has finished, the RU is restarted and is ready to use.

When updating a CU, it will also be automatically restarted. The restart will take longer than usual; because part of the update process takes place during the booting process. The progress of the update can be seen on the LCD screen. In case no screen is available, the STAT LED blinks while booting and updating is in progress.

The CU firmware update can last up to 10 minutes. Do NOT turn off, restart or reboot the CU during this time. IF the CU is restarted or turned off, the firmware update process fails and the previous firmware version remains in use.

After restart has completed, please check the Firmware versions from Modem Info, RU and CU categories (see chapters 8.5 and 8.4) to see that the Firmware versions have been updated to the new version.

8.3.2 USB Stick during boot CU update method

This method is completely different from the Firmware Updater application. The CU update files used are not *.update* files; instead they are RAW kernel and/or file system images. The files are placed on a USB Memory Stick and renamed according to the table below. The USB stick is then inserted, and then SATELLAR is rebooted. The update is done automatically during the device boot.

The Radio Unit can also be updated from the USB stick. The normal .update file can be placed on the stick, and the file will be applied during the boot. If multiple .update files can be found, the first one will be selected alphabetically.

The progress of the update process is displayed on the LCD screen. In case the CU is not equipped with a LCD screen, you can follow the process by the STAT LED. While the STAT LED is blinking, the update is underway.

Image updated	Files needed	File name example	Rename file name to	Approximate duration of update
kernel[1)]	kernel image	satel-0.2757_uImage	uImage	5 minutes
	signature file	satel-0.2757_uImage.sig	uImage.sig	
filesystem[2)]	filesystem image	satel-0.2757_rootfs.jffs2	rootfs.jffs2	10 minutes or more
	signature file	satel-0.2757_rootfs.jffs2.sig	rootfs.jffs2.sig	

Table 8.5 Update process

[1)] Note about kernel update using this method: After the device has booted, it must be restarted again to actually start using the new kernel.

[2)] Note about filesystem update using this method: This method removes all files AND settings, including IP settings, stored in the CU. RU settings such as Frequency are not affected. (CU settings can be identified by the sub-unit number “1”). The advantage of this method is that the previous file system version number is not needed; you can update any filesystem version over any other.

8.3.3 Firmware update over-the-air

This chapter explains how the firmware of devices in an installed, running network consisting of SATELLAR devices in Packet routing / TCP/IP mode can be remotely updated.

Both SATELLAR CU and RU firmware can be updated using this method. The method has the following steps:

- Preparation
- Transfer of files
- Update process
- Confirmation

The time taken is dependent on the relatively slow (compared to the size of the update packets) transfer speed over radio. While comparatively slow, the time may still be less than doing the updates by hand, i.e. going to the site physically and doing an USB-memory-stick update. This depends fully on the size and geography of the installed network.

8.3.3.1 Preparation steps

Before starting the firmware update, make sure the following preconditions are fulfilled.

Step 1. Plan the time needed for the update process

You should plan your update process so you know the downtime of the data system beforehand and can proceed with less uncertainty.

Table 1 lists the time needed for some examples. All times are calculated without any other traffic in the radio network. (I.e. data transfer has been stopped)

Air speed	Update file size	Transfer time	Total update time per device (approximate)
38.4 kbps	4.5 MBytes	28 minutes (measured)	50 minutes
38.4 kbps	3.5 MBytes	24 minutes (approximate)	45 minutes
19.2 kbps	4.5 MBytes	45 minutes (approximate)	1 hour 10 minutes
19.2 kbps	300 kB	5 minutes (approximate)	15 minutes

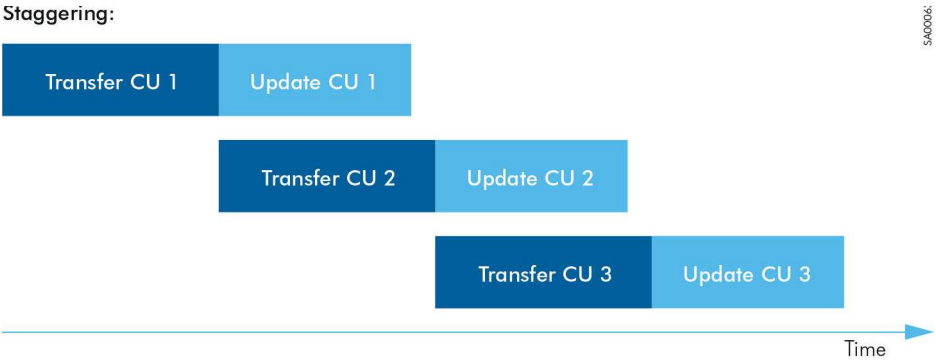
Table 8.6 Update file transmit time examples

Notes about the time needed:

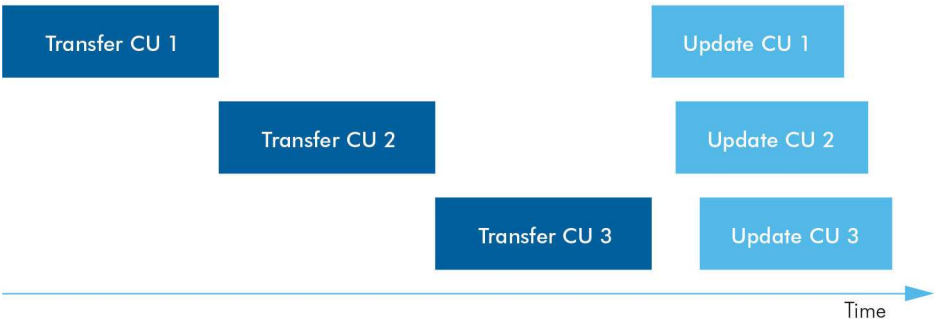
Transmit time is the critical factor. Total time includes data transfer, delays such as using the WWW interface manually, which can be speeded up with a little practice, and the time taken by the CU to actually install the update, a process which is done separately from file transfer. Actually, you can stagger the process by starting the update process in one modem while the update file is being transferred to the next modem. This “staggering” method can save time. Alternatively, transfer all files first (one after the other), then update all modems at once.

Do not start multiple uploads at the same time, as this will cause slower transfer speeds and potentially cause some transfers to fail. (It could be worth trying for overnight transfers, though)

Staggering:



Alternative:



Step 2. Make sure there is a connection to all SATELLAR devices

You need a working TCP/IP connection to all modems. This can be confirmed by opening the WWW setup interface of each remote SATELLAR device by writing the IP address of the device in the address bar of your web browser.

The update is done via the WWW interface of each modem. The HTTP protocol used to control the update and transfer the files is running in the SATELLAR radio network. For this reason the update cannot be done if the Protocol Mode setting in your network is not set to “Packet Routing” or IP connections to all devices do not work for some other reason. You can use either the “radio IP addresses” or the “Ethernet IP addresses” of the Central Units for ping tests and WWW interface access.

If you are using a PC which is connected to other LANs or the Internet at the same time as you are connected to the SATELLAR network, you need to add a temporary IP route to your PC configuration for the purpose of connecting to the SATELLAR network. Assuming your local SATELLAR unit connected via
Ethernet has IP 192.168.1.1 and your PC is 192.168.1.2 and this connection is working, you can then use this command in windows to add the temporary route:

First, start cmd.exe using administrator privileges. Then enter the following command:

```
c:\> route add 10.10.32.0 mask 255.255.255.224 192.168.1.1
```

Now you can access all SATELLARs by using their radio IP address, such as 10.10.32.2, 10.10.32.3 etc.

A simpler way is to disconnect the PC from all other networks and set your local SATELLAR unit as the default gateway. This way you don't need to use the ROUTE command.

Step 3. Organize your modems into browser tabs

This is a very useful feature in modern web browsers. If you put each SATELLAR unit's web interface into a separate web browser tab, it is easy to go through the update process. This is also helpful if using the staggering method to save time.

Step 4. Identify the current firmware versions

It is possible that your modems have different firmware versions. When the CU firmware is updated it is important to know what the current version number is. Go to "Modem info, CU" menu (See chapter 7.2.3) in the WWW interface of each of the modems and look at file system version (NMSID 1.650).

For RU firmware, the current version is not important.
If you have different CU firmware versions, it can be helpful to record the version on a piece of paper or excel sheet for easy reference while updating or you could check the version every time using the WWW modem info page.

If you transfer the wrong file to the CU you have just lost 25 minutes or more time, because the wrong update file cannot be used to upgrade the firmware!

Step 5. Gather the needed update files

See CU User Manual chapter 8.2.1 for help identifying the correct files. Make a note which files go into which modems, if your network has different versions currently installed.

Step 6. Stop all other data traffic

To speed up the file transfer and reduce the risk of transfer errors, it is recommended to stop all other traffic from your radio network while updating.

8.3.3.2 Transferring the files

Actual transfer of the .update file is done exactly as detailed in the chapter 8.2.2. Note that while the file is uploaded, there is no progress indication, other than what is provided by your web browser.

Typically uploads are not tracked by web browsers, while downloads have very good progress indicators.

When one upload is complete, this screen appears:

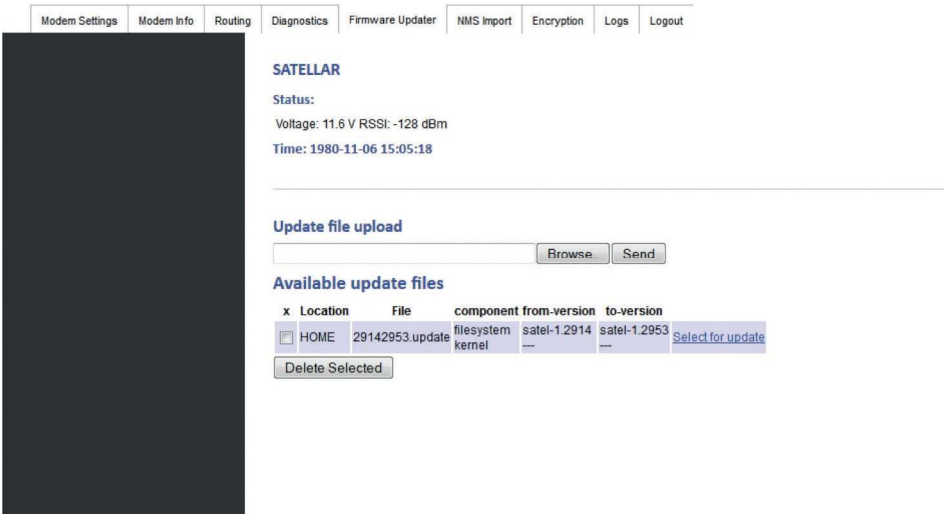


Figure 8.5 Update file transfer complete

Now you can start the update process as indicated in next chapter, and then start file upload for the next modem.

8.3.3.3 Updating

To start each firmware update, just click on the “Select for update” link text (see Figure 1) as explained in the user manual chapter 8.3.1.3, and follow instructions in chapter 8.3.1.4. Note especially:

- Select only the target device ‘0’
- Update is done in two stages, “transfer” and “reboot”.
  - Transfer is quick, a minute at most (Do not confuse this with file transfer)
  - Reboot, which can take more than 10 minutes for the CU. (The actual update is done at this stage)

While the firmware is being updated (about 10 minutes for CU firmware), little or no data is being sent or received, so this time can be used for transferring another update file to another modem

8.3.3.4 Confirming the update

After 10 minutes or so, the web interface should reload automatically. You can also refresh the page manually using your browser (hit F5). Note that the modem is unresponsive while the reboot process in underway.

When the web interface is responding again, go to “Modem Info” and confirm the version number from either the “CU” or “RU” category as appropriate. You should do this step at once for all modems (by going through the browser tabs in order) as the last step of the update process. If any modem does NOT display the new version number, you should:

- Refresh the web page (press F5)
- if still old version, reboot the updated device (RU or CU)
- if still old version, retry the update (select for update, also double-check the from version is correct)
- if still old version, confirm the original .update file is valid and re-transmit, effectively doing the whole process again for the affected modem(s).

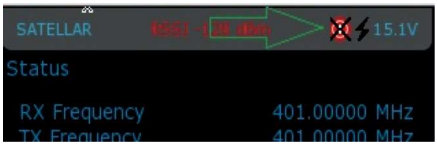
When all modems are running the new firmware versions, re-start your data traffic.
Updates do not normally change any settings, but if they do, there should be a mention of this in the release notes.

8.3.3.5 Verification of update integrity

When the system has been booted up after the update, a verification process ensures that it is working properly. This will take approx. 2.5 minutes. If the process detects that something is not working correctly, it reverts the system to previously used version. The system shall not be rebooted during the verification process. Rebooting reverts the system to old version too.

Web UI shows the verification state like this:

In GUI there is a do not reboot-icon that indicates the same thing. Green arrow points to this icon:



In addition to these, STAT and PWR LEDs are blinking simultaneously at a rate of faster (half second) and slower (one second) blinks until the verification is over.

8.4 Remote settings

This application is only available in the LCD GUI. It is used to change settings of a remote SATELLAR, over the air. (The same functionality can be achieved in the WWW interface by contacting the WWW server in the target SATELLAR directly, by using its IP number. Remember that both tun0 and eth0 IP numbers can be used.)

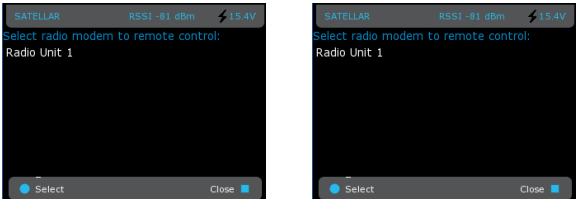


Figure 8.6 Remote settings by CU: Graphical user interface (GUI/LCD)

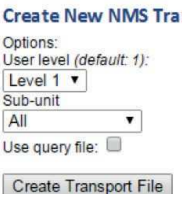
8.5 NMS Import

This application is available in the WWW interface only. It allows to export and import settings as text files. The file is called a NMS Transport file. For example you can export all modem settings into a file and save it to your computer as a backup. You can also edit this file and send it back to the modem, or to another modem. The modified file could contain only one or a few settings, not all settings originally found in the file are needed. This can be used to change the same few settings to multiple modems relatively quickly. (By creating a file with just the settings to be changed, and importing it to all the modems).

8.5.1 Exporting settings from modem

When exporting settings, SATELLAR CU creates a file which contains the settings. The file can then be saved on a computer and kept as a backup, or edited using a text editor and sent back to the modem. The following procedure can be used to export all user settings from a radio station (both CU and RU).

1. Go to the NMS Import Application of WWW GUI. The export section of the page looks like this:



2. Ignore the query file, User level and sub-unit selections for now. Just select Create Transport File button. SATELLAR now generates the transport file.

3. The new transport file appears at the top of the page, under Available NMS Transport Files:

4. Click on “satellar_export.nmst” to transport the export file to your computer.

8.5.2 NMS Export advanced features

These optional features are available:

Option	Effect

Query file	If you wish to export only some specific settings, create a text file containing only the NMSIDs, one per row, and use it as the query file. Click Browse to select the file and Upload to send it to the modem.
	
	Example query file contents:
	`1.398`
	`1.33`
	`1.80`

Use query file	Mark this checkbox to use the query file that was uploaded. The resulting export file will only contain the values of the NMSIDs that were specified in the query file.
User level	Level 1 is the normal level. Sometimes SATEL technical support may request you to export level 5 or 9 settings in case the information is needed to solve a problem. Level 5 or 9 settings cannot be changed.
Sub-unit	Choose All to export both RU and CU settings. Sub-unit 0 exports only RU settings and sub-unit 1 exports only CU settings.

Table 8.7 NMS Export advanced features

8.5.3 The export/import file contents

The transport file is a text file in UNIX format. This means that the windows default text editor ‘notepad.exe’, does not correctly split the text into lines, instead all text appears on one long line. The file should not be edited with an editor which does not support Unix-style text. We recommend using a better text editor,

such as 'Notepad++' which is freely available on the net.

The file contains a list of NMSIDs, followed by the '=' character and the value assigned to that NMSID. There are also comment rows, which usually give the name of the following NMSID and possibly the list of valid values.

A special case is related to ignoring of errors. If text "Ignore Errors" is added as a first line of transport file, it enables error ignoring mechanism. See more about that from chapter "Importing settings to a modem".

Example 1:

```
#Address (RMAC)
0:1.398=1
```

The first row is a comment, identified by the '#' character. Everything on comment rows is ignored when importing. This comment tells us that the next NMSID is the address.

The next row begins with a zero, followed by a colon character ':'. The zero indicates the sub-unit is the RU (1 would be CU). Next number is the NMSID, which is '1.398'. After the equal sign '=' is the value, which is 1. The address of the RU is therefore set to 1.

Example 2:

```
#Protocol Mode
#0 = Basic-RX Priority, 1 = Basic-TX Priority, 2 = Basic-Repeater, 6 = Packet Routing
0:1.409=6
```

The two comment rows tell that this is the Protocol Mode setting, and valid choices are 0, 1, 2, or 6. The comment explains what each number means. The actual NMSID row again shows that sub-unit is 0 (RU), the NMSID is '1.409' and the current value is '6'.

8.5.4 Managing export files

You can use transport files as backup to store the settings of devices in your network, so in case you need to replace the hardware, you can just import the saved settings to the new hardware. In this case it is useful to name the transport files to the name of the radio station, for example.

Remember that the file extension must remain as .nmst, otherwise you are free to rename the file. Avoid using special characters in the name.

Another way to use transport files is to create a file containing all the settings, which are common to all modems in your network. Some such settings are RX and TX frequencies (0:1.256 and 0:1.257), bandwidth, airspeed, encryption keys, network ID, TUN Base Address (1:1.3212) etc. These settings must be the same in each modem for the network to work. If you put all these settings in a single file, you can easily import it to all modems, saving time and avoiding errors caused by inputting all the settings by hand.

Another use related to the above is to copy some settings from one modem to another. In this case you should carefully edit the file after exporting, removing any settings you do not wish to modify in the target

device. For example you might want to create a copy of a modem you have already configured, except for the Address and IP settings, which should remain as they are. In this case remove the relevant rows from the file before importing it to the target modem.
Always be careful of typing errors when editing the file. If any errors appear in the file, the whole import process fails (see next paragraph).

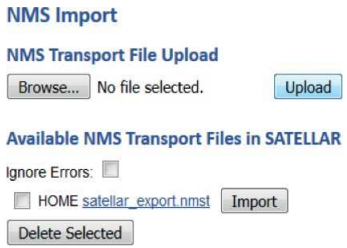
NMS Commands, such as Save User settings, Restore User settings and Reset should NOT be used in a transport file.

8.5.5 Importing settings to a modem

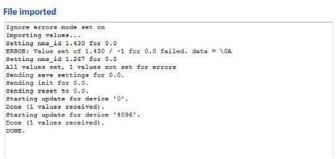
To send a transport file to the modem follow this procedure:

5. Click the Browse… button under the NMS Transport File Upload heading, select your file in the window that opens, and finally select the Upload button.

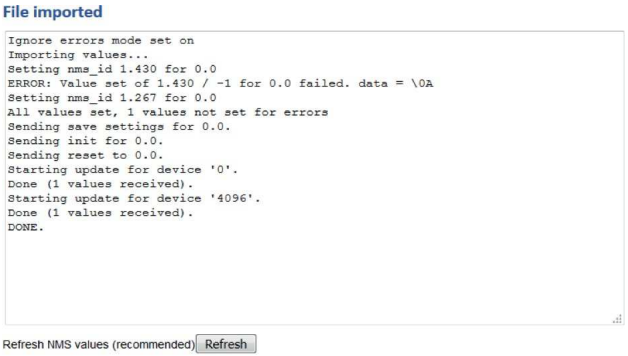
6. The file will appear under the Available NMS Transport Files heading. Select on the "Import" button to import the settings. By default, run stops in case setting of any value returns error. However, it is possible to run import so that possible errors are ignored. This means that in case importing of some ID returns error, run is not stopped. This option can be selected with check box Ignore Errors.
NOTE: In general, importing that stops for an error must be investigated i.e. it should be checked what caused the error and why. In most cases setting of all values from NMST file maintains the system integrity better. Thus it is usually safer to run import first at least once without error ignoring.



7. The importing process result is shown in a text box.



8. A) Ignore Errors have not been selected: In case of any errors, the process stops and an error message is displayed. The error message will tell which NMS ID caused the error. For example, an error message such as this: “ERROR: Value set of 1.769/-1 for 0.0 failed” means that the NMS ID with the problem was 1.769, and the subunit was 0 (the first number in 0.0 or 1.0 is the subunit). If an error hap- pens, NO values are saved. Fix the error and try again.
   B) Ignore Errors have been selected: In case of any errors, an error message is displayed similar to case where errors are not ignored and the error message will tell which NMS ID caused the error. Difference to case where ignoring has not been selected is that the process continues to end and sets all the values which are not causing errors. At the end, the amount of errors are listed values are saved.



8.5.6 Importing files from USB stick

If a USB stick containing a transport file is attached to the SATELLAR when it boots, the files on it are automatically imported during the boot process. The files will be imported even if the device is being updated,
i.e. the USB stick also contains update files for the SATELLAR. The message “Loading settings from NMST file...” can be seen on the screen while the file is being imported.

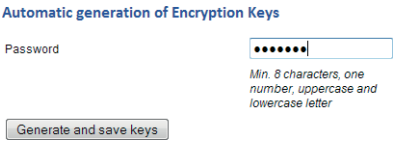
If there are multiple transport files on the stick, the following logic will be used to select the file:

- If the file is named n_*.nmst, where n is the RMAC address of the SATELLAR, that file will be used. For example the file 2_satellar_export.nmst would be used if the RMAC address is 2.
- If there are multiple files beginning with the same number, the first one alphabetically will be selected
- If there are no matches to the RMAC address, the first transport file will be based on alphabetical order

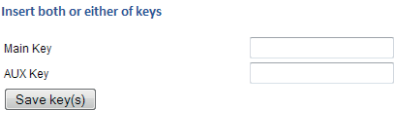
8.6 Encryption

The Encryption Application is used to set the encryption keys of the radio protocol of the RU. See the RU User Manual for information about encryption.

You have two choices to input encryption keys. The easiest way is to use a password, and SATELLAR then automatically generates encryption keys from the password. Type your password in the “Password” text field. The web page will show an indicator about how strong the password is. Then click the Generate and save keys button. The same password will always generate the same keys.



The other way to insert encryption keys is to manually insert them. This option is for power users who wish to generate keys themselves.



You can insert either one or both keys at the same time. The key that is left empty is not saved.

Note that as a security measure, the encryption keys or passwords in the device cannot be read back, but you can see a CRC checksum in Modem Info->RU, which can be used to verify if modems have the same keys inserted.

8.7 Logs

Logs are available on the WWW interface only. These can be used to debug problems. If you contact SATEL representative with a problem report, it may be a good idea to include copies of the logs in your report, or SATEL may request you to provide copies.

- Kernel Messages: Linux kernel messages
- System Messages: Linux system messages
- Service Messages: Messages of the SATELLAR Services
- RU NMS Log: internal NMS traffic between the RU and the CU
- OSPF: Logs of OSPF routing protocol
- RT Logger: Logs collected with RT Logger functionality including different radio statistics

– Automatic QAM Modulation: Logs related to monitoring of automatic modulation including the link specific modulation values. Log format is local -> remote modulation, remote->local modulation. E.g. local -> 5 64-QAM, 5->local 32-QAM means modulation from this device to 5 is 64-QAM and from 5 to this is 32-QAM

8.8 Administration

This application contains settings which are not usually needed and have a high possibility of rendering the modem inoperable if they are set into incorrect values.

To access the Administration application in the LCD GUI, select the Admin Tools icon and press Start. This application requires a PIN code.

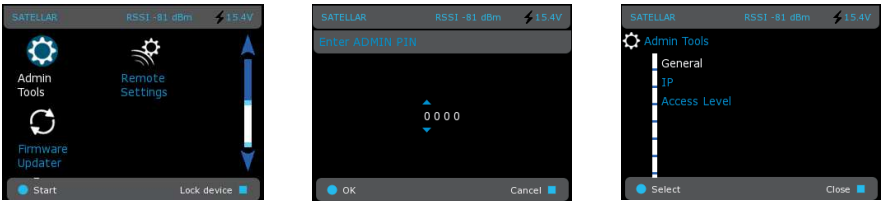


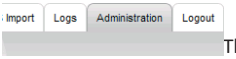
Figure 8.7 Admin tools / Access to Administration applications by CU: Graphical user interface (GUI/LCD)

LCD GUI default pin code	0000

To access Administration application in the WWW User Interface, you need to log out and log in using the admin password.

WWW username	admin
WWW default password	Satel456

After login, the WWW interface has an additional “Administration” tab.



The following setting categories are available in the Administration application.

8.8.1 General

General category of Administration application includes (in WWW interface) a possibility to change SSH password. Method is common in many web-based systems i.e. first input field is for old password, second is for new and third is the same as second i.e. re-typed new password for being able to compare two entries for checking that content is correct.

NOTE: SSH password changed

Change SSH password:

Old SSH password:
New SSH password:
Retype new SSH password:
Change SSH password

Notice that due to security reasons ssh-password cannot be changed with regular http-connection, it requires https.

Change SSH password:

Old SSH password:
New SSH password:
Retype new SSH password:
Cannot change password over HTTP, please change to HTTPS

Item	Explanation	Sub unit	NMSID
Boot Counter RU	This value indicates the number of reboots for the RU.	0	1.119
Error Report RU	The currently active error codes. If an internal error caused the unit(s) to reboot, these values will show what caused the error. In case of problems, please send a screen capture of this page to SATEL technical support.	0	1.797
Error Report CU		1	1.797
ADMIN PIN Code	Allows changing the admin pin code.	1	1.3245
Web GUI Admin Password	Allows changing the WWW interface admin password.	1	1.3260

Table 8.8 Admin tools, General

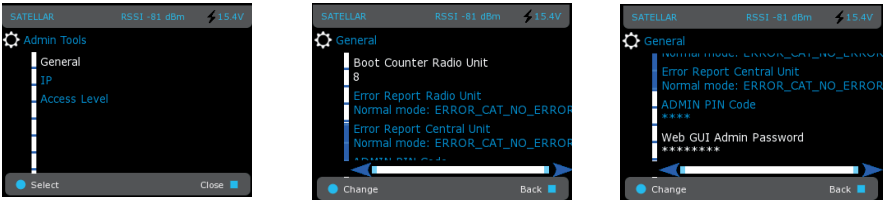


Figure 8.8 Admin tools, General by CU: Graphical user interface (GUI/LCD)

8.8.2 IP

Item	Explanation	Sub unit	NMSID
TUN Base Address	This can be used to change the IP Network address of the radio network. It must be the same in all modems of a network. Only change this if your system already uses the 10.10.32.0/19 network. The default is 10.10.32.0/19. For more information, see chapter 6.1.2.	1	1.3212
Transmission Deny Timeout	A timer given in milliseconds. If the radio unit is unable to send a packet for the time set here, it will be reset. This value should not generally be changed.	1	1.3323
Inactivity Timeout	A parameter that defines the maximum time of inactivity (in seconds) in radio traffic which triggers Central Unit to send a reset command to Radio Unit. If there is a radio traffic jam, the quick reset will solve it but in certain cases the reset may also be caused by the natural inactivity of the traffic. In any case the reset is so short term that it hardly affects radio traffic while still adding robustness of the radio system. Default is 3600 seconds meaning that if no traffic is received or sent via radio, radio is reset. See also Inactivity Timeout Multiplier.	1	1.3352
Inactivity Timeout Multiplier	Usage of this parameter is related to value of inactivity timeout. If inactivity timeout is triggered and reset is done, time for next timeout is not the one in inactivity timeout. Instead it is longer time which is timeout value multiplied with this value. Default is 10 which means that with default inactivity value 3600 seconds the timeout period after reset is 10 x 3600 seconds = 36000 seconds i.e. 10 hours.	1	1.3358

Table 8.9 Admin tools, IP

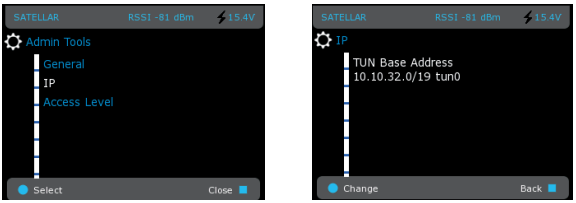


Figure 8.9 Admin tools, IP by CU: Graphical user interface (GUI/LCD)

8.9 Tools

This application contains maintenance, verification and troubleshooting tools.

8.9.1 Ping

This tool is used to verify the reachability of a destination IP address with the standard network administration utility ping. It operates by sending echo requests to the destination address and expecting the response back. These requests are used to measure the round-trip time and packet loss. The ping tool in the WWW interface has the following parameters:

Option	Effect
Destination IP address	The IP address that the requests are sent to. The format used is four integers from the range 0-255, separated by dots. For example: 192.168.1.1 10.10.32.1
Source IP address	The source IP address to be sent with the query. It is selected from a drop-down menu containing all the IP addresses of the unit.
Number of pings	Defines how many messages will be sent to the destination address. If left blank, the messages will be sent continuously until “Stop Ping” is selected.
Packet size	Size of the sent message. Useful parameter to adjust to verify the network operation by simulating user data messages of different sizes.
Interval	How often are new ping requests send

Table 8.10 The ping tool in the WWW interface

Ping and Ping All buttons are shown above the output window. When the button Ping is selected, sending the requests with the provided parameters will start. Results calculated based on the received responses will be shown in the output window. The window is refreshed every 5 seconds until the operation is complete. If some of the parameters are invalid, an error message will be displayed.

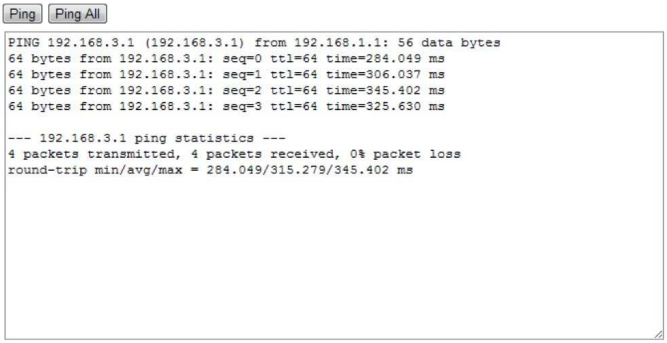


Figure 8.10 Ping error message

When Ping All is selected, then the echo requests will be sent to all gateways known to the unit. The gateways are specified in the Routing -> IP Routes. The parameter of destination IP address will be ignored in this case, but all other parameters will be applied.

When the Ping is running, a third button will appear:

Figure 8.11 Stop Ping -button

When Stop Ping is selected, the currently running Ping operation will be terminated. Leaving the page will not stop the operation. Even if other pages are accessed in the browser, the Ping will still continue running on the background. It will not stop until Stop Ping has been selected.

8.9.2 Traceroute

Traceroute is a network diagnostic tool for displaying the hops taken by the IP packet along the route to the destination. Traceroute also measures and displays round-trip times for each hop. In the resulting listing, the hops are represented by their IP addresses, or if the tool is not able to request information from one of the hops, an asterisk ("*") will be displayed instead. Note that this is not a necessarily an indication of a problem.

There are only two parameters for this tool: the destination IP address and the source IP address. Both have same functionality as with the Ping tool. After the parameters are set, the Traceroute button is selected to start the operation. An example the output of finished traceroute operation:

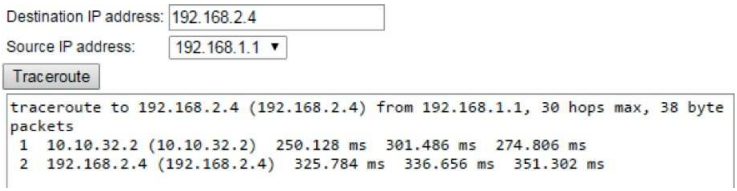


Figure 8.12 Output of the finished Traceroute operation

8.9.3 NMS Value

The NMS value tool is used to show the values of individual settings with the help of NMSIDs. See chapter 5.8 for more information about NMSIDs.

The tool has the following options:

Option	Effect
NMSID	The NMSID of the setting to be shown, for example 1.389. Chapter 7 provides a list of available NMSIDs. Multiple NMSIDs can be provided, separated by whitespace. The maximum number of NMSIDs is 30.
Device	The target device to read the NMSID value from: • 0 for local RU • 4096 for local CU • RMAC of the remote device for remote RU • 4096+ RMAC of the remote device for the remote CU
Display as hexadesimal	If this option is selected, the value of the NMSID will be displayed as hexadesimal.
Display only value	If this option is selected, only the returned value will be sown. All other information, for example messaging, will be omitted.

Table 8.11 NMS Value options

Select the button Show Value to start the operation. As a result, the output will appear in the text field. See the following picture for an example output:

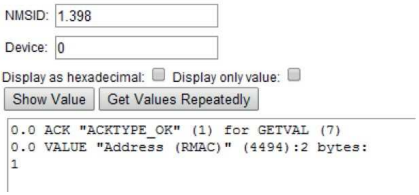


Figure 8.13 Output of the NMS Value

The result consists of three rows. The first row is an acknowledgement message from the device. The next row contains the name of the parameter that was queried and the size of the value in bytes. The third row contains the actual value. In case of errors, for example if the queried NMSID is unknown, the second row shows an error message and the third row will be omitted.

If the button Get Values Repeatedly is selected, the values will be queried respectively, until the button Stop NMS Value Fetching is selected. Leaving the page will not stop the process. The Stop NMS Value Fetching button is also available, when multiple NMSIDs are inserted and the query process is running.

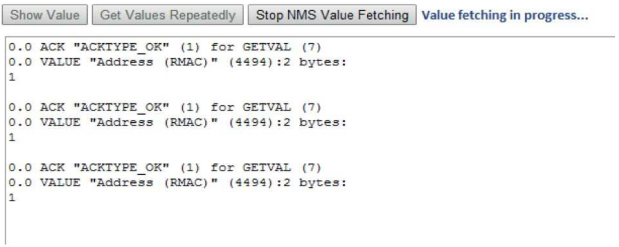


Figure 8.14 Stop NMS Value Fetching

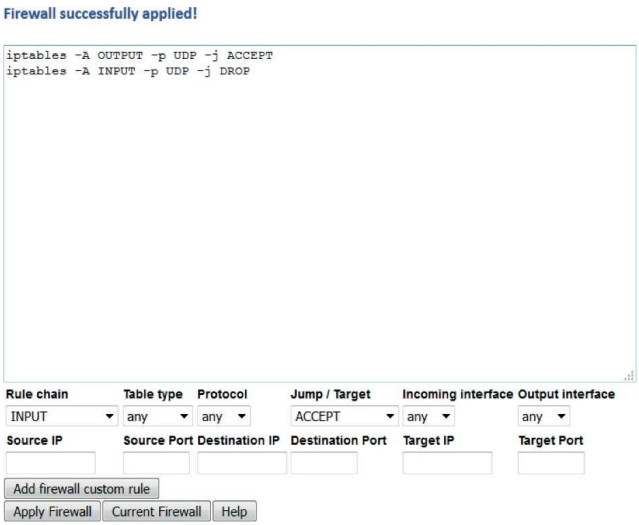
8.9.4 Firewall and NAT

This tool is used to set up a firewall to the SATELLAR with the Linux tool iptables. This is a feature for advanced users, and using it in the wrong way can easily block essential IP traffic. This manual will not explain the usage of iptables itself, more information about the tool can be found at http://www.iptables.org

The tool page in the WWW interface contains one editor window, four buttons and group of input fields and drop downs for custom rule creation. Valid iptables commands may be written into the window, each command on a new line. The commands will be applied when the button “Apply Firewall” is selected.

If the button “Current Firewall” is selected, a new window will open showing the current firewall rules (if any). The third button “Help” displays the help text of the iptables tool.

An example allowing outgoing but blocking incoming UDP traffic can be seen in the following figure:



It is also possible to use helper fields for creating firewall rules. Page contains selection of inputs and drop downs that can be used to create rule:

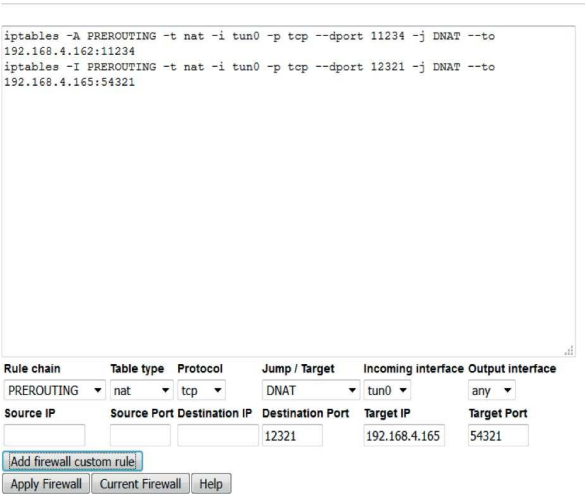
- Rule Chain
  - INPUT: Handles incoming traffic Right before being handed to a local process.
  - OUTPUT: Handles outgoing traffic Right after being created by a local process
  - FORWARD: Handles traffic that is forwarded for any packets coming in one interface and leaving out another
  - POSTROUTING: Handles and modifies routable traffic after routing Right before leaving an interface
  - PREROUTING: Handles and modifies routable traffic before routing, immediately after being received by an interface.

- Table type
    - Any: concerns all traffic
    - Filter: This is the default table (if no -t option is passed). It contains the built-in chains INPUT (for packets destined to local sockets), FORWARD (for packets being routed through the box), and OUTPUT (for locally-generated packets).
    - Nat: This table is consulted when a packet that creates a new connection is encountered. It consists of three built-ins: PREROUTING (for altering packets as soon as they come in), OUTPUT (for altering locally-generated packets before routing), and POSTROUTING (for altering packets as they are about to go out).
    - Mangle: This table is used for specialized packet alteration. PREROUTING is used for altering incoming packets before routing, OUTPUT for altering locally-generated packets before routing, INPUT for altering packets coming into the box itself, FORWARD for altering packets being routed through the box, and POSTROUTING for altering packets as they are about to go out.
    - Raw: This table is used mainly for configuring exemptions from connection tracking in combination with the NOTRACK target. It registers at the netfilter hooks with higher priority and is thus called before ip_conntrack, or any other IP tables. It provides the following built-in chains: PREROUTING (for packets arriving via any network interface) OUTPUT (for packets generated by local processes)
    - Security: This table is used for Mandatory Access Control (MAC) networking rules, such as those enabled by the SECMARK and CONNSECMARK targets. Mandatory Access Control is implemented by Linux Security Modules such as SELinux. The security table is called after the filter table, allowing any Discretionary Access Control (DAC) rules in the filter table to take effect before MAC rules. This table provides the following built-in chains: INPUT (for packets coming into the box itself), OUTPUT (for altering locally-generated packets before routing), and FORWARD (for altering packets being routed through the box).
- Protocol
    - Any
    - Tcp
    - Udp
    - Icmp
- Jump i.e. type of traffic handling
    - ACCEPT: Accept type(s) of traffic defined with this option
    - DROP: Drops type(s) of traffic defined with this option, does not send any response
    - REJECT: Prohibit type(s) of traffic defined with this option from passing. Differs from drop so that sends an ICMP destination-unreachable back to the source host) unless the ICMP would not normally be permitted, e.g. if it is to/from the broadcast address).
    - SNAT: Changes the source address of connections to something different, typical example is home network where modem acts as a NAT machine having a public IP and home network devices are having internal IPs. Each outgoing packet is modified having source IP of modem. This is done in the POSTROUTING chain
    - MASQUERADE: Specialized case of Source NAT called masquerading. Does not require source address explicitly with masquerading: it will use the source address of the interface the packet is going out from
    - DNAT: Modifies the target address (and possibly port) of packet just as the packet comes in; this means that anything else on the Linux box itself (routing, packet filtering) will see the packet
    going to its `real' destination. Probably most common case is port forwarding where device with

this rule acts as a relay and when receiving the packet to certain port, changes the target to something else and packet forwarded to that new target. This is done in the PREROUTING chain.
- REDIRECT: Similar to masquerade, there is a specialized case of Destination NAT called redirection. It is a simple convenience which is exactly equivalent to doing DNAT to the address of the incoming interface. So, redirect is used to alter the port of incoming packet to something else for incoming interface and acts only internally whereas DNAT includes a wider scope of functionality and can be used either for internal or external targeting.

Not all fields are needed for all rules, the needed values depend on the case. When the needed fields have been set, rule can be created with “Add firewall custom rule button”. This does not yet save and set the rule to system so it can be ignored with e.g. reloading the page or edited manually in editor window.

An example setting all traffic incoming from radio tun0 interface port 12321 target address to 192.168.4.15 and port to 54321 by using helper fields can be seen in the following figure:



ID description of firewall array.

Attribute	Explanation	Sub unit	NMSID
Firewall Rule	Array of firewall rules	1	1.3734

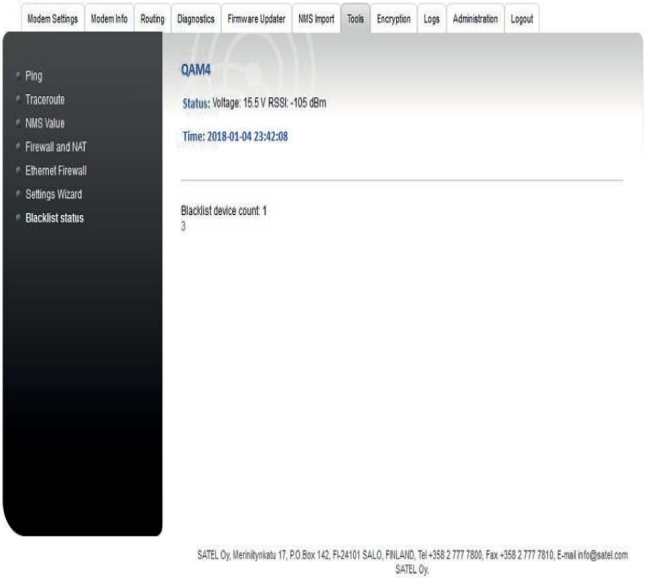
More detailed syntax and content of iptables rules in general can be found from iptables.org

8.9.5 Ethernet Firewall

Guidance for Ethernet Firewall usage can be seen from Chapter 7.11.3 Ethernet Firewall.

8.9.6 Blacklist status

Blacklist status presents the possible list of devices which are blocked. This is related to functionality which monitors the communication to other devices and if some device is noticed as non-responsive, it is blacklisted i.e. blocked for a while. More information about this functionality can be read from radio unit user guide.
First line presents the amount of devices, next lines define the RMAC addresses of blocked devices.

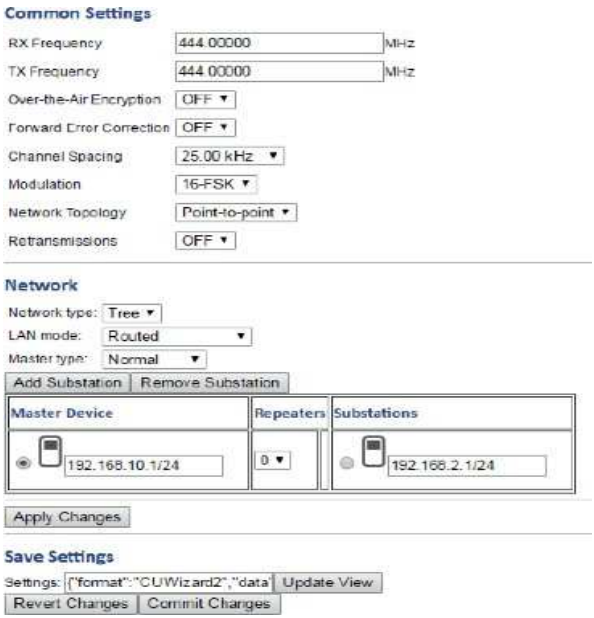


The default case is zero devices blacklisted.

8.9.7 SATELLAR CU Settings Wizard

The Setting Wizard can be used to create a small and simple network. To create a larger network an external tool like NETCO should be used. Example of simple network creating can be found from manufacturer's web site.

The main view looks like this:



The page is divided into three sections: Common Settings, Network and Save Settings.

Common Settings lists some basic radio parameters that need to be the same in each device in order for the network to work. The Network section allows the user to create a network topology and show where the current device exists in the network. The last section allows the user to store the settings, as well as take them into use.

8.9.7.1 Basic Usage

Creating a network can be roughly divided into four stages:

- Select radio settings
- Create network topology
- Save the settings to the device
- Copy the settings to the other devices in the network

The first step is simple, just set all the visible fields to the correct values. The changes will be reverted if the page is reloaded at some point. They can be saved by selecting "Apply Changes". This will not yet take

the settings into use in the device.

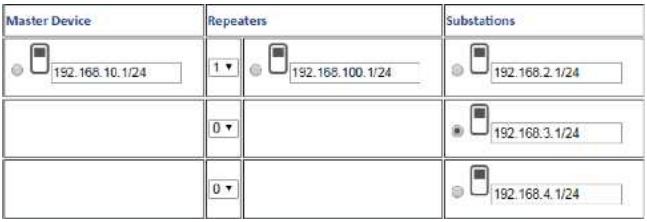
Next, the network topology must be created. The wizard supports creating a network with one master device and a number of substations. Each substation can have 0-2 repeaters between it and the master. Selecting "Add Substation" adds new rows to the network table. After that the number of repeaters can be selected from the drop-down menu. Finally, an IP address and mask must be given for each device.

Substations can be removed by selecting "Remove Substation".
In addition to creating the topology, the network section has three global parameters that affect the network as a whole. They can be set from the two drop-down menus above the device view:

- Network type:
  - Tree: all the substations (and their repeaters) are connected to the master only, and not other substations
  - All: Every device in the network can connect to any other device
- LAN mode:
  - Routed: The devices are connected with IP routes
  - Proxy ARP*: Like routed, but Proxy ARP is enabled
  - Bridge Open: The devices will form one bridge, that will connect any connected devices
  - Bridge Restricted*: Like open bridge, but only listed devices are allowed into the bridge
- Master type:
  - Normal: One SATELLAR
  - Redundant: Two physical SATELLAR devices, forming one redundant master

*) This mode allows non-SATELLAR devices to be added to the network, see section 8.9.5.2 for more information.

After the settings and the topology are all set, it is time to save the settings into the device. Before that, the wizard must know what device is being configured right now. The current device is set by selecting the radio button next to the correct device in the network view. So for example if we were storing the settings to the second substation, the selection would look like this:



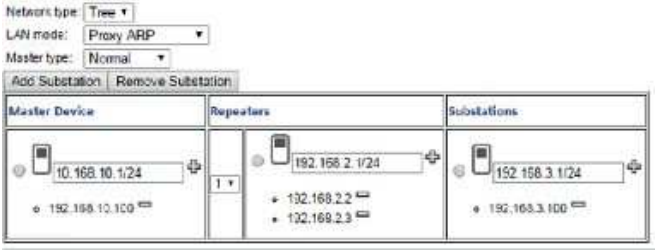
Selecting "Apply Changes" will store the current setup as text into the text box. This text works two ways. It stores the current setup, but the settings text can also be copied from another wizard. After that if "Update View" is selected, the settings from the text will be applied to the current view. This is a simple way of copying the settings from one device to another.

After the settings are set and stored, selecting Commit Changes will configure the device. The settings are saved with NMS Import, and the web page is redirected there. After the import process has finished, the device is configured.

8.9.7.2 Adding non-SATELLAR devices to the network

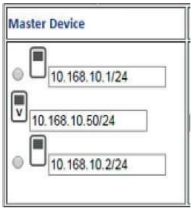
If Proxy ARP or Bridge Restricted is used, the user can add generic IP devices to the network. In Proxy ARP those generic devices are used so that the SATELLARs can route to those devices as well. With bridge, those are the devices that are allowed into the bridge.

When it is possible to add IP devices into the network, a plus symbol appears next to each device. Selecting the plus will add one device into the network that is connected locally to the SATELLAR. The devices can be removed with the minus symbol.



8.9.7.3 Redundant master

If the master type is redundant, the master part of the network is different:



The redundant master consists of two physical devices using VRRP. Both devices need individual IP addresses, as well as a common virtual IP address that will be the IP address of the redundant master. The master settings need to be stored to two different devices.

9. Type designation

The label of the CU is located on the back of the CU.

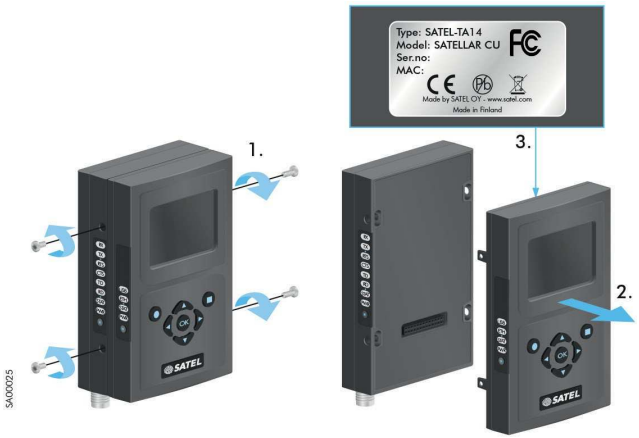


Figure 9.1 Location of the labels in CU

10. Troubleshooting

10.1 Error codes

If the MCU detects an error in operation, it indicates the error state by LEDs in the following way:

At first all the LEDs are switched on for one second. Thereafter all the LEDs are switched off for one second and then an error code is shown for three seconds. This sequence is repeated for approximately one minute or until the MCU is restarted. In some cases the error causes the unit to restart automatically.

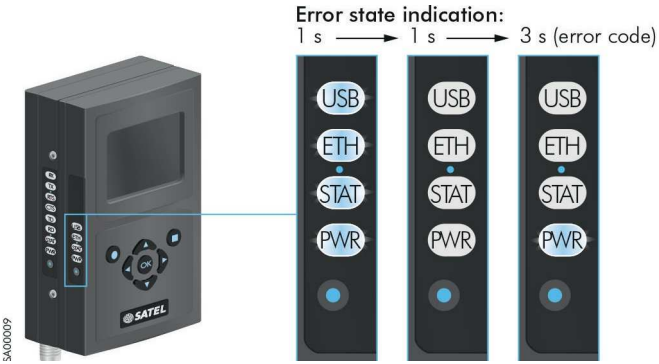


Figure 10.1 Error state and error code indicated by LEDs

For displaying the error codes the four LEDs indicates a binary number, USB LED is the first (MSB) and PWR LED the last (LSB). LED switched on means bit '1'. The error codes are the following:

	Binary	Error code	Description
	0001	1	USB over current
	0010	2	USB under voltage
	0011	3	Ethernet interface problem
	0100…1111	4…15	Reserved for future needs
	0000	0	Not used

Table 10.1 Error codes

11. SATEL open source statements

11.1 LGPL and GPL software

This SATEL product contains open source software (OSS), licensed under LGPLv2, GPLv2, GPLv3 and other licenses.

License details for LGPLv2.1 are available from http://www.gnu.org/licenses/lgpl-2.1.html
License details for GPLv2 are available from http://www.gnu.org/licenses/old-licenses/gpl-2.0.html
License details for GPLv3 are available from http://www.gnu.org/licenses/gpl-3.0.html

ALL OPEN SOURCE SOFTWARE used in this software is distributed WITHOUT ANY WARRANTY and is subject to copyrights of one or more respective authors. For more details, see the GPL and LGPL license texts.

11.2 Written offer for LGPL and GPL source code

Where such specific license terms entitle you to the source code of such software, SATEL will provide upon written request via email and/or traditional paper mail the applicable LGPL and GPL source code files via CD-ROM for a nominal fee to cover shipping and media charges as allowed under those respective licenses.

Contact SATEL Technical support for more details: Please visit http://www.satel.com

12. Settings selection guide

12.1 Modem Settings

Menu	Submenu	Value (* = default, but if NETCO synchronization has been done values may have been changed)
Network	NetID	Satel NG* (max 8 characters)
Protocol Mode	Address (RMAC)	FSK: 0001* (1 - 4093)
		QAM: 0001* (1 - 1022)
	Protocol Mode	Basic-RX Priority
		Basic-TX Priority
		Basic-Repeater
		Packet Routing *
Radio	TX Frequency	460.000000 MHz (Depends on hardware configuration)
	RX Frequency	460.000000 MHz (Depends on hardware configuration)
	RF Output Power	100, 200, 500 mW, 1*, 2, 5 W
	Signal Threshold	-114 dBm *
	Over the Air Encryption	OFF * / ON (FSK: AES-128, QAM: AES-128 / AES-256)
	Sensitivity Enhance	FSK: OFF*, Half FEC, Two-thirds FEC (Forward Error
		Correction) QAM: OFF, ON* (Trellis Encoding)
	Channel Spacing	FSK: 12.5, 25*, 150 kHz
		QAM: 6.25, 12.5, 25* kHz
	Modulation	FSK: 2-, 4-*, 8-, 16-FSK
		QAM: 2-, 4-, 8-, 16-, 32-, 64-QAM
	Mobile mode	OFF*, ON
	Auto QAM SNR Level	0 dB*
	Encryption Compatibility Mode	QAM: Legacy Mode*, Improved Robustness
	Link Specific Modulation	QAM: OFF*, Manual, Auto
Serial Connector Configuration	Radio Unit Port Assignment	NONE
		MCU UARTS TO SATBUS *
		DATA UART TO RADIO D9 RD/TD
		DATA UART TO RADIO D9 RD/TD - NMS TO D9
		DTR/DSR DATA UART TO RADIO D9 RD/TD - NMS TO D9 RTS/CTS DATA UART TO RADIO D9 RD/TD - NMS TO SATBUS MCU UARTS TO SATBUS CAN
	DTE Port Physical Communication Mode	RS-232 (with handshaking)
		RS-422, RS-485, FD-RS485 (without handshaking)

Menu	Submenu	Value (* = default, but if NETCO synchronization has been done values may have been changed)
Data Port Settings	Rate	1200, 2400, 4800, 9600, 19200 *, 38400, 57600, 115200 bps
	Data Bits	7, 8 bits *
	Parity	No Parity Check *, Even, Odd
	Stop Bits	1 bit *, 2 bits
Serial Data Flow Control	TX Delay	0 * (0 - 65535)
	CRC	OFF / ON *
	Handshaking CTS Line	Clear To Send, TX buffer state *, RSSI Threshold, Always ON
	Handshaking RTS Line	Ignored *, Flow control, Reception control
	Handshaking CD Line	RSSI Threshold *, Data on channel, Always ON
	Pause Length	3 bytes * (3 -
	255) Maximum Number of Accepted Errors	0 * (0 - 255)
Packet Mode Radio Access Control	Network Topology	FSK: Point-to-point *, Repeater, Fast mode
	Handshaking	QAM: OFF / ON *
	Packet Expiration Time	0 * (0 - 65535) QAM-product only
	Retransmissions	OFF / ON *
	Back Off Counter	FSK: 8 * (4 - 63)
	Minimum Back Off Counter Value	QAM: 4 * (1 -
	1023) Blacklist Enabled	QAM: OFF*, ON
	Link Specific Handshake	QAM: OFF*, ON
	Link Specific Retransmission	QAM: OFF*, ON
General	Name	SATELLAR * (1 - 30 characters)
	PIN Code	0000 * (4 numbers: 0000-9999)
	Temperature Unit	Celsius *, Fahrenheit, Kelvin
	Temperature Min	+0 (-50 - +80 Celsius)
	Temperature Max	+50 (-50 - +80 Celsius)
	SNR Critical Level	0 (0 - 35)
	UI Voltage Critical Level	9 V * (9 - 30 V)
	UI RSSI Critical Level	-110dBm * (-100 - -118dBm)
	UI Voltage Display Mode	Numeric * / Bar
	UI Voltage Bar Min	9 * (9 - 30 V)
	UI Voltage Bar Max	30 * (9 - 30 V)
	PIN Code Required	No * / Yes
	USB Device Mode	Serial Port * / Mass Memory
	Display Brightness	255 * (0 - 255)
	Web GUI Password	Satel123 * (8 characters)
	GUI Color Profile	Blue / Black *
	LCD Timeout	2560 s * (1 - 65535 s)

Menu	Submenu	Value (* = default, but if NETCO synchronization has been done values may have been changed)
Services	SSHD State	OFF / ON *
	HTTPD State	OFF / ON *
	NMSBluetoothd State	OFF / ON *
	NMSTcpsocketd State	OFF / ON *
	NMSLoggerd State	OFF / ON *
	Linklayer State	OFF / ON *
	NMSGathererd Timeout	5000 ms * (1000 - 65535 ms)
	NMSLoggerd Interval	3000 ms * (1000 - 65535 ms)
	NMSLoggerd Timeout	5000 ms * (1000 - 65535 ms)
	NMSLoggerd Retries	2 * (0 - 10)
	RU Commslogd State	OFF / ON *
	SNMPD State	OFF / ON
	USB Host Control	OFF / ON *
	UI Power Control	OFF / ON *
	HTTPD IP Address	All local addresses
	SSHD IP Address	All local addresses
	NMSTcpsocketd IP Address	All local addresses
	OSPFD State	OFF* / ON
	OSPFD Telnet Port	2604* (1-65535)
	OSPFD IP Address	All Local Addresses
	RT Logger	QAM: OFF*, ON
	RT Logger Query Interval	QAM: 10 s*
	RT Logger Backup Interval	QAM: 30*
	Automatic Modulation Monitoring	QAM: OFF*,
	ONAutomodulation Monitoring Interval	QAM: 10 s
Commands	Restore Default Factory Settings Radio Unit	Do not reset / Reset
	Restore Default Factory Settings Central Unit	Do not reset / Reset
	Reset Radio Unit	Do not reset / Reset
	Reset Central Unit	Do not reset / Reset
	Reboot Central Unit	Do not reboot / Reboot
	Statistical Counters Clear	Do not clear / Clear
Remote Devices	Pre-Cache All Settings of Device	OFF * / ON
	Diagnostics Polling of Device	OFF* / ON
SNMP	SNMP RO Community	public
	SNMP RW Community	private
	SNMP RW Community IP	0.0.0.0
	SNMP Notification IP	192.168.1.2
	SNMPv3 User name	user123

Menu	Submenu	Value (* = default, but if NETCO synchronization has been done values may have been changed)
	SNMPv3 User Type	Read-write* / Read-only
	SNMPv3 USM Security Type	No Auth*/MD5 No Priv/SHA No Priv/MD5 DES/SHA DES/MD5 AES/ SHA AES
	SNMPv3 Authentication Passphrase	pass123word
	SNMPv3 Privacy Passphrase	pass123word
	SNMP Listening IP Address	0.0.0.0
	Notification interval	30 (10-600 s)
	Voltage Notification	OFF* / ON
	RSSI Notification	OFF* / ON
	Temperature Notification	OFF* / ON
	SNR Notification	OFF* / ON
	Commit Notification	OFF* / ON
	Redundancy Notification	OFF* / ON
	Automatic Commit	OFF*/ON
	Link Info Collector	OFF*, ON
	Link Info Collector Timer	10 s*
Time Control	Time Operation Mode	No time operation *, Manual time operation, NTP time
	NTP Server Address	192.168.1.1 *
	NTP Request Source IP Address	All local addresses
	NTP Interval	100 s *
	Time	1-1-2016 00:00:00 *
	Time Zone	Greenwhich Mean Time *
		Central European Time (GMT+1)
		East European Time (GMT+2)
		Moscow Time (GMT+3)
		Iran Standard Time (GMT+3:30)
		Iran Daylight Saving Time (GMT+4:30)
		Mauritius Time (GMT+4)
		Afghanistan Time (GMT+4:30)
		Pakistan Time (GMT+5)
		Indian Standard Time (GMT+5:30)
		Nepal Time(GMT+5:45)
		Bhutan Time(GMT+6)
		Myanmar Time (GMT+6:30)
		Bangladesh Standard Time(GMT+7)
		China Standard Time(GMT+8)
		Apo Island Time (GMT+8:15)
		Australian Central Western Standard Time (GMT+8:45)
		Japan Standard Time (GMT+9)
		Australian Central Standard Time(GMT+9:30)
		Australian Eastern Standard Time (GMT+10)
		Australian Central Daylight Time (GMT+10:30)

Menu	Submenu	Value (* = default, but if NETCO synchronization has been done values may have been changed)
		Vanuatu Time (GMT+11)
		New Zealand Standard Time (GMT+12)
		New Zealand Daylight Time (GMT+13)
		Chatham Island Standard Time (GMT+12:45)
		Chatham Island Daylight Time (GMT+13:45)
		Line Island Time (GMT+14)
		Baker Island Time (GMT-12)
		Samoa Standard Time (GMT-11)
		Hawaiian Standard Time (GMT-10)
		Marquesas Island Time (GMT-9:30)
		Alaska Standard Time (GMT-9)
		Pacific Standard Time (GMT-8)
		Mountain Standard Time (GMT-7)
		Central Standard Time (GMT-6)
		Eastern Standard Time (GMT-5)
		Venezuela Standard Time (GMT-4:30)
		Atlantic Standard Time (GMT-4)
		Atlantic Daylight Time (GMT-3)
		Newfoundland Standard Time (GMT-3:30)
		Newfoundland Daylight Time (GMT-2:30)
		Brazilian Standard Time (GMT-3)
		Brazilian Eastern Standard Time (GMT-2)
Testing and Calibration	Carrier Test	OFF* / ON
	Carrier Test Timeout	0 (0 - 65535 s)
	Fast RSSI Scan	OFF* / ON
	RSSI RMAC Address	4096 (1 - 4096)
NMS Modbus	NMS Modbus Service	ON / OFF*
	Slave ID	1* (0 - 247)
	Protocol	Modbus RTU*/Modbus TCP/Modbus RTU over TCP
	TCP Port	502* (1 - 65535)
	Binding IP Address	All local addresses
	Serial Port	D9*/USB-A, Radio
	Register Mapping	See section 7.1.9
ATPC	Automatic TC Power Control	OFF* / ON
	Target RMAC Address	1* (1 - 4095)
	Target RSSI Floor	-85* (-127, 127)
	Allowed RSSI Range	10* (0 - 255)
	Update Period	60* (15 - 65535)

12.2 Routing

Menu	Submenu	Value (* = default, but if NETCO synchronization has been done values may have been changed)	
Packet Routing	see chapter 7.3.1		
Array			
IP	IP Address (eth0)	192.168.2.1/24 *	
	Secondary IP Address **)	192.168.1.1/24 eth*	
	Ethernet Speed	Auto *, 10 Mbps, 100 Mbps	
	Automatic IP State	OFF * / ON	
	Ethernet Duplex	Full * / Half	
	IP Queue Max Time Length	5000 ms * (1 - 65535 ms)	
	IP Queue Max Packets	10 * (1 - 65535)	
	IP MTU Size	1500 Bytes	
	Proxy ARP	OFF * / ON	
	IP Header Compression	OFF*, Van Jacobson, ROHC	
	USB Ethernet IP Address (eth1)	192.168.10.1/24*	
	USB Ethernet Secondary IP Address	192.168.1.1/24 eth*	
WLAN	SSID	Satellar*	
	WPA-PSK Passphrase	satellar*	
	IP Address	192.168.0.242/28* wlan0	
	Proxy ARP	OFF*, ON	
VLAN	see chapter 7.5		
IP Route	see chapter 7.3.3		
Route Monitoring	Check Interval Only Check With Traffic	60 (30 - 65535 s)	Yes / No*
	Allowed Fail Count	2 (0 - 65535)	
	Only Monitor Primary	Yes / No*	
	Revert Timer	300 (0 - 65535 s)	
	Ping Timeout	10 (0 - 65535 s)	
VRRP	VRRP State	OFF* / ON	
	VRRP Virtual IP Address	0.0.0.0/24	
	VRRP Virtual Router ID	0* (1 - 255)	
	VRRP Priority VRRP advertisement Interval	100 (2- 255)	1 (1 - 65535 s)
	VRRP Check Target Radio IP	0.0.0.0	
	VRRP Inetrface	eth0	
	VRRP Check Target Local IP	0.0.0.0	
	VRRP Virtual RMAC	0 (0 - 4095)	
	RF Link	OFF*, ON	

Serial IP	Serial IP Mode	OFF*/Server mode/Client mode/Send only/Receive only/ Twoway mode
	Port Rate	1200 bps/2400 bps/4800 bps/9600 bps/19200 bps/38400 bps/57600 bps/115200 bps*/460800 bps
	Port Data Bits	7 bits / 8 bits*
	Port Parity	No Parity Check* / Even / Odd
	Port Stop Bits	1 bit* / 2 bit
	Protocol	TCP*/ UDP/ Telnet/ Bulk Mode
	Listening Port	2005 (1 - 65535)
	Destination Port	2006 (1 - 65535)
	Destination IP Address	10.10.32.1
	Sender Retry Count	5 (0 - 255)
	Sender Retry Interval	1000 (500 - 65535 s)
	UDP Listener Port Timeout	5 (0 - 65535 s)
	Remote Control Port Mode	OFF* / ON
	Remote Control Port Rate	9600 bps/19200 bps/38400 bps/57600 bps/115200 bps*/460800 bps
	Remote Control Port	2007 (1 -
	65535) Minimum Packet Characters	1 (0 - 255 bytes)
	Packet Creation Timeout	0.0 (0 - 255 s)
	Local Ip Address	All local addresses
	Serial Output	Serial Port* / Radio
Application Routing	Application Protocol	OFF* / DNP3 / Modbus RTU / Modbus TCP / NMEA 0183 / Custom Protocol / IEC101 / Sinaut ST1/ST7
	Application Transport Protocol	TCP* / Serial Port
	Application Listening Port	20000 (1 – 65535)
	Serial Port	D9* / USB-A / Radio
	Port Rate	1200 bps/2400 bps/4800 bps/9600 bps/19200 bps/38400 bps/57600 bps/115200 bps*/460800 bps
	Port Data Bits	7 bits/8 bits*
	Port Parity	No Parity Check*/Even/Odd
	Port Stop Bits	Port Stop Bits, 1 bit*/2 bits
	Transport Protocol For Substation Data	TCP / UDP*
	Destination Port For Substation Data	2006 (1 – 65535)
	Listening Port For Substation Data	2005 (1 – 65535)
	Application Listening IP Address	All local addresses
	Address Mapping	Application Address To RMAC* / Manual / Point-to-point
	Custom Address Offset	0* (0 - 255)
	Custom Address Length (bits)	8* / 16
	Maximum Serial Packet Size	255
	Address Mapping Row**)	1 10.10.32.1

QoS	DSCP Marking	See chapter 7.10
	Traffic Rule	See chapter 7.10
Bridge	Bridge	OFF*, Open (deprecated), Restricted (deprecated), GRETAP, GRETAP Tagged, Broadcast (QAM), Broadcast All (QAM)
	Allowed IP	Empty by default
	Spanning Tree	OFF*, STP, Rapid STP
	Priority	32768*
Proxy	Proxy	See section 7.11
IEC	IEC	OFF * / ON
	T1 Timeout	0-65535 (10) seconds
	T3 Timeout	0-172800 (500*) seconds
	IEC 101 Poll timeout	0-65535 (3000*) milliseconds
	Error Object Address	0- 4294967295 (500*)
	Device port	D9 *, USB-A
	Port Rate	1200, 2400, 4800, 9600, 19200 *, 38400 bps
	Port Data Bits	7, 8 * bits
	Port Parity	No parity check, Even *, Odd
	Port Stop Bits	1 *, 2 bits
	Link Address Length	0, 1 *, 2 bytes
	ASDU Address Length	1, 2 * bytes
	Object Address Length	1, 2, 3 * bytes
	Cause-of-transmission Length	1, 2 * bytes
	Primary Remote IP Address	IP address (0.0.0.0 i.e. any address *)
	Redundant Remote IP Address	IP address (0.0.0.0 i.e. any address *)
	Local IP Address	Available IPs in device (All local addresses i.e. no limitation*)
	2nd Primary Remote IP Address	IP address (0.0.0.0 i.e. any address *)
	2nd Redundant Remote IP Address	IP address (0.0.0.0 i.e. any address *)
	2nd Local IP Address	Available IPs in device (All local addresses i.e.no limitation *)
	IEC 101 Station	0-65535 (No stations *)
SNMP	Cost	100*
	Hello Time	2*
	Max Age	20*
	Forward Delay	15*
	USB Ethernet Bridge State	OFF*, ON
VPN	VPN	OFF*, ON
	Server IP Address	0.0.0.0*
	Handshake Window	3600s*
	Connection Check Interval	10s*
	Traffic time gap for reconnection	35s*
	VPN IP	Undefined*
	Authentication	SHA1*, MD5, SHA224, SHA256, SHA384, SHA512
	Cipherin	OFF*, Blowfish, CAST5, AES-128 CBC, AES-128 CFB, AES-128 OFB, AES-192 CBC, AES-192 CFB, AES-192 OFB, AES-256 CBC, AES-256 CFB, AES-256 OFB, AES-256 CFB1, AES-256 CFB8
	Substation	1*

DHCP	DHCP State	OFF*,ON
	DHCP Lease Time	864000*
	DHCP Static Lease Mode	OFF*, ON
	DHCP Start Of IP Lease Block	0.0.0.0*
	DHCP End Of IP Lease Block	0.0.0.0*
	DHCP Subnet Mask	0*
	DHCP Interface	Default eth0*
	DHCP VLAN ID	0*

12.3 Administration

Menu	Submenu	Value (* = default)
General	ADMIN PIN Code	0000 * (0000 - 9999)
	Web GUI Admin Password	Satel456 * (8 characters)
IP	TUN Base Address	10.10.32.0/19 *
	Transmission Deny Timeout	20000* (1 -
	4294967295) Inactivity Timeout	3600*
	Inactivity Timeout Multiplier	10*

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