CYBOX RT 2-A

AUTOMOTIVE WIRELESS ROUTER WITH LTE CAT-6 AND WI-FI 5

CONFIGURATION MANUAL

Version: 2.0 for firmware V22.42.2 | Date: 03.03.2023

Contents

1 IMPORTANT INFORMATION

1.1 Disclaimer

1.1.1 Copyright

1.1.2 GPL Statement for CyBox Software

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1.1.3 Regulatory Limits for Changes in Country and Transmit Power Settings

Make sure that only persons with proper knowledge also in regulatory matters have access to the access point’s configuration settings. They must be aware of the consequences of an improper setting of country and transmit power (there may be additional settings). To do so, the standard configuration password must be changed before the access point is deployed. This new password must be given to knowledgeable and responsible persons only.

One example of a regulation affecting country selection is that in Germany, as of October 2016, the frequencies in the range 5150 MHz - 5350 MHz must be used in closed rooms and similar environments only. For more information please see www.bundesnetzagentur.de.

1.2 Known Issues

- When operating WLAN in 11ac mode, the transmit data rate is erroneously wrongly reported as 6 Mbit/s.

2 ABOUT THIS DOCUMENT

This configuration manual is intended for system developers and integrators. It is not intended for end users. It describes the firmware functions of the access point/router/gateway product family and provides information for special applications and configurations of the product.

This manual is intended to guide through the configuration process of an Access Point/Router/Gateway (the names of which are used interchangeably for this manual) for use in a train or bus. We tried to cover the main aspects of this task, including

- Backup and restore of configurations
- Install new firmware versions
- Handling of IP addresses, DHCP, VLAN, VPN, firewall
- Configuration of WiFi and LTE
- MWAN configuration for multiple WAN connection
- ELTEC's train coupling, wireless backbone protocol ICCP
- Remote administration via SNMP
- Scripting and UCI.

Not covered is a complete list of all functions and of all configuration elements in detail.

Information about mechanical and electrical installation of the access points is available in a separate product-specific installation manual which can be downloaded from the Download Center at www.eltec.com.

2.1 Information about Formatting

In the following sections, text formatted like `this` refers to titles, tabs, boxes, menu names, group names, keys, and other descriptive text on the web-based configuration user-interface ("LuCI"). They are grouped by "→".

This markup is used for all navigation elements needed to access settings, independent from the elements used to click on them or just for visual grouping.

A `typewriter font` is used for text typed in.

The internal version of this document is d1934c2.

3 ABOUT THE CyBox RT 2-A

The CyBox RT 2-A is a member of the CyBox family of robust wireless communication routers. It is particularly designed to meet the requirements of automotive applications. It offers stable, secure, and broadband LTE connections for data exchange via vehicle-to-ground connections and high-speed internet.

The CyBox RT 2-A hosts two LTE modems, two independent Wi-Fi radios, a 5-port Ethernet switch (one port being occupied by CyBox RT 2-A itself), an additional Ethernet port and a CAN port. It can be used to connect multiple mobile wireless clients to the internet on a long distance bus for example.

The CyBox RT 2-A firmware provides a convenient management interface via a web service. Besides global setup parameters the open source software allows the configuration of the radio interfaces, such as channel selection, SSID, encryption keys, and firewall setup. The access point and router configurations as well as the management firmware can be updated remotely.

The firmware of the device is based upon Linux and OpenWRT. For Open Source information see the preface.

4 HOW TO ACCESS THE CyBox RT 2-A

The CyBox RT 2-A can be configured in several ways:

1. The graphical web interface
2. The command line interface via a SSH or serial connection, see 9 SSH / SERIAL CONSOLE
3. Using an USB stick (to update the firmware or apply a prepared configuration, see 10.2 USB Possibilities)
4. Using SNMP (see 7 SNMP)

4.1 IP Addresses of the CyBox RT 2-A

By default, the CyBox RT 2-A is accessible through the following IP addresses (see figure The page Network → Interfaces (default settings)):

- 192.168.100.1 (LAN)
- An address obtained using DHCP (if possible LAN_DHCP)
- An address derived from the serial number (LAN_ALIAS)
- An address derived from the MAC of the first Ethernet port (LAN_MAC)

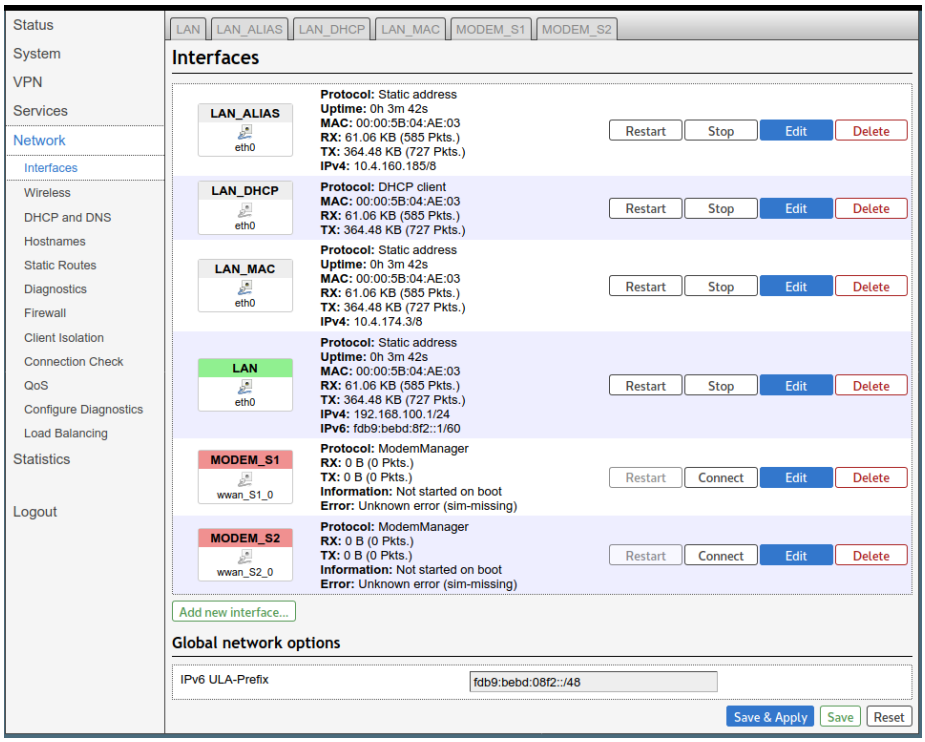
The LAN_ALIAS address is derived from the serial number (which is printed on the type plate) as follows (Example Serial Number: EL303289):

1. Strip non-digits: 303289
2. Print as six-digit hex value: 0x04A0B9
3. Use the upper 8 bits for x, the middle for y and the lower for z: x=0x04 y=0xA0 z=0xB9
4. Convert x,y,z to decimal: x=4 y=160 z=185
5. The LAN_ALIAS address is 10.4.160.185

In a similar manner, the LAN_MAC address is derived from the MAC address of the first Ethernet interface, which is printed on the type plate (example MAC 00:00:5B:04:AE:03):

1. Take the last three bytes: 04:AE:03
2. Use the upper 8 bits for x, the middle for y and the lower for z: x=0x04 y=0xAE z=0x03
3. Convert x,y,z to decimal: x=4 y=174 z=3
4. The LAN_MAC address is 10.4.174.4

You can delete unneeded network interfaces by clicking on the red “Delete” button in the web interface.



The page Network → Interfaces (default settings)

4.2 Getting to the Web Interface

Before accessing the web interface, your computer must be connected to the Ethernet port `LAN 1`, and it must be configured to use the same subnet as the CyBox RT 2-A.

The web interface is accessible using HTTPS on the IP addresses listed in 4.1 IP Addresses of the CyBox RT 2-A (default: https://192.168.100.1/ in the subnet `192.168.100.0/24`). It uses a self-signed SSL certificate. Your browser should warn you about that. You can either accept the certificate or fall back to HTTP: http://192.168.100.1/.

On the login web page, use username `root` and password `root`. Of course, you should 5.1 Change Password as soon as possible.

Once connected, you can navigate through the different tabs to start configuration. A few rules apply:

- To apply and also save your configuration, click on the button `Save & Apply` on the bottom-right corner of most pages. Not clicking on this button will discard your modifications.
- Saved configurations will be kept after a reboot.
- If IP addresses are changed, the Access Point must be addressed under the new URL in the browser.

5 QUICK START GUIDE

This chapter describes the steps to configure standard access point operation. The device must be electrically connected (see installation manual). Factory default settings are used.

This chapter shows some common use-cases and an exemplary implementation for each.

When the CyBox RT 2-A configuration requires deep changes, e.g. for a new use-case, there is some risk that previous (maybe meanwhile forgotten) settings get into conflict with the new configuration. Thus it is recommended to start the configuration from factory default settings. Pressing the hardware reset switch for more than 5 seconds will restore the factory settings.

The web interface provides the same function: `System` → `Backup / Flash Firmware` → `Perform reset`.

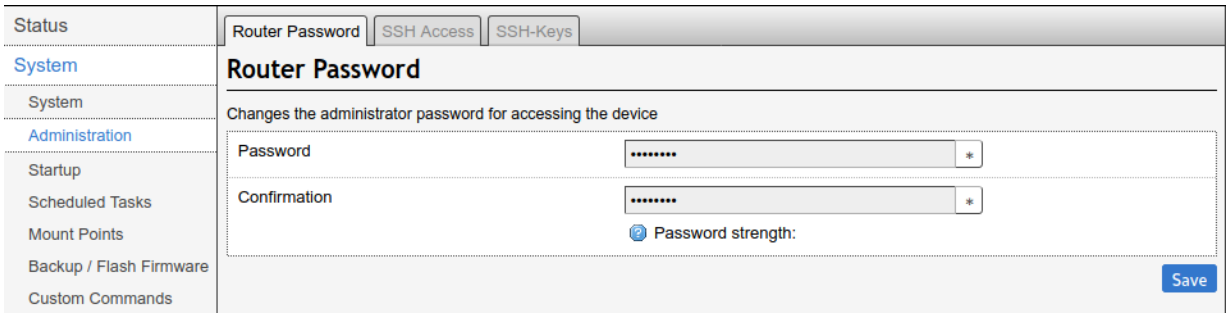
For all below configuration examples, the following initial situation is assumed:

- CyBox RT 2-A is running
- CyBox RT 2-A has been reset to factory defaults, the IP address is 192.168.100.1
- Default Root-User password: 'root'
- Operator workstation and CyBox RT 2-A are connected via Ethernet
- Workstation browser is logged-in to the CyBox RT 2-A web interface
- Operator is additionally logged in to CyBox RT 2-A via SSH (if available, a serial console terminal would be preferable).

In the following examples [square brackets] are used to indicate actions not requiring operator interaction because they happen automatically or have already been done (mentioning them here might be useful for checking configuration is on the right way).

5.1 Change Password

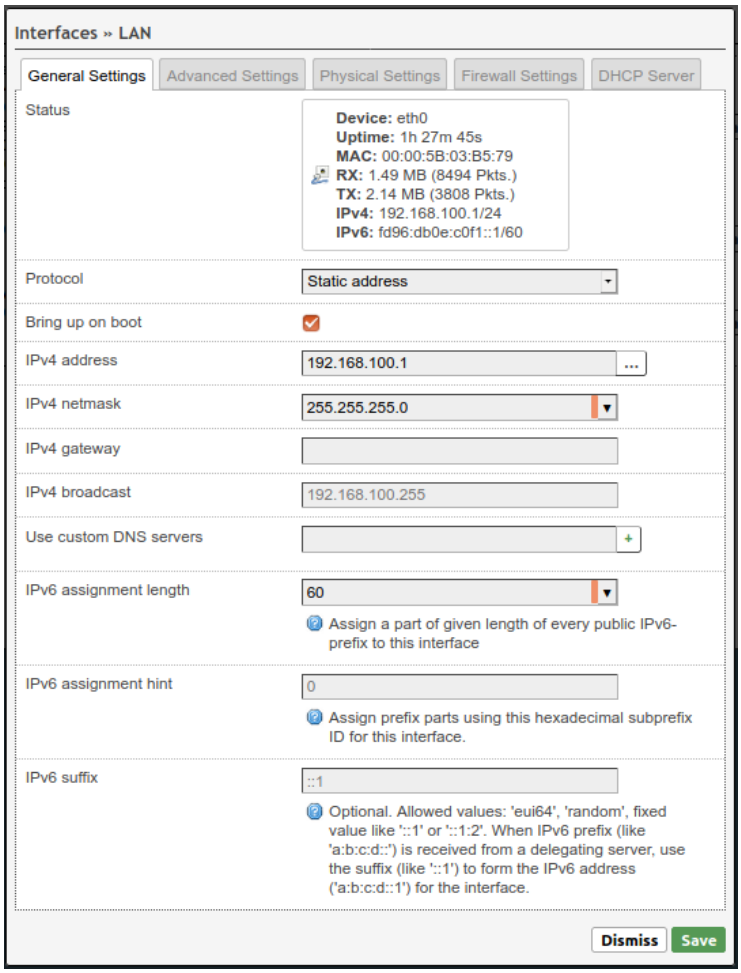
The password should be changed first to avoid legal consequences as described in the preface. The default user/password is'root'/'root'. To change it, go to `System` → `Administration`, type new password and click `Save`.



Change Password

5.2 Change LAN IP address (Quick Guide)

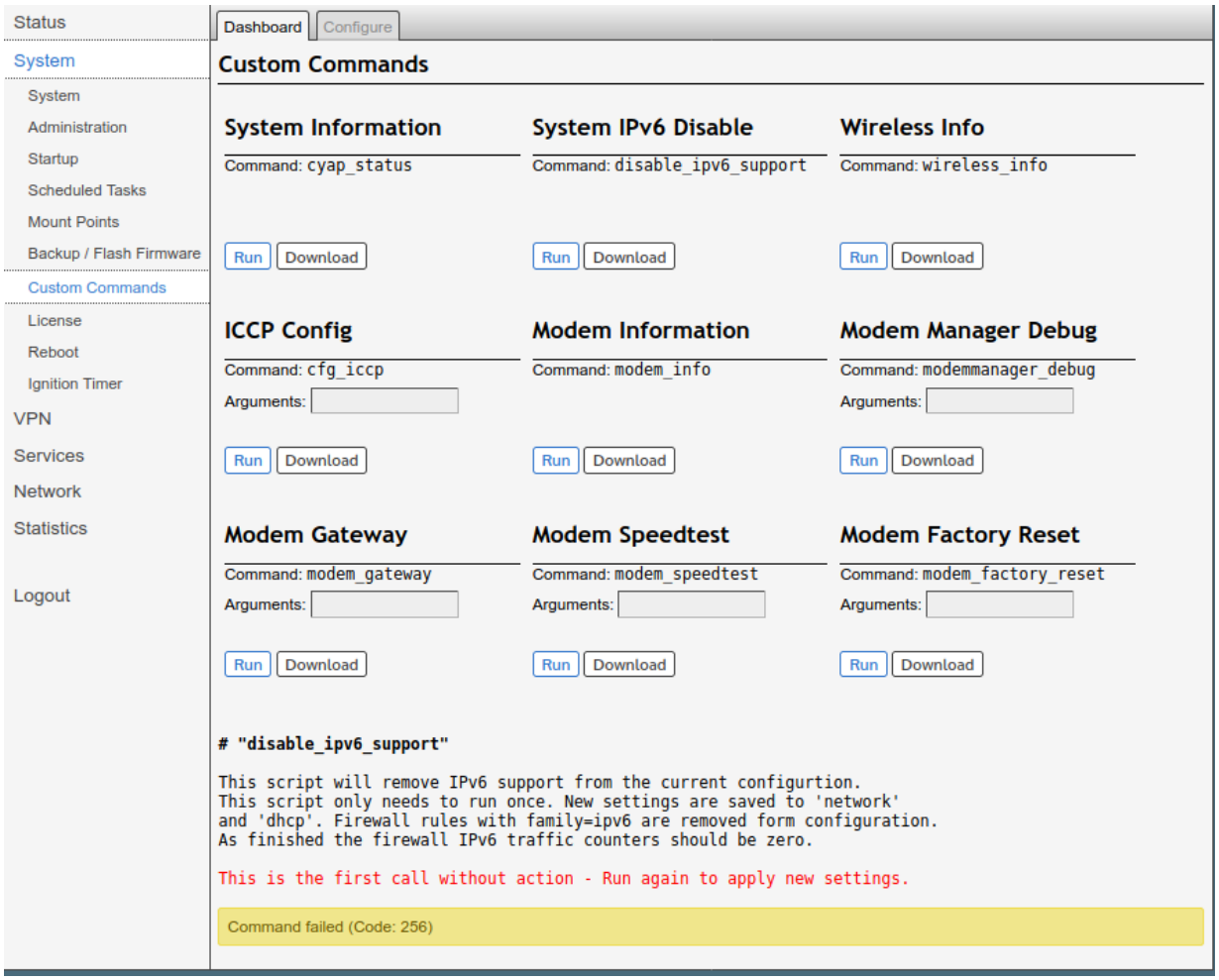
The factory default IP address 192.168.100.1 must be changed to meet your network topology. Open `Network` → `Interfaces` and click the `Edit` button of the LAN interface. Modify the IP address (`IPv4 address` field), or change the `Protocol` field to `DHCP client`, then click on `Save & Apply`. To regain access to the web interface, you must type the new IP address in your browser.



LAN Configuration Example

5.2.1 Disabling IPv6

The custom helper script under `System` → `Custom Commands` → `Dashboard` will modify the network / firewall configuration to disable all IPv6 network traffic. Normally all network interfaces have an automatic IPv6 address applied. If your environment has no need for IPv6 network traffic, you should use this script in early configuration steps, to remove every IPv6 address setup form network interfaces and to remove IPv6 firewall rules. Note that the Run button has to be executed twice. The first time is only for user information. The configuration modification is permanent.



Disable network IPv6 support – first run

5.3 Example: Local Access Point

As a first step, a simple access point is configured. The wired Ethernet and the wireless radios form an isolated local domain where the CyBox RT 2-A provides DHCP services. Finally the example in „LAN IP Address“ shows how to set a new static IP address. In Network > Interfaces → LAN → Protocol you can configure the DHCP client setup to obtain an IP address from a DHCP server in your network. The access point and its clients become part of another local domain where DHCP, DNS, and a gateway are provided, connecting the CyBox RT 2-A and its clients to higher-level networks.

5.3.1 System Settings

- Select `System` → `System` (yes, two *System* tabs nested).
- In box `System Properties` select tab `General Settings`: adjust the entries as needed; button `Sync with browser` is useful for cases where no NTP server is available. Tabs `Logging` and `Language and Style` may be ignored for now.
- In the tab `Time Synchronization`: adjust the entries if needed.
- Click button `Save & Apply`

5.3.2 Prepare WLAN Radio Interface

- Select `Network` → `Wireless`: this shows the wireless controllers *radio0* and *radio1* with some software buttons
- Select tab `radio0: Unknown "OpenWrt"` or click the `Edit` button of `radio0`
- In box *Device Configuration*:
  - Select tab *Advanced Settings*
    - In drop-down menu *Country Code*, select the country of the current location
  - Select tab *General Setup*
    - In drop-down menu *Mode*, select a mode, usually *N* or *AC*
    - In drop-down menu *Channel*, select a channel (or *auto*)
    - If needed, select an appropriate value in drop-down menu *Transmit Power*
- In box *Interface Configuration*:
  - [Select tab *General Setup*]
    - Enter an arbitrary *ESSID* (will be quoted below as "WLssid")
    - [*Mode*: select *Access Point*]
    - [Field *Network*: activate checkbox *lan*]
    - [Field *Network*: clear checkbox *create*]
    - If needed, activate checkbox *Hide ESSID*
  - Select tab *Wireless Security*
    - In drop-down menu *Encryption*, select as needed
    - In drop-down menu *Cipher*, select *auto* unless a specific algorithm is required
    - Enter encryption *Key* at least 8 characters
- Click button *Save & Apply*
- Select `Network` → `Wireless`
  - For radio0, click button *Enable*

At this point, the radio interface should become visible to possible WLAN clients and vice versa. Probably clients need to be prompted to scan for available wireless networks. Then, those clients will become visible in tab *Network*, tab *WiFi*, box *Associated Stations*.

5.3.3 Connect radio0 to the Network

- Select tab *Network* tab *Interfaces* tab *LAN*
- In box *Common Configuration*
  - Select tab *Physical Settings*:
    - *Bridge interfaces*: activate checkbox
    - [*Enable STP*: clear checkbox *Spanning Tree Protocol on this bridge*]
    - [*Interface* : activate checkbox *Ethernet Adapter: "eth0"*]
    - *Interface* : activate checkbox *Wireless Network: Master* "<SSID>"
    - [*Interface* : clear checkbox *Custom Interface*]

- In box *DHCP Server*
  - Select tab *General Setup*
    - Clear checkbox *Disable DHCP for this interface*
  - If needed, modify more things in tab *General Setup* and tab *Advanced Settings*
- Click button *Save & Apply*

Now the CyBox RT 2-A connects the Ethernet and all WLAN clients in the local domain 192.186.100.0 and provides a local DHCP service, but there is not yet an uplink to a gateway.

5.3.4 Connecting to WAN

As a goal, the CyBox RT 2-A shall integrate its clients via Ethernet in a higher-level network. DHCP, DNS, and gateway services are supposed to be available in that net.

- Select tab *Network* tab *Interfaces* tab *LAN*
- In section *Common Configuration*:
  - In drop-down menu *Protocol*, select *DHCP Client*
  - Click button *Switch Protocol*
- Click button *Save & Apply*

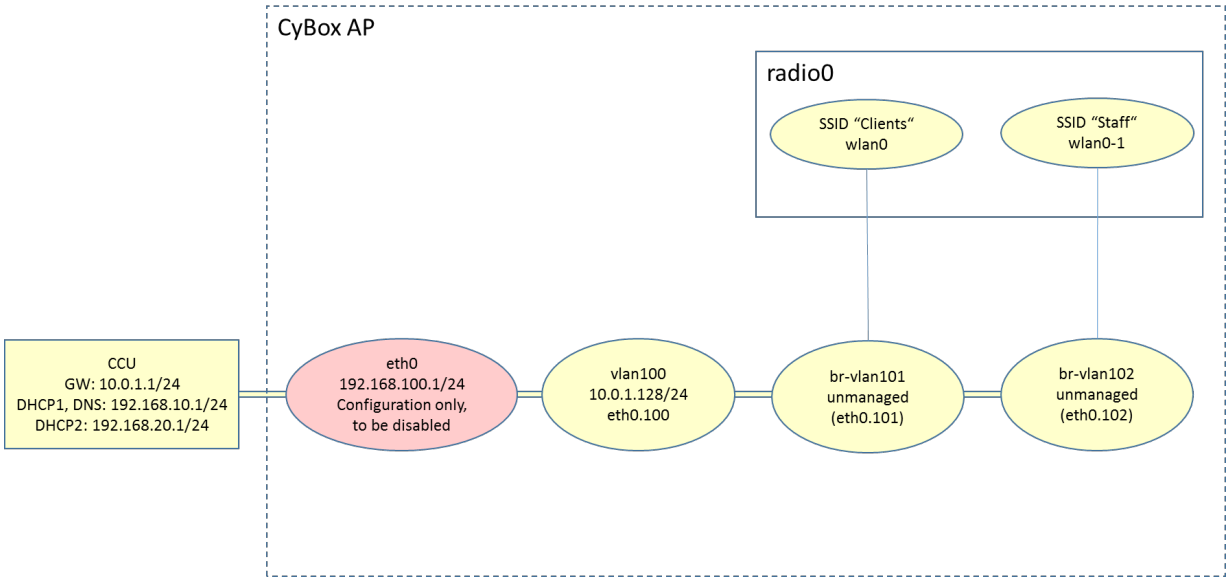
This terminates the local domain 192.186.100.0. Now connect the CyBox RT 2-A via Ethernet to the gateway domain, restart the CyBox RT 2-A (use hardware reset switch) and reconnect the WLAN clients.

5.4 Example: Connecting three VLANs to a server

In this use-case the access point provides 3 VLAN interfaces:

- one for management access via wired Ethernet, using a static IP address
- an unmanaged WLAN access for “clients”, no encryption
- another unmanaged WLAN access for “staff” members, encrypted, optional hidden SSID

The access point is connected via Ethernet to a server (or a host computer, called CCU in the illustration below) providing DHCP, DNS, and gateway services. Starting from factory defaults, apply system settings as described in section 7.2.1 (if needed).



Network Topology with Three VLANs

5.4.1 Create the Management VLAN

Create a new Ethernet interface (eth0.100) and give it the name “vlan100”. Make it a full-valued net host by assigning a static address and a gateway.

- Select tab *Network* tab *Interfaces*
- Click button *Add new interface*
- Enter *Name of new interface*: “vlan100”
- [Select *Protocol of the new interface*: Static address]
- [Clear checkbox “*Create a bridge over multiple interfaces*”]
- Enter name of *Custom Interface*: “eth0.100”
- Click button *Submit*
- [page VLAN100 opens]
- [Tab *Network* tab *Interfaces* tab *VLAN100* tab *General Setup*]
    - Enter *IPv4 address* “10.0.1.128”
    - Select *IPv4 netmask* 255.255.255.0
    - Enter *IPv4 gateway* “10.0.1.1”
- Click button *Save & Apply*

5.4.2 Add two unmanaged VLANs

We create 2 more Ethernet interfaces eth0.101 and eth0.102 with names vlan101 and vlan102, resp.

- Network Interfaces: Add new interface → Name of new interface: “vlan101”
- Protocol of new interface: Unmanaged
- [Clear Create a bridge over multiple interfaces]
- Custom Interface: “eth0.101 “
- Submit
- [page VLAN101 opens]
- Click button *Save & Apply*

Do the same for “vlan102” and “eth0.102”.

5.4.3 Configure and Enable the radio(s)

You are free which interface to assign to which radio. If both radios are to be used then this section (7.3.3) must be done for *radio1* as well.

- Select tab *Network* –> tab *WiFi* –> tab *radio0* (or click button *Edit* for *radio0*)
- In box *Device Configuration:*
    - Select tab *Advanced Settings*
        - Select Country Code
        - Select Mode

The following 3 lines fix a problem with this LuCI page (The drop-down menu for the country code is not updated correctly)

- Click button *Save & Apply*
- Logout / Login
- Select tab *Network* –> tab *WiFi* –> tab *radio0* (or click button *Edit* for *radio0*)

Now we can complete the configuration for *radio0*:

- In box *Device Configuration*:
  - Select tab *Advanced Settings*
    - Select *HT mode*
    - Select *Channel*
    - Select *Transmit Power*
- Click button *Save & Apply*
- Select tab *Network* –> tab *WiFi*
- Click button *Enable* for *radio0*

5.4.4 Attach the “Clients” VLAN to radio0

- Select tab *Network* –> tab *WiFi* –> tab *radio0* (or click button *Edit* for *radio0*)
- In box *Interface Configuration*:
  - [Select tab *General Setup*]
    - Enter *ESSID* “Clients”
    - Clear checkbox *lan*
    - Activate checkbox *vlan101*
- Click button *Save & Apply*

5.4.5 Attach the “Staff” VLAN to radio0

- Select tab *Network* tab *WiFi*
- Click button *Add* for *radio0* (if both VLANs shall run on the same radio).

Alternatively, if the “Staff” shall use the other radio and that radio has been configured and enabled (see 7.3.3), then (instead of *Add*) select tab *Network* tab *WiFi* tab *radio1* (or click button *Edit* for *radio1*)

- In box *Interface Configuration*:
  - [Select tab *General Setup*]
    - Enter *ESSID* “Staff”
    - [Clear checkbox *lan*]
    - Activate checkbox *vlan102*
    - If needed, set checkbox *Hide ESSID*
  - Select tab *Wireless Security*
    - Select *Encryption* (e.g. WPA2-PSK)
    - Enter *Key* (at least 8 characters)

- Click button *Save & Apply*

5.4.6 Check Configuration

As a check, you may login to the CyBox RT 2-A through SSH and issue the ifconfig command. The following interfaces should be shown:

```
br-vlan101 Link encap:Ethernet …

br-vlan102 Link encap:Ethernet …

eth0 Link encap:Ethernet

inet addr:192.168.100.1 Bcast:192.168.100.255 Mask:255.255.255.0

…

eth0.100 Link encap:Ethernet

inet addr:10.0.1.128 Bcast:10.0.1.255 Mask:255.255.255.0

…

eth0.101 Link encap:Ethernet …

eth0.102 Link encap:Ethernet …

lo Link encap:Local Loopback …

wlan0 Link encap:Ethernet …

wlan0-1 Link encap:Ethernet …
```

Oder alternativ (anstelle von wlan0-1), wenn beide Funkmodule verwendet werden:

```
wlan1 Link encap:Ethernet …
```

5.4.7 Disable Unneeded Default Address

After successfully testing the VLAN-based management access (vlan100), the default address 192.168.100.1 may be disabled. This is easily achieved by deleting the *LAN* interface:

- Select tab *Network* tab *Interface*
- Click button *Delete* for the *LAN* interface (usually the lowermost)
- Select tab *Network* tab *Interfaces* tab *LAN*

  Alternatively, you may change the protocol of the *LAN* interface to *Unmanaged*:
- Select tab *Network* tab *Interface* tab *LAN*
- In box *Common Configuration*:
  - In drop-down menu *Protocol* select *Unmanaged*
- Click button *Save & Apply*

5.5 Example: Client Isolation within the Access Point

By default, all clients of an access point can directly communicate with each other. Depending on the use case, this might be undesirable.

5.5.1 Isolate the Radio Clients

- Select tab *Network* –> tab *WiFi* –> tab *radio0* (or click button *Edit* for *radio0*)
- In box *Interface configuration*
    - Select tab *Advanced settings*
    - Activate checkbox *Separate clients*
- Click button *Save & Apply*
- Do the same for the other radio

5.5.2 Restrict Access to Local Ports to Specified Interfaces

- Select tab *System* tab *Administration*
- In box *Dropbear Instance*
    - Click radio button *lan*
    - [unselect radio button *unspecified*]
- Click button *Save & Apply*

This affects the mentioned port only. To protect more ports against WLAN access, use button *Add*.

Note that all interfaces listed in the *lan* field are allowed to access the respective socket.

6 THE WEB INTERFACE

Most pages of the web interface are concerned with the configuration of the CyBox RT 2-A. Many of these pages show some of the following buttons:

- `Reset`: clicking on this button reverts the unsaved input fields of the current page to the values as they were before you modified them.
- `Save`: This button copies the modified input fields of the current page to an intermediate memory. It collects changes without applying them to the CyBox RT 2-A. This is important because some changes - if applied stand-alone - could break the IP connection between host and the CyBox RT 2-A.

  When clicking this button, a change count notification appears at the upper left, indicating the number of to-be-changed lines in the configuration data (The actual text in that message is kind of misleading: it claims to state the number of "unsaved changes" but actually means the number of saved but not yet applied new configuration lines.)

  It should be noted, that saved data are not longer subject to the *Reset* button. Rather, saved changes - if not applied - are kept until you click the `Save & Apply` button, or the `Revert` button (see below), or CyBox RT 2-A reboots. The configuration is not yet complete as long as the change count is non-zero.
- `Revert`: Clicking on the change count message pops up an extra window showing the data exactly as they would be entered into the related configuration files. This window provides a button named `Revert`. Clicking it invalidates the saved changes and clears the change count to zero.
- `Save & Apply`: this button performs the *Save* operation (see above), modifies the configuration data according to the saved changes, and clears the change count. Please note that `Revert` and `Reset` *cannot* undo those changes after a *Save & Apply* operation! Also, depending on the specific parameters changed, networking interfaces are re-initialized with the new data. In consequence, the host-side browser might require to connect a new IP address to access the CyBox RT 2-A.
- *Submit*: Some pages provide a single *Submit* button instead of the above. Essentially, *Submit* performs an immediate *Save* operation. Thus, the change count in the upper left corner of the screen will increment. The *Save* operation also takes place when clicking special buttons like *Add new interface* or *Setup DHCP Server*. Again, the change count will change. In these cases, *Save & Apply* is needed to complete the operation.
- Buttons named `Enable` or `Disable` cause immediate execution.

6.1 Network

6.1.1 Interfaces

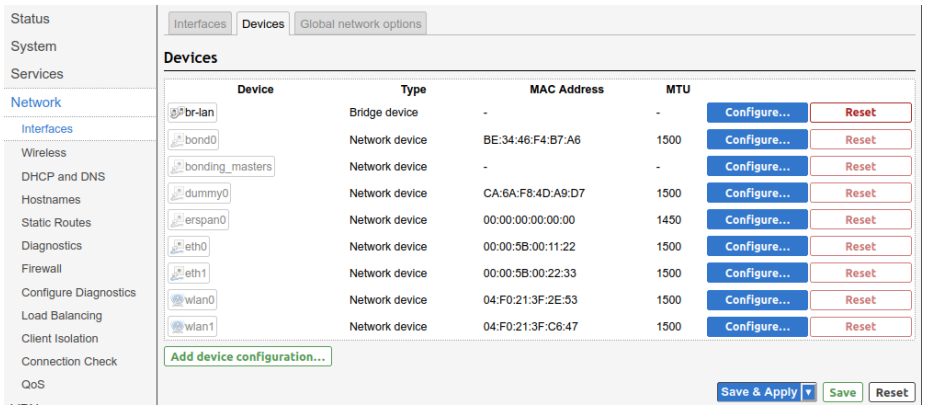
6.1.1.1 DHCP Server per Interface

A DHCP server can run on the device to assign IPv4 addresses to WLAN clients. It is enabled by unchecking *Disable DHCP for this interface*. However, DHCP often is managed by a dedicated DHCP server on the backbone and not directly on the access point. In that case, the DHCP server on the access point must be disabled.

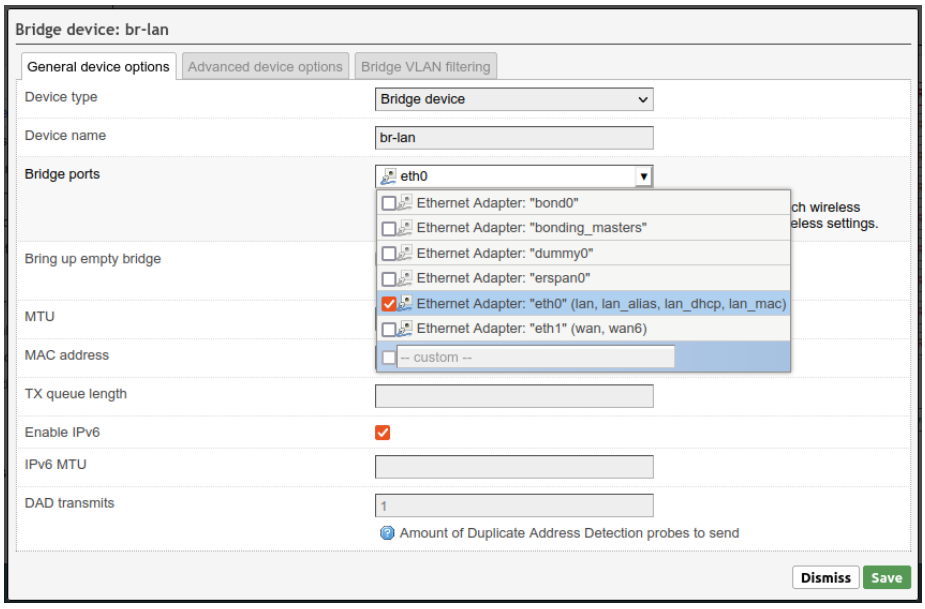
6.1.1.2 Bridges

Physical network interfaces may be bridged to form a "software Ethernet switch". For example, by bridging the LAN 1 interface with a wireless interface, WLAN clients can communicate with LAN clients like they were connected by a switch.

To set up a bridge, use the tab Network → Interfaces → Devices menu. Use the `Add device configuration ...` button to set up a new Linux device as bridge type. To be compatible with older OpenWrt versions the new Linux device could be named "br-lan".



Bridge Interface Create



Bridge Interface Configure

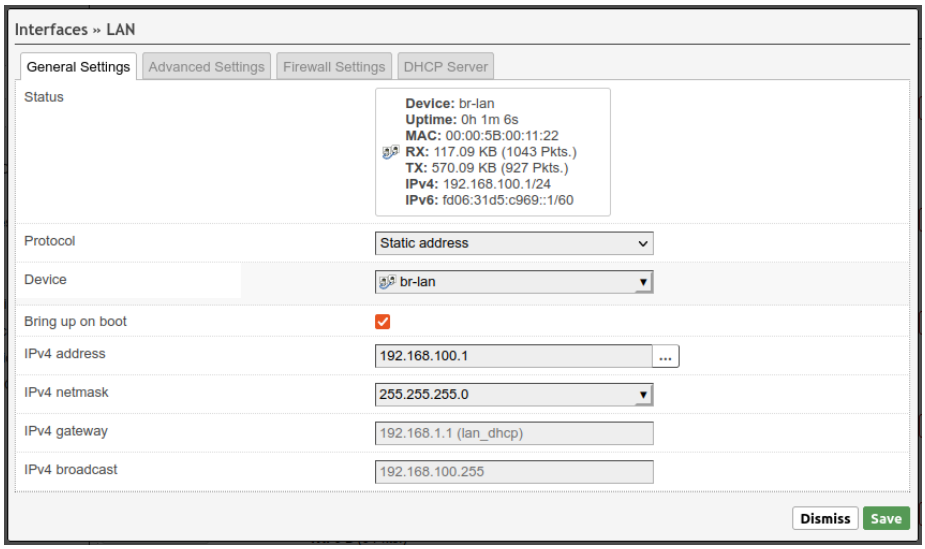
The configuration specifies the wired ports to attach to this bridge. In order to attach wireless networks, choose the associated interface as network in the wireless settings.

Check Bridge interfaces and include all *Interfaces* that should belong to the new bridge interface.

In older OpenWrt version the LAN interface automatically created the physical device “br-lan” if bridging was enabled. Since this is no longer done automatically the LAN interface now should be set to *br-lan* instead of *eth0* and also to have this new bridge device in the green firewall zone.

Note that radio interfaces like *wlan0* or *wlan1* will be part of the *br-lan* bridge by selecting the LAN interface in the wireless configuration menu.

LAN Interface Status

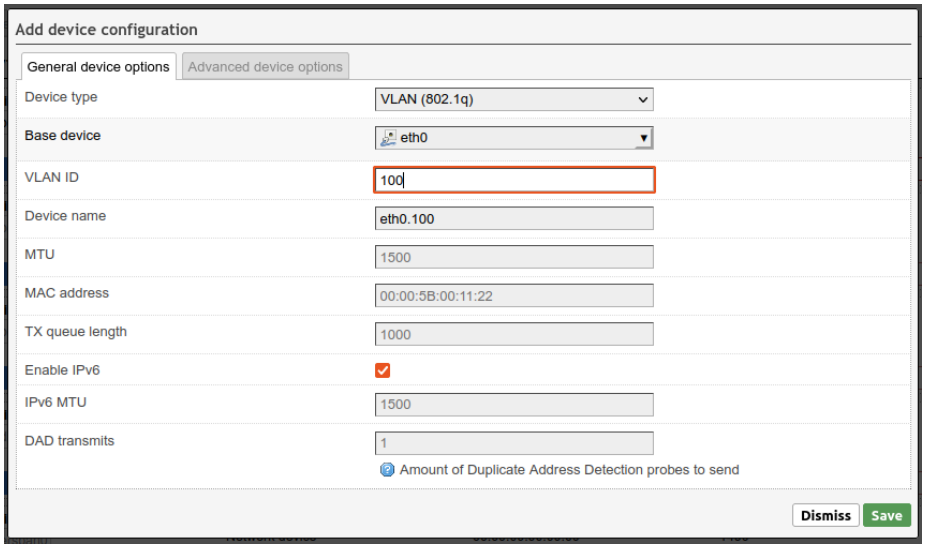


Set LAN Interface to use physical device br-lan

Note: Physical interfaces, as eth0 or wlan0, belonging to a network interface, such as LAN, cannot be in any other network interface.

6.1.1.3 VLAN

To enable VLAN (virtual LAN, mostly used for logical subnets built on real LANs) tagging, a new custom interface must be set up for the *LAN*. The VLAN interfaces are named e.g. “eth0.100”. In this example “100” is the VLAN tag to be used.



VLAN interface setup

Use *eth0.X* as custom interface and disable *eth0* as shown in the dialog above.

WARNING: After saving and applying the changes, the network output on *eth0* is tagged with your VLAN tag and the AP will not be accessible through normal network anymore. You need to enable VLAN tagging on the host interface, or connect to a switch that is able to handle this VLAN tag to be able to access the AP.

6.1.1.4 LTE

This chapter shows how to connect the CyBox RT 2-A to a mobile LTE network.

By using the WLAN modules, CyBox RT 2-A can be turned into a WLAN hotspot.

6.1.1.4.1 Configuring LTE

The CyBox RT 2-A provides 2 SIM slots per LTE modem. Only one slot per modem can be active at any time. The slots can be selected via an SNMP command or using the web interface.

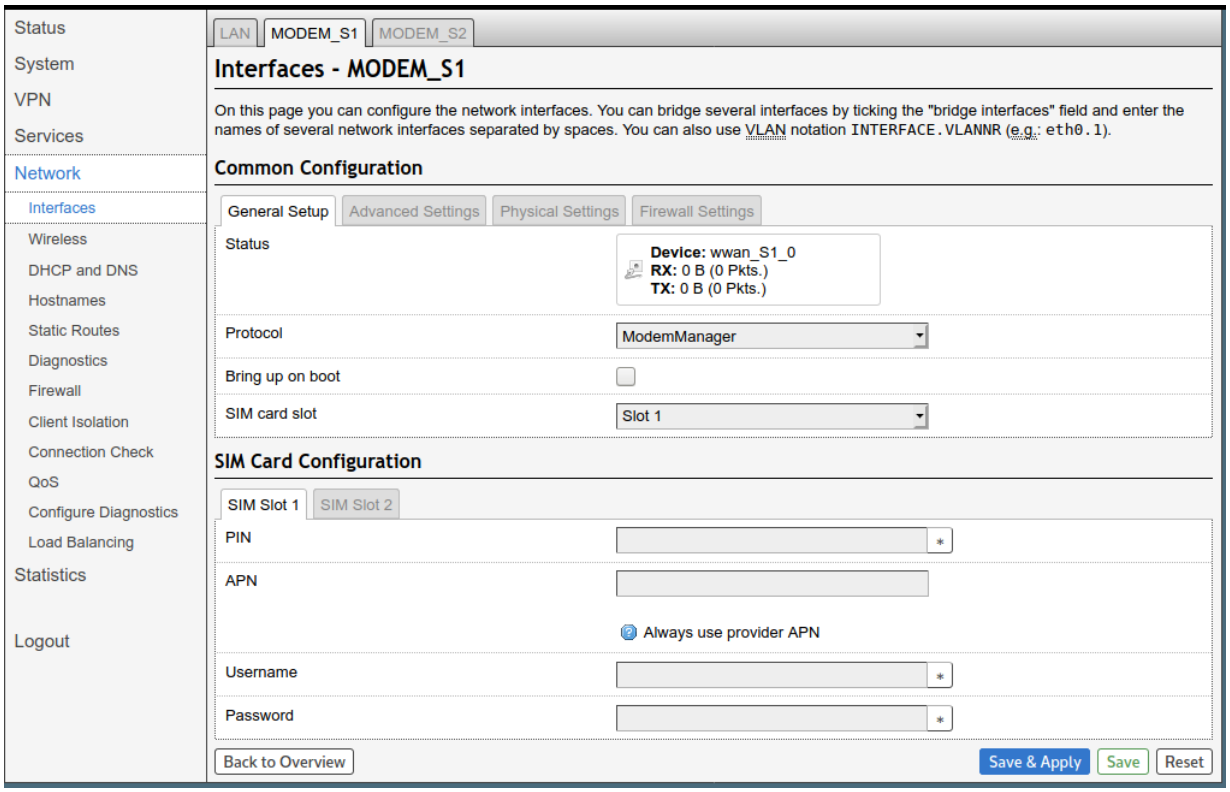
Note: Switching between SIM slots takes about 30 seconds, Slot 1 being preselected at power up. If you plan to use only one SIM card for a given LTE modem, it is advisable to use Slot 1 to avoid slot switching delay during the boot phase.

To access the SIM cards, the cover must be removed. It is secured with two Torx T10 screws. Insert the SIM cards at the desired position. The contacts of the SIMs must be faced toward the circuit board. Finally, mount the cover again.

The LTE configuration requires the following parameters which can be requested from the LTE provider:

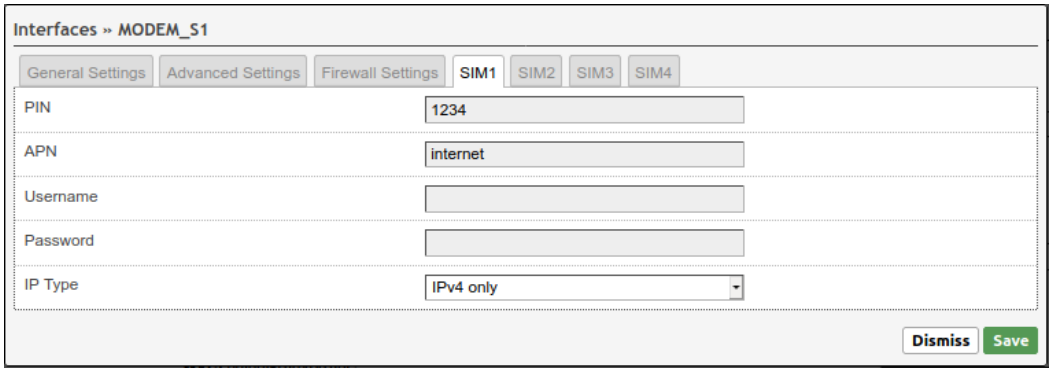
- PIN code of the SIM card
- APN (Access Point Name)
- Username (most often empty)
- Password (most often empty)

On the page `Network` → `Interfaces`, click the `Edit` button for the modem to be configured (e.g. `Modem_S1`). On the appearing page the active slot is chosen and the LTE parameters are configured (see next Figure):



The modem configuration page

- In the section `SIM Card Configuration`, enter the configuration for each SIM card. Do so by first selecting a tab (e.g. `SIM Slot 1`) and then enter the corresponding configuration. Note that these tabs do no influence which SIM is actually active. For each SIM card:



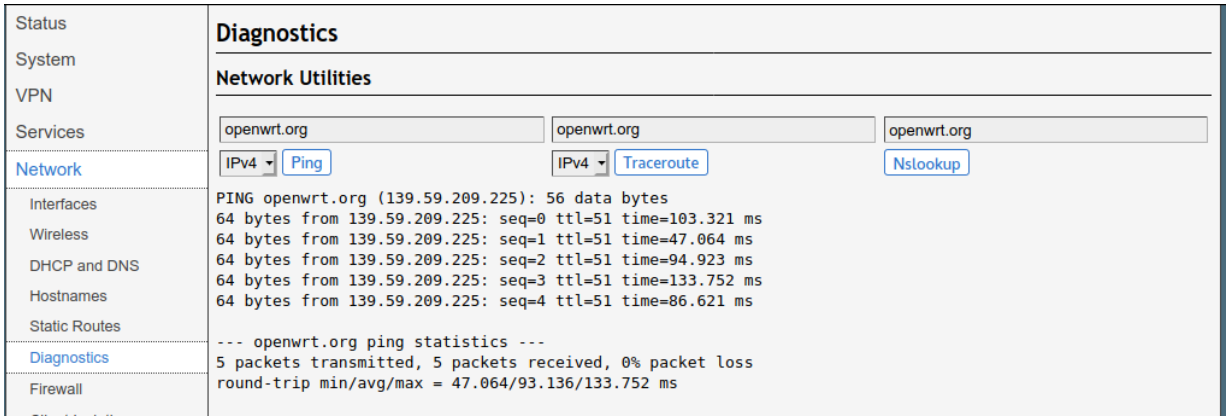
The SIM slot configuration page

- Enter The PIN of the SIM card. Take care to enter the PIN on the correct tab, as a wrong configured PIN may lead to SIM card locking.
- Enter the APN, Username and Password as supplied by the LTE provider.

Complete the configuration by pressing the Save & Apply button. The modem needs to be (re)started in order to re-detect the SIM card. You can do so on the `Network` → `Interfaces` page by clicking `Restart` for the modem. After a short while, the info box for the modem shows an IPv4 address, and any Error message in the box disappears:

MODEM_S1 is now connected

After the LTE connection was established, a “ping” test can verify that a connection to the internet is actually available. Go to `Network` → `Diagnostics` and press `Ping`. Instead of pinging the default host “openwrt-project.org” you might as well use another one. The figure below shows a successful run of the test.



A successful “ping” test

Please refer to chapter 7.9.4 SNMP Support for LTE to learn about the LTE related SNMP commands.

Now switch to the ‘Network Interface Overview’ and delete unused LAN interfaces like LAN_DHCP, LAN_MAC and LAN_ALIAS. LAN_MAC and LAN_ALIAS are using IPs in the 10.x.y.z network, which are often also used by internet service providers and may disturb routing. The LAN_DHCP should also be deleted because it may get a DHCP

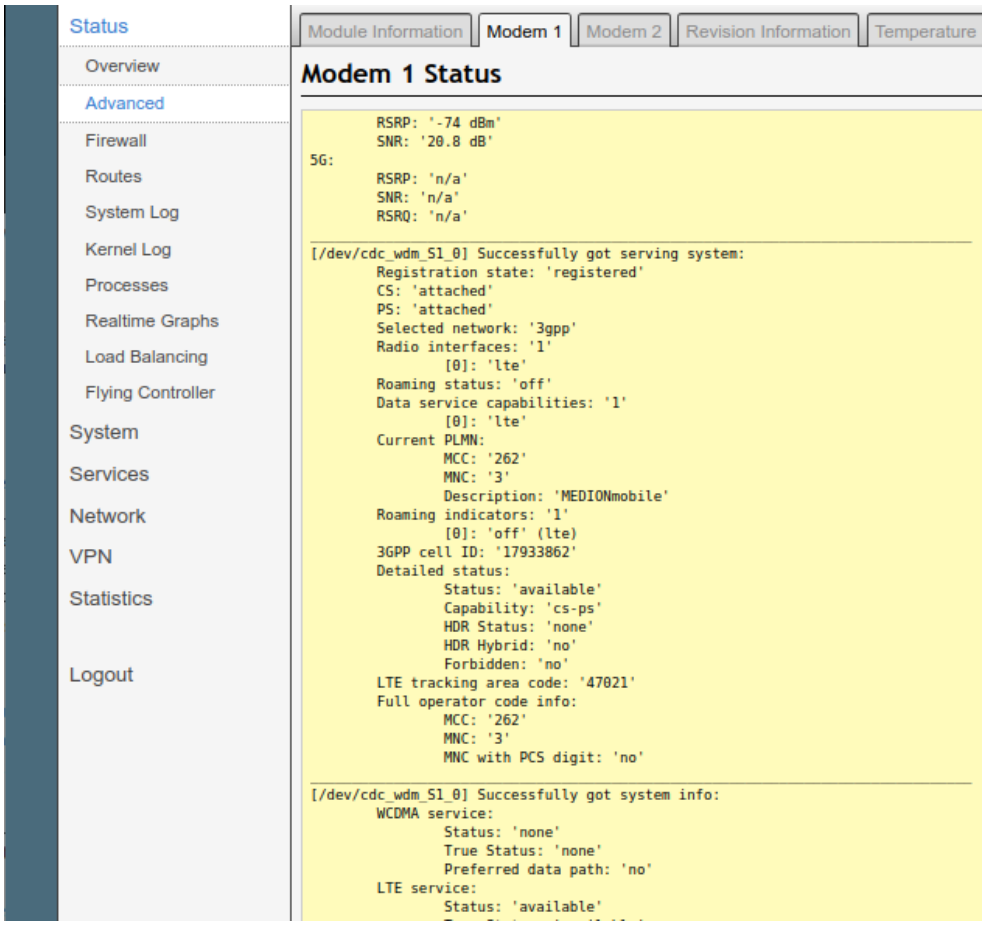
setup with a gateway which is not part of this MWAN configuration. You may setup a new IP for the LAN interface using a private address pool (192.168.x.y).

6.1.1.4.2 LTE Troubleshooting

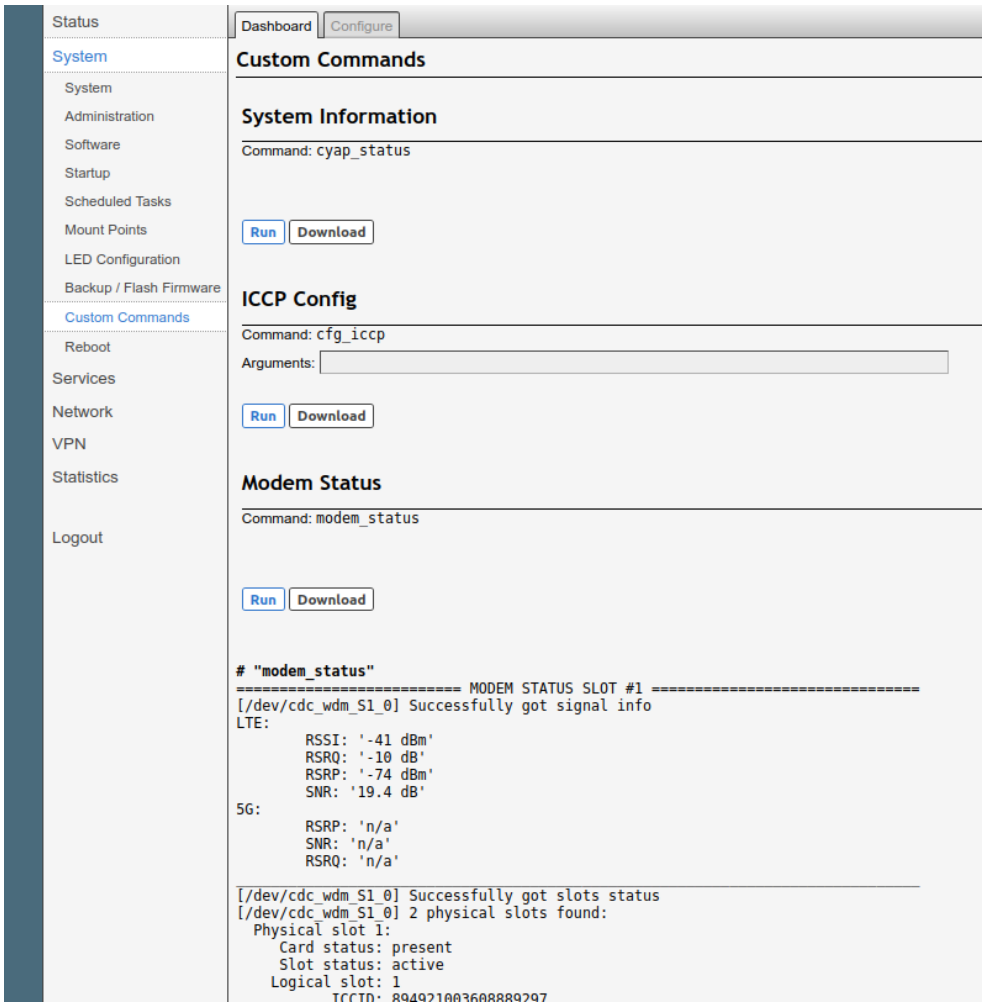
Problem	Possible cause and solution
No LTE connection	Missing configuration parameters. Some providers require additional parameters for the LTE connection, namely the IP type (4 or 6) and the authentication method (PAP, CHAP or BOTH). The web interface does currently not provide means to enter these parameters; however, as a workaround, it is possible to add them to the “APN” parameter as follows: pinternet.interkom.de,ip-type=4,auth=CHAP Note that the string must not contain spaces.
LTE can reach the internet, but devices connected to it can’t	1. The firewall settings might be wrong. Normally, the LTE interface should be assigned to the firewall zone “wan”, while the Ethernet/WLAN interfaces should be assigned to “lan”. However, depending on your firewall settings, another configuration might apply, see 6.1.6 Firewall (zone-based) for details. 2. Routing conflict if LTE provider assigns private IPv4 addresses. . Some LTE providers assign IPv4 addresses within the private subnet 10.0.0.0/8. This interferes with the preconfigured interfaces which uses addresses within the same subnet (LAN_ALIAS, LAN_MAC). These interfaces should be reconfigured or deleted.

6.1.1.4.3 Modem Status Information

The extended status menu, `Status` → `Advanced` → `Modem X`, in the web interface, can display the current modem connection status cyclically, every 10 seconds. It does not matter whether a connection to the provider has already been established. The information is queried via *qmicli* and *AT-Command* at the selected modem.



Analogous to the extended Status menu, further information can be queried via the menu `System` → `Custom Commmands` → `Modem Status`. The information query is done once for all modems installed in the system.



6.1.1.4.4 5G

5G is the “fifth generation” of the mobile communication standard which is developed by the global initiative 3GPP.

Many applications with specific demands for very low response time and faster connection requirements can be realized for the first time by using of 5G mobile broadband standard.

Some of specified mobile bands (e.g. 3.6 GHz) are already ready to use, especially in the cities. Other bands are still experimental. They will provide download/upload rates up to 100 times faster than LTE. All this by having very low latency!

5G is the next big step in the evolution of mobile communication technology!

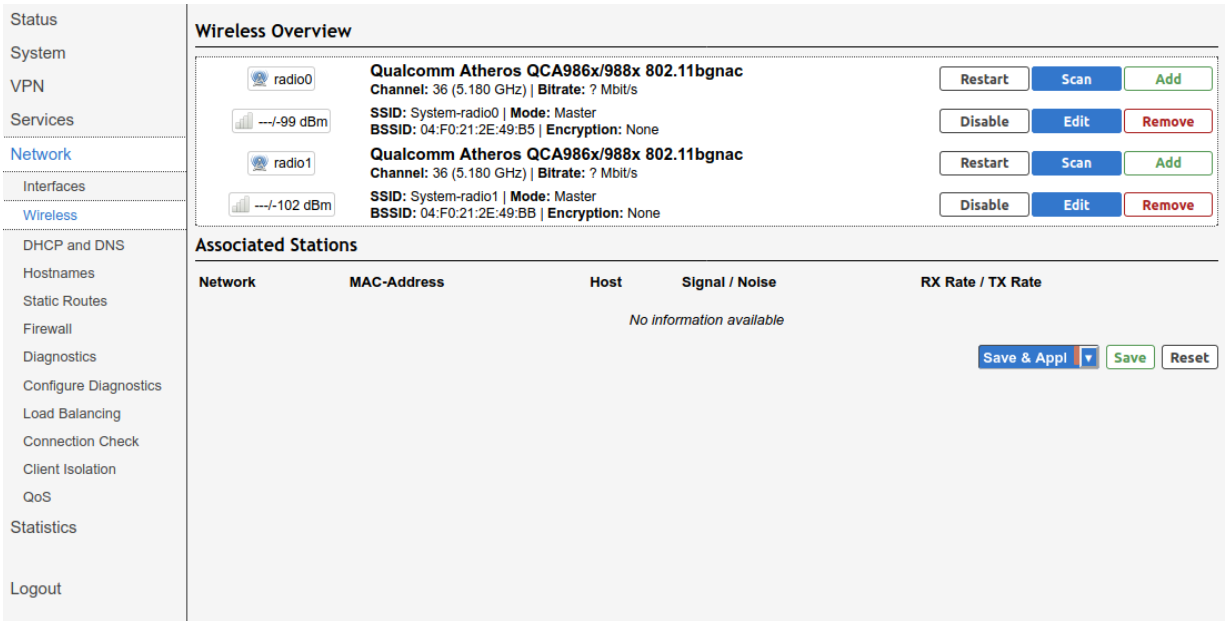
In order to setup a 5G connection the same steps like for using of LTE have to be done (see chapter 6.1.1.4 LTE).

Important

A **must** precondition to establish a 5G connection is a use of a modem with 5G capabilities as well as a SIM card with a 5G support.

6.1.2 WLAN

Wireless radios are disabled by default to avoid erroneous WLAN operation. Use `Network` → `Wireless` → `Edit` to enter the configuration menu. Details about WLAN configuration can be found in the next section. After configuration, enable the interfaces with `Enable`.



Wireless Device Overview

The example shows a CyBox RT 2-A with two radios installed. Depending on the hardware, other configurations may be shown.

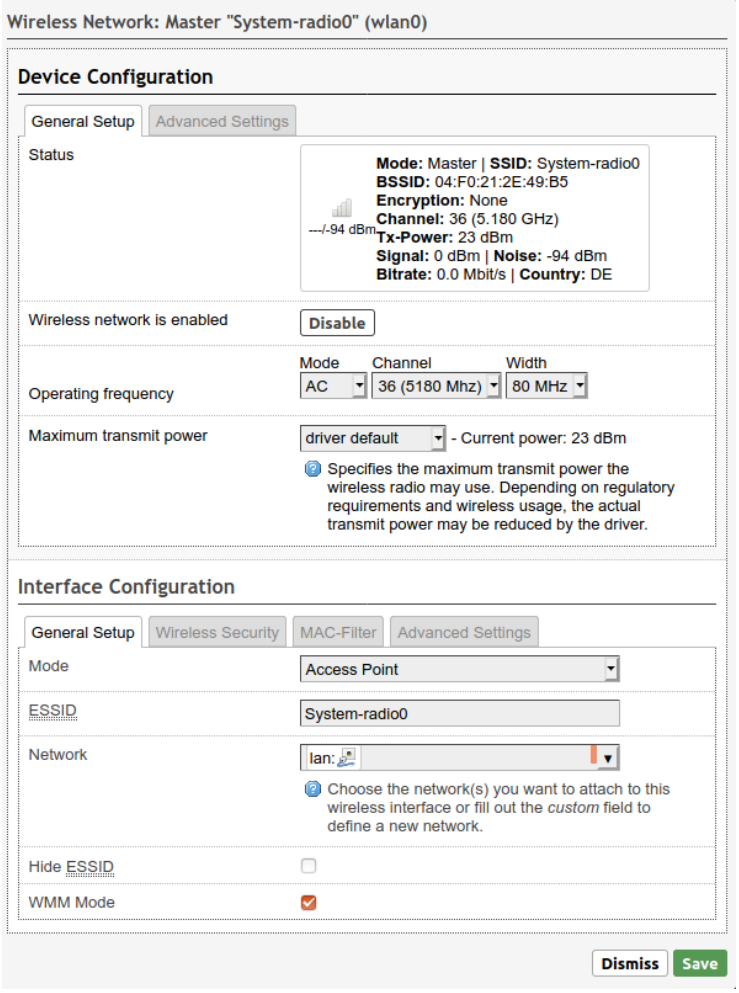
After enabling the radio, you can configure physical settings. Clicking `Network` → `Wireless` → `Edit` redirects you to the *'Device Configuration'* menu.

6.1.2.1 Channel, Wireless mode, HT mode, Power settings

Advanced Settings allows to select the appropriate country in the pull-down menu. After a country change, press the *Save & Apply* button, refresh the browser page, and reboot.

Disclaimer: The wireless configuration must observe the local regulation. The upper limit of the transmission power has to be set correctly ("Transmit power"). This does not account for an antenna gain. If, for example, the regulation imposes a maximal power of 15 dBm and the gain of the antenna is 5 dBm, you must set the transmit power to a value at or below 10 dBm.

In *General Setup* you can configure wireless mode, HT mode and channel. Wireless mode can be forced to any 802.11 standard supported by the radio. The channel selection is adapted to the wireless mode chosen. The channel configuration can be set to auto but this slows down WLAN activation and requires a reboot to work properly. Therefore, it is recommended to select a defined channel.



Wireless Device Configuration

After the device has been enabled, the radio status should be checked if the selected channel / mode combination is working.

6.1.2.2 Radio Band Configuration for Models with Antenna Combiner

If the system is equipped with an antenna combiner, (e.g. having two radio modules (WLE-900) but only three antennas) the frequency bands 2.4 GHz and 5 GHz cannot be freely configured for each wireless module. The first radio module radio0 must use band 2.4 GHz and the second radio radio1 the 5 GHz band. An incorrect wireless band configuration in the software is possible. However, this means that no output power arrives at the antenna ports.

6.1.2.3 ESSID, WDS Mode, Client separation

The ESSID is used for WLAN clients to select the wireless LAN by name. Set up a ESSID name for the wireless network in the *General Setup* of the *Interface configuration* and use mode *Access Point*.

A Wireless Distribution System (WDS) can be set up by using two access points with the same ESSID, one in “Access Point (WDS)” mode and the other in “Client (WDS)” mode. This mode is required for the Inter Carriage Connection Protocol (ICCP).

In public access point environments the client-to-client communication should be prevented by activating the `Interface Configuration` → `Advanced Settings` → `Isolate Clients` checkbox. Note that this configuration only prevents the communication between clients connected to the same access point. In a

backbone with many access points having the same SSID, an additional “Client isolation” function between APs is needed (see 6.1.2.5 Multi-AP Client Isolation).

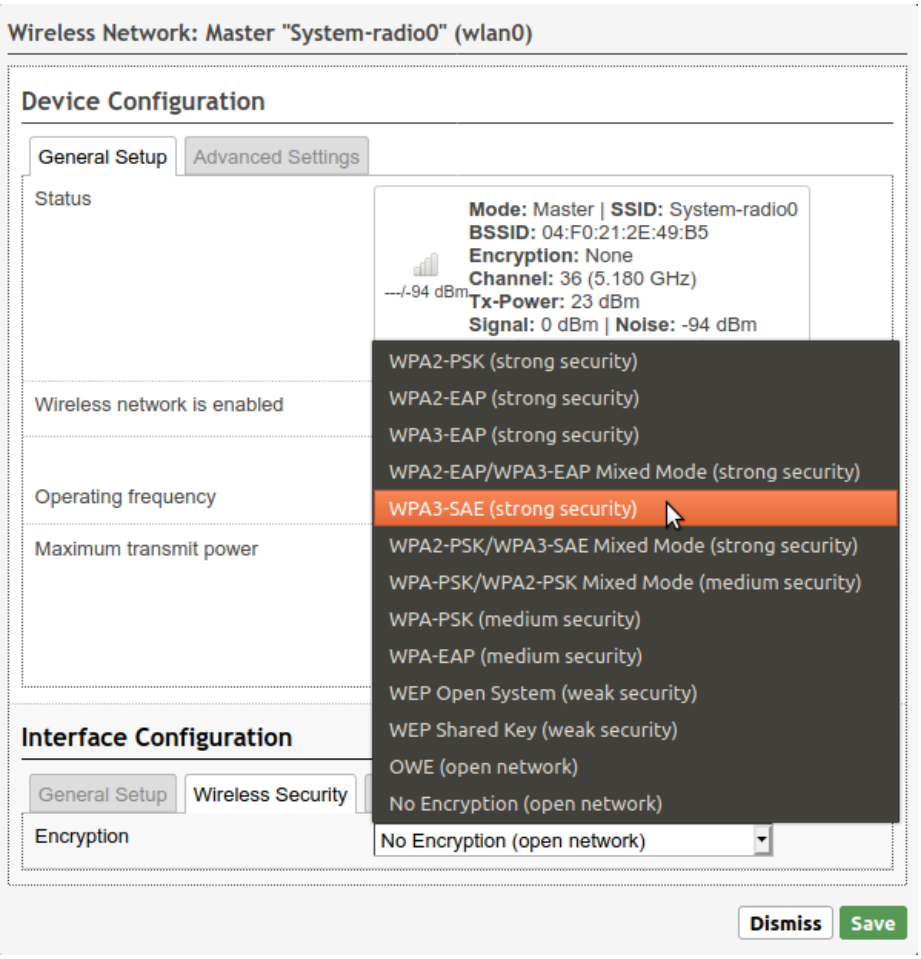
6.1.2.4 Encryption

On the tab `Wireless Security` you can choose a security mode. The following modes are supported:

- WPA3 (strong security)
    - WPA3-SAE: “personal mode”, using a key (password) for access.
    - **WPA3-EAP: “enterprise mode”, using a RADIUS server for client** authentication.
- WPA2 (strong security)
    - WPA2-PSK: “personal mode”, using a password for access. Note that the cipher “TKIP” is considered insecure, and CCMP should be used instead.
    - WPA2-EAP: “enterprise mode”, using a RADIUS server for client authentication.
- WPA (medium security)
    - WPA-PSK: WPA in “personal mode”, using a password for access. Note that the cipher “TKIP” is considered insecure, and CCMP should be used instead.
    - WPA-EAP: “enterprise mode”, using a RADIUS server for client authentication.
- WEP (weak security)
    - WEP Shared Key
    - WEP-EAP Open System
- OWE (open, encrypted)
    - OWE: The “Opportunistic Wireless Encryption” mode requires no password, yet the WLAN traffic is encrypted. This mode is intended for public access points.
- No Encryption (open):
    - The WLAN traffic is not secured at all.

In addition, some of these modes can be combined (“mixed mode”). For an access point, this allows to support multiple modes, supporting newer encryption standards while still supported older clients. When configuring the CyBox RT 2-A as client with a “mixed mode”, it will try both modes when connecting to an access point (normally, only the configured mode is used). The following modes can be combined:

- WPA3 and WPA2 in enterprise mode (EAP)
- WPA3 and WPA2 in personal mode (PSK respective SAE)
- WPA2 and WPA in personal mode (PSK)



Wireless Device Configuration – Encryption Settings

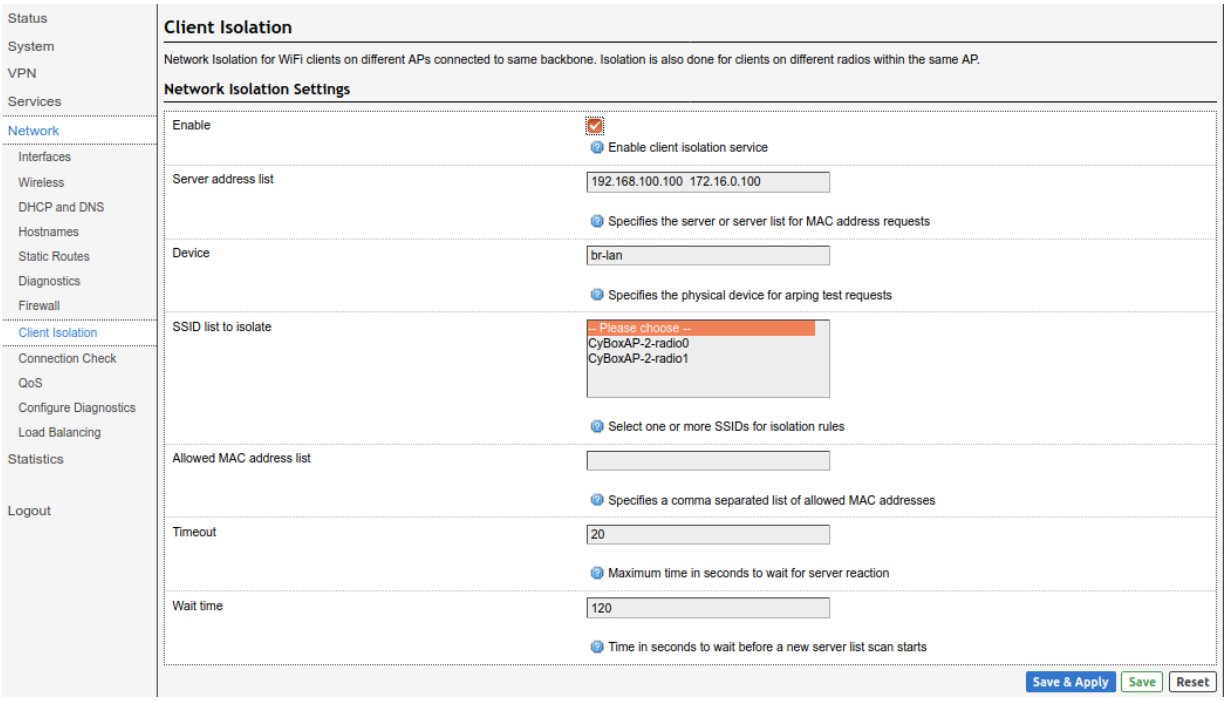
6.1.2.5 Multi-AP Client Isolation

Client separation inhibits direct communication between clients of the same WLAN radio. However, if more than one Access Point is attached to the same cable backbone, and the wifi clients use the same subnet, client isolation must also be enabled between APs. This is also true if the CyBox RT 2-A operates multiple APs on different WLAN modules which are connected (e.g. by using a bridge). Isolation is also done for clients on different radios within the same Access Points.

In order to use Multi-AP client isolation, all APs must use the same Server and use the same interface name. (Network traffic can be restricted with a configuration for 'ebtables' on FORWARD rules, managed by the 'client isolation' functionality).

For Client isolation over APs, check Network → Client Isolation → Enable, then enter parameters for your configuration.

The screenshot below shows a configuration where the server address is set in the parameters of the LAN interface (under '*Network*' → '*Interfaces*'). When the interface is set up as a bridge, the corresponding Bridge name is always 'br-<*original_interface_name*>'



Client isolation across access points

6.1.2.6 Connection Check

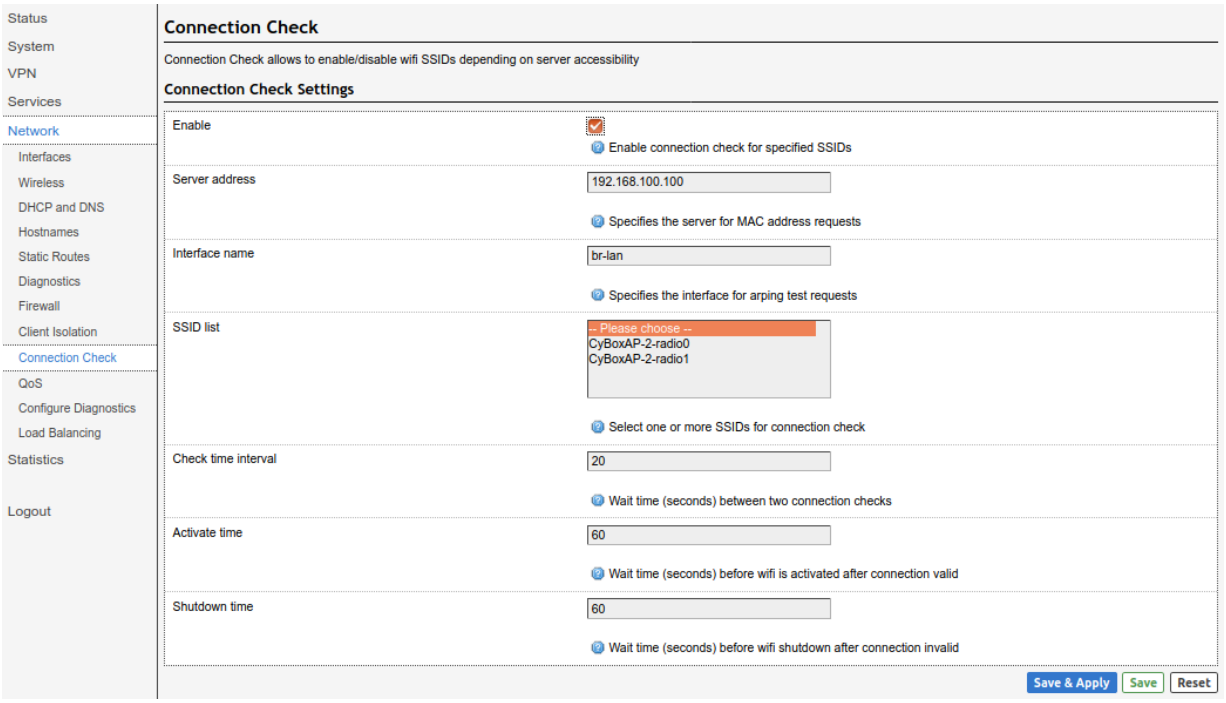
The connection check service allows to disable WLANs while no internet connectivity is possible. This can improve the user experience by avoiding being connected to a WLAN which delivers no internet connectivity.

The connection check works by issuing an *arping* to the server. When the server cannot be reached, the WLAN gets deactivated. Otherwise, the WLAN gets activated. The service can be configured on the page `Network` → `Connection Check` (see figure “Deactivate SSIDs when the server is not reachable” below). The checkbox `Enable` enables or disables it.

The parameter `Server address` determines which address is arpinged to determine whether the connection is healthy. The parameter `Interface name` dictates which interface to use for the arping. Note that this is a physical interface, such as `br-lan` or `eth0`.

In the `SSID list`, the controlled SSIDs can be chosen. The selected SSIDs are activated or deactivated by the service, while the others remain unaffected.

The connection is checked every `Check time interval` seconds. The selected SSIDs are disabled when the connection was down for at least `Shutdown time` seconds, and they are enabled again when the connection was healthy for at least `Activate time` seconds. Note that the latter two work at the granularity of `Check time interval`: If `Check time interval` → 15s and `Activate time` → 20s, the WLANs will be activated after the 2nd successful check, i.e. after 30s.



Deactivate SSIDs when the server is not reachable

6.1.3 Multi-WAN Manager (MWAN3)

The multi-WAN manager (MWAN3) can be used to control which network connection is to be used for traffic. This section uses LTE uplink connections as example, but other connections - like WLAN or Ethernet - can also be used.

It provides the following features:

- Monitoring of WAN connectivity using repeated ping tests (ping | arping | httping).
- Routing of outbound traffic to another WAN interface if the first WAN interface loses connectivity, based on metric. The connection with the lowest metric is preferred, other connections are only used if the preferred one fails. Interfaces sharing the same metric value form a “group”.
- Outbound WAN traffic load balancing over multiple WAN interfaces based on a numeric weight assignment. All connections sharing the same metric (“within the same group”) are used simultaneously, distributing traffic over them. Connections with higher weights gets more traffic assigned.
- Different policies can be defined for different traffic types. For example, OpenVPN traffic could be routed through the first connection (using the other connections only if it fails), while routing all other traffic through the remaining connections (using load-balancing among them).

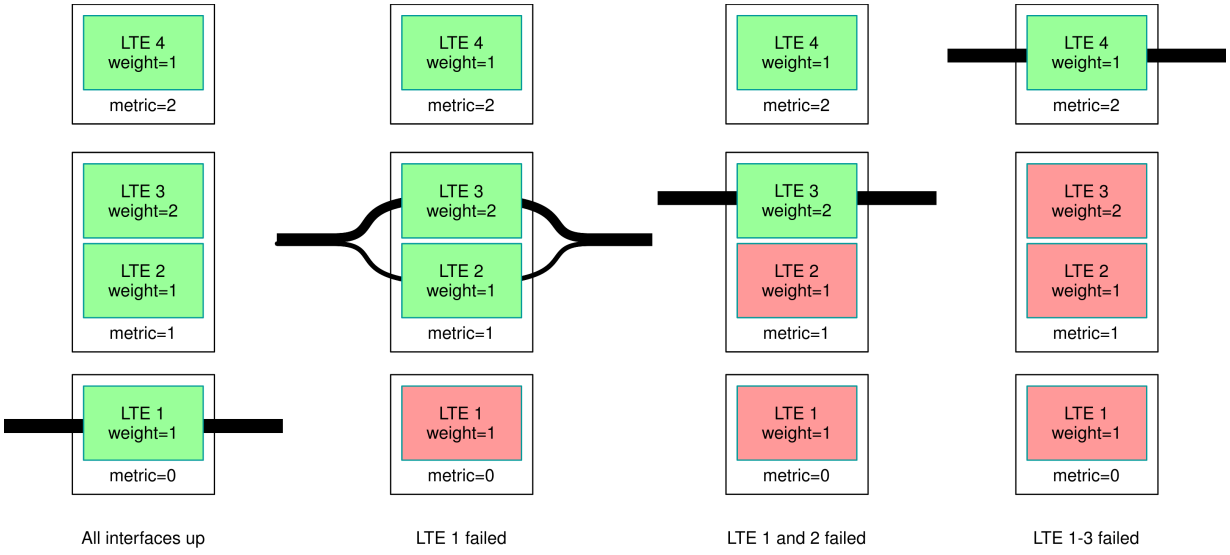
Load-balancing requires no remote station on the ground, it is handled entirely by the CyBox RT 2-A. As such, it is no link aggregation. It distributes traffic by streams, not by packets, i.e. a single stream cannot benefit from multiple LTE connections. For example, a single download stream can only use one LTE connection. However, multiple streams (e.g. generated by many WLAN users onboard a train) can be distributed over multiple WAN connections, increasing the overall bandwidth.

The figure Example traffic flow in MWAN shows an example configuration and visualizes the traffic flows in various situations:

- When all interfaces are up, all traffic is routed through the interface with the lowest metric, which is LTE 1 (metric=0).

- If LTE 1 fails, all traffic is still routed through the operable interfaces with the lowest metric (=1). But now, this is LTE 2 and LTE 3, which share the same metric. The traffic is distributed (load-balanced) over these interfaces.
- If LTE 1 and 2 fail, the traffic is routed over LTE 3, because this is now the operable interface with the lowest metric. There is no load-balancing any more, because only one interface is used.
- It LTE 1-3 fail, LTE 4 is used. Technically it is the operable interface with the lowest metric.

Note that the load balancing between LTE 2 and LTE 3 routes more traffic through LTE 3 than through LTE 2. This is because of the different weights. The interface with the higher weight gets more traffic. When there is now load balancing, the weight values have no effect.



Example traffic flow in MWAN

6.1.3.1 Capabilities

The MWAN3 package provides the following capabilities:

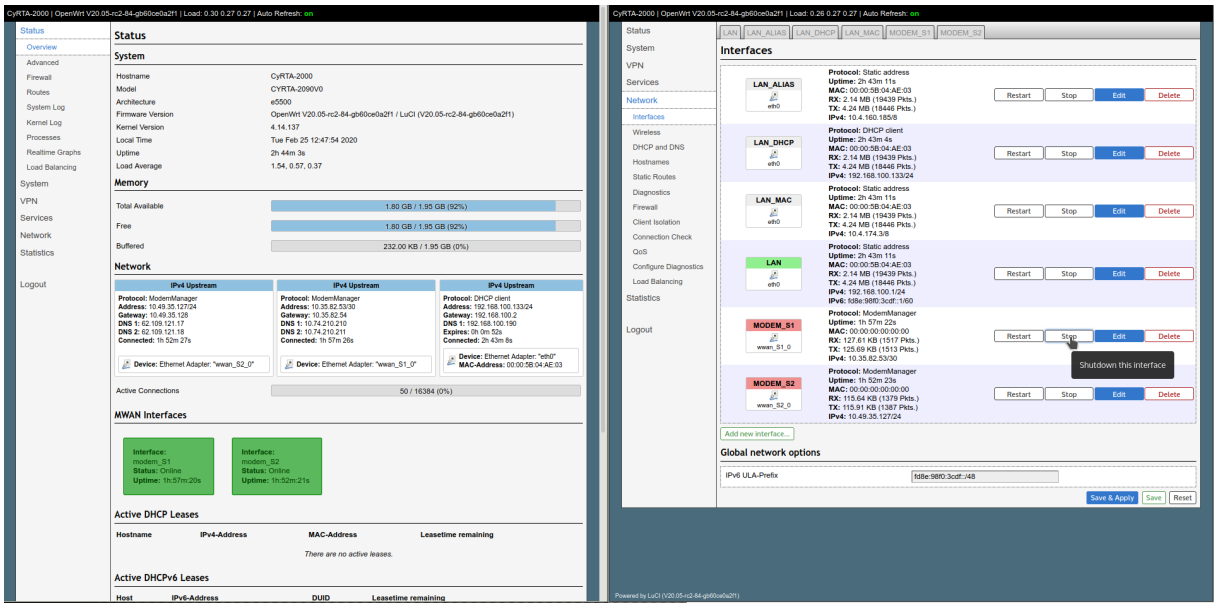
- provides outbound WAN traffic load balancing over multiple WAN interfaces based on a numeric weight assignment
- monitors WAN connections using repeated ping tests (ping | arping | httping) and automatically routes outbound traffic to another WAN interface if the first WAN interface loses connectivity
- provides specific outbound traffic rules to customize which outbound connections should use which WAN interface

6.1.3.2 MWAN Test

6.1.3.2.1 Gateway

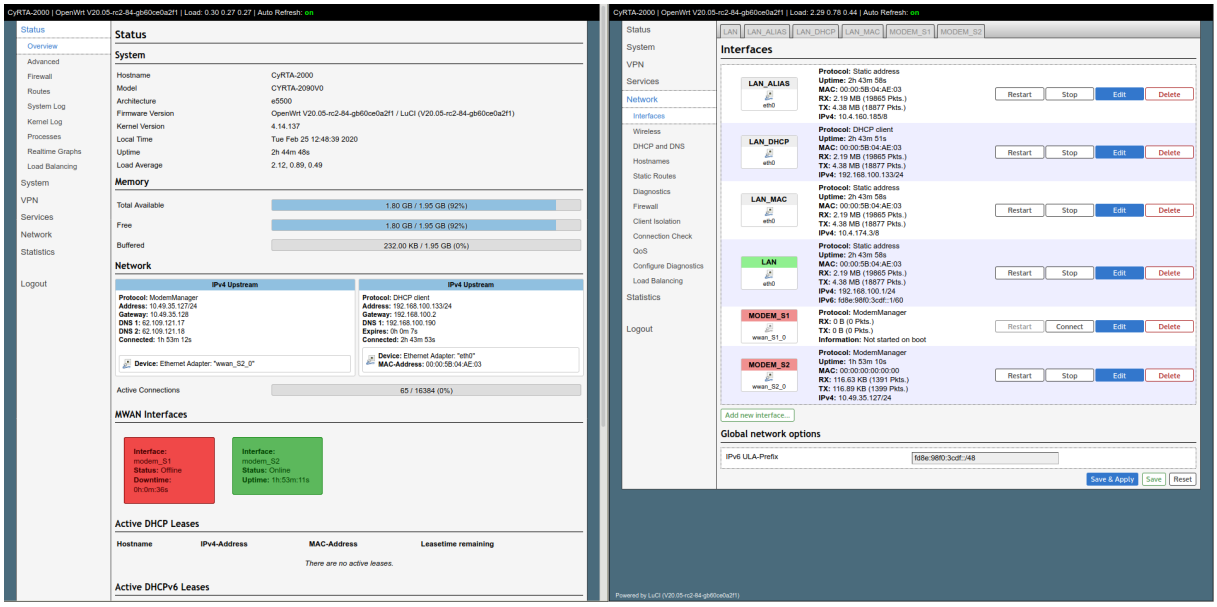
After complete Modem setup the modem interfaces are up and tracking via ping is active. To check the hotplug MWAN mechanism open a second web interface to CyBox RT 2-A and go to `Network` → `Interfaces`.

In this example `MODEM_S1` has the lowest metric and will be first standard gateway. The test is started with *Stop* action on interface `MODEM_S1`.



MWAN test stopping a modem

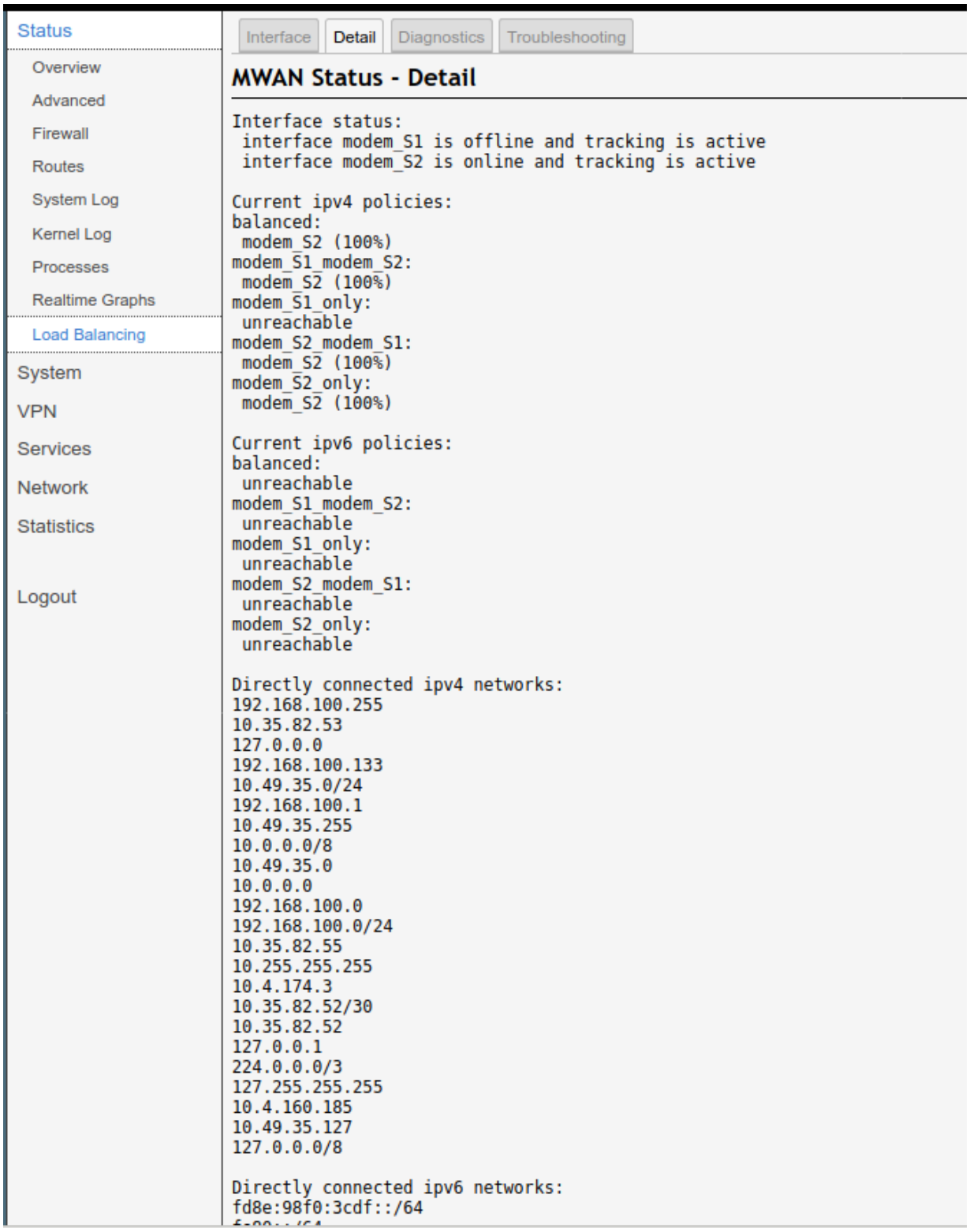
As the interface is down, all traffic has stopped and standard gateway switches to modem1.



MWAN test

6.1.3.3 MWAN Status

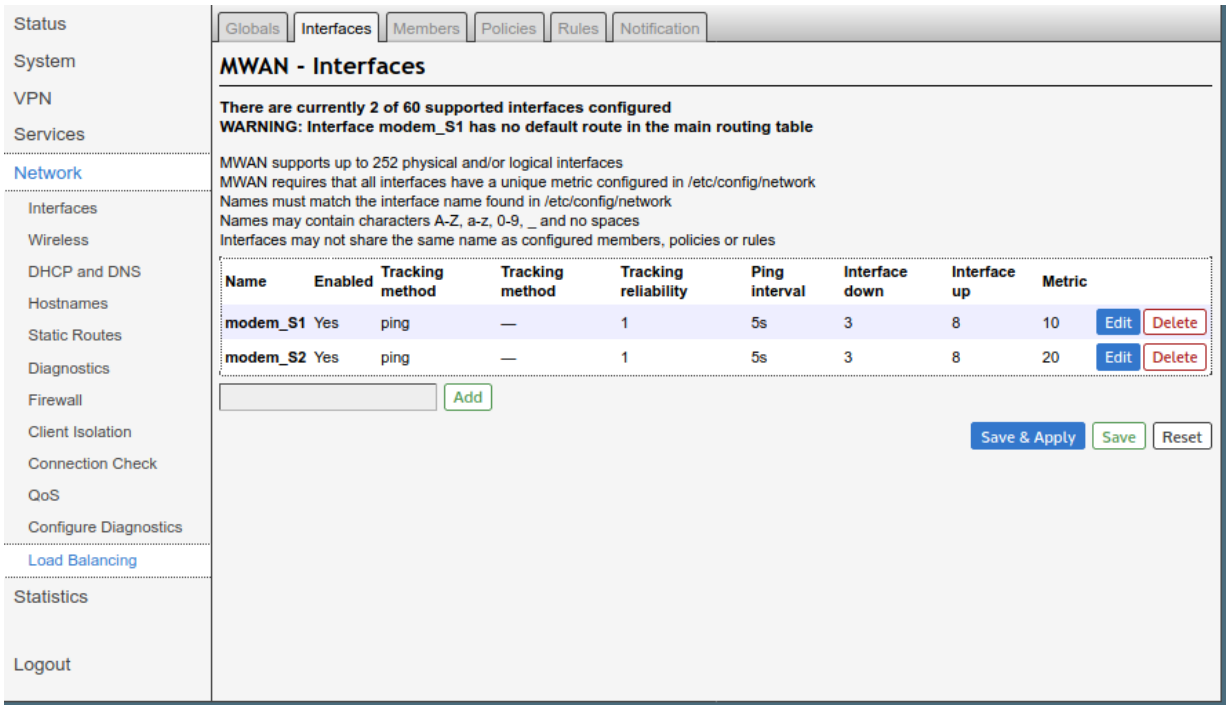
The detailed MultiWan status information is found in Status → Load Balancing → Detail.



MWAN detailed status page

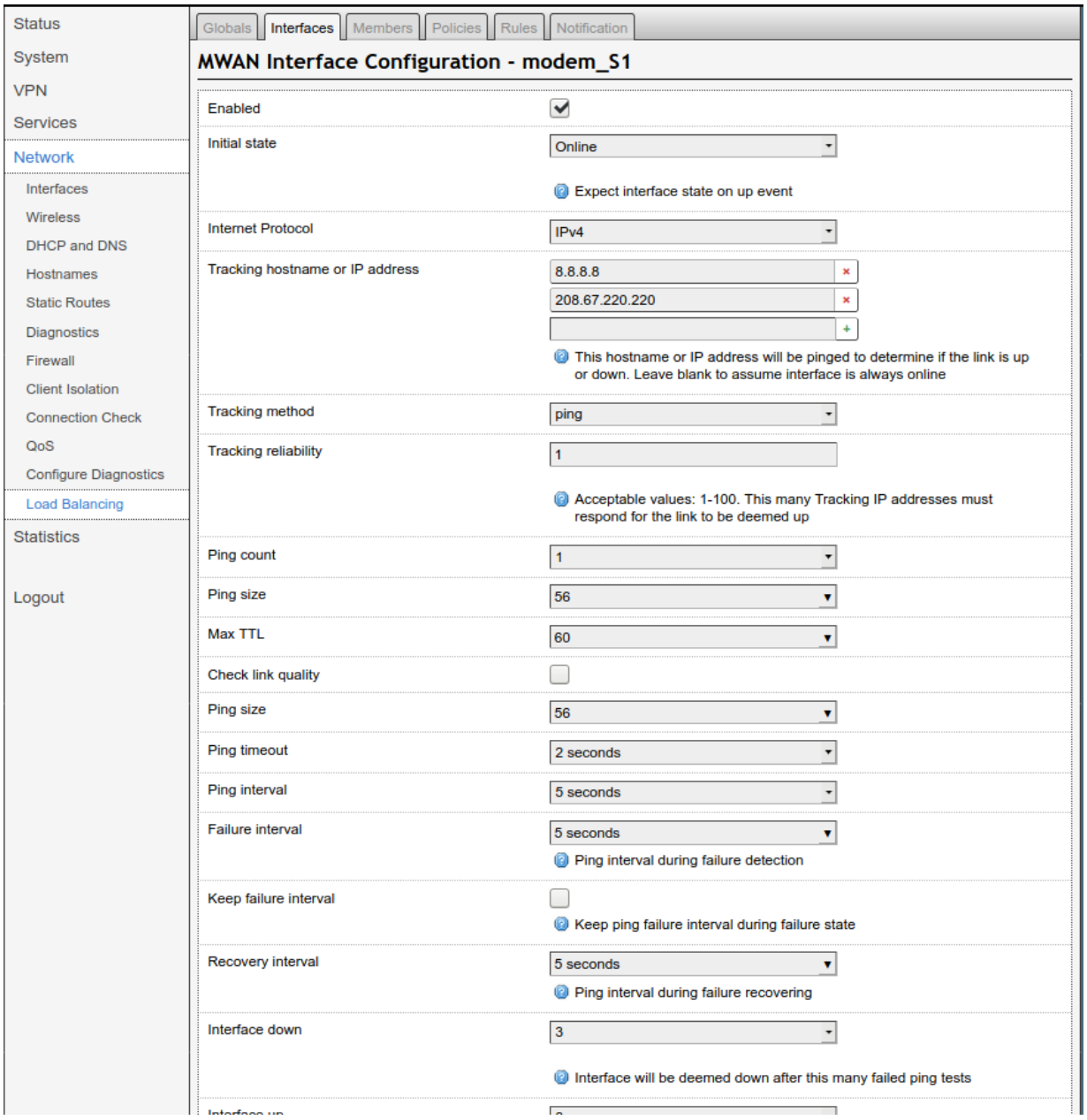
6.1.3.4 MWAN Modem Interface Configuration

The MWAN interface configuration has a default setup for every modem card.



MWAN Interface configuration

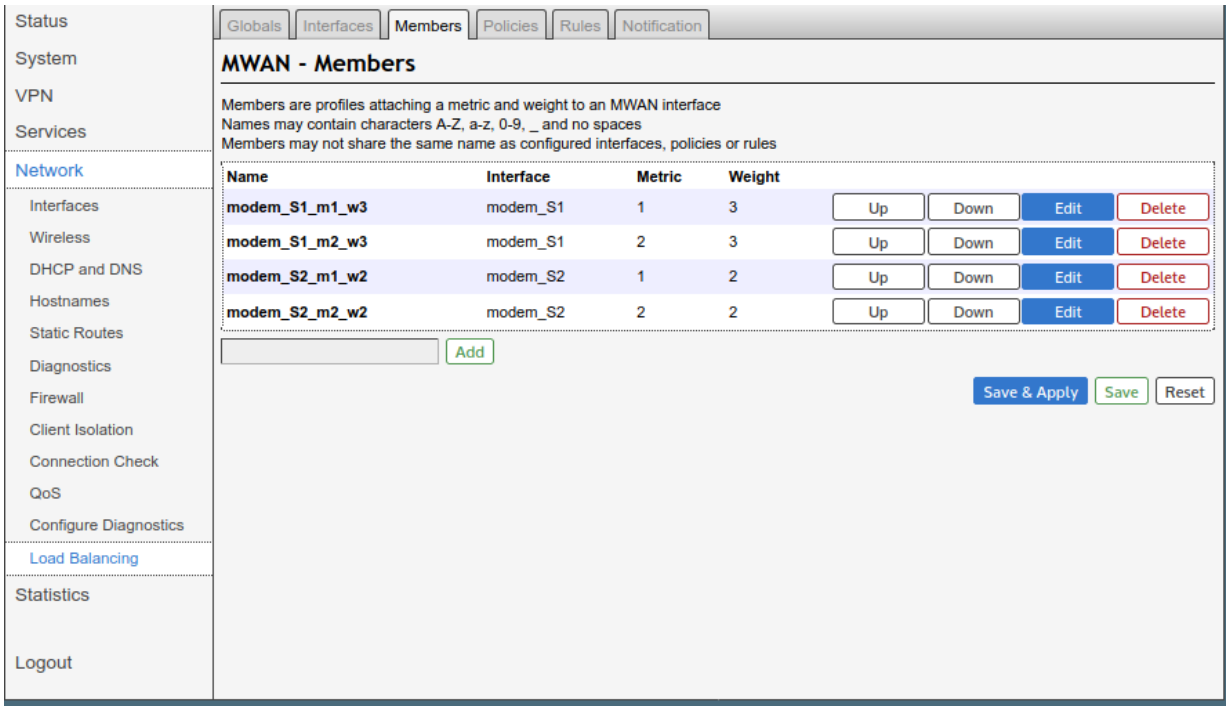
The tracking parameters can handle target host IPs, ping interval and timeout.



Tracking parameters

6.1.3.5 MWAN Members Configuration

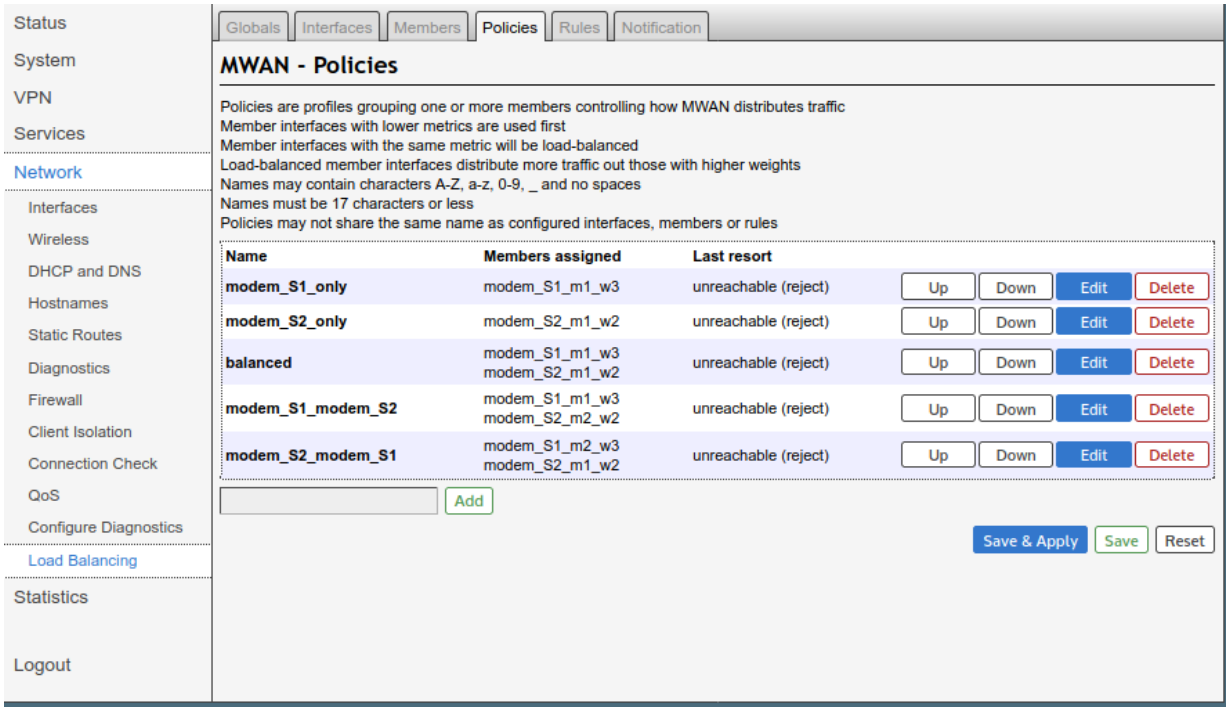
Members are profiles attaching a metric and weight to an MWAN interface. Names may contain characters A-Z, a-z, 0-9, _ and no spaces. Members may not share the same name as configured interfaces, policies or rules.



MWAN members

6.1.3.6 MWAN Policies Configuration

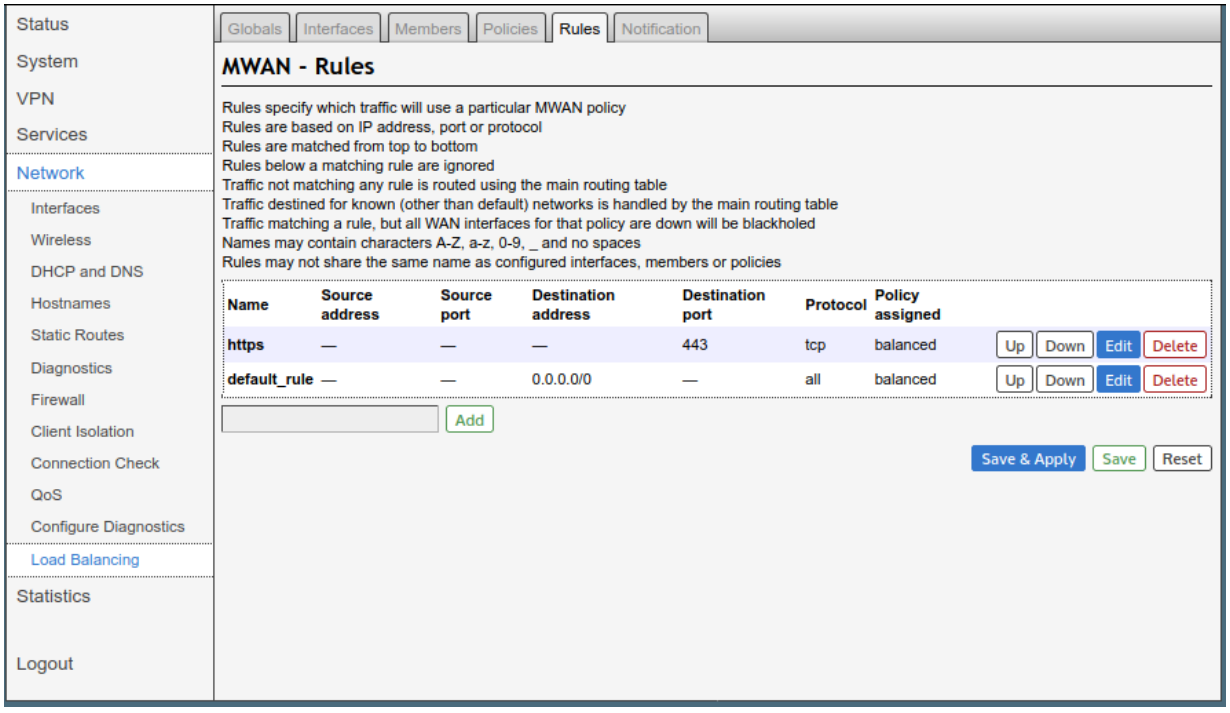
Policies are profiles grouping one or more members controlling how MWAN distributes traffic. Member interfaces with lower metrics are used first. Interfaces with the same metric use load-balancing. Load-balanced member interfaces distribute more traffic out through those interfaces with higher weights.



MWAN policies page

6.1.3.7 MWAN Rules Configuration

Rules specify which traffic will use a particular MWAN policy based on IP address, port, or protocol. Rules are matched from top to bottom. Rules below a matching rule are ignored. Traffic not matching any rule is routed using the main routing table. Traffic destined for known (other than default) networks is handled by the main routing table. Traffic matching a rule, but with all WAN interfaces for that policy down, will be blackholed.



MWAN rules page

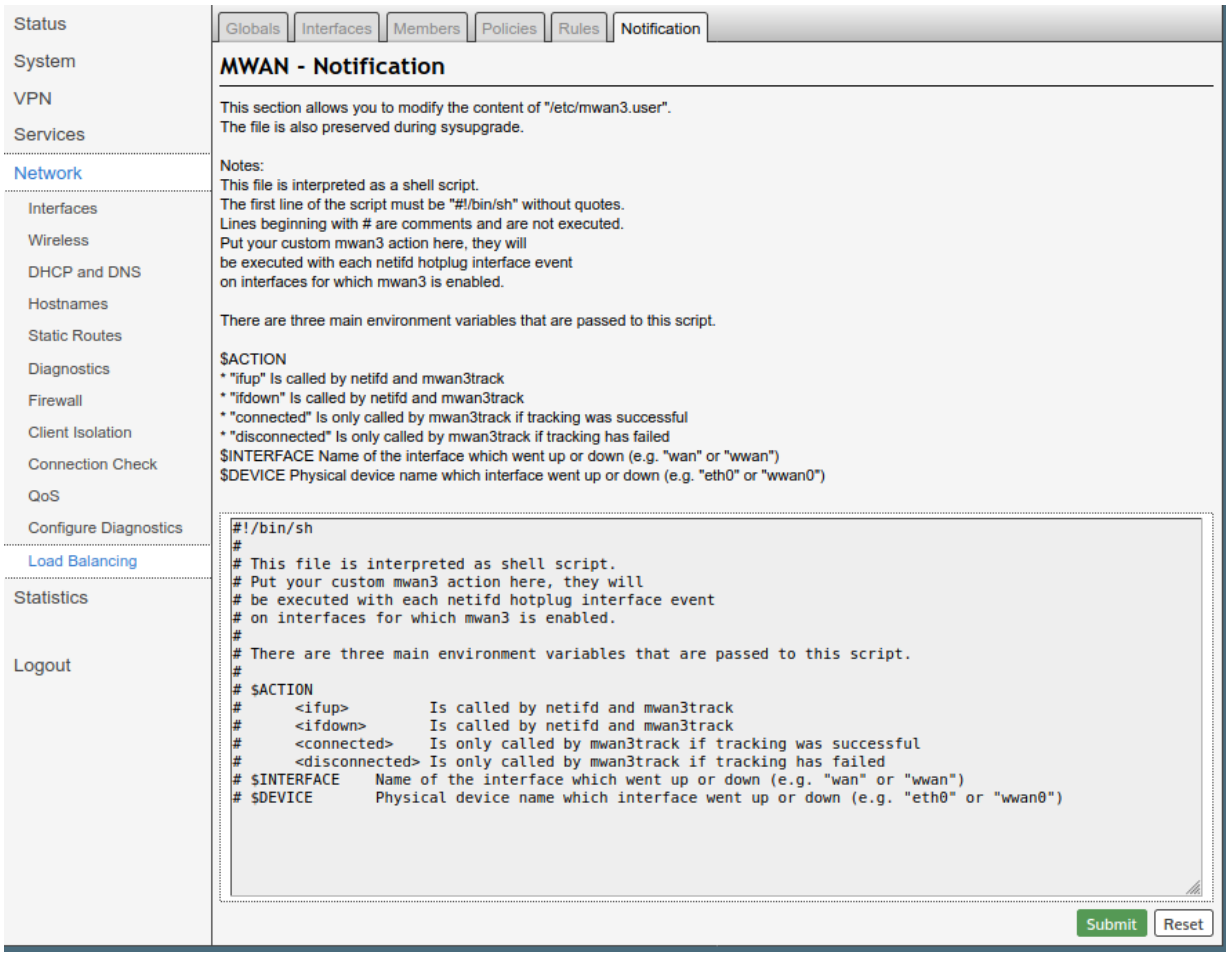
6.1.3.8 MWAN Notification Configuration

In the advanced configuration you may add a custom specific action on MWAN3 hotplug events, on interfaces for which MWAN3 is enabled.

This section allows to modify the content of “/etc/mwan3.user”. The file is also preserved during sysupgrade.

Notes:

- This file is interpreted as a shell script.
- The first line of the script must be “#!/bin/sh” without quotes.
- Lines beginning with # are comments and are not executed.
- There are three main environment variables that are passed to this script:
- $ACTION Either “ifup” or “ifdown”
- $INTERFACE Name of the interface which went up or down (e.g. “wan” or “wwan”)
- $DEVICE Physical device name which interface went up or down (e.g. “eth0” or “wwan0”)



MWAN notification configuration

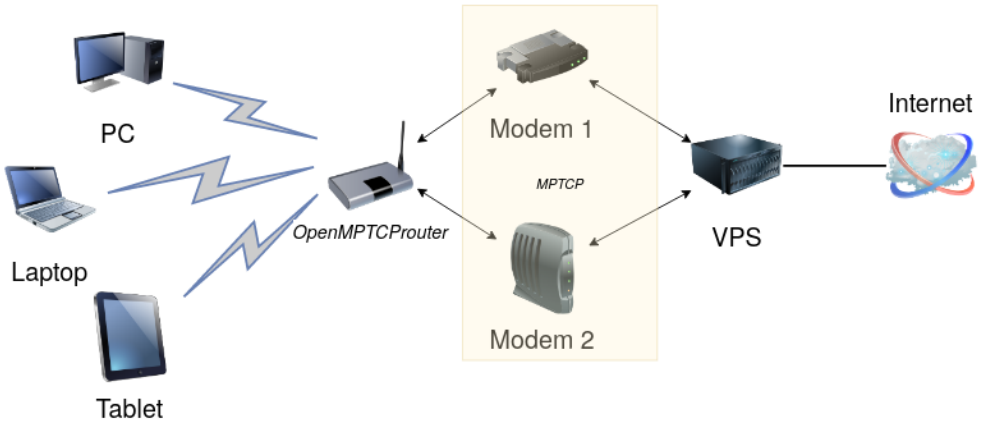
6.1.4 MultiPath TCP / Link Aggregation

Getting better throughput performance and failsave connections by using of MultiPath TCP (MPTCP) protocol.

Link aggregation part is done by package OpenMPTCProuter.

OpenMPTCProuter

OpenMPTCProuter use MultiPath TCP (MPTCP) to really aggregate multiple Internet connections and OpenWrt.



A simple diagram to describe how OpenMPTCProuter is working.

Aggregation	Failover	Security
Bonding connections to really aggregate bandwidth from up to 8 internet connections (Fiber, ADSL, VDSL, 4G,...) *Provide hybrid Internet with any FAI*	Always up with connection and VPS failover	All data between the router and the VPS can be encrypted and obfuscated

Important

A **shall** precondition to use OpenMPTCProuter feature is the availability of at least two network interfaces e.g. modems configured and connected to provider. Otherwise no link aggregation or connection fallback will be possible.

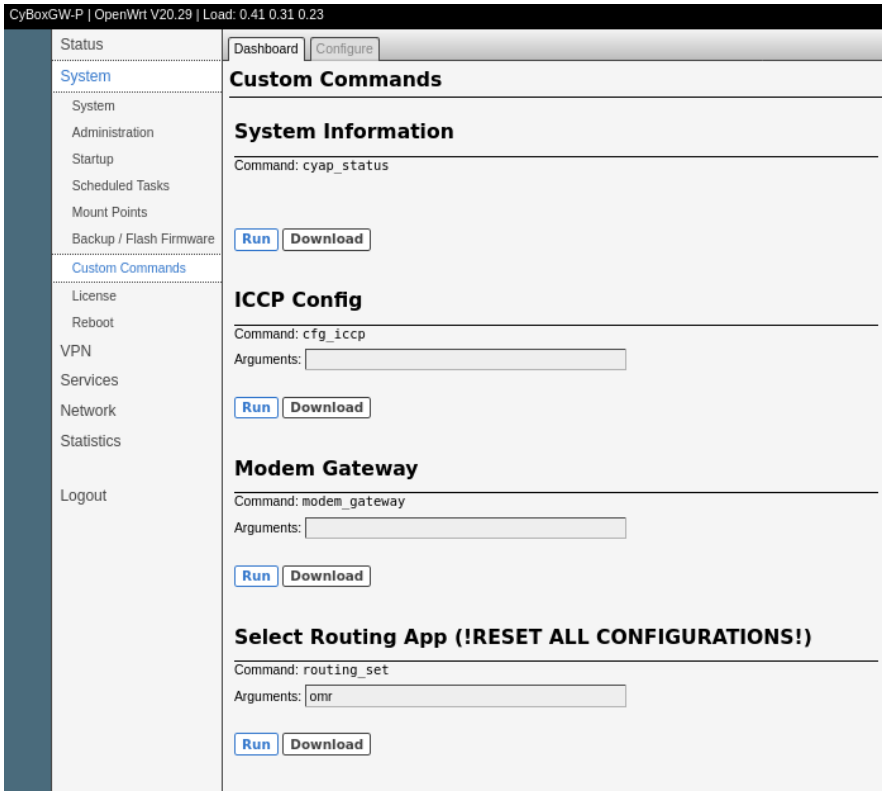
6.1.4.1 OpenMPTCProuter versus MWAN3

MultiWAN (mwan3) algorithm distributes multiple TCP connections over multiple lines. All packets of one TCP session are always transferred over a single line. Resulting data throughput is limited by a capabilities of this line. In case of connection fail, established session will be closed. If other line is available, a new session will be established over another line.

While MultiWAN uses only one line for all session packets, OpenMPTCProuter split one TCP session over several lines. Resulting data throughput is limited by a sum of all used lines together. In case of a connection error e.g. one of a lines goes down, established session is not closed. Transmission of remaining TCP packets belonging to a session continues over other available lines.

6.1.4.2 OpenMPTCProuter/MWAN3 selection

OpenMPTCProuter and MWAN3 are concurrent tools and can not run at the same time. The active tool can be selected by using the UI page `System` → `MWAN3` and the command “routing_set mwan3” have to be executed. Also the factory reset is triggered. After the system restart MWAN3 UI pages and configuration defaults are available. OpenMPTCProuter UI pages and configurations are not available. To use OpenMPTCProuter instead of MWAN3 the same procedure has to be done. The only difference is using parameter “omr” instead of “mwan3” for command “routing_set”.



6.1.4.3 VPS Configuration

6.1.4.3.1 Recommendations

Multiple interface data streams are ends up into a single data stream (Link Aggregation) on a special Server (VPS) which OpenMPTCProuter software are connecting to. Therefore the VPS/server need to have the lowest latency as possible with used network connections. It is recommended to use a linux based server with e.g. Debian 10 or Ubuntu 18.04 installed on as a VPS/server.

6.1.4.3.2 Install / setup VPS tools

VPS Setup is done by using of installation scripts provided by OpenMPTCProuter project.

Connect with SSH on your server, using ssh command under Linux or Putty under windows for example.

Then, as root:

```
wget -O - https://www.openmptcprouter.com/server/debian10-x86_64.sh | sh
```

This will install and configure mptcp kernel, shadowsocks, glorytun and shorewall (as firewall). Key for shadowsocks and glorytun are generated by the script.

- SSH port is changed to 65222 (TCP)
- Shadowsocks port is 65101 (TCP & UDP)

- Glorytun port is 65001 (TCP & UDP)
- OMR JSON admin is 65500 (TCP)
- OpenVPN port is 65301 (TCP)
- MLVPN ports are 65201-65208 (UDP)
- Iperf3 on port 65400 (TCP & UDP)
- DSVPN port is 65401 (TCP)

6.1.4.3.3 Generated keys

After installation, keys can be found in file /root/openmptcprouter_config.txt.

```
root@fe-multipathtcp:# cat /root/openmptcprouter_config.txt
SSH port: 65222 (instead of port 22)
Shadowsocks port: 65101
Shadowsocks encryption: chacha20
Your shadowsocks key: xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
Glorytun port: 65001
Glorytun encryption: chacha20
Your glorytun key: xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
A Dead Simple VPN port: 65011
A Dead Simple VPN key: xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
MLVPN first port: 65201'
Your MLVPN password: xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
Your OpenMPTCProuter Server key: xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
Your OpenMPTCProuter Server username: openmptcprouter
root@fe-multipathtcp:/home/eltec
```

6.1.4.3.4 Choosing a VPN Technology

Per default VPS (Virtual Private Server) is prepared to interact with multiple common implementations of VPN (Virtual Private Network) technology. Each of the supported VPN's OpenVPN/Glorytun/DSVPN/MLVPN) have preconfigured ports and keys. The decision which VPN should be used, or use it at all can be met by user during configuration of OMR (OpenMPTCProuter). The choice of using a VPN Shadowsocks only or a combination of Shadowsocks and VPN should be met depending on project goals and available tools.

Shadowsocks implementation make use of SOCKS5 Protocol which can handle not just multiple link connections, but also support different encryption methods. A default configuration of VPS and OMR software setup uses Shadowsocks connection for all TCP traffic and a GlorytunTCP VPN for any non-TCP traffic. In case Glorytun TCP VPN is deactivated or disconnected, all traffic is done over Shadowsocks interface. Alternative, if the Shadowsocks interface is disabled or disconnected, all data is send/received over Glorytun TCP VPN interface OMRVPN.

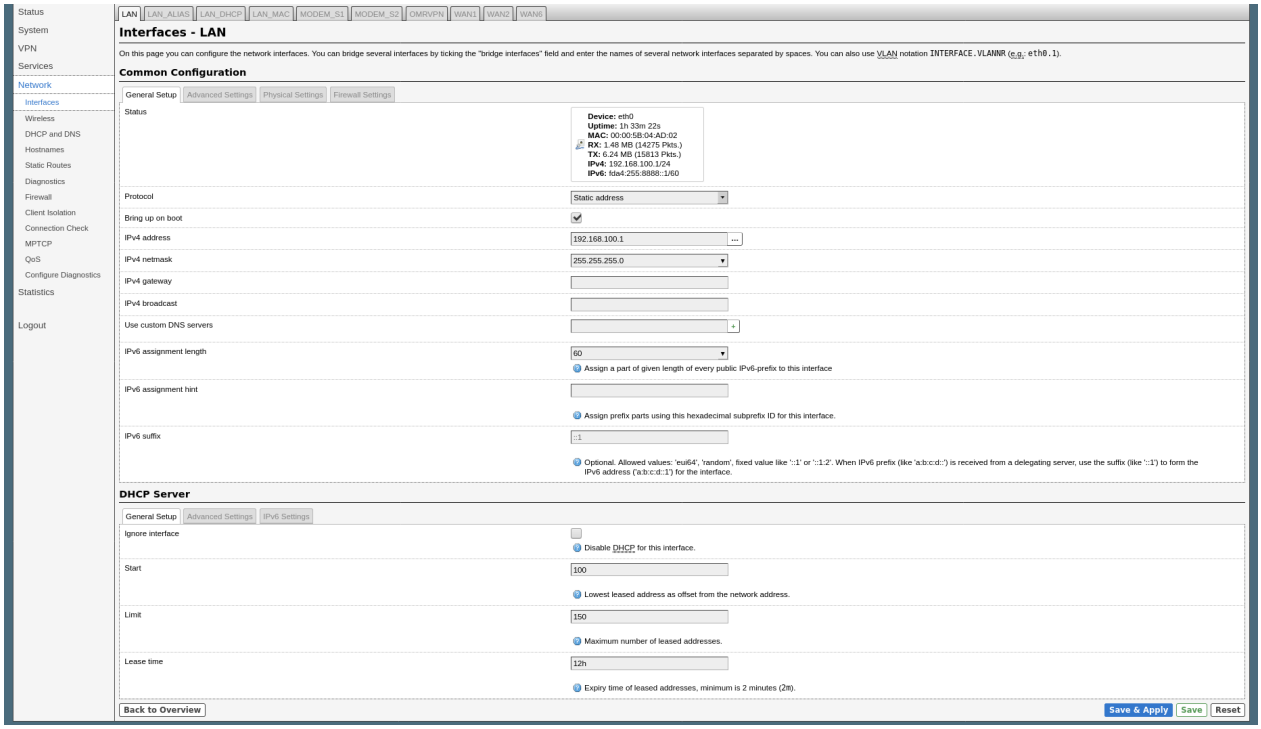
> **Important**
>
> In the following example, a default setup, a combination of Shadowsocks/Glorytun is used.

6.1.4.4 OpenMPTCProuter configuration example

The following example gives a step-by-step instruction of the configuration and testing of Link Aggregation with MPTCP by using two LTE modems as internet connections to a VPS server.

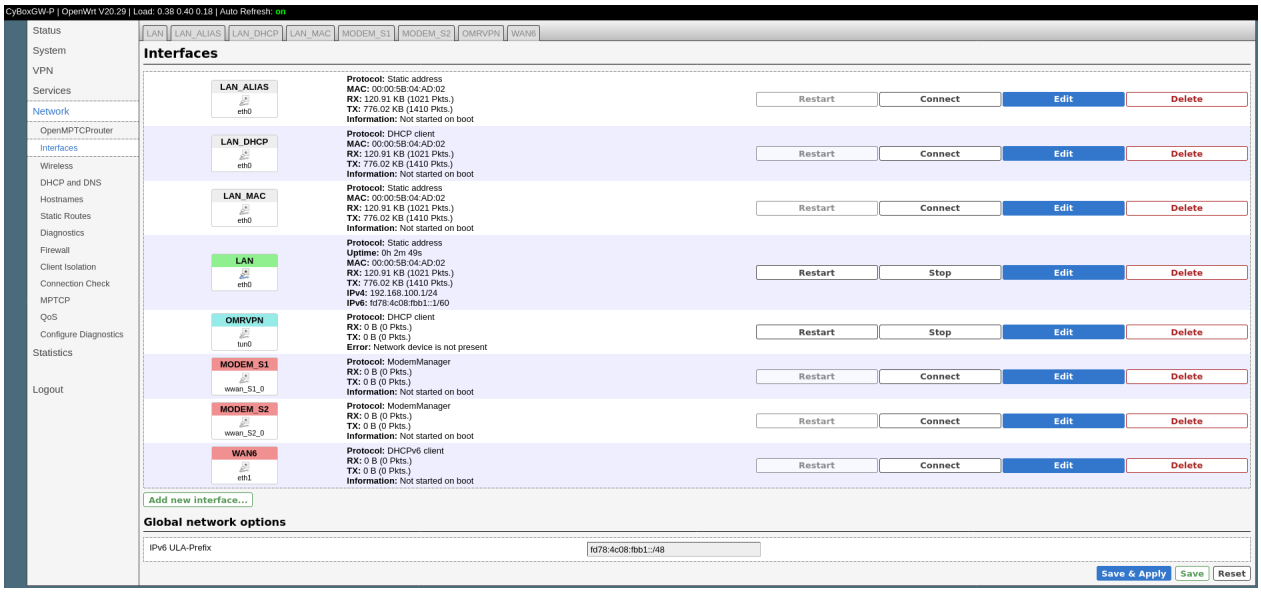
6.1.4.4.1 Setup DHCP

Optionally DHCP server functionality can be activated for LAN interface. This can be helpful for later connection of e.g. clients to router.



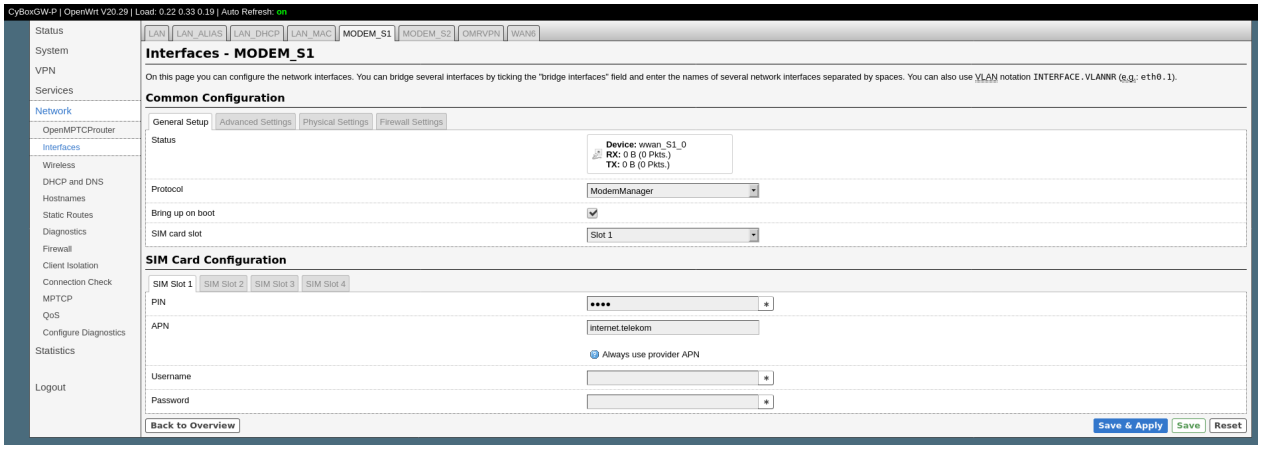
6.1.4.4.2 Remove / Disable unused default interfaces

Unused network interfaces should be either removed from configuration or set as disabled to not disturb MPTCP functionality.

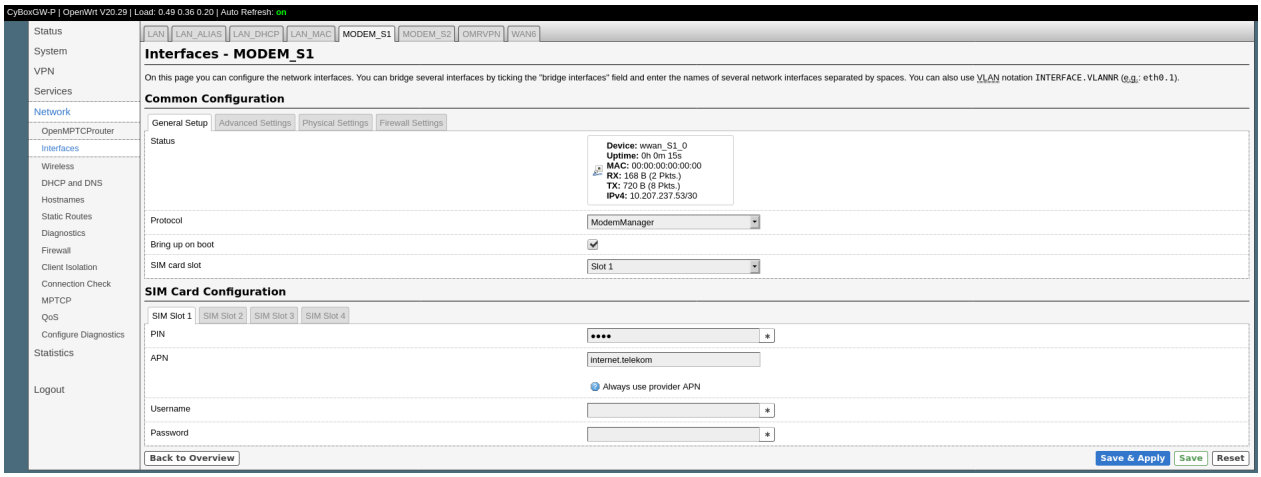


6.1.4.4.3 Setup LTE Modems

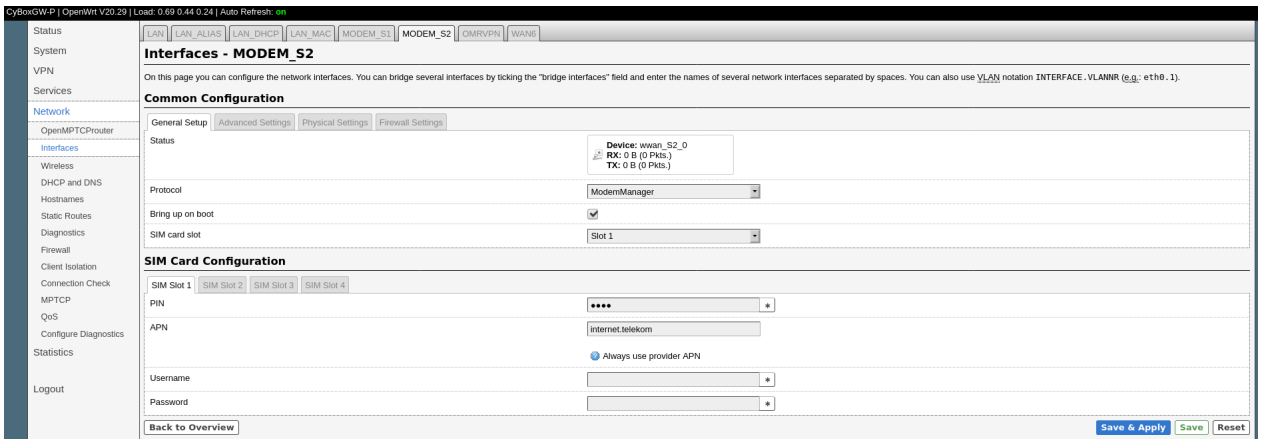
Configuration of the first modem (MODEM_S1) can be done by using of UI page `Network` → `Interfaces` → `MODEM_S1`. In order to initiate a data connection, SIM_PIN and APN have to be specified. After that `Bring up on boot` flag has to be checked.

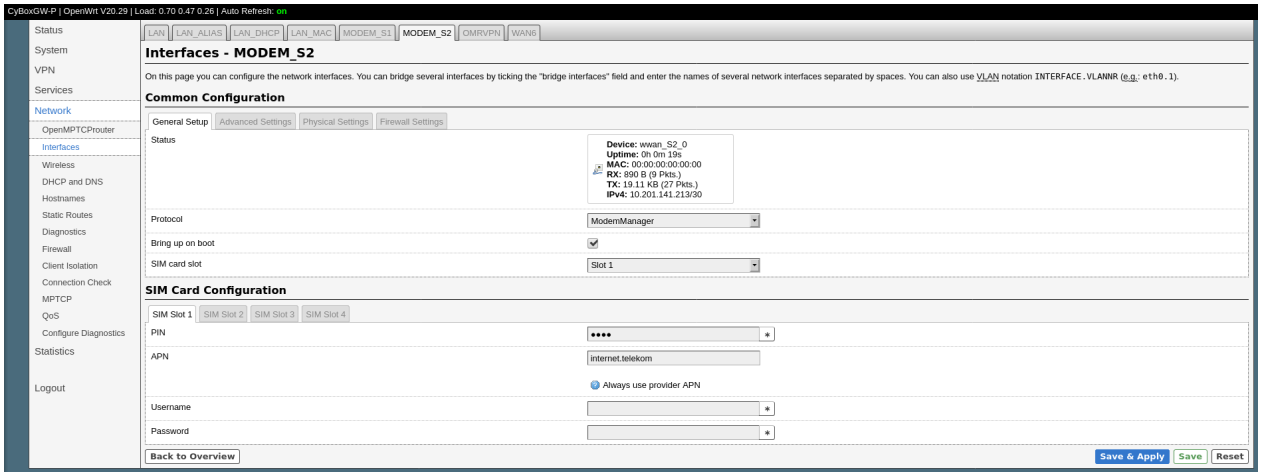


After applying new settings the connection process starts. After some time, depending e.g. on signal strength, modem connection should be established.



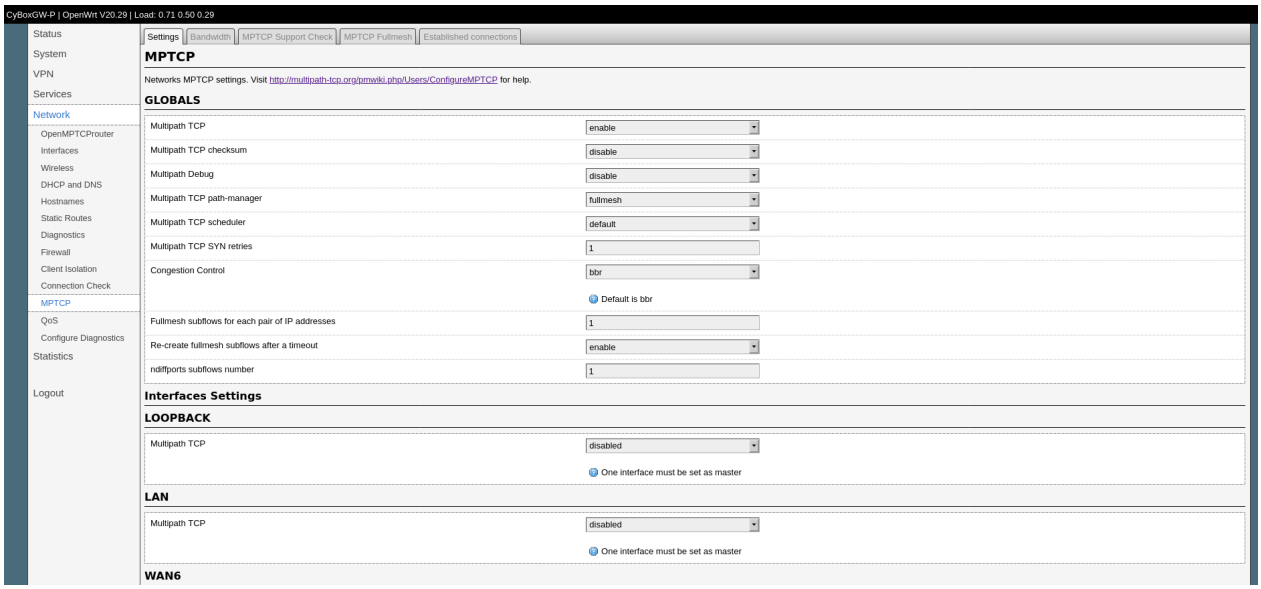
Same procedure have to be done for the second modem interface (MODEM_S2) too.



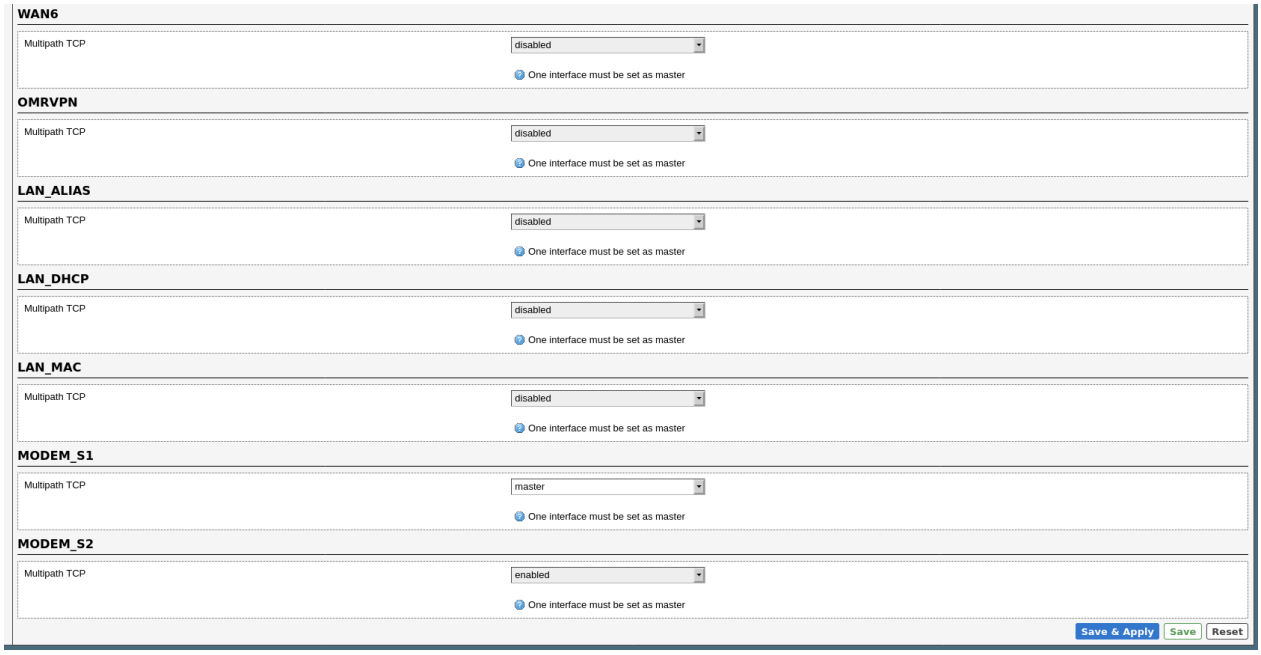


6.1.4.4.4 Setup MPTCP

Now, MPTCP can be configured.This can be done by using of UI page (`Network` → `MPTCP` → `Settings`). By default MPTCP is enabled. Configuration of e.g. MultiPath TCP scheduler and MultiPath TCP path-manager can be done according to project goals. Configuration manual of a MultiPath TCP project ConfigureMPTCP contains further information about possible settings and their meaning.

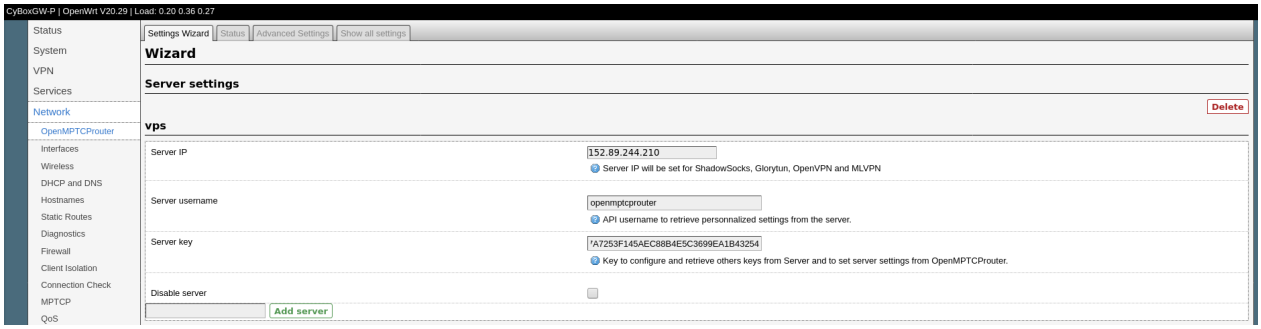


The role of each interface running MPTCP have to be defined. One interface have to be selected as master. Unused interfaces have to be marked as disabled.



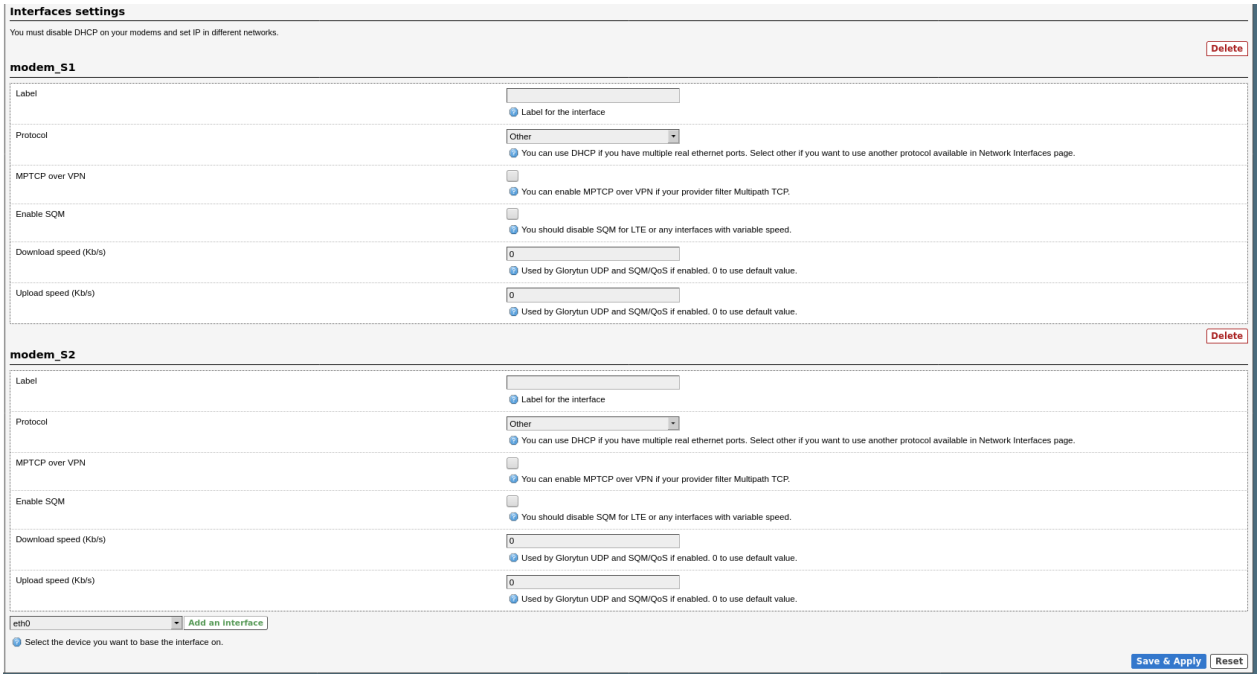
6.1.4.4.5 Setup VPS access

Last part needed for using of Link Aggregation is configuration of OpenMPTCProuter (OMR). OMR configuration can be done by using of UI page (`Network` → `OpenMPTCProuter` → `Settings Wizard`). Server IP, username and also server key have to be entered.

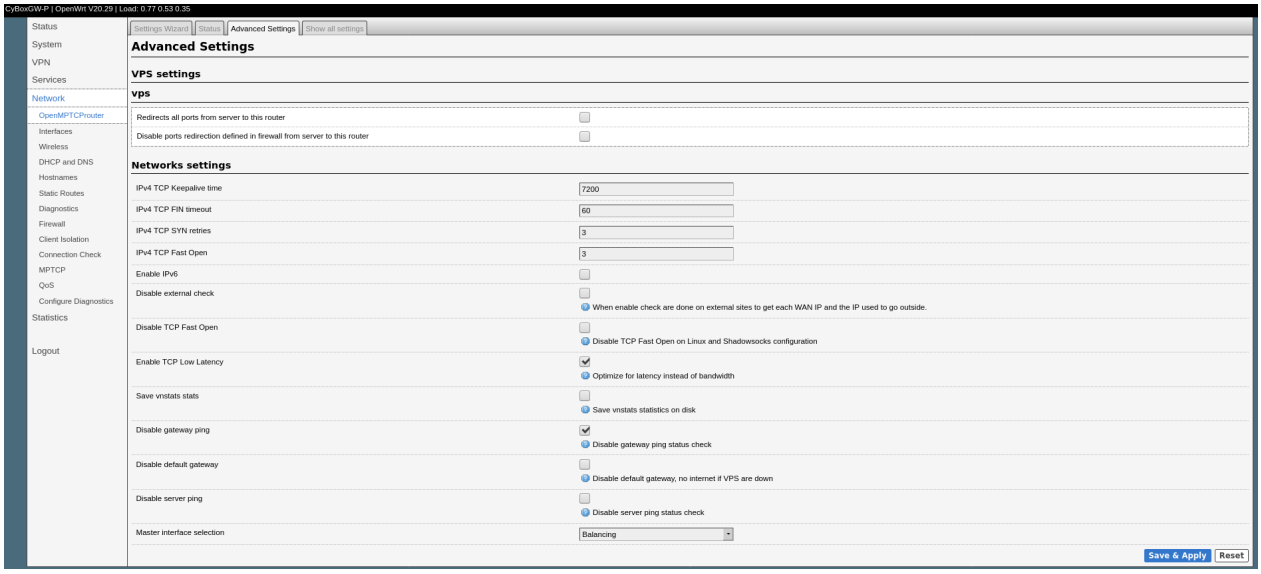


Settings according to technology which should be used for OMR<->VPS communication can be configured by using of the same UI page (`Network` → `OpenMPTCProuter` → `Settings Wizard`). Default setup allows usage of `Shadowsocks` between OMR and VPS. As a default encryption algorithm is `chacha20` chosen. Also multiple different types of VPN endpoints can be used for communication between OMR and VPS.

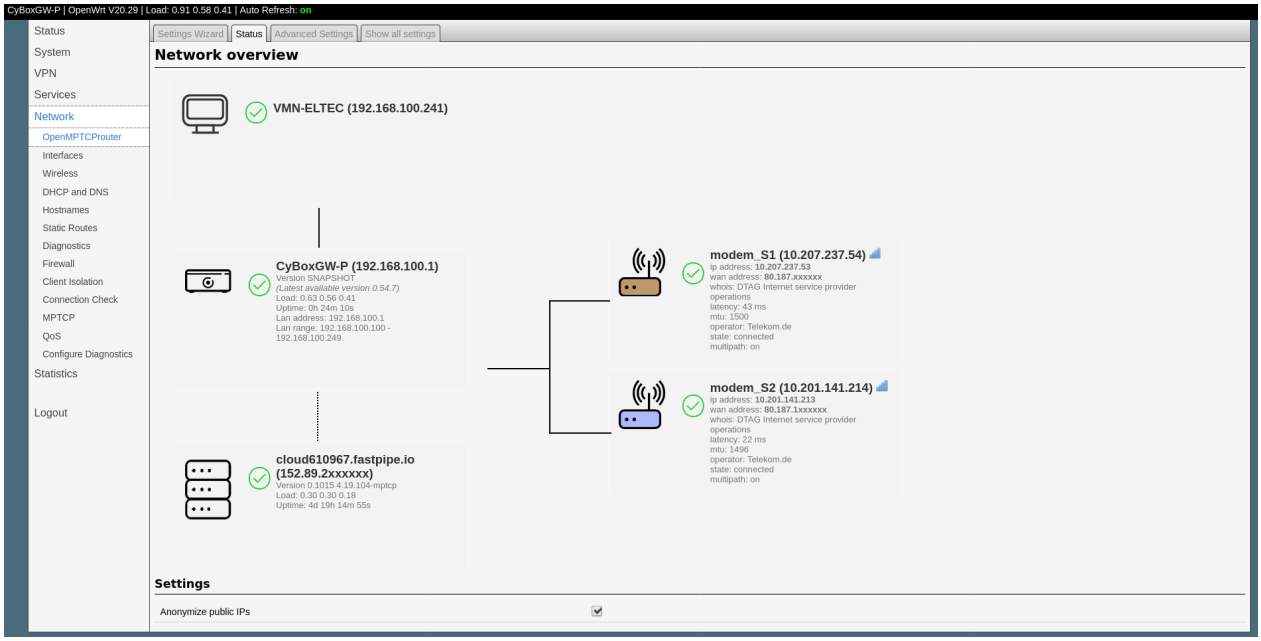
Further network interface configuration according to OMR<->VPS communication can be done by using of the same UI page (`Network` → `OpenMPTCProuter` → `Settings Wizard`).



Advanced settings such as e.g. runtime Master interface selection can be done by using of UI page (`Network` → `OpenMPTCProuter` → `Advanced Settings`).



After all settings are done and applied, network overview can be discovered by using of UI page (`Network` → `OpenMPTCProuter` → `Status`).

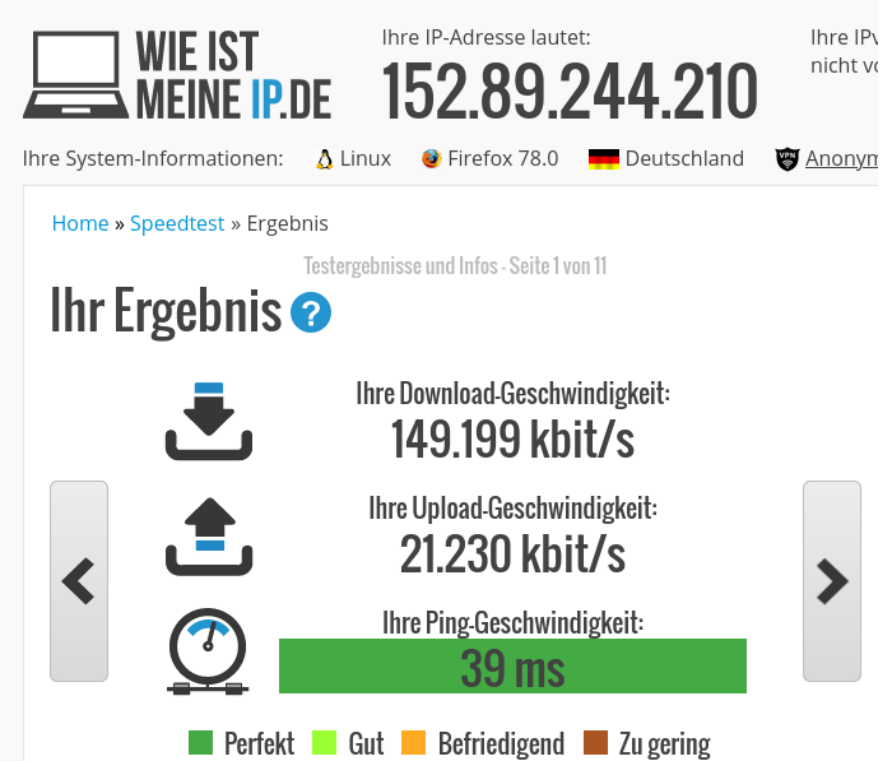


6.1.4.4.6 Speed test / IP

Previously configured OMR<->VPS constellation is used to validate link aggregation functionality.

> **Important**
>
> Client connection to the internet destinations should be established over external VPS servers IP and not over one of two local uplinks at OMR! Check the IP reported by the website. It should match the IP of the VPS.

> **Important**
>
> Measured bandwidth is strongly dependent as well on currently available signal strength respectively quality as on contractual provider limitations for each used interface. Measurement values are only a snapshot. The exactly reproducibility can not be guaranteed!

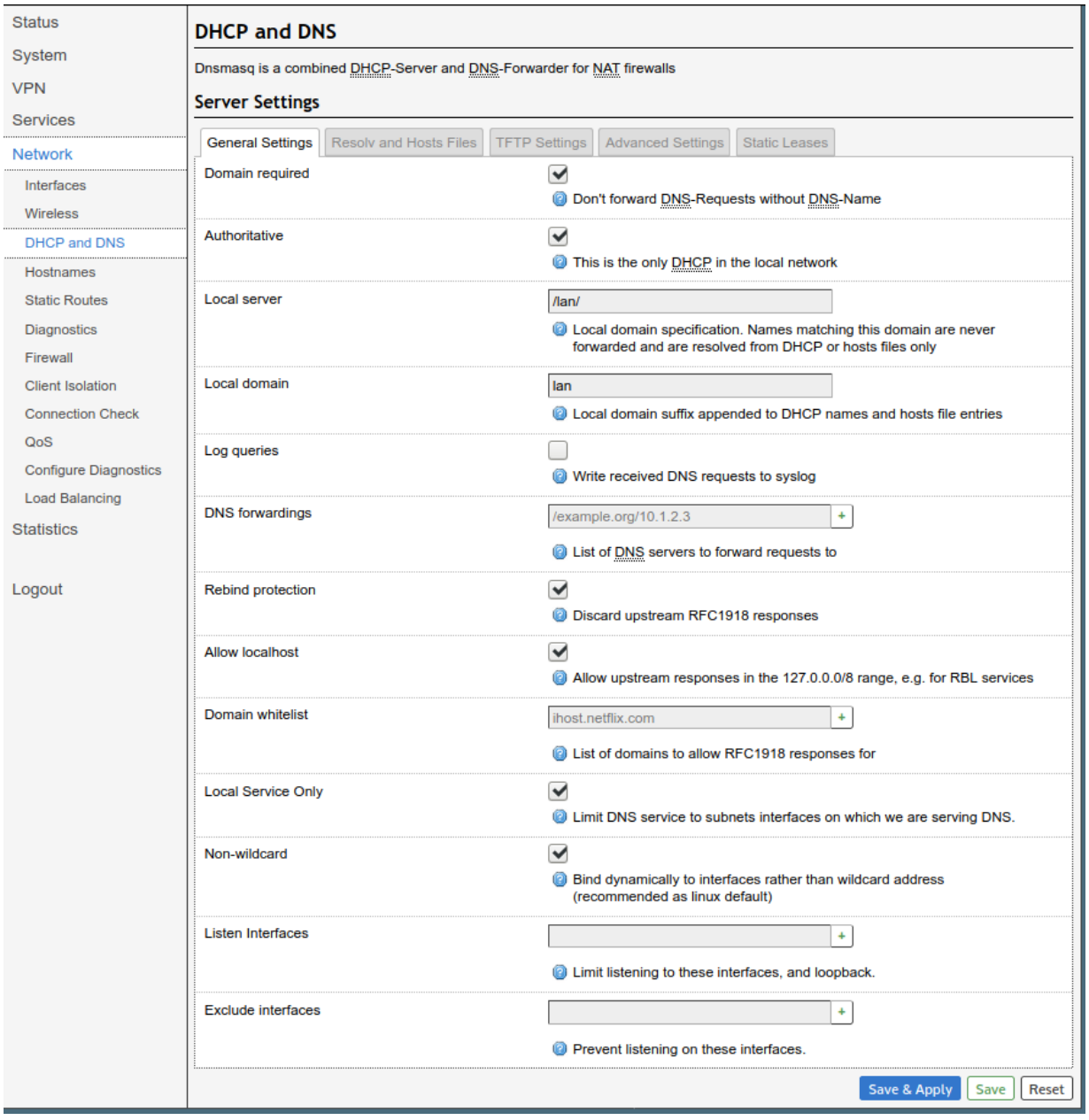


6.1.5 Global DHCP and DNS Settings

Be sure you understand DHCP and DNS services before changing any configurations. Under normal circumstances, keeping the factory default setting should be sufficient.

The CyBox RT 2-A uses a DNS, TFTP and DHCP server. It is intended to provide coupled DNS and DHCP service to a LAN. This service accepts DNS queries and either answers them from a small, local, cache or forwards them to a real, recursive DNS server. See Chapter DHCP server 6.1.1.1 DHCP Server per Interface .

The DHCP server supports static address assignments and multiple networks. It automatically sends a sensible default set of DHCP options, and can be configured to send any desired set of DHCP options, including vendor-encapsulated options. It includes a secure, read-only, TFTP server to allow net/PXE boot of DHCP hosts and also supports BOOTP.



DHCP And DNS Configuration Screen

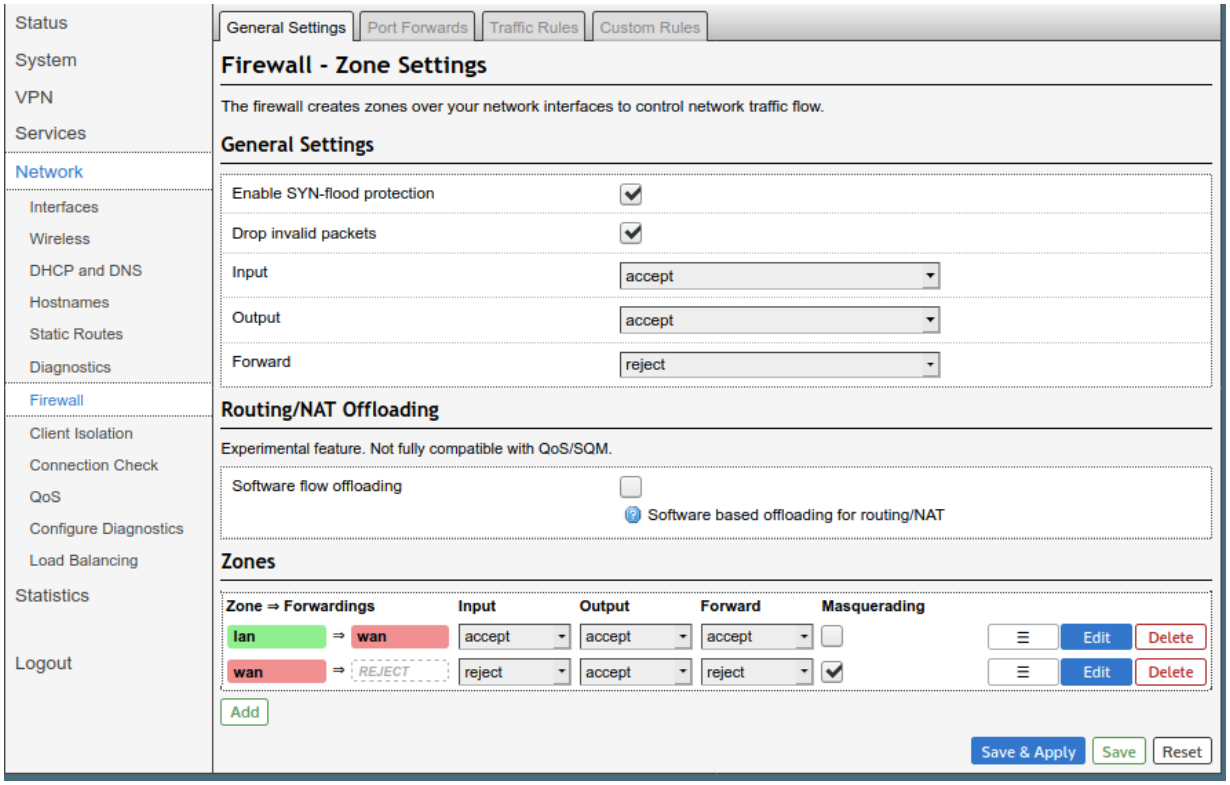
6.1.6 Firewall

Be sure you understand zone-based firewalls before changing the firewall configurations.

The CyBox RT 2-A has a built-in stateful firewall mapping interfaces into Zones that are used to describe default rules for a given interface, forwarding rules between interfaces, and extra rules that are not covered by the first two.

The first rule that matches is executed, often leading to another rule-chain until a packet hits either ACCEPT or DROP/REJECT. Such an outcome is final, therefore the default rules take effect last, and the most specific rule takes effect first. Zones are also used to configure masquerading also known as NAT (network-address-translation) as well as port forwarding rules, which are more generally known as redirects.

Zones must always be mapped onto one or more Interfaces, which ultimately map onto physical devices; therefore zones cannot be used to specify networks (subnets), and the generated iptables rules operate on interfaces exclusively. The difference is that interfaces can be used to reach destinations not part of their own subnet, when their subnet contains another gateway. Usually however, forwarding is done between LAN and WAN interfaces, with the router serving as 'edge' gateway to the Internet. The default configuration of the Firewall provides for such a common setup.



Firewall Zone Setting Screen

6.1.7 OpenVPN

Starting with firmware version 3.2 the Open Source VPN solution is included. The firmware before version 4.0 does not support a web frontend for OpenVPN configuration.

The OpenVPN program has many parameters to setup a connection. This chapter describes a basic Client OpenVPN tunnel configuration. In the next example the VPN tunnel connection is made through an already running LTE interface providing the Internet gateway.

6.1.7.1 Configuration file generation on Windows

OpenVPN for Windows can use an OpenVPN-GUI, which allows managing OpenVPN connections from a system tray applet. It can be used to generate a complete client configuration (zip file) including the .ovpn configuration file.

6.1.7.2 VPN interface setup – 3 methods

The VPN connection setup can be achieved by the three following methods.

6.1.7.2.1 Copy Ready-to-use configuration with SCP

This is the easiest way to configure a VPN connection. It is assumed that the server side has a configured network environment. The server administrator should create a valid client configuration package, including certificates, client keys and preferably a myclient.ovpn config file. The VPN connection is built on this configuration file (myclient.ovpn). This example uses four files that have to be static stored on the CyBox RT 2-A to allow the

openvpn program to build up a connection without user interaction. If the 'auth-user-pass' option is given to openvpn without a parameter, the connection setup is interrupted and will ask for a username and password. To make this run automatically a two-line file with username (in first line) and password (in second line) has to be provided. All four files, the 'auth_user_pass', the 'pfelt1-udp-vpnuser_fg.p12' , the user key file 'pfelt1-udp-vpnuser_fg-tls.key' and the 'myclient.ovpn' config file have to copied from host system via 'scp' command to permanent storage located in '/etc/openvpn/' directory. Ensure that all files in '/etc/openvpn' have file permission 600 (cd /etc/openvpn; chmod 600 *).

The 'myclient.ovpn' configuration is:

```
dev tun
persist-tun
persist-key
cipher AES-256-CBC
auth SHA1
tls-client
client
resolv-retry infinite
remote 166.93.10.174 1194 udp
lport 0
verify-x509-name "VPN Server Cert" name
auth-user-pass auth\_user\_pass
pkcs12 pfelt1-udp-vpnuser\_fg.p12
tls-auth pfelt1-udp-vpnuser\_fg-tls.key 1
ns-cert-type server
comp-lzo
```

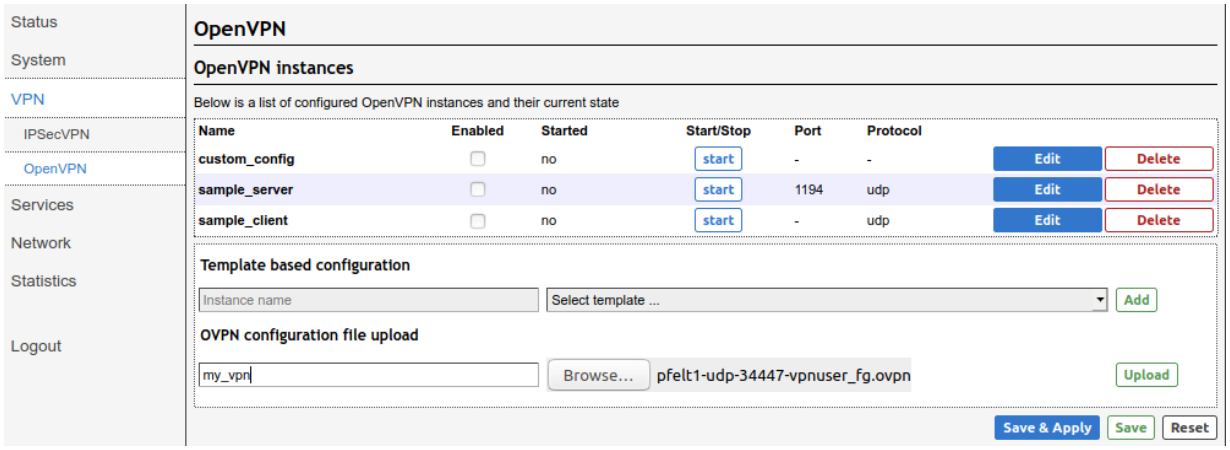
6.1.7.2.2 Upload configuration, certs, key-files with web interface

The second method is quite the same as the first. A modified 'myclient.ovpn' file is used. The difference is, that the certificate, the key files and the password files are uploaded from web interface. The default web interface upload directory is /etc/luci-uploads/ and the uploaded file is appended with service type and interface name e.g.:

/etc/luci-uploads/cbid.openvpn.my_vpn.myclient.ovpn

As a first step add your new VPN configuration using a predefinition.

1. New VPN configuration using a predefinition:



Edit your config.ovpn file and make sure that all certificates, key-files, user-name-pass files have the correct path including your config name, here 'my_vpn'.

The prepared 'myclient.ovpn' configuration looks like and is ready for upload:

(uploaded to /etc/luci-uploads/cbid.openvpn.my_vpn. myclient.ovpn)

```
dev tun
persist-tun
persist-key
cipher AES-256-CBC
auth SHA1
tls-client
client
resolv-retry infinite
remote 166.93.10.174 1194 udp
lport 0
verify-x509-name "VPN Server Cert" name
auth-user-pass
/etc/luci-uploads/cbid.openvpn.my\_vpn.auth\_user\_pass
pkcs12
/etc/luci-uploads/cbid.openvpn.my\_vpn.pfelt1-udp-vpnuser\_fg.p12
tls-auth
/etc/luci-uploads/cbid.openvpn.my\_vpn.pfelt1-udp-vpnuser\_fg-tls.key
1
ns-cert-type server
comp-lzo
```

6.1.7.2.3 Manual configuration with web interface

The third method does not use a preconfigured .ovpn file. You will have to enter each single parameter in the web interface. As the service is started, all given parameter are passed to the 'openvpn' program. This method may be useful for fast switching of parameters for server and client.

6.1.7.3 VPN host configuration (on console)

After the VPN client part configuration has been done, it's time to configure the rest of the system and start a first connection. This configuration can be done at console (via SSH) with 'uci' commands.

The openvpn program execution on the CyBox RT 2-A is managed with the '/etc/init.d/openvpn' script.

The following configuration is done at the command prompt:

Create the VPN interface: (if not running server-bridge)

```
uci set network.vpn0=interface
uci set network.vpn0.ifname=tun0
uci set network.vpn0.proto=none
uci set network.vpn0.auto=1
```

Allow inbound VPN traffic:

```
uci add firewall rule
uci set firewall.@rule[-1].name=Allow-OpenVPN-Inbound
uci set firewall.@rule[-1].target=ACCEPT
uci set firewall.@rule[-1].src=\*
uci set firewall.@rule[-1].proto=udp
uci set
`firewall.@rule[-1].dest\_port=1194 <mailto:firewall.@rule[-1].dest_port=1194>`__
```

Allow OpenVPN tunnel utilization: (not needed when bridging using tap)

```
uci set firewall.@zone[-1].input=REJECT
uci set firewall.@zone[-1].forward=REJECT
uci set firewall.@zone[-1].output=ACCEPT
uci set
`firewall.@zone[-1].network=vpn0 <mailto:firewall.@zone[-1].network=vpn0>`__
uci set firewall.@zone[-1].masq=1
uci set firewall.@zone[-1].mtu\_fix=1
uci add firewall forwarding
```

```
uci set firewall.@forwarding[-1].src='lan'
uci set firewall.@forwarding[-1].dest='vpn'
```

Commit the changes:

```
uci commit network
/etc/init.d/network reload
uci commit firewall
/etc/init.d/firewall reload
```

Enable the start flag and setup configuration file:

```
echo > /etc/config/openvpn
uci set openvpn.vpn=openvpn
uci set openvpn.vpn.enabled=1
uci set openvpn.vpn.config='/etc/openvpn/myclient.ovpn'
uci commit openvpn
```

Finally do a first test and start manually the openvpn connection:

```
/etc/init.d/openvpn start
```

Use the 'logread' command to watch the connection progress.

```
Nov 26 15:59:05 CyBoxAP daemon.notice openvpn(vpn)[8040]: OpenVPN 2.3.4
powerpc-openwrt-linux-gnu [SSL (OpenSSL)] [LZO] [EPOLL] [MH] [IPv6]
built on Nov 12 2015

Nov 26 15:59:05 CyBoxAP daemon.notice openvpn(vpn)[8040]: library
versions: OpenSSL 1.0.1i 6 Aug 2014, LZO 2.08

Nov 26 15:59:06 CyBoxAP daemon.notice openvpn(vpn)[8040]: Control
Channel Authentication: using 'pfelt1-udp-vpnuser\_fg-tls.key' as a
OpenVPN static key file

Nov 26 15:59:06 CyBoxAP daemon.notice openvpn(vpn)[8040]: UDPv4 link
local (bound): [undef]

Nov 26 15:59:06 CyBoxAP daemon.notice openvpn(vpn)[8040]: UDPv4 link
remote: [AF\_INET] 166.93.10.174:1194

Nov 26 15:59:06 CyBoxAP daemon.warn openvpn(vpn)[8040]: WARNING: this
configuration may cache passwords in memory -- use the auth-nocache
option to prevent this

Nov 26 15:59:08 CyBoxAP daemon.notice openvpn(vpn)[8040]: [VPN Server
Cert] Peer Connection Initiated with [AF\_INET] 166.93.10.174:1194

Nov 26 15:59:11 CyBoxAP daemon.notice openvpn(vpn)[8040]: TUN/TAP device
tun0 opened

Nov 26 15:59:11 CyBoxAP daemon.notice openvpn(vpn)[8040]: do\_ifconfig,
tt->ipv6=0, tt->did\_ifconfig\_ipv6\_setup=0

Nov 26 15:59:11 CyBoxAP daemon.notice openvpn(vpn)[8040]: /usr/sbin/ip
link set dev tun0 up mtu 1500

Nov 26 15:59:11 CyBoxAP daemon.notice openvpn(vpn)[8040]: /usr/sbin/ip
addr add dev tun0 local 192.168.20.6 peer 192.168.20.5

Nov 26 15:59:11 CyBoxAP daemon.notice netifd: Interface 'vpn0' is
```

```
enabled

Nov 26 15:59:11 CyBoxAP daemon.notice netifd: Network device 'tun0' link
is up

Nov 26 15:59:11 CyBoxAP daemon.notice netifd: Interface 'vpn0' has link
connectivity

Nov 26 15:59:11 CyBoxAP daemon.notice netifd: Interface 'vpn0' is
setting up now

Nov 26 15:59:11 CyBoxAP daemon.notice netifd: Interface 'vpn0' is now up

Nov 26 15:59:11 CyBoxAP daemon.notice openvpn(vpn)[8040]: Initialization
Sequence Completed

Nov 26 15:59:11 CyBoxAP user.notice firewall: Reloading firewall due to
ifup of vpn0 (tun0
```

6.1.8 QoS

In the following example, a networking interface LAN or WLAN is prepared to use the Quality of Service function (QoS). The CyBox RT 2-A implements a QoS function with scripts to configure traffic control (‘tc’ command), which reduces throughput at a selected interface. To see the effect, a performance test can be started with the built-in ‘iperf’ program to measure the throughput.

- Select `Network` → `QoS`
- The default ‘Interface’ WAN is not activated and can be deleted.
    - In box Interfaces enter an existing interface name e.g. ‘lan’ an click button Add
        - Enter 1024 in the Download speed (kbit/s) field
        - Enter 1024 in the Upload speed (kbit/s) field
        - Activate checkbox Enable
    - Click `Save & Apply`

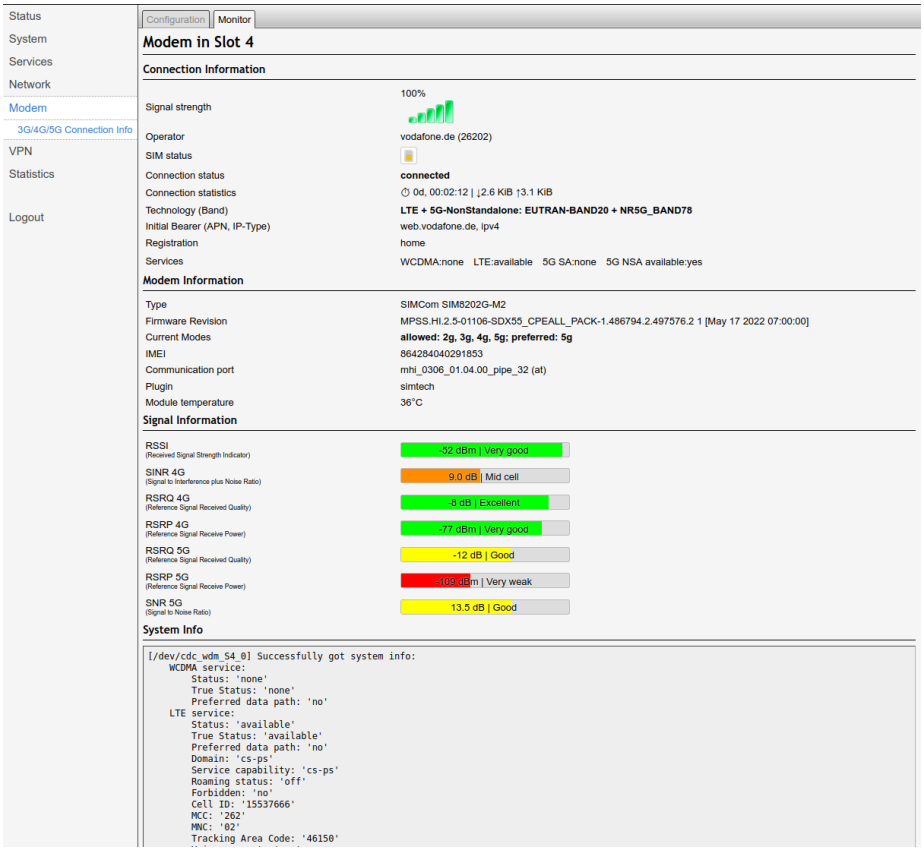
Do an ‘iperf’ performance test. The throughput should be about 10 Mbits/s. If a WLAN interface is bridged with the LAN port, the traffic control can even work on a single part of the bridge. To reduce the wireless traffic only, a new interface label must be added to `Network` → `Interfaces` menu e.g. WLAN. Then the new interface label has to be used in the QoS menu.

6.2 Modem

The **Modem Connection 3G/4G/5G** web page provides status information about a selected modem interface. The information is updated cyclically (about every 10 seconds). This page is divided into four sections, where the first section shows the connection status to the provider and the SIM card data. In the second section static modem parameters are displayed, such as type and firmware version.

The third section shows the current signal strengths as bar graphs. At the end of the page the output of a QMI command function is provided as text. Several QMI command functions can be configured, but only one is displayed at a time.

Modem Monitor

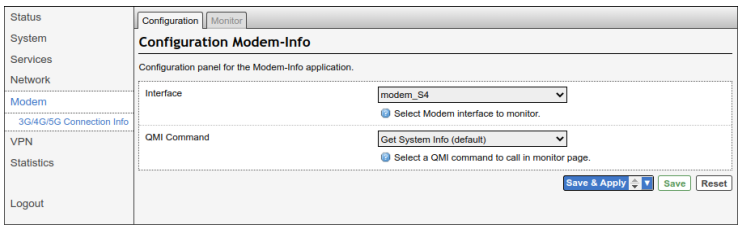


6.2.1 Modem Configuration

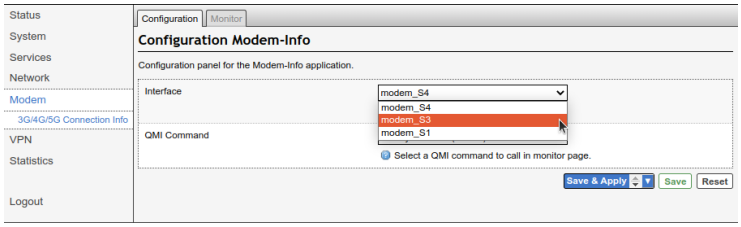
Use the `Modem` → `Modem Connection 3G/4G/5G` → `Configuration` tab to enter the configuration section.

Only one modem interface can be displayed on the monitor page. After a configuration `factory reset` the first modem found in the system is used. Only network modem interfaces can be selected.

Modem Interface Configuration

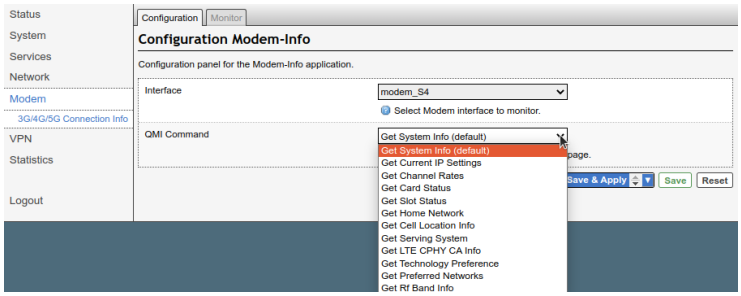


Modem Interface Select



The call of the QMI function, which can be seen on the `Monitor` page, is also selected on the configuration page. With these QMI commands special connection parameters like TAC, LAC, Cell ID, rx/tx data-rates etc. can be read out. For detailed information about these `QMI Command` functions please refer to https://www.freedesktop.org/software/libqmi/man/latest/qmicli.1.html.

QMI Command Select

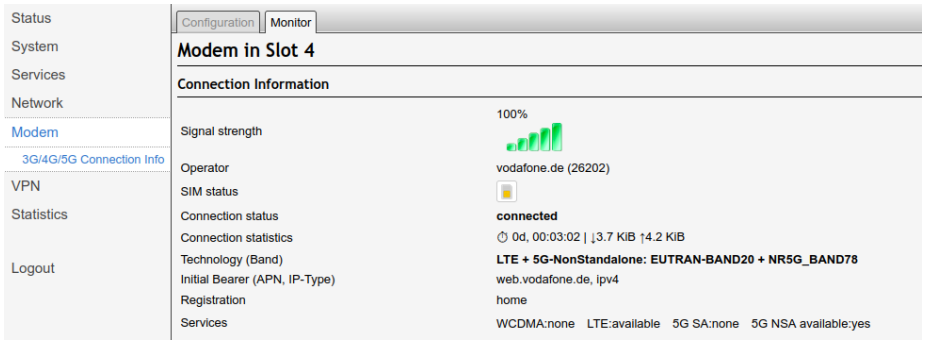


6.2.2 Modem Monitor

Use the `Modem` → `Modem Connection 3G/4G/5G` → `Monitor` tab to enter the monitoring section.

6.2.2.1 Connection Information

Modem Connection Section



The signal strength is shown here in percent as an increasing bar graph. The basis for the display is the measured **RSSI** value. The display is always shown, even if no provider is connected.

If the connection was successful, the provider and the *mobile country codes (MCC)* as well as *mobile network codes (MNC)* are displayed in brackets in the operator line.

In the connection status line shows the individual phases of the connection establishment such as **searching, registered, connected, …** but also a possible error message such as for example: **SIM missing**.

The connection statistics shows the duration of the connection and the amount of data for download and upload.

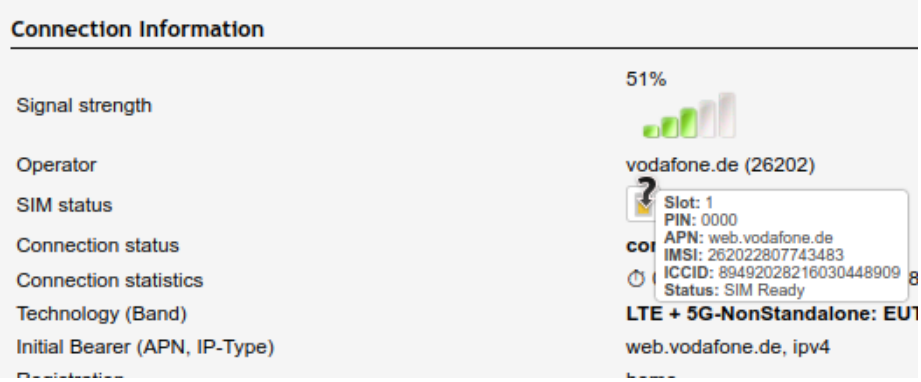
In the technology line the the 3G/4G/5G network registration mode and the occupied frequency bands are displayed. The type of network registration can also change within the **connected** phase without the connection being interrupted. e.g. `LTE+5GNSA => LTE => LTE+5GNSA`.

The next two lines show the APN used, the IP type and the registration mode (here: home).

The last line provides information about the registered cell and the services available in it, such as **WCDMA, UMTS, LTE, 5G-SA and 5G-NSA**. The availability of a certain service does not mean, however, that this service mode is also registered. For example, a 5G connection will not be established without a corresponding SIM card contract.

To display the SIM card information, move the mouse cursor over the SIM card icon. The used SIM **card slot**, the corresponding **PIN** and **APN** are read from the current configuration for the selected modem interface. The **Status** of the SIM card is listed in last line, is normally **SIM Ready**, but may also indicate a card problem e.g. Card busy, PIN error, …

Modem SIM Card Information

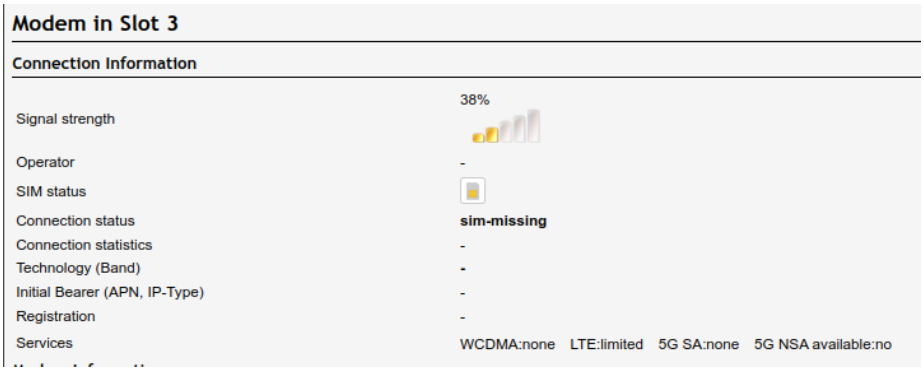


The **IMSI** number stands for International Mobile Subscriber Identity. That uniquely identifies every user of a cellular network. It is stored as a 64-bit field and is sent by the mobile device to the network.

The **ICCID** stands for Integrated Circuit Card Identification Number. It's a unique 18-22 digit code that includes a SIM card's country, home network, and identification number. Usually the ICCID is printed on the back of a SIM card, but sometimes it's included in the packaging materials instead.

If no SIM card is installed for a modem interface or if there is no configuration, the modem still returns the signal strength values.

Modem SIM Card Missing



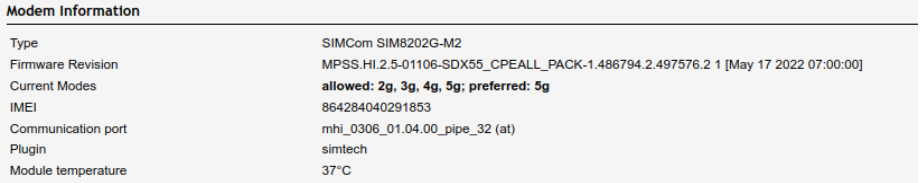
6.2.2.2 Modem Information

The modem information section displays the type of modem and the active modem firmware version. The **Current Modes** line shows the connection technologies currently allowed and preferred in the modem.

The communication port, which is used to send AT-Commands to the modem, and the software plugin are defined by the ModemManager. The module temperature is e.g. read out by an AT-Command.

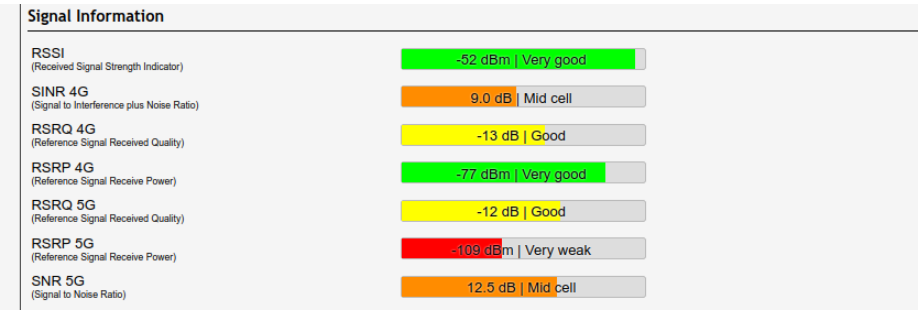
The **EMEI** (International Mobile Station Equipment Identity) is a 15-digit serial number that is used to uniquely identify each GSM or UMTS terminal worldwide.

Modem Static Information



6.2.2.3 Signal Information

Modem Signal Information



RSSI (Signal strength) The signal strength value indicates the level of the signal received by the modem. These values correspond to the RSSI (Received Signal Strength Indication) readings of the connection. The value is measured in *[dBm]*. RSSI is typically displayed in a range from -94 dBm (very weak) up to >74 dBm (very good).

SINR 4G (Signal Interference + Noise Ratio), is the ratio of the signal level to the noise level (or simply the signal-to-noise ratio). The SINR value is measured in *[dB]* and ranges from 0 very low (cell edge) to 21 and higher (excellent). It is quite simple: the higher the value, the better the signal quality. With SINR values below 0, the connection speed is very low (cell edge), as this means that the received signal contains more noise than the useful part, and there is also a probability of losing an LTE connection.

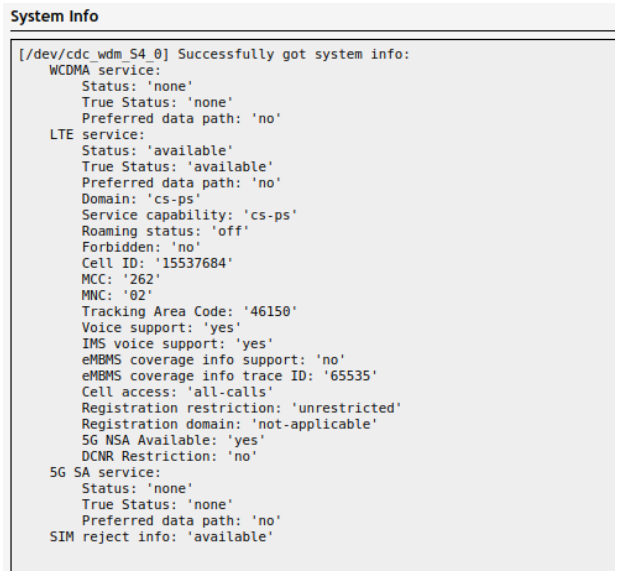
RSRQ 4G/5G (Reference Signal Received Quality) The RSRQ is a calculated ratio value that results from the value for RSRP and the RSSI. It is enormously important for assessing the reception quality of a 5G or LTE connection. The value is measured in *[dBm]*. RSRQ is typically displayed in a range from -19 dB (cell edge) up to -9 dB (excellent).

RSRP 4G/5G (Reference Signal Received Power) The average power of the received pilot signals (Reference Signal) or the level of the received signal from the Base Station. The RSRP value is measured in *[dBm]*. RSRP is typically displayed in a range from -100 dB (very weak) up to >79 dB and higher (very good).

SNR 5G (Signal to Noise Ratio) It is the ratio of signal power to that of all other electrical signals in the area, known as the noise level. Noise is measured by the Root-Mean-Square (RMS) value of the fluctuations over time. This ratio is expressed in decibels *[dB]*. With SNR value is only shown for 5G environments and ranges from <=15 dB (cell edge) up to >=40 dB (excellent).

6.2.2.4 QMI Command Information

QMI Command Output

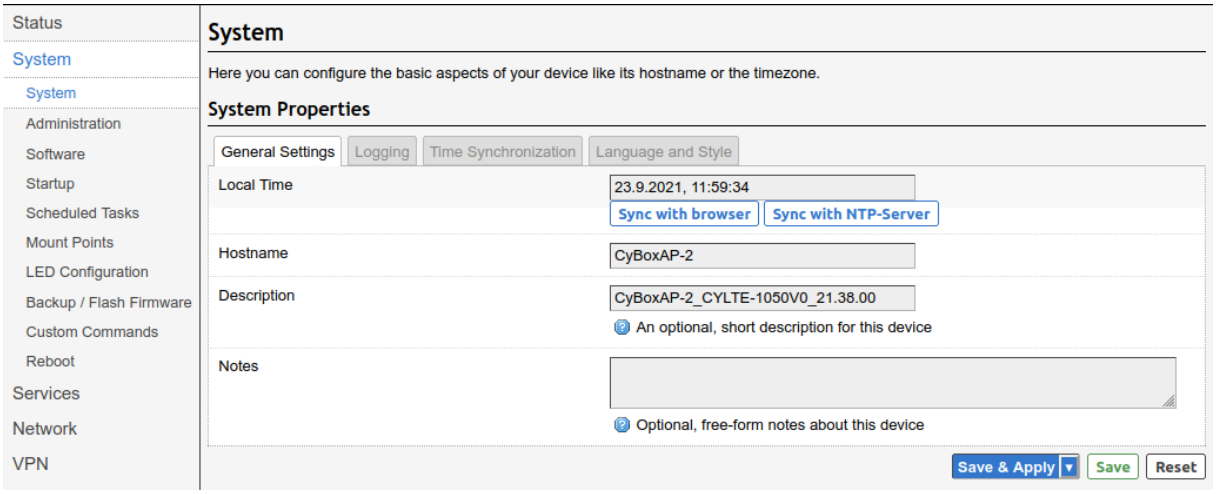


This text area shows the QMI function call returned output. For detailed information about qmilib functions please refer to https://www.freedesktop.org/software/libqmi/man/latest/qmicli.1.html.

6.3 System

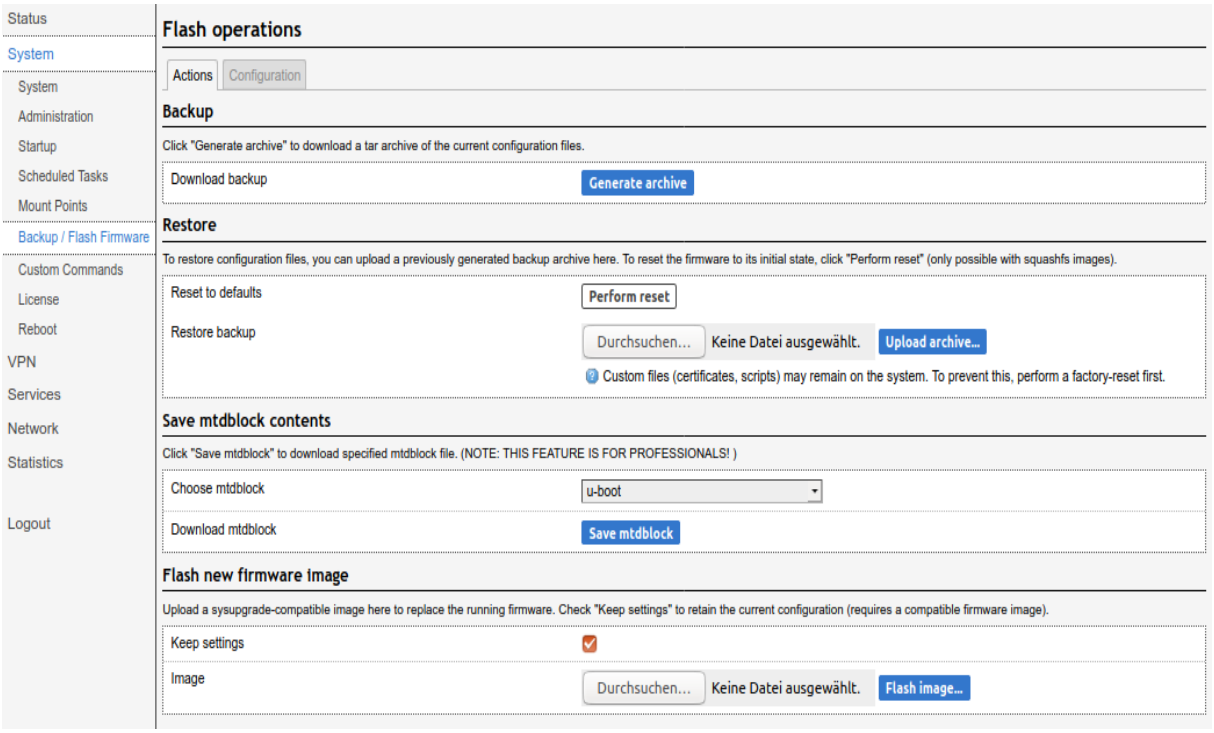
6.3.1 System Properties

The **System Properties** are managed in the tab `System` → `System`. These menus handle logging options, NTP time synchronisation and the appearance, language of the web interface. In the `General Settings` tab the operating system time, that is always stored as UTC time can be synchronized with current browser time. Note that the shell console time, of a serial or a remote SSH connection, is always reported as UTC time stamp.



6.3.2 Configuration Backups

Configuration is managed in the tab `System` → `Backup/Flash Firmware`.



Configuration Backup Settings

a. Restore factory settings

Perform reset restores factory settings and performs a reboot.

b. Export configuration

Use the Generate archive button to export a configuration backup.

The generated configuration tar archive is not hardware-specific and may be distributed to other access points, as long as they share the same model and the same firmware version.

Note: Configuration archives are not compatible between firmware revisions 4.x and 17.xx.yy.

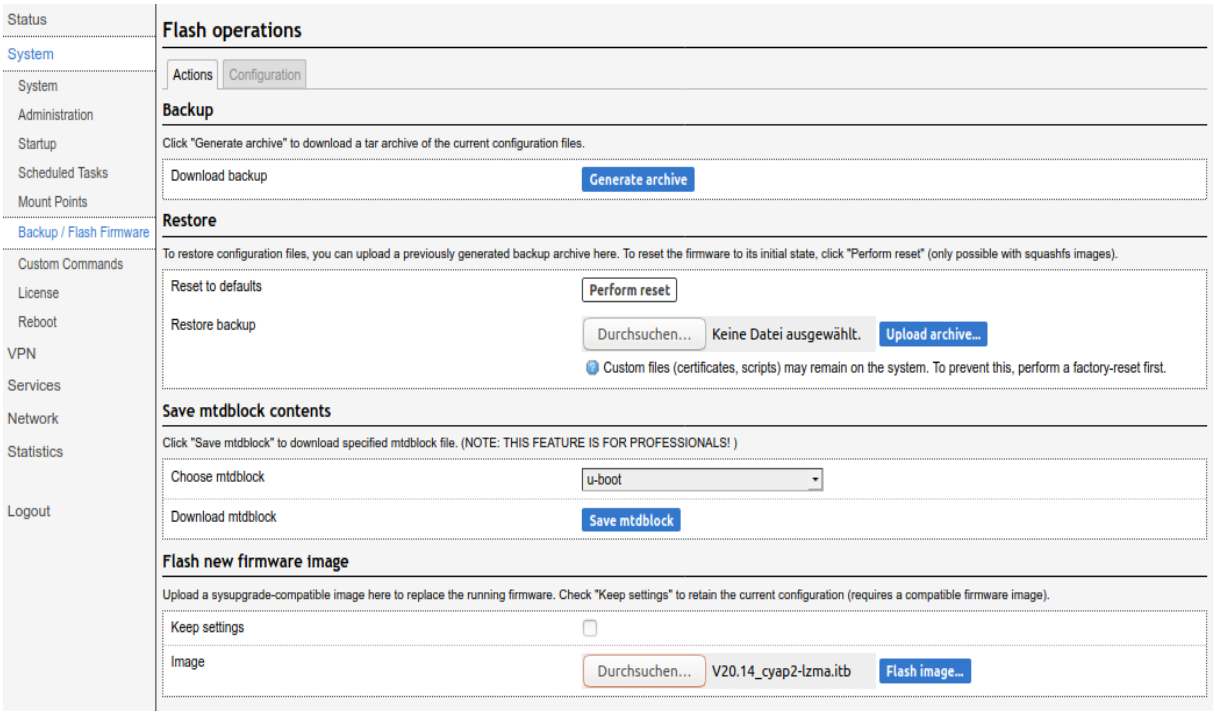
With the Upload archive… button you can restore a previously saved configuration. After restoring a configuration, the access point will reboot.

c. Import configuration

Before restoring a configuration archive, make sure that the factory settings have been restored in order to avoid any conflict between your old and new configuration. The configuration file must be named according to the pattern backup-*.tar.gz and can then be uploaded in the Restore backup field.

6.3.3 Firmware Upgrade

The procedure to update the device firmware with a new image is shown below.



Firmware Update Settings

Firmware Updates are provided as binary images with the extension .itb and will be uploaded from the host computer. Keep settings should always be **cleared** to ensure not to mixup old and new config switches. The uploaded image has a MD5 checksum that must be confirmed in the following dialog.

WARNING: Do NOT POWER OFF the access point while upgrading/restoring firmware to flash. Remember that if ``Keep settings`` checkbox is cleared, the device will revert to its network default address after restart.

6.3.4 Reboot

The device can be rebooted on the `System` → `Reboot` tab.

6.3.5 Reset Button

The operations which can be done with the reset button are: reboot, triggering the emergency mode, restoring factory settings.

a. Restore factory settings

After booting, a factory reset can be triggered by pressing the reset button with a pin for more than 5 seconds. The Fail LED will blink in green and after a few seconds the device will reboot with the default configuration.

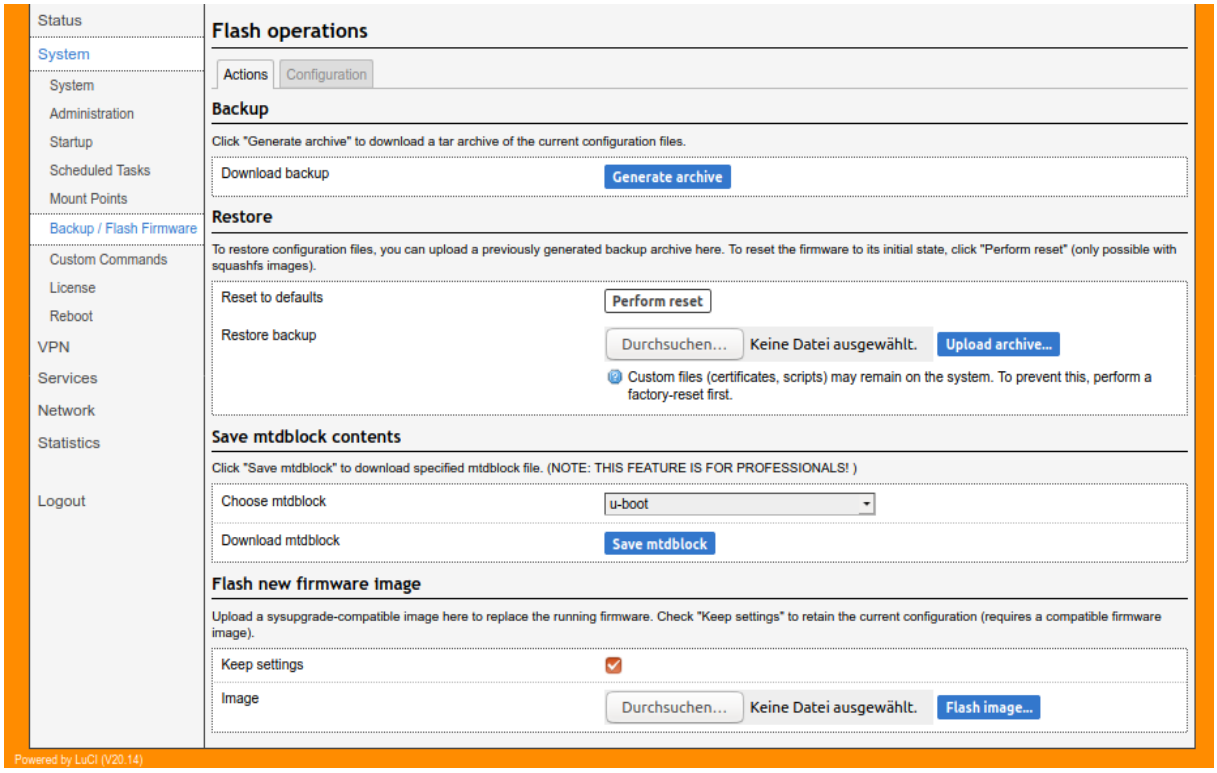
A reboot can be triggered by pressing the reset button with a pin for less than 2 seconds.

6.3.6 Emergency Mode

Emergency mode should only be needed in case of system firmware upgrade or crash restore.

The CyBox AP family uses at least five partitions in flash memory. The first flash device contains the low level firmware U-Boot. The second flash device holds an emergency image of OpenWrt/Linux and the third device contains the standard image of OpenWrt/Linux. The fourth flash device contains a journaling flash file system partition with user configuration settings and a customer partition. Normally the standard OpenWrt/Linux image is loaded with U-Boot and checked with MD5 sum against errors. If checksums are valid the linux boots and access point service starts. User configuration parameters are loaded and applied from the JFFS partition.

In case of a damaged standard image (OpenWrt/Linux in third flash) U-Boot detects a MD5 checksum error and tries to start the emergency system image from second flash. While booting no user configuration settings are applied. The CyBox RT 2-A comes up with network default address 192.168.100.1 (user=root, password=root) and Wifi disabled. The Fail LED blinks orange (red and green on) and the web interface background is orange, as Figure indicates. All configuration settings are volatile. This system should only be used to Upgrade/Restore a working firmware image to second flash via *Backup / Flash Firmware* menu.



Emergency System Indication

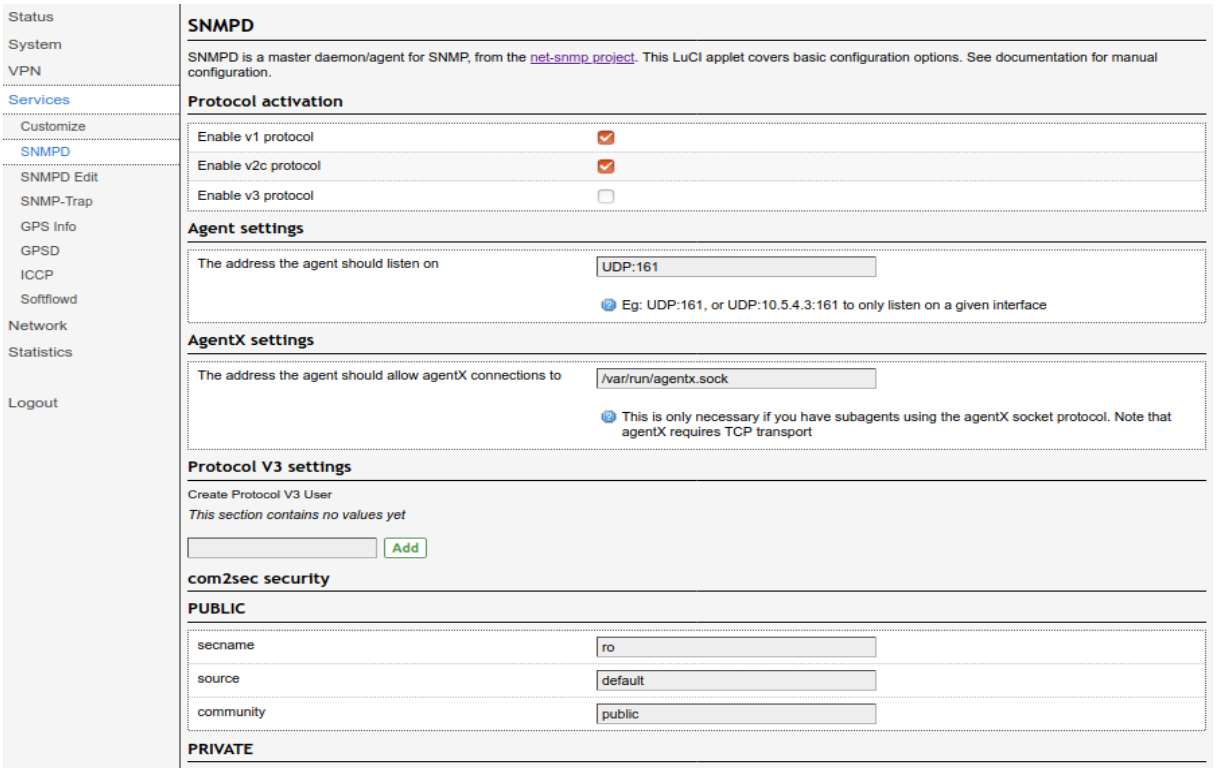
Emergency mode can also be entered by holding the reset button pressed for 5 seconds at the beginning of the boot phase.

Note: Normally, the blue background indicates the standard mode and the orange background indicates emergency mode. But many web browsers keep the colours in cache, which means that the wrong colour can be displayed. To ensure that the correct one is shown, open a new window in private or incognito mode before consulting the web interface.

7 SNMP

7.1 SNMP Protocol Support

Firmware implementations before 2020 only have protocol support for version **v1** and **v2c**. Since 2020 the SNMP protocol **v3** is also included in every CyBox firmware. The **v1**, **v2c** protocol variants are present with factory default setup. In factory default setup only `read` access is permitted.



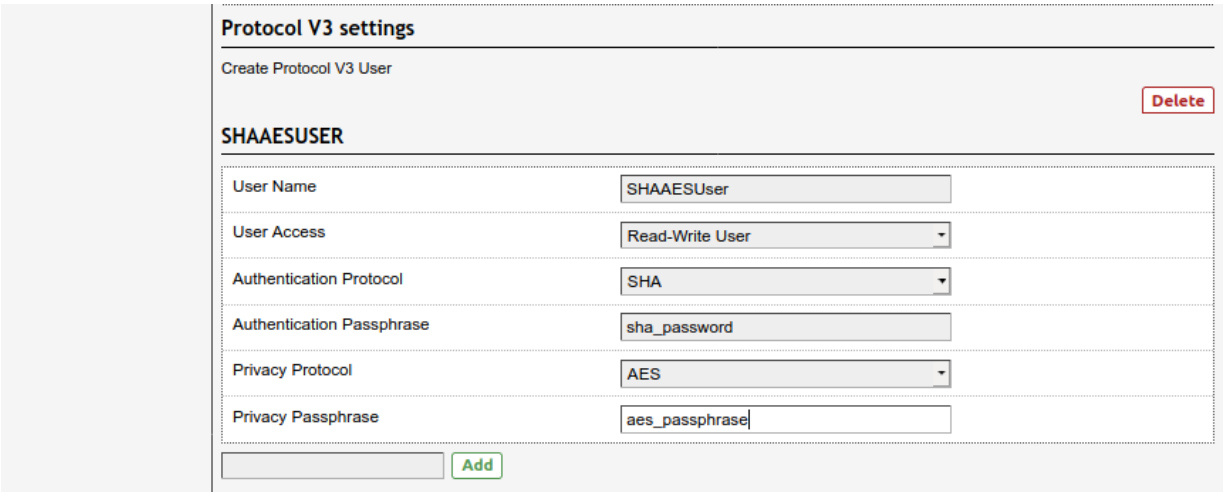
SNMPD factory default settings with protocol v1 and v2c enabled

7.2 SNMP V3 Protocol Support

Before any **v3** protocol access can be executed one or more V3 User Accounts have to be created. To add a new **v3** User Account, the name must be entered `case sensitve`. Later the WUI is showing the User Account name in upper case.

Add new v3 User Account

The new User Account can be created as `read-only`, or with `read-write` permission. The authentication protocol is either **MD5** or **SHA** (preferred). If a authentication protocol is selected the authentication passphrase must also be given. For data paket encryption select **DES** or **AES** (preferred) and also apply a passphrase. For demonstration use the same settings as in figure below to copy and paste them in examples.



Demo user account settings

The default protocols **v1** and **v2c** should be disabled, when using SNMP-V3 protocol.

Activate only SNMP-V3 protocol

After all new settings are entered press the `Save & Apply`. Then the SNMPD service will restarted automatically.

7.2.1 SNMP V3 Protocol Examples

Read access with **snmpget**: `Get order identifier`

The command:

```
snmpget  -v 3 -n "" -u SHAAESUser -a SHA -A "sha_password" -x AES -X "aes_passphrase" -l authPriv
192.168.100.1     1.3.6.1.4.1.2021.8.1.2.100.101.1
```

Returns:

```
iso.3.6.1.4.1.2021.8.1.2.100.101.1 = STRING: "CYAPW-1057P0"
```

Read access with **snmpwalk**: `Get firmware version`

The command:

```
snmpwalk  -v 3 -n "" -u SHAAESUser -a SHA -A "sha_password" -x AES -X "aes_passphrase" -l authPriv
192.168.100.1     1.3.6.1.4.1.2021.8.1.2.103
```

Returns:

```
iso.3.6.1.4.1.2021.8.1.2.103.1.1 = INTEGER: 1
iso.3.6.1.4.1.2021.8.1.2.103.2.1 = STRING: "firmware_version"
iso.3.6.1.4.1.2021.8.1.2.103.3.1 = STRING: "/usr/bin/eltec_version"
```

```
iso.3.6.1.4.1.2021.8.1.2.103.100.1 = INTEGER: 0
iso.3.6.1.4.1.2021.8.1.2.103.101.1 = STRING: "20.14"
iso.3.6.1.4.1.2021.8.1.2.103.102.1 = INTEGER: 0
iso.3.6.1.4.1.2021.8.1.2.103.103.1 = ""
```

Write access with **snmpset**: `Set a new system hostname and reload system settings`

Use the following sequence to set the new hostname:

```
snmpset  -v 3 -n "" -u SHAAESUser -a SHA -A "sha_password" -x AES -X "aes_passphrase" -l authPriv
192.168.100.1    1.3.6.1.4.1.2021.8.1  s "uci set system.@system[0].hostname=Brutus"

iso.3.6.1.4.1.2021.8.1 = STRING: "uci set system.@system[0].hostname=Brutus"

snmpset  -v 3 -n "" -u SHAAESUser -a SHA -A "sha_password"  -x AES -X "aes_passphrase" -l authPriv
192.168.100.1    1.3.6.1.4.1.2021.8.1  s "uci commit system"

iso.3.6.1.4.1.2021.8.1 = STRING: "uci commit system"

snmpset  -v 3 -n "" -u SHAAESUser -a SHA -A "sha_password"-x AES -X "aes_passphrase" -l authPriv
192.168.100.1    1.3.6.1.4.1.2021.8.1  s "service system reload"

iso.3.6.1.4.1.2021.8.1 = STRING: "service system reload"
```

The new system hostname can be checked on web Status page.

7.3 SNMP Basic Functions

The SNMP service is included in CyBox RT 2-A Starting with firmware Version 2.6. The service is enabled, if a valid configuration file '/etc/config/snmpd' is present and service startup is not disabled. On system start this configuration file is parsed and translated into a 'snmpd.conf' file which is required by the SNMP daemon. The 'snmpd.conf' is stored in '/var/run' and a symbolic link is available under '/etc/snmp'.

There is a basic web interface provided for SNMP private / public configuration under Services → SNMPD. The whole configuration file is quite large (~120KB) and can be modified on command line with UCI commands or by editing the configuration file with Services → SNMPD-Edit edit window. The current implementation is automatically generated from a build script.

The OpenWrt default configuration provides a set of standard MIB files with OID .1.3.6.1.2.1 (iso.org.dod.internet.mgmt.mib-2). ELTEC also provides an extension for the default configuration, using the UC DAVIS (University of California, Davis) MIB object (UCD-SNMP-MIB MIB document as .1.3.6.1.4.1.2021) to map many configuration settings with a wrapper shell for reading '/usr/sbin/get_snmp' and one for writing '/usr/sbin/get_snmp' single entries in the configuration files located under '/etc/config'. The 'get_snmp' script provides also information about WLAN to SSID assignment, WLAN bitrates, signal quality, etc. Most of this information is gained via UCI commands for reading and writing system configuration settings.

/etc/snmp/snmpd.conf # Symlink to SNMPD config file (automatically created)

/etc/config/snmpd # OpenWrt configuration file

See Appendix 10 for a SNMP command OID overview.

7.4 SNMP Read and Write Authorizations

The CyBox RT 2-A runs a local SNMP daemon, which currently is configured for two access groups:

- By default, group "public" allows unrestricted read-only access
- Group "private" allows a single specified host to read and write. By default, "localhost" is specified i.e. only the local administrative user on CyBox RT 2-A is allowed for SNMP write operations.

This address can be changed by means of an UCI command. Assuming to be logged-in on a CyBox RT 2-A via SSH as administrative user, the following command would allow re-specifying the IP address of the “private” group:

```
root@CyBoxAP:~# uci set snmpd.private.source=<ccu>
root@CyBoxAP:~# uci commit snmpd
root@CyBoxAP:~# /etc/init.d/snmpd restart
```

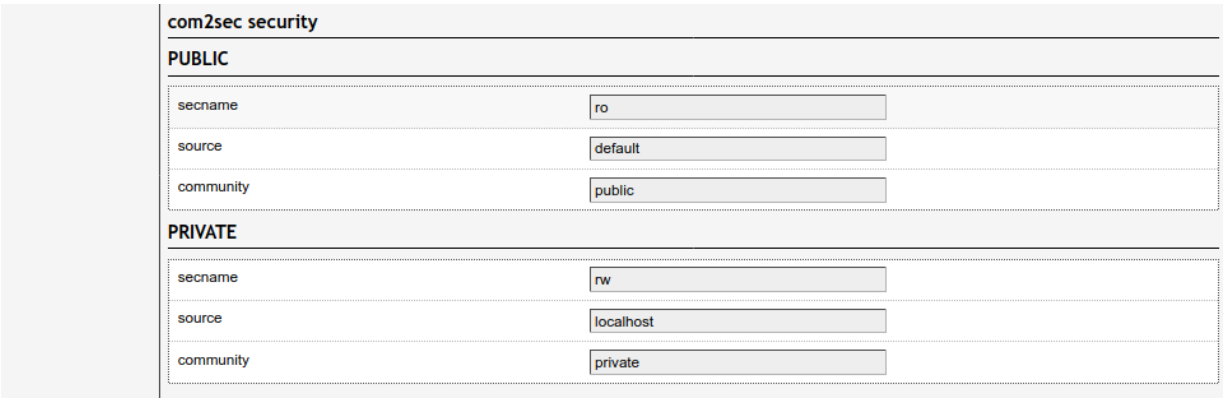
Where <*ccu*> refers to the IP address (or hostname) of the remote host which is allowed to perform SNMP write operations. The keyword “default” instead of a specific address allows any hosts to access the SNMP demon.

Similarly, the address of the “public” group can be changed:

```
root@CyBoxAP:~# uci set snmpd.public.source=<ccu>
root@CyBoxAP:~# uci commit snmpd
root@CyBoxAP:~# /etc/init.d/snmpd restart
```

Note: Generally local UCI commands on the CyBox RT 2-A should be used for handling the configuration of the SNMP demon. Run ’*uci show snmpd’* to view the current settings.

Alternatively, the public and private sources can be modified with the web interface in the field ‘*com2sec security*’ of the tab ‘*Services’* → ‘*SNMPD*’.



SNMPD change ‘com2sec security’ for write access

7.5 SNMP Commands

The CyBox RT 2-A SNMP demon supports the following commands:

- snmpget
- snmpset
- snmpstatus
- snmptest
- snmptrap
- snmpwalk

A special case arises when snmpset writes to non-MIB extensions. In this case, there is an asymmetry between snmpget and snmpset with respect to OIDs. Reading (snmpget) requires the complete numeric identifier including the server-specific extension. Writing (snmpset) accepts only the “extEntry” trunk “iso.3.6.1.4.1.2021.8.1”, while the server-specific name of the object must be passed as first argument.

The assignment of names and OID numbers can be found by executing snmpwalk.

7.6 SNMP Read (snmpwalk and snmpget)

The following chapters describe the read and write access via console commands.

7.6.1 Reading System Information

```
boardname 1.3.6.1.4.1.2021.8.1.2.100
serial_number 1.3.6.1.4.1.2021.8.1.2.101
uboot_version 1.3.6.1.4.1.2021.8.1.2.102
firmware_version 1.3.6.1.4.1.2021.8.1.2.103
config_version 1.3.6.1.4.1.2021.8.1.2.104
uptime 1.3.6.1.4.1.2021.8.1.2.105
loadavg 1.3.6.1.4.1.2021.8.1.2.106
temperature 1.3.6.1.4.1.2021.8.1.2.107
uci_get 1.3.6.1.4.1.2021.8.1.2.108
custom1 1.3.6.1.4.1.2021.8.1.2.109
custom2 1.3.6.1.4.1.2021.8.1.2.110
custom3 1.3.6.1.4.1.2021.8.1.2.111
mpstat 1.3.6.1.4.1.2021.8.1.2.112
```

The command

```
snmpwalk -c public -v 2c 192.168.100.1 1.3.6.1.4.1.2021.8.1.2.100
```

will deliver

```
iso.3.6.1.4.1.2021.8.1.2.100.1.1 = INTEGER: 1
iso.3.6.1.4.1.2021.8.1.2.100.2.1 = STRING: "boardname"
iso.3.6.1.4.1.2021.8.1.2.100.3.1 = STRING: "/bin/cat /tmp/sysinfo/eeprom/BOARDNAME"
iso.3.6.1.4.1.2021.8.1.2.100.100.1 = INTEGER: 0
iso.3.6.1.4.1.2021.8.1.2.100.101.1 = STRING: "CYAP.-V-W8IRQWWEUPX"
iso.3.6.1.4.1.2021.8.1.2.100.102.1 = INTEGER: 0
iso.3.6.1.4.1.2021.8.1.2.100.103.1 = ""
```

MIB name:

```
iso.3.6.1.4.1.2021.8.1.2.100.2.1 = STRING: "boardname"
```

Function executed on CyBox RT 2-A:

```
iso.3.6.1.4.1.2021.8.1.2.100.3.1 = STRING: "/bin/cat /var/BOARDNAME"
```

Error code from function call:

```
iso.3.6.1.4.1.2021.8.1.2.100.100.1 = INTEGER: 0
```

Return value from function call:

```
iso.3.6.1.4.1.2021.8.1.2.100.101.1 = STRING: "CYAP.-V-W8IRQWWEUPX"
```

7.6.2 Reading SNMP Object Information

The main problem to access a network device (WLAN or LAN) is that the listing order depends on the creation order made by user when the config file is being edited. The fact that network/interface naming is free to choose and that UCD MIB object names are static, makes it necessary to use predefined names like:

- network0, network1 … network9

- wireless0, wireless1 … wireless19

Note: A normal CyBox RT 2-A configuration consists of six wireless interfaces, but there are up to twenty interfaces possible, so snmpwalk will result in up to 80 percent of undefined (Empty UCI entry) values.

The following objects are available to determine the actual network/wireless ordering.

7.6.2.1 Readout current Network Device Order

The command

```
snmpwalk -c public -v 2c 192.168.100.1 1.3.6.1.4.1.2021.8.1.2.150
```

delivers

```
iso.3.6.1.4.1.2021.8.1.2.150.1.1 = INTEGER: 1
iso.3.6.1.4.1.2021.8.1.2.150.2.1 = STRING: "network_order"
iso.3.6.1.4.1.2021.8.1.2.150.3.1 = STRING: "/etc/snmp/get_cyboxap network_order"
iso.3.6.1.4.1.2021.8.1.2.150.100.1 = INTEGER: 0
iso.3.6.1.4.1.2021.8.1.2.150.101.1 = STRING: "loopback=lo" **<--- network0**
iso.3.6.1.4.1.2021.8.1.2.150.101.2 = STRING: "lan=eth0" **<--- network1**
iso.3.6.1.4.1.2021.8.1.2.150.101.3 = STRING: "vlan007=eth0.7" **<--- network2**
iso.3.6.1.4.1.2021.8.1.2.150.101.4 = STRING: "vlan123=eth0.123" **<--- network3**
iso.3.6.1.4.1.2021.8.1.2.150.101.5 = STRING: "vlan500=eth0.500" **<--- network4**
iso.3.6.1.4.1.2021.8.1.2.150.101.6 = STRING: "cfg_net=eth0.999" **<--- network5**
iso.3.6.1.4.1.2021.8.1.2.150.102.1 = INTEGER: 0
iso.3.6.1.4.1.2021.8.1.2.150.103.1 = ""
```

Example:

IP address of LAN interface ‘cfg_net’ will be (network5 starts at 550):

```
network5.ipaddr 1.3.6.1.4.1.2021.8.1.2.552
```

The command

```
snmpget -c public -v 2c 192.168.100.1 1.3.6.1.4.1.2021.8.1.2.552.101.1
```

delivers

```
iso.3.6.1.4.1.2021.8.1.2.552.101.1 = STRING: "192.168.99.98"
```

7.6.2.2 Readout SSID / WIFI Interface Order

The following command shows the order of the Wifi interfaces.

```
snmpwalk -c public -v 2c 192.168.100.1 1.3.6.1.4.1.2021.8.1.2.151
iso.3.6.1.4.1.2021.8.1.2.151.1.1 = INTEGER: 1
iso.3.6.1.4.1.2021.8.1.2.151.2.1 = STRING: "ssid_order"
iso.3.6.1.4.1.2021.8.1.2.151.3.1 = STRING: "/etc/snmp/get_cyboxap ssid_order"
iso.3.6.1.4.1.2021.8.1.2.151.100.1 = INTEGER: 0
iso.3.6.1.4.1.2021.8.1.2.151.101.1 = STRING: "CyAP0_00486889_00486886_EST0" **<--- wireless0**
iso.3.6.1.4.1.2021.8.1.2.151.101.2 = STRING: "Guest_007" **<--- wireless1**
iso.3.6.1.4.1.2021.8.1.2.151.101.3 = STRING: "CyAP0_00486889_00486886_vlan007" **<--- wireless2**
iso.3.6.1.4.1.2021.8.1.2.151.101.4 = STRING: "CyAP0_00486889_00486886_vlan123**" <--- wireless3**
iso.3.6.1.4.1.2021.8.1.2.151.101.5 = STRING: "CyAP0_00486889_00486886_vlan500" **<--- wireless4**
iso.3.6.1.4.1.2021.8.1.2.151.101.6 = STRING: "CyAP0_00486889_00486886_cfg_net" **<--- wireless5**
iso.3.6.1.4.1.2021.8.1.2.151.101.7 = STRING: "Guest_123" **<--- wireless6**
iso.3.6.1.4.1.2021.8.1.2.151.101.8 = STRING: "VIP_500" **<--- wireless7**
```

```
iso.3.6.1.4.1.2021.8.1.2.151.102.1 = INTEGER: 0
iso.3.6.1.4.1.2021.8.1.2.151.103.1 = ""
```

7.6.2.3 Readout Network Device to SSID Assignment

The following command shows the order of the Wifi interfaces.

```
snmpwalk -c public -v 2c 192.168.100.1 1.3.6.1.4.1.2021.8.1.2.152
iso.3.6.1.4.1.2021.8.1.2.152.1.1 = INTEGER: 1
iso.3.6.1.4.1.2021.8.1.2.152.2.1 = STRING: "wlan_ssid"
iso.3.6.1.4.1.2021.8.1.2.152.3.1 = STRING: "/etc/snmp/get_cyboxap wlan_ssid"
iso.3.6.1.4.1.2021.8.1.2.152.100.1 = INTEGER: 0
iso.3.6.1.4.1.2021.8.1.2.152.101.1 = STRING: "wlan0 : \\"CyAP0_00486889_00486886_EST0\\""
iso.3.6.1.4.1.2021.8.1.2.152.101.2 = STRING: "wlan0-1 : \\"CyAP0_00486889_00486886_vlan007\\""
iso.3.6.1.4.1.2021.8.1.2.152.101.3 = STRING: "wlan0-2 : \\"CyAP0_00486889_00486886_vlan123\\""
iso.3.6.1.4.1.2021.8.1.2.152.101.4 = STRING: "wlan0-3 : \\"CyAP0_00486889_00486886_vlan500\\""
iso.3.6.1.4.1.2021.8.1.2.152.101.5 = STRING: "wlan0-4 : \\"CyAP0_00486889_00486886_cfg_net\\""
iso.3.6.1.4.1.2021.8.1.2.152.101.6 = STRING: "wlan1 : \\"Guest_007\\""
iso.3.6.1.4.1.2021.8.1.2.152.101.7 = STRING: "wlan1-1 : \\"Guest_123\\""
iso.3.6.1.4.1.2021.8.1.2.152.101.8 = STRING: "wlan1-2 : \\"VIP_500\\""
iso.3.6.1.4.1.2021.8.1.2.152.102.1 = INTEGER: 0
iso.3.6.1.4.1.2021.8.1.2.152.103.1 = ""
```

Note 1: This assignment may change every time a specific SSID is disabled or enabled and the wireless interface is restarted. The corresponding Linux WLAN device for a SSID is needed to readout current assoclist, bitrates and signal quality values.

Note 2: The order/assignment functions 150, 151 and 152 should not be polled in an application, since they require some CPU resources. The network status should only be readout once after system start and every time operator causes a change in the network layout.

Example:

Readout assoclist, bitrate and signal quality from wlan0-2 (CyAP0_00486889_00486886_vlan123)

```
assoclist_wlan0-2 1.3.6.1.4.1.2021.8.1.2.202
bitrate_wlan0-2 1.3.6.1.4.1.2021.8.1.2.242
signal_wlan0-2 1.3.6.1.4.1.2021.8.1.2.282
```

The command

```
snmpget -c public -v 2c 192.168.100.1 1.3.6.1.4.1.2021.8.1.2.202.101.1
```

returns the assoclist

```
iso.3.6.1.4.1.2021.8.1.2.202.101.1 = STRING: "06:0E:8E:67:08:64"
```

The command

```
snmpget -c public -v 2c 192.168.100.1 1.3.6.1.4.1.2021.8.1.2.242.101.1
```

returns the bitrate information

```
iso.3.6.1.4.1.2021.8.1.2.242.101.1 = STRING: "65.0 Mbit/s"
```

The command

```
snmpget -c public -v 2c 192.168.100.1 1.3.6.1.4.1.2021.8.1.2.282.101.1
```

returns the signal quality information

```
iso.3.6.1.4.1.2021.8.1.2.282.101.1 = STRING: "Link Quality: 70/70 Signal: -33 dBm Noise: -95 dBm "
```

7.7 SNMP Write (snmpset)

By default all SNMP write control is restricted to localhost. Refer to chapter 8.1 to enable write access.

A write command to the CyBox RT 2-A is always done on the same UCD MIB OID '1.3.6.1.4.1.2021.8.1'. The write operation requires a string parameter, which is parsed with '/etc/snmp/set_cyboxap' and translated into a system internal call on the CyBox RT 2-A. Consider that all writes to a configuration item are permanently stored in the overlay file system and will be present after next power cycle.

Usage of the SNMPSET system call:

```
snmpset -c private -v 2c <IPv4> 1.3.6.1.4.1.2021.8.1 s <command string or set entry string>
```

The given parameter string can be for example:

Command Type	Parameter String
Direct command	"radio0_up" "radio0_down" "modem0_up" "modem0_down" … see Appendix for all commands "reboot"
System service action	"service <name> <action>"
UCI configuration call	"uci <command> <config>.<section> [<option>]=<value>"
Configuration set to new value	"network<index>.<entry> <value>" "radio<index>.<entry> <value>" "wireless<index>.<entry> <value>"

7.7.1 Direct command

7.7.1.1 Reboot

```
snmpset -c private -v 2c 192.168.100.1 1.3.6.1.4.1.2021.8.1 s "reboot"
```

7.7.2 Edit configuration using Object Identifier (OID)

7.7.2.1 Set a new IP address

```
snmpset -c private -v 2c 192.168.100.1 1.3.6.1.4.1.2021.8.1 s "network5.ipaddr 192.168.20.20"
snmpset -c private -v 2c 192.168.100.1 1.3.6.1.4.1.2021.8.1 s "uci commit network"
snmpset -c private -v 2c 192.168.100.1 1.3.6.1.4.1.2021.8.1 s "service network reload"
```

7.7.2.2 Set a new SSID

```
snmpwalk -c public -v 2c 192.168.100.1 1.3.6.1.4.1.2021.8.1.2.151
iso.3.6.1.4.1.2021.8.1.2.151.1.1 = INTEGER: 1
iso.3.6.1.4.1.2021.8.1.2.151.2.1 = STRING: "ssid_order"
iso.3.6.1.4.1.2021.8.1.2.151.3.1 = STRING: "/etc/snmp/get_cyboxap ssid_order"
iso.3.6.1.4.1.2021.8.1.2.151.100.1 = INTEGER: 0
iso.3.6.1.4.1.2021.8.1.2.151.101.1 = STRING: "CyAP0_00486889_00486886_EST0"
iso.3.6.1.4.1.2021.8.1.2.151.101.2 = STRING: "Guest_007"
iso.3.6.1.4.1.2021.8.1.2.151.101.3 = STRING: "CyAP0_00486889_00486886_vlan007"
iso.3.6.1.4.1.2021.8.1.2.151.101.4 = STRING: "CyAP0_00486889_00486886_vlan123"
iso.3.6.1.4.1.2021.8.1.2.151.101.5 = STRING: "CyAP0_00486889_00486886_vlan500"
iso.3.6.1.4.1.2021.8.1.2.151.101.6 = STRING: "CyAP0_00486889_00486886_cfg_net"
iso.3.6.1.4.1.2021.8.1.2.151.101.7 = STRING: "Guest_123" <== change index 6
iso.3.6.1.4.1.2021.8.1.2.151.101.8 = STRING: "VIP_500"
iso.3.6.1.4.1.2021.8.1.2.151.102.1 = INTEGER: 0
iso.3.6.1.4.1.2021.8.1.2.151.103.1 = ""
```

Get radio module from wireless6.device=1.3.6.1.4.1.2021.8.1.2.1440 (may be omitted if SSID-radio is known):

```
snmpget -c public -v 2c 192.168.100.1 1.3.6.1.4.1.2021.8.1.2.1440.101.1
```

delivers

```
iso.3.6.1.4.1.2021.8.1.2.1440.101.1 = STRING: "radio1"
snmpset -c private -v 2c 192.168.100.1 1.3.6.1.4.1.2021.8.1 s "wireless6.ssid New_345"
snmpset -c private -v 2c 192.168.100.1 1.3.6.1.4.1.2021.8.1 s "uci commit wireless"
snmpset -c private -v 2c 192.168.100.1 1.3.6.1.4.1.2021.8.1 s "service network reload"
```

7.7.2.3 Set a new Macfilter

Apply a new ‘macfilter’ on the access point “VIP_500”. Specific user mac is excluded.

```
snmpset -c private -v 2c 192.168.100.1 1.3.6.1.4.1.2021.8.1 s
"wireless7.macfilter deny"
```

Single user:

```
snmpset -c private -v 2c 192.168.100.1 1.3.6.1.4.1.2021.8.1 s
"wireless7.maclist 11:22:33:44:55:66"
```

Multiple user:

```
snmpset -c private -v 2c 192.168.100.1 1.3.6.1.4.1.2021.8.1 s "uci
add_list wireless.@wifi-\ face[7].maclist=11:22:33:44:55:66"

snmpset -c private -v 2c 192.168.100.1 1.3.6.1.4.1.2021.8.1 s "uci
add_list wireless.@wifi-face[7].maclist=22:33:44:55:66:77"

snmpset -c private -v 2c 192.168.100.1 1.3.6.1.4.1.2021.8.1 s "uci
commit wireless"

snmpset -c private -v 2c 192.168.100.1 1.3.6.1.4.1.2021.8.1 s "service
network reload"
```

7.7.3 Edit configuration parameters, create new fields and delete items

If a ‘config.section.option’ is known, the ‘uci set’ command call can be used to read and modify any existing configuration item. If a snmpset command with a string “uci <command> config-item=new-value” is executed, it marks the config-item. The next snmpget call with ‘1.3.6.1.4.1.2021.8.1.2.108’ (uci_get) remembers the last config-item and returns the curre nt value (read-back function). If the snmpset was executed without the string

part “=new-value” only the config-item marker is set. This can be used to readout an item (no OID) without modifying it.

Note: Remember to commit changes in order to save then with the command ‘*uci commit*’.

7.7.3.1 Set new Hostname

Hostname is configured in ‘/etc/config/system’ (no OID).

The commands

```
snmpset -c private -v 2c 192.168.100.1 1.3.6.1.4.1.2021.8.1 s "uci set
system.@system[0].hostname"

snmpwalk -c public -v 2c 192.168.100.1 1.3.6.1.4.1.2021.8.1.2.108
```

will deliver

```
iso.3.6.1.4.1.2021.8.1.2.108.1.1 = INTEGER: 1

iso.3.6.1.4.1.2021.8.1.2.108.2.1 = STRING: "uci_get"

iso.3.6.1.4.1.2021.8.1.2.108.3.1 = STRING: "/usr/sbin/get_snmp
uci_get"

iso.3.6.1.4.1.2021.8.1.2.108.100.1 = INTEGER: 0

iso.3.6.1.4.1.2021.8.1.2.108.101.1 = STRING:
"system.@system[0].hostname=CyBoxAP"

iso.3.6.1.4.1.2021.8.1.2.108.102.1 = INTEGER: 0

iso.3.6.1.4.1.2021.8.1.2.108.103.1 = ""
```

Use the following sequence to set the new hostname

```
snmpset -c private -v 2c 192.168.100.1 1.3.6.1.4.1.2021.8.1 s "uci set
system.@system[0].hostname=CYAP-14"

snmpset -c private -v 2c 192.168.100.1 1.3.6.1.4.1.2021.8.1 s "uci
commit system"

snmpset -c private -v 2c 192.168.100.1 1.3.6.1.4.1.2021.8.1 s "service
system reload"
```

7.7.3.2 Creating a system configuration description text

The regular firmware configuration does not provide such information. The following command sequence

```
snmpset -c private -v 2c 192.168.100.1 1.3.6.1.4.1.2021.8.1 s "uci set
system.@system[0].config_description=Version 1.1 Beta ABC"

snmpwalk -c public -v 2c 192.168.100.1 1.3.6.1.4.1.2021.8.1.2.108
```

delivers

```
iso.3.6.1.4.1.2021.8.1.2.108.1.1 = INTEGER: 1

iso.3.6.1.4.1.2021.8.1.2.108.2.1 = STRING: "uci_get"

iso.3.6.1.4.1.2021.8.1.2.108.3.1 = STRING: "/usr/sbin/get_snmp
uci_get"
```

```
iso.3.6.1.4.1.2021.8.1.2.108.100.1 = INTEGER: 0

iso.3.6.1.4.1.2021.8.1.2.108.101.1 = STRING:
"system.@system[0].config_description=Version 1.1 Beta ABC"

iso.3.6.1.4.1.2021.8.1.2.108.102.1 = INTEGER: 0

iso.3.6.1.4.1.2021.8.1.2.108.103.1 = ""
```

Commit this change from UCI temporary storage to permanent overlay file system.

```
snmpset -c private -v 2c 192.168.100.1 1.3.6.1.4.1.2021.8.1 s "uci
commit system"
```

No service reload is required.

7.7.3.3 Delete system configuration description text

The following command sequence

```
snmpset -c private -v 2c 192.168.100.1 1.3.6.1.4.1.2021.8.1 s "uci
delete system.@system[0].config_description"

snmpwalk -c public -v 2c 192.168.100.1 1.3.6.1.4.1.2021.8.1.2.108
```

delivers

```
iso.3.6.1.4.1.2021.8.1.2.108.1.1 = INTEGER: 1

iso.3.6.1.4.1.2021.8.1.2.108.2.1 = STRING: "uci_get"

iso.3.6.1.4.1.2021.8.1.2.108.3.1 = STRING: "/usr/sbin/get_snmp
uci_get"

iso.3.6.1.4.1.2021.8.1.2.108.100.1 = INTEGER: 0

iso.3.6.1.4.1.2021.8.1.2.108.101.1 = STRING: "uci: Entry not found"

iso.3.6.1.4.1.2021.8.1.2.108.101.2 = STRING:
"system.@system[0].config_description="

iso.3.6.1.4.1.2021.8.1.2.108.102.1 = INTEGER: 0

iso.3.6.1.4.1.2021.8.1.2.108.103.1 = ""
```

Commit this change from UCI temporary storage to permanent overlay file system.

```
snmpset -c private -v 2c 192.168.100.1 1.3.6.1.4.1.2021.8.1 s "uci
commit system"
```

7.8 SNMP Applications

7.8.1 SNMP Support for GPS

The following information data structure can be obtained via SNMP command ‘snmpwalk’ from a host system.

The command

```
user@host:~$ snmpwalk -c public -v2c 192.168.100.1
1.3.6.1.4.1.2021.8.1.2.155
```

delivers

```
iso.3.6.1.4.1.2021.8.1.2.155.1.1 = INTEGER: 1

iso.3.6.1.4.1.2021.8.1.2.155.2.1 = STRING: "gps_info"

iso.3.6.1.4.1.2021.8.1.2.155.3.1 = STRING: "/bin/cat
/var/run/gps/gps.info"

iso.3.6.1.4.1.2021.8.1.2.155.100.1 = INTEGER: 0

iso.3.6.1.4.1.2021.8.1.2.155.101.1 = STRING: "Status: A"

iso.3.6.1.4.1.2021.8.1.2.155.101.2 = STRING: "Quality: 1"

iso.3.6.1.4.1.2021.8.1.2.155.101.3 = STRING: "Sat: 9"

iso.3.6.1.4.1.2021.8.1.2.155.101.4 = STRING: "Wed Jul 5 09:45:15
2017"

iso.3.6.1.4.1.2021.8.1.2.155.101.5 = STRING: "N: 49.960107"

iso.3.6.1.4.1.2021.8.1.2.155.101.6 = STRING: "E: 8.258518"

iso.3.6.1.4.1.2021.8.1.2.155.101.7 = Hex-STRING: 4E 3A 20 34 39 C2
B0 35 37 27 33 36 2E 33 38 34

22

iso.3.6.1.4.1.2021.8.1.2.155.101.8 = Hex-STRING: 45 3A 20 38 C2 B0
31 35 27 33 30 2E 36 36 36 22

iso.3.6.1.4.1.2021.8.1.2.155.101.9 = STRING: "Alt: 175.75m"

iso.3.6.1.4.1.2021.8.1.2.155.101.10 = STRING: "Speed: 1 km/h"

iso.3.6.1.4.1.2021.8.1.2.155.101.11 = ""

iso.3.6.1.4.1.2021.8.1.2.155.102.1 = INTEGER: 0

iso.3.6.1.4.1.2021.8.1.2.155.103.1 = ""
```

The values “Latitude DMS” and “Longitude DMS” are returned as Hex strings because they contain quote and double quotes.

This converted NMEA 0183 data struct is supplied with default configuration (after factory reset). The configuration can be adapted to supply the raw NMEA 0183 protocol. Following steps are necessary to switch over to raw protocol.

Open a remote root console with ‘ssh’ access and apply following commands.

```
root@CyBoxAP:/# uci set system.@gps[0].raw='1'

root@CyBoxAP:/# uci commit

root@CyBoxAP:/# reboot
```

After reboot the GPS subsystem is configured to supply raw NMEA 0183 data. Note that this data is not shown in web interface, but can be readout via SNMP (different OID than converted GPS info).

The command

```
user@host:~$ snmpwalk -c public -v2c 192.168.100.1
1.3.6.1.4.1.2021.8.1.2.156
```

will return

```
iso.3.6.1.4.1.2021.8.1.2.156.1.1 = INTEGER: 1

iso.3.6.1.4.1.2021.8.1.2.156.2.1 = STRING: "gps_raw"

iso.3.6.1.4.1.2021.8.1.2.156.3.1 = STRING: "/bin/cat
/var/run/gps/gps.raw"

iso.3.6.1.4.1.2021.8.1.2.156.100.1 = INTEGER: 0

iso.3.6.1.4.1.2021.8.1.2.156.101.1 = STRING:
"$GPRMC,094908.000,A,4957.5942,N,00815.4955,E,0.2,194.2,050717,,,A\*6E"

iso.3.6.1.4.1.2021.8.1.2.156.101.2 = STRING:
"$GPGGA,094908.000,4957.5942,N,00815.4955,E,1,07,1.3,149.90,M,47.9,M,,\*6E"

iso.3.6.1.4.1.2021.8.1.2.156.101.3 = STRING:
"$GNGSA,A,3,24,25,32,29,31,02,,,,,,,2.2,1.3,1.8\*2C"

iso.3.6.1.4.1.2021.8.1.2.156.101.4 = STRING:
"$GNGSA,A,3,77,,,,,,,,,,,,2.2,1.3,1.8\*27"

iso.3.6.1.4.1.2021.8.1.2.156.101.5 = STRING:
"$GPGSV,3,1,10,02,39,076,17,06,13,033,,12,40,086,13,14,30,267,\*7F"

iso.3.6.1.4.1.2021.8.1.2.156.101.6 = STRING:
"$GPGSV,3,2,10,24,12,151,34,25,79,051,21,26,02,280,,29,61,213,25\*77"

iso.3.6.1.4.1.2021.8.1.2.156.101.7 = STRING:
"$GPGSV,3,3,10,31,40,305,25,32,22,244,32,,,,,,,,\*7D"

iso.3.6.1.4.1.2021.8.1.2.156.101.8 = STRING:
"$GLGSV,2,1,07,81,19,201,,70,11,350,,77,42,124,33,79,34,317,\*6F"

iso.3.6.1.4.1.2021.8.1.2.156.101.9 = STRING:
"$GLGSV,2,2,07,69,08,297,,88,69,171,,87,52,044,,,,,\*59"

iso.3.6.1.4.1.2021.8.1.2.156.102.1 = INTEGER: 0

iso.3.6.1.4.1.2021.8.1.2.156.103.1 = ""
```

7.8.2 SNMP Support for Second GPS Source

On some CyBox AP models the LTE modem can also provide additional GPS information. If the modem GPS is activated, and an additional GPS antenna is plugged in, these SNMP OIDs can be used to gather the additional GPS information.

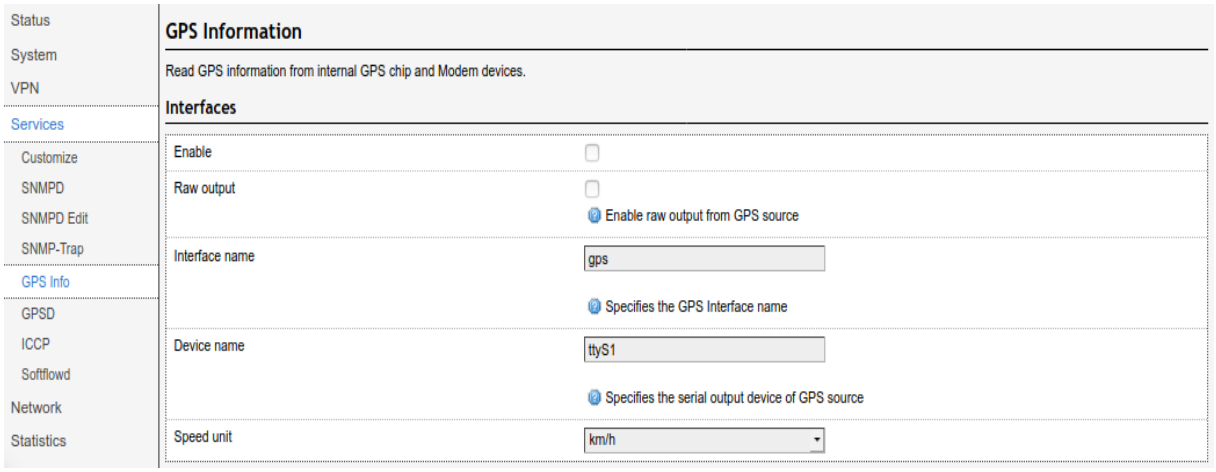
gps_module0_info	1.3.6.1.4.1.2021.8.1.2.157
gps_module0_raw	1.3.6.1.4.1.2021.8.1.2.158
gps_module1_info	1.3.6.1.4.1.2021.8.1.2.159
gps_module1_raw	1.3.6.1.4.1.2021.8.1.2.160

7.9 GPS

Some CyBox family members are equipped with an additional GNSS hardware module. The GPS antenna is routed to the front panel. Once an appropriate antenna is attached, the GPS signal is received and can be processed, if a version V3.03 or newer is installed. The GPS hardware supplies NMEA 0183 protocol on the second serial port, which is converted into a human-readable form.

7.9.1 GPS activation

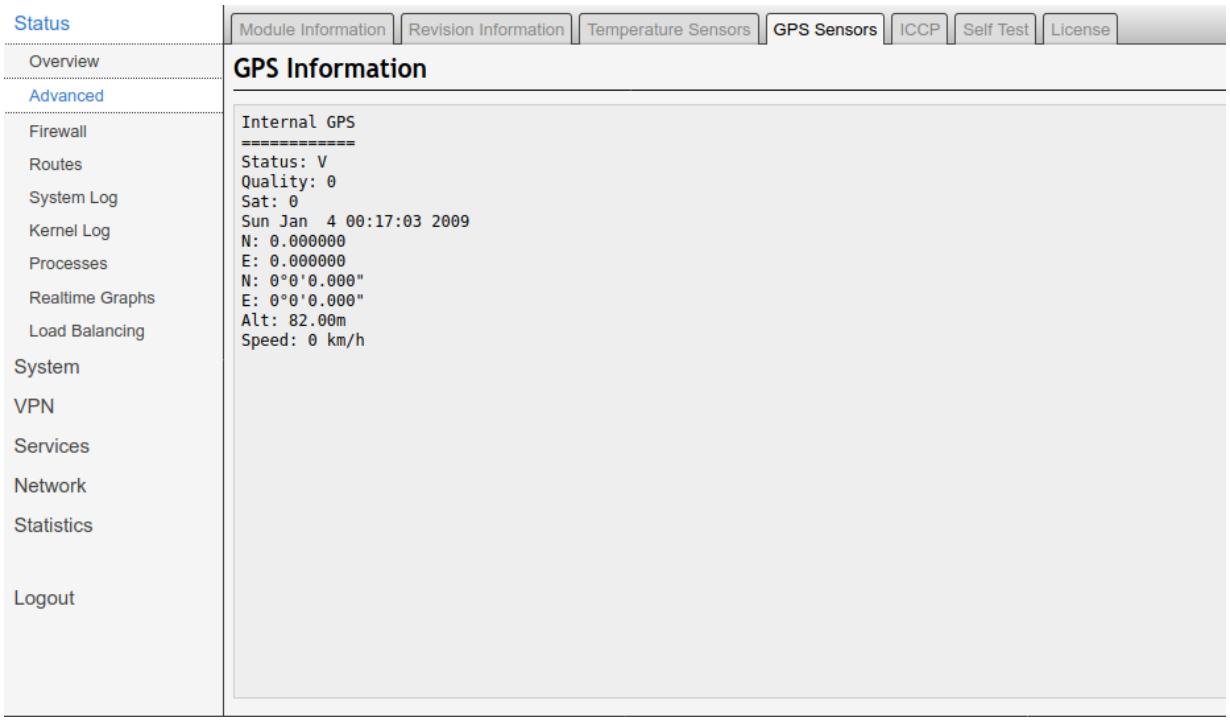
The GPS is disabled by default. It can be enabled via the web interface. Enter `System` → `GPS Info` and check Enable.



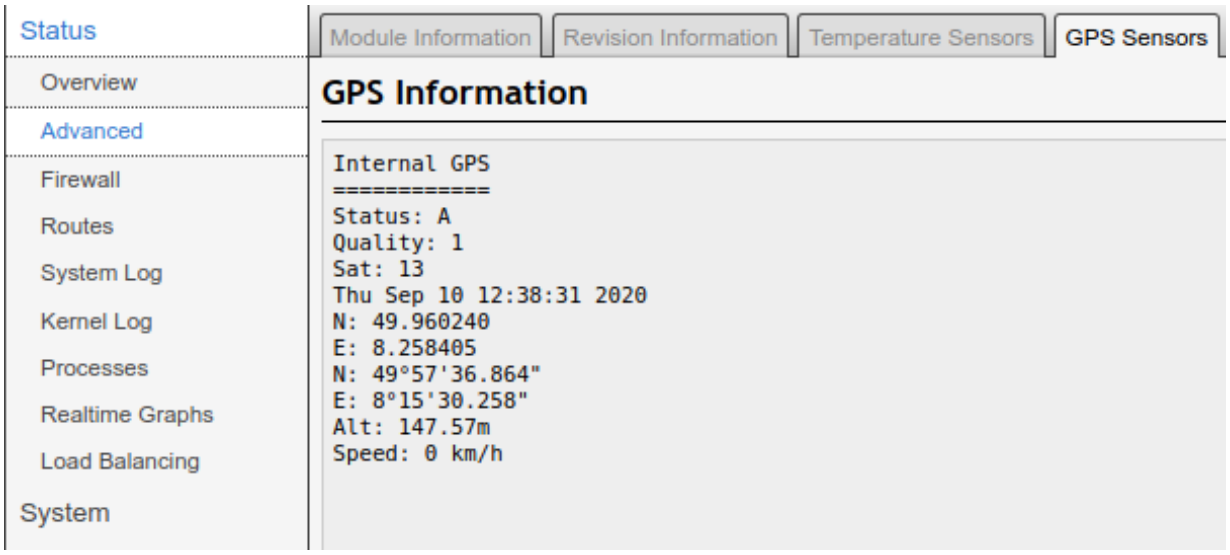
GPS Activation

7.9.2 GPS status

The GPS information will show on the `Status` → `Advanced` of the web interface. The next figure shows an example available immediately after startup. And the figure below provides the same status after the receiver has calibrated itself. The table below provides an interpretation of the GPS status data.



GPS Info immediately after startup



Reliable GPS Info after Hardware Calibration

GPS Status Data:

Data Item	Value	Description
Status	A	Active
	V	Void
Quality	0	Invalid
	1	GPS fix (SPS)

	2	DGPS fix
	3	PPS fix
	4	Real Time Kinematic
	5	Float RTK
	6	Estimated
	7	Manual input mode
	8	Simulation mode

7.9.3 SNMP for GPS

See chapter SNMP Support for GPS

7.9.4 SNMP Support for LTE

A number of LTE connection and control parameters can be read and written using SNMP commands. It is also possible to start or stop the LTE modem card and to select a predefined SIM card slot.

The SNMP OIDs are listed twice. The first installed LTE modem card uses SNMP calls starting with **modem0_xxx,** and the second modem card uses calls starting with **modem1_xxx**. Since both lists are otherwise identical, the description refers only to **modem0_xxx**.

7.9.4.1 LTE SNMP Read Control

Get Current LTE Configuration: modem0_config **1.3.6.1.4.1.2021.8.1.2.3000**

The command

```
user@host:~$ snmpwalk -c public -v2c 192.168.100.1
1.3.6.1.4.1.2021.8.1.2.3000
```

returns

```
iso.3.6.1.4.1.2021.8.1.2.3000.1.1 = INTEGER: 1

iso.3.6.1.4.1.2021.8.1.2.3000.2.1 = STRING: "modem0_config"

iso.3.6.1.4.1.2021.8.1.2.3000.3.1 = STRING: "/usr/sbin/get_snmp
modem0_config"

iso.3.6.1.4.1.2021.8.1.2.3000.100.1 = INTEGER: 0

iso.3.6.1.4.1.2021.8.1.2.3000.101.1 = STRING:
"network.LTE=interface"

iso.3.6.1.4.1.2021.8.1.2.3000.101.2 = STRING:
"network.LTE.proto='qmi'"

iso.3.6.1.4.1.2021.8.1.2.3000.101.3 = STRING:
"network.LTE.ifname='wwan1'"

iso.3.6.1.4.1.2021.8.1.2.3000.101.4 = STRING:
"network.LTE.simslot='1'"

iso.3.6.1.4.1.2021.8.1.2.3000.101.5 = STRING:
"network.LTE.pincode1='4173'"

iso.3.6.1.4.1.2021.8.1.2.3000.102.1 = INTEGER: 0

iso.3.6.1.4.1.2021.8.1.2.3000.103.1 = ""
```

Get Current Modem Signal Quality: modem0_signal 1.3.6.1.4.1.2021.8.1.2.3010

The command

```
user@host:~$ snmpwalk -c public -v2c 192.168.100.1
1.3.6.1.4.1.2021.8.1.2.3010
```

returns

```
iso.3.6.1.4.1.2021.8.1.2.3010.1.1 = INTEGER: 1

iso.3.6.1.4.1.2021.8.1.2.3010.2.1 = STRING: "modem0_signal"

iso.3.6.1.4.1.2021.8.1.2.3010.3.1 = STRING: "/usr/sbin/get_snmp
```

```
modem0_signal"

iso.3.6.1.4.1.2021.8.1.2.3010.100.1 = INTEGER: 0

iso.3.6.1.4.1.2021.8.1.2.3010.101.1 = STRING: "[/dev/cdc-wdm1]
Successfully got signal info"

iso.3.6.1.4.1.2021.8.1.2.3010.101.2 = STRING: "HDR:"

iso.3.6.1.4.1.2021.8.1.2.3010.101.3 = STRING: " RSSI: '-125 dBm'"

iso.3.6.1.4.1.2021.8.1.2.3010.101.4 = STRING: " ECIO: '-2.5 dBm'"

iso.3.6.1.4.1.2021.8.1.2.3010.101.5 = STRING: " IO: '-106 dBm'"

iso.3.6.1.4.1.2021.8.1.2.3010.101.6 = STRING: " SINR (8): '9.0 dB'"

iso.3.6.1.4.1.2021.8.1.2.3010.101.7 = STRING: "LTE:"

iso.3.6.1.4.1.2021.8.1.2.3010.101.8 = STRING: " RSSI: '-56 dBm'"

iso.3.6.1.4.1.2021.8.1.2.3010.101.9 = STRING: " RSRQ: '-13 dB'"

iso.3.6.1.4.1.2021.8.1.2.3010.101.10 = STRING: " RSRP: '-86 dBm'"

iso.3.6.1.4.1.2021.8.1.2.3010.101.11 = STRING: " SNR: '19.2 dB'"

iso.3.6.1.4.1.2021.8.1.2.3010.102.1 = INTEGER: 0

iso.3.6.1.4.1.2021.8.1.2.3010.103.1 = ""
```

Get Current Modem DHCP Settings: modem0_dhcp_status 1.3.6.1.4.1.2021.8.1.2.3015

Use command

```
user@host:~$ snmpwalk -c public -v2c 192.168.100.1
1.3.6.1.4.1.2021.8.1.2.3015
```

returns

```
iso.3.6.1.4.1.2021.8.1.2.3015.1.1 = INTEGER: 1

iso.3.6.1.4.1.2021.8.1.2.3015.2.1 = STRING: "modem0_dhcp_status"

iso.3.6.1.4.1.2021.8.1.2.3015.3.1 = STRING: "/usr/sbin/get_snmp
modem0_dhcp_status"

iso.3.6.1.4.1.2021.8.1.2.3015.100.1 = INTEGER: 0

iso.3.6.1.4.1.2021.8.1.2.3015.101.1 = STRING:
"{\"up\":true,\"pending\":false,\"available\":true,\"autostart\":true,\"dynamic\":true,
\"uptime\":437,\"l3_device\":\"wwan1\",\"proto\":\"dhcp\",\"device\":\"wwan1\",
\"updated\":[\"addresses\",\"routes\",\"data\"],\"metric\":0,\"dns_metric\":0,
\"delegation\":true,\"ipv4-address\":[{\"address\":\"10.118.124.205\",\"mask\":30}],
\"ipv6-address\":[],\"ipv6-prefix\":[],\"ipv6-prefix-assignment\":[],
\"route\":[{\"target\":\"10.118.124.206\",\"mask\":32,\"nexthop\":\"0.0.0.0\",
\"source\":\"10.118.124.205\\/32\"},{\"target\":\"0.0.0.0\",\"mask\":0,
\"nexthop\":\"10.118.124.206\",\"source\":\"10.118.124.205\\/32\"}],
\"dns-server\":[\"62.109.121.17\",\"62.109.121.18\"],\"dns-search\":[],
\"inactive\":{\"ipv4-address\":[],\"ipv6-address\":[],\"route\":[],\"dns-server\":[],
\"dns-search\":[]},\"data\":{\"leasetime\":7200}}"

iso.3.6.1.4.1.2021.8.1.2.3015.102.1 = INTEGER: 0
```

```
iso.3.6.1.4.1.2021.8.1.2.3015.103.1 = ""
```

7.9.4.2 LTE SNMP Write Control

By default SNMP write control is restricted to the localhost. Refer to chapter 8.1 to enable write access.

Any changes on provider settings e.g. APN, PIN, etc. must be done in the web interface. For SNMP writing only switching between preconfigured SIM cards is supported.

Activate/Deactivate Network Interface my_lte

Use commands

```
snmpset -c private -v 2c 192.168.100.1 1.3.6.1.4.1.2021.8.1 s
"modem0_up"

snmpset -c private -v 2c 192.168.100.1 1.3.6.1.4.1.2021.8.1 s
"modem0_down"
```

Select another SIM card slot and restart network

Use commands

```
snmpset -c private -v 2c 192.168.100.1 1.3.6.1.4.1.2021.8.1 s
"modem0_simslot 1"

snmpset -c private -v 2c 192.168.100.1 1.3.6.1.4.1.2021.8.1 s "
modem0_simslot 2"

snmpset -c private -v 2c 192.168.100.1 1.3.6.1.4.1.2021.8.1 s
"modem0_simslot 3"

snmpset -c private -v 2c 192.168.100.1 1.3.6.1.4.1.2021.8.1 s
"modem0_simslot 4"
```

8 HotSpot as Service

HotSpot as Service is a service by Telekom.

The service provides a solution to configure an infrastructure allowing to connect to the `HotSpot` platform via site-to-site IPSec/IKEv2 VPN tunnel.

To be able to use this service, you need a contract with Telekom.

The following recipe describes how to set up the service.

8.1 Setup data provided by the service provider

Telekom will provide a set of parameters (passwords, ip addresses, …) for each single system.

The following table shows an example:

Example access parameters

Username	Password	Client netbase/prefix	Client netmask	Client gateway
Provided by Telekom	Provided by Telekom	Provided by Telekom	Provided by Telekom	Provided by Telekom

Additionally there are configuration data independent of the single system:

Internet-facing IP address of the VPN load balancer

Provided by Telekom

DHCP IP address

Provided by Telekom

Remote identity of the VPN terminator

Provided by Telekom

Maximum segment size (MSS)

1320

8.2 Setting up the system

With the information provided, the system can now be set up using the web interface.

8.2.1 General assumptions

The current configuration assumes that the SIM card is inserted in the SIM 1 slot for LTE 1.

This procedure was tested with a CyBox RT 2-A with two Wi-Fi and two LTE modules, but only one Wi-Fi and LTE module was used.

On other system variants the dialogs may look differently.

8.2.2 Preliminary steps

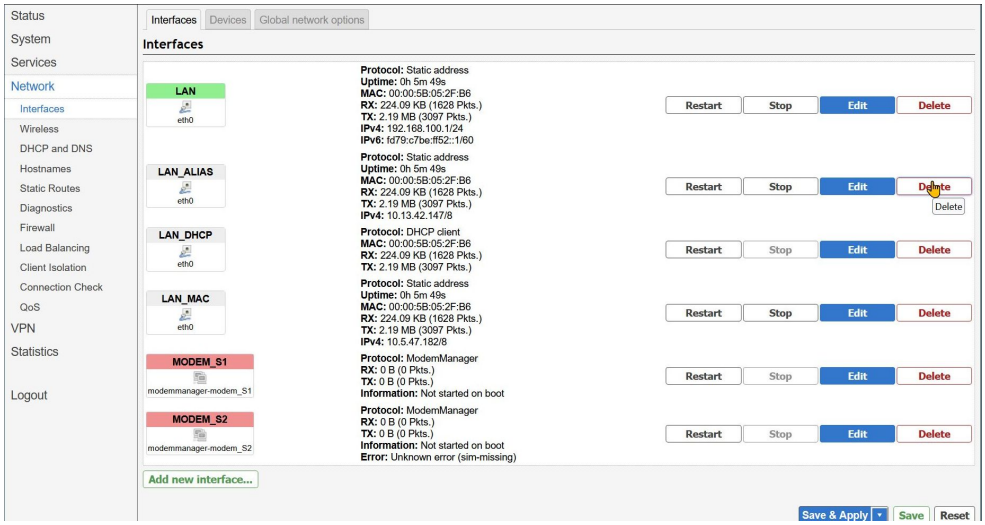
Before the system-dependent data and the “Hotspot as Service” parameters can be set, some first steps have to be done.

8.2.2.1 Factory reset

First perform a factory reset as described in the corresponding chapter.

8.2.2.2 Remove not required interfaces

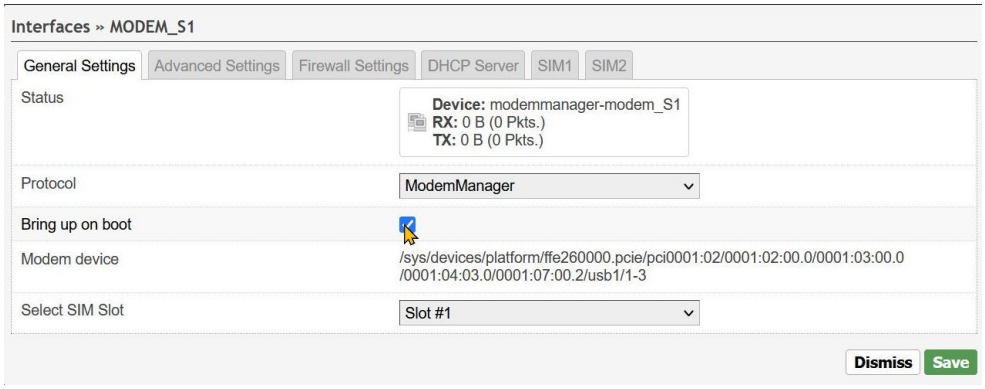
The two network interfaces *LAN_ALIAS* and *LAN_MAC* have an IP address in the range of *10.X.Y.Z*. These IPs conflict with the IP addresses provided by the network provider Telekom. Both have to be removed or changed to another IP-range except 10.X.Y.Z.



Remove networks LAN_ALIAS and LAN_MAC.

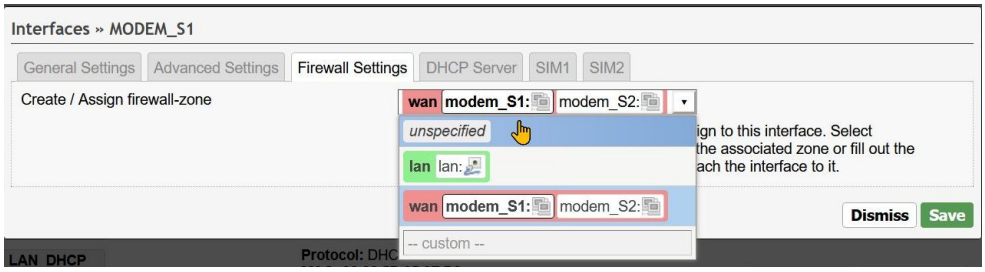
8.2.2.3 Setup *MODEM_S1*

Open the settings menu of *MODEM_S1* which is used for the LTE connection and set the checkbox “Bring up on boot”.



Bring up MODEM_S1 on boot.

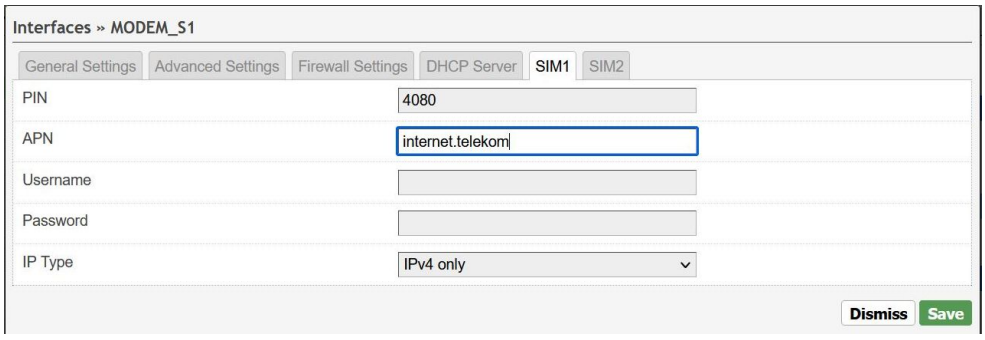
The firewall zone of *MODEM_S1* is “wan”, it must be set to unspecific.



Set the MODEM_S1 firewall zone to unspecific.

The SIM PIN and APN must be set in the following dialog. The APN for the Telekom connection is “internet.telekom”. Of cause the proper PIN of the SIM card - usually not “4080” - must be used.

As always the changes must be saved, after all hit “Save & Apply”.

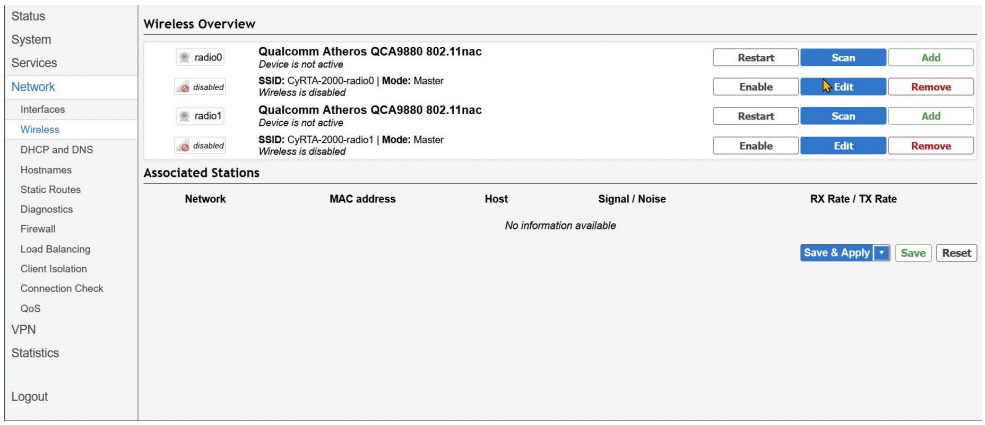


Set PIN and APN for MODEM_S1.

After these steps *MODEM_S1* should be ready.

8.2.2.4 Wireless network

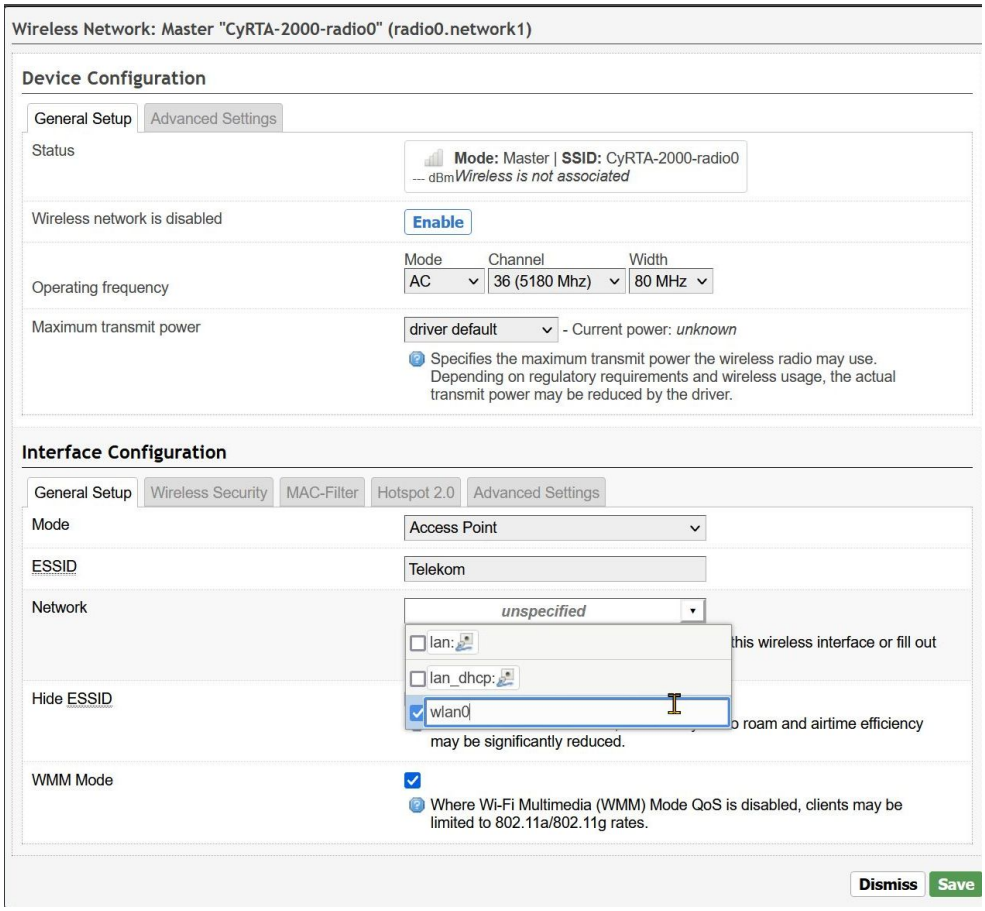
Navigate to “Network -> Wireless” and edit the wireless interface *radio 0*.



Edit the wireless radio setup.

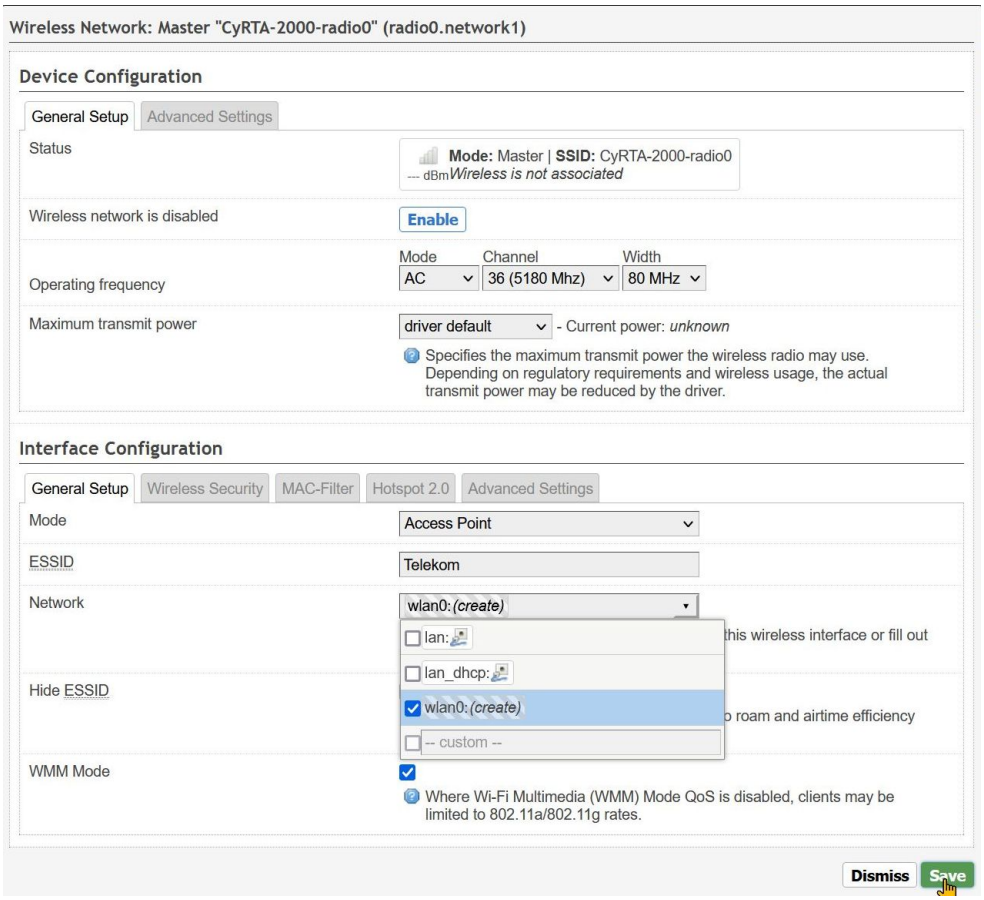
Set the custom value for the Network setting to “wlan0” in the “Interface Configuration” dialog. Under “Interface Configuration”, set the “ESSID” to “Telekom”.

For “Network”, unmark “lan” and set the custom value to “wlan0” as shown in the picture.



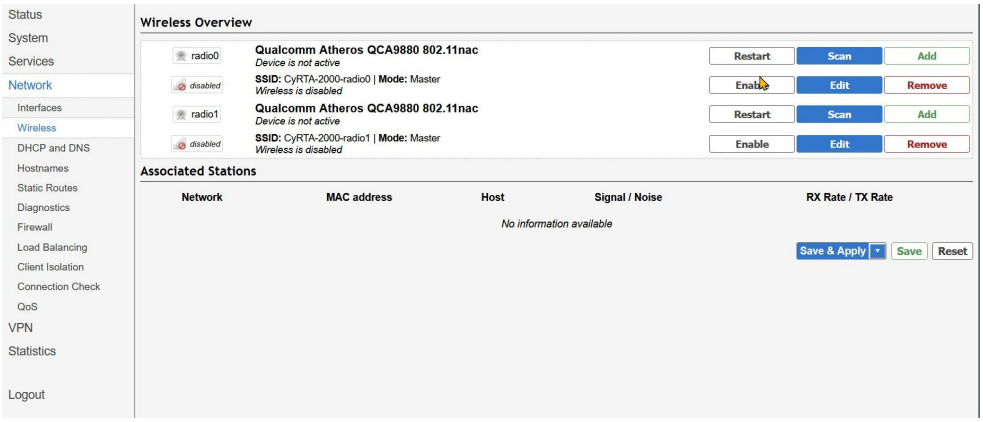
Set the ESSID and Network for radio 0.

When hitting “enter” on the keyboard, the dialog shows that the interface will be created.



Set the ESSID and the Network for radio 0.

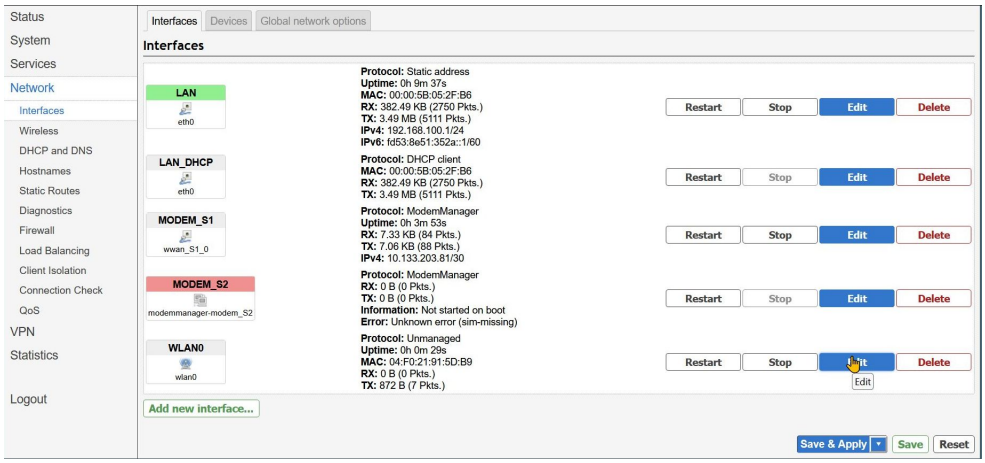
Save the wireless network configuration and enable the interface in the “Wireless Overview” dialog.



Enable the network radio 0.

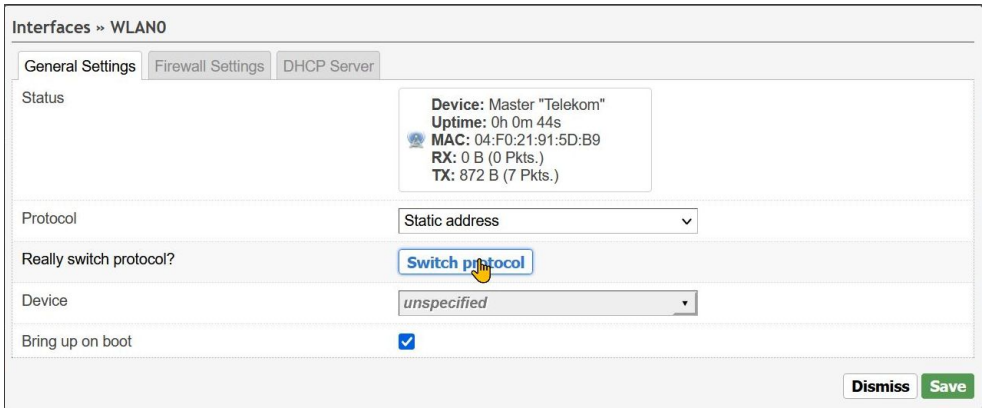
8.2.2.5 Wireless network settings

Navigate to “Network -> Interfaces” to edit the newly created wireless interface “WLAN0”.



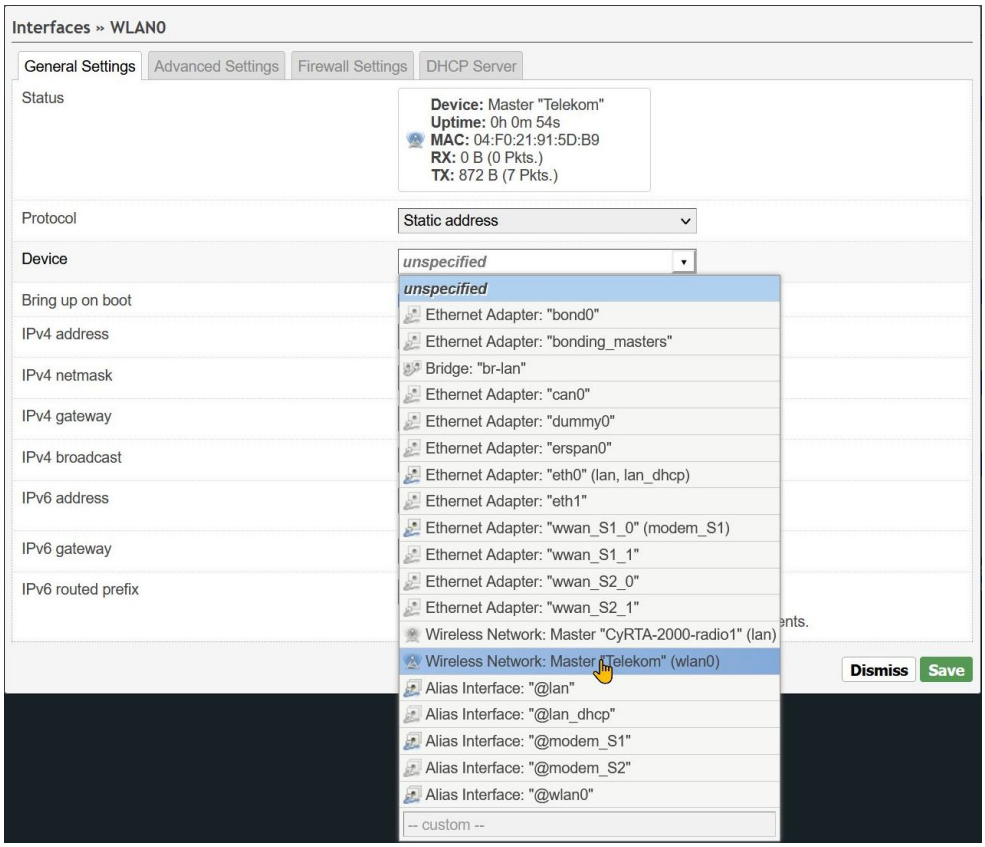
Configure the wlan interface.

As this interface was newly created, the protocol must be changed to “Static Address”.



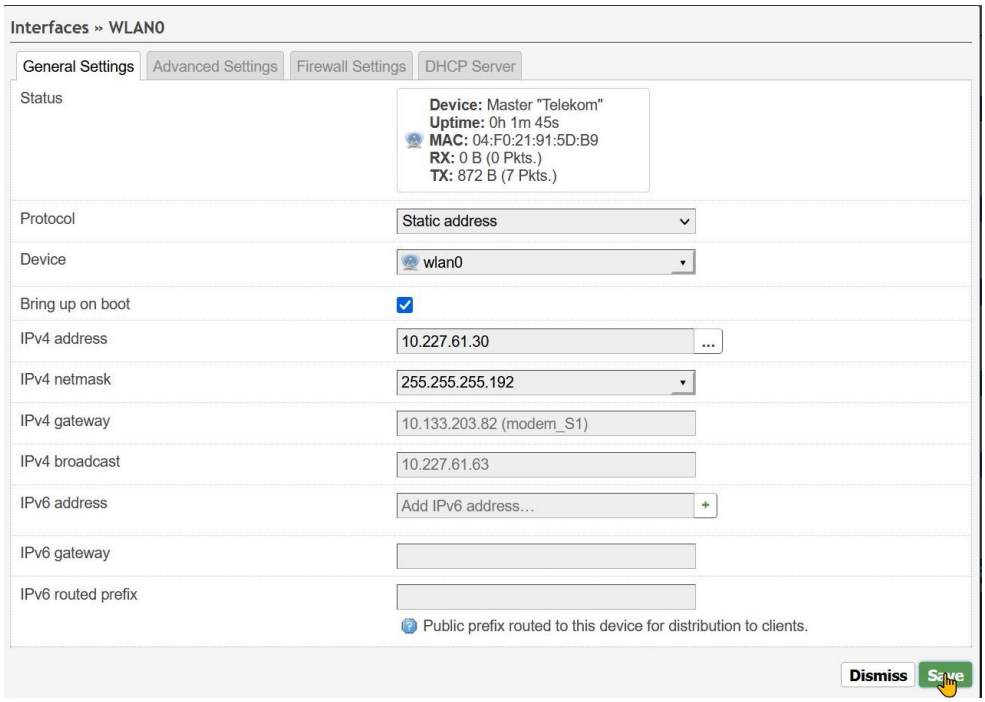
Switch the protocol

Hit “Switch protocol” and choose for “Device” the entry “Wireless Network: Master “Telekom” (wlan0)” as shown in the following picture.



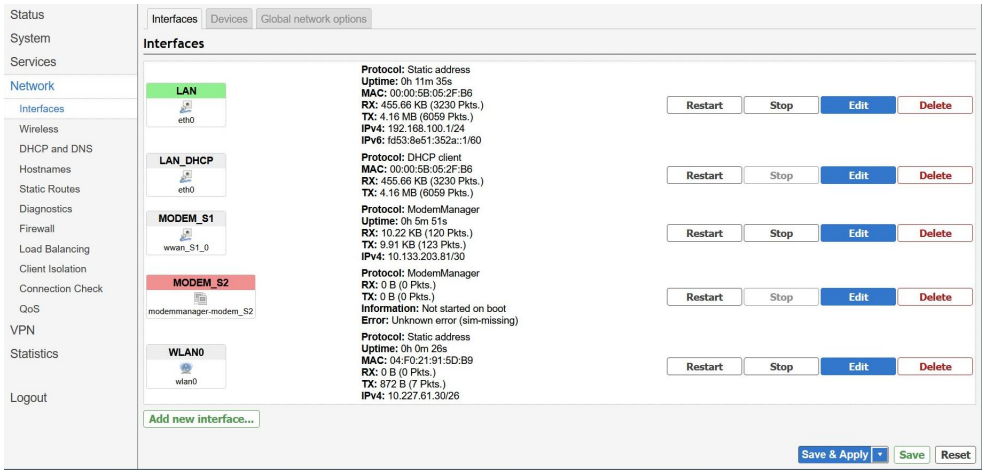
Use the WLAN device.

Setup the “IPv4 adress” (client_gw) and “IPv4 netmask” (client_netmask) provided by the net provider Telekom. Set the checkbox “Bring up on boot” and “save” the changes. Hit “Save & Apply”.



Setup IP address and "Bring up on boot" flag.

After a certain boot time (~30-60sec) the interfaces are active.



MODEM_S1 and WLAN0 are active

8.2.2.6 Hotspot as Service Settings

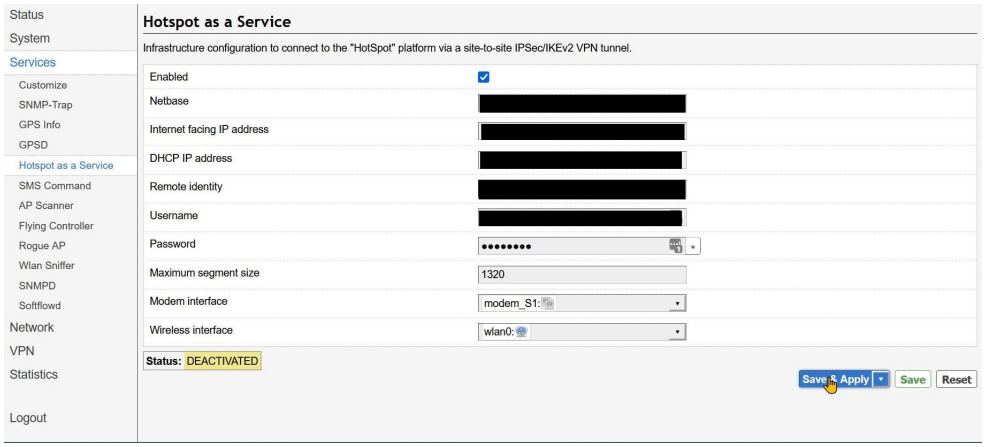
Navigate to "Services" -> "Hotspot as a Service".

Set "Netbase" (client_netbase), username and password to the values are provided by the net provider Telekom.

The interfaces "Modem interface" and "Wireless interface" have to be set to "modem_S1" and "wlan0" as shown in the picture below.

The preset values in the category "Hotspot as a Service" (Internet facing IP address, DHCP IP address, Remote identity and Maximum segment size) are usually fixed for the VPN connection.

Mark "Enabled" and hit "Save & Apply".



Setup the service Hotspot as Service.

If everything is ok, the status marker changes from *Status: DEACTIVATED* to *Status: OFFLINE* and finally *Status: ONLINE*.

This may last several minutes especially, when the connection is established for the first time.

Final status display.

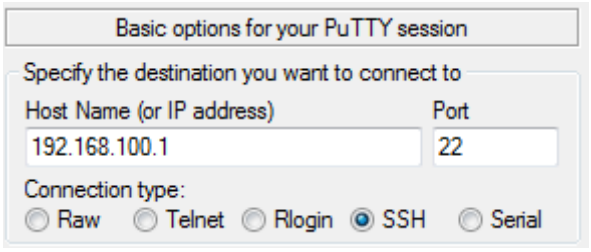
9 SSH / SERIAL CONSOLE

On a Windows PC, you can use the program PuTTY (http://www.putty.org).

a. Ethernet cable (SSH)

Ensure that an Ethernet cable is connected between your PC and the access point. The following instruction assumes that the default settings are used.

- If you are using a UNIX/Linux PC then run the command 'ssh root@192.168.100.1'.
- If you are using a Windows PC, PuTTY should be configured as follows:

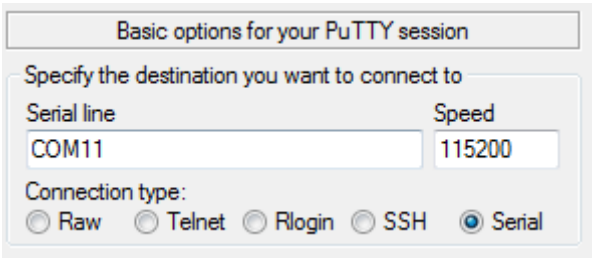


PuTTY - SSH connection

b. Serial cable

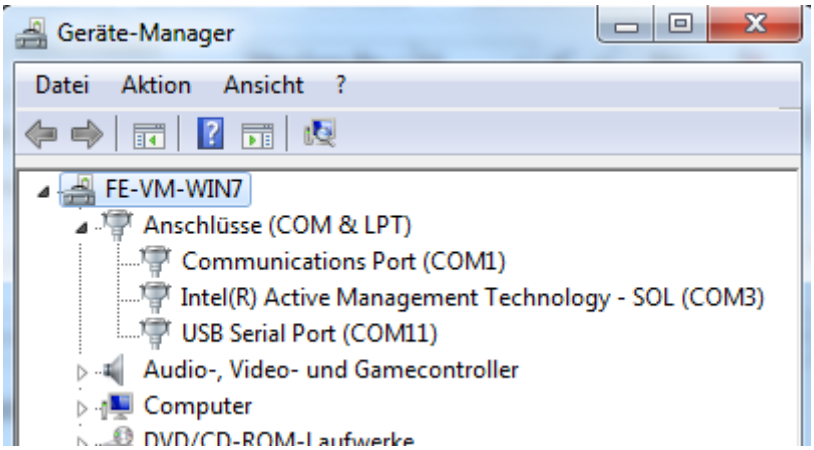
Ensure that a serial cable is connected between your PC and the access point (a specific CyBox adapter plugged in the USB port is required).

- On a UNIX PC, install the program picocom, and run command picocom -b 115200 /dev/ttyUSB0 (*'ttyUSB0'* must be modified depending on your PC*)*.
- If you are using a Windows PC, PuTTY should be configured as follows:



PuTTY - Serial connection

The value *'COM11'* must be adapted for your PC. A list of the COM ports can be found in the device manager window as shown below.



Windows device manager showing COM ports

Once the connection is established, a login should be requested on serial console window.

If this is not the case, press Enter on the keyboard and/or disconnect and reconnect the USB serial adapter on the CyBox side. To edit files on target system the build-in text editor **nano** can be used.

9.1 UCI Configuration

This section describes the UCI (**Unified Configuration Interface**). UCI can be scripted for remote configuration using shell commands and scripts. UCI can be seen as the OpenWRT main configuration interface. It is best used for main network interface configuration, wireless settings, logging functionality and remote access configuration.

With OpenWrt, the user should change only UCI configuration file(s), which are read by individual programs.

For a more complete description of UCI commands and files used see https://wiki.openwrt.org/doc/uci.

9.1.1 UCI configuration files

The OpenWRT central configuration is split into several files located in the /etc/config/ directory. Each file is named according to the part of the system it configures. The configuration files can either be modified using a text editor or by using UCI. UCI configuration files are also modifiable through various programming APIs (like Shell, Lua and C), which is also how web interfaces like LuCI make changes to the UCI files.

After changing a UCI configuration file, the services affected must be restarted by an init.d call, so the updated UCI configuration is used. Many programs are made compatible with UCI by making their init.d script write their standard program-specific configuration files. The init.d script first writes the configuration file to the location expected by the software and it is read in again by restarting the executable. Note that just (re)starting the executable directly, without init.d calls, will not result in an UCI update. Changes in files in /etc/config/ then take no effect.

9.1.2 UCI Example

As an example, suppose you want to change the device's IP address from the default 192.168.100.1 to 192.168.2.1. Change the line in the file `/etc/config/network`:

```
option ipaddr 192.168.100.1
```

to:

```
option ipaddr 192.168.2.1
```

Next, commit the settings by running:

```
/etc/init.d/network restart
```

Remember to login again to the new IP address.

9.2 Other commands

a. Restore factory settings

   The factory settings can be restored with the command factory_reset

b. Export configuration

   The current configuration can be saved in the CyBox folder *'/tmp/'* with the command `sysupgrade -b /tmp/backup<mybackupname>.tar.gz`. It can then be exported to a PC with SCP (or the program WinSCP for Windows).

c. Import configuration

   Restore the factory settings and then import your archived configuration to *'/tmp/'* with SCP (or WinSCP), the configuration can be installed with the command `sysupgrade -r /tmp/backup-<mybackupname>.tar.gz ; reboot`

Typing reboot in the command line will reboot the device.

USB stick is auto-mounted to /mnt/sda1.

10 SYSTEM MAINTENANCE

10.1 Remote Firmware Upgrade

The *standard_boot* flash partition, which contains the standard firmware binary image (.itb image), can be updated remotely. The new firmware image must be copied to the target system with **scp** command. Afterwards **ssh** calls will execute local target programs to install the new firmware.

While OpenWrt operating system is running, the *standard_boot* partition can be written at any time.

If firmware update does **not** require a configuration change, the current system configuration can be kept. Please contact support or sales department if a configuration reset is needed for your update purpose from an older version to a newer one.

The **Appendix: Script for Remote Firmware Update** provides a *Bash* script **rsysupgrade.sh** to demonstrate the remote update process from a Linux Host console.

10.1.1 Remote Firmware Upgrade without Config Change

Normally a firmware update should also include a configuration reset to the new version. Only in some few cases e.g. a small bug fix on a wireless driver, will not require to adapt and install a new configuration backup archive.

The following commands may be executed from a Linux console or with similar Windows **Putty** utils.

1. Copy the new firmware image to the target system

   ```
   scp <new_firmware.itb> root@<target_ipv4>:/tmp/firmware.img
   ```

2. Flash new firmware to the **standard_boot** flash partition (mtd2) and reboot the target system

   ```
   ssh root@<target_ipv4>: "/sbin/sysupgrade -t /tmp/firmware.img; reboot"
   ```

10.1.2 Remote Firmware Upgrade with New Config

In most cases an adapted or new configuration archive must also be installed, to match the new firmware version. The overlay partition is used to keep the configuration settings made by user to be present after power cycle. If the firmware detects an empty (cleared) overlay partition, the target directory **/mnt/custom/** is checked for a single **backup-<target>-<cfg>.tar.gz** archive to be installed as a new configuration. If a **/mnt/custom/backup-<target>-<cfg>.tar.gz** archive does **not** exist, the `factory default` settings are applied.

To create your custom configuration for a new firmware, the old system firmware should be updated to the new version with deleted configuration and `factory settings` applied. Make your complete system configuration setup with the new firmware version and save the **backup-<target>-<cfg>.tar.gz** archive to your Host System. The uploaded backup archive can then be exported to other (stationary) targets with the same hardware components equipped.

The following commands may be executed from a Linux console or with similar Windows **Putty** utils.

1. Copy the new firmware image to the target system
   ```
   scp <new_firmware.itb> root@<target_ipv4>:/tmp/firmware.img
   ```
2. Flash new firmware to the **standard_boot** flash partition (mtd2)
   ```
   ssh root@<target_ipv4>: "/sbin/sysupgrade -t /tmp/firmware.img"
   ```
3. Ensure that no backup configuration is stored in **/mnt/custom/**
   ```
   ssh root@<target_ipv4>: "rm -rf /mnt/custom/backup*"
   ```
4. Optionally, export your new custom configuration to `/mnt/custom/`. *Note* that the target system will perform a extra reboot cycle, to activate your new configuration setup. If no configuration is exported, the default configuration of the new firmware will automatically be applied.
   ```
   scp backup-<my_config>.tar.gz root@/<target_ipv4>:/mnt/custom/
   ```
5. Delete the current configuration and reboot:
   ```
   ssh root@<target_ipv4>: "rm -rf /mnt/jffs2/*; reboot"
   ```

WARNING: Do NOT POWER OFF the access point while upgrading/restoring firmware to flash

10.2 USB Possibilities

Via USB stick it is possible to update configuration and firmware.

A USB stick can be connected to the device, it needs a dedicated USB adapter.

a. Export configuration

Archived configurations can be exported from the command line to an empty USB stick by copying the configuration to *'/mnt/sda1'*.

b. Import configuration

To import an archived configuration to the access point, wait until booting is completed, then connect a USB stick with a configuration file on it named like *'backup-<mycustomname>.tar.gz*' No other file or folder must be present on the stick. Once plugged in, the configuration will be automatically read in and two reboots will successively happen in order to apply your settings. The USB stick can safely be removed at the beginning of a boot phase (when all LEDs are turned off), or when the boot sequence is completed.

A USB hotplug script is triggered if the USB stick is plugged in after booting. It reads the root directory of the stick and checks for a list of known file types:

Files on upgrade USB stick:

File Type (wildcard=*)	Description	Board	Action	Who ?
"backup*tar.gz"	New configuration archive	ALL	Untar to Overlay FS (/dev/mtd3)	End user
"factory*reboot"	Marker to do a factory reset and reboot after upgrade operation.	ALL	Execute factory_reset	End user
"config*reboot"	Marker to do a perform a normal reboot.	ALL	Execute reboot	End user
"cyap*upgrade*tgz" "cyap*upgrade*zip"	Upgrade archive must contain an 'install.sh' script (executable) in archive root. The archive is unpacked to /tmp/usb_upgrade and 'install.sh' is executed.	ALL	Shell script execution	System Integrator

Every install is executed only once for each file on the USB stick; updates already installed are not tried again. Check *'System Log'* in web interface or logread on console for upgrade messages.

For a firmware upgrade with *.zip archive the USB stick should only provide one archive file in USB root directory:

Example:

cyap-upgrade-V20.36.3.zip

This upgrade archive file must contain the new *V20.36.3-cyap2-lzma.itb* firmware image and an executable install script named *install.sh*. The install script executes commands to flash the new firmware into the desired partition. The upgrade archive may also include a new configuration backup archive, suitable for the new firmware version. After firmware upgrade, the new configuration may also applied with commands from the install script.

Example for an *install.sh* script:

```
#!/bin/sh

sysupgrade -t V20.36.3-cyap2-lzma.itb
sysupgrade -r backup-cyap2-20.36.3.tar.gz

exit 0
```

10.3 Status LED Blink Codes

While the upgrade process is running or has finished the 'Fail LED' (red/green) is used as status indicator.

Blink codes in upgrades:

Blink Code repeated	Description
RED 0.2sec on - GREEN 0.2sec on	Upgrade process running
GREEN continuous on	Upgrade successful
RED continuous on	USB stick mount failed
RED 3sec on - OFF 0.5sec	Mount of overlay FS failed
GREEN 3sec on – OFF 0.5sec	Some Upgrade is already one
RED 0.2sec – OFF 0.5sec – RED 0.2sec – OFF 2sec	Copy to flash failed
RED 0.2sec – OFF 0.5sec – RED 0.2sec – OFF 0.5sec – RED 0.2sec OFF 2sec	'install.sh' missing
GREEN 0.2sec – OFF 0.5sec – RED 0.2sec – OFF 0.5sec – RED 0.2sec - OFF 0.5sec	Password missing
GREEN 0.2sec – OFF 0.5sec – RED 0.2sec – OFF 0.5sec – RED 0.2sec - OFF 0.5sec – RED 0.2sec - OFF 0.5sec	Password invalid
OFF	USB stick is removed

11 APPENDIX: GPL LICENSE

GNU GENERAL PUBLIC LICENSE

Version 3, 29 June 2007

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```
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```

12 APPENDIX: SNMP OID OVERVIEW

This overview is also available with factory settings via the web interface using the URL: http://192.168.100.1/snmpd.txt.

```
#
# SNMP command overview for the CyBox AP family (automatically generated)
#
#
# SNMPSET commands:
#
# radio0_up
# radio0_down
# radio1_up
# radio1_down
# modem0_up
# modem1_up
# modem2_up
# modem3_up
# modem4_up
# modem0_down
# modem1_down
# modem2_down
# modem3_down
# modem4_down
# modem0_simslot <value>
# modem1_simslot <value>
# modem2_simslot <value>
# modem3_simslot <value>
# modem4_simslot <value>
# network<index>.<entry> <value>
# radio<index>.<entry> <value>
```

```
# wireless<index>.<entry> <value>

# uci <command> <config>.<section>[.<option>]=<value>

# service <name> <action>

# reboot

#

# SNMPSET system call:

#

# snmpset -c private -v 2c <IPv4> 1.3.6.1.4.1.2021.8.1 s <command string
or set entry string>

#

#

#

# SNMPGET/SNMPWALK objects:

#

# see list below

#

# SNMPGET system call:

#

# snmpget -c public -v 2c <IPv4> 1.3.6.1.4.1.2021.8.1.2.<ID>.101.1

#

# SNMPWALK system call:

#

# snmpwalk -c public -v 2c <IPv4> 1.3.6.1.4.1.2021.8.1.2.<ID>

#

##### system Table0 objects #####

boardname 1.3.6.1.4.1.2021.8.1.2.100

serial_number 1.3.6.1.4.1.2021.8.1.2.101

uboot_version 1.3.6.1.4.1.2021.8.1.2.102

firmware_version 1.3.6.1.4.1.2021.8.1.2.103

config_version 1.3.6.1.4.1.2021.8.1.2.104

uptime 1.3.6.1.4.1.2021.8.1.2.105

loadavg 1.3.6.1.4.1.2021.8.1.2.106

temperature 1.3.6.1.4.1.2021.8.1.2.107

uci_get 1.3.6.1.4.1.2021.8.1.2.108
```

```
custom1 1.3.6.1.4.1.2021.8.1.2.109

custom2 1.3.6.1.4.1.2021.8.1.2.110

custom3 1.3.6.1.4.1.2021.8.1.2.111

mpstat 1.3.6.1.4.1.2021.8.1.2.112

##### system Table0 objects #####

network_order 1.3.6.1.4.1.2021.8.1.2.150

----listing not printed here, see console command on top of this page
for live listing. The editor.----
```

13 APPENDIX: DEFAULT FACTORY SETTINGS

When shipped, the device has the following default settings:

Defaults for Ethernet 1 (all models):

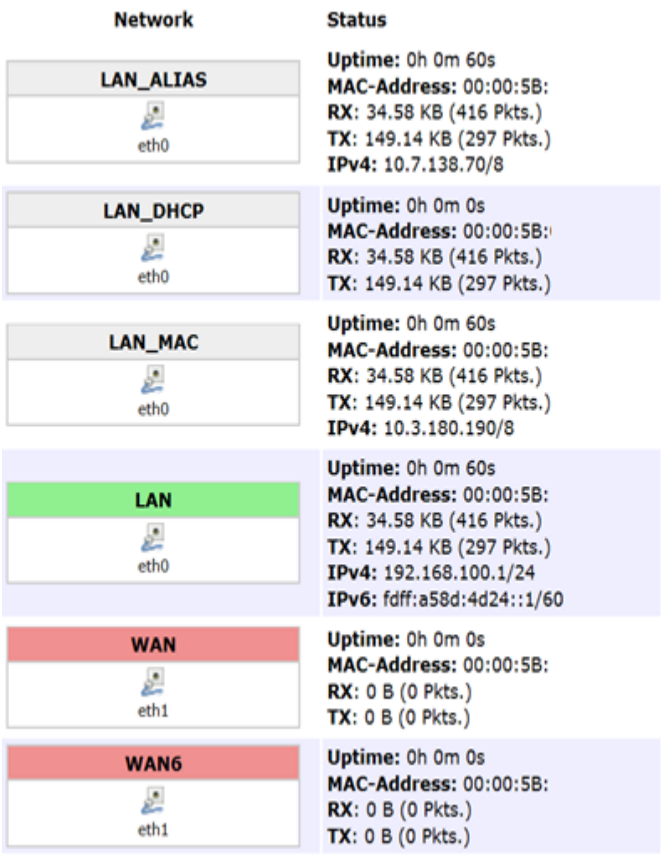
Interface	IPV4 address type	Address	Remark
lan	static IPv4 address	192.168.100.1/24	
lan_alias	static IPv4 address	Calculated based on serial number	See chapter 4.1 IP Addresses of the CyBox RT 2-A
lan_dhcp	IPv4 DHCP client		
lan_mac	static IPv4 address	Calculated based on eth0 MAC address	See chapter 4.1 IP Addresses of the CyBox RT 2-A

Defaults for Ethernet 2:

Interface	IPV4 address	Address	Remark
wan	IPv4 DHCP client		
wan6	IPv6 DHCP client		

Other Defaults (all models):

Interface	Parameter	Remark
Password for user ‘root’	root	Be sure to change it before deployment
WLAN, LTE, GPS	disabled	
Bridge	disabled	
DHCP/DNS server	disabled	
Firewall	*‘Input’* and *‘Output’* are set to *ACCEPT*, *‘Forward’* is set to *REJECT*	
VLAN	Not configured	



Default Network Configuration