CORDIS ARRAY II

Operation manual

DOCUMENT TITLE	Cordis Array II Operation manual						
Project							
Archive ref.	2.01.0280						
Revision	1	2	3	4	5	6	7
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Date	17.10.19	08.01.20	10.06.20	13.11.20	20.05.21	06.10.22	
Approved	HSH	TB	LG	AS	AS	SA	
Date	25.10.19	08.01.20	25.06.20	16.11.20	20.05.21	06.10.22	

Document history

Document number: 2.01.0280 / Revision 6.00		
Rev. 1.00	October 2019	First version. Mostly based on short form manual.
Rev. 2.00	January 2020	Structural change.
Rev. 3.00	June 2020	Small changes in the procedure and implemented advanced functions.
Rev. 4.00	November 2020	Change procedure and features for 2.15 release.
Rev. 5.00	May 2021	Added crypto procedure and password authentication description for 2.19 release.
Rev. 5.10	August 2021	Revised description regarding synchronized multi network site.
Rev. 5.20	October 2021	Added description about QoS priority function under 3.4.9.2.
Rev. 6.00	September 2022	Revised status description and updated according to 2.21 release.

Copyright

Note

Cordis Array II

Operation manual

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1 SYSTEM OVERVIEW

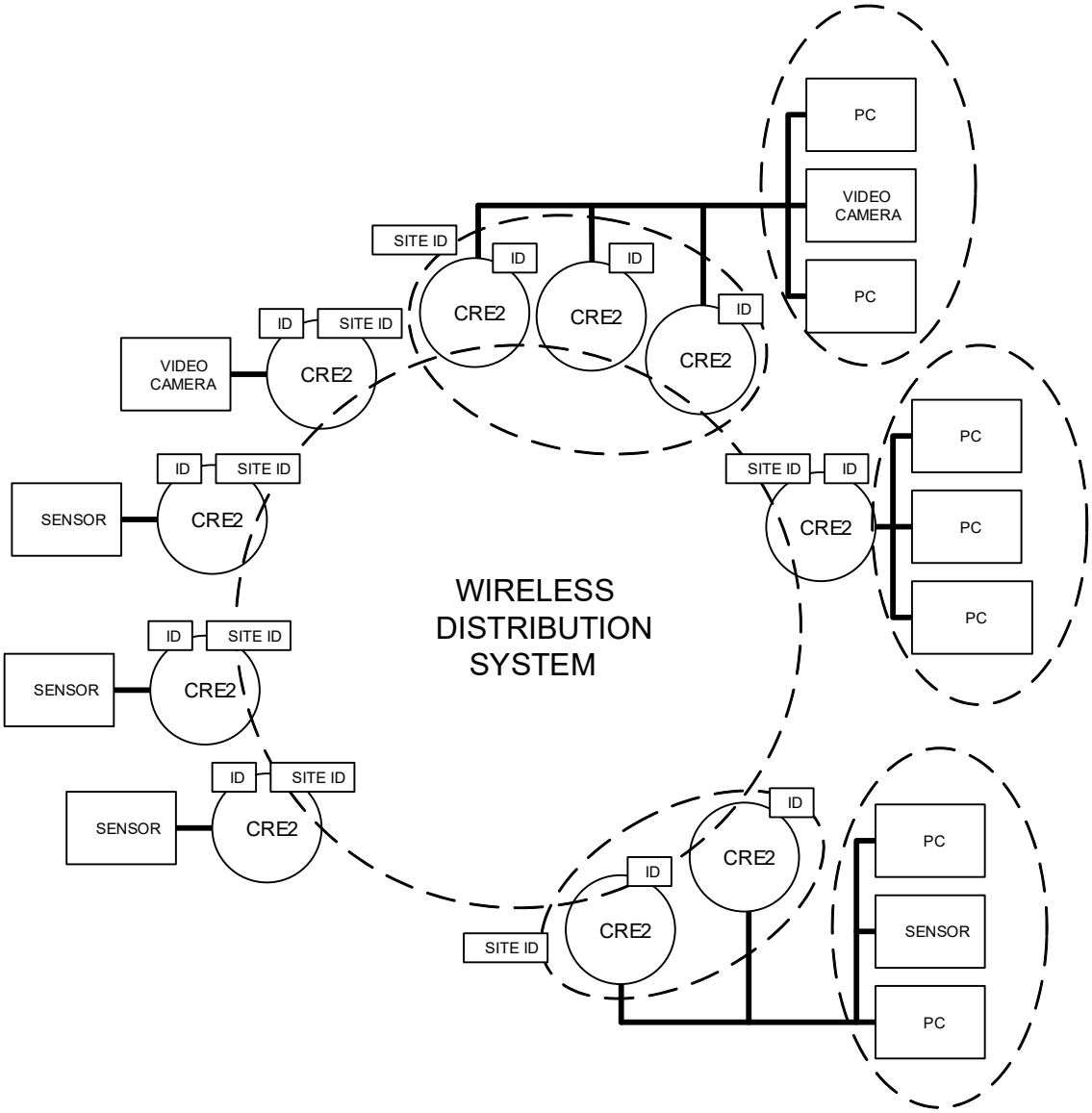


Figure 1 CRE2 network architecture

The network configuration as shown in Figure 1 illustrates the combination of sensors and systems attached to the wireless distribution system provided by the Cordis Array II phased array antennas.

Wireless routing is performed on network layer 2, the same layer as wired ethernet. For connected networking equipment, the wireless system will behave similarly to an ethernet switch. For the system to work the IP and subnet mask of all connected networking units must be preconfigured in all CRE2 units.

The IP range of the connected units can be selected freely for communication over the wireless link, but the user must be aware that IP address conflicts must be resolved for the entire network.

2 DEFINITIONS

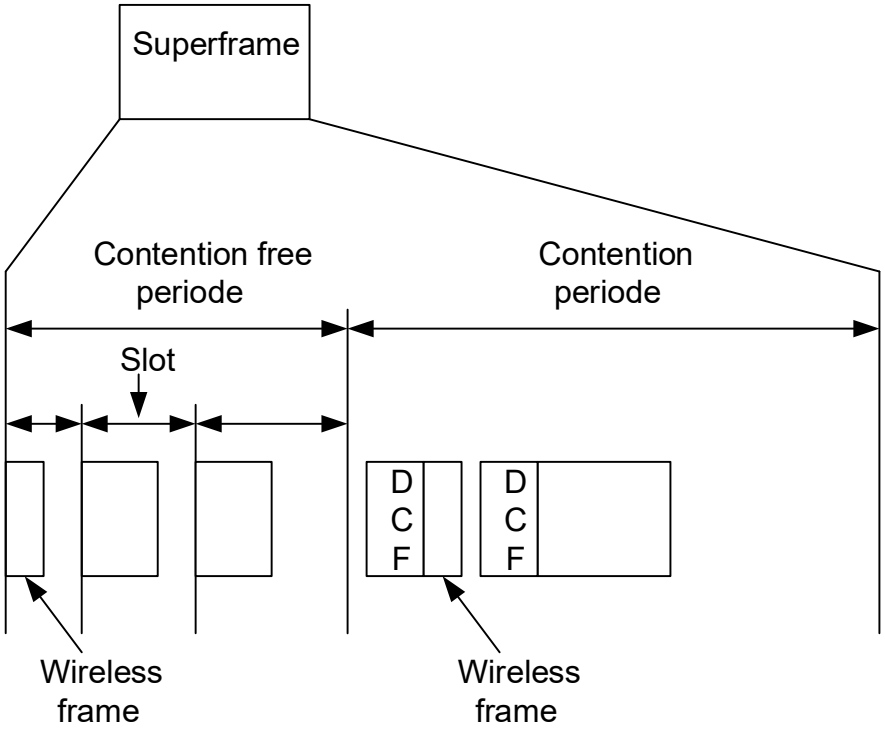


Figure 2 Wireless transmission timing

ID is a unique ID for every single equipment unit. The global ID database is maintained by Radionor.

Site ID is a unique ID for a site for a single CRE2 or a group of CRE2s that is installed at the same physical location.

Wireless profile is a wireless configuration defining wireless parameters that need to be common for all CRE2 in an operating network such as operating frequency, length of contention free/contention periode, superframe length etc. All CRE2 in the network must have the same profile for optimum operation. The CRE2 unit has a factory programmed default profile, and the context may be different according to the geographical area which the CRE2 operates or changed during operations.

Wireless frame is the smallest wireless entity on the air and consist of modulated digital data by the wireless PHY. See Figure 2 for details. The wireless frame consists of two parts, a PLCP

part modulated with a robust, fixed data rate in the network and a PSDU which can be set to various data rates. A receiver can decode different data rates in the PSDU, but the PLCP data rate need to be a fixed rate agreed by all nodes in the wireless distribution system. If the network has very long range or operate in deep non line of sight conditions, the lowest PLCP data rate should be selected. A low PLCP rate reduces the maximum user data throughput. If the network operates in line of sight conditions and should be optimized for high user data rate, a high PLCP data rate should be selected. Note that the PSDU data rate should not be set to a lower rate than the PLCP data rate.

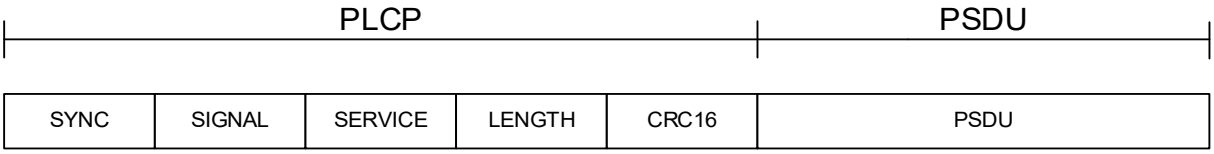


Figure 3 Basic structure of the wireless frame

Network ID is a unique ID that identifies the wireless distribution system. The network ID is used to make a logical separation on different wireless networks operating at the same frequency.

Contention free period is a defined time where transmissions of wireless frames are guaranteed free from collisions. A prerequisite for the contention period to operate is that all wireless units in the network are synchronized and share a common transmission schedule. See Figure 2 for details.

Contention period is a defined time where transmissions of wireless frames are not guaranteed free from collisions. A distributed coordination function (DCF) is used as mechanism to minimize the probability for collisions. See Figure 2 for details.

DCF is a method used for medium sharing in the contention period. DCF is an abbreviation for Distributed Coordination Function and is a method of sharing the wireless medium in an ad-hoc network and reduce the probability of collisions on the air. When a CRE2 shall transmit a frame with DCF medium access control, the CRE2 picks a random backoff-time for which the CRE2 listens that the medium is not occupied by transmissions from other CRE2s. If the medium is free at the end of the random backoff-time the wireless frame is transmitted. If the CRE2 detects that another CRE2 has started transmission during the back-off time, the CRE2 wait until the transmission is finished and picks another random time and repeat the backoff-process. The DCF mechanism reduces the available bandwidth efficiency to 20-40% of the available bandwidth. For short frames with 30-50 bytes payload, the efficiency becomes is typically only 5-10% because the DCF has a longer duration than the wireless frame itself.

Superframe is the time defined by the sum of the contention free period time and the contention period time.

Slot is a reserved time dedicated for transmission of data frames from a CRE2 in the wireless distribution system.

Wireless distribution system provides connectivity between the CRE2's in the network. It contains the MAC/PHY mechanisms in the CRE2 to control beam steering, modulation, frame handling, timing control and retry-mechanisms to provide a transfer of a wireless frame from one CRE2 to another.

Wireless sweep broadcast is a method of transmitting wireless broadcast frames with maximum directed power and diversity. By setting the destination site to broadcast in the CRE2 datagram header, a wireless sweep broadcast, a broadcast frame N times while the beam direction is set to N different directions to cover the complete operating sector of the CRE2. A transmission of a wireless broadcast frame is shown in Figure 4. Wireless broadcast sweep is performed simultaneously on all the CRE2 units at the same location. Transmission of broadcast frames has no wireless acknowledge from the receiving station.

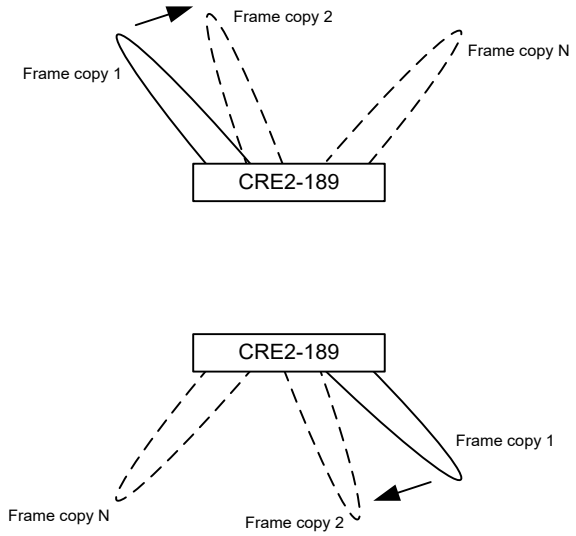


Figure 4 Wireless broadcast sweep, top view

Wireless sector broadcast is transmission of a broadcast frame in a single direction with high gain on the CRE2 antenna beam. By setting a unique destination site in the CRE2 datagram header, the CRE2 sets the transmission direction to the destination site found by the CRE2 internal positioning system. If the destination ID in the CRE2 datagram header is set to broadcast, all equipment on the site will process the data, otherwise only the targeted equipment with matching ID on the destination site will decode and process the data.

CRE2 relative direction coordinate system is the coordinate system for definition of relative directions for the CRE2 antennas. When a data frame is received by a CRE2, the in-coming direction is measured and presented in this coordinate system.

A positive pitch angle for a received signal is defined for directions above the horizontal plane (XY-plane).

A positive yaw angle for a received signal is defined for directions to the right when looking in the X-direction.

The roll angle may be used to define the orientation of the antenna, but not used for positioning of received signals.

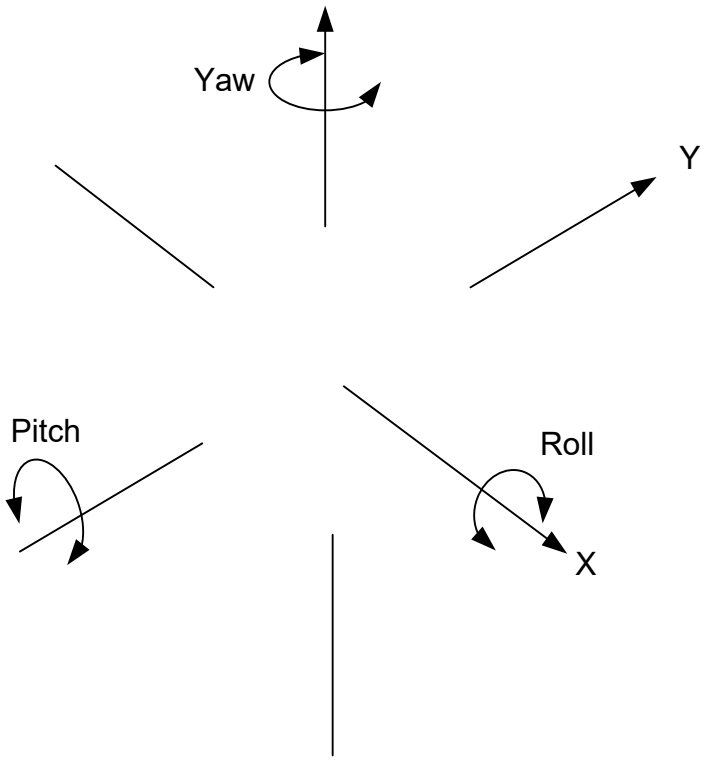


Figure 5 Coordinate system for measurement of relative direction for the CRE2-189

3 CONFIGURATION OF THE SYSTEM

The system has a web interface and API for configurating the system and its network. For configuration with the API you will have to look into the radio control API documentation which is supplied with the firmware upgrade package.

The system is in the current version a pre-configured «wireless switch» routing system on the IEEE 802.3 MAC level.

The radio graphical interface is accessed by entering its IP address in an internet browser. The IP address is located on the label on the radio unit close to its connector. The IP address starts with 10.19 followed by numbers based on the serial number. The general algorithm for IP address is then 10.19.{SN / 256}.{SN % 256}, where % is modulo.

3.1 Flash antenna panels with new firmware

The radio units can be upgraded either locally or remotely. Upgrade packages will be provided by Radionor on request or when a new software with bugfixes or new features is released. Upgrade files can be downloaded at your web server:

www.support.radionor.no/company-name

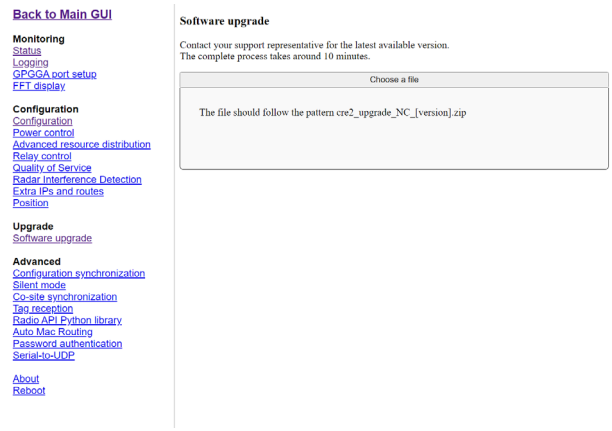
3.1.1 Upload firmware file locally

Note

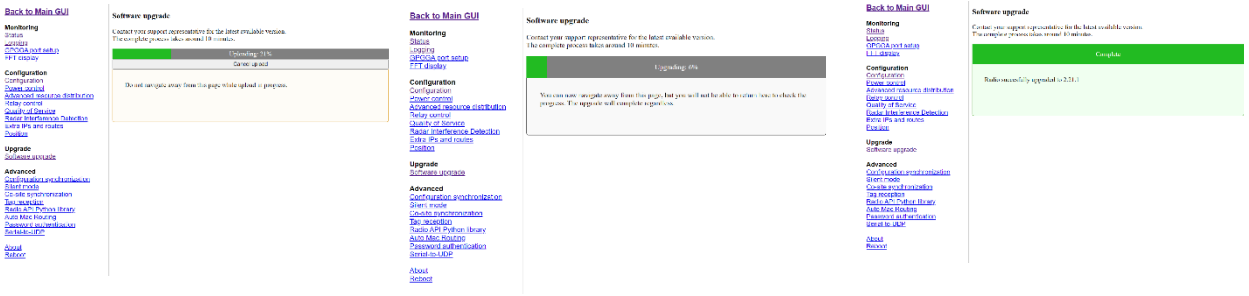
Recommended to avoid using Windows Internet Explorer.

Enter the advanced function page by entering the IP address of the radio unit followed by "/advanced" eg. "10.19.0.100/advanced". Then click on "Software upgrade" in the menu on the left-hand side.

Select the firmware file by hitting "Choose a file". Browse to the firmware file eg. "cre2_upgrade_NC_2.21.1". It is important to make sure that the correct file is used. Then continue by hitting "Start upgrade". This may take 5-10 minutes.

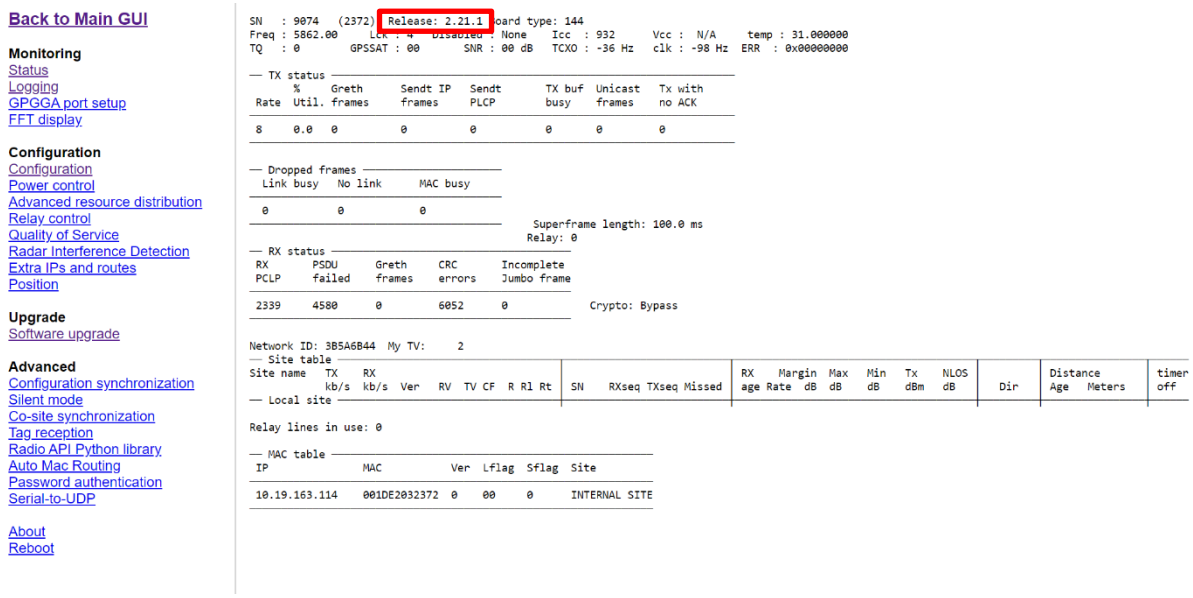


Then the radio unit will upload the firmware file. When the upload is completed, it will automatically continue upgrading. Upgrading will take several minutes. The radio unit will reboot, and the progress bar will state "Complete".



3.2 Confirm successfully upgrade

To confirm successful upgrade, navigate to the advanced section. The current software version is listed on top in the “home” or “status” page:



3.3 Configurating the radio site and network

3.3.1 Access CRE2 Radio Unit

You must establish a ethernet connection with the Radio Unit to be able to communicate with the radio. Configuration is done through a web browser.

Prerequisites

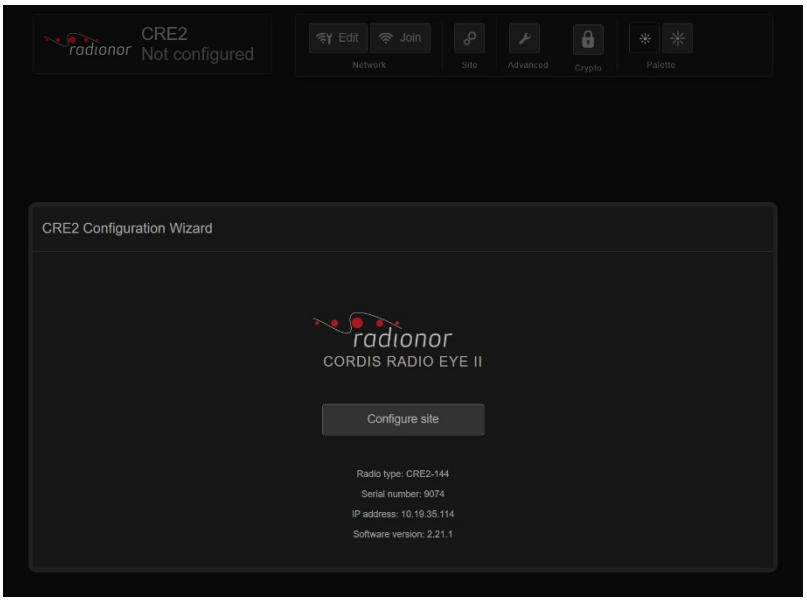
In order to carry out the configuration you need these items:

- PC or laptop with an Ethernet interface.
- Up-to-date web browser.

Procedure

1. Add these settings to your network interface
   - **Network**: 10.19.0.0/16
   - **Example**:
     IP address: 10.19.127.10 Netmask: 255.255.0.0
2. Connect the PC to the Radio Unit via Ethernet.
3. Enter the radio's IP address in the web browser address bar.

The IP address for the Radio Unit is found on a label at the rear of the Radio Unit. Observe that the **Welcome** page appears.



Result

You are now ready to start configuration of your site.

Note

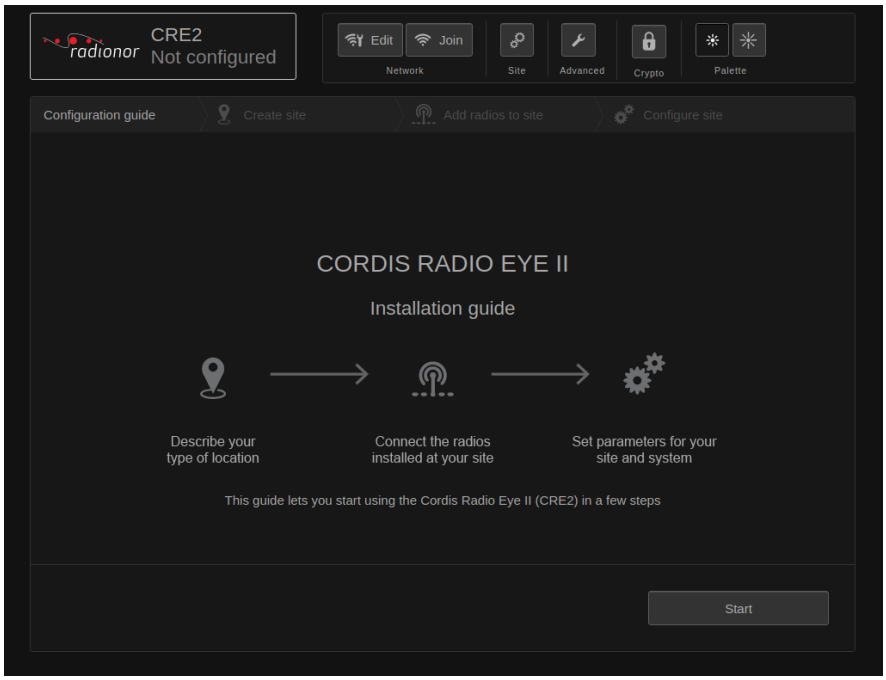
The Welcome page only appears the first time you configure your site. After the configuration is completed, the web interface will take you directly to the Main view.

3.3.2 Configuring the radio site

A radio site (CRE2 site) can consist of one or several radios. You must configure the site before you can start the network configuration. Configuration of the CRE2 is done through the web interface or the API. Here's a procedure of configuration via the web interface.

Procedure

In the **Welcome** page, click the **Configure site** button.

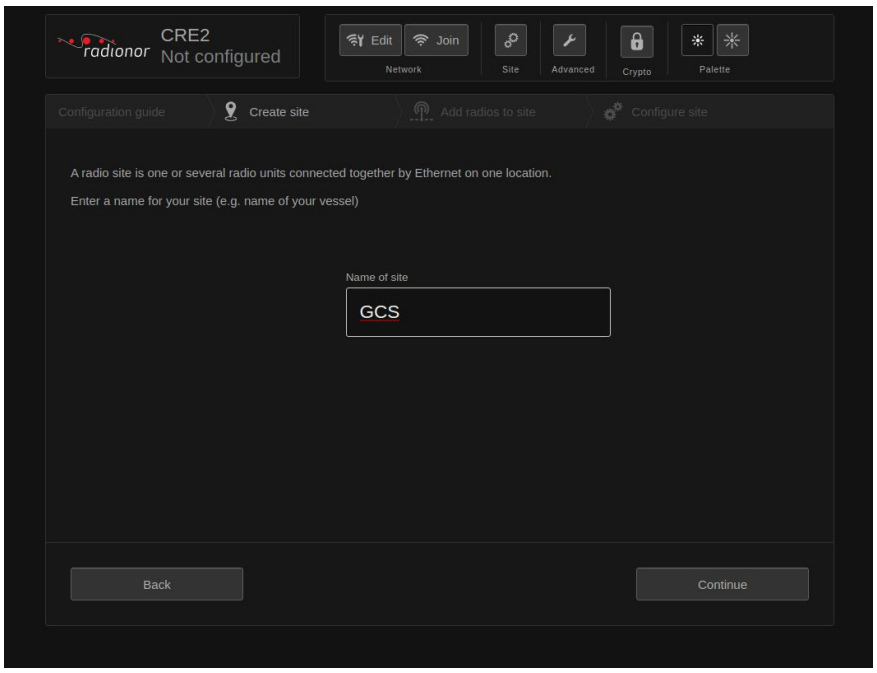


Observe that the Installation guide page appears.

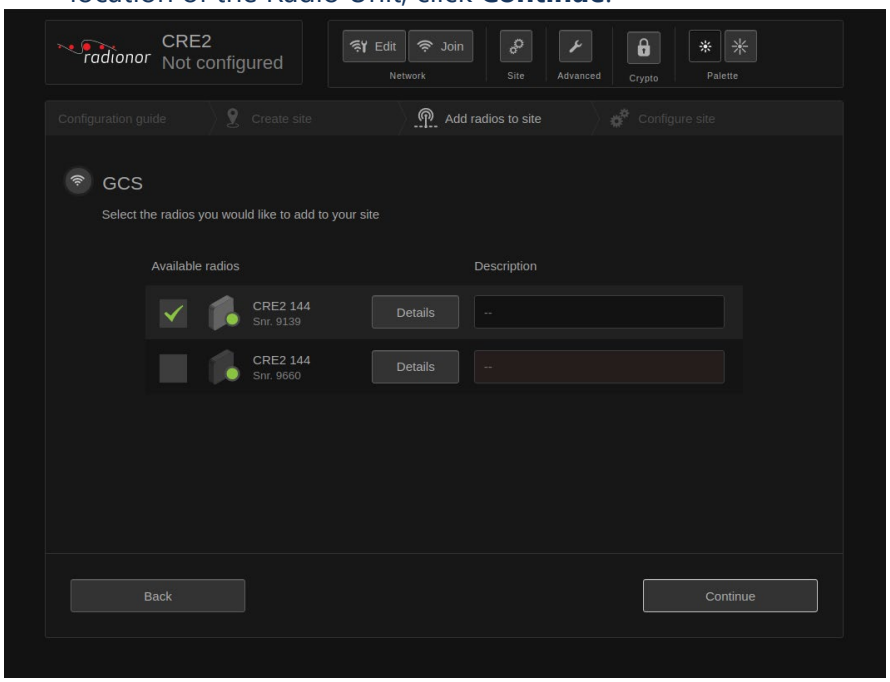
Note

The default colour palette setting is with dark background. If your current light conditions require white background, there is a Palette section in the upper right corner for changing the colours.

1 Click **Start** to start the step-by-step configuration of your radio site.
2 Type a suitable name for your site and click **Continue**.



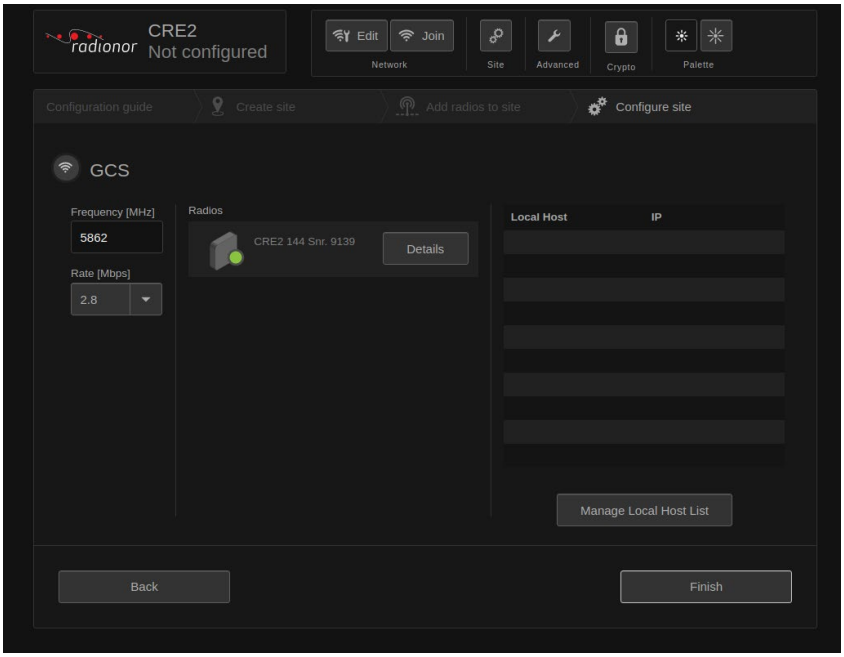
3 Select the radios you want to add to the site and give a description of the location of the Radio Unit, click **Continue**.



Note

Radio Units connected on the same local area network will appear automatically and are by default not selected. For multi panel site tick all radios for that site, if not untick all other radios.

4 Type the radio frequency and select data rate for the site from the **Rate** list.

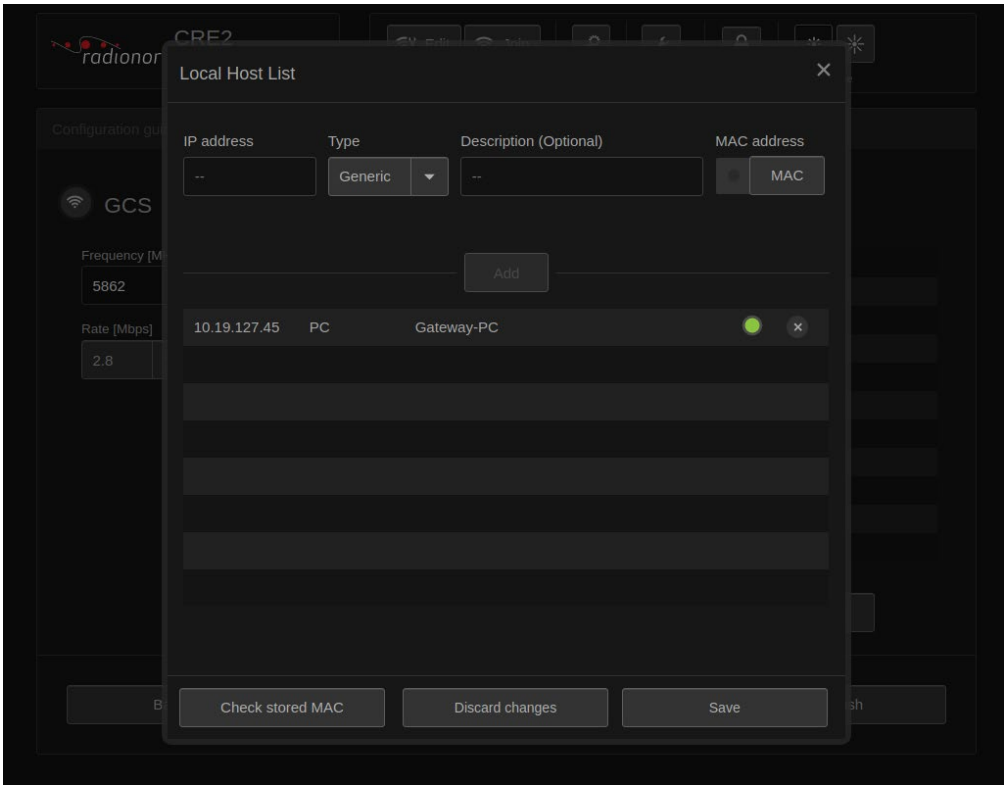


5 Click the **Manage Local Host list** button to add third party equipment to your site.

Observe that the **Local host list** dialog box appears.

Note

Equipment added to "Local host list" must belong to the sites where they are added. If you change position of equipment, it has to be removed beforehand.



6 Type the IP address of the equipment you want to connect, select equipment type from the **Type** list and add a description of the equipment for identification purposes. If the third-party equipment is switched on, the MAC address appears automatically. If not, type the MAC address. Click **Add** to add the equipment.

Note

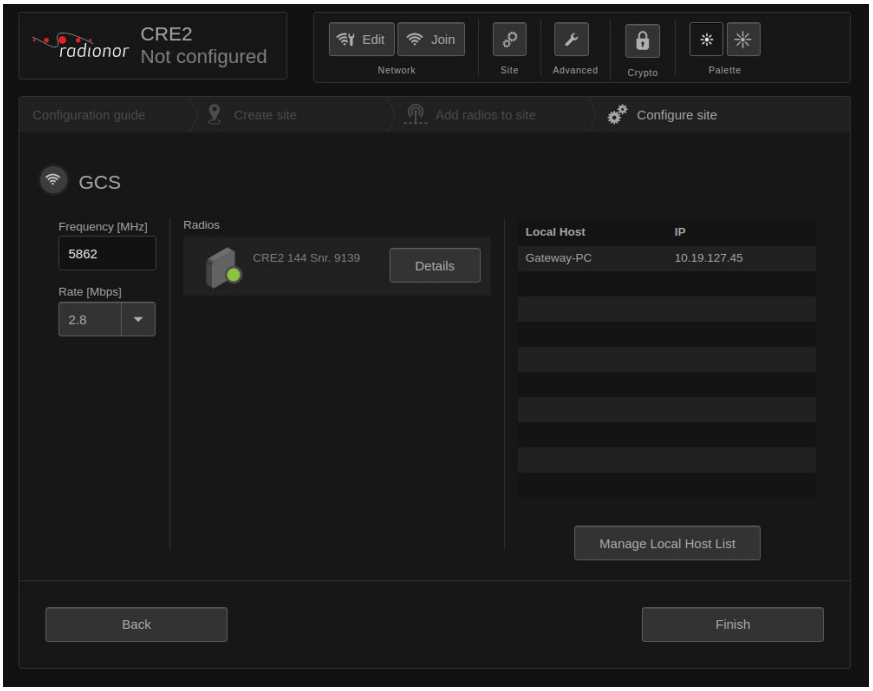
You can add/change information later by selecting the equipment, making changes, and clicking Update. You can also delete equipment by clicking the X symbol at the end of the line.

Tip

CRE2 uses static layer 2 routing (OSI model - Open Systems Interconnection Basic Reference Model) and hence needs both the IP address and the MAC address of the equipment in order to establish IP connection.

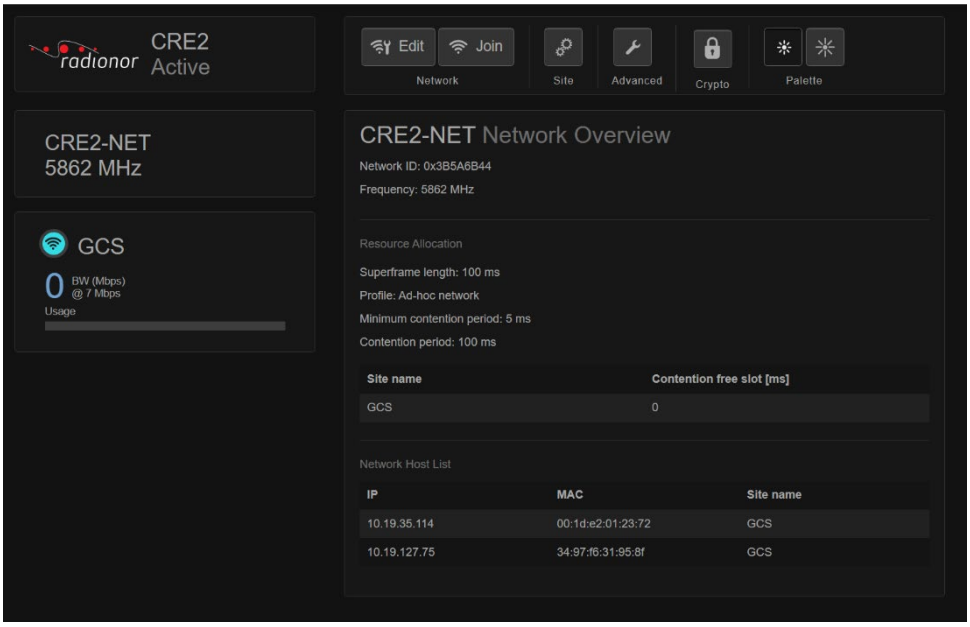
7 Replicate this prosess for all the equipment you want to add and click **OK** when finished.

8 Click **Finish** to complete your site configuration.



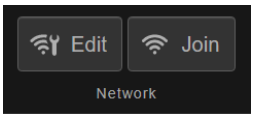
Result

The main view appears, and you are now ready to start using the radios:



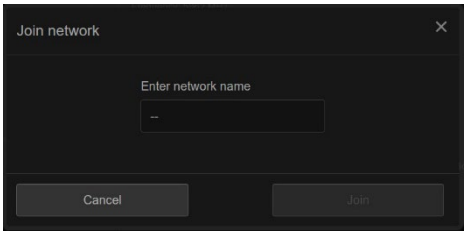
3.3.3 Establishing network connection

If you don't have an existing network, you need to create a new wireless network.



Procedure

1. In the **System menu**, click the **Join** button. Observe that the **Join network** dialog box appears.
2. Type the name of the network you want to join.



Note

The network name is in upper case.

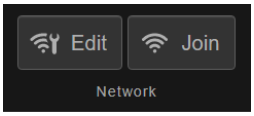
3. Click **Join** to join the network.

Result

You have now prepared your site for network connection. If you are out of range of the network at the time you carry out this procedure, the radio will automatically detect the network and establish a connection when you are within reach of this network.

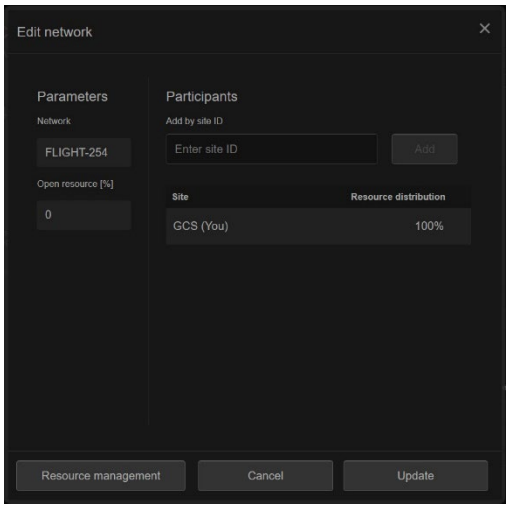
3.3.3 Changing network settings

When sites/radios have established network connection, you are free to change network parameters:

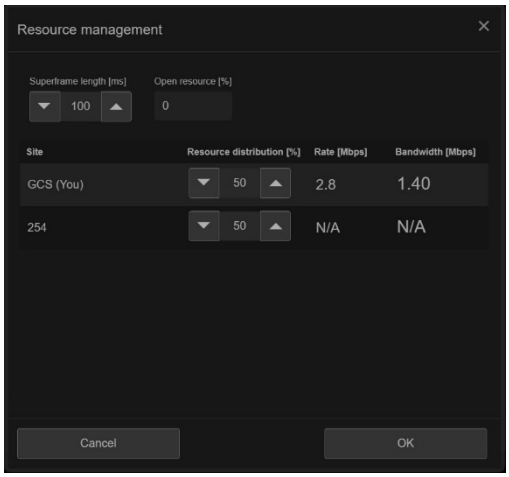


Procedure

1. In the **System menu**, click the **Edit** button. Observe that the **Edit network** dialog box appears.



2. This window shows your current network with all participating sites listed. Network parameters, ***Network*** and ***Open resource***, is also shown. Click the **Resource management** to distribute bandwidth.
3. When the **Resource distribution [%]** is done, click OK.



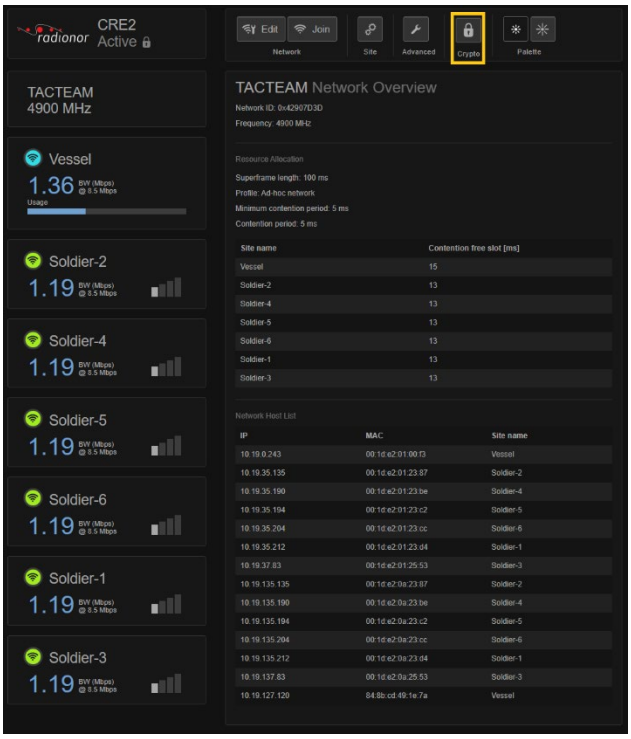
Now your network has all the parameters needed to work as you want. Enable settings by clicking **Update.**

3.3.5 Crypto

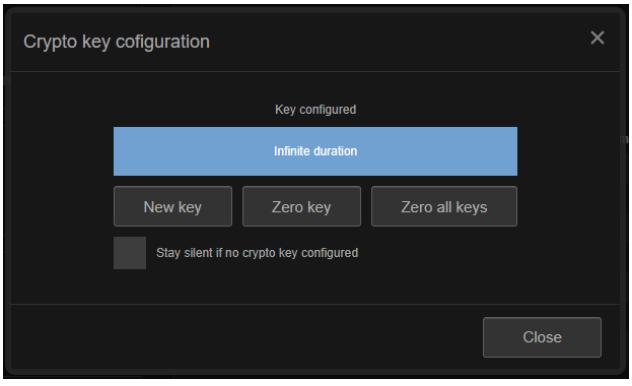
Radionor CRE2 have built-in AES-256 bit encryption.
On the radios main GUI you can set-up the encryption with a few easy steps.

Procedure

1. In the **System menu**, click the **crypto** button in the top right. This will open the crypto key configuration window.



2. In the crypto key configuration windows you have several options:



   a. **New key**
      Opens up a new window for configuration of a new AES-256 bit encryption key
   b. **Zero key**
      Deletes the currently active key on the radio

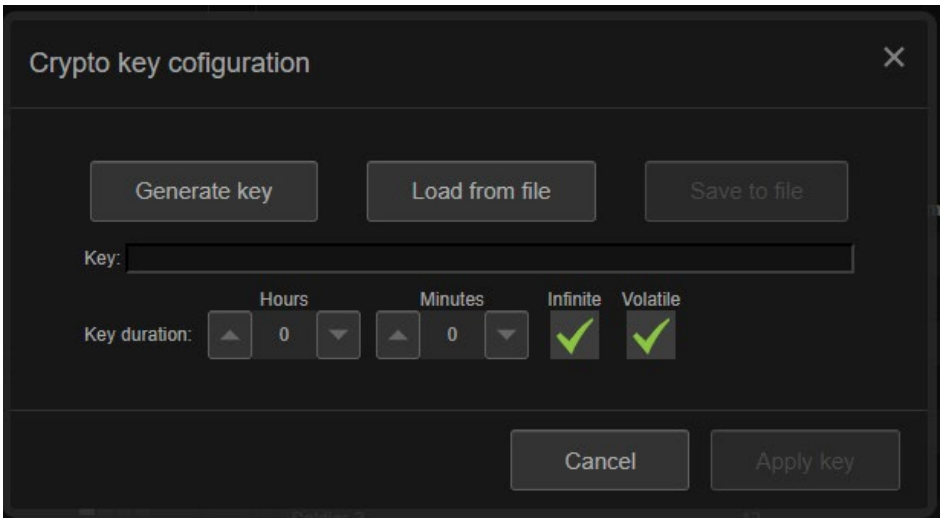
   c. **Zero all keys**

Deletes the currently active key on all radios connected in the same network

d. **Stay silent in no crypto key configured**
If this box is checked, the radio will not transmit data as long as no crypto key is configured

e. **Close**
Close the windows and go back to radio main GUI

3 Hit **New key** to configure a new AES-256 bit encryption key. New key windows will appear:



a. **Generate key**
Generates a new random AES-256 key. This key can be applied to the radio, saved to file, or both.

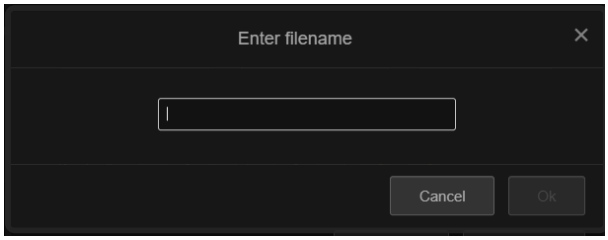
Example of key:

«34AE34E6» is the first 32-bits parts of the 256 bits key and "F0C8315E" is the last 32-bits part of the 256 bits key.

After key is applied it is not possible to save to file. Save to file must therefore be done before applying the key to the system

b. **Load file**
Upload a locally stored AES-256 key to the radio

c. **Save to file**
Save the entered, generated, or uploaded AES-256 encryption key to file

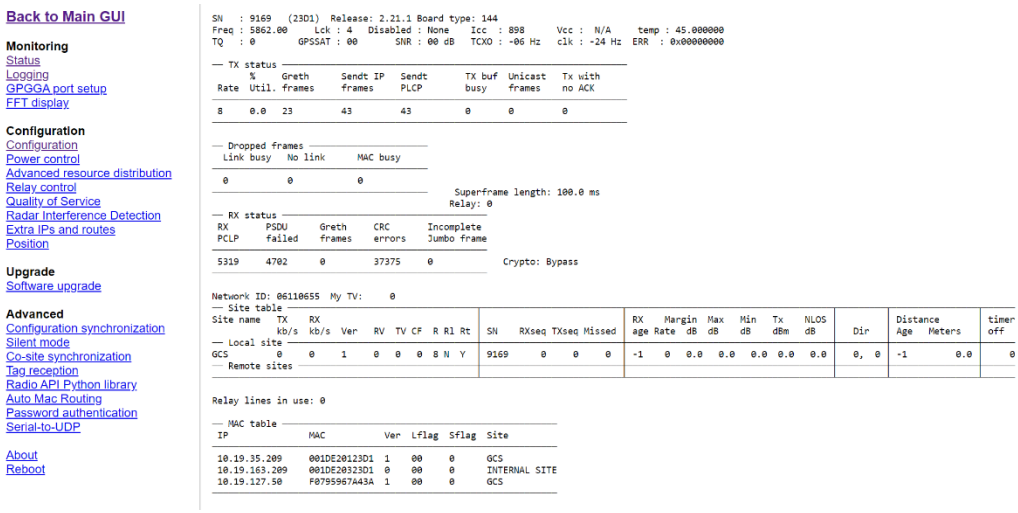


d. **Infinite**
The crypto key will have an expiration date. The hours and minutes before expiration is selected to the left of the box. This choice will be grayed out until the box is unchecked

e. **Volatile**
Checked: The crypto key will not be stored in the radio configuration and will be erased on powerloss/reboot.
Unchecked: The crypto key will be stored in the radio persistently and will survive powerloss/reboot.

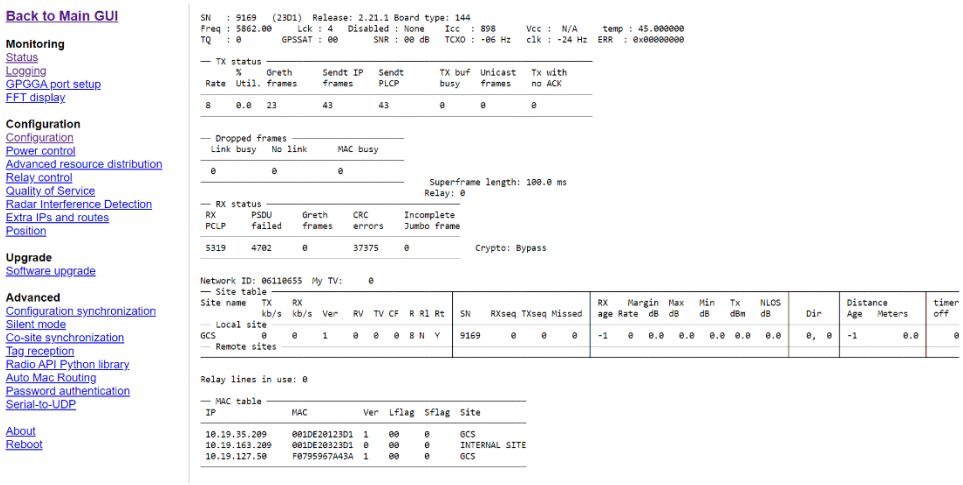
3.4 Advanced functions

This is a description of Cordis Array II advanced functions.
Enter the advanced function page in the web interface by typing IP address of radio unit followed by '/advanced', for example: 10.19.0.100/advanced, in your browser (if the radio serial number is 100). Then this page should appear:



3.4.1 Status

This page display information about the current site config and network:



SN: Serial number in decimal and in hexadecimal.

Freq: Current operating frequency.

Lck: Number of internal antenna elements enabled.

Disabled: non-locked radios. Number of internal antenna elements disabled.

Icc: Instantaneous current drawn by radio unit, in milliamps.

Vcc: Instantaneous voltage input, in millivolts.

temp: Radio Unit internal temperature.

TQ: Quality of superframe syncronization.

GPSSAT: Number of GPS Satellites in use.

SNR: GPS signal to noise ratio.

ERR: Hexadecimal error code.

TCXO: TCXO calibration offset.

Clk: System clock offset.

********** TX status **********

Rate: Current transmit data rate.

Util. Current utilisation of assigned timeslots (resources) in percentage.

Greth frames: Number of frames sent from ethernet driver to wireless mac co-processor.

Sent IP frames: Wireless frames set to transmit. The counter does not take into account whether packages have been sent before or if ack has been received.

Sent PLCP: Sent wireless frame headers. A single wireless header may be followed by multiple ethernet frames in a jumbo frame

TX buf busy: Current number of frames in TX queue.

Unicast frames: Number of wireless frames sent with ack request.

TX with no ack: Number of wireless transmitted frames with no ack.

Dropped Link busy: Number off frames dropped due to overflowing TX queue.

No link: Number of frames dropped due to failed ranging.

Mac busy: Number of packets dropped due to mac-controller being busy.

Superframe length: The configured length of each superframe, in milliseconds**.**

Relay: Number of frames relayed through this radio.

********** RX status **********

RX PLCP: Received wireless frame headers. A single wireless header may be followed by multiple ethernet frames in a jumbo frame

PSDU failed: Number of valid frame headers followed by a data frame with invalid checksum.

Greth frames: Number of frames sent from wireless co-processor to ethernet driver.

CRC errors: Number of CRC errors, indicates wireless frames not verified.

Network ID: Identity code in hexadecimal to this network.

My TV: Time allocation setup version of this site.

Site name: Name of site. All values in line apply to this site.

TX kb/s: Data sent from ethernet driver to wireless co processor during last second.

RX kb/s: Data received from wireless co processor during last second.

Ver: Locally stored version of remote site configuration. Should be same version as RV, which indicates that sites are in sync.

RV: Version of site configuration, indicated in last wireless frame from this site.

TV: Time allocation setup version used by this site.

CF: Assigned contention free resources in percent.

R: Transmit data rate used to this site.

RI: Allow relay through this radio

Rt: Local routing state in multipanel site.

SN: Serial number of radio on that site.

RXseq: Last received sequence number.

TXseq: Last transmitted sequence number.

Missed: Number of missed frames.

RX age: Time since latest received wireless frame.

Rate: Datarate used on last frame from this radio.

Margin dB: Average signal margin relative to remote site, updated once a second.

Max dB: Maximum signal margin relative to remote site, updated once each superframe period.

Min dB: Minimum signal margin relative to remote site, updated once each superframe.

TX dBm: Tx power used by remote site, in dBm.

NLOS dB: dB lost due to Non-line-of-sight.

Dir: Direction to other sites [x,y].

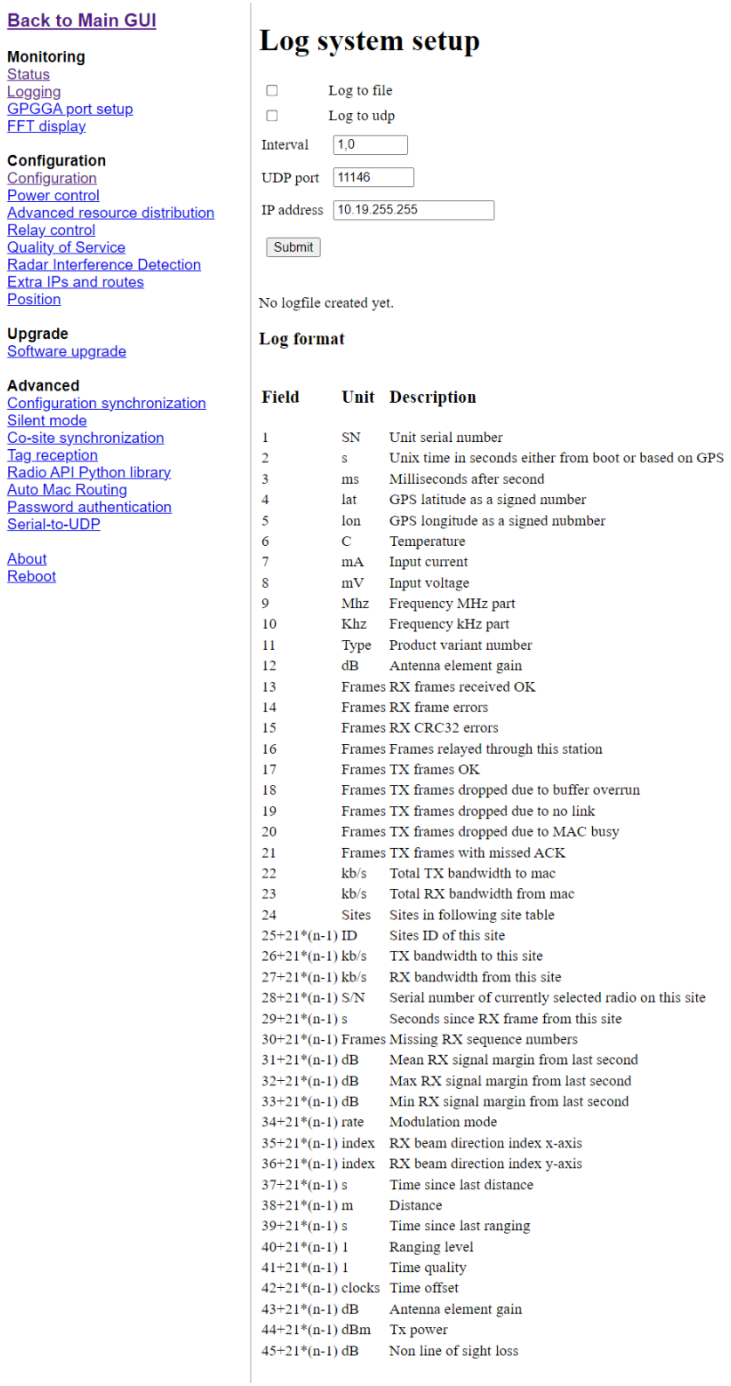
Distance age: Time since latest range was updated.

Meters: Distance to other sites in meters.

Relay lines in use: Number of radios used as relay.

MAC table: Table of all user equipment connected to the network.

3.4.2 Logging



Back to Main GUI

Monitoring
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Log system setup

Log to file
Log to udp
Interval 1,0
UDP port 11146
IP address 10.19.255.255
Submit

No logfile created yet.

Log format

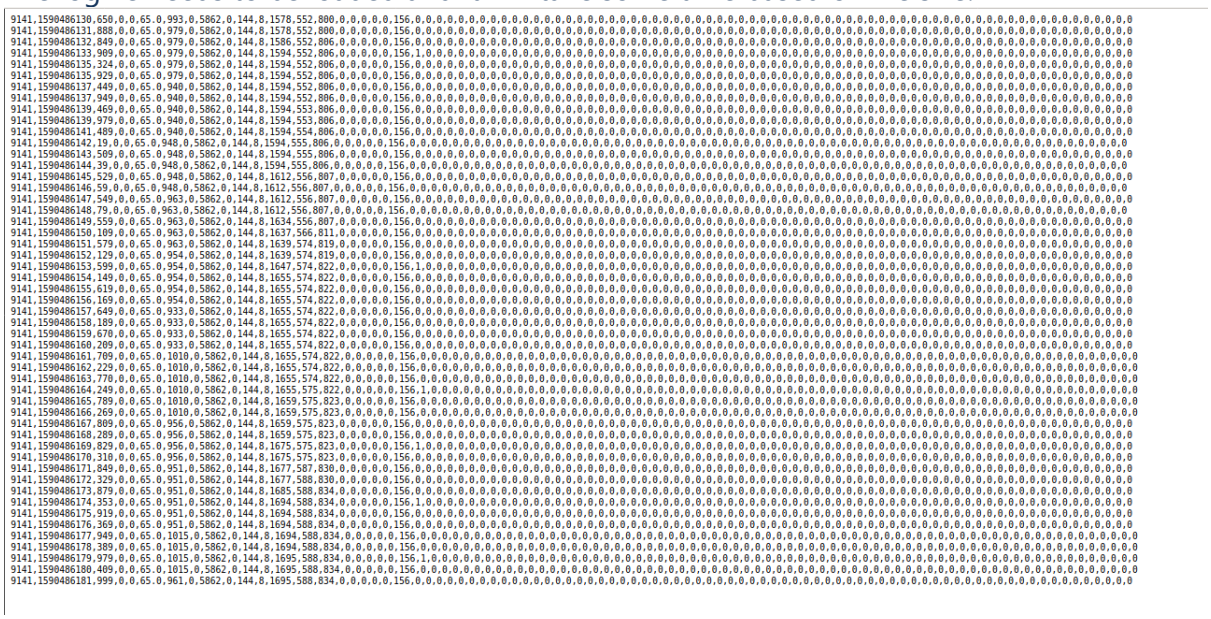
Field	Unit	Description
1	SN	Unit serial number
2	s	Unix time in seconds either from boot or based on GPS
3	ms	Milliseconds after second
4	lat	GPS latitude as a signed number
5	lon	GPS longitude as a signed nubmber
6	C	Temperature
7	mA	Input current
8	mV	Input voltage
9	Mhz	Frequency MHz part
10	Khz	Frequency kHz part
11	Type	Product variant number
12	dB	Antenna element gain
13	Frames	RX frames received OK
14	Frames	RX frame errors
15	Frames	RX CRC32 errors
16	Frames	Frames relayed through this station
17	Frames	TX frames OK
18	Frames	TX frames dropped due to buffer overrun
19	Frames	TX frames dropped due to no link
20	Frames	TX frames dropped due to MAC busy
21	Frames	TX frames with missed ACK
22	kb/s	Total TX bandwidth to mac
23	kb/s	Total RX bandwidth from mac
24	Sites	Sites in following site table
25+21*(n-1)	ID	Sites ID of this site
26+21*(n-1)	kb/s	TX bandwidth to this site
27+21*(n-1)	kb/s	RX bandwidth from this site
28+21*(n-1)	S/N	Serial number of currently selected radio on this site
29+21*(n-1)	s	Seconds since RX frame from this site
30+21*(n-1)	Frames	Missing RX sequence numbers
31+21*(n-1)	dB	Mean RX signal margin from last second
32+21*(n-1)	dB	Max RX signal margin from last second
33+21*(n-1)	dB	Min RX signal margin from last second
34+21*(n-1)	rate	Modulation mode
35+21*(n-1)	index	RX beam direction index x-axis
36+21*(n-1)	index	RX beam direction index y-axis
37+21*(n-1)	s	Time since last distance
38+21*(n-1)	m	Distance
39+21*(n-1)	s	Time since last ranging
40+21*(n-1)	1	Ranging level
41+21*(n-1)	1	Time quality
42+21*(n-1)	clocks	Time offset
43+21*(n-1)	dB	Antenna element gain
44+21*(n-1)	dBm	Tx power
45+21*(n-1)	dB	Non line of sight loss

Here you can enable logging of the radio system. The log format is described.
UDP port: where the log packet will sent to as broadcast.

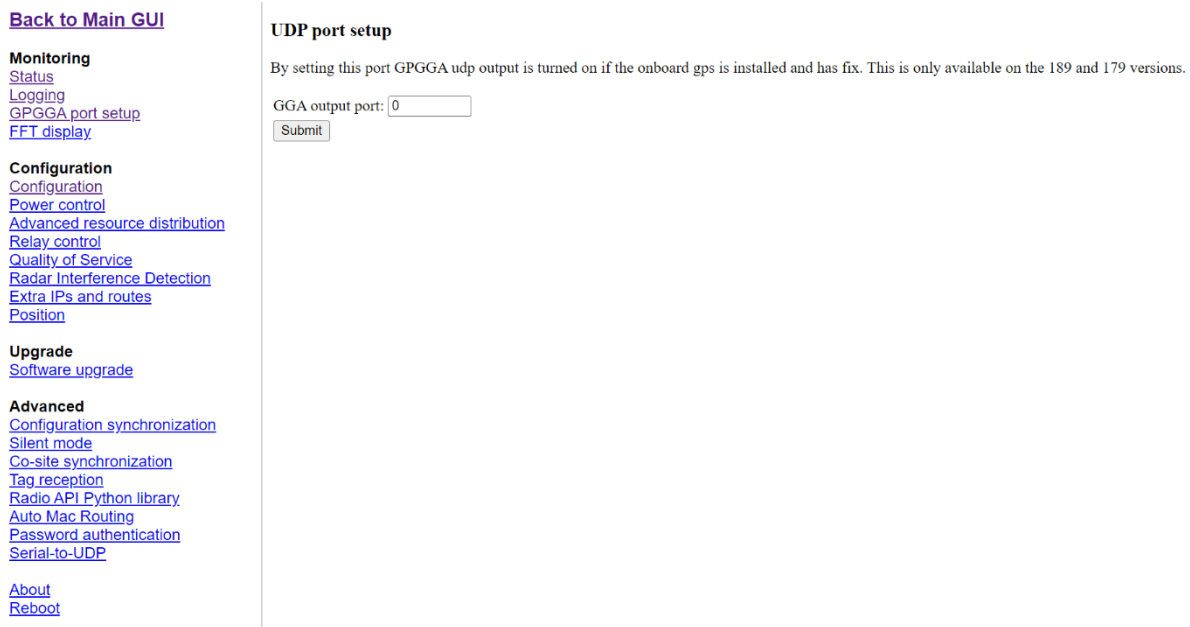
Current logfile can be downloaded by clicking at the logfile:

You can download the current logfile from: SN_9169.log (4786 bytes)

The logfile needs to be loaded and it will take some time based on file size:



3.4.3 GPGGA port setup

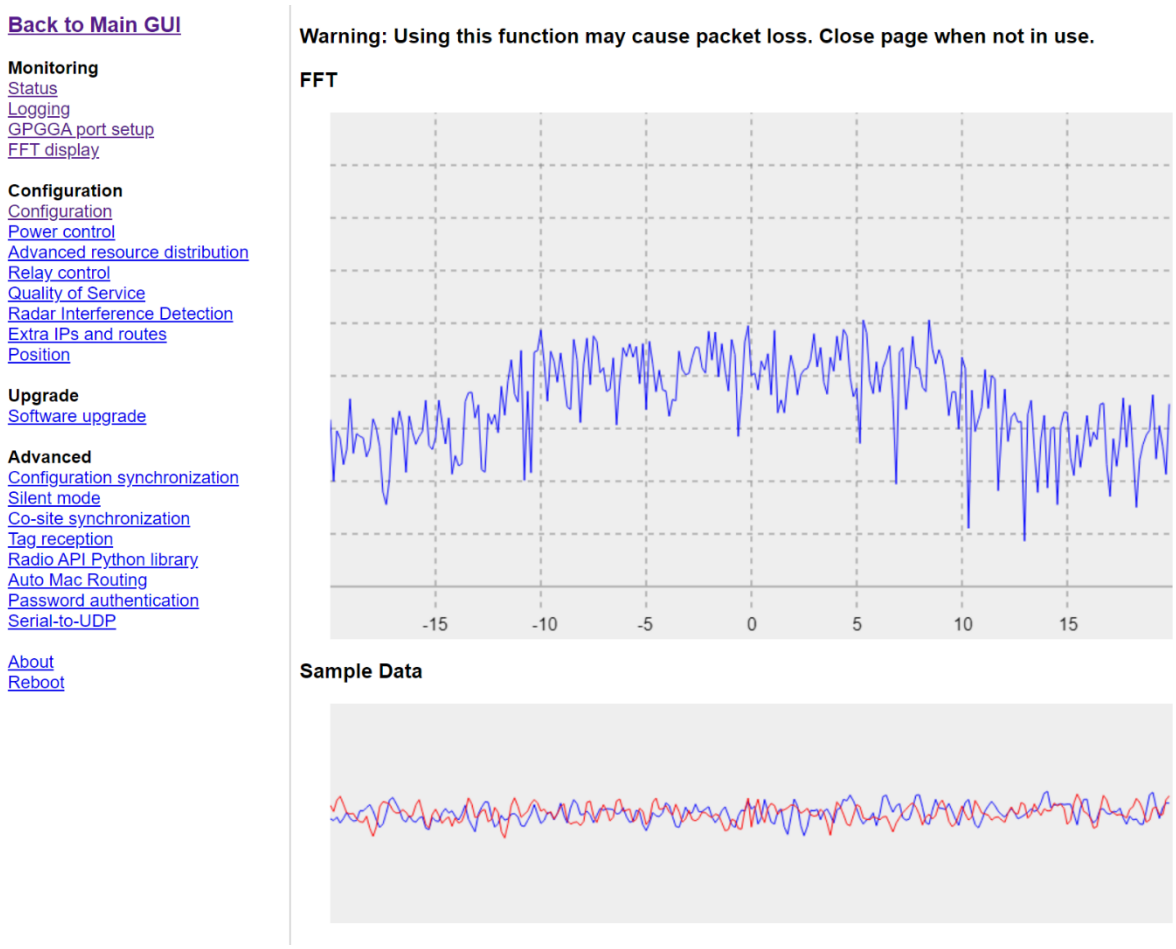


GGA output port: output port for the GPS data. This is only available if the radio has internal GPS.

Note

Radios with internal GPS is not a standard product.

3.4.4 FFT display

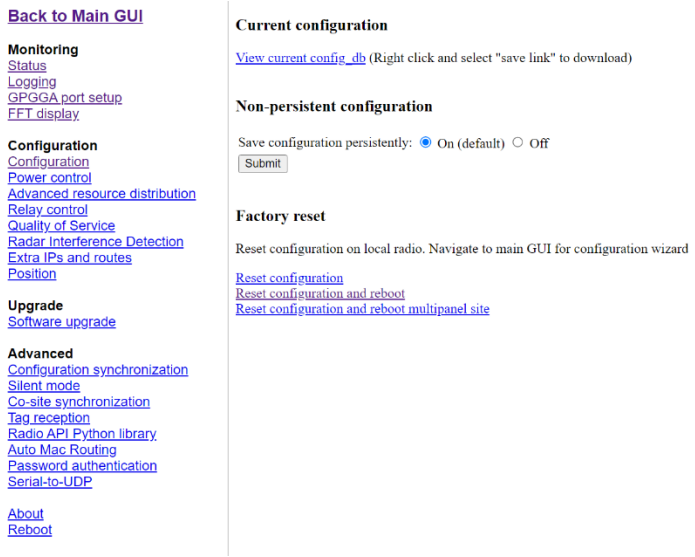


Fast Fourier transform of the radio frequency channel. Here you can detect if there are other activities within the channel.

Note

The centre frequency can be changed in the main page.

3.4.5 Configuration



Current configuration:

Here you can view and download the current configuration file in JSON format. This file is only for troubleshooting and to save the configuration for later.

Non-persistent configuration:

If you don't want the configuration sent to radio to persist on reboot. Then tick for "Off" and click "Submit". By default the configuration will persist on boot.

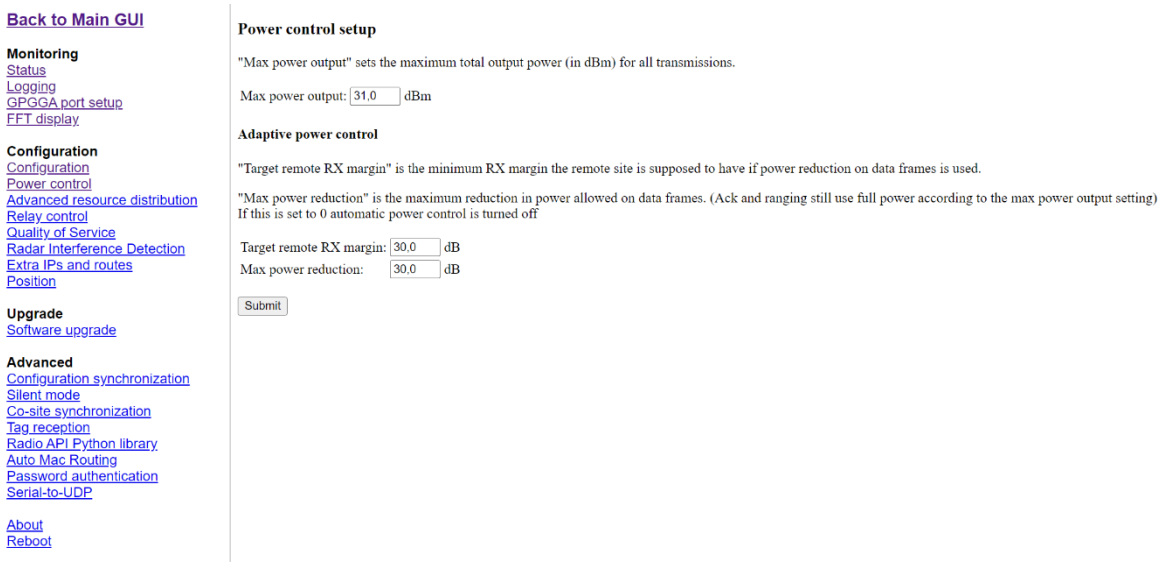
Factory reset:

This setting allows all network setup to be deleted. Radio must be rebooted to get into factory reset mode. "Reset configuration and reboot" will do this is one click. If there is a multipanel site all radio of the site will be reset by clicking "Reset configuration and reboot multipanel site".

Note

If equipment in a multi site wants to be removed, on click resetting of entire multi panel site is required. Then all equipment must be added again.

3.4.6 Power control



Note

Max output power for CRE2-189 and CRE2-179 products is 37dBm and for CRE2-144 products it is 31dBm.

Max power output: sets the maximum total output power (in dBm) for all transmissions.
Target remote RX margin: is the minimum rx margin the remote site is supposed to have if power reduction on data frames is used.
Max power reduction: is the maximum reduction in power allowed on data frames. (Ack and ranging still use full power according to the max power output setting) If this is set to 0, automatic power control is turned off.

Note

When lab testing it is recommended to either have the max power output set to 0 or set max power reduction to 40.

3.4.7 Advanced resource distribution

This feature allows you to upload a more intricate timing schedule than in the main GUI. In contrast to the usual timing where each site is granted one time slot, it is possible to interweave slots.

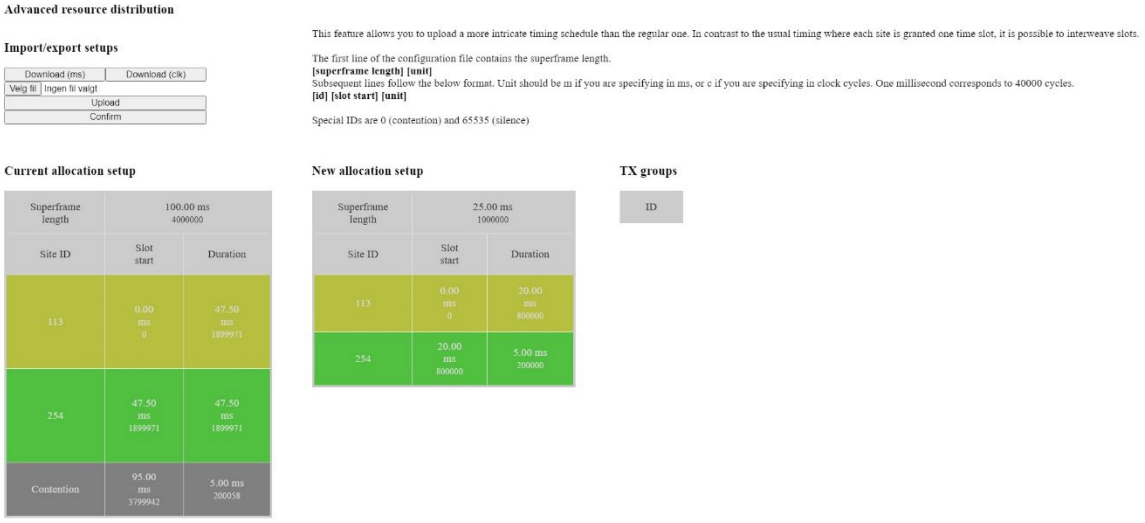
Import/export setups: download current timing setup file and you can upload a new one of one that is downloaded and adjusted.

The current allocation setup is shown in the matrix. Timing setup file needs to have following lines:

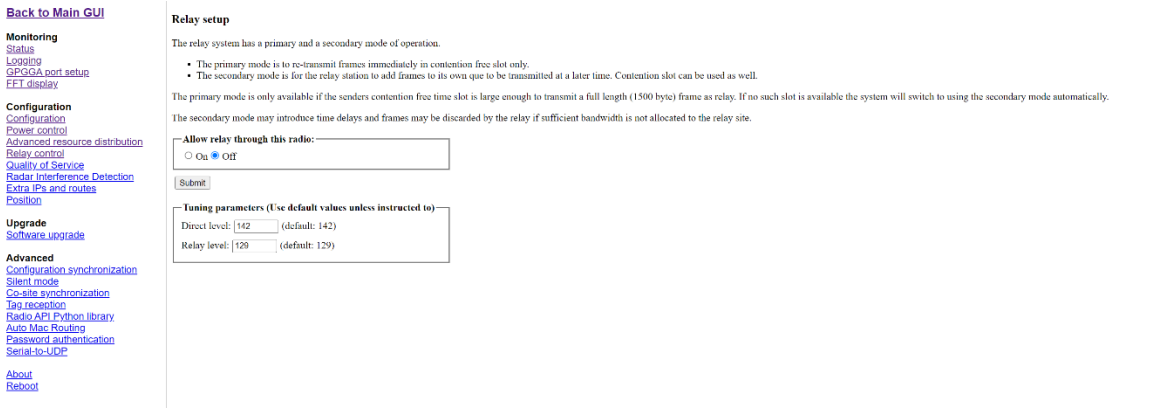
100 m
101 0 m
108 45 m
0 90 m

First line is the superframe length followed by serial number for each radio in the network and its starting transmission time in the superframe length. The file ends with 0 for contetions periode and then where in the superframe the contetion periode starts.

Upload by browsing the wanted allocation setup file followed by *Upload* followed by *Confirm:*



3.4.8 Relay Control



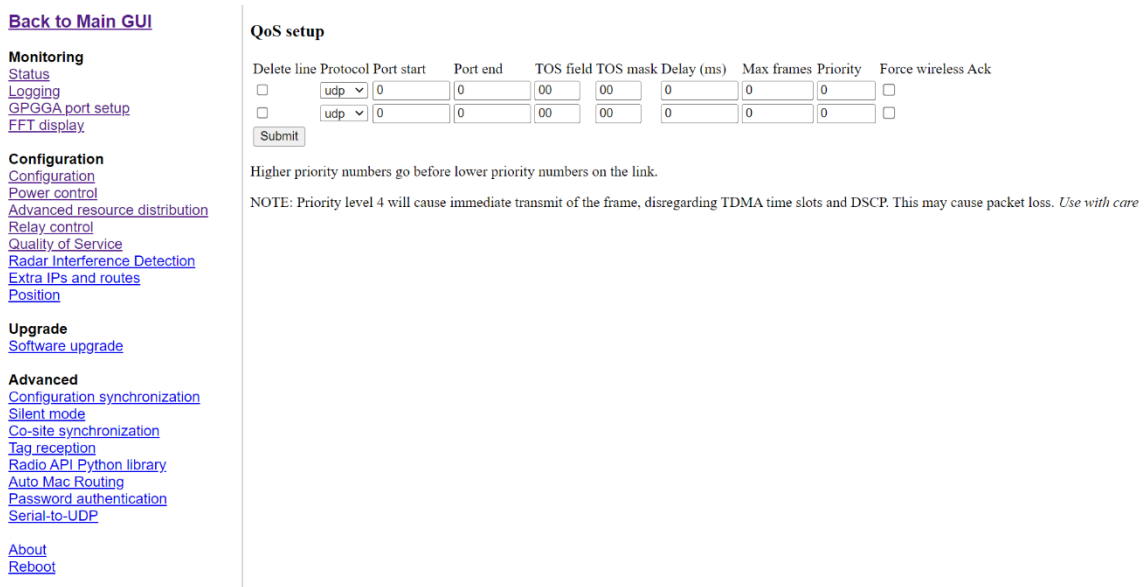
Allow relay through this radio: allows radios to transmit as a relay. If "On" is ticked, this radio will function as a relay for other radios.
Tuning parameters: these are the limit values for the relay setup and are not suppose to be changed unless instructed to.

3.4.9 QoS

Quality of service is the ability to provide different priority to different applications, users, or data flows, or to guarantee a certain level of performance to a data flow.

3.4.9.1 Correction of UDP

For transmission of error corrected UDP packets through the CRE2 network, access the /advanced site in a browser, eg. 10.19.0.244/advanced. Protocol needs to be set to UDP, port range entered, TOS field and mask to 00, delay (correction buffer size) or max frames in the buffer. Leave the field max frames in the buffer to 0 for buffer size in milliseconds delay.



The QoS can be monitored in the main page at eg. 10.19.0.244/advanced. At the bottom of the page there is a section looking like this (it can also be accessed by logging in with ssh and by typing 'dash -q'):

```
 Source site | in que | missing |  lost | retry |   dup |  late |    delay   | rx frames
         CAR |    140 |       1 |    38 |   871 |     0 |    19 | 1000/ 990 | 112434
         CAR |      0 |       0 |     3 |     0 |     0 |     0 | 100/ 110 |  826
1 9394 0xB2E32B1E 83296 83113 11 0 0 0
```

Explanation:
Source site: which site the video source is connected to.
In que: number of packets in que buffer.
Missing: number of packets missing since last update
Lost: number of packets lost from the QoS system.
Retry: number of retry packets sent.
Dup: number of duplicate packets received.
Late: number of packets received too late.
Delay: configured delay/actual delay [ms].
Rx frames: number of packets received since startup.

3.4.9.2 Set priority for special type of data

Go to /advanced page and to QoS for configurating data priority. For setting priority, you enter *'Port start'* and *'Port end'* or *'TOS field'* and *'TOS mask'* to declare which data to prioritize. In which order it will be prioritized is based on which number you enter in the *'Priority'* field. Higher priority will be sent before lower priority number on the link.

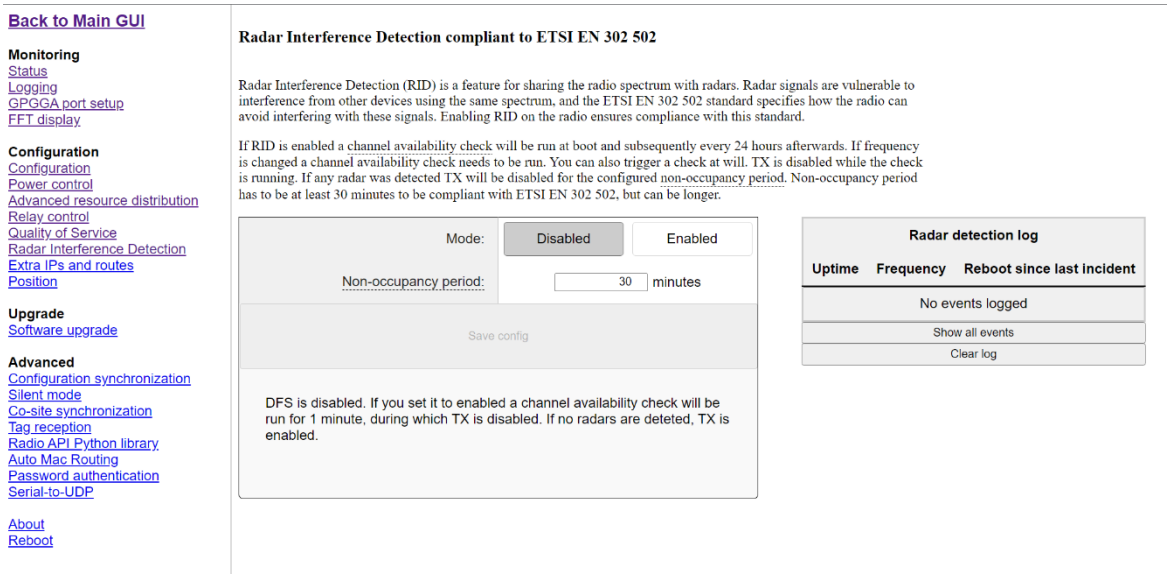
To explain the function, all prioritization is relative, so if nothing is set to 1 then it does not matter if you use 1 or 2 as a priority. Each priority has its own queue. When packets are sent, the queue with the highest priority is emptied first, before it starts sending packets with lower priority.

Note

Priority level 4 will cause immediate transmit of the frame, disregarding TDMA time slots and DSCP. This may cause packet loss. Use with care.

3.4.10 Radar Interface Detection

The current list of TX of states is: Transponder mode, Silent mode, Channel availability check and Radar detected:

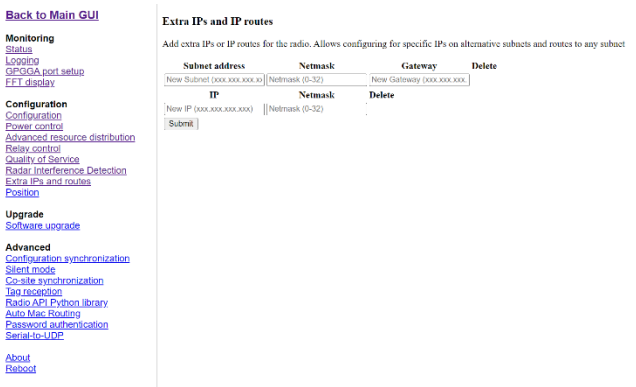


Radar Interface Detection works as described at this page. Enabled by clicking *Enabled* followed by *Save Config*. Non-occupancy periode can changed before enabling. This will set the radio to scan after radars and if no radars are detected then the radios works as normal. If any radar is detected it will stop transmitting for the configured *Non-occupancy period*. Radar dection log is presented on the right hand side. This feature is disabled by default.

3.4.11 Extra IPs and routes

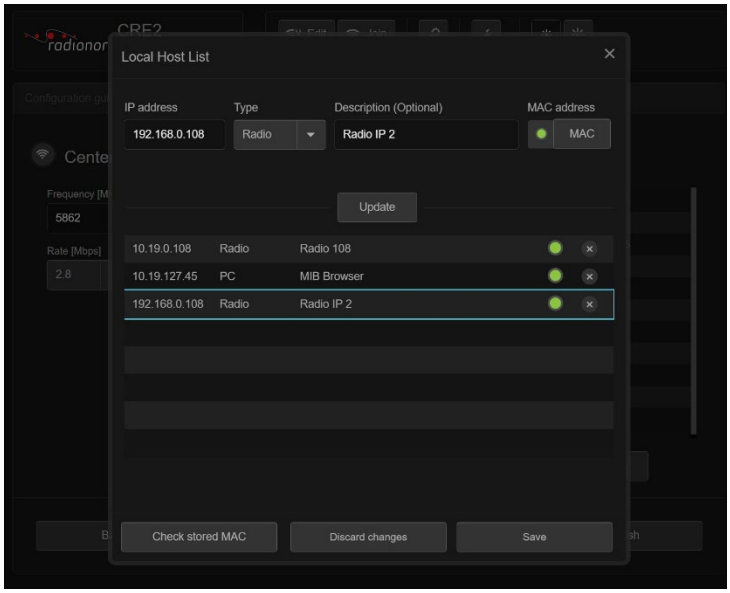
IP route can be added by entering its subnet address, netmask and gateway.

An extra IP address can be added to the radio network interface by adding its IP address and netmask followed by *Submit*. Changes is enabled immediately.

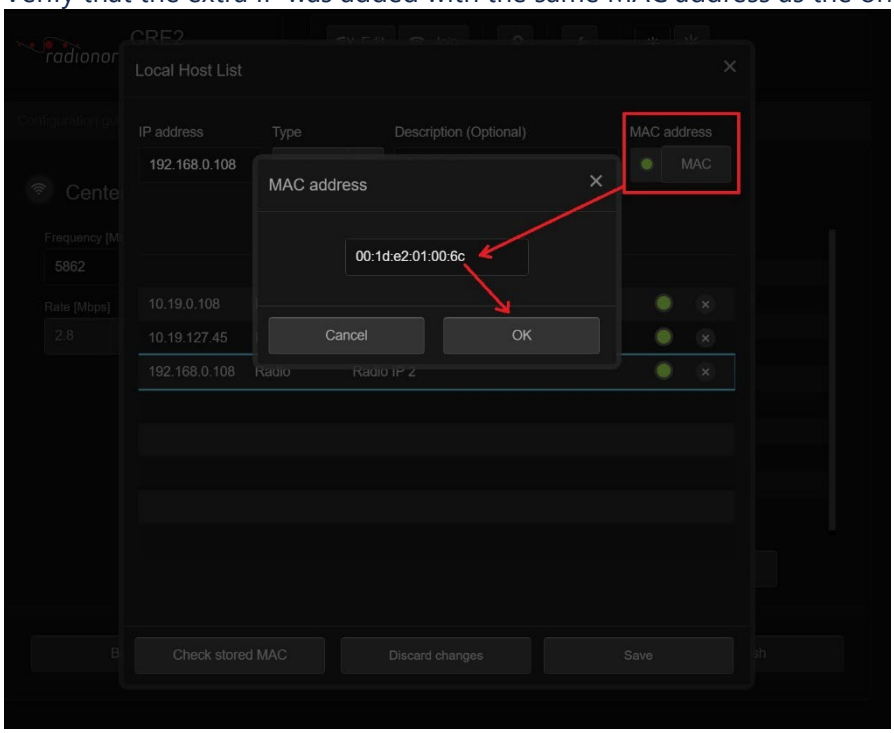


Added extra IP address can be removed by ticking the box for delete, followed by *Submit*.

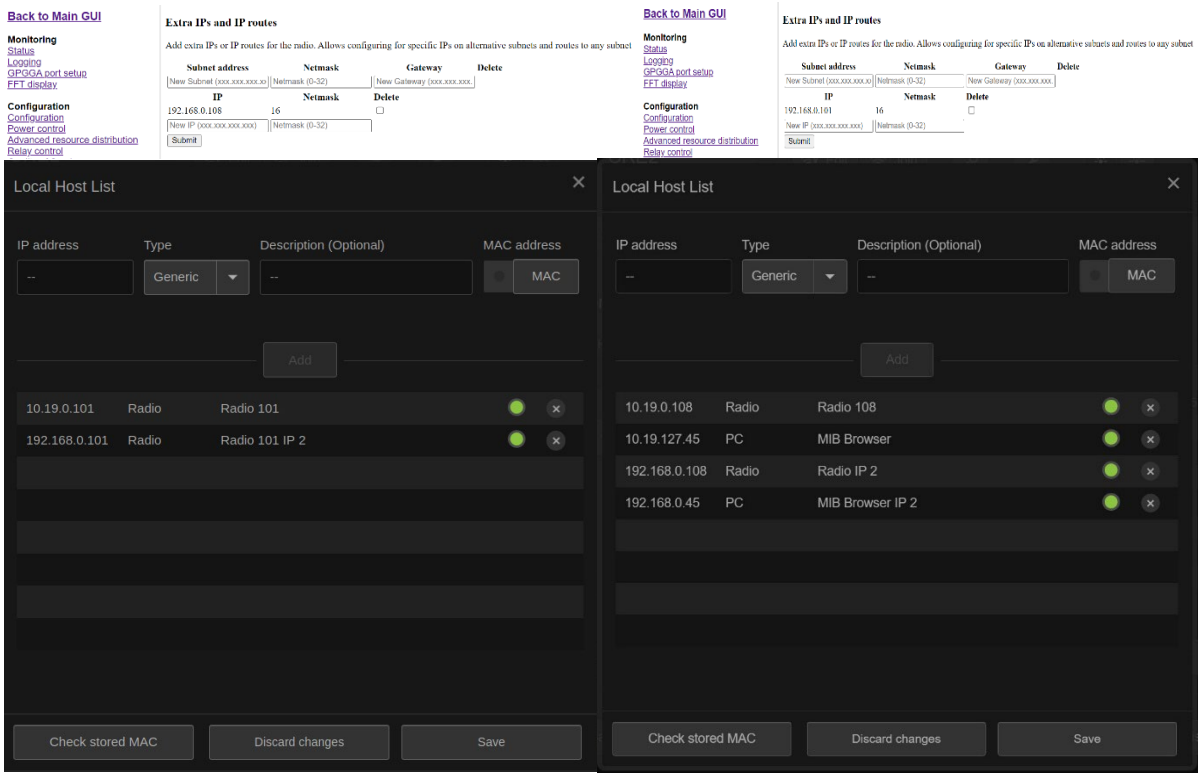
If the extra IP should be used to send data over the link, it needs to be added to the Third party equipment list



Verify that the extra IP was added with the same MAC address as the original IP

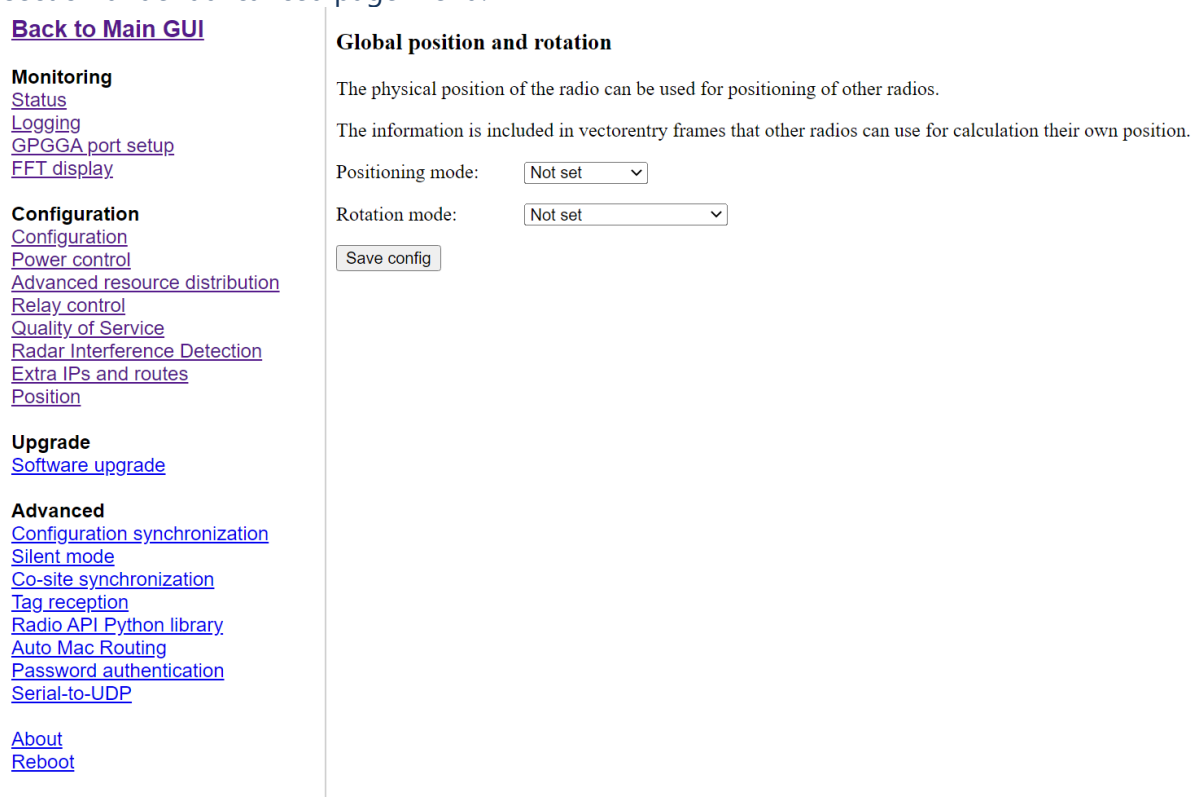


A complete Extra IP setup might look like this:

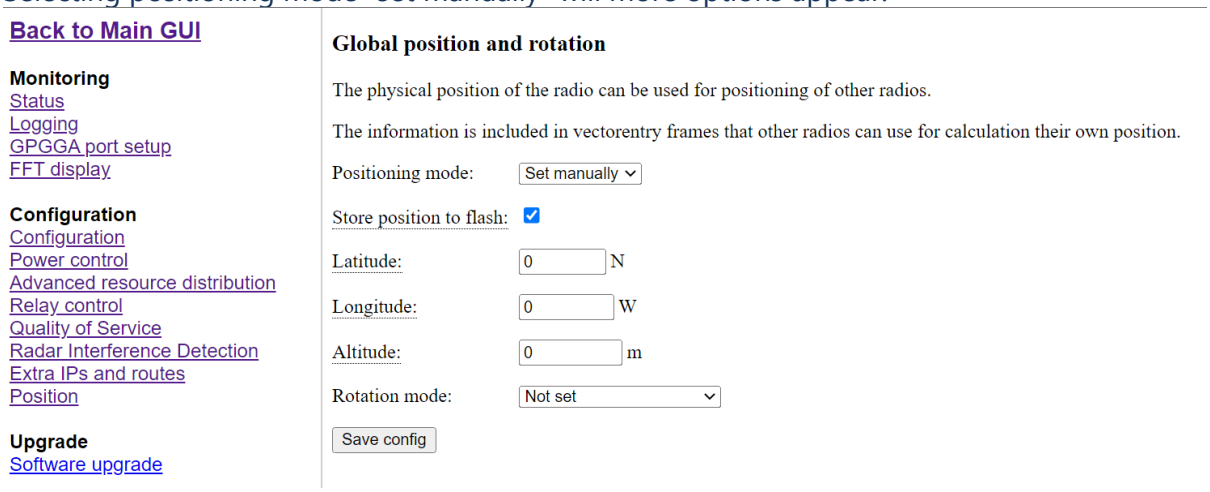


3.4.12 Position

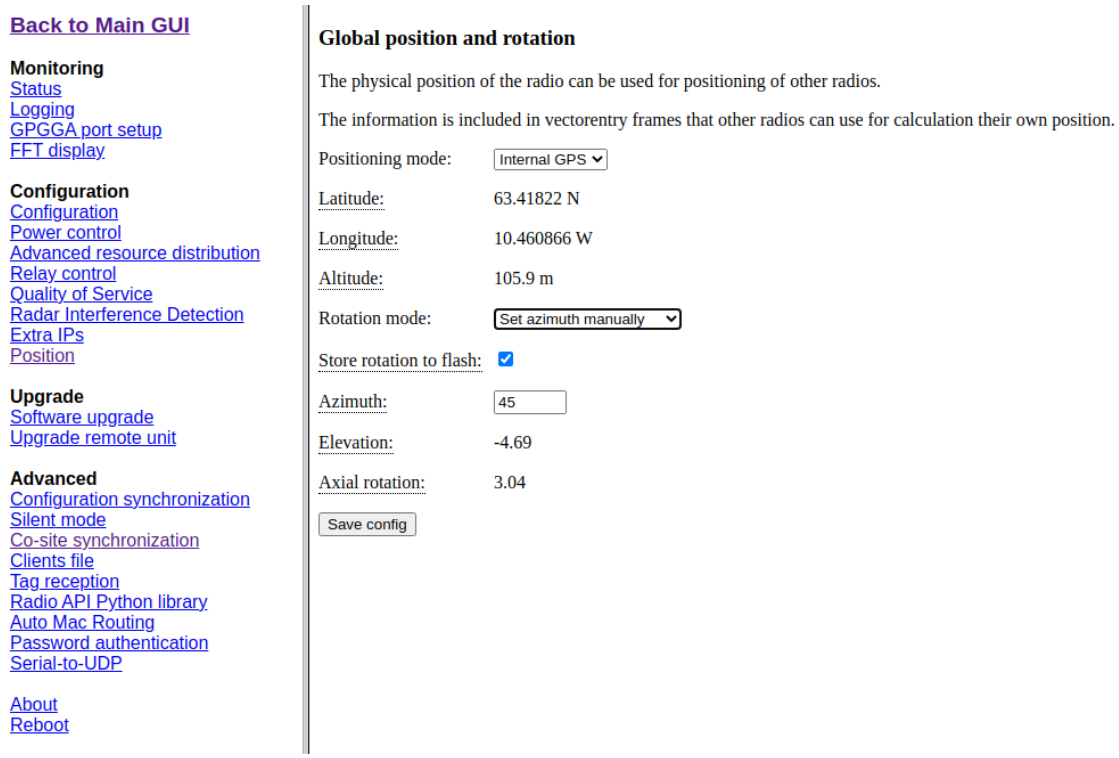
For positioning other radios in the network with redbox functionality it is mandatory to put in one or several physical position for ground units. This must be done under position section under advcanced page menu:



Selecting positioning mode “set manually” will more options appear:



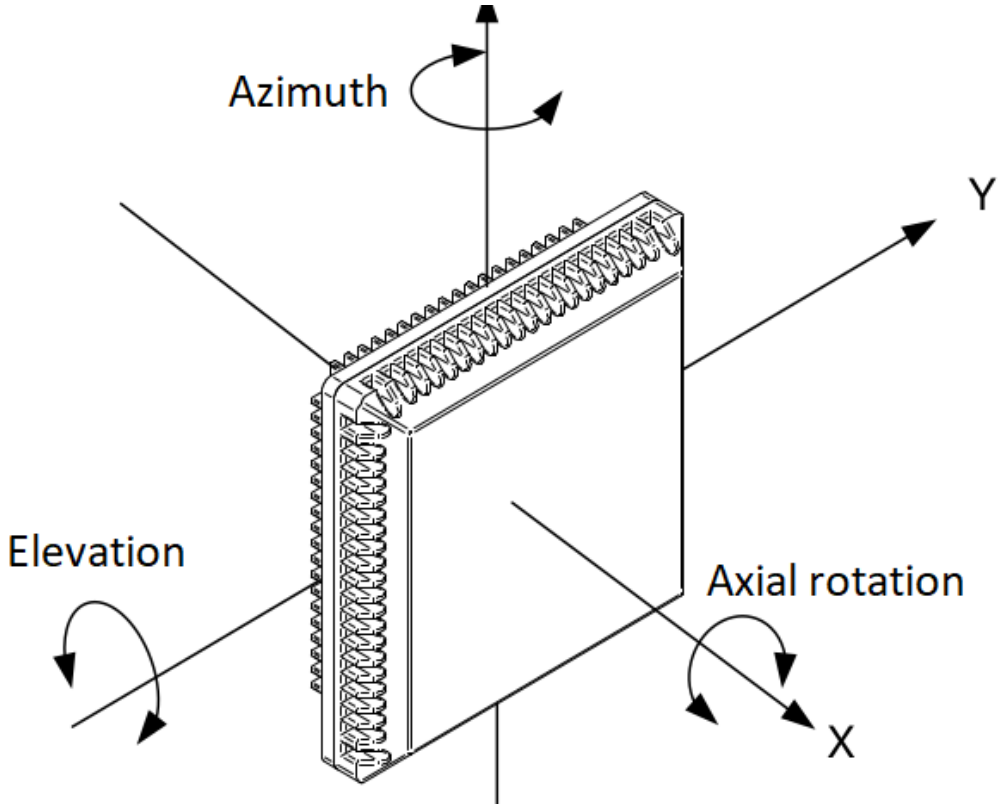
Ground Station position can be obtained from internal GPS or set manually by entering Latitude, Longitude and Altitude in configuration in advanced web interface under section **Position** and **Azimuth:**



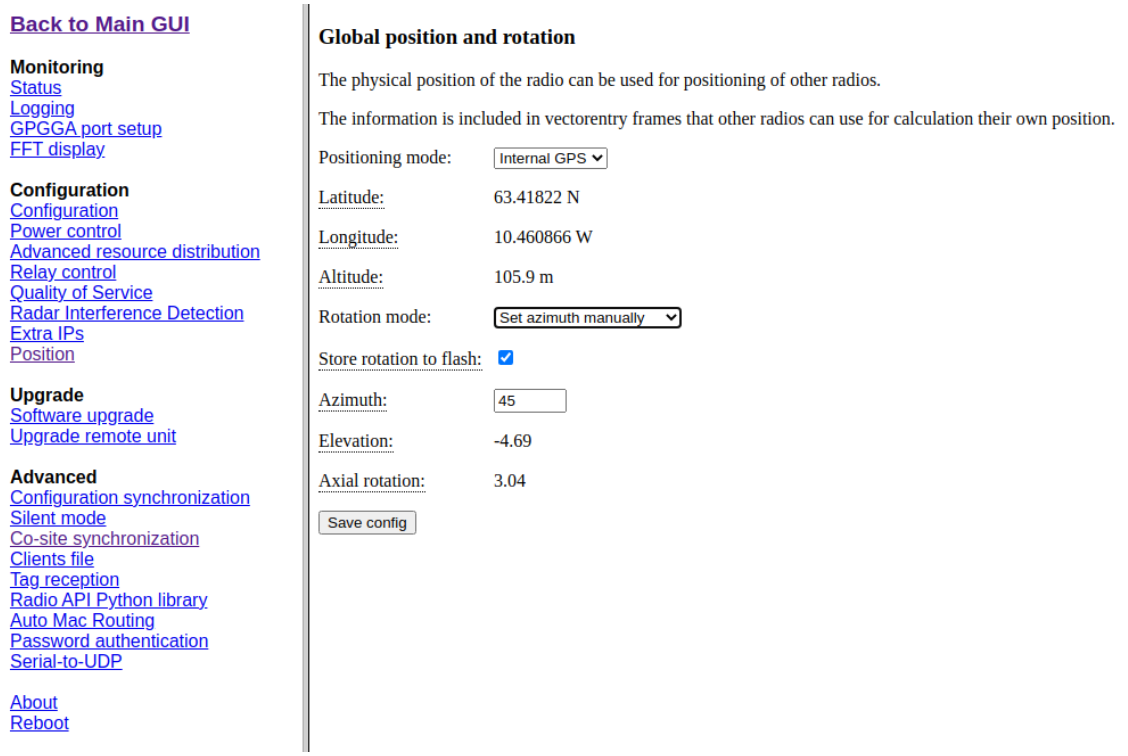
Ground Station orientation

It is recommended to calibrate ground station orientation as precise as possible, because Red Box uses its position and orientation as reference when calculating position of the aircraft.

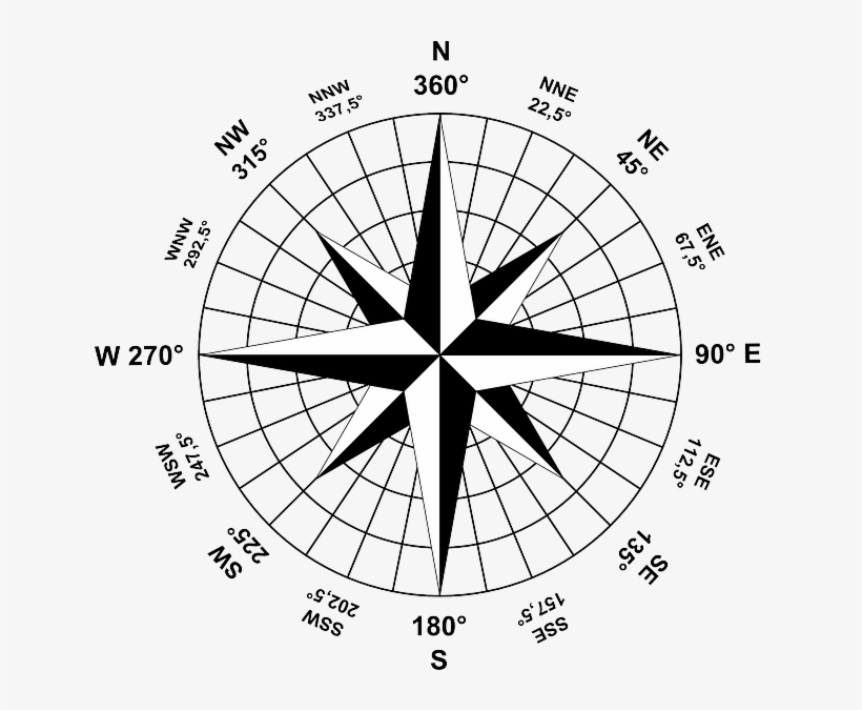
3.4.1



The CRE2-189 must not be mounted pointing to much downward or upwards. This to maintain valid measurements from the magnetometer. This means that the elevation and axial rotation must **not tilt more than 45 degrees**. Azimuth, compass heading, must be measured and entered in configuration in advanced web interface under section **Position** and **Azimuth**:

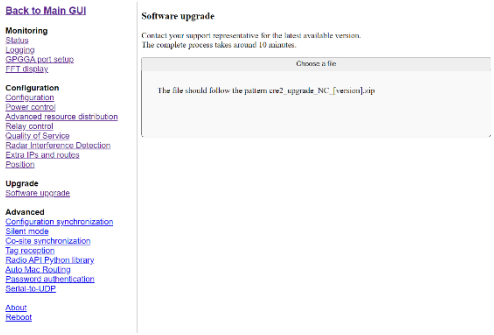


The azimuth value is the compass heading in degrees relative to north:

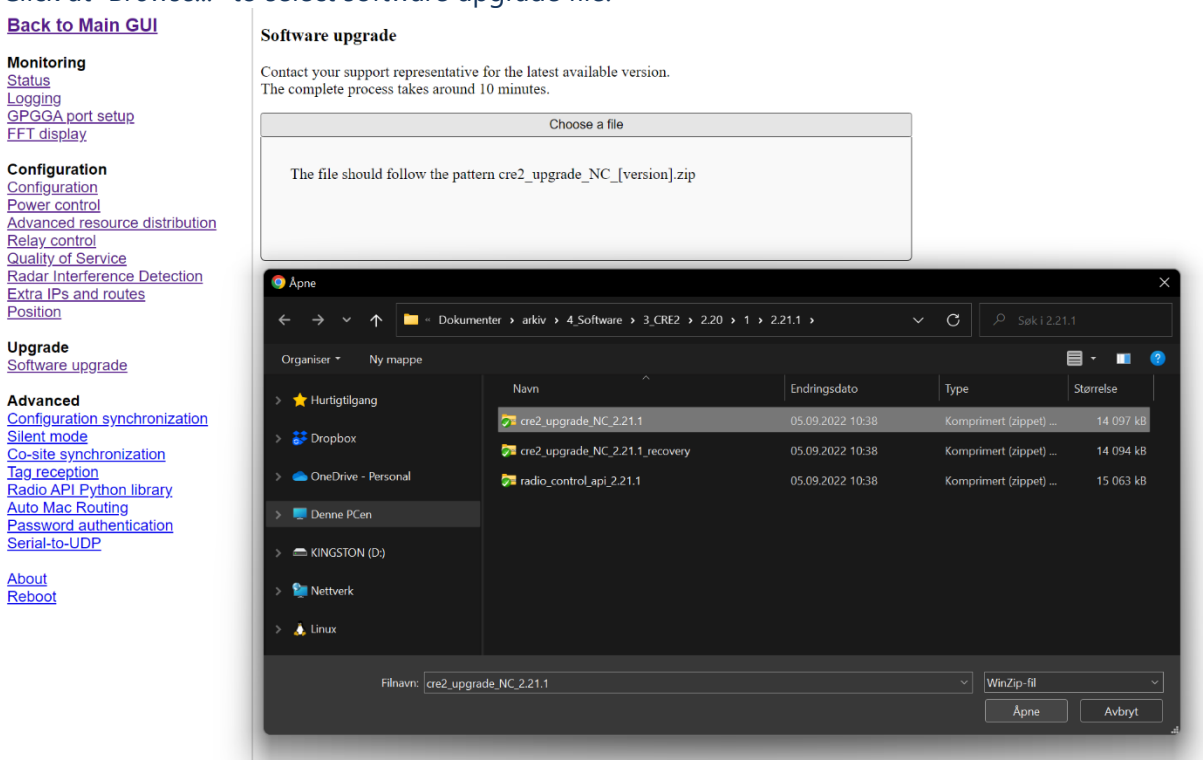


3.4.13 Software upgrade

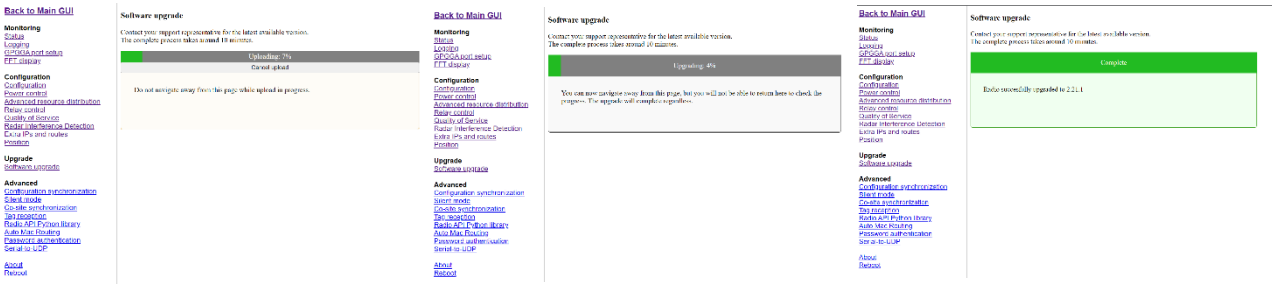
To upgrade software version navigate to advanced page and to section *Software upgrade:*



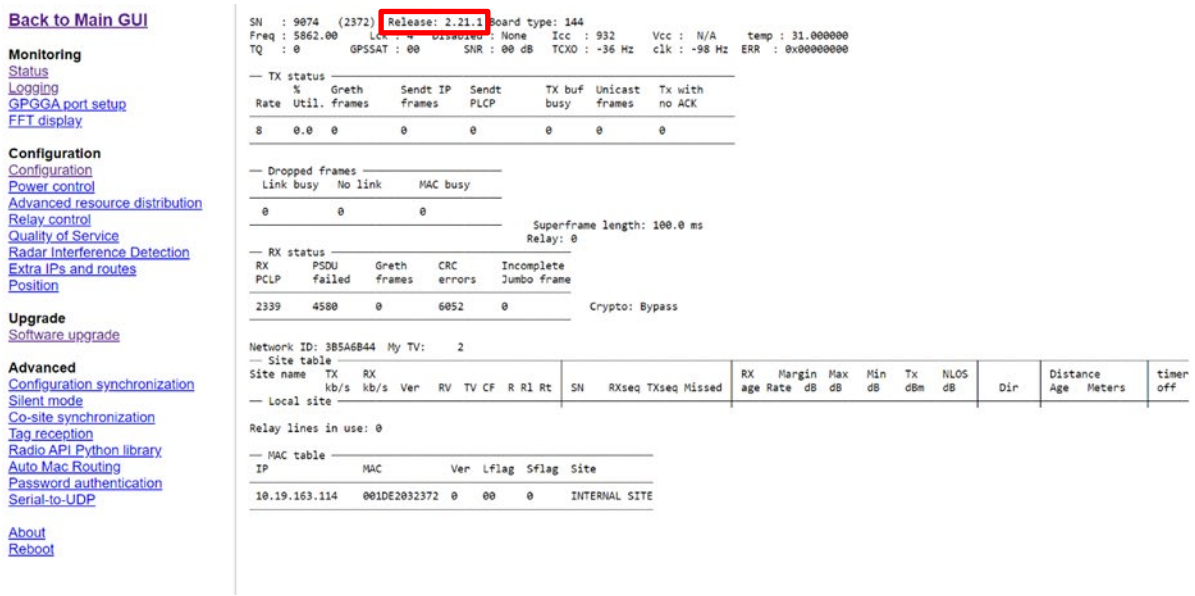
Click at "*Browse...*" to select software upgrade file:



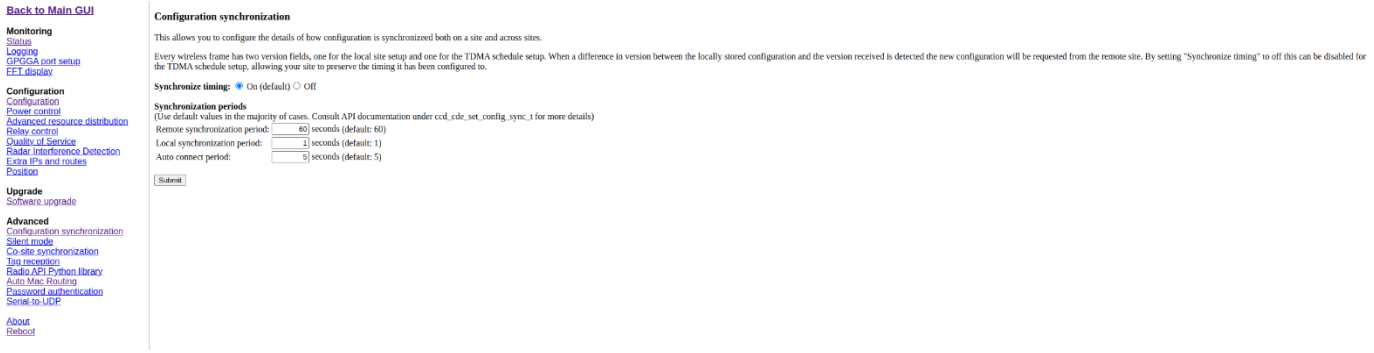
Then the radio unit will upload the firmware file. When the upload is completed it will automatically continue upgrading. Upgrading will take several minutes. The radio unit will reboot, and the status will be “Complete”.



To confirm that the upgrade process was successfully you have to enter the advanced tab once again. The current software version is listed on top in the “home” or “status” page:



3.4.14 Configuration synchronization



At this page you are able to configure how often synchronization is being done locally and remote.

Remote synchronization period
How often wireless synchronization packets being sent to other radios.

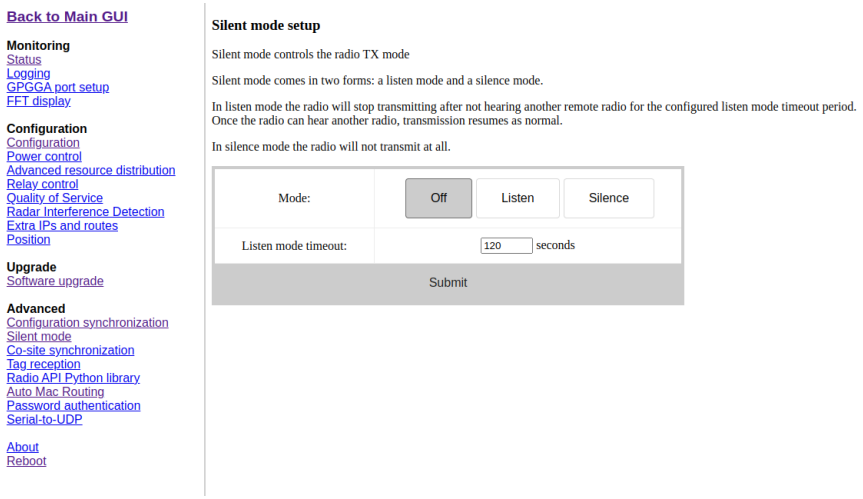
Local synchronization period
How often local synchronization packets being sent between local radios.

Auto connect period
How often auto connect packets being sent.

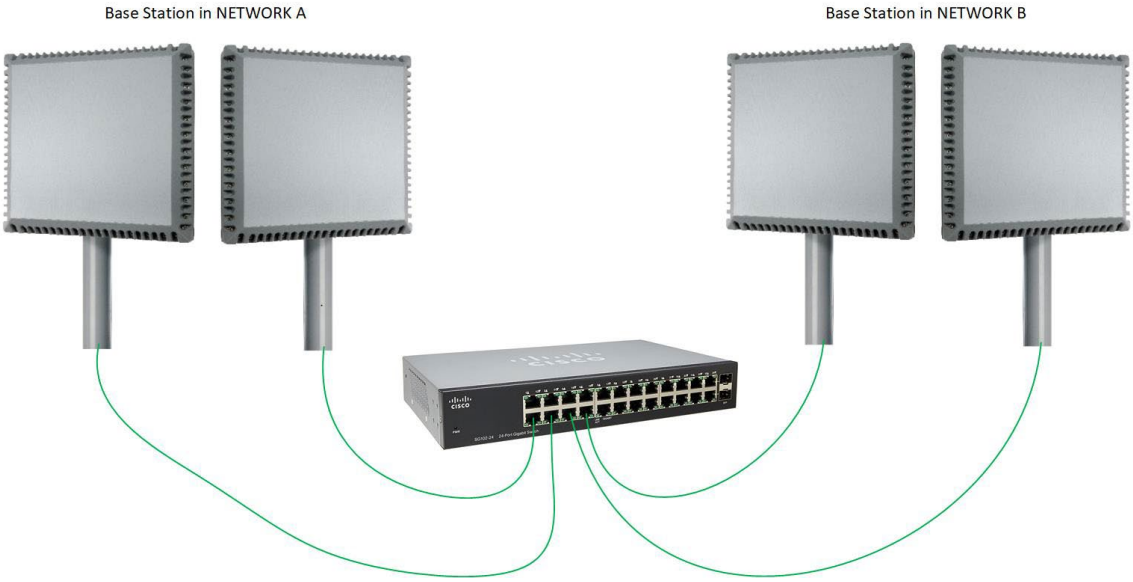
3.4.15 Silent mode

This mode allows you to configure a radio to stop transmitting. Two different modes:

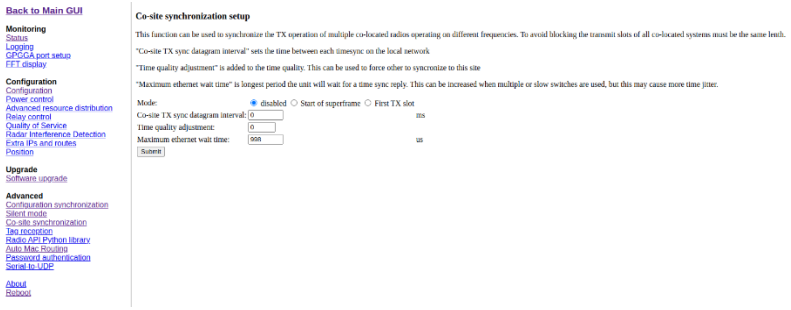
1. Listen mode: radio will stop transmitting after not receiving anything from remote radio for a preconfigured period of time.
2. Silence mode: radio will no transmit until silence mode is manually turned off.



3.4.16 Co-site synchronization (synchronization of multi-network site)

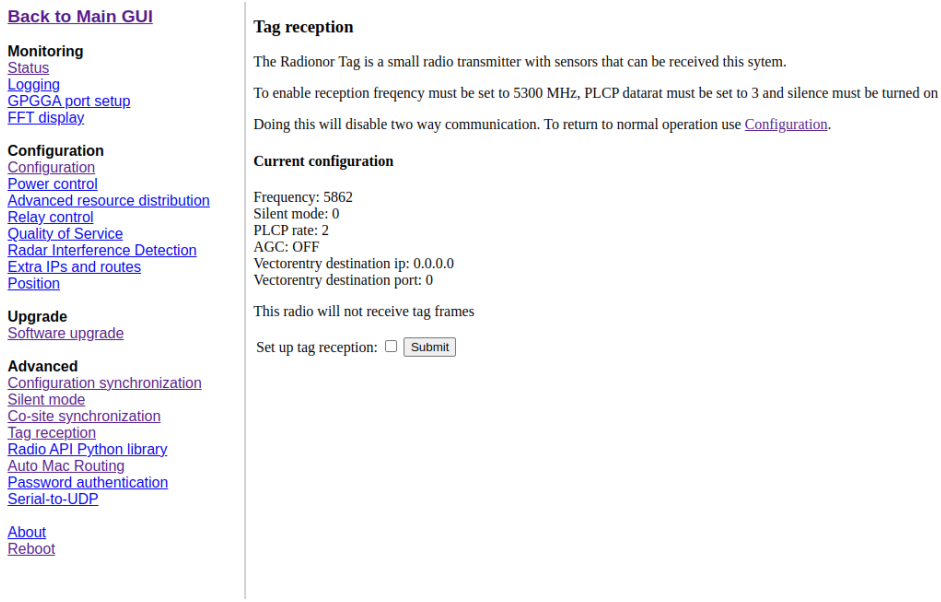


In a multi network site there is mandatory to have them synchronized so that the two networks do not jam each other. It is a configuration where you have multiple networks located at the same spot, and therefore it is necessary to have them connected to same switch to have them synchronized. When they are synchronized they will transmit and receive in the same time slot. Then there is important that they are configured with the same superframe length and same amount of network resource distributed.



Ethernet timesync interval: sets the time between each timesync on the local network
Time quality adjustment: is added to the time quality. This can be used to force other to synchronize to this site

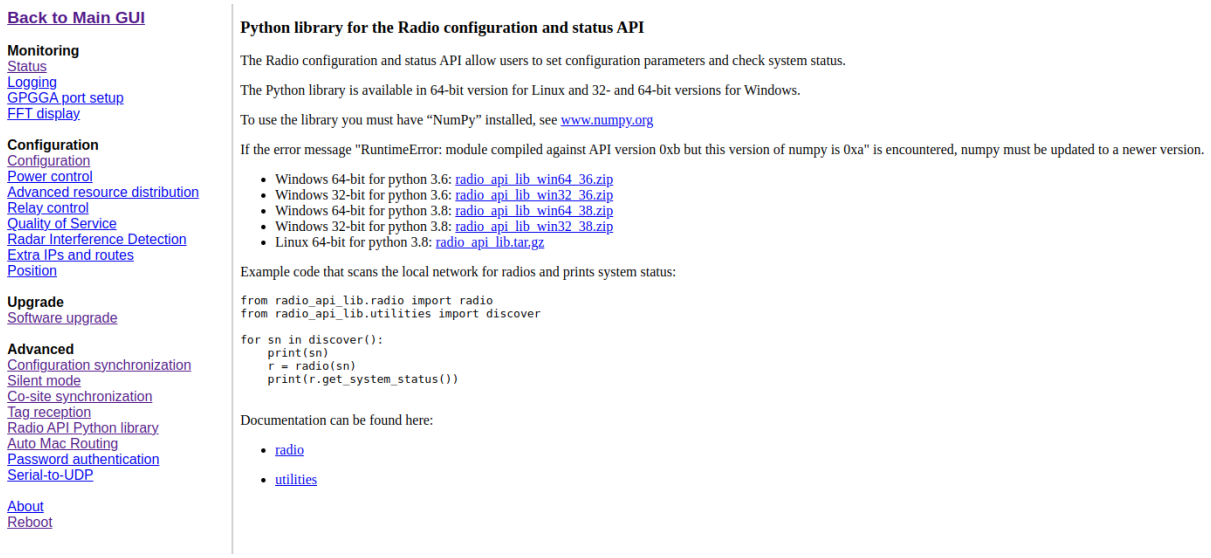
3.4.17 Tag reception



This section allows you to enable tag reception from the Radionor Tag transmitter. When tag reception mode is enabled it will change to required frequency, silent mode and required PLCP rate.

To return to normal operation use “Reset configuration” under *Configuration* section.

3.4.18 Radio API Python lib



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Python library for the Radio configuration and status API

The Radio configuration and status API allow users to set configuration parameters and check system status.

The Python library is available in 64-bit version for Linux and 32- and 64-bit versions for Windows.

To use the library you must have "NumPy" installed, see www.numpy.org

If the error message "RuntimeError: module compiled against API version 0xb but this version of numpy is 0xa" is encountered, numpy must be updated to a newer version.

- Windows 64-bit for python 3.6: radio_api_lib_win64_36.zip
- Windows 32-bit for python 3.6: radio_api_lib_win32_36.zip
- Windows 64-bit for python 3.8: radio_api_lib_win64_38.zip
- Windows 32-bit for python 3.8: radio_api_lib_win32_38.zip
- Linux 64-bit for python 3.8: radio_api_lib.tar.gz

Example code that scans the local network for radios and prints system status:

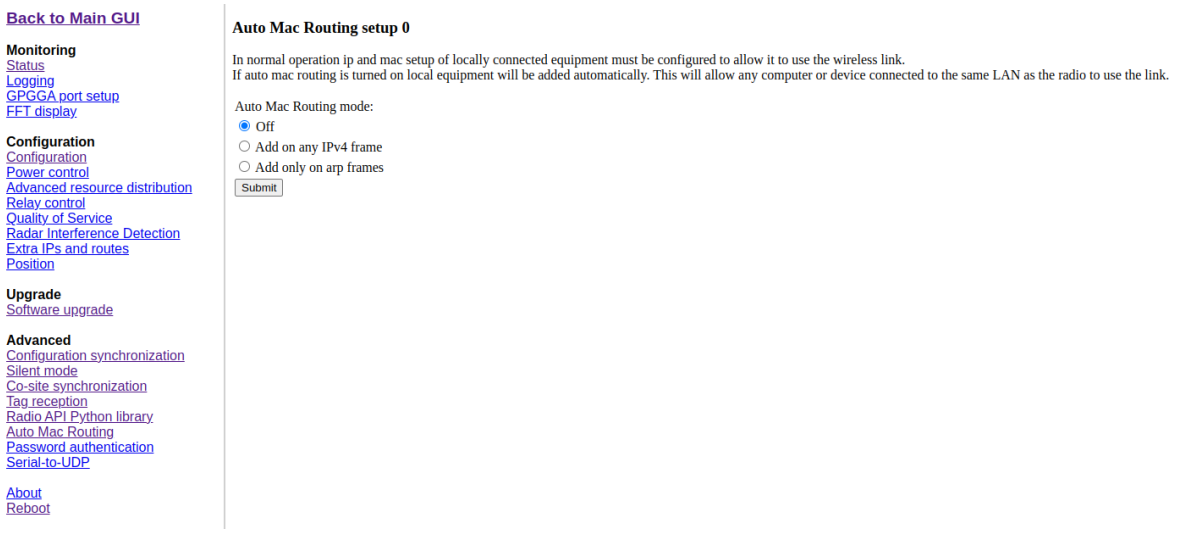
```
from radio_api_lib.radio import radio
from radio_api_lib.utilities import discover

for sn in discover():
    print(sn)
    r = radio(sn)
    print(r.get_system_status())
```

Documentation can be found here:

- radio
- utilities

The Radio configuration and status API allow users to set configuration parameters and check system status. The API library can be downloaded to Windows and Linux platforms. Documentation is also available for download.

3.4.19 Auto Mac Routing

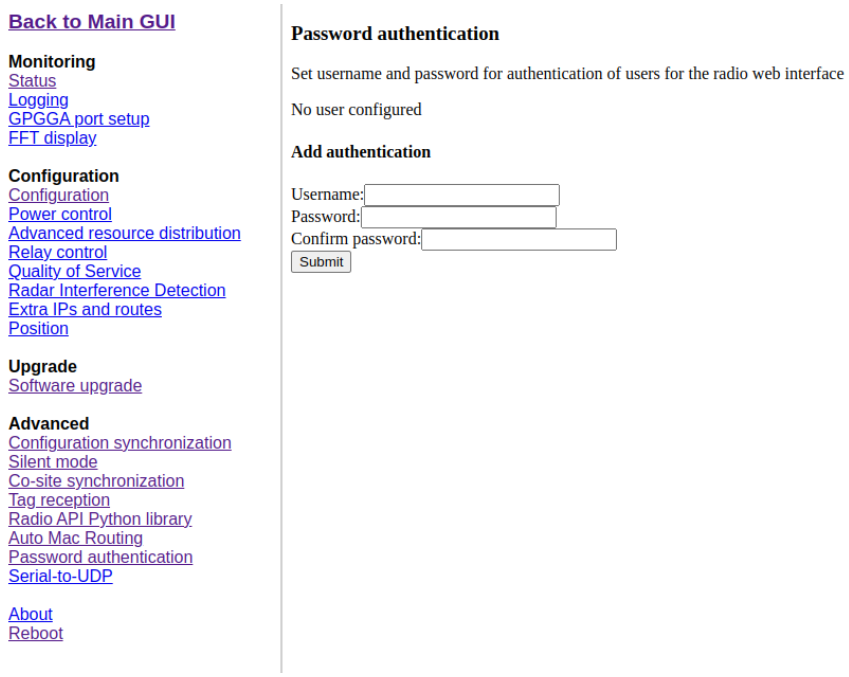


This feature sets the radio to add all available equipment in the local network to the local host list so they will become available in the configured radio network. This must be done for all radios in the network if it is wanted that all network equipments and their traffic becomes available. It can take a few seconds before all network nodes becomes available since this depends on frequency of arp request in the local networks. Broadcast and multicast will not be routed automatically, it needs to be added as described in section 3.4.18 at page 40.

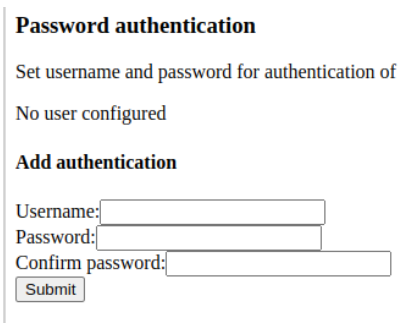
NOTE! If auto mac routing mode is disabled all mac addresses in local host list will remain.

NOTE! This can also create a lot of unwanted traffic. Use with care.

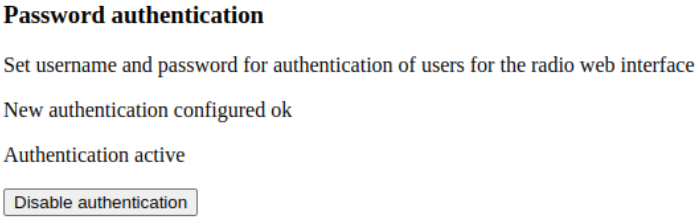
3.4.20 Password authentication



Under **Password authentication** current status is shown. If no password authentication is configured it will show:

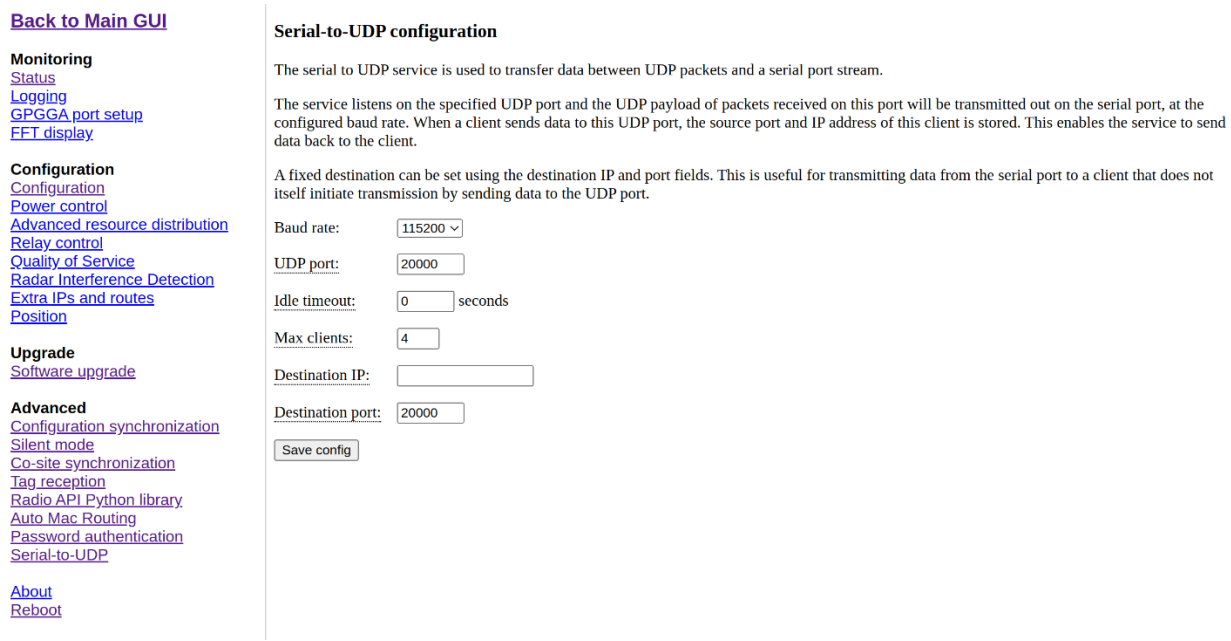


To set a authentication fill inn **Username, Password and Confirm password** followed by pressing **Submit.** Then it will show:



To disable authentication – press **Disable authentication**

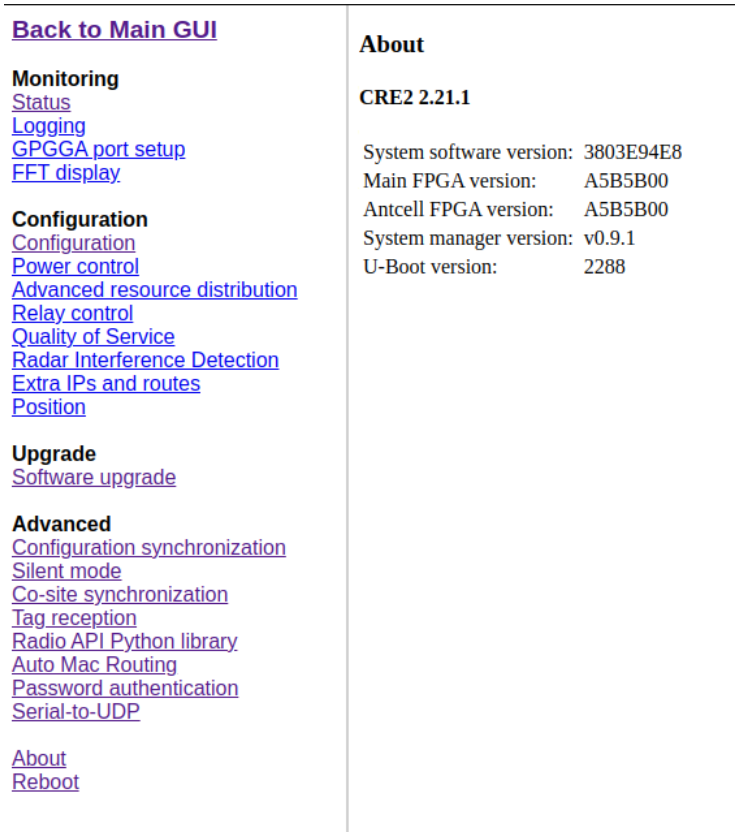
3.4.21 Serial-to-UDP



Serial-to-UDP function is used to convert serial data to UDP and vise versa. Useful for Command and Control Systems with serial port interface. Select and type in parameters to communicate with your user defined serial port interface:

Baudrate: serial port communications speed.
UDP port: UDP receiver port in radio for where to send UDP data which will be converted to serial data.
Idle timeout: Timeout for serial port converting to UDP since last received UDP packet. "0" means disabled.
Max clients: Number of maximum IP nodes to convert data for
Destination IP: UDP Destination IP Address for UDP converted serial port data.
Destination port: UDP Destination port for UDP converted serial port data.

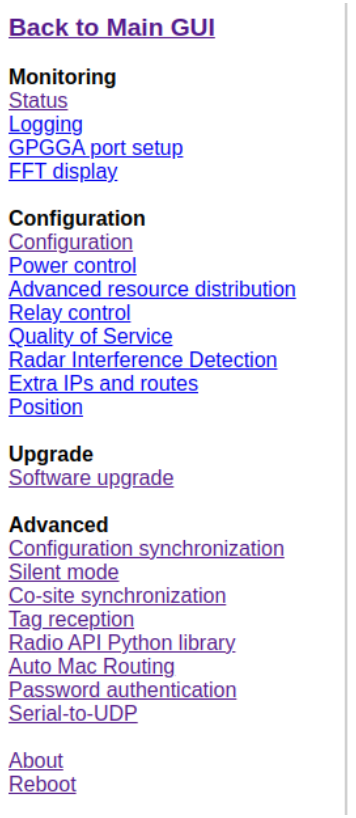
3.4.22 About



Here is different versions of the radio components listed such as software, FPGA, system manager and U-Boot.

3.4.23 Reboot

This section allows you to manually reboot the radio by clicking *Reboot*.



4 PROCEDURES FOR MONITORING AND MAINTAINING THE SYSTEM

4.1 Logging in to an antenna panel

Each antenna panel has a built-in Linux server used for monitoring and maintenance. To log in to the antennas can either be done from a personal computer that have installed client program on the PC. The PC should have an IP address that is in the area 10.19.127.X where X is in the range 1-255 - ex. 10.19.127.10. The subnet mask on the PC is set to 255.255.0.0.

A simple way to check if everything is ok is to "ping" the antenna IP-address on the local network.

One can log in to one or more antenna panel together with an SSH client or a telnet client. Example of command to log in antenna panel with IP-address 10.19.0.192 is "ssh root@10.19.0.192". The username to login is "root" and no password.

It is also possible to access antenna panels on the other remote antenna panels over the wireless. If your configurating PC is declared in the "Third Party Equipment" then you can access directly. Otherwise you need to setup a ssh tunnel or log in via the local radio.

After you are logged in, you get a "CRE2_192:~ #" prompt. The number on the prompt line is the serial number of the product.

4.2 Monitoring the hardware-status on an antenna panel

The antenna panel status can be monitored by the following command on the local network on the service PC (Assuming the PC runs a Linux operating system):

socat UDP4-RECV:56710 -

To filter data from, say, the antenna panel 10.19.0.192, the command may look like this:

sudo tcpdump -i eth0 '(host 10.19.128.192 || host 10.19.0.192) && port 56710' -A

An example could be a printout like this:

```
sudo tcpdump -i eth0 '(host 10.19.128.192 || host 10.19.0.192) && port 56710' –A

tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on eth0, link-type EN10MB (Ethernet), capture size 65535 bytes
15:07:30.385134 IP 10.19.128.192.56720 > 255.255.255.255.56710: UDP, length 472
```

```
E.....@.@..&
.............$RNWSTAT,1,030192,0000000B,00:1D:E2:03:00:C0,'2014-01-03 11:13 r6652
branches/1.03',04251113,00009386,00009352,5230.0,00000A2D,0000F5D3,10,10.19.128.192,33000,56720,58960,140730.00,6325.09228,N,01027.65099,E,2,11,0.78,110.8,14,4
6,FFFF,FFFFF77F,F77FFFFF,891A,F44F,C7E6,E4E1,4C98,2400,E6DD,9019,EDC7,3457,6910,07B7,F9EC,F923,6B46,E04E,8,5,8,0,0,9,0,0,0,3,0000000A,001DE20300BF,001,000,00000
000,0000000B,001DE20300C0,001,000,00000000,00000000,FFFFFFFFFFFF,004,000,00000000*43
15:07:35.094318 IP 10.19.0.192.1024 > 255.255.255.255.56710: UDP, length 252
E.....@.@.2.
.............7$RNSSTAT,00:1D:E2:03:00:C0,6816,'2014-01-06 11:14 r6676 trunk','v1.02-rc10  2012-05-03 14:40 SVN ver. 3734',1392,47975,0,0,2020,3340,35.687,-5,4,-980,685,-
146,352,-46,-31,2,47250,6609,8625,37,40,2000,00000005,21,03,00000000,2,10.19.0.192,10.0.64.192*7b
15:08:35.094395 IP 10.19.0.192.1024 > 255.255.255.255.56710: UDP, length 252
E...._@.@...
```

Each antenna panel sends a $RNSSTAT message about once a minute. If the messaged should be logged, this can be done by entering the command:

sudo tcpdump -i eth0 'port 56710'- w testlog.cap
or
socat UDP4-RECV:56710 - > testlog.cap

It is possible to check a few things manually by looking at the log, see logformat at page 57. For example, one can look at the fields following the field 'v1.02 - RC10 2012-05-03 2:40 p.m. SVN ver. 3734' in $RNSSTAT message. In this example, 1392 means that the antenna panel draws 1392 milliamps (1.392 amps) - which is a normal current draw - it should be between 1300 and 1600. Moreover, the number 47975, which means that the input voltage is 47 975 millivolts (47.975 volts) which is within the range for nominal operation. Then there are four comma separated numbers and then the number 35.687 which is the temperature inside the product (35.687 °C). The internal temperature should not exceed +85° C.

If you want to check how long the antenna panel has been in continuous operation, you type the command "uptime" when you are logged in to the linux server. Example of response are:

```
01:08:39 up  1:08, load average: 0.14, 0.03, 0.01
```

In this case the system has been operating for 1 hour and 8 minutes and 39 seconds.

4.3 Version of the Linux-system

If one is to check the version of the Linux system antenna terminal type the command "cat /etc/gitversion." Example of response are:

```
2020-06-11 14:35:34 +0200 0d44d2737
git@192.168.0.14:software/snapgear-2.6-p40-CRE2/tree/0d44d2737
```

In this example, the version number is 6676 which was released at 11:14 on 6th of November 2020.

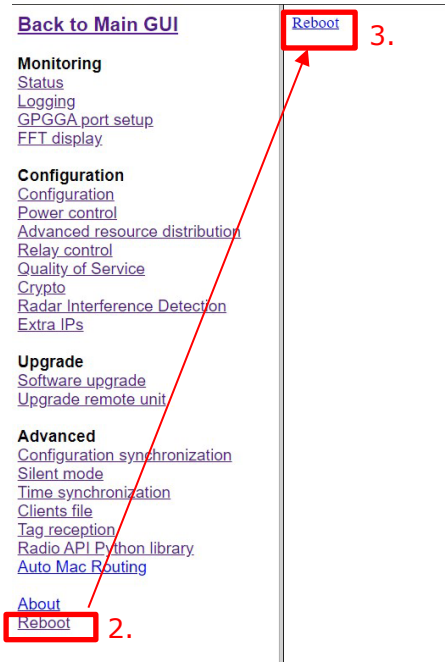
The antenna panel status can also be monitored with the API by the following command “get_system_status(dest_ip, dest_id, datagram_port, source_id)”. See “radio_api_functions.py” in the API zip file which can be downloaded under “Radio API Python lib” in the advanced site. See section 3.4.20 Radio API Python lib at page 43 for more information.

4.4 Restart of an antenna panel

A panel antenna can be re-started by logging in and then type the command "reboot" or by recycling the power. It takes around one minute for the antenna panel to start and another one minute to get the configuration loaded and the data to be transferred.

Reboot of the antenna panel can be done by following steps:

1. Enter advanced site by entering the ip address of the radio followed by "/advanced". If the serialnumber is 100 then the correct URL would be: 10.19.0.100/advanced.
2. Move to the Reboot section by click on "Reboot" in the list in the top left corner.
3. There you click "Reboot". Now the radio unit will reboot and in approximately 2 minutes be up and running.



4.5 CPU workload

To check the load in the Linux system in the antenna panel, the command "top" should be run. It will then show a list of processes and their load on the processor. To get out of this view, one must hold down the "Control" button and press 'C'. An example of a response of the 'top' command is:

```
Mem: 20156K used, 102024K free, 0K shrd, 32K buff, 12412K cached
CPU:  11% usr  23% sys   0% nice  64% idle   0% io   0% irq   0% softirq
Load average: 0.07 0.04 0.01
  PID  PPID USER     STAT   VSZ %MEM %CPU COMMAND
  564   526 root     R     3812   3%  35% top
   64     1 root     S    44060  36%   0% /bin/arp_handling -g -u -l
   91     1 root     S    19432  16%   0% qos_retry_server
   89     1 www-data S    15956  13%   0% hiawatha
   84     1 root     S    11256   9%   0% /bin/rtp_retry_server
```

```
 85    1 root     S    11252   9%   0% cre_controller
 77    1 root     S    10908   9%   0% /bin/commandreceiver
 45    1 root     S     3820   3%   0% /usr/sbin/telnetd
526   45 root     S     3820   3%   0% -sh
 92    1 root     S     3820   3%   0% /bin/sh
  1    0 root     S     3812   3%   0% init
 75    1 root     S     3812   3%   0% /bin/sh /bin/upgradewatch.sh
 52    1 root     S     3768   3%   0% /bin/sshd -f /etc/ssh_c
563   75 root     S     3680   3%   0% sleep 10
 61    1 root     S     2148   2%   0% /bin/ftpd -D
 44    1 1        S     1732   1%   0% /bin/portmap
 12    1 root     SW       0   0%   0% [mtdblockd]
  4    1 root     SW<      0   0%   0% [events/0]
  2    1 root     SWN      0   0%   0% [ksoftirqd/0]
  3    1 root     SW       0   0%   0% [watchdog/0]
  5    1 root     SW<      0   0%   0% [khelper]
  6    1 root     SW<      0   0%   0% [kthread]
  7    6 root     SW<      0   0%   0% [kblockd/0]
  8    6 root     SW       0   0%   0% [pdflush]
  9    6 root     SW       0   0%   0% [pdflush]
 10    6 root     SW<      0   0%   0% [kswapd0]
 11    6 root     SW<      0   0%   0% [aio/0]
```

Total CPU load shall not be more than 20%. No processes shall be more than 50%.

4.6 Status of the radio system

When being logged into the Linux system, you can type command "rf". This displays a RF status report on the screen with information about radio system version and configuration:

```
-----------------------------
RF status

RF frequency          : 5230.0 MHz
RF transceivers locked  : 60
RF transceivers disabled: None
PLCP RX rate          : 0
PLCP TX rate          : 0
-------------------------
GPS sub-system

Number of satellites    : 17
Peak S/N              : 48 dB
-------------------------

------- BUFFER 0 --------
PSDU TX rate          : 8
Received PSDU's OK      : 0
PLCP OK with failed PSDU: 0
TX UNICAST PSDU's       : 0
TX PSDU's             : 0
Missed TX PSDU ACK's    : 0

------- BUFFER 1 --------
PSDU TX rate          : 5
TX PSDU's             : 9

------- BUFFER 3 --------
PSDU TX rate          : 8
TX PSDU's             : 0
Superframe time quality : 0
```

```
-------------------------
```

In this example the frequency is set to 5230 MHz (5.230 GHz). The “RF transceivers locked" shall be 60 if the antenna is operation normally, and "RF transceivers disabled" should be "None".

GPS sub-system is an option that is relevant for the ground antenna panel. Note that the GPS sub-system is not required for system to operate, but the GPS provides additional information such as timing info that can be useful for test experimentation data logging.

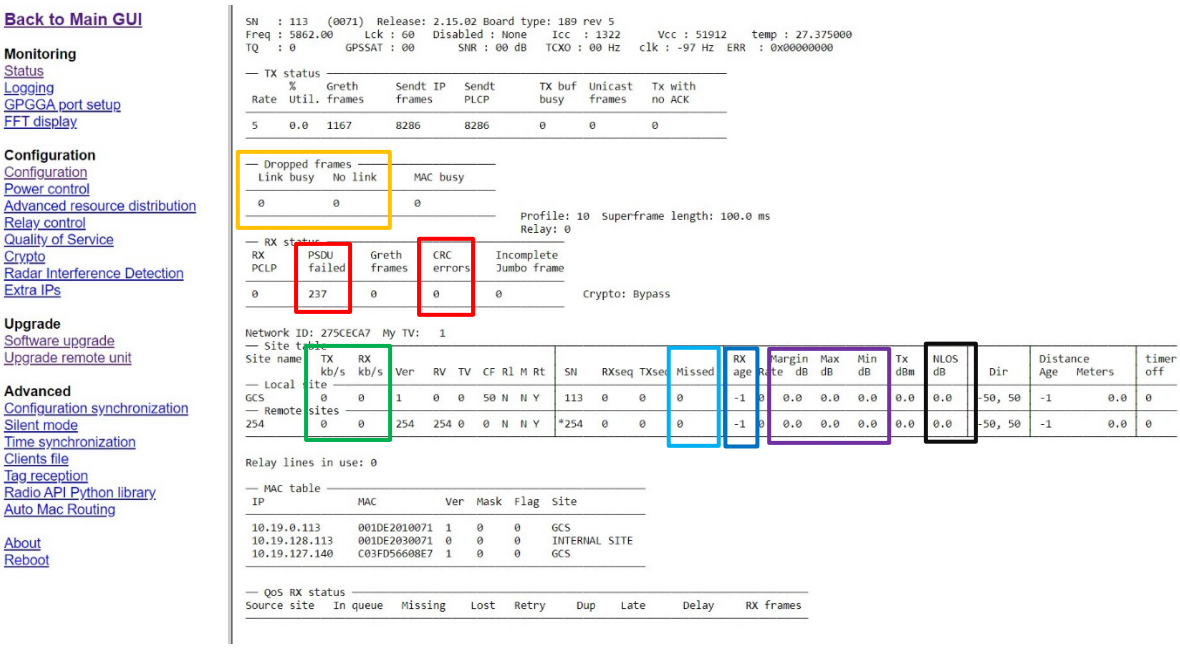
The field "Received PSDU's OK" indicates the number of correctly received data frames. If you run the following "rf" commands can be seen in this field counts. The field "PLCP OK with failed PSDU" specifies limits where one has decoded the beginning but no end correctly. If this field counts down, it is signs of interference or a marginal link. If the other moving antenna is in the immediate area normally receives all four panel data from the other moving antenna, but when one is in the outskirts of the operational area, only the panel where the other moving antenna is in operative sector is receiving data.

4.6.1 Live status report

By typing the command "dash" when you are logged in to the linux system, the live status report of the radio system with uploading frequency of 1sec will be presented (also presented at 10.19.X.X/advanced and *Status*). See for description on page 23-26.

4.7 Basic health check

There are a lot of parameters in the live status report that can be checked for diagnosticifation of the radio system (presented at 10.19.X.X/advanced and *Status* or *Home)*:



The basics to check after the system has booted:

- See if there is any transmission. The TX and RX throughput is seen in the green marking.
- RX age is the time since last receive packet. If no transmission the RX age is >25. RX age is found in the blue marking.
- CRC errors and PSDU failed can indicate interruptions, interference or out of sector. These parameters are found in the red markings.
- Link busy under *Dropped frames section* in orange marking indicates that there is more data throughput in the buffer than there is bandwidth available. No link increments for each ethernet frames the radio where not able to transmit due to no connection.
- Missed is a counter that count each packet that is sent from other radios and not received.
- Signal margin [dB] tells you how much signal you have left until you will lose the connection. Numbers down to 0 dB tells you that you are on the edge. There are three numbers in the purple marking, *average*, *min* and *max*. Min is the one that present the minimum signal margin received whitin the last 2 second interval.
- NLOS, marked in black, gives you the lost signal due to non-line of sight conditions.

4.8 Monitoring of signal strength

When standing in the Linux shell (with "#" prompt) type the command "lr" to display report on the screen received signal level from the second antenna panel:

```
                  | RX    margin  max  min  Tx   NLOS    |        |Distance     |Ranging   |Timing
SN  RXseq TXseq Missd| age rate  dB   dB   dB  dBm    dB   |  Dir   |age    meters|age   lvl |TQ    diff
180    0     0    0|   -1  0  0.0  0.0  0.0  0.0   0.0    | -50, 50 |  -1       0.0| -1     0 | 0       0 |   0
72   3918  3673  8926| 0.4   5  9.0 11.1  6.9 37.0 -38.1    |  50,  8 |0.4   19796.2|0.4    39 | 0    9055 |   0
```

In this example, we see listed SN (Serial Number) from each antenna panel that is part of the broadband system.

What is of interest is to look at the number in the "Dir" column. This shows the direction of the received signal is coming from. The numbers are in degrees and relative to the antenna direction. The first number is the horizontal direction - a negative number is to the left of center axis and positive to the right of center axis. The second number is the vertical direction - a negative number is down and a positive number up. Example 30,8 indicates that the signal is 30 degrees to the right of center axis and 8 degrees up the center axis. The example specifies direction 30,8 from an antenna panel with Serial Number 72 which means that the signal is 30 degrees to the left and 2 degrees below. Keep in mind that these numbers are invalid if the signal is outside the operational sector.

One should also check the value of “diff” should be greater than -10000 and less than 10000. This number indicates the time difference between the radios.

Received signal strength can be read in "margin dB" column. In this example, the received signal strength "9.0”. The strength is presented in decimal watts.

NLOS dB is the signal strength lost in multipath reflections and blocking objects.

Distance 19796.2 is the distance in meters from SN 180 to SN 72.

4.9 Applying continuous wave transmission for test purposes

When being logged into the Linux system, type the command "co_proc" and you will then have a "192 ->" prompt where the number is the serial number of the product.

To start continous wave transmission, enter the command (Note that it's case sensitive):

```
mw 01180a14 14
```

The antenna will enter a test mode where it transmits a continuos carrier wave at the maximum power. To turn of this carrier transmission, enter the command:

```
mw 01180a14 0
```

To exit this shell, press the control key and then press 'X'. You will then return to the Linux system.

5 CRE2 SYSTEM STATUS MESSAGES DESCRIPTION

The CRE2 sends UDP system status messages as broadcast messages on the local network. There are two status messages that are sent with approx. 60 seconds interval. These messages are useful to monitor units attached to the network. Because these UDP frames are broadcasted it can be used to find "lost" units where the IP settings are unknown. The $RNSSTAT and $RNWSTAT also contains low level debug and system information that can be used for monitoring purposes. There are two messages:

- $RNSSTAT is the system operation status (Power supply conditions, on-board temperature, orientation data etc. This message is sent from the CRE2 system management/housekeeping module.
- $RNWSTAT is the wireless system status (Wireless status and set-up etc.). This message is sent from the CRE2 MAC co-processor module.

5.1 System operation status message

The system operation status message is sent with broadcast destination IP address 255.255.255.255 with default UDP destination port 56710. The system operation status message is formatted as a NMEA-0183 message with $ at the start and * at the end of the message followed by a two character hexadecimal checksum.

$RNSSTAT,WIRELESSMAC,SDCARDVER,INITFSVER,SYSMANVER,ICC_IN,VCC_IN,VCC_A,ICC_A,VCC_B,ICC_B,TEMP,ACC_X,ACC_Y,ACC_Z,MAG_X,MAG_Y,MAG_Z,GYR_X,GYR_Y,GYR_Z,PMB_VIN,PMB_VOUT,PMB_IOUT,PMB_T1,PMB_T2,DCDCPA_VSET,BL_VER,BL_RES,BL_RTY,BOOT_DBG,IPNUM,IPADDR_1..IPADDR_N,*CC

where

$RNSSTAT is the indicator for system operation status message.

WIRELESSMAC is the wireless MAC-address for the CRE2 on the form AA:BB:CC:DD:EE:FF where AA is the most significant byte and FF is the least significant byte. The MAC address is always upper case.

SDCARDVER is an integer number with the SD-card release number. This number is the unique SVN release number for all combinations of firmware and software, and should be used to verify a system upgrade.

INITFSVER is a version string with the current Linux filesystem version. The length of this string may be up to 65 characters. The string does not contain the comma separator but may contain other signs including white spaces. The string is surrounded by apostrophes.

SYSMANVER is a version string with the current system manager version. The length of this string may be up to 65 characters. The string does not contain the comma separator but may contain other signs including white spaces. The string is surrounded by apostrophes.

ICC_IN is an integer number with the supply input current in milliamperes.

VCC_IN is an integer number with the supply input voltage in millivolts.

VCC_A is an integer number with the internal branch A supply voltage in millivolts. For main board systems with rev. 5 PCB this number is set to 0.

ICC_A is an integer number with the internal branch A supply current in milliamperes. For main board systems with rev. 5 PCB this number is set to 0.

VCC_B is an integer number with the internal branch B supply voltage in millivolts.

ICC_B is an integer number with the internal branch B supply current in milliamperes.

TEMP is a floating point number with . as comma separator with the interface board temperature in degrees Celcius.

ACC_X is an integer number with the X-component of the on-board accelerometer in milli-G.

ACC_Y is an integer number with the Y-component of the on-board accelerometer in milli-G.

ACC_Z is an integer number with the Z-component of the on-board accelerometer in milli-G.

MAG_X is an integer number with the X-component of the on-board magnetometer.

MAG_Y is an integer number with the Y-component of the on-board magnetometer.

MAG_Z is an integer number with the Z-component of the on-board magnetometer.

GYR_X is an integer number with the X-component of the on-board rate gyro.

GYR_Y is an integer number with the Y-component of the on-board rate gyro.

GYR_Z is an integer number with the Z-component of the on-board rate gyro.

PMB_VIN is an integer number with the BMR453 supply voltage in millivolts.

PMB_VOUT is an integer number with the BMR453 output voltage in millivolts.

PMB_IOUT is an integer number with the BMR453 output current in millivolts.

PMB_T1 is an integer number with the BMR453 temperature from sensor #1 in degrees Celcius.

PMB_T2 is an integer number with the BMR453 temperature from sensor #2 in degrees Celcius.

DCDCPA_VSET is an integer number with the DCDC+PA voltage in millivolts.

BL_VER is a hexidecimal number with the bootloader version.

BL_RES is a hexidecimal number with the bootloader result code.

BL_RTY is a hexidecimal number with the bootloader retry count.

BOOT_DBG is a hexidecimal number for debug purposes.

IP_NUM is the number of configured IP adreeses. IP_NUM is an integer in the range 0-255.

IPNUM_1-IPNUM_N are the configure IP addresses for the format A.B.C.D where A,B,C and D are integers in the range 0-255.

***CC** is the end-terminator '*' followed by a two digit hexadecimal checksum for the wireless status message. The checksum field consists of a * and two hex digits representing the exclusive OR of all characters between, but not including, the "$" and "*".

5.2 Logging of wireless system status message

Logging of wireless system status message must be enabled in the 10.19.X.X/advanced – Logging tab. Start logging by enter destination port and click “start”. The status message is sent with broadcast destination IP address 255.255.255.255 with the entered destination port. The wireless status message is formatted as a NMERA-0183 message with $ at the start and * at the end of the message followed by a two-character hexadecimal checksum. Check out page 32 for logging.

6 VECTORENTRY FORMAT

This section describes the format for sending vector and sensor data from the CRE2 to an application that need positioning information. It is called the *vectorentry* format.

NOTE: This specification describes the UDP payload element only.

The protocol header identifies the version of the *vectorentry* data being transmitted. The frame is divided into two sections:

HEADER This section contains syncmarker, size and protocol version.

BODY This section contains data about the received packet and optionally the content of the packet.

6.1 ENABLE BROADCAST OF VECTORYENTRY PACKETS

Vectorentry must be configured via API. See API documentation which come along with the firmware files or can be downloaded from the radio, see page 41.

6.2 HEADER format

Offset	Size	Name	Description
0x00	4	SYNC Marker	The code word identifies the start of the frame and can also be used to check if data has been sent in little or big-endian format. The SYNC Marker code word is: **0x8CEF5AC3**
0x04	4	Size	The total size of sync marker, size field, protocol version and body. For protocol version 3, the size should be: between 94 and 1452. NOTE: The total size is word-aligned with an additional two bytes. Ex: If the vector entry size is 83 bytes, the SIZE field will be 96 bytes. The total UDP payload size will be 98 bytes.
0x08	4	Protocol version	Set to 3.
0x0c	82-1440	Body	Se next table

Each octet is sent with LSB first and MSB last in time.

Note that for other protocol versions, the size field and the number of octets in the vector entry field can change.

6.3 BODY of location frame format

Offset	Size	Name	Description
0x0c	6	MAC address	Wireless MAC address for the tag or station sending the frame.
0x12	4	Sequence number	Sequence number for the received frame. Unsigned integer.
0x16	8	Monotonic ns timer	Monotonic nano second timer that starts on CRE2 power on. 64-bit unsigned integer.
0x1e	4	UTC time seconds	UTC time for the frame time of arrival. Seconds from 1970-01-01. 32-bit unsigned integer. This field is optional and set to 0 if the field is not included.
0x22	4	UTC time microseconds	Fractional part of time. Number of microseconds for the current second. This field is optional and set to 0 if the field is not included.
0x26	4	Tracking quality	Optional field for a quality metric. Set to -1 if the data field is not available.
0x2a	1	Signal level type	Unsigned char defining the type of the presentation of signal level: 0x00: dB signal is invalid/not available 0x01: dB signal is scaled signal in 1/100 dBm as seen by the receiver after beamforming 0x02: dB signal is in 1/100 dB unscaled
0x2b	3	Signal level dB	Signal level in dB according to the signal level type field. 24-bit signed integer.
0x2e	4	Signal level linear	Linear signal level. Unsigned integer.
0x32	4	Frequency offset	Bit 31..16 Offset availability 0x0000: No frequency offset available 0x0001: Offset is available Bit 15..0 Signed frequency offset in Hz
0x36	4	Angle y	Angle in y direction in millidegrees. Signed integer.
0x3a	4	Angle x	Angle in x direction in millidegrees. Signed integer.
0x3e	2	RF frequency MHz	MHz part of frequency. 16-bit unsigned integer.
0x40	2	RF frequency kHz	kHz part of frequency. 16-bit unsigned integer.
0x42	4	Product variant	Integer defining the product variant of the CRE2. Valid ID's: 1893 CRE2-189 revision 3 1895 CRE2-189 revision 5 1793 CRE2-179 revision 3 1795 CRE2-179 revision 5
0x46	4	Unit serial number	Unique serial number for the product.

<table>
<tr><th>Offset</th><th>Size</th><th>Name</th><th>Description</th></tr>
<tr><td>0x4a</td><td>4</td><td>Distance</td><td>Distance in mm. 32-bit signed integer. Set to -1 when the field is unavailable.</td></tr>
<tr><td>0x4e</td><td>2</td><td>RX vector size</td><td>Number of octets of rx vectors.
For CRE2 the field is either 0 or 64*8 = 512.</td></tr>
<tr><td>0x50</td><td>2</td><td>tag data size</td><td>Number of octets in the tag data field, i.e. the total number of bytes in
address1, address3 and tag payload.</td></tr>
<tr><td>0x52</td><td>12-1024*</td><td>Tagdata</td><td>Payload data from the “tag” in the following format:
<table><tr><td>6 octets</td><td>Address 1</td></tr><tr><td>6 octets</td><td>Address 2</td></tr><tr><td>0-1012 octets</td><td>Payload data</td></tr></table></td></tr>
<tr><td>0x5e – 0x452</td><td>0-1024*</td><td>RX vectors</td><td>Included if the RX vector size field is not set to 0.

64 complex vectors with 32-bit signed integer I and 32-bit signed integer Q.</td></tr>
</table>

* NOTE

The combined size of RX vectors and Tag data must not exceed 1358 octets

7 TROUBLESHOOTING

7.1 No contact with the local radio

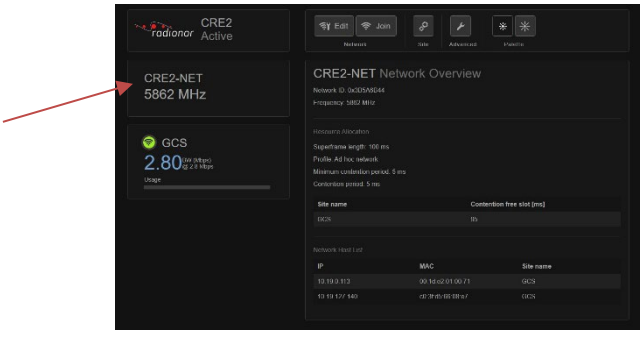
When no contact with radio, these features should be checked:

1. Is the power supply powered?
2. Is the radio connected properly?
3. Is the power supply connected properly?
4. Is the ethernet connected properly?
5. Does the LED in the ethernet port of the computer or switch indicate any activity?
6. Is the PC on the same IP-network? Please check the subnet mask. IP of the radio is found on a label on the radio unit, close to the connector.
7. Can the power supply supply enough current within the required voltage? Please see Technical specification in the installation manual of the respective unit.

7.2 No contact with one of the remote units

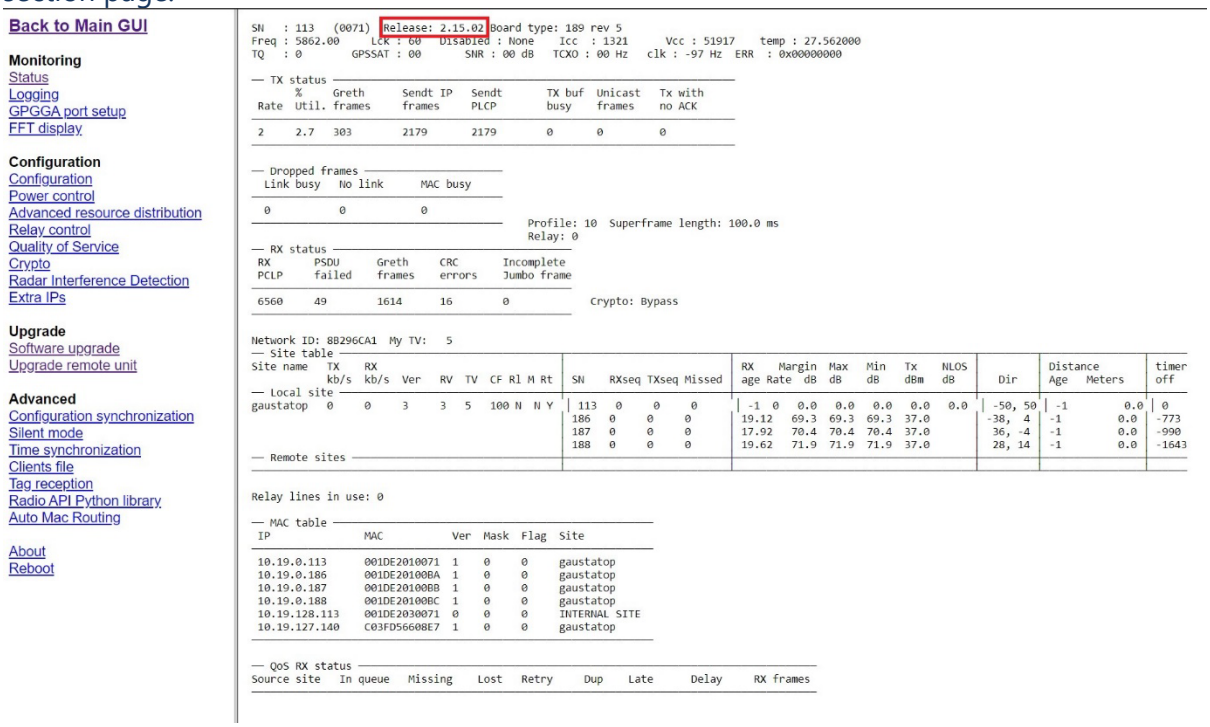
When experiencing no connection with one of the remote units, some or all points under previous chapter must be checked. If the answer to all questions is 'YES', it could be a result of several radio-based parameters:

1. Is the radio set on the correct network ID and frequency? This can be checked at the main system page in a browser.



2. In the live status screen, is the parameter RX age updating? If not, it can indicate that you are out of range, remote radio not powered, or it can be on a different frequency.

3. In the live status screen, is the parameter *Missd* counting? This can indicate interruptions, interference or bad connection.
   Try to change frequency.
4. All radios in the network must have same firmware release version - check if all radios have same firmware version. This can be checked in the status page at advanced section page:



7.3 Link quality

If experiencing a non-expected low link quality, there are different parameters in the radio that needs to be checked. See 4.7 Basic Health Check for explanation.

If one of the following parameters counting:

1. Missed. This parameter counts for each packet which is transmitted from other radios but not received. The reason may be various. Check the following parameters:
2. Dropped frames
   a. Link busy means that the data transmission is higher than the throughput (overflow). Try to change the datarate or the bandwidth distribution. Check also the bitrate of the attached equipment.
   b. No link means that the radio is not able to send the data due to no connection/link. Check if the network name/ID and frequency is correct.
3. RX Status
   a. CRC errors
   b. PSDU failed

   Both these parameters can indicate disturbtion or interference. Try to change frequency or check if there is other activity at this frequency. The channel bandwidth is 20Mhz.

4. dB margin. Numbers down under 10db can indicate you are far from the respective radios – double check with the distance measurement. Otherwise it can be massive objects in between, behind horizon, deep into the woods etc. If there are any obstacles in between the radios in the network the NLOS parameter should tell how much signal is lost due to non-line of sight. If this is the case, try to lower the data rate bandwidth because it will give you more signal margin and robustness. Otherwise the locations must be changed.

7.4 Configuration resets after reboot

Resetting of site and network configuration can be caused by a advanced function called "non-persistent mode". *See 3.4.3 Configuration on page 26.* If "reset configuration on boot" is turned *ON* then the configuration will be reset after each reboot.

7.5 Still no solution

If none of the above troubleshooting recommendations have solved the issue, please contact Radionor Support:

support@radionor.no