ELTEC systems

CYBOX AP 3

WIRELESS ACCESS POINT

CONFIGURATION MANUAL

Version: 1.0 for firmware V20.48.00 | Date: 14.04.2021

Contents

1 IMPORTANT INFORMATION

1.1 Revision

Internal version: ff6db28

Revision	Changes	Date
1.0	Initial version for this firmware	14.04.2021

1.2 Disclaimer

1.2.1 Copyright

1.2.2 GPL Statement for CyBox Software

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55129 Mainz

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1.2.3 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.

1.3 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.

3 ABOUT THE CyBox AP 3

The CyBox AP 3 is a member of the CyBox family of robust wireless railway access points. It is particularly designed to meet the requirements of rolling stock applications. It offers stable, secure, and high bandwidth connections between the local Ethernet and wireless clients. With the assistance of the access point, multiple mobile Wi-Fi-compatible devices in a passenger train or subway have the possibility to communicate with the Internet or access local data, for example.

The CyBox AP 3 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/LEDE. For Open Source information see the preface.

4 HOW TO ACCESS THE CyBox AP 3

The CyBox AP 3 can be configured in several ways:

1. The graphical web interface
2. The command line interface via a SSH or serial connection, see 10 SSH / SERIAL CONSOLE
3. Using an USB stick (to update the firmware or apply a prepared configuration, see 11.2 USB Possibilities)
4. Using SNMP (see 7 SNMP)

4.1 IP Addresses of the CyBox AP 3

By default, the CyBox AP 3 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)

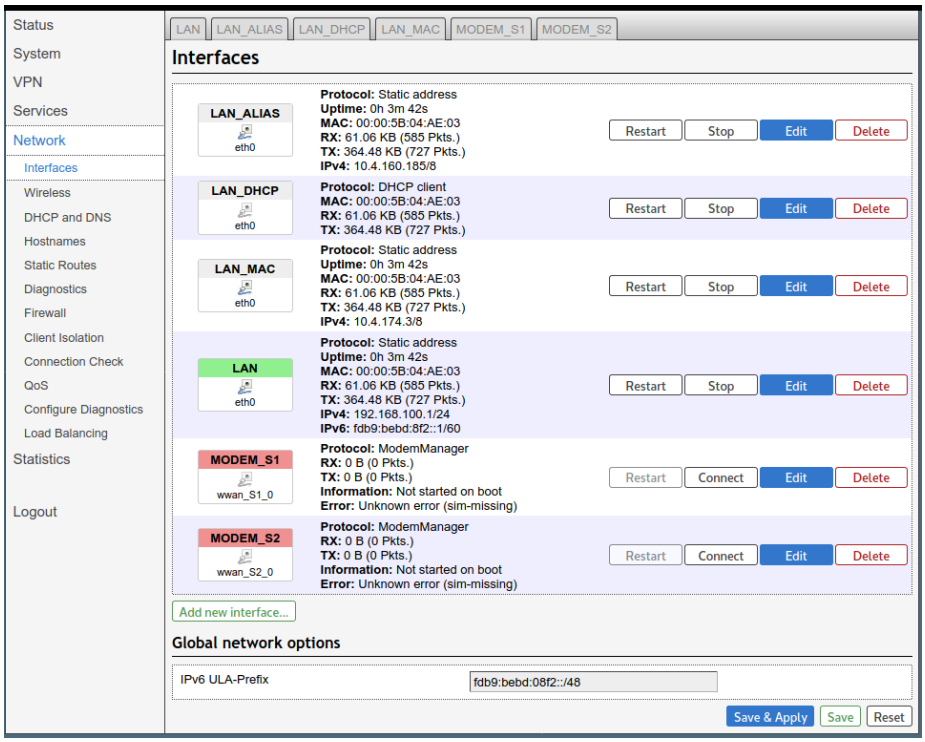
The LAN_ALIAS address is derived from the serial number (which is printed on the type plate) as follows (Example Serial Number: EL303289):

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 AP 3.

The web interface is accessible using HTTPS on the IP addresses listed in 4.1 IP Addresses of the CyBox AP 3 (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 AP 3 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`.

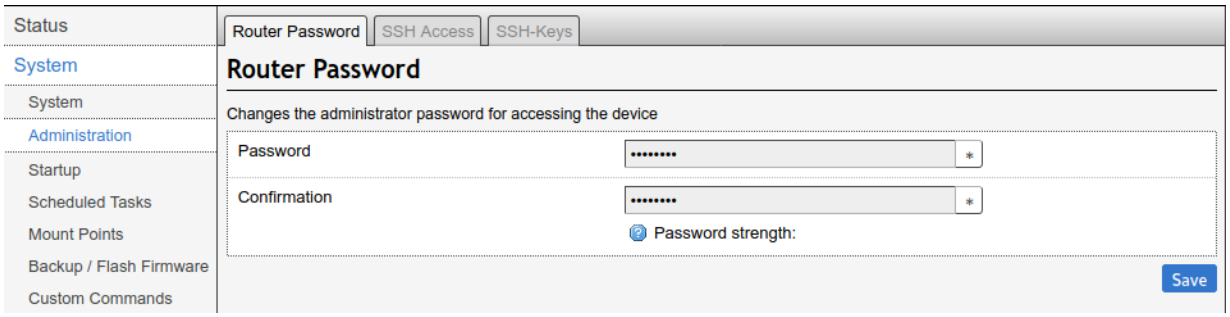
For all below configuration examples, the following initial situation is assumed:

- CyBox AP 3 is running
- CyBox AP 3 has been reset to factory defaults, the IP address is 192.168.100.1
- Default Root-User password: 'root'
- Operator workstation and CyBox AP 3 are connected via Ethernet
- Workstation browser is logged-in to the CyBox AP 3 web interface
- Operator is additionally logged in to CyBox AP 3 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

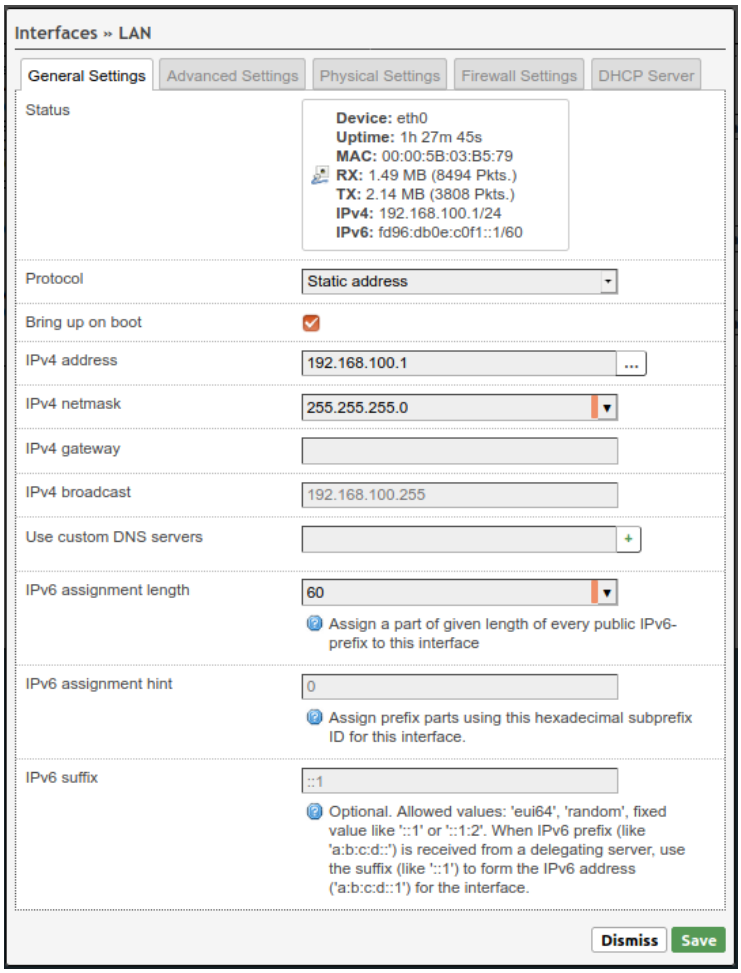
The password should be changed first to avoid legal consequences as described in the preface. The default user/password is'root'/'root'. To change it, go to `System` → `Administration`, type new password and click `Save`.



Change Password

5.2 Change LAN IP address (Quick Guide)

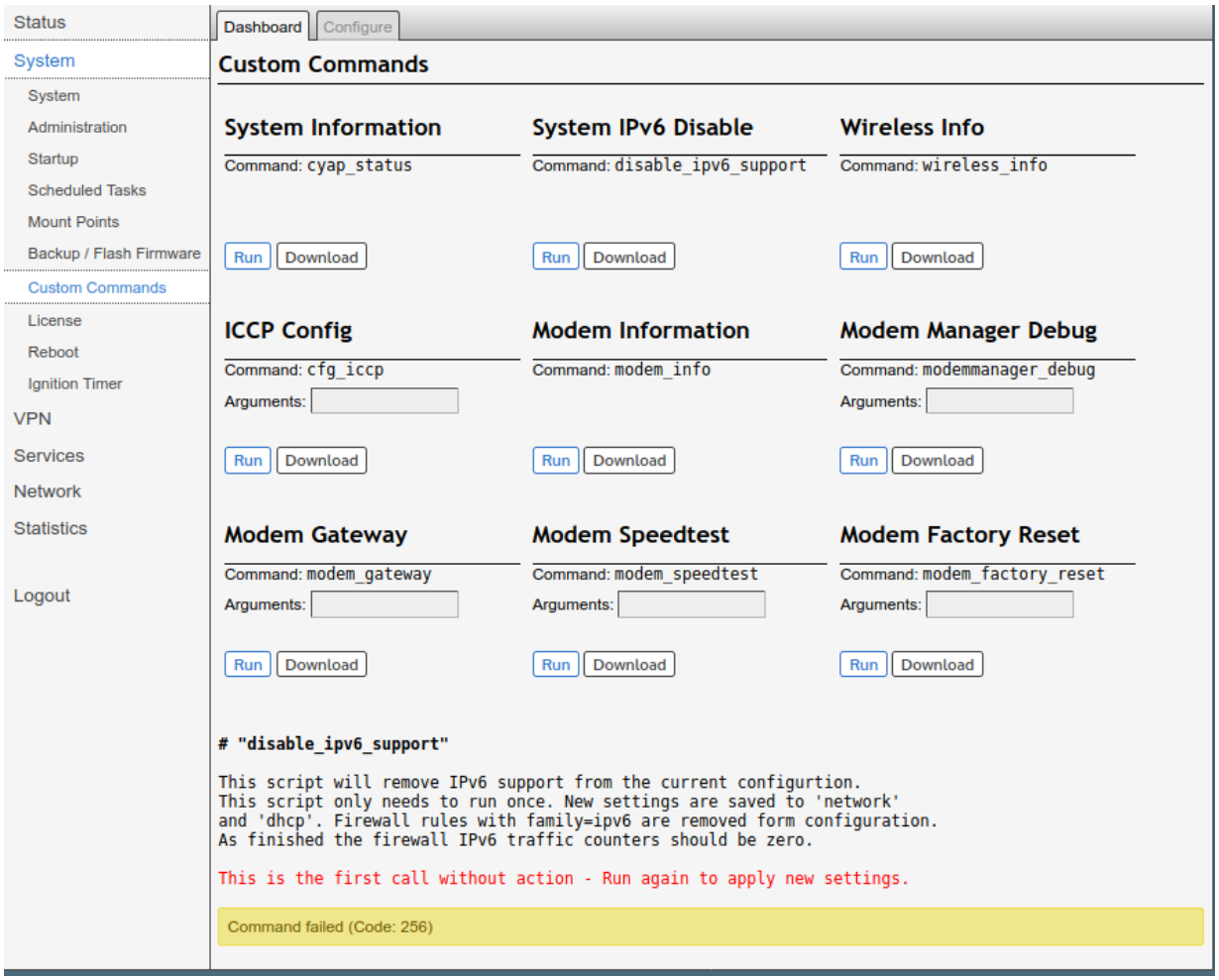
The factory default IP address 192.168.100.1 must be changed to meet your network topology. Open `Network` → `Interfaces` and click the `Edit` button of the LAN interface. Modify the IP address (`IPv4 address` field), or change the `Protocol` field to `DHCP client`, then click on `Save & Apply`. To regain 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 AP 3 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 AP 3 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 AP 3 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 AP 3 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*

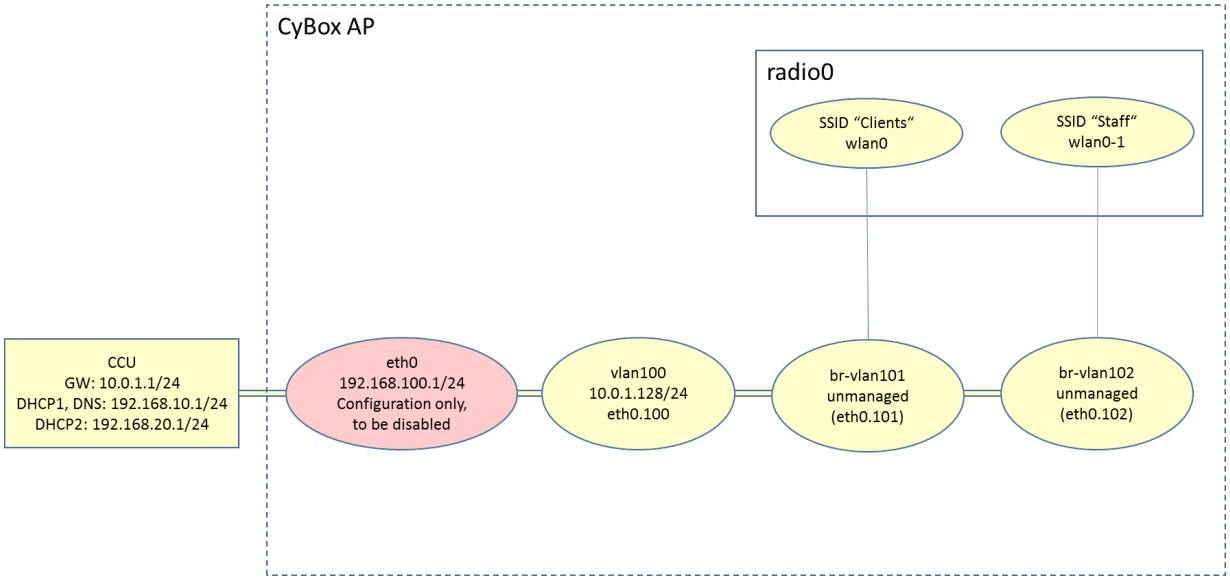
This terminates the local domain 192.186.100.0. Now connect the CyBox AP 3 via Ethernet to the gateway domain, restart the CyBox AP 3 (use hardware reset switch) and reconnect the WLAN clients.

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 AP 3 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 AP 3. 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 AP 3. This is important because some changes - if applied stand-alone - could break the IP connection between host and the CyBox AP 3.

  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 AP 3 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 AP 3.
- *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

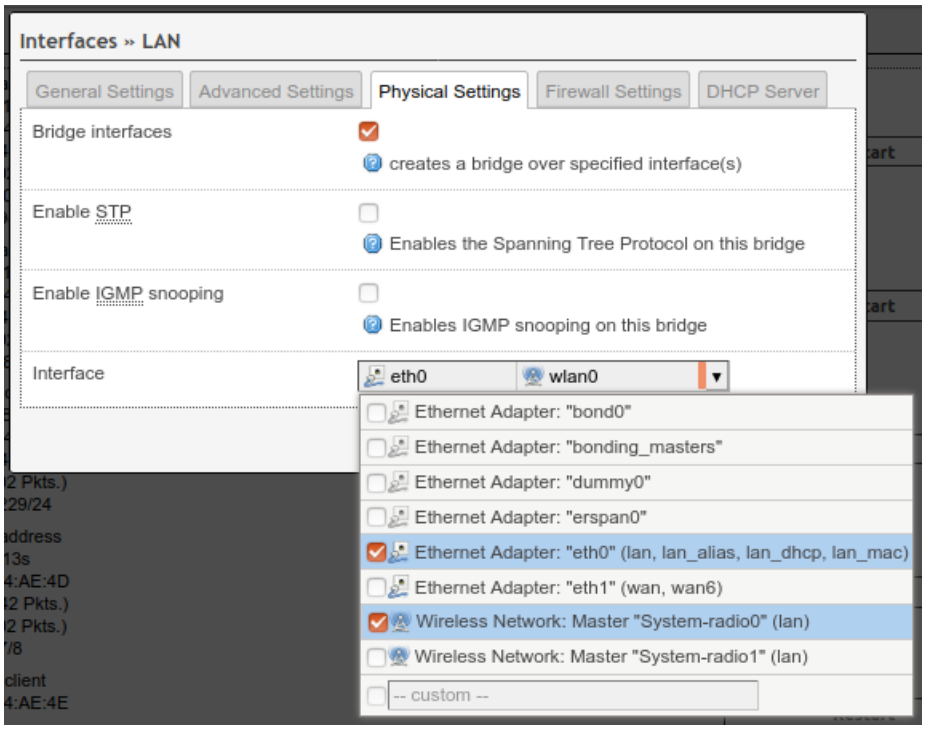
A DHCP server can run on the device to assign IPv4 addresses to WLAN clients. It is enabled by unchecking *Disable DHCP for this interface*. However, DHCP often is managed by a dedicated DHCP server on the backbone and not directly on the access point. In that case, the DHCP server on the access point 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 → LAN → section Common Configuration → Physical Settings. Check Bridge interfaces and include all *Interfaces* that should belong to the new bridge interface.

The example Bridge Interface Setup shows a bridge containing "Ethernet Adapter: eth0" and "wlan0" (Wireless Network: Master "System-radio0").

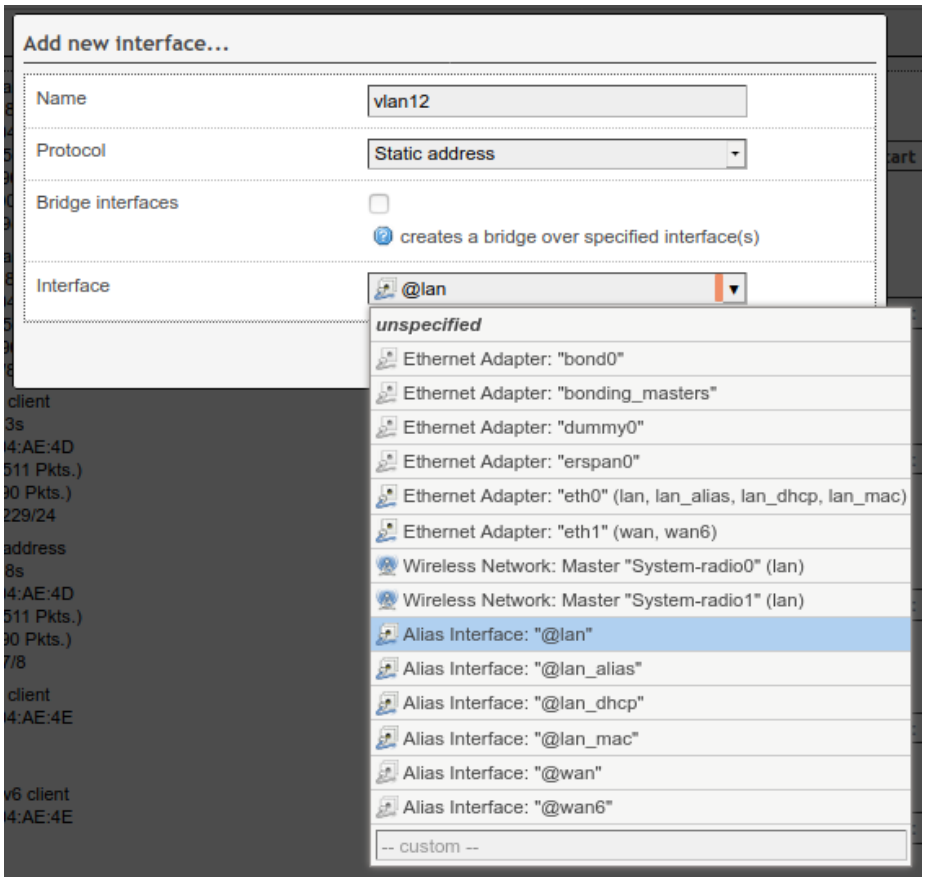


Bridge Interface Setup

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. “eth0.12”. In this example “12” is the VLAN tag to be used.



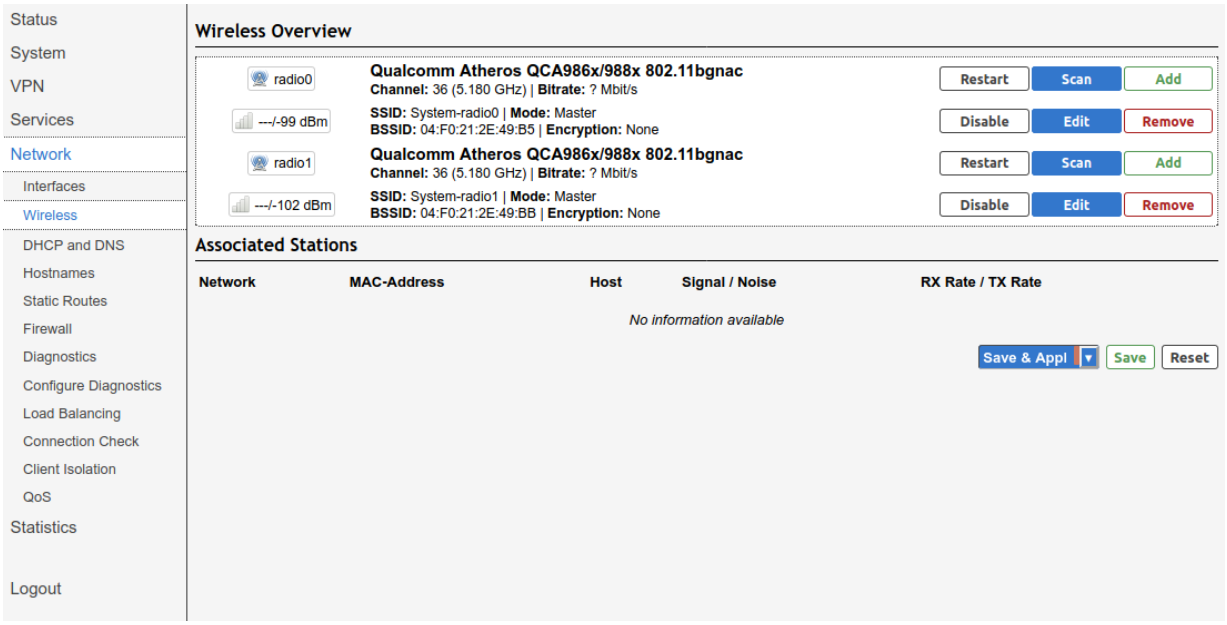
VLAN interface setup

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.

6.1.2 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 AP 3 with two radios installed. Depending on the hardware, other configurations may be shown.

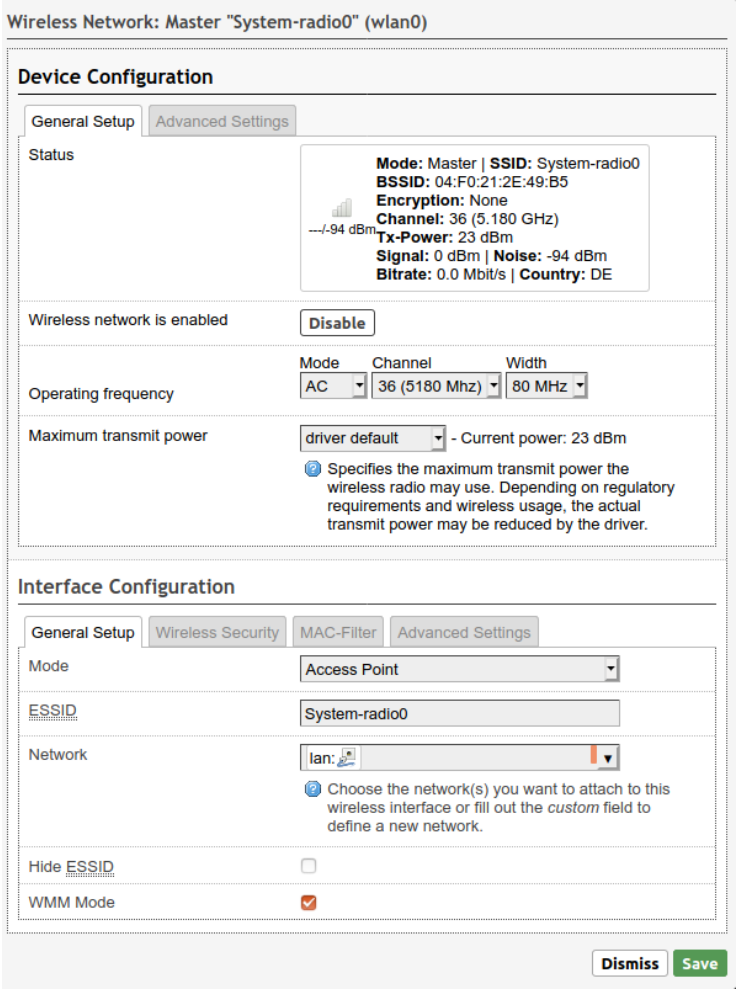
After enabling the radio, you can configure physical settings. Clicking `Network` → `Wireless` → `Edit` redirects you to the *'Device Configuration'* menu.

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

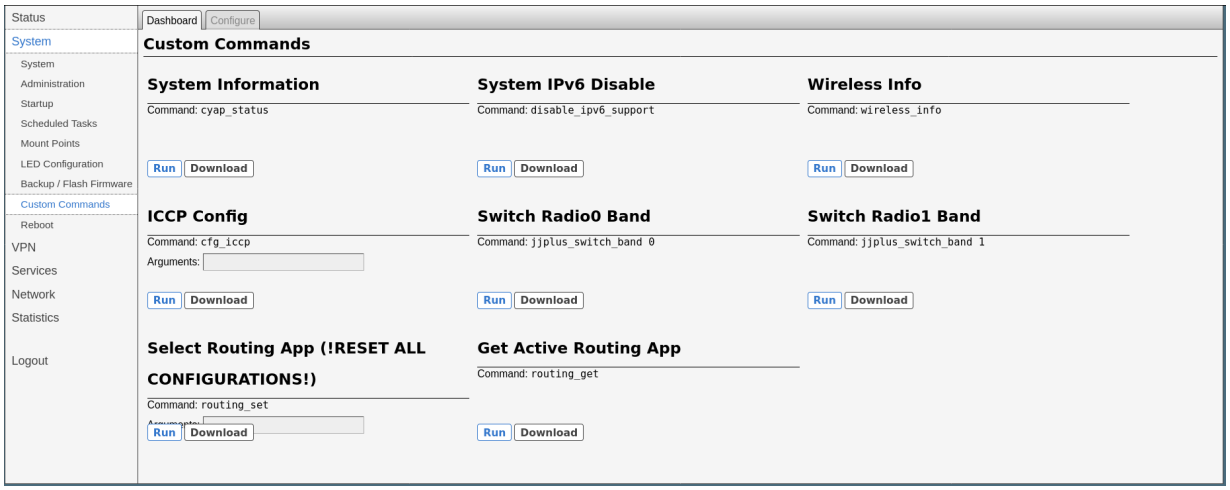
After the device has been enabled, the radio status should be checked if the selected channel / mode combination is working.

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 JJPlus Radio Card Band Configuration

If system is equipped with a **JJPlus Wave-2** radio module, the frequency band 2.4 GHz and 5 Ghz cannot be switched on the fly (runtime) in the wireless configuration menu. After a *Factory Reset* the radio modules are configured for 5 GHz as default band. To switch to the 2.4 GHz band a **Custom Command=>Switch RadioX Band** must be executed and after that a system reboot must be triggered. The 2.4 GHz mode then, will be permanently stored in the configuration backup archive. Executing the custom command button again will toggle from 2.4 GHz to 5 GHz and vice versa. The selected mode is always stored in the configuration backup archive. Note that a band toggle will always *disable* the selected radioX. After reboot the selected radioX must be activated again and the channel/bandwidth must be configured.



JJPlus Wave-2 Frequency Band Toggle

6.1.2.4 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 6.1.2.8 Multi-AP Client Isolation).

6.1.2.5 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)

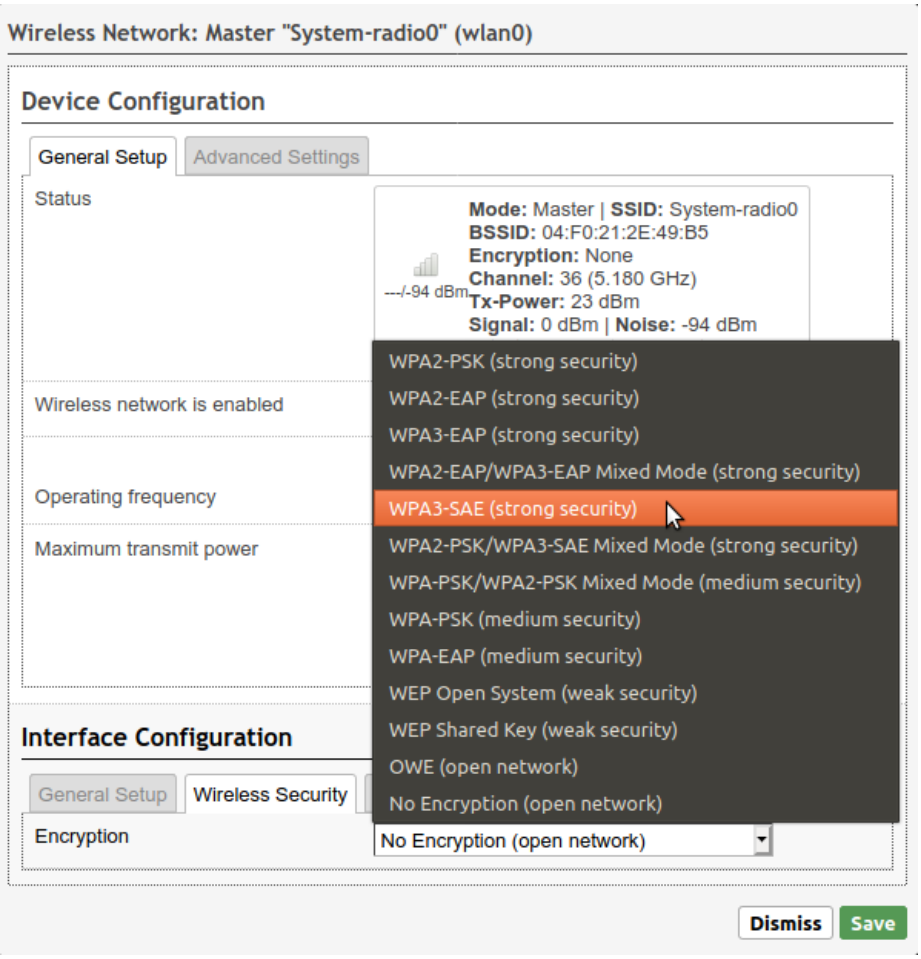
- WEP Shared Key
- WEP-EAP Open System

- 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 AP 3 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

6.1.2.6 Hotspot 2.0

The CyBox AP 3 supports Hotspot 2.0 (Release 1), which is configured on the tab `Hotspot 2.0`.

> **Note**
>
> The `Hotspot 2.0` tab is only present if
>
> - The WLAN is configured as AP
> - The encryption mode uses RADIUS (i.e. EAP)
>
> SP/HO

Hotspot 2.0 separates the hotspot operator from the service providers. The hotspot operator maintains the access point offering Hotspot 2.0 services while the service providers are responsible for authentication and authorization of WLAN clients. It is possible to configure multiple service providers on a single access point.

Each hotspot operator has one or more domain names, which can be configured in the `Domain Names` setting.

Service providers are identified by one of the following:

- `Consortium IDs`: Numeric values assigned by the IEEE. Each ID names a consortium of multiple service providers.
- `NAI Realms`: The domain names of the service providers. Optionally, the authentication scheme can be appended to each name. The WLAN clients can fetch this information prior before they connect.
- `3GPP Cell Identifiers`: Each cell ID consists of the MCC and MNC of a service provider. A mobile device can seamlessly roam between mobile networks and WLAN by identifying its mobile network provider on a Hotspot 2.0 access point.

At least one of these three parameters must be configured.

The `Operator Friendly Name` is the access point operators name. It is intended to be presented to human users of WLAN clients. Multiple entries can be configured to present the name in different languages.

The `Venue Group` and `Venue Type` settings classify the type of the venue in which the access point is installed. This might be a coffee shop, for example. The possible values are defined in IEEE Std 802.11u-2011.

The `Venue Name` might be presented to human users. It can be configured for multiple languages.

The `Network Access Type` describe the type of the offered network access. The `Internet is available` indicates whether internet access is available from this access point. Both are presented to WLAN clients before they connect.

The `ANQP Domain ID` can be used to group multiple access points which reside in the same ESS (Extended Service Set).

The `Additional ANQP Elements` setting allows to add elements.

6.1.2.7 WLAN Clients test

After setup is completed, the access point is ready to associate WLAN clients to the local network.

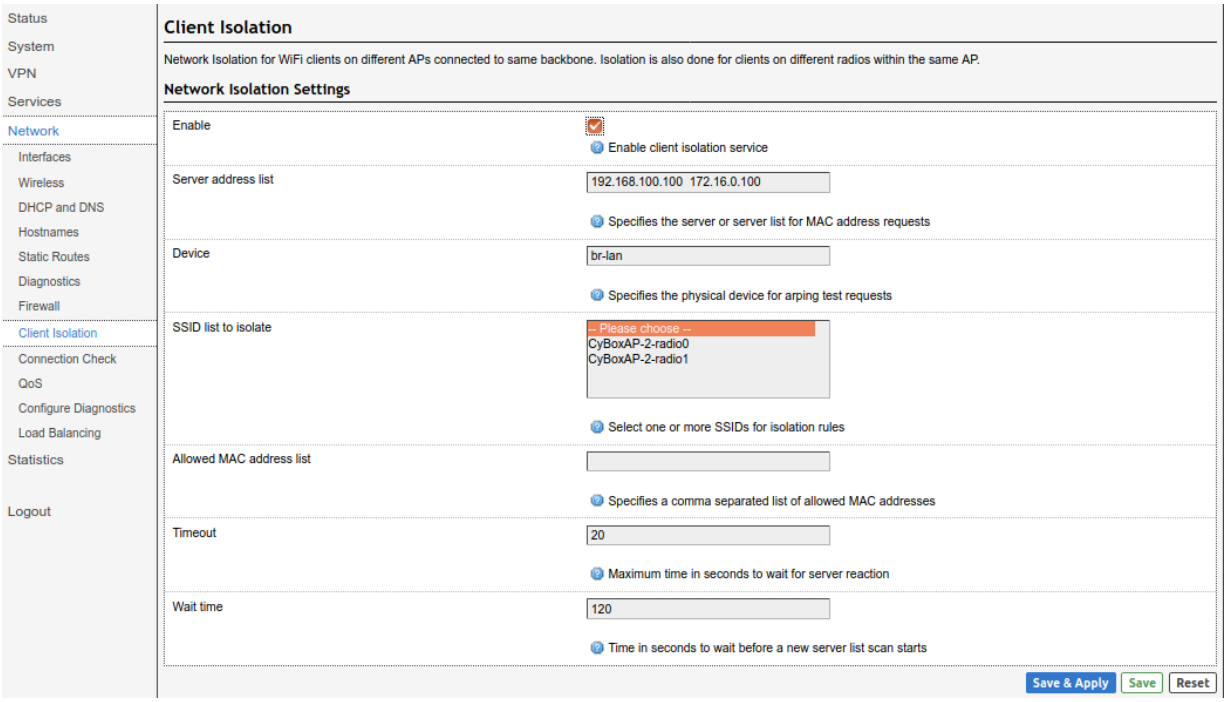
6.1.2.8 Multi-AP Client Isolation

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 AP 3 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

6.1.2.9 Connection Check

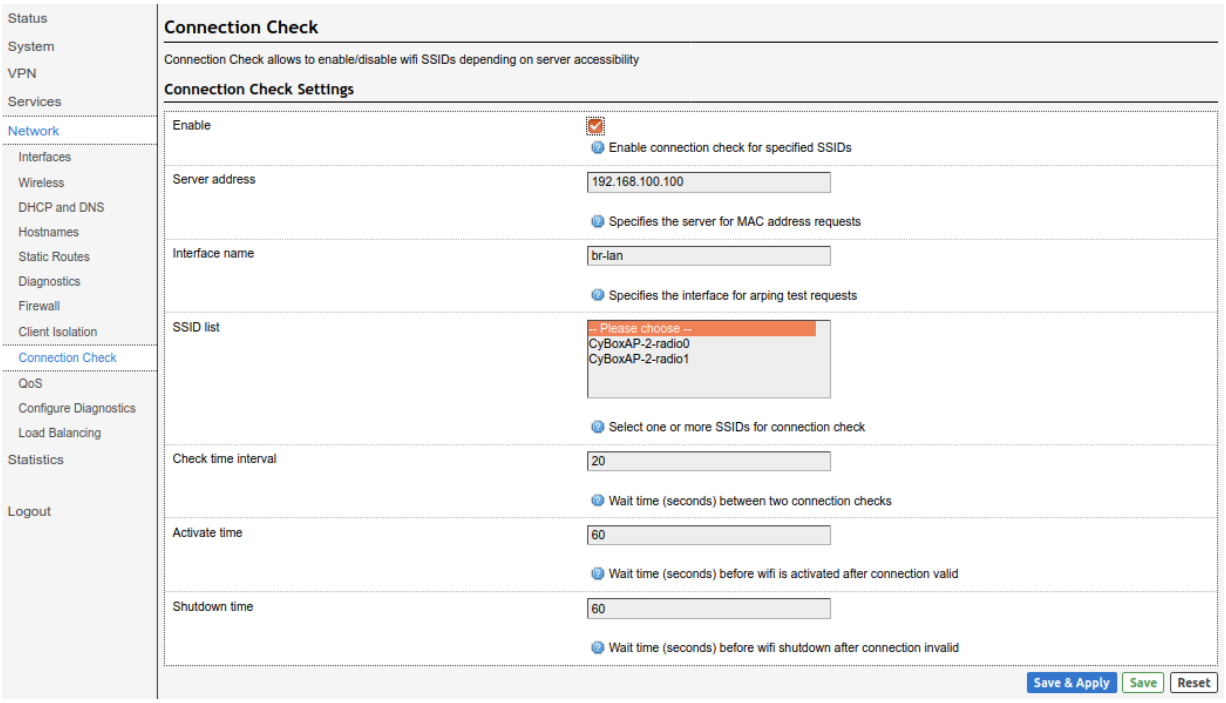
The connection check service allows to disable WLANs while no internet connectivity is possible. This can improve the user experience by avoiding being connected to a WLAN which delivers no internet connectivity.

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

6.1.2.10 Access Point Scanning Service (Wireless Monitoring)

Reporting nearby APs to interested parties

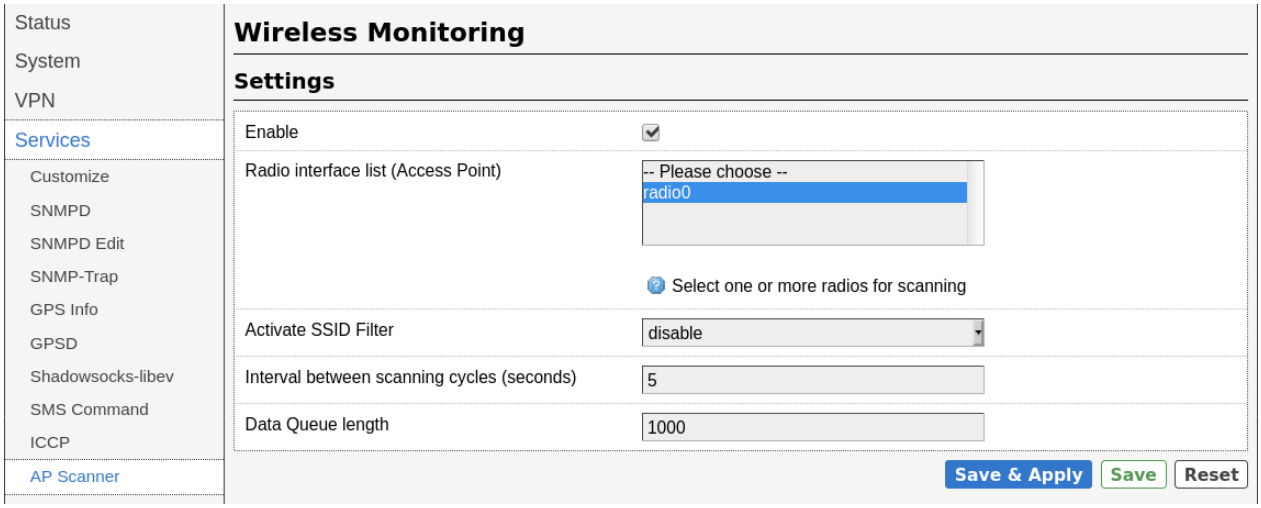
> **Important**
>
> A **must** precondition to use this service is to have at least one available radio device running AP (AccessPoint) mode. Please make sure, such configuration is done and running **before** activating this service. Otherwise no scanning results can be obtained.

Since service is activated (enabled), scanning is done continiously in the background. All channels of selected radio device(s) are scanned one after another. Scan results are stored to a temporarily FIFO queue and can be obtained anytime.

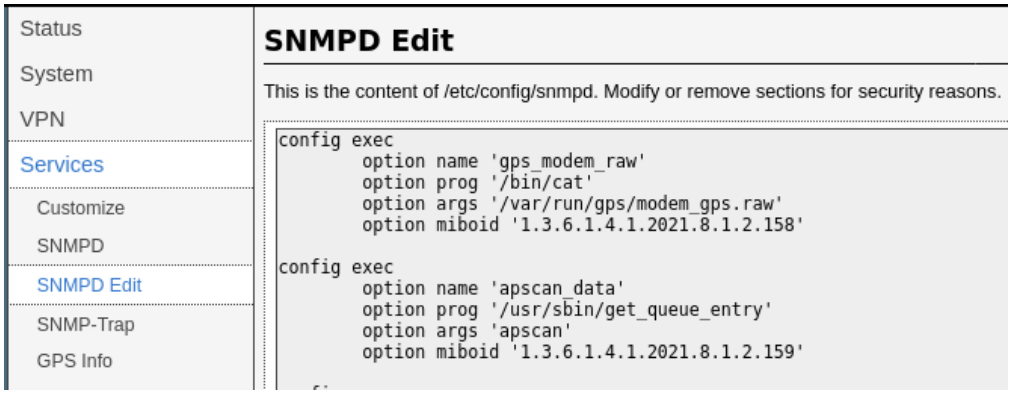
The scanning service is configurable over UCI resp. LUCI. A separate page (Services -> AP Scanner) can be used to configure radio devices which are used for scanning. Also the interval between scanning cycles and the maximum queue length can be configured.

Important

System load and network traffic caused by SNMP calls can be minimized by using of SSID filter parameters. As long SSID filter is enabled, only entries matching the predefined filter will be stored to a result queue.



Scanning results can be obtained by a SNMP request. Request configuration can also be done by using of UI page (Services->SNMPD Edit).



Getting queue entry from remote host

```
~# snmpget -c public -v 2c <device_ip>   1.3.6.1.4.1.2021.8.1.2.159.101.1;
iso.3.6.1.4.1.2021.8.1.2.159.101.1 =
STRING: "00:15:61:20:AC:8A;CyBoxGW-P-radio1;04:F0:21:3F:2E:AA;36;-27;2020-05-06 13:20:17"
```

In case of empty queue respone will be a “nil” value.

```
~# snmpget -c public -v 2c <device_ip>   1.3.6.1.4.1.2021.8.1.2.159.101.1;
iso.3.6.1.4.1.2021.8.1.2.159.101.1 = STRING: "nil"
```

Important

As soon queue has reached the configured maximum length, every time there is a new entry added to queue the “oldest” one will be dropped!

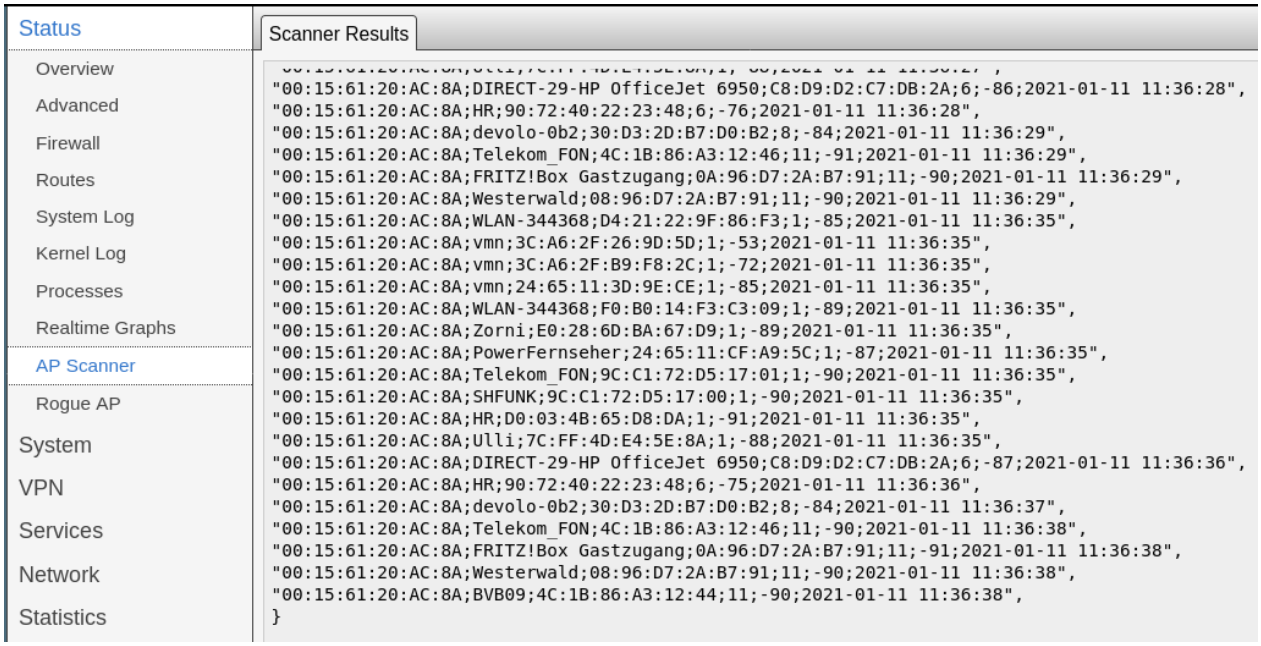
How to avoid data lost?

1. increase maximum queue length
2. collect sampled data more often e.g. once a second (snmp request)

Scanning results are stored in CSV format:

- S_BSSID (MAC of scanner radio)
- SSID (the name)
- BSSID (the MAC)
- channel
- signal level
- “last seen” timestamp

Current queue status (entries) can be also discovered on the UI page (Status->AP Scanner).



6.1.2.11 Client Counting Service

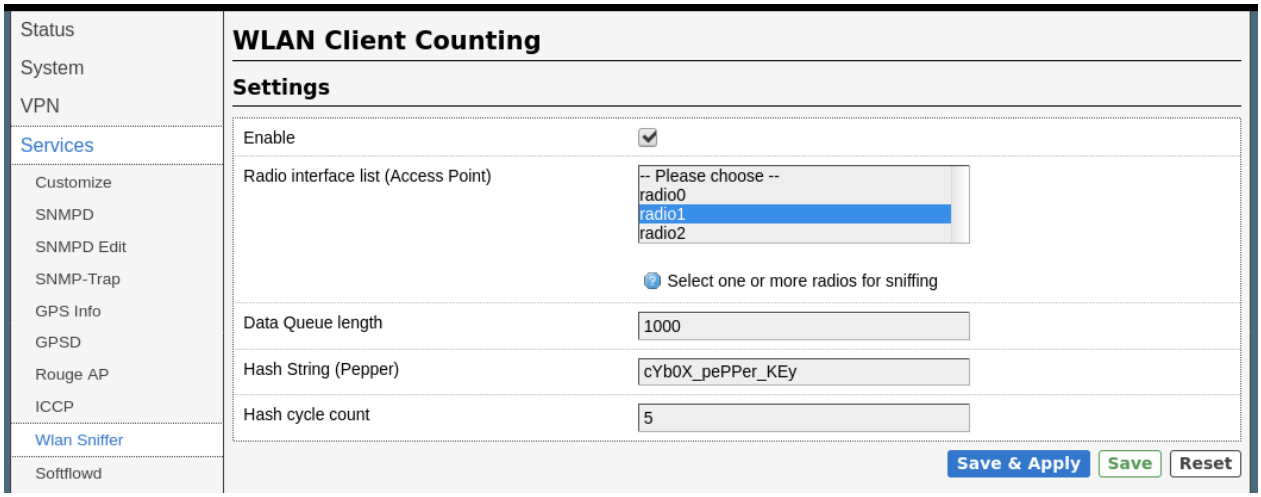
Reporting nearby Clients to interested parties

Important

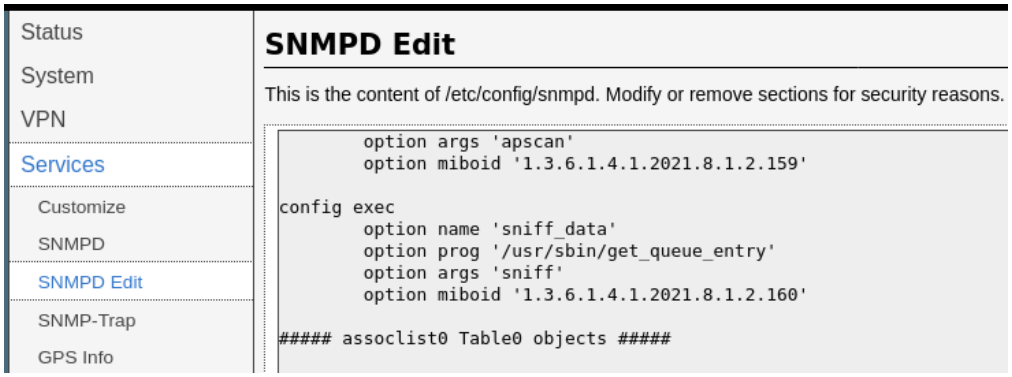
A **must** precondition to use this service is to have at least one available radio device running AP (AccessPoint) mode. Please make sure, such configuration is done and running **before** activating this service. Otherwise no sniffed results can be obtained.

Since the service is activated (enabled), sniffing is done continiously in the background. A special monitor device is created for selected radio interface(s). Data received by radio interface (AP) also goes throw the monitor device. Probe Requests sent by clients around the monitor device are used for definitely client identification. Sniffed personal data (`MAC` and `SSID`) have to be protected according to the requirements of personal data protection regulations (DSGVO). Encryption algorith uses additional String (`Pepper`), configured by user, to achieve better anonymization results. Also there is a mechanism to encrypt personal data up to multiple times (`hash_count`). Results are stored to a temporarily FIFO queue and can be obtained anytime.

The sniffing service is configurable over UCI resp. LUCI. A separate page (Services -> WLAN Sniffer) can be used to configure radio devices which are used for sniffing. Also the maximum queue length, additional string and hash cycle count values can be configured.



Results can be obtained by a SNMP request. Request configuration can also be done by using of UI page (Services->SNMPD Edit).



Getting queue entry from remote host.

```
~# snmpget -c public -v 2c <device_ip>   1.3.6.1.4.1.2021.8.1.2.160.101.1;
iso.3.6.1.4.1.2021.8.1.2.160.101.1 =
```

```
STRING: "radio1;
    c78236b5fb56b9023249e23e94dae7092aaa16f792aa168b21c064713b9883fe;
    n/a;
    -29dBm;
    2020-05-07 09:25:20"
```

In case of empty queue respone will be a “nil” value.

```
~# snmpget -c public -v 2c <device_ip>   1.3.6.1.4.1.2021.8.1.2.160.101.1;
iso.3.6.1.4.1.2021.8.1.2.160.101.1 = STRING: "nil"
```

Important

As soon queue has reached the configured maximum length, every time there is a new entry added to queue the “oldest” one will be dropped!

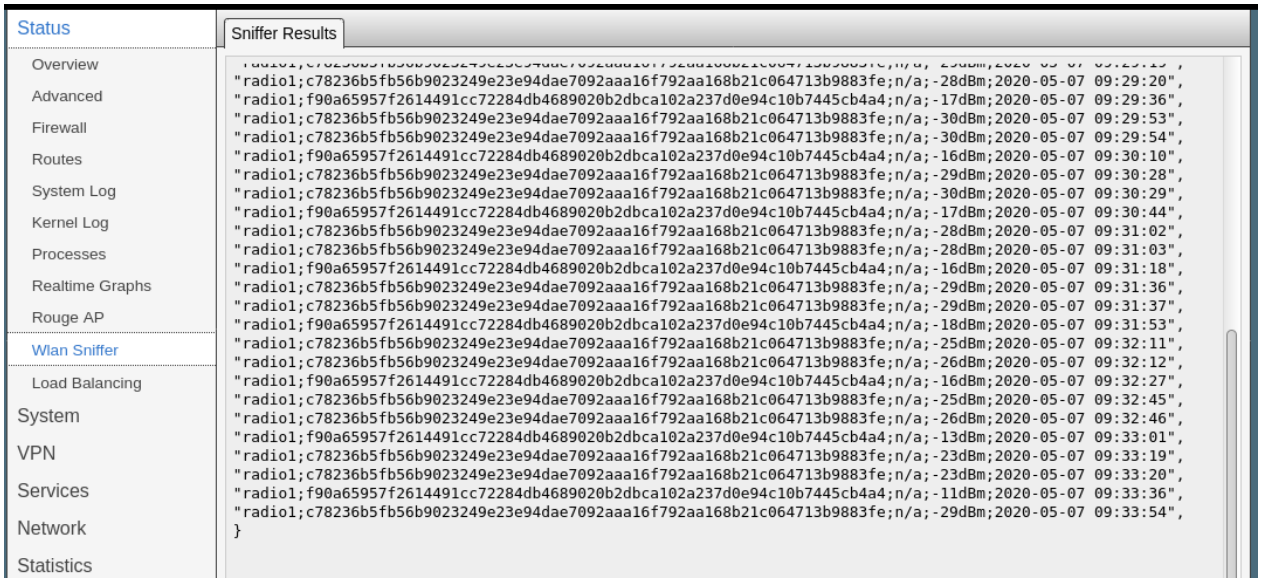
How to avoid data lost?

1. increase maximum queue length
2. collect sampled data more often e.g. once a second (snmp request)

Sniffed results are stored in CSV format:

- radio device (which is used for sniffing e.g. radio0)
- MAC
- SSID (n/a for empty SSID)
- RSSI (signal level in dBm)
- “last seen” timestamp

Current queue status (entries) can be also discovered on the UI page (Status -> WLAN Sniffer).



6.1.2.12 Rogue Access Point Detection Service

This service is used to detect unauthorized Access Points nearby and scans nearby access points and classifies them as “rogue” or “not rogue”. The rogue APs are reported via SNMP traps.

> **Important**
>
> The rogue AP detection algorithm relies on the 8 THE FLYING CONTROLLER MECHANISM . The detection algorithm is only active on devices running in **controller** mode. As the controller mode selection is done automatically between devices running in the same network (LAN), all potentially candidates for Rogue AP detection have to be configured identically.

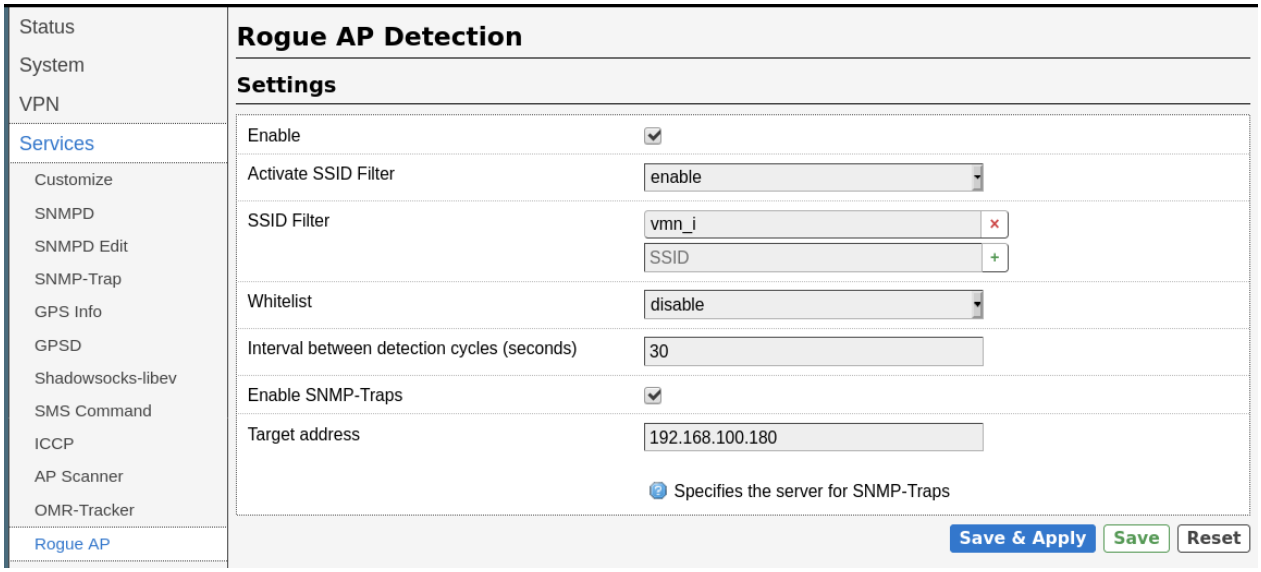
Multiple devices can take part on rogue access point detection. Every device running the AP scanning service and Flying Controller services and connected to the common wired network can be used as a part of the detection network. All scanned data from detection participants are requested by the controller device via SNMP calls and used for rogue AP detection.

> **Important**
>
> The rogue AP detection algorithm relies on the 6.1.2.10 Access Point Scanning Service (Wireless Monitoring) running on all participating devices.

As long as an SSID filter is enabled, only entries matching the predefined filter will be used during for detection. Known authorized devices can be whitelisted by using of whitelist parameter. Participants of the common network (i.e. the workers of the flying controller mechanism) are whitelisted automatically.

> **Important**
>
> System load and network traffic caused by SNMP calls can be minimized by using of SSID filter parameters. This also can be done for AP Scanner Service.

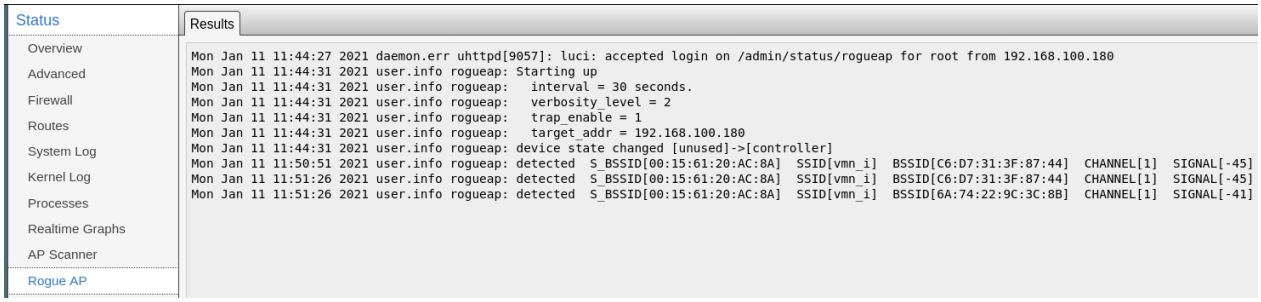
Participants connected to the wired network (all workers and the controller itself) are automatically whitelisted by service and not recognized as rogue devices. All other scanned APs with the same SSID will be declared as rogue and reported to a specified host. These notifications can be enabled with parameter “Enable SNMP Traps”. IP address of the SNMP trap receiver can be configured with the parameter “Target address.”



SNMP notifications are defined within the ELTEC MIB and have following format:

```
ELTEC-CYAP-MIB::rogueAPdetected
ELTEC-CYAP-MIB::rogueDataSSID
ELTEC-CYAP-MIB::rogueDataBSSID
ELTEC-CYAP-MIB::rogueDataChannel
ELTEC-CYAP-MIB::rogueDataSignal
ELTEC-CYAP-MIB::rogueDataLastseen
ELTEC-CYAP-MIB::rogueDataSBSSID
```

Status messages can be discovered on the UI page (Status->RogueAP).



6.1.3 Multi-WAN Manager (MWAN3)

> **Important**
>
> Since MWAN3 and LinkAggregation are concurrent routing features, only one of them can be active at the same time. Please refer to chapter 6.1.4.1 OpenMPTCProuter versus 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:

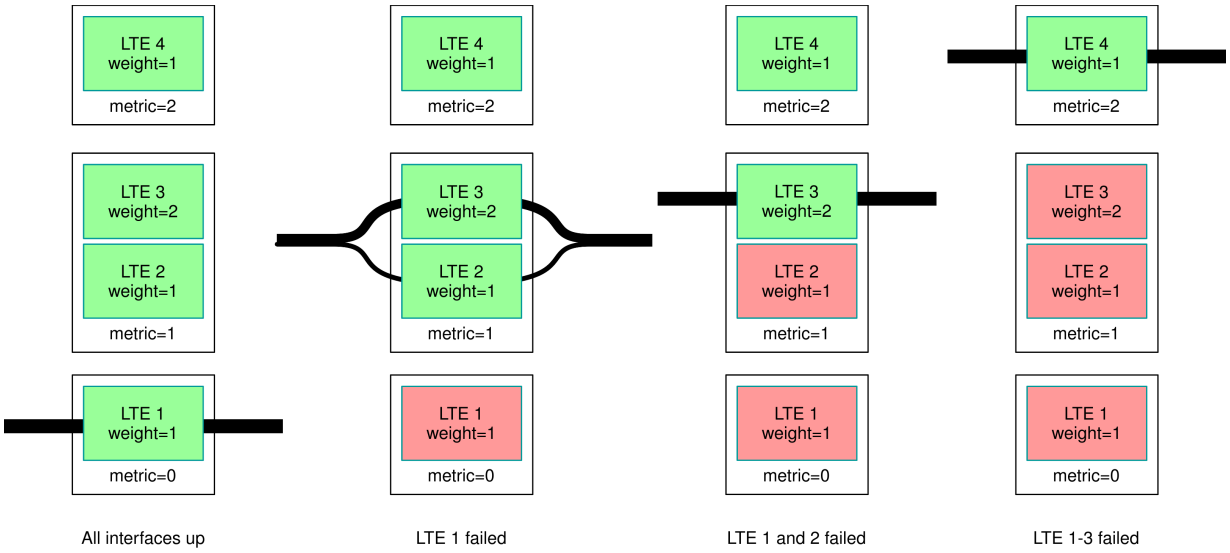
- Monitoring of WAN connectivity using repeated ping tests (ping | arping | httping).
- Routing of outbound traffic to another WAN interface if the first WAN interface loses connectivity, based on metric. The connection with the lowest metric is preferred, other connections are only used if the preferred 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 AP 3. 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:

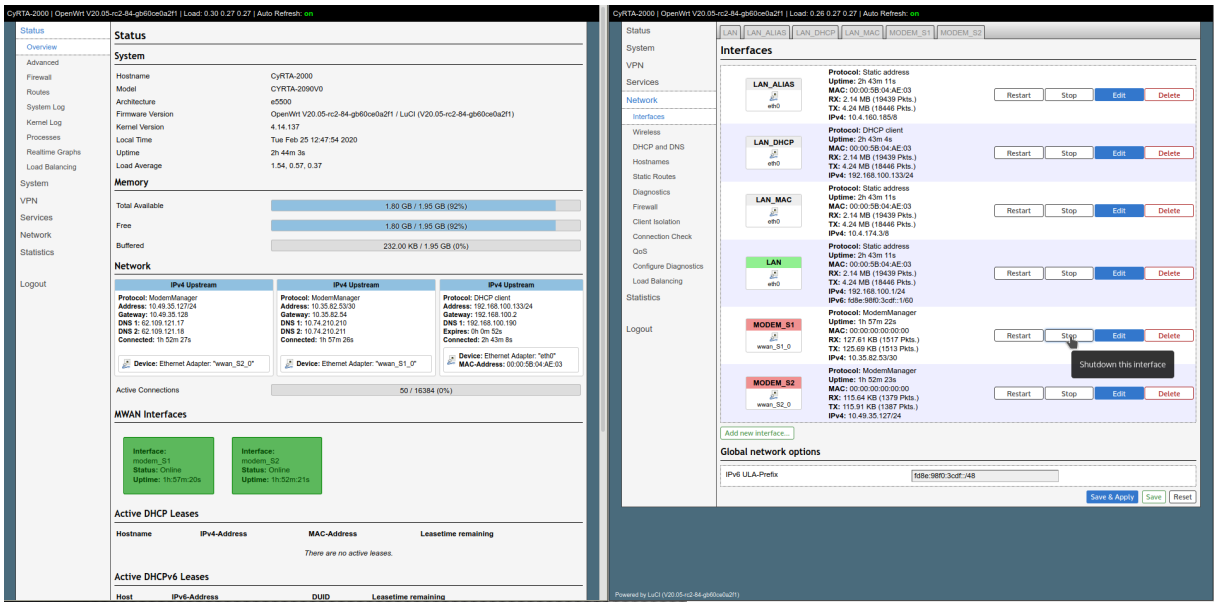
- provides outbound WAN traffic load balancing over multiple WAN interfaces based on a numeric weight assignment
- monitors WAN connections using repeated ping tests (ping | arping | httping) and automatically routes outbound traffic to another WAN interface if the first WAN interface loses connectivity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

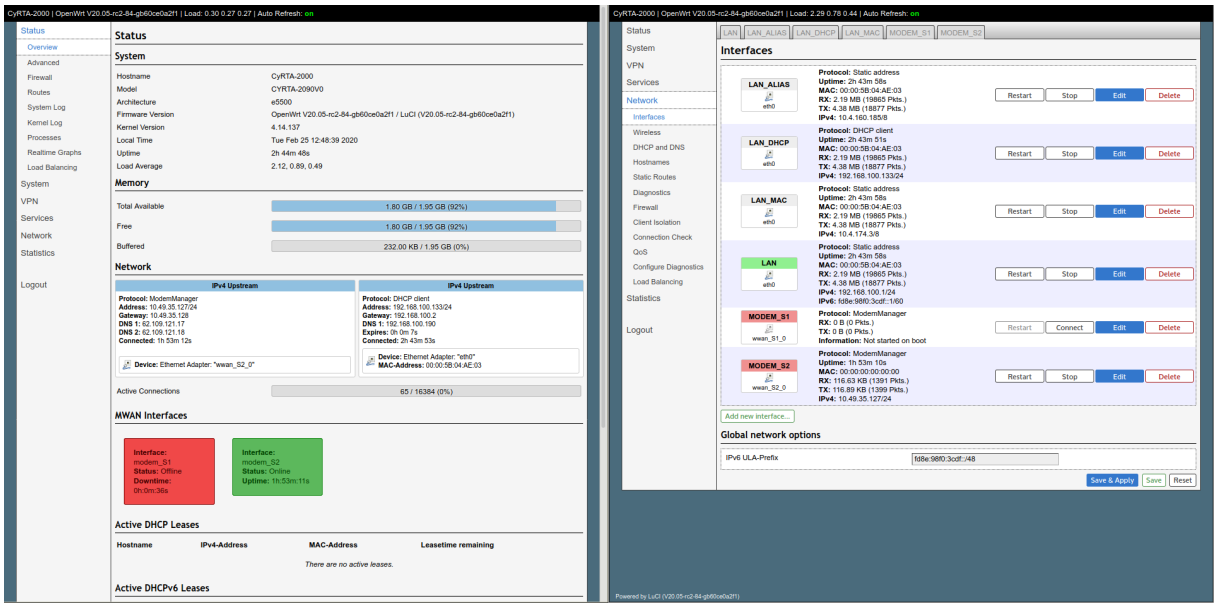
After complete Modem setup the modem interfaces are up and tracking via ping is active. To check the hotplug MWAN mechanism open a second web interface to CyBox AP 3 and go to `Network` → `Interfaces`.

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

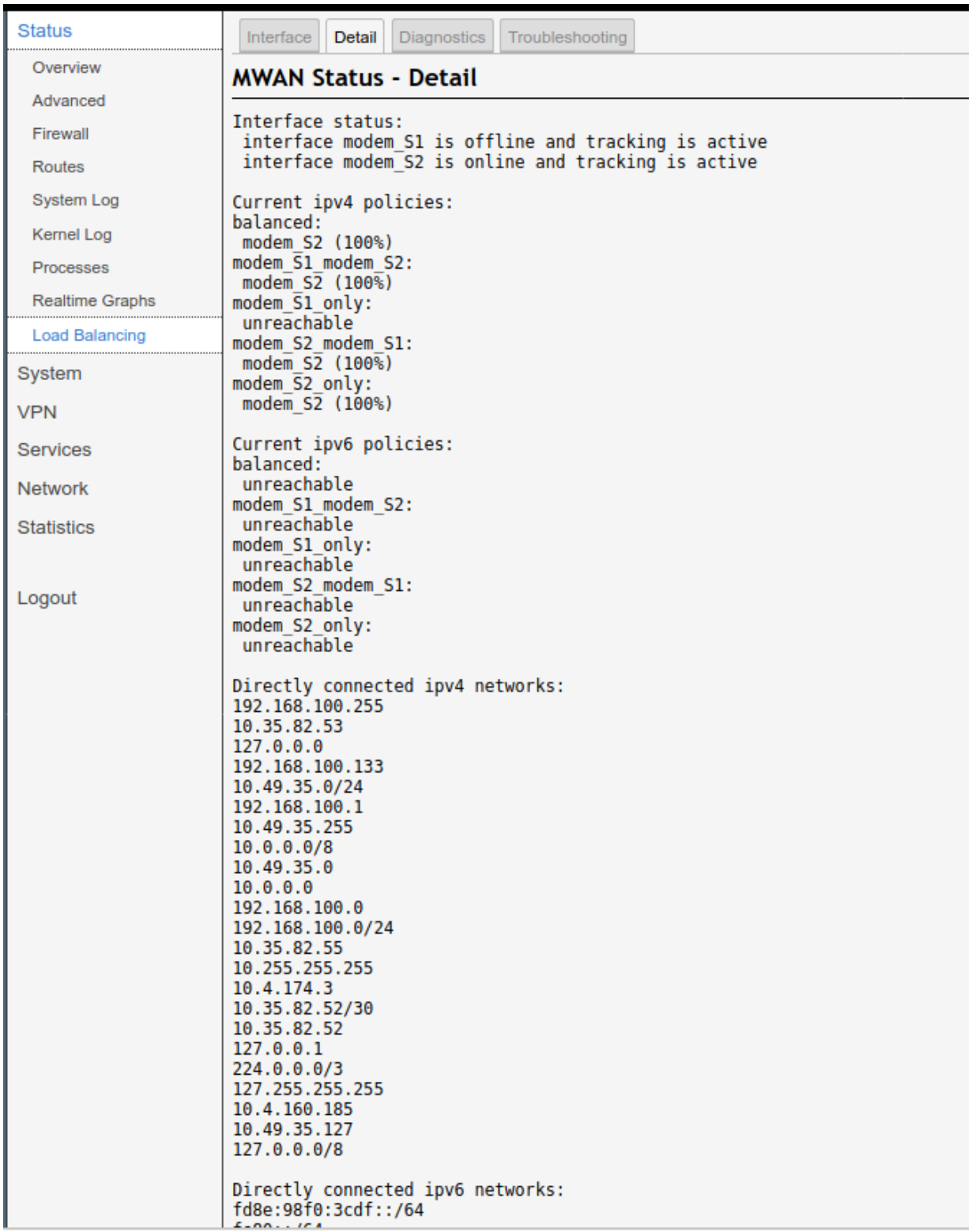
As the interface is down, all traffic has stopped and standard gateway switches to modem1.



MWAN test

6.1.3.3 MWAN Status

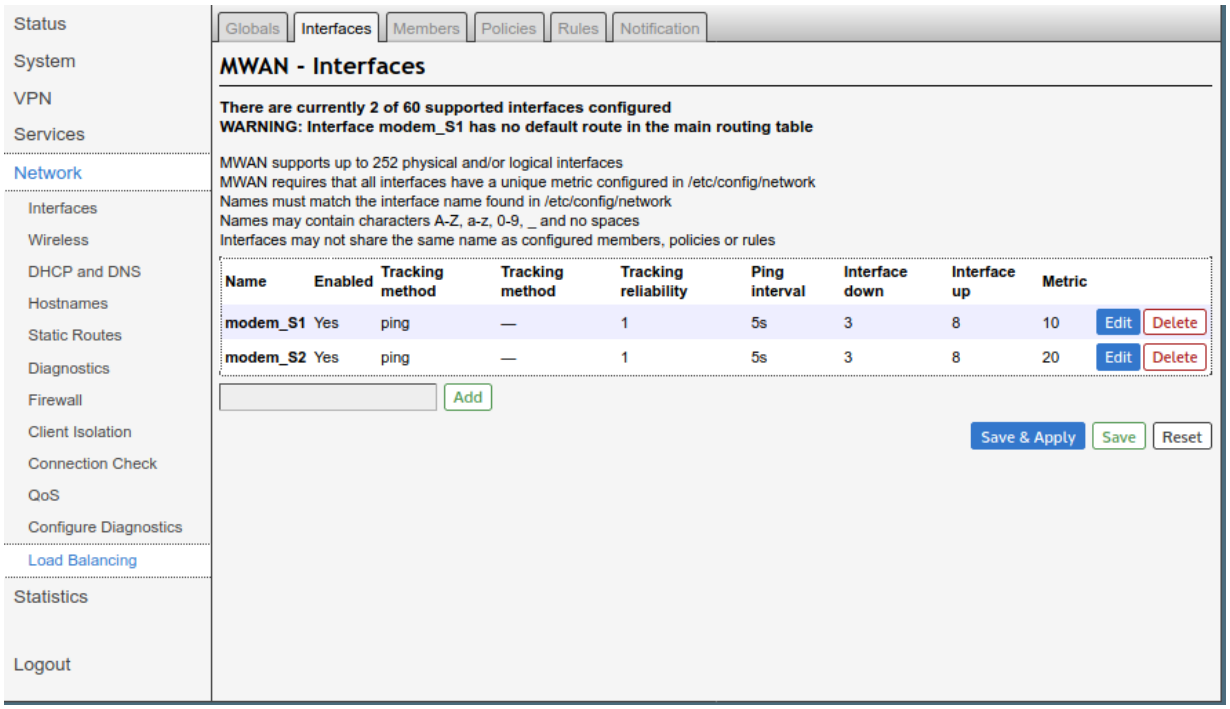
The detailed MultiWan status information is found in Status → Load Balancing → Detail.



MWAN detailed status page

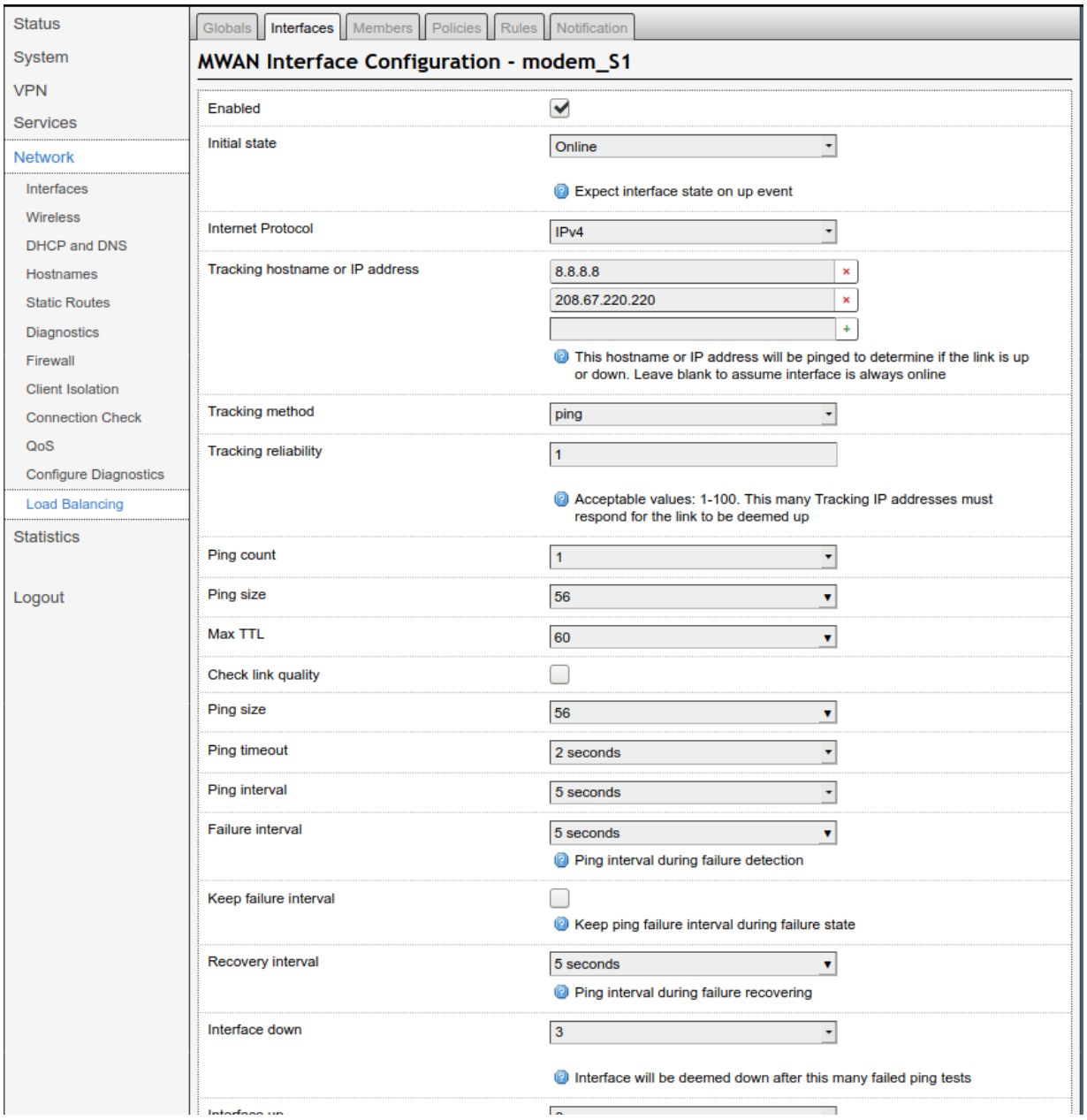
6.1.3.4 MWAN Modem Interface Configuration

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



MWAN Interface configuration

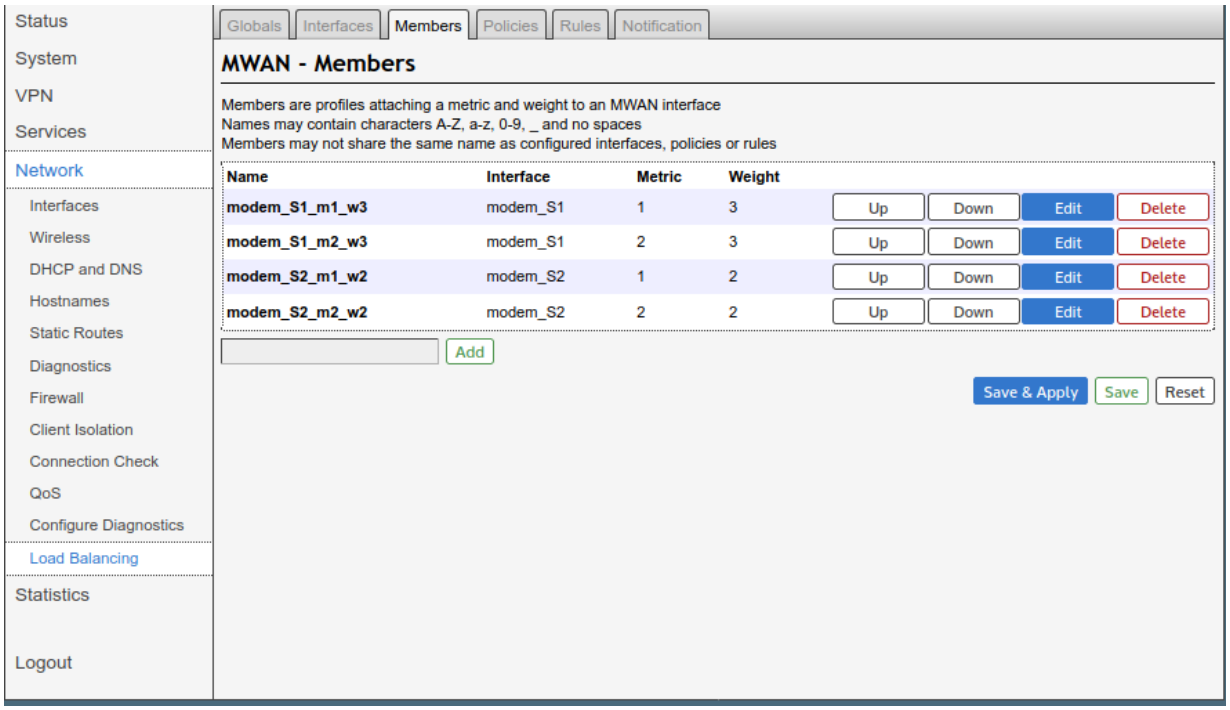
The tracking parameters can handle target host IPs, ping interval and timeout.



Tracking parameters

6.1.3.5 MWAN Members Configuration

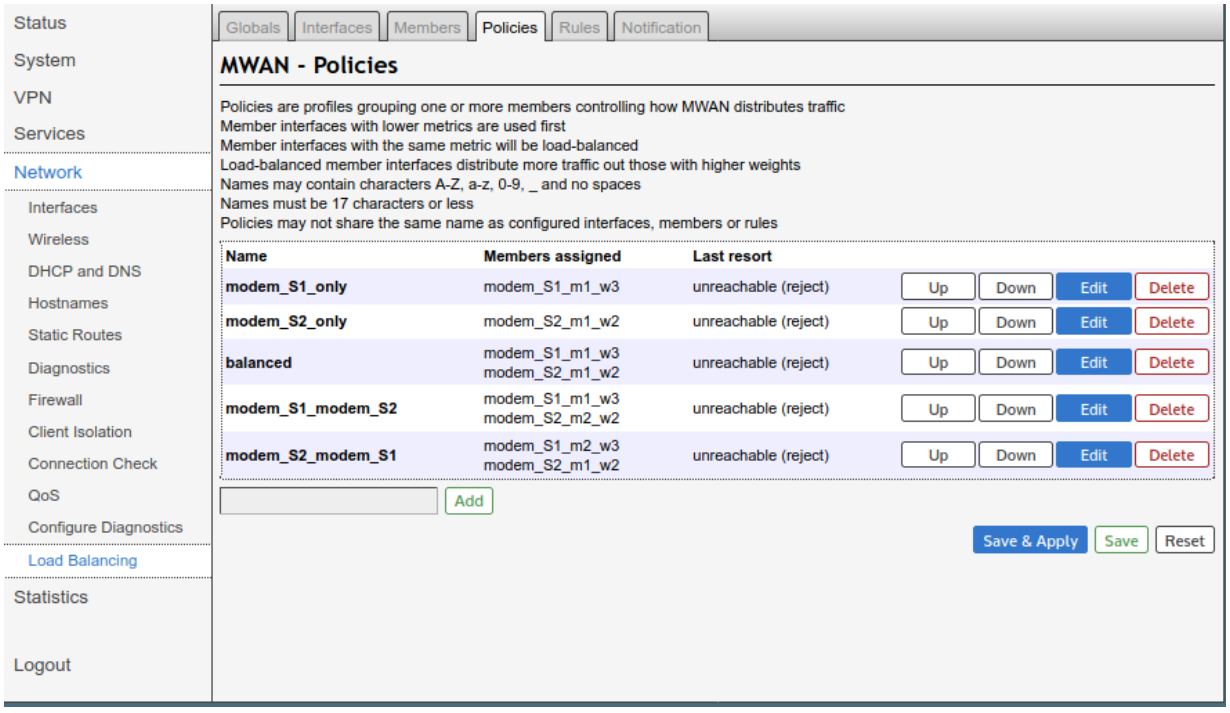
Members are profiles attaching a metric and weight to an MWAN interface. Names may contain characters A-Z, a-z, 0-9, _ and no spaces. Members may not share the same name as configured interfaces, policies or rules.



MWAN members

6.1.3.6 MWAN Policies Configuration

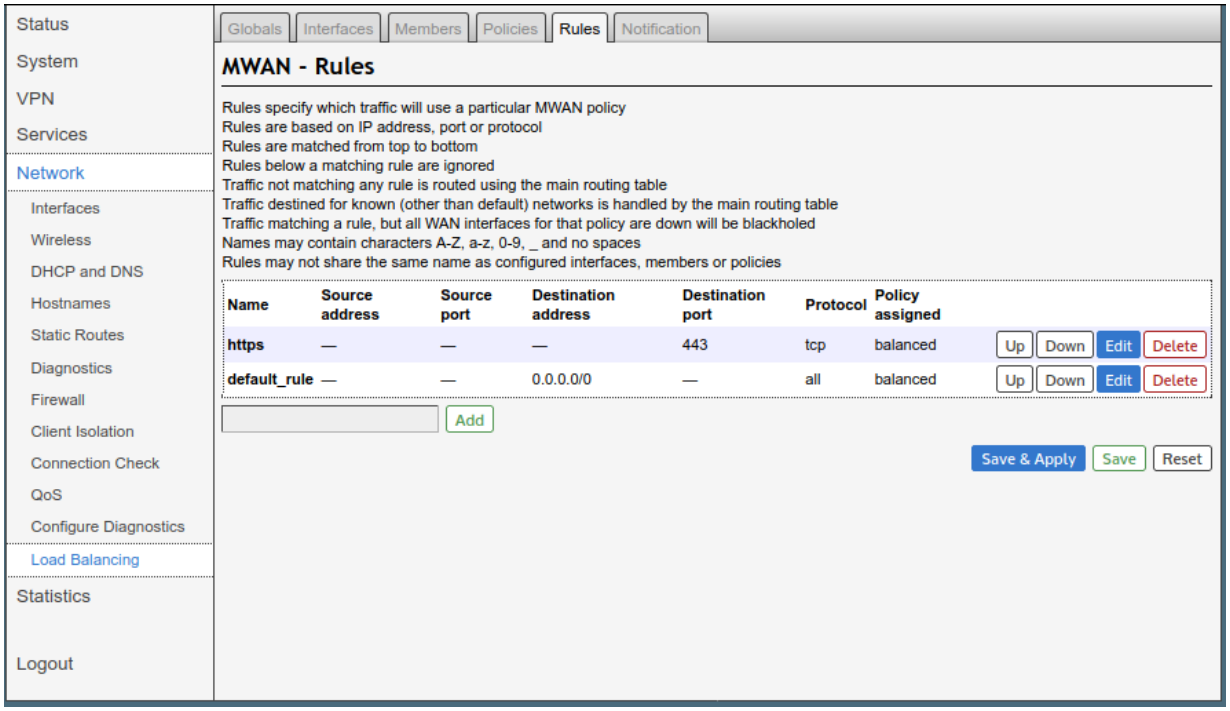
Policies are profiles grouping one or more members controlling how MWAN distributes traffic. Member interfaces with lower metrics are used first. Interfaces with the same metric use load-balancing. Load-balanced member interfaces distribute more traffic out through those interfaces with higher weights.



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

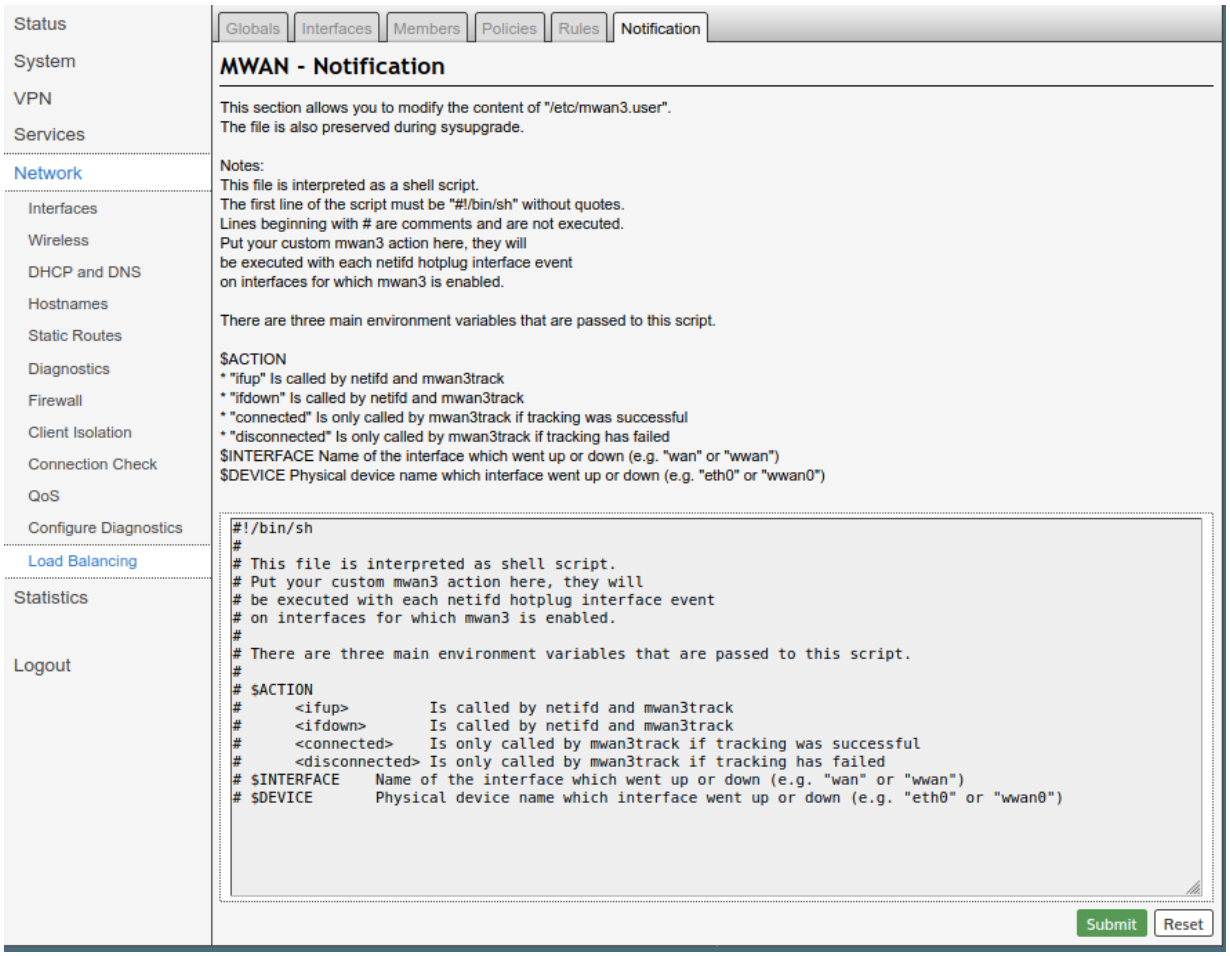
6.1.3.8 MWAN Notification Configuration

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

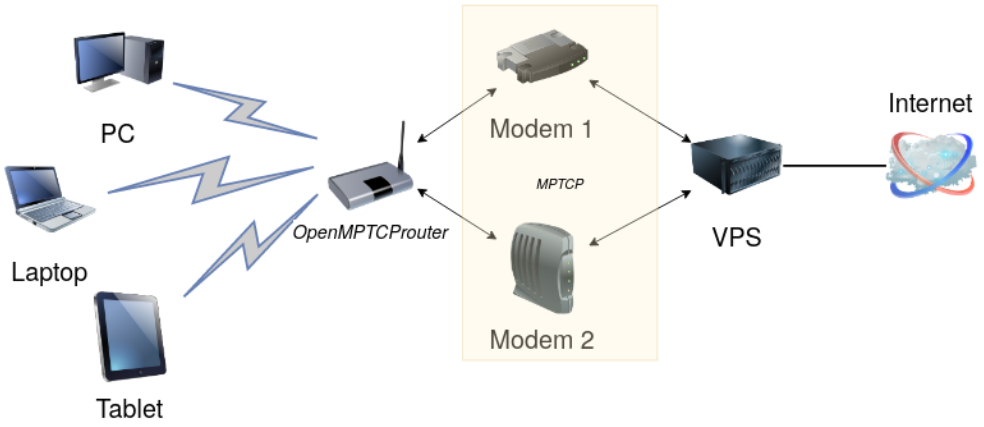
6.1.4 MultiPath TCP / Link Aggregation

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.

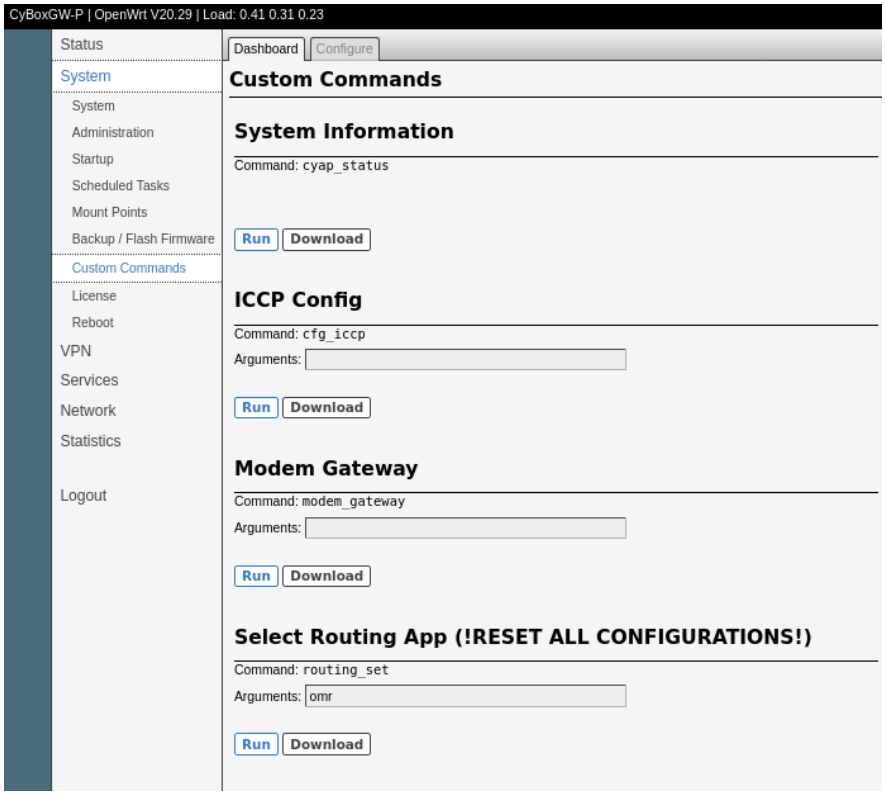
6.1.4.1 OpenMPTCProuter versus MWAN3

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: xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
Your OpenMPTCProuter Server key: xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
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.

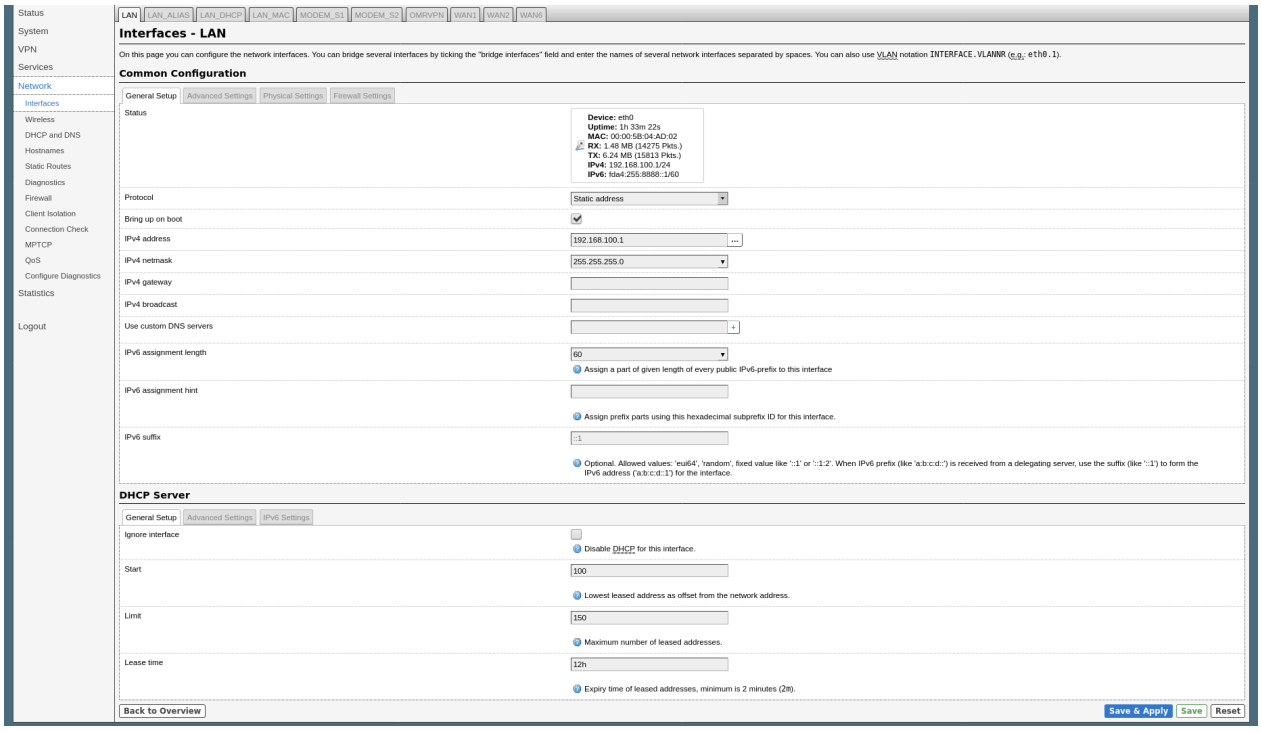
> **Important**
>
> In the following example, a default setup, a combination of Shadowsocks/Glorytun is used.

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.

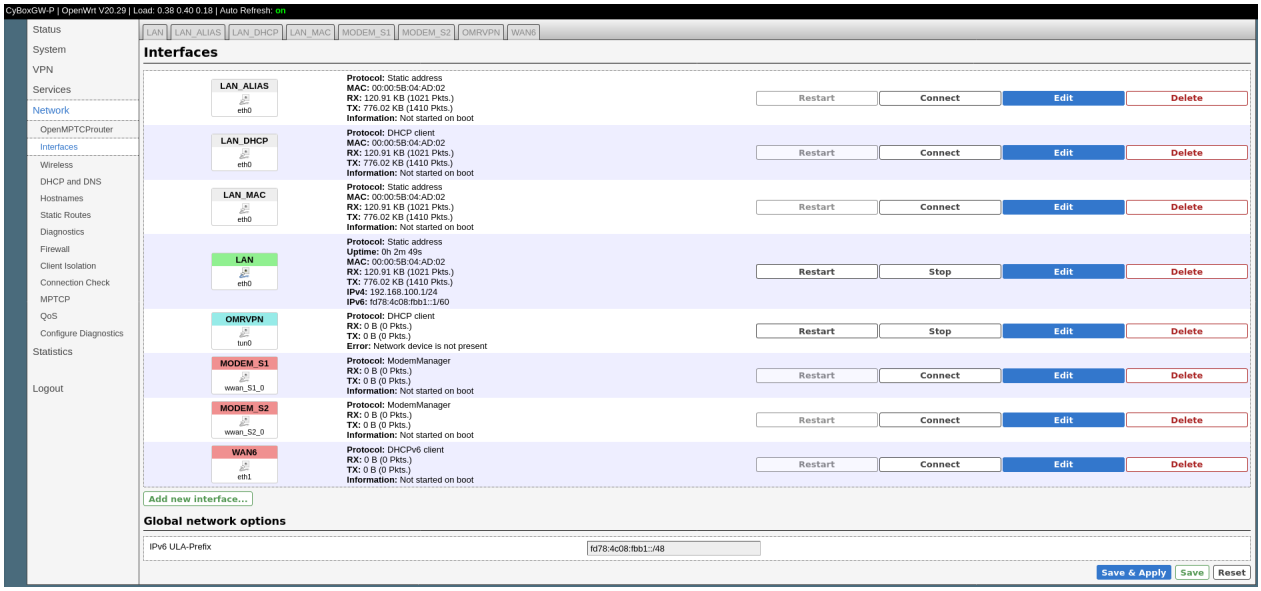
6.1.4.4.1 Setup DHCP

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



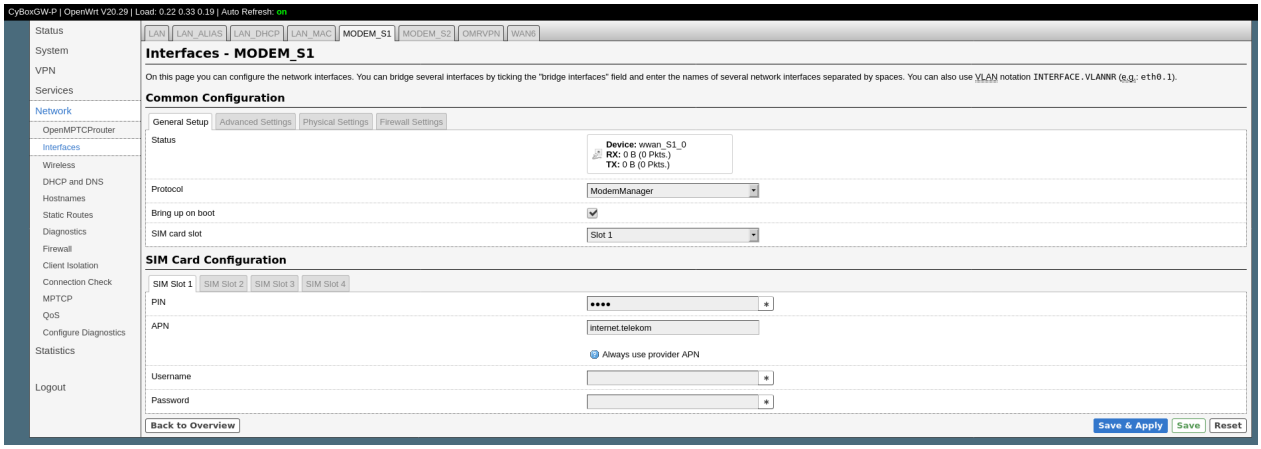
6.1.4.4.2 Remove / Disable unused default interfaces

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

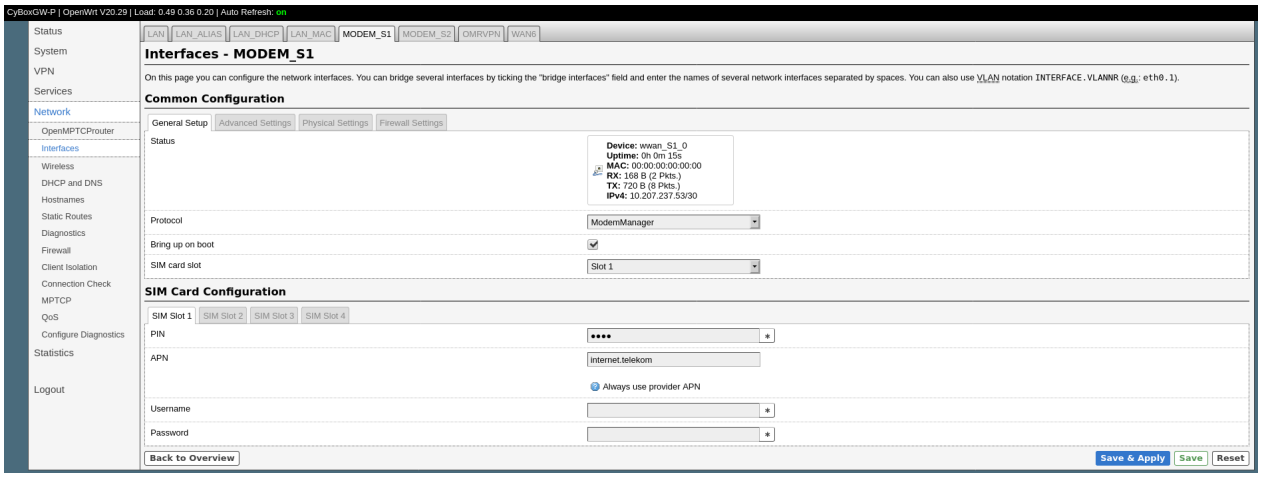


6.1.4.4.3 Setup LTE Modems

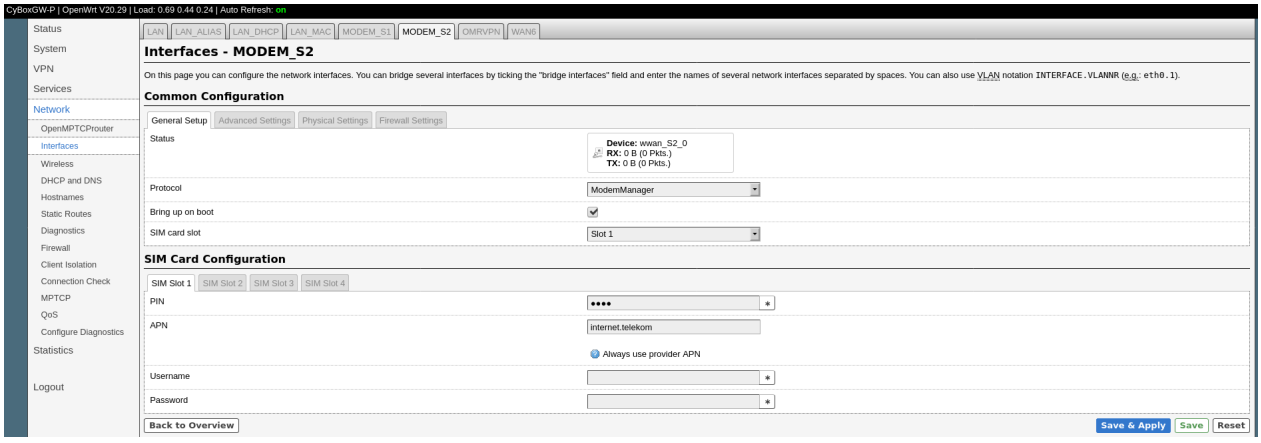
Configuration of the first modem (MODEM_S1) can be done by using of UI page `Network` → `Interfaces` → `MODEM_S1`. In order to initiate a data connection, SIM_PIN and APN have to be specified. After that `Bring up on boot` flag has to be checked.

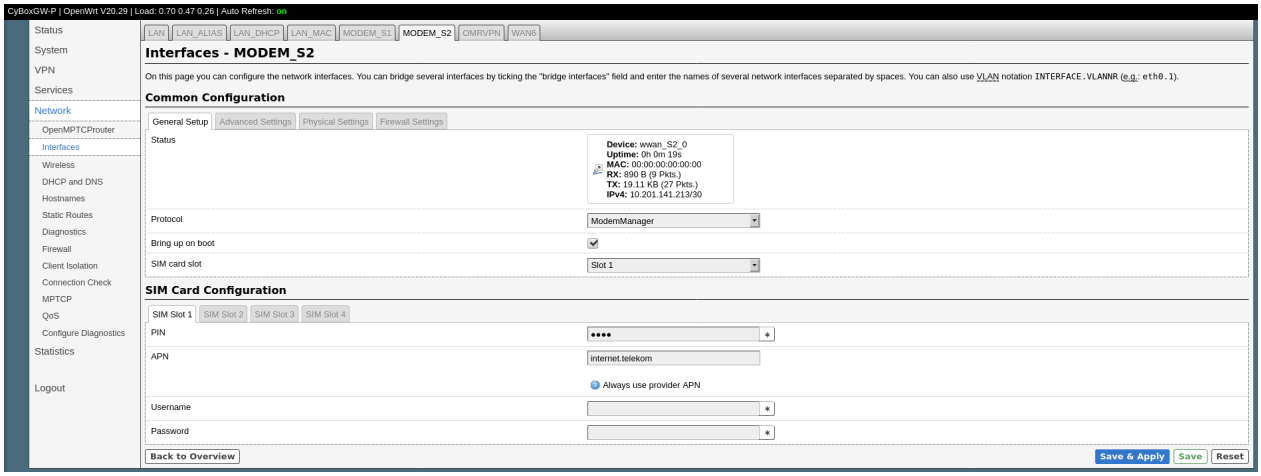


After applying new settings the connection process starts. After some time, depending e.g. on signal strength, modem connection should be established.



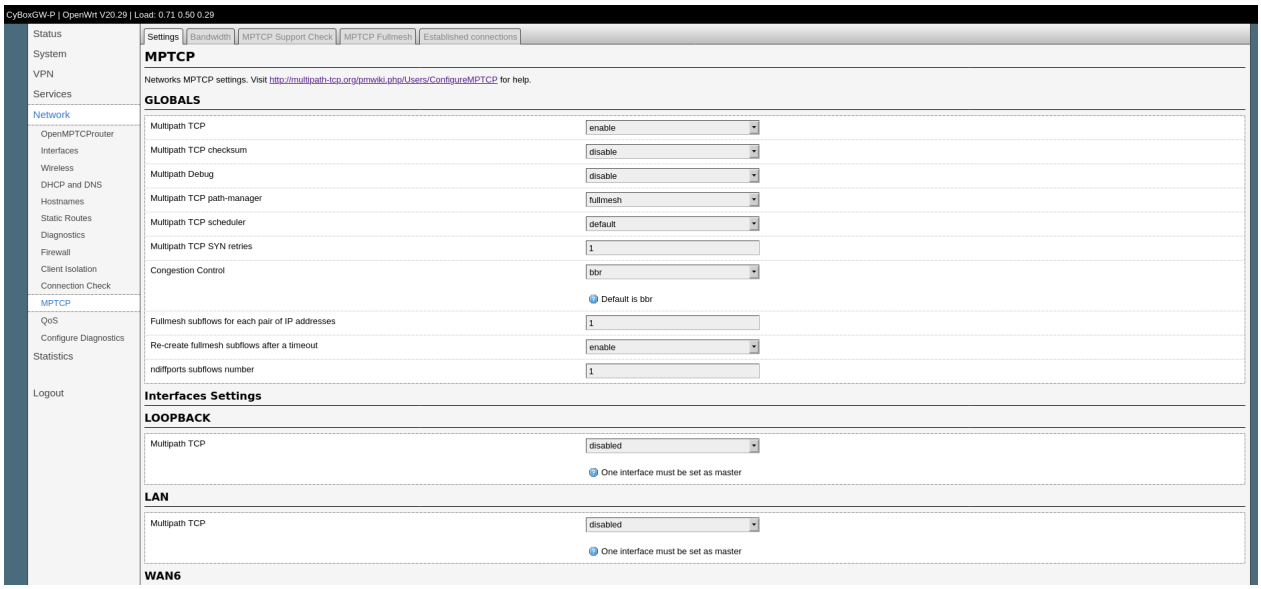
Same procedure have to be done for the second modem interface (MODEM_S2) too.



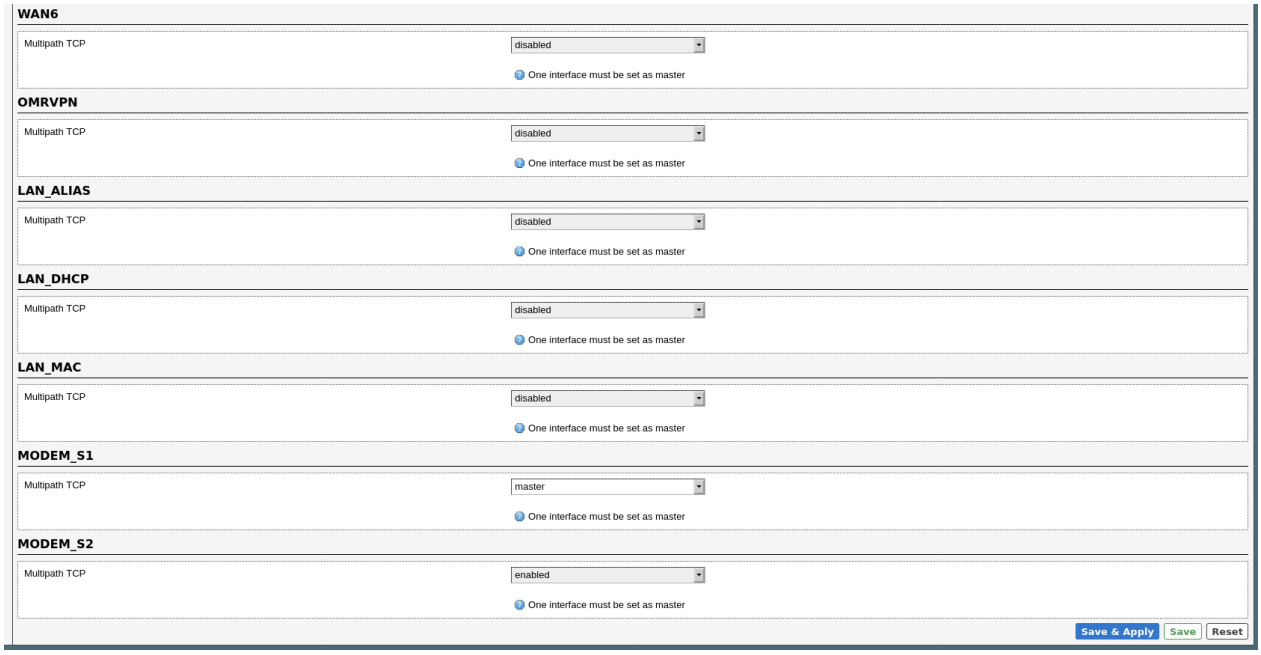


6.1.4.4.4 Setup MPTCP

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.

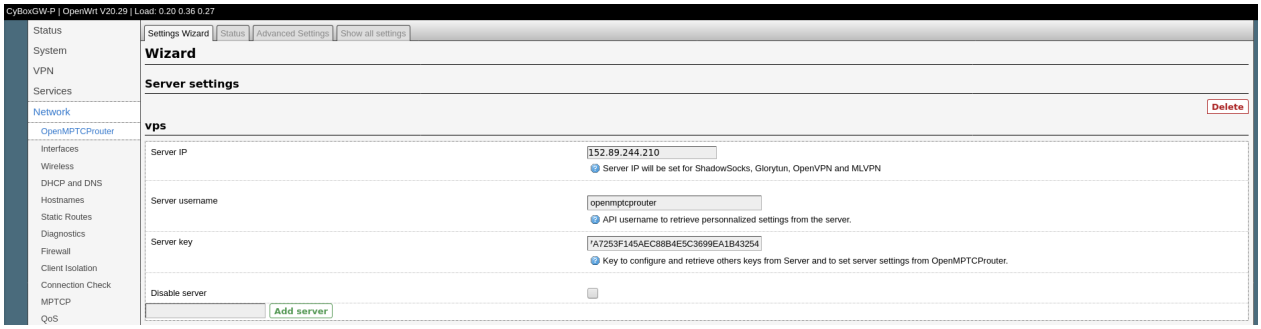


The role of each interface running MPTCP have to be defined. One interface have to be selected as master. Unused interfaces have to be marked as disabled.



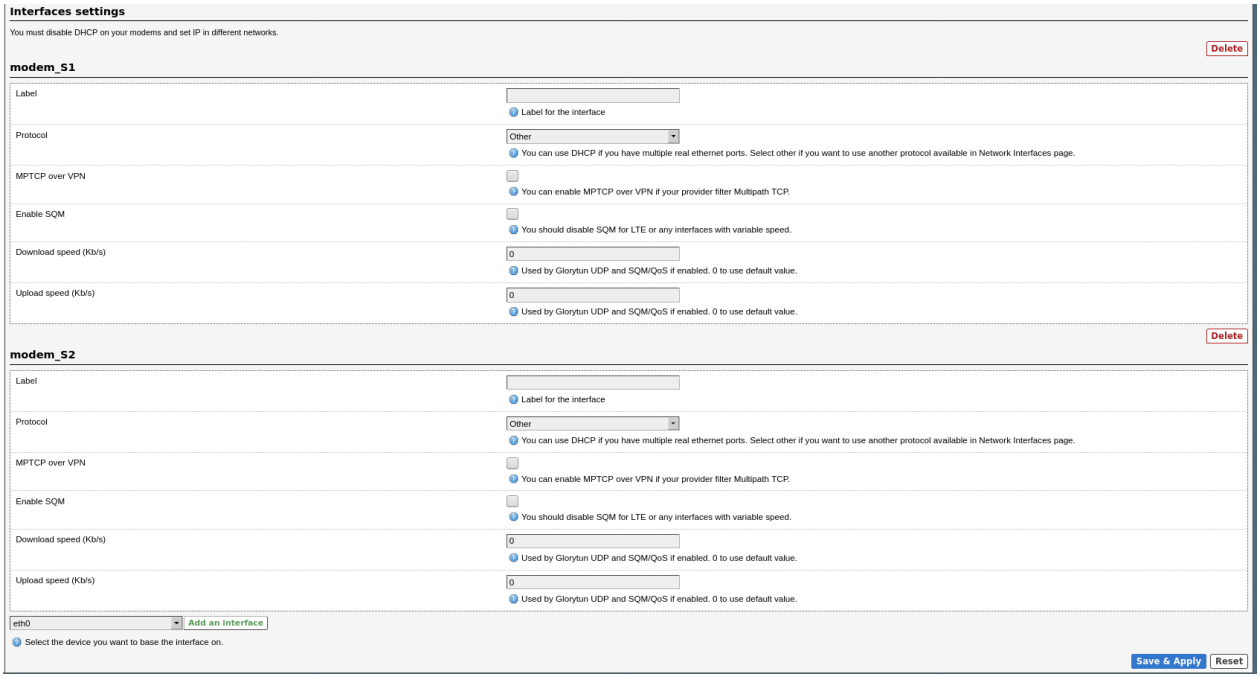
6.1.4.4.5 Setup VPS access

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.

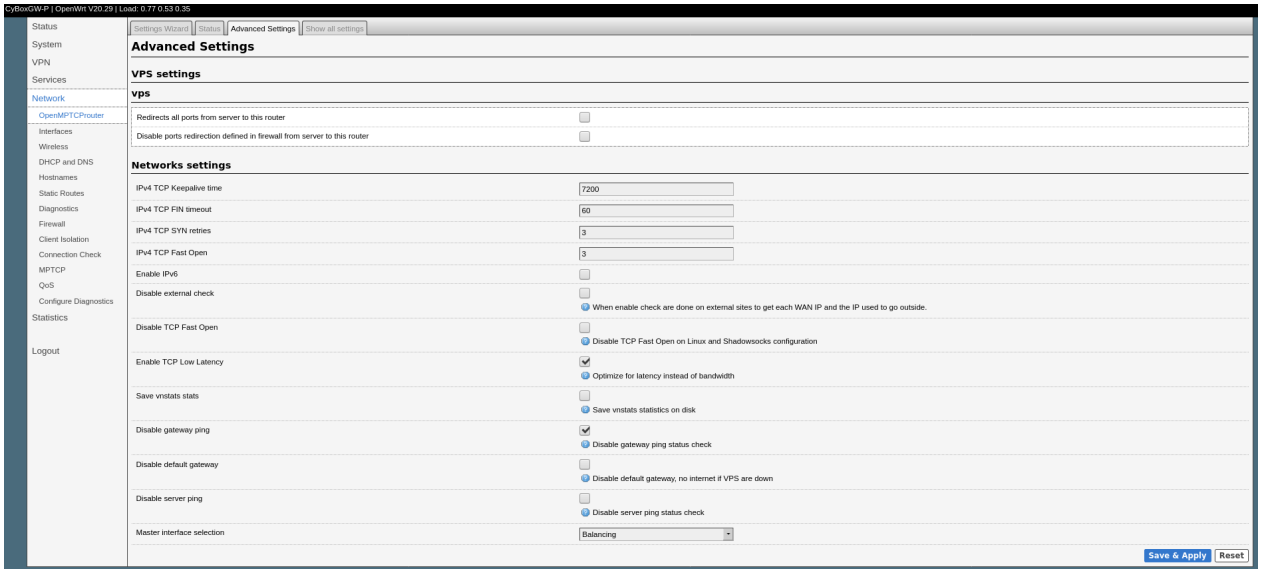


Settings according to technology which should be used for OMR<->VPS communication can be configured by using of the same UI page (`Network` → `OpenMPTCProuter` → `Settings Wizard`). Default setup allows usage of `Shadowsocks` between OMR and VPS. As a default encryption algorithm is `chacha20` chosen.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

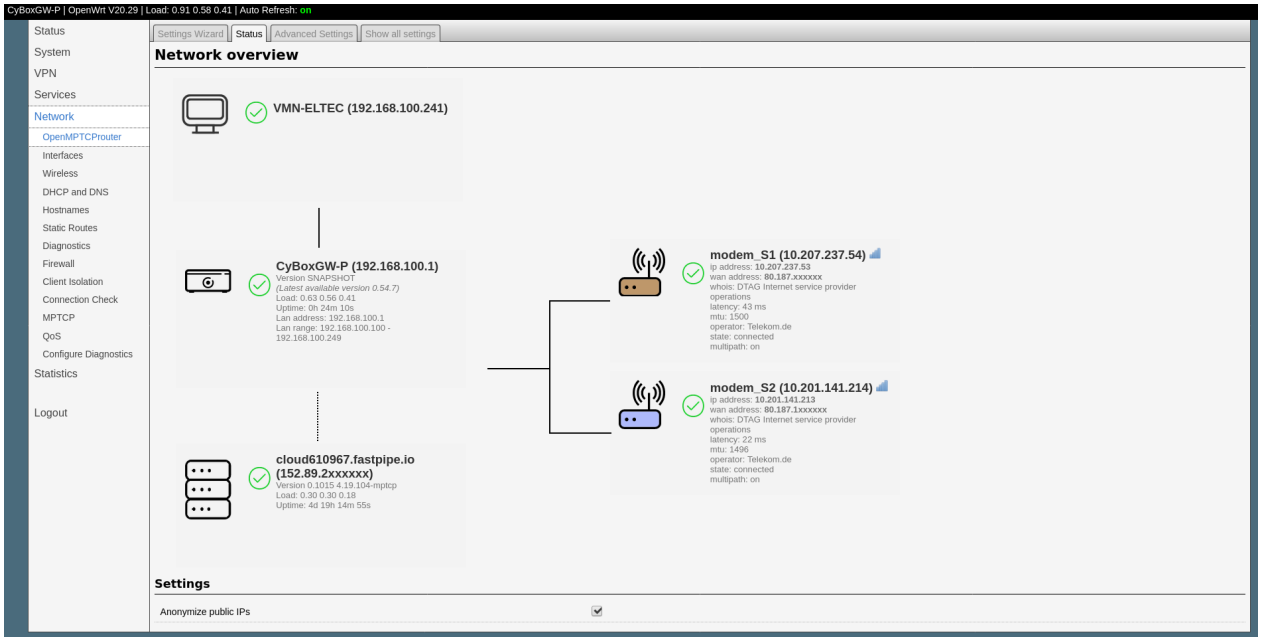
Further network interface configuration according to OMR<->VPS communication can be done by using of the same UI page (`Network` → `OpenMPTCProuter` → `Settings Wizard`).



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`).

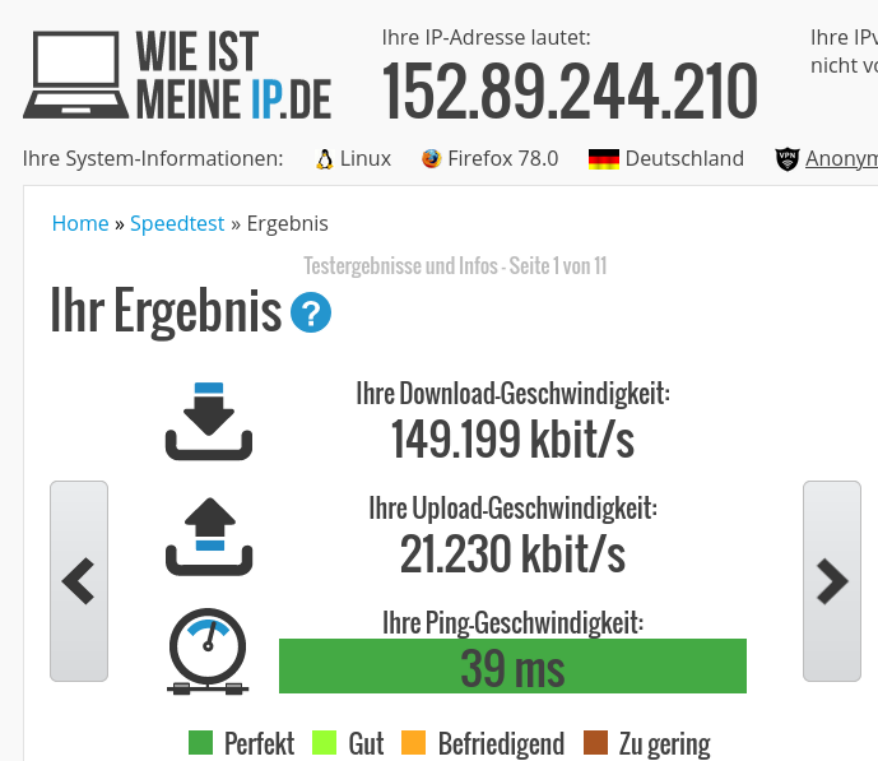


6.1.4.4.6 Speed test / IP

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 LACP / Bonding

Getting better overall bandwidth and failsave connections by using of Link Aggregation Control Protocol (LACP).

Combining multiple Gigabit Ethernet interfaces into a single logical bonding interface results in increased overall bandwidth between connected devices.

For detailed information about bonding interface configuration parameter please refer to Linux Kernel documentation.

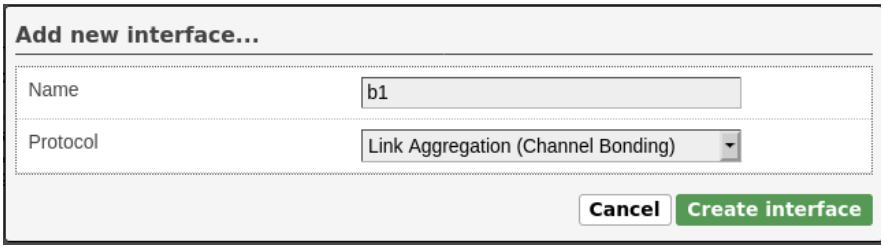
6.1.5.1 LACP configuration example

Following example gives a step-by-step instructions of configuration and testing of LACP with two Gigabit Ethernet devices.

> **Important**
>
> Please use a different interface for communication with the user interface than the one you want to use for LACP.

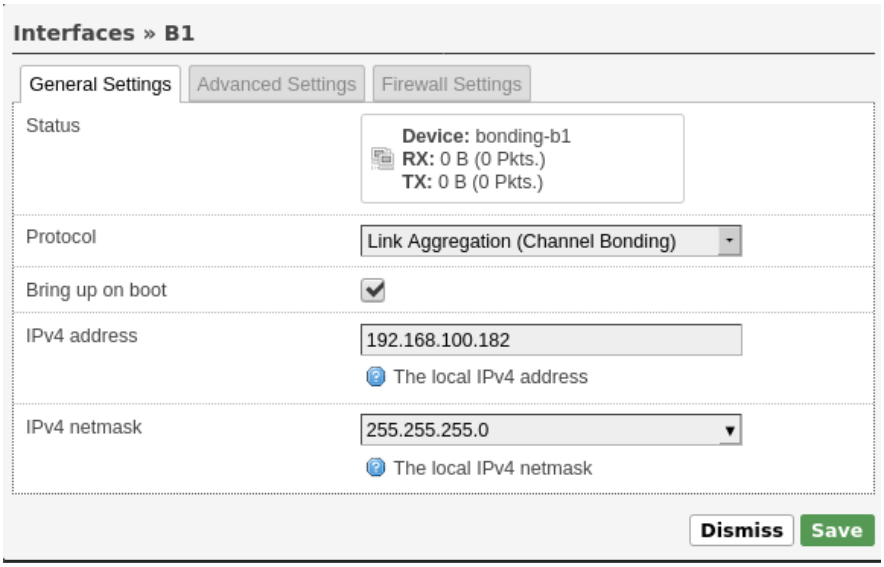
6.1.5.1.1 Create LACP interface

First of all a logical bonding interface should be created. This can be done by using of UI page (`Network` → `Interfaces` → `Add new interface`).



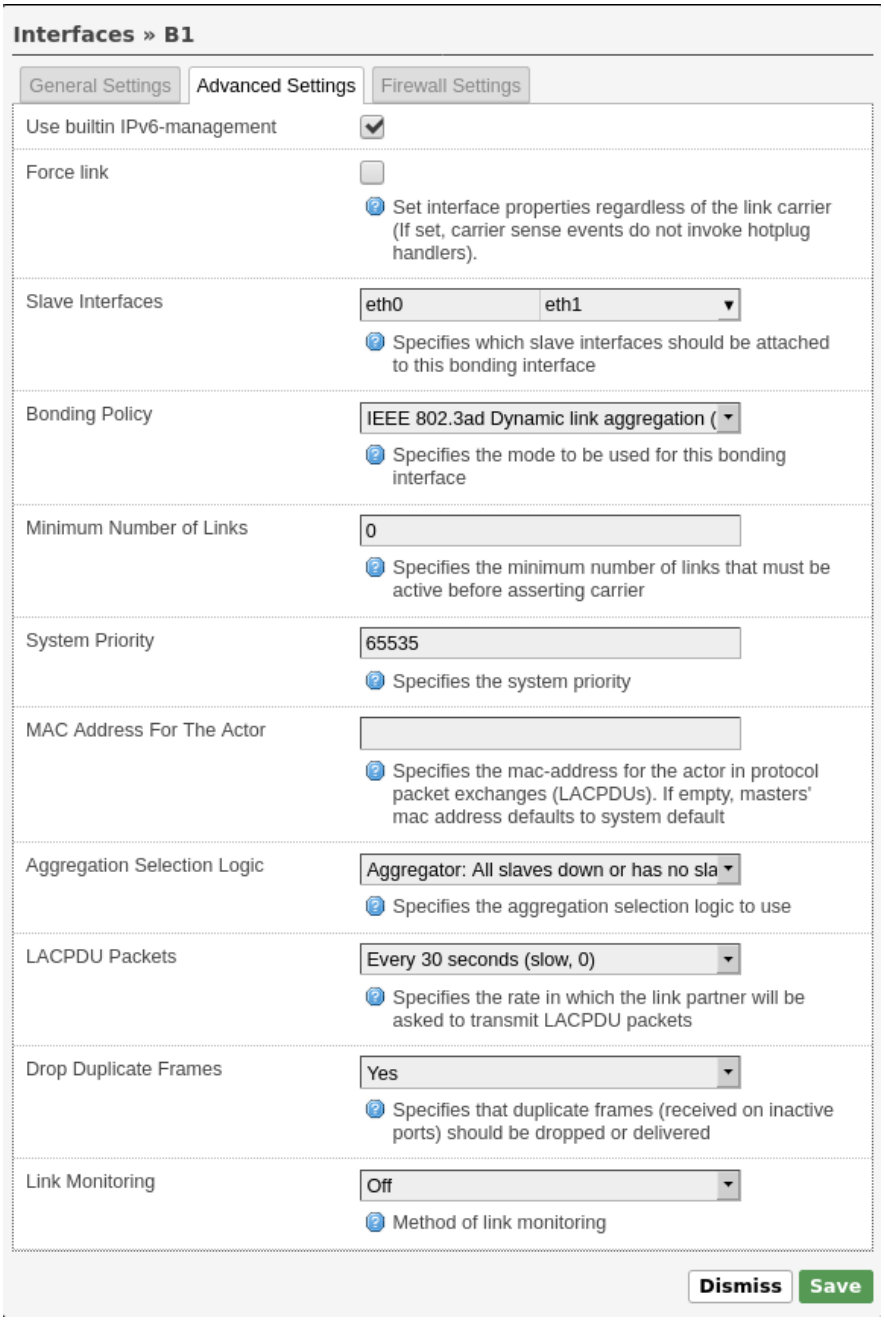
6.1.5.1.2 Setup IP / Netmask

Next step is setting an ip address and a netmask for new created bonding interface (see tab -> General Settings).



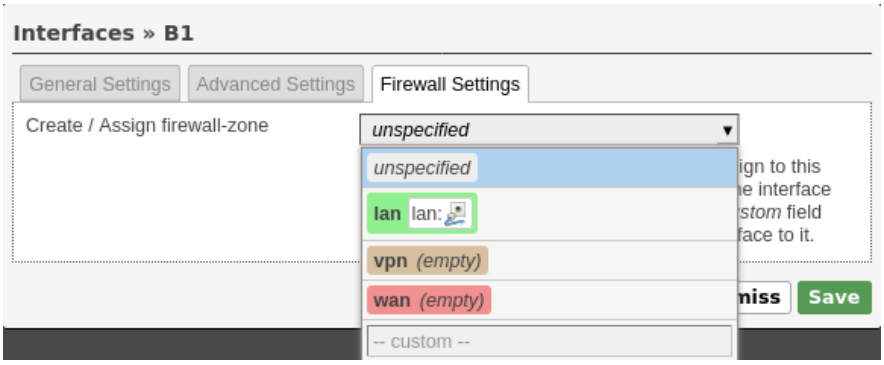
6.1.5.1.3 Setup bonding Policy / add slave Interfaces

Slave interfaces and bonding policy (IEEE 802.3ad = LACP) can be configured with tab `Advanced Settings`.



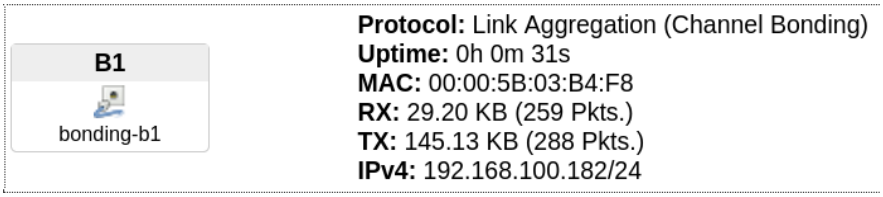
6.1.5.1.4 Setup Firewall

If needed, firewall configuration can be done with tab `Firewall Settings`.



6.1.5.1.5 Check interface Status

After applying new configuration settings, bonding interface `bonding-b1` should be up and running.



Interface status can also be verified by using of debug console.

```
root@LACP_TEST:~# cat /proc/net/bonding/bonding-b1
Ethernet Channel Bonding Driver: v3.7.1 (April 27, 2011)

Bonding Mode: IEEE 802.3ad Dynamic link aggregation
Transmit Hash Policy: layer2 (0)
MII Status: up
MII Polling Interval (ms): 100
Up Delay (ms): 0
Down Delay (ms): 0

802.3ad info
LACP rate: slow
Min links: 0
Aggregator selection policy (ad_select): stable
System priority: 65535
System MAC address: 00:00:5b:03:b4:f8
Active Aggregator Info:
    Aggregator ID: 2
    Number of ports: 2
    Actor Key: 9
    Partner Key: 1
    Partner Mac Address: 44:a5:6e:43:5d:70

Slave Interface: eth0
MII Status: up
Speed: 1000 Mbps
Duplex: full
Link Failure Count: 1
Permanent HW addr: 00:00:5b:03:b4:f8
Slave queue ID: 0
Aggregator ID: 2
Actor Churn State: monitoring
Partner Churn State: monitoring
Actor Churned Count: 1
Partner Churned Count: 1
details actor lacp pdu:
    system priority: 65535
    system mac address: 00:00:5b:03:b4:f8
```

```
    port key: 9
    port priority: 255
    port number: 1
    port state: 61
details partner lacp pdu:
    system priority: 32768
    system mac address: 44:a5:6e:43:5d:70
    oper key: 1
    port priority: 128
    port number: 2
    port state: 63

Slave Interface: eth1
MII Status: up
Speed: 1000 Mbps
Duplex: full
Link Failure Count: 1
Permanent HW addr: 00:00:5b:03:b4:f9
Slave queue ID: 0
Aggregator ID: 2
Actor Churn State: monitoring
Partner Churn State: monitoring
Actor Churned Count: 0
Partner Churned Count: 1
details actor lacp pdu:
    system priority: 65535
    system mac address: 00:00:5b:03:b4:f8
    port key: 9
    port priority: 255
    port number: 2
    port state: 61
details partner lacp pdu:
    system priority: 32768
    system mac address: 44:a5:6e:43:5d:70
    oper key: 1
    port priority: 128
    port number: 1
    port state: 63
root@LACP_TEST:~#
```

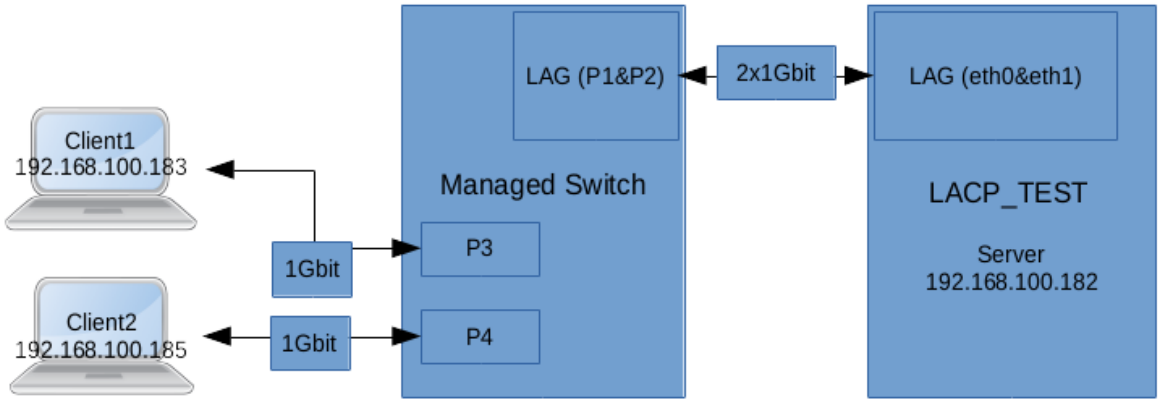
6.1.5.2 LACP testing example

After bonding interface is configured and running, additional hardware is needed for verification of its functionality.

One of the most common bonding usage scenarios is a improvement of bandwidth and reliability between Server and Client's.

6.1.5.2.1 Test Setup

To have a practical setup a managed Switch with LACP support, our previously configured LACP_TEST device and also two client PCs with 1 Gigabit Ethernet interface are needed.



6.1.5.2.2 Test bonding bandwidth improvement

Without using of logical bonding interface maximal available bandwidth between switch and LACP_TEST device would be 1 Gbit, from a purely theoretical point of view. So the client PC's which are connected to switch would share this bandwidth and get not more than 500Mbits each. As we configured two 1 Gigabit Ethernet devices to one logical bonding interface the maximal bandwidth should be 2 Gbit. Each Client should be abble to communicate with Server with maximal bandwidth of 1000Mbits.

In practical terms, the theoretical possible bandwidth cannot be reached! The maximal bandwidth would be round about 50-60% more than without bonding, so not 100%!

As a Measurement tool `iperf` is used. LACP_TEST device have iperf server instance running. Both client PC's communicating with the iperf server instance on LACP_TEST device at the same time. During the test we see both slaves of LACP_TEST bonding interface running. Each client communicates with the servers iperf instance over one of the both slave interfaces with about 800Mbits bandwidth.

6.1.5.2.3 Test bonding reliability improvement

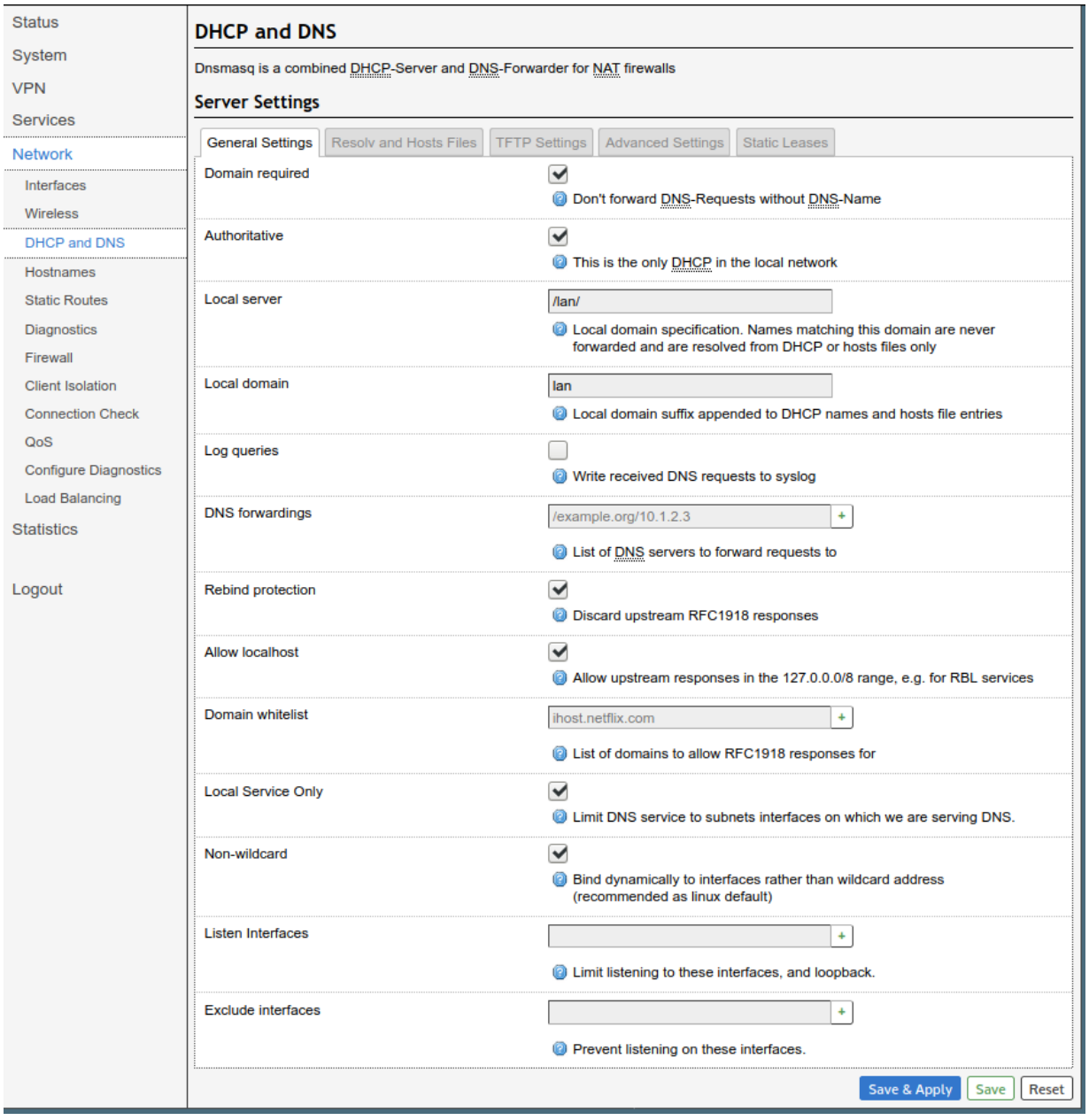
In case Switch<->Server connection run without LACP, any communication errors will result in broken client connection. Due to reliability improvements of bonding implementation, communication between clients and server works also if one of the both LACP slaves goes down. This scenario can be easily verified by disconnecting one of the two bonding slaves e.g. eth0.

6.1.6 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 AP 3 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

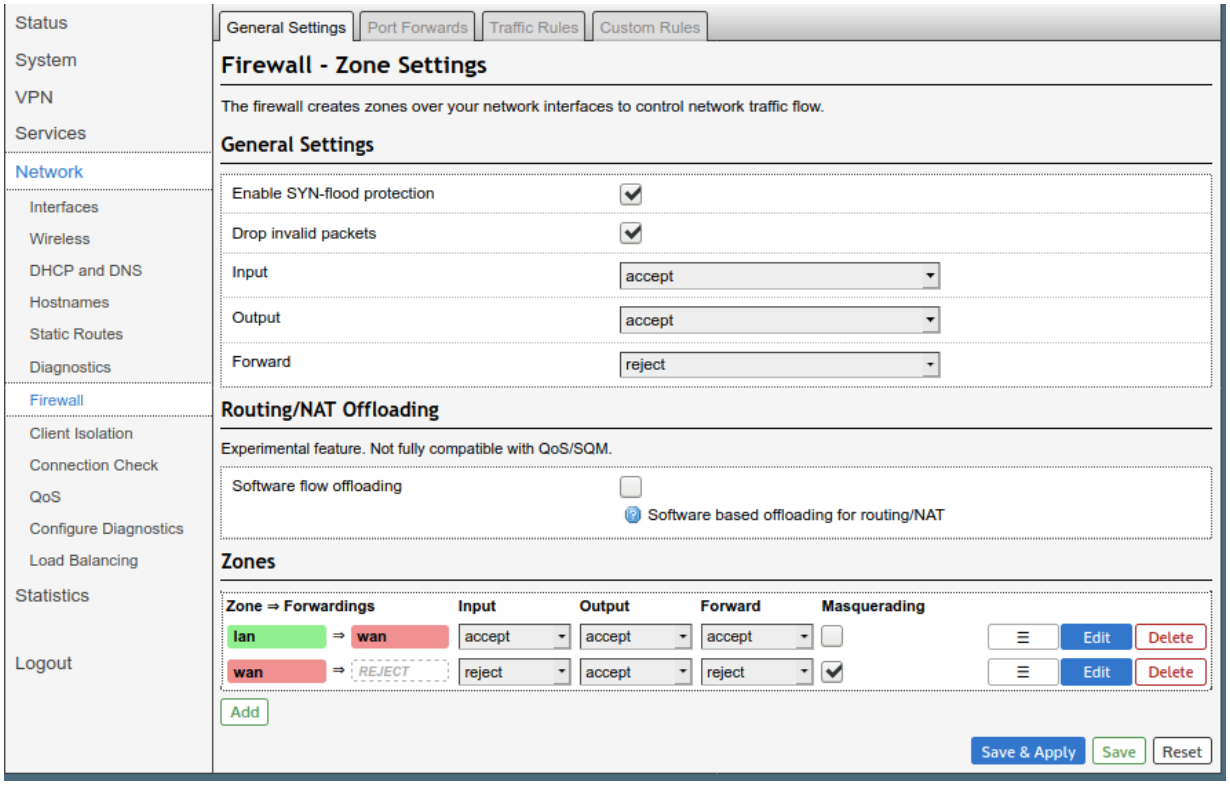
6.1.7 Firewall

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

The CyBox AP 3 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

6.1.8 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.

6.1.8.1 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.

6.1.8.2 VPN interface setup – 3 methods

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

6.1.8.2.1 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 AP 3 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
```

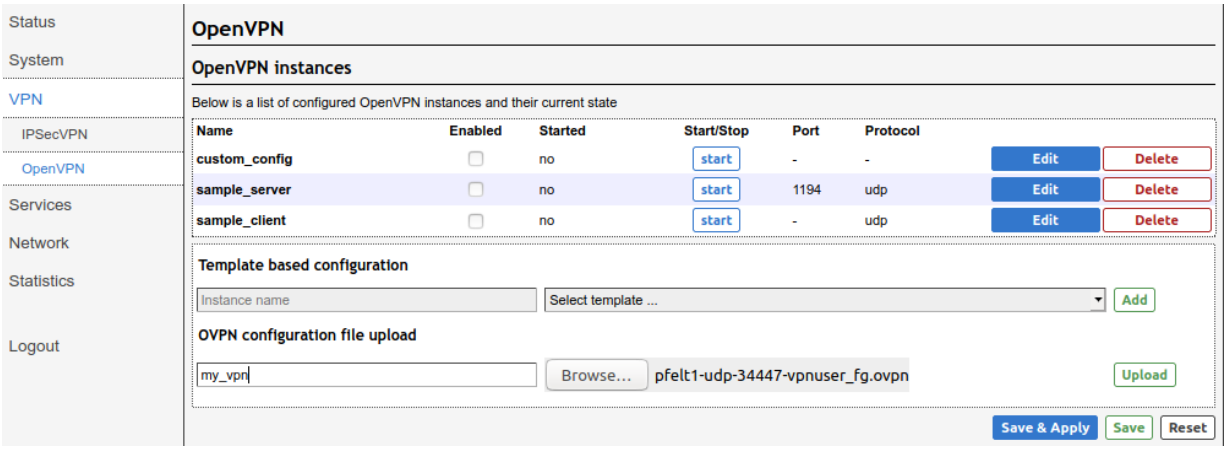
6.1.8.2.2 Upload configuration, certs, key-files with web interface

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
```

6.1.8.2.3 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.

6.1.8.3 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 AP 3 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
```

6.1.9 ICCP

The **I**nter **C**arriage **C**onnection **P**rotocol is a bridging algorithm developed by ELTEC to automatically establish and maintain a wireless LAN backbone for trains. It can be used in retrofit applications, where it is too expensive to install backbone Ethernet cables in throughout the train. The challenge is to establish and maintain connections in an unstable environment, exposed to disturbances, such as train re-configuration, connection losses, or other trains on neighbor tracks.

The main characteristics of ICCP are:

- Utilization of RSSI to determine best coupling partner in range
- Usage of WDS (Wireless Distribution System) mode for AP_Master-Client connection
- Support of all encryption modes (WPA2-PSK, etc.)
- One-Time configuration
- Unattended coupling/decoupling process, restore of previously established connections after power loss
- Free channel selection in 2.4 GHz with all HT-modes or 5 GHz with HT-modes (20/40/80)

6.1.9.1 Coupling Concept

The coupling concept follows different states in which the access point tries to determine the best partner for communication, establishes a connection and maintains it. The following table provides an overview of the states.

ICCP Coupling States:

State	Description
IDLE	The radio is enabled. The default mode is AP with SSID broadcasted and own serial number coded into the SSID. The WLAN mode is configured as “Access Point (WDS)” master using an eight character SSID broadcasted and own serial number coded into the SSID. The LAN port is configured for bridging and Spanning Tree Protocol is enabled.
BIND	WLAN has been enabled and the device searches for the qualified peer offering the best signal strength. The search is repeated multiple times to ensure that a stable situation is encountered. To qualify as best neighbor requires a minimal signal quality. The ID (foreign serial number) of the best neighbor found is passed to the next state CONNECT.

CONNECT	The own ID and the ID of the best neighbor found are coded into the new own SSID; the device waits for an SSID broadcast of the neighbor device with the same combination of IDs. This state has a time limit to establish the connection. If the time limit is exceeded, the state falls back to BIND. The expected client partner can extend the time limit for the master to set a common SSID, and switches into ESTABLISHED state as soon as the SSID contains the “EST” marker.
ESTABLISHED	Both devices enter a new configuration: the device with the larger ID becomes “Master” the other device becomes “Client”. The SSID that has been negotiated in the previous state becomes hidden, if the master recognizes the client MAC. The WLAN access key is derived from the IDs.
DROPPED	Connection lost due to radio disturbance or train reconfiguration. The device tries to re-establish the last known connection for a preconfigurable time.

6.1.9.2 SSID Usage

The coupling procedure takes advantage of the fact that SSIDs contain alphanumeric characters and that it can be broadcast. Thus, an SSID can be used to broadcast information useful for coupling and enter a dialog to establish the connection. The access points will use their serial numbers - an eight-digit number - to identify themselves. In addition, the SSID may contain state information to allow the potential communication peer to monitor the progress of the negotiation. However, the current implementation does not use this additional state information. The SSIDs start with a well-known sequence of letters (“CyAP”), providing a means to filter out radio activities of other networks’ access points. Starting with firmware version 4.0 this start tag “CyAP” is changeable but must keep its length of four characters.

The following table provides an overview of the SSIDs used in different states.

ICCP SSIDs Used:

SSID	Description
CyAPi_oooooooo	SSID broadcasted during BIND state. The characters ooooo are replaced by the own serial number of the AP. The letter ‘i’ represents the index of the WLAN module.
CyAPi_oooooooo_ nnnnnnnn	SSID broadcasted during CONNECT state. The characters ooooo are replaced by the own serial number of the AP, the characters nnnnn are replaced by the serial number of the AP that has been detected as best neighbor during search state.
CyAPi_oooooooo_ nnnnnnnn	SSID broadcasted at the begin of ESTABLISHED state. Still the same as in CONNECT, but only for a few seconds until the master detects the MAC link
CyAPi_oooooooo_ nnnnnnnn_ESTp	Private SSID (not broadcasted), used during state ESTABLISHED. Coding is identical to CONNECT SSID. The letter ‘p’ represents the index of the partner WLAN module.
CyAPi_oooooooo_ nnnnnnnn_<custo m-ssid/network>	VLAN mode only. Private SSID (not broadcasted), used during state ESTABLISHED. Coding is identical to CONNECT SSID.

6.1.9.3 WLAN Encryption

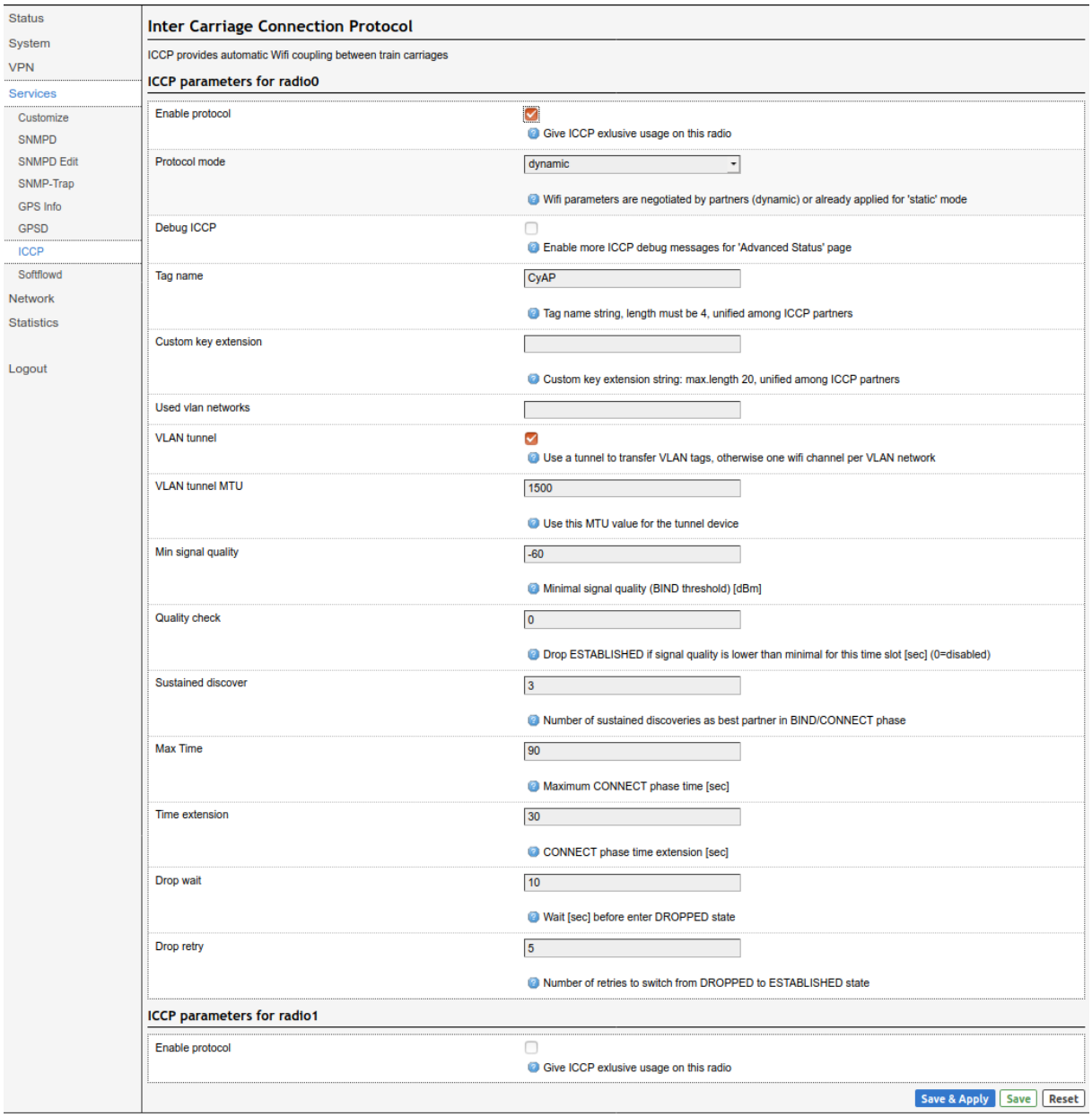
A suitable encryption mode must be activated for the communication between the wagons. For authentication individual access keys (PSK) must be established between the peers. The key is generated from the SSID using a hash algorithm that is known by both access points. During BIND and CONNECT state the WLAN mode is set to “Access Point (WDS)” (Wireless Distribution System), using an eight character random key for encryption.

6.1.9.4 Configurable Parameters

Before configuring the ICCP parameters, make sure that the following actions have been done:

- Delete all unnecessary interfaces with the web interface tab Network → Interfaces (e.g. *lan_alias*)
- Configure your ICCP management interface as desired in `Network` → Interfaces (e.g. configure the *lan* interface as a bridge composed of eth0, wlan0 and wlan1, then set the IP address to 192.168.100.2)
- Enable the WLAN radio you want to use for ICCP in `Network` → WiFi (e.g. radio o only).

After that, you can start configuring ICCP in the tab 'Services' → 'ICCP'. Then click 'Save & Apply'.



ICCP Configuration Screen

Note 1: When ICCP is used without VLAN connections, the 'dynamic' mode has to be used.

Note 2: 'Operating frequency parameters' must be identical for both ICCP partners.

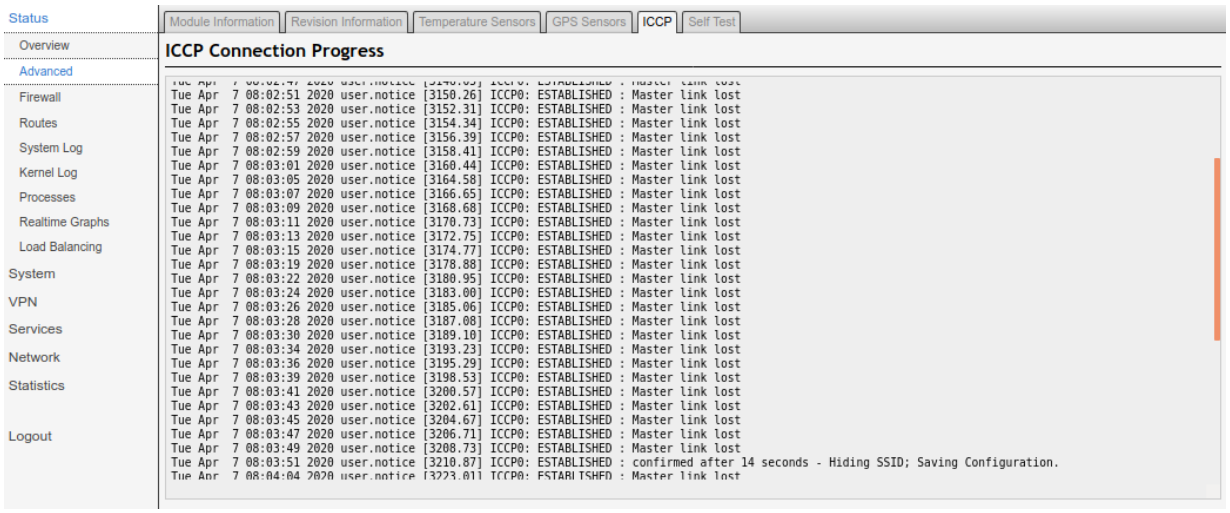
Table 6 table below lists the parameters that influence the timing behavior or the connection procedure.

ICCP Parameters:

Parameter	Description	Unit	Range	Default
USED_VLAN_NETWORKS	Using standard ICCP: empty - ICCP sets up a bridge between native eth0 and wlan0/1. Using VLAN ICCP: List of all configured VLAN networks/ssid. Case sensitive names for network interfaces and virtual SSIDs should configured first in appropriate menu pages.	Comma separated list	custom	empty
CHANNEL_SETTINGS	Predefined channel settings - make sure all desired coupling partners uses the same channel mode.	mode string	predefined or custom	2.4 GHz, CH 11, HT40-
MIN_SIGNAL_QUALITY	Minimal signal quality. Partners below that value will be ignored.	dBm	-100…0	-60
RECOVER	Number of times that another AP must be detected as best neighbor in a row. This value applies to BIND and CONNECT state.	times	1…5	3
CONNECT_MAX TIME	Time limit for connection state.	seconds	20…200	90
CONNECT_EXTENSION	Client time limit extension for connection state.	seconds	1…60	30
WAIT_RECONNECT	Time to wait for reconnecting an established link (link signal lost).	seconds	3…30	10
DROPPED_RETRY	Value that determines the time in which the AP will attempt to re-connect the previous connection, using the stored SSID and access key. The old SSID and access key will be discarded if this time has elapsed, and the AP will enter IDLE state.	times	1…10	5

6.1.9.5 Configuration Hint Web Interface

When the ICCP process is enabled and configured on both partners, the protocol status can be observed via web interface on main status/advanced page ICCP menu tab.



ICCP Status Indication on Web Server

6.1.9.6 VLAN over Wireless ICCP

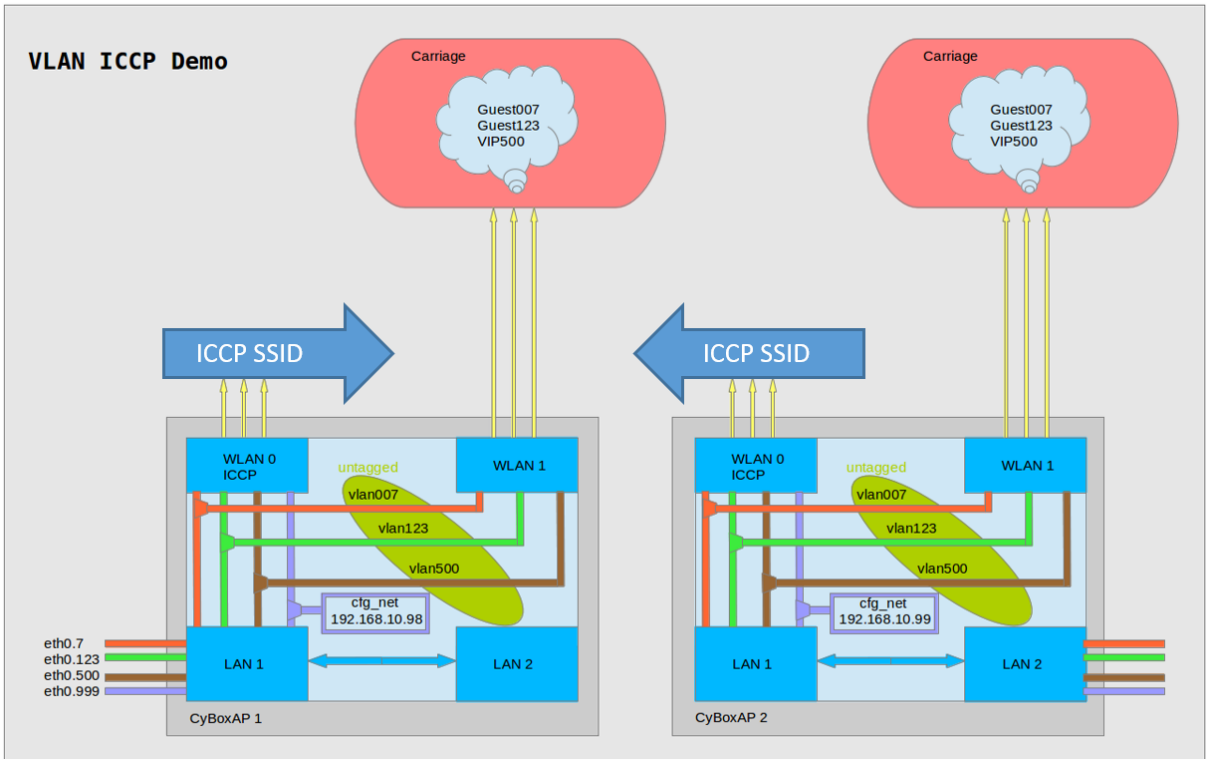
The latest ICCP implementation has been enhanced to be used in a VLAN network environment. This may increase network security by splitting the traffic into different virtual channels, i.e. a dedicated channel for the configuration and for service purposes as well as other channels, e.g. for guest access and VIP access.

6.1.9.6.1 Features and Restrictions

- The native ‘eth0’ interface and the native ‘wlan0/1’ (which is used by ICCP) are no longer available for any bridge devices.
- The backbone VLAN networks/bridges must be configured manually. Each VLAN channel needs a separate network interface.
- The network interface name can be up to 7 characters long. Any character may be used, but *name* must not be a substring of another name. e.g. a combination of ‘vlan1’ and ‘vlan123’ is not allowed. Names should be ‘vlan001’ and ‘vlan123’ instead.
- The corresponding Ethernet interface must be created (e.g eth0.123 for vlan123).
- All VLAN channels (network name) on the backbone must be exactly entered as a comma separated list in ICCP menu entry ‘Used VLAN networks’.
- The second WLAN module, which is not used for ICCP, can act as standard Access Point. The SSIDs for this module must different from any name used as an ICCP SSID. Traffic on these Access Point SSIDs are always untagged, but will be tagged as soon as packets enter a backbone bridge. Any traffic on the backbone is tagged.
- As soon as the master channel is in established state, all configured ‘Used VLAN networks’ will be started via tunnels (i.e. gretap interfaces). After all channels are in established state, the configuration is permanently saved. Thus, the ICCP partners can quickly reconnect at the next power up of the system. If the connection drops and the master channel goes to idle state, the corresponding VLANs will be disabled.

6.1.9.6.2 Examples

Figure 34 shows an example of a configuration that uses VLANs over ICCP.



ICCP illustration for VLAN Usage

Case 1: Dynamic ICCP

The configuration has to be performed on both ICCP partners.

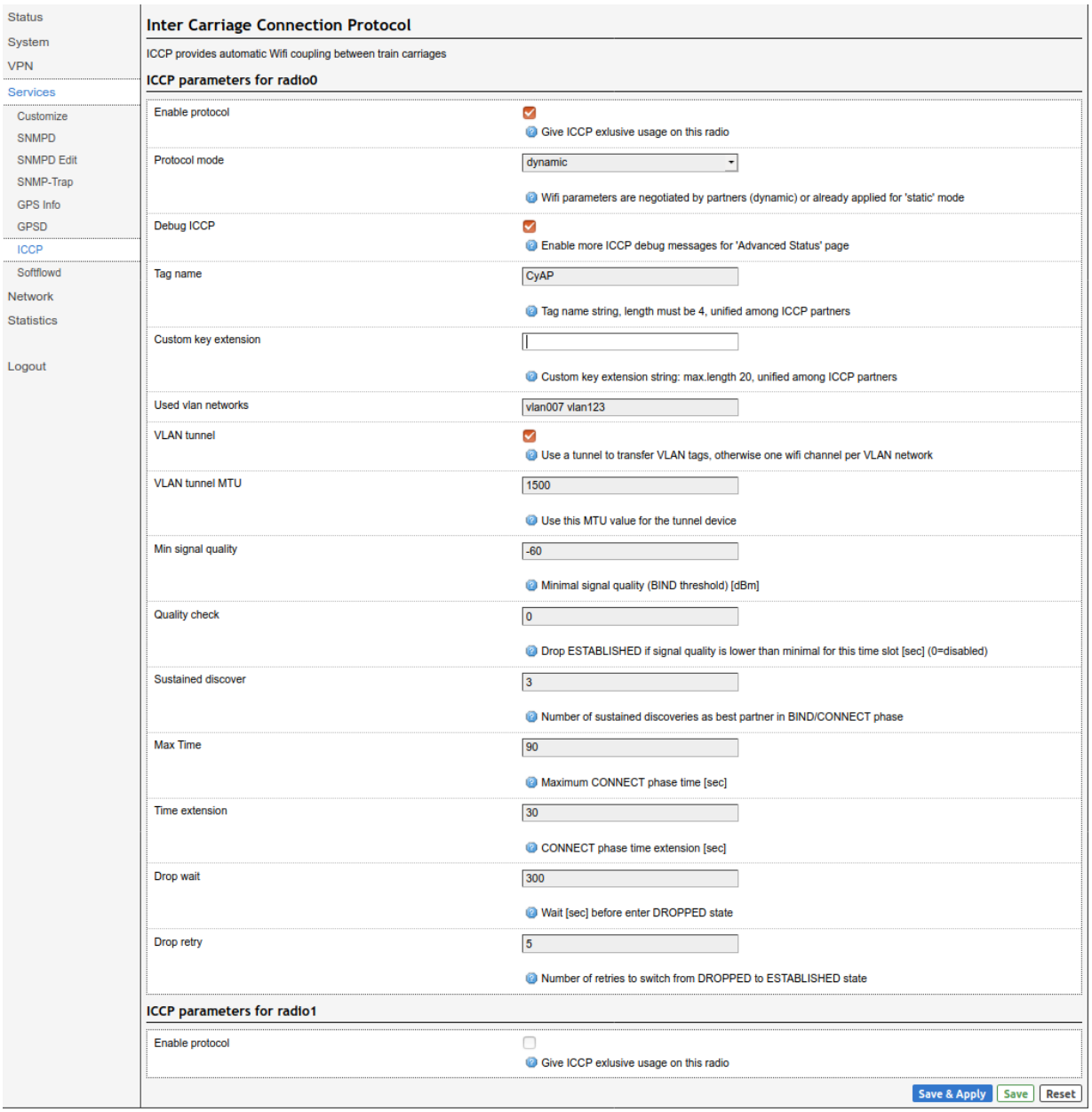
a. *Interfaces configuration*

In addition to the steps described in `Configurable Parameters`, each VLAN (vlan007 and vlan123) must be configured as follows:

- Create new interface called 'vlan007' in the tab `Network` → Interfaces
- When ask to specify a physical interface, create the custom interface called '*eth0.007*' then click on Save & Apply

b. *ICCP VLAN configuration*

ICCP can be configured via the web interface as shown below, or via the command line with the command 'cfg_iccp -d -p dynamic -r 0 -v vlan123 -v vlan007'.



Dynamic ICCP VLAN configuration

Note: Make sure that the VLAN tunnel checkbox is on.

Case 2: Static ICCP

Static ICCP can be used when you have no train carriage reconfigurations and the endpoints of VLAN tunnels are already known at time of configuration.

The configuration has to be performed on both ICCP partners.

a. *Interfaces configuration*

In addition to the steps described in `Configurable Parameters`, each VLAN (vlan007 and vlan123) must be configured as follows:

- Create new interface called ‘vlan007’ in the tab `Network` → `Interfaces`

- When ask to specify a physical interface, create the custom interface eth0.007 then click on '*Save & Apply*'

Further steps are also required regarding the configuration of the ICCP management interface:

- The WLAN modules from both ICCP partners have to be connected to each other. This means that on one radio the "Access Point (WDS)" mode must be selected and the mode "Client (WDS)" must be selected on the other radio. All other parameters such as SSID, encryption and operating frequency have also to be tuned to ensure the connection as for a standard Master/Client WLAN connection. All these setups can be configured in the tab `Network` → `Wireless`.
- Static IPs on the same subnet have to be set for the ICCP management interface in the tab '*Network*' → 'Interfaces' (e.g. if the lan interface is selected as ICCP management interface including eth0 and wlan0, the IP address can be set to 10.0.0.1 on on "ICCP partner A" and to 10.0.0.2 on "ICCP partner B".)

b. *ICCP VLAN configuration*

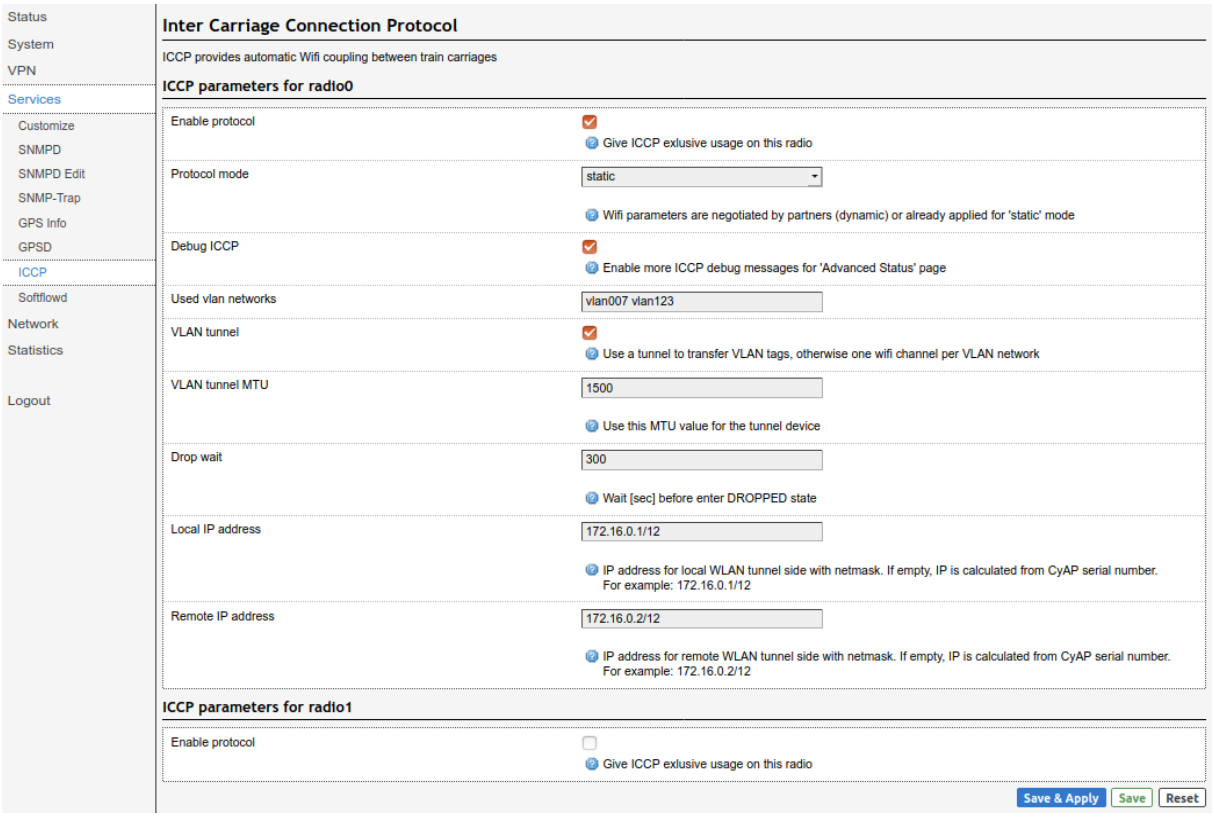
ICCP can be configured via the web interface as shown below, or via the command line with the commands:

On ICCP Partner A:

cfg_iccp -d -p static -r 0 -v vlan123 -v vlan007 -lip 172.16.0.1 -rip 172.16.0.2 -cidr 12

On ICCP Partner B:

cfg_iccp -d -p static -r 0 -v vlan123 -v vlan007 -lip 172.16.0.1 -rip 172.16.0.2 -cidr 12



Static ICCP VLAN configuration

Note 1: The VLAN tunnel checkbox should be checked.

Note 2: The local and remote IP address fields have to be exchanged on the connection ICCP partner. The local IP is the one set on the ICCP management interface on the access point you are currently configuring. The screenshot above applies for ICCP partner A.

6.1.10 QoS

In the following example, a networking interface LAN or WLAN is prepared to use the Quality of Service function (QoS). The CyBox AP 3 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`

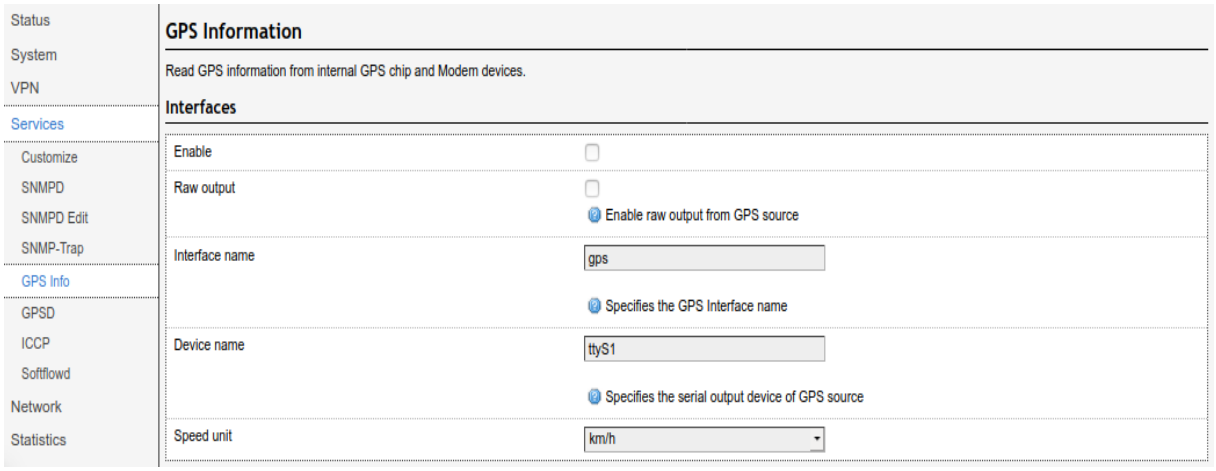
Do an 'iperf' performance test. The throughput should be about 10 Mbits/s. If a WLAN interface is bridged with the LAN port, the traffic control can even work on a single part of the bridge. To reduce the wireless traffic only, a new interface label must be added to `Network` → `Interfaces` menu e.g.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

6.2 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.

6.2.1 GPS activation

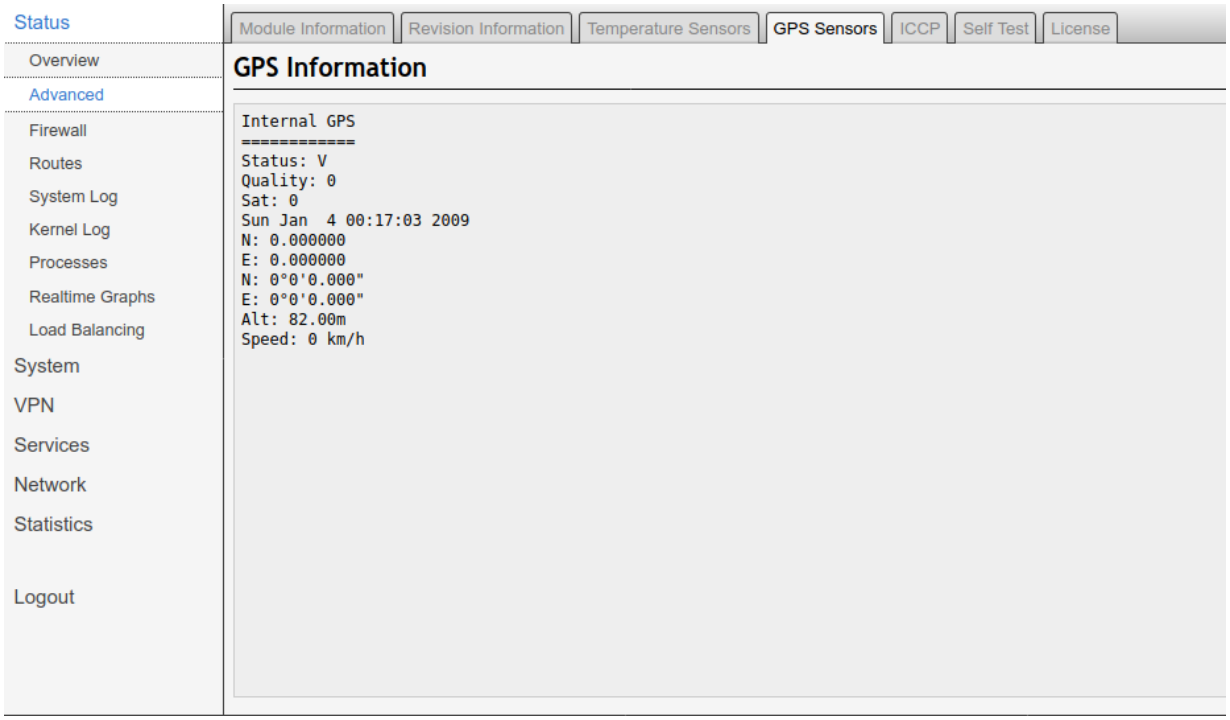
The GPS is disabled by default. It can be enabled via the web interface. Enter `System` → `GPS Info` and check Enable.



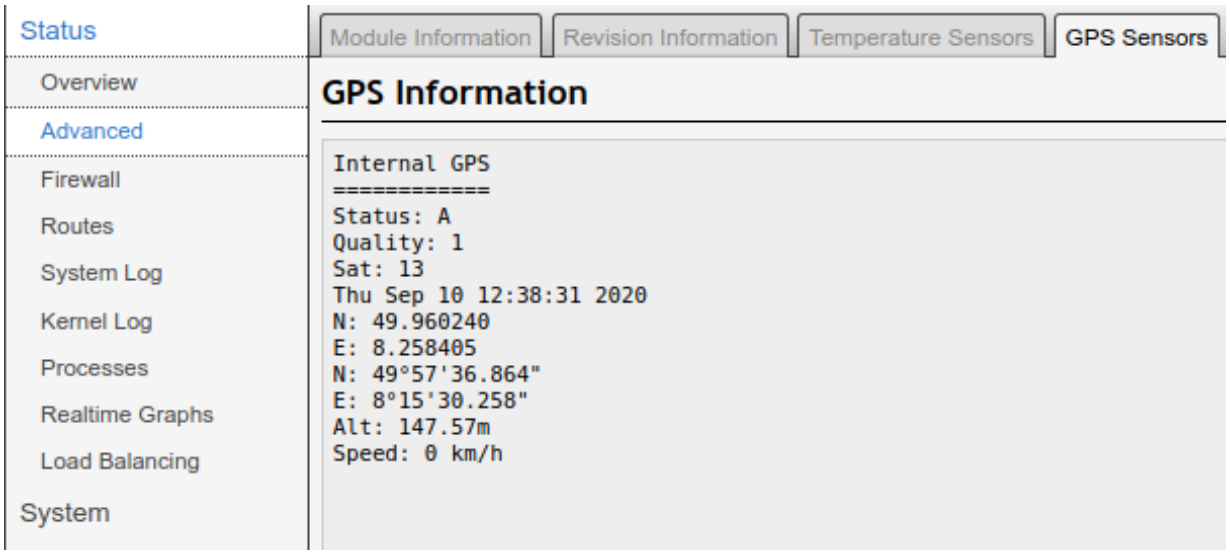
GPS Activation

6.2.2 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

Integrity	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

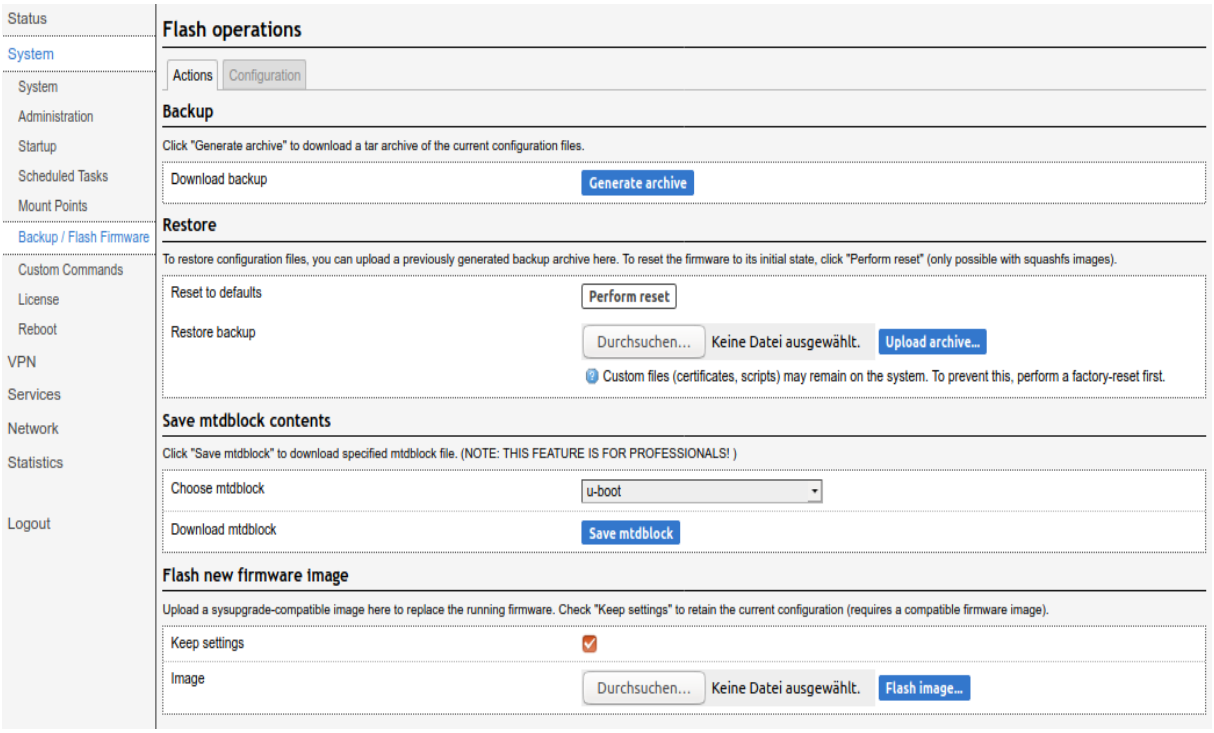
6.2.3 SNMP for GPS

See chapter SNMP Support for GPS

6.3 System

6.3.1 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.

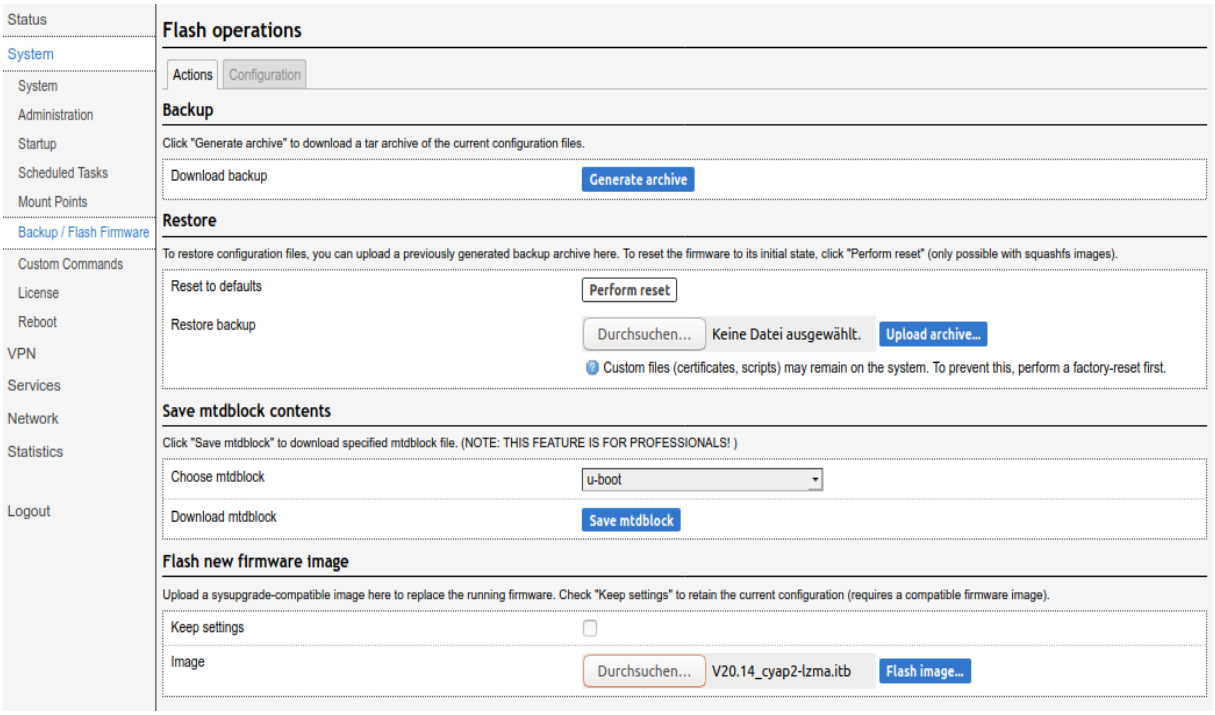
With the Upload archive… button you can restore a previously saved configuration. After restoring a configuration, the access point will reboot.

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.

6.3.2 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.

6.3.3 Reboot

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

6.3.4 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.

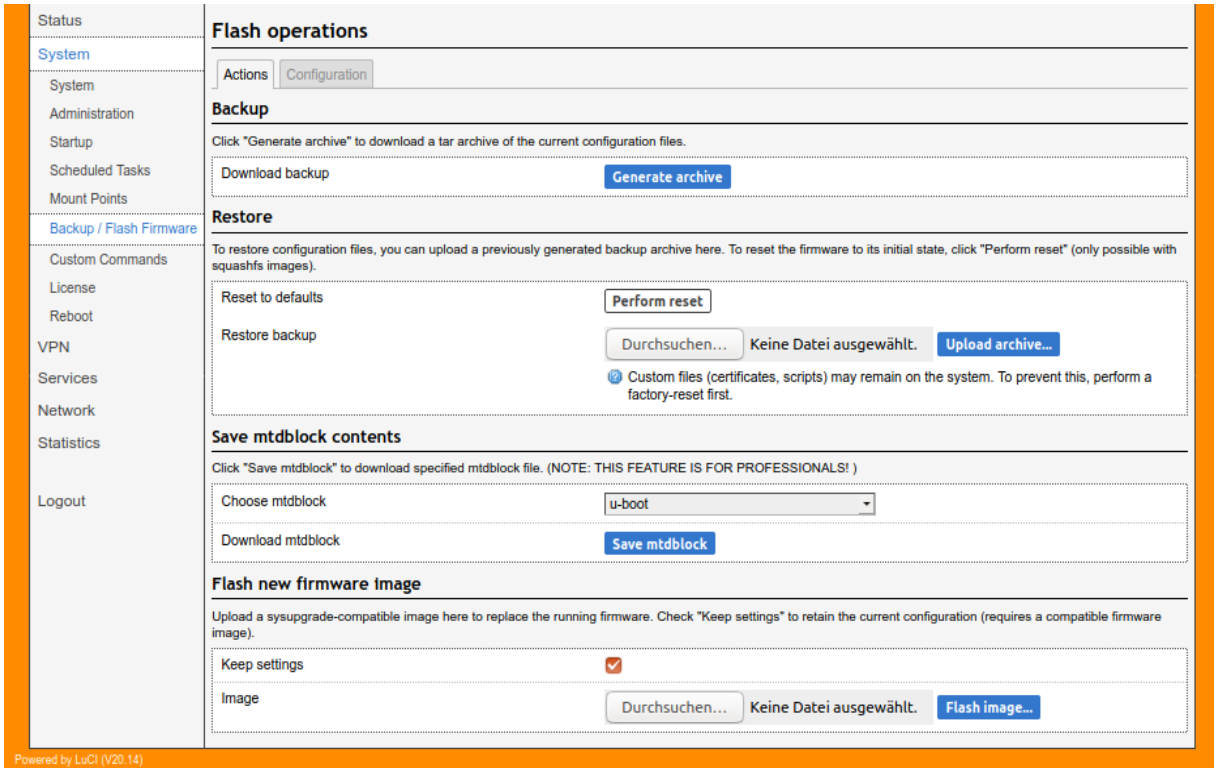
A reboot can be triggered by pressing the reset button with a pin for less than 2 seconds.

6.3.5 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 AP 3 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

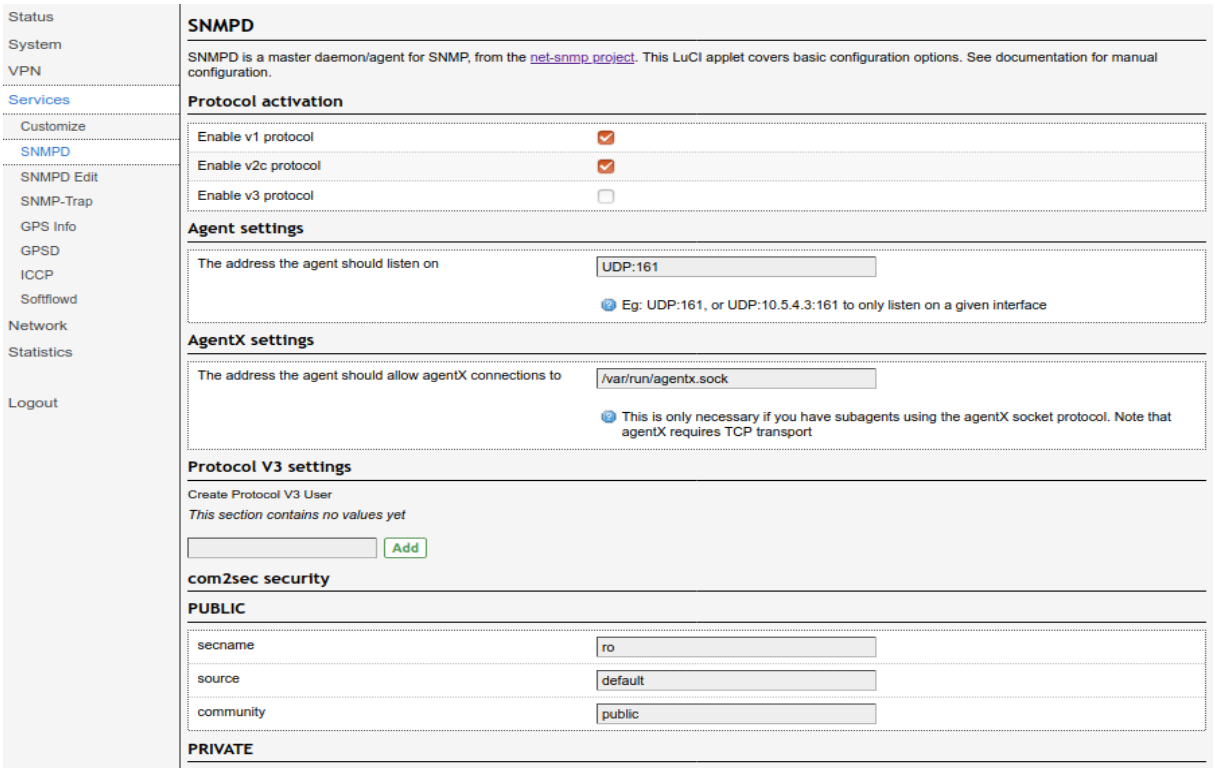
Emergency mode can also be entered by holding the reset button pressed for 5 seconds at the beginning of the boot phase.

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.



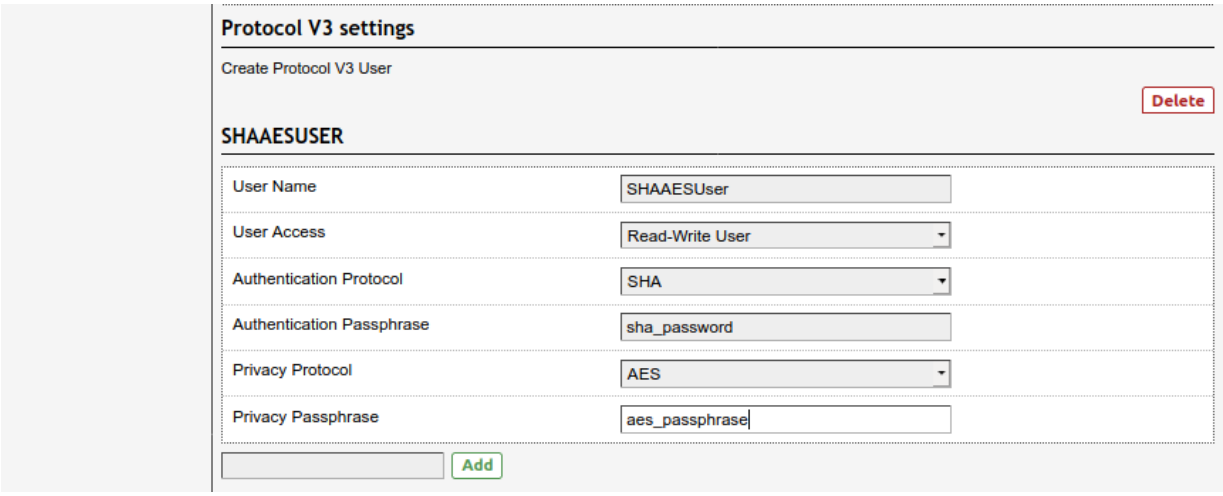
SNMPD factory default settings with protocol v1 and v2c enabled

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 AP 3 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 AP 3 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 AP 3 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 AP 3 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
```

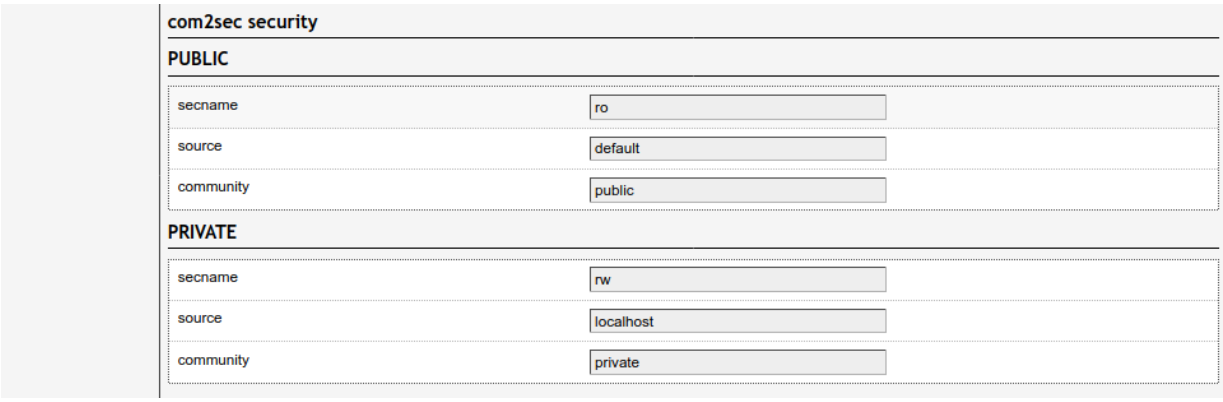
Where <*ccu*> refers to the IP address (or hostname) of the remote host which is allowed to perform SNMP write operations. The keyword “default” instead of a specific address allows any hosts to access the SNMP demon.

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 AP 3 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 AP 3 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 AP 3:

```
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 AP 3 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 AP 3 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 AP 3. 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

8 THE FLYING CONTROLLER MECHANISM

Some tasks require knowledge which is not available at a single network node. For example, to detect a “rogue access point”, all access points belonging to the WLAN network must be known, in order to identify those who don’t. Also, multiple access points scan the vicinity, and their results have to be collected and evaluated at one central point. Therefore a single “controller” is needed in the network which collects those information and then performs the rogue AP detection.

The “flying controller” is an algorithm which runs on multiple network devices simultaneously and which elects one of these devices as the “controller”. All other devices are called “workers”. If the controller fails, a new one is elected, hence the term “flying”. This way, a central controller is established without creating a single point of failure.

The CyBox AP 3 automatically takes part on the mechanism and could be elected as controller, or otherwise will be a worker.

The election mechanism is the foundation for the 6.1.2.12 Rogue Access Point Detection Service . This service runs on the controller and collects data from the workers to detect rogue APs.

The flying controller mechanism has no configuration options.

9 IPSecVPN / StrongSwan

strongSwan is a multiplatform IPsec implementation. The focus of the project is on strong authentication mechanisms using X.509 public key certificates and optional secure storage of private keys and certificates on smartcards through a standardized PKCS#11 interface and on TPM 2.0.

Detailed information about the **strongSwan IPsec** implementation can be found here:

https://www.strongswan.org/about.html

https://wiki.strongswan.org/projects/strongswan

9.1 IPSec Customized Configuration

The implementation of the IPSecVPN LuCi web interface and the OpenWrt service startup is to generate three service conform config files out of the OpenWrt configuration file ‘*/etc/config/ipsec*’.

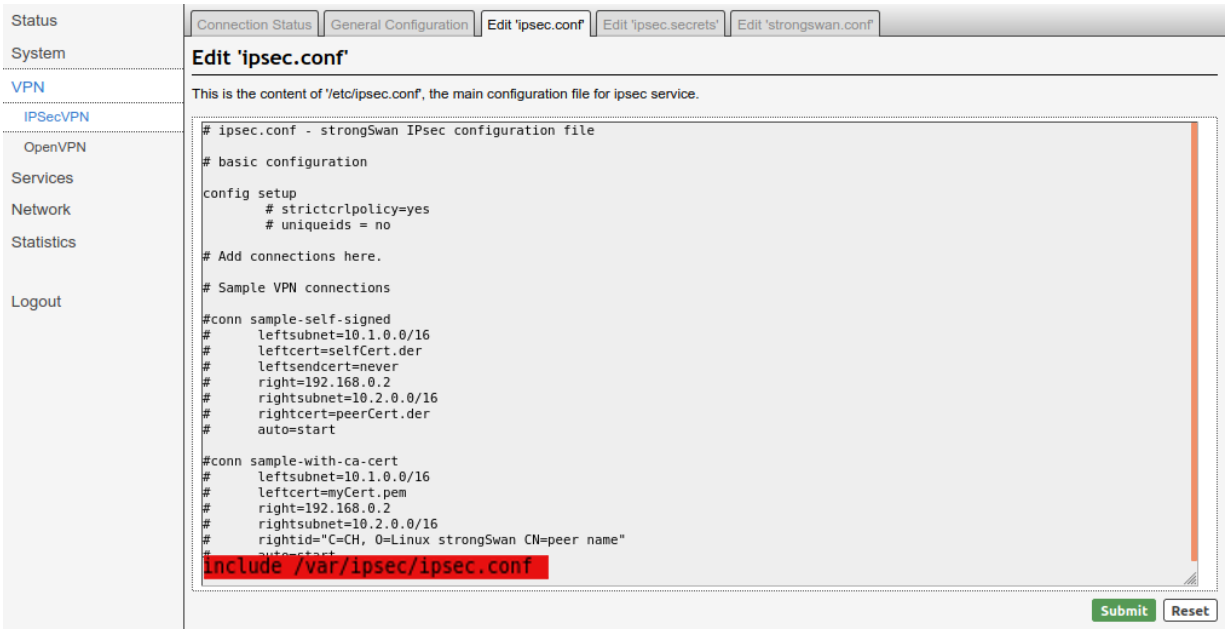
These three standard configuration files are:

- IPSEC_SECRETS_FILE=/etc/ipsec.secrets
- IPSEC_CONN_FILE=/etc/ipsec.conf
- STRONGSWAN_CONF_FILE=/etc/strongswan.conf

When IPSec service is started, the configuration file ‘*/etc/config/ipsec*’ is converted into three volatile config include files located in ‘*/var/ipsec/*’

- IPSEC_VAR_SECRETS_FILE=/var/ipsec/ipsec.secrets
- IPSEC_VAR_CONN_FILE=/var/ipsec/ipsec.conf
- STRONGSWAN_VAR_CONF_FILE=/var/ipsec/strongswan.conf

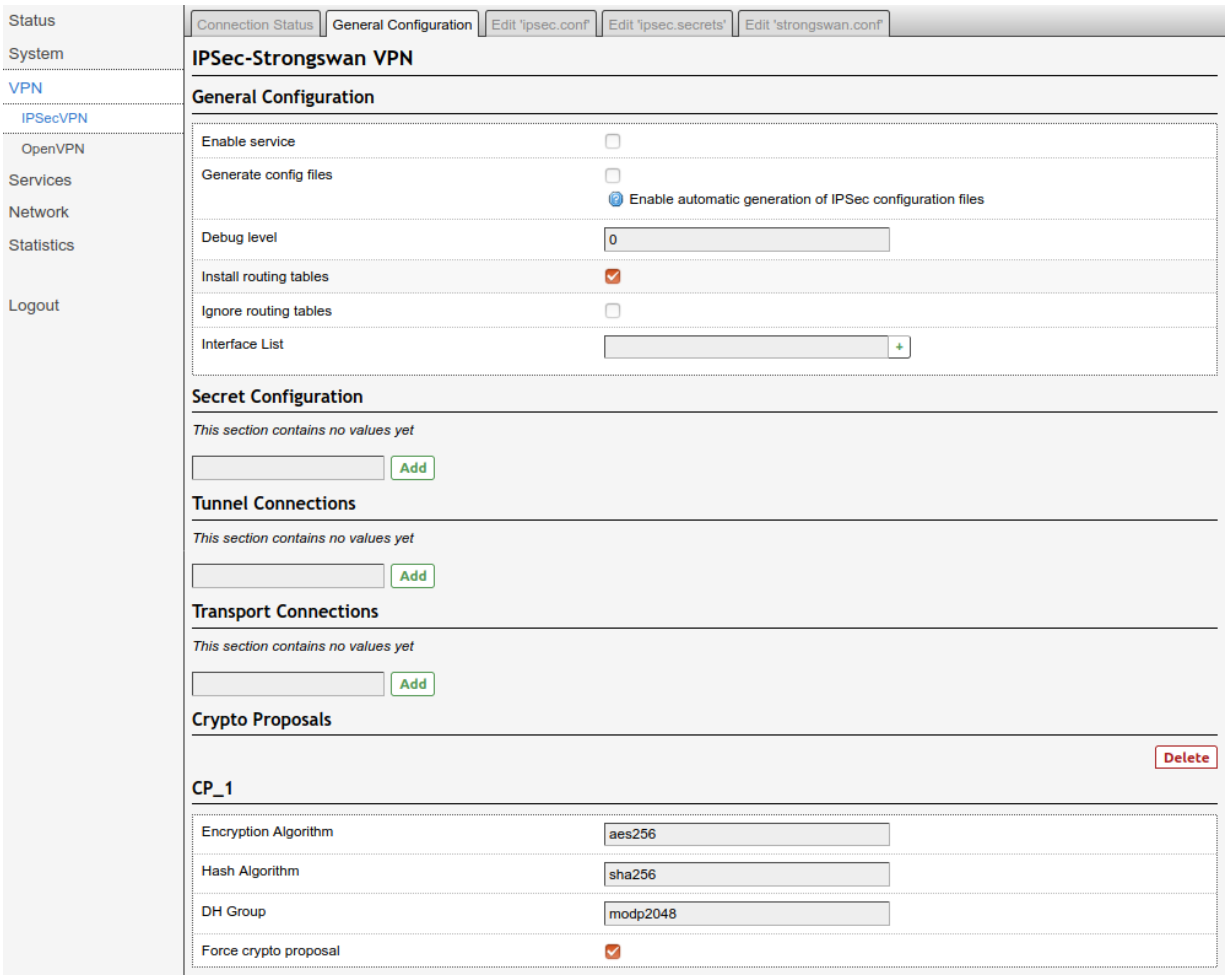
The three standard configuration files do include the generated files, but may also be adapted on the IPSecVPN web page with the corresponding menu editor.



IPSec service configuration files can be edited (customized)

9.2 IPSec default configuration

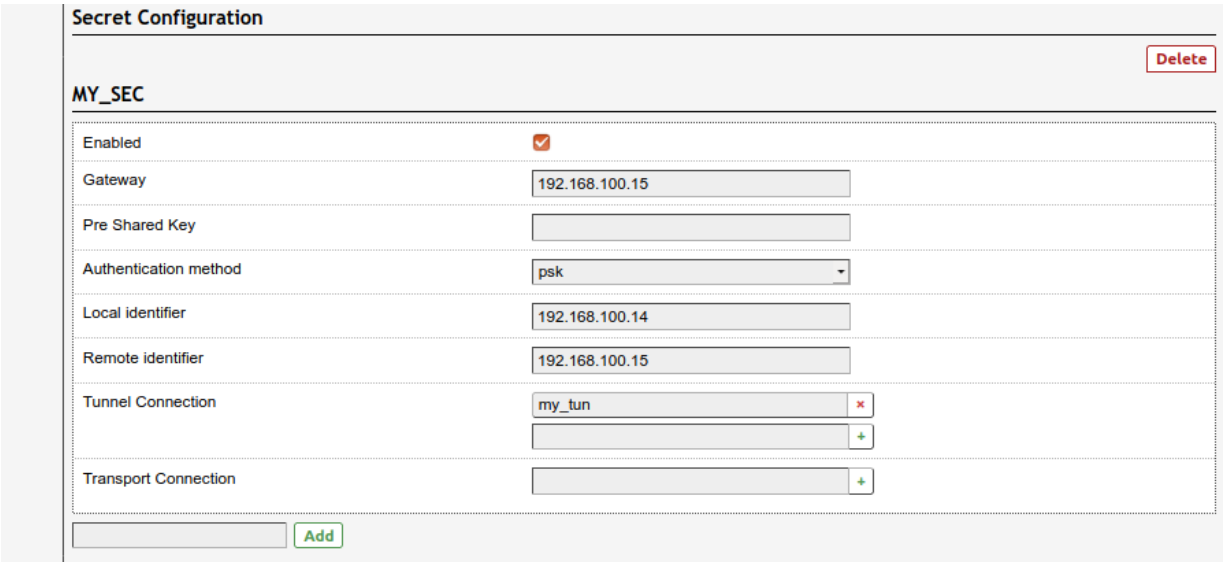
The service is disabled in default factory configuration. First step is to decide if configuration files should be automatically generated or are provided and edit by operator. The next chapters supposes that configuration is generated by IPSec start script (`init.d/ipsec`).



IPSec factory default configuration

9.3 IPSec Secret configuration

The `ipsec.secrets` file keeps the Pre-Shared-Keys (*PSK*) for a prior configured `Tunnel` and/or `Transport` connection. The *PSK* is the one and only supported authentication method.

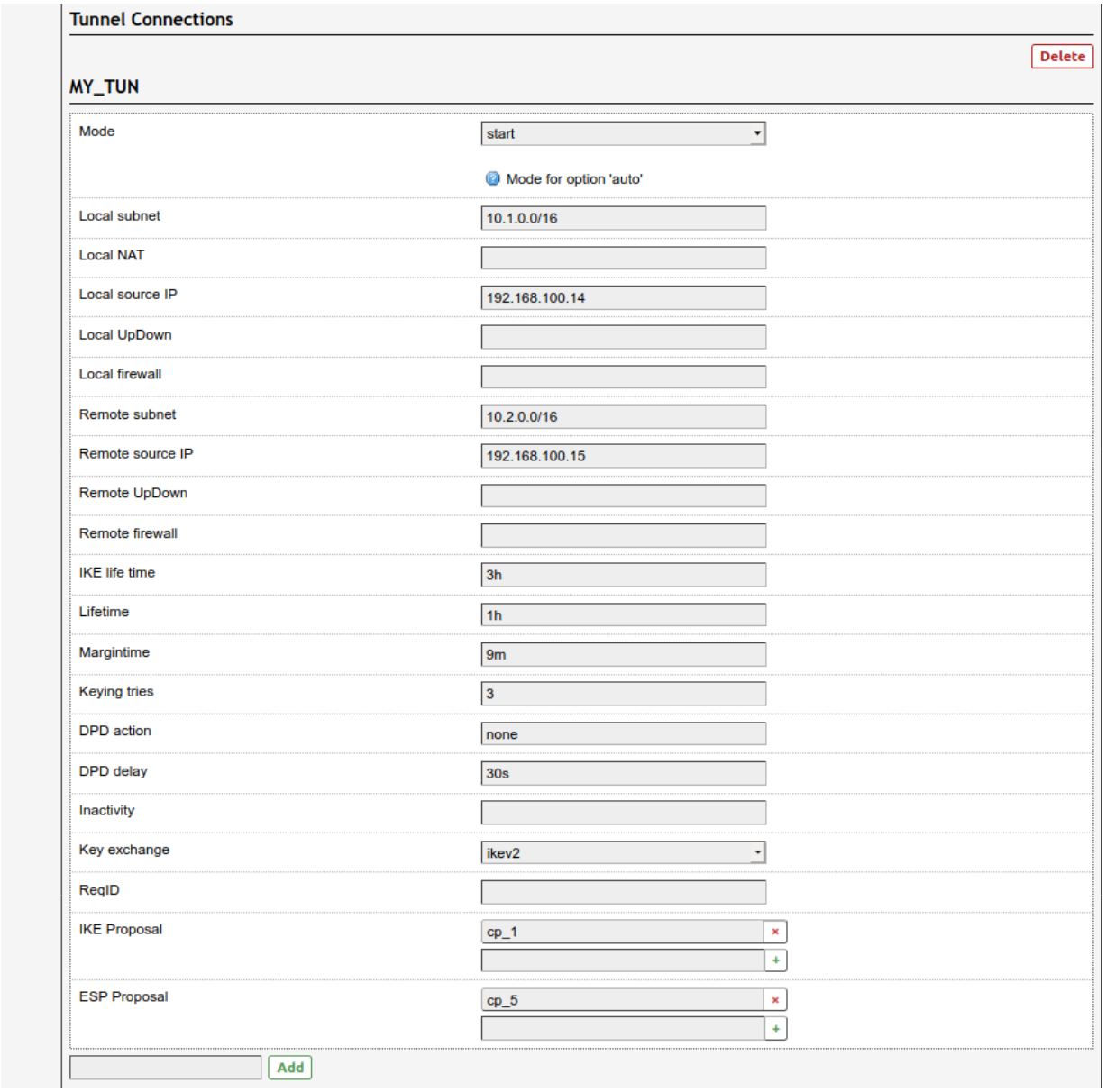


PSK Secret configuration

9.4 IPSec Tunnel / Transport Connection

The parameters in this menu are named analogue to the standard parameters in offical configuration documentation. Please refer to:

https://wiki.strongswan.org/projects/strongswan/wiki/ConfigurationFiles



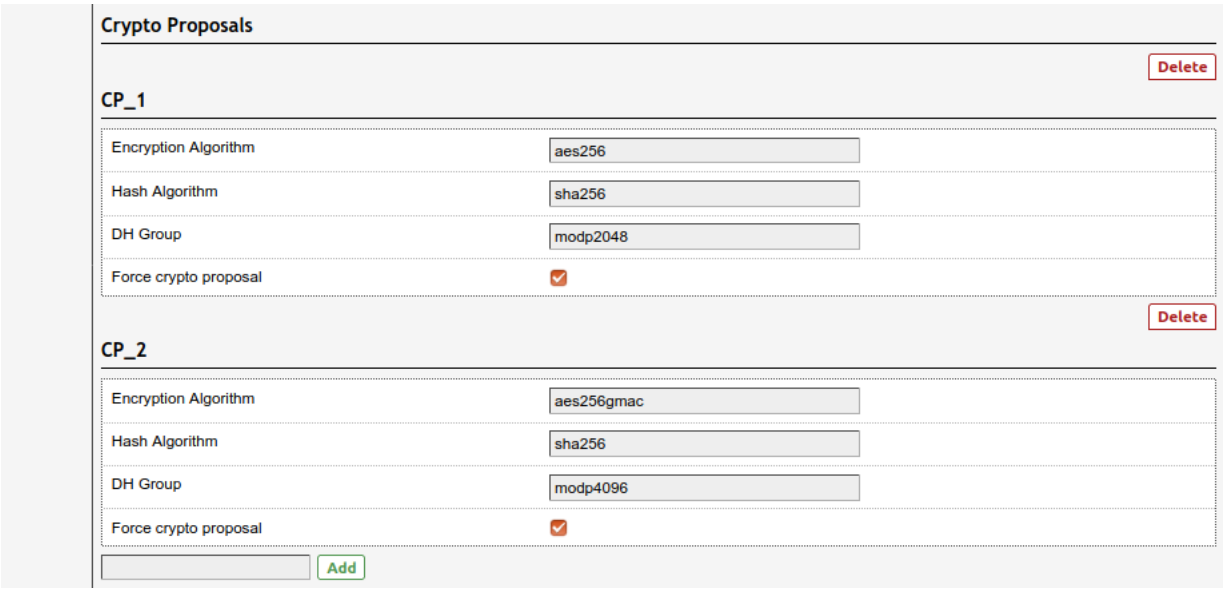
Tunnel Connection configuration

The Transport Connection is similar to the Tunnel Connection setup.

Transport Connection configuration

9.5 IPSec Crypto Proposal configuration

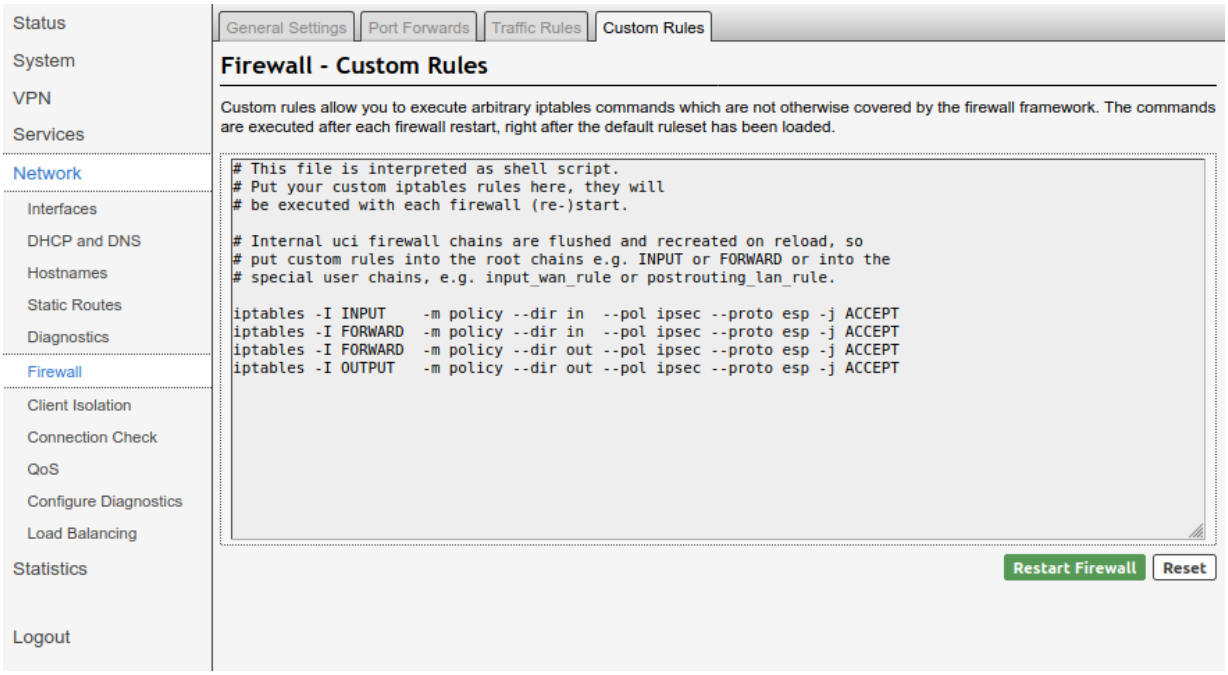
In default factory configuration some Crypto Proposal are already defined. With the `Add` button new proposals can be added. Use the `Delete` button to remove unneeded Crypto Proposals from configuration.



Crypto Proposals, some are predefined

9.6 IPSec Firewall Custom Rules

The standard firewall setup (factory default) may require new custom rules to handle IPSec ESP package forwarding.



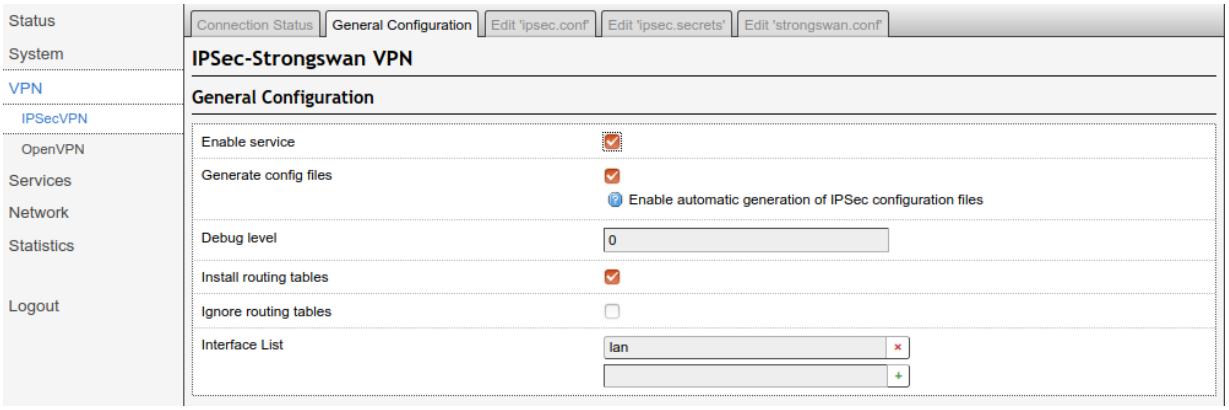
The firewall obtained some additional custom rules

Cut and Paste buffer for IPSec `Firewall - Custom Rules` edit:

```
iptables -I INPUT    -m policy --dir in  --pol ipsec --proto esp -j ACCEPT
iptables -I FORWARD  -m policy --dir in  --pol ipsec --proto esp -j ACCEPT
iptables -I FORWARD  -m policy --dir out --pol ipsec --proto esp -j ACCEPT
iptables -I OUTPUT   -m policy --dir out --pol ipsec --proto esp -j ACCEPT
```

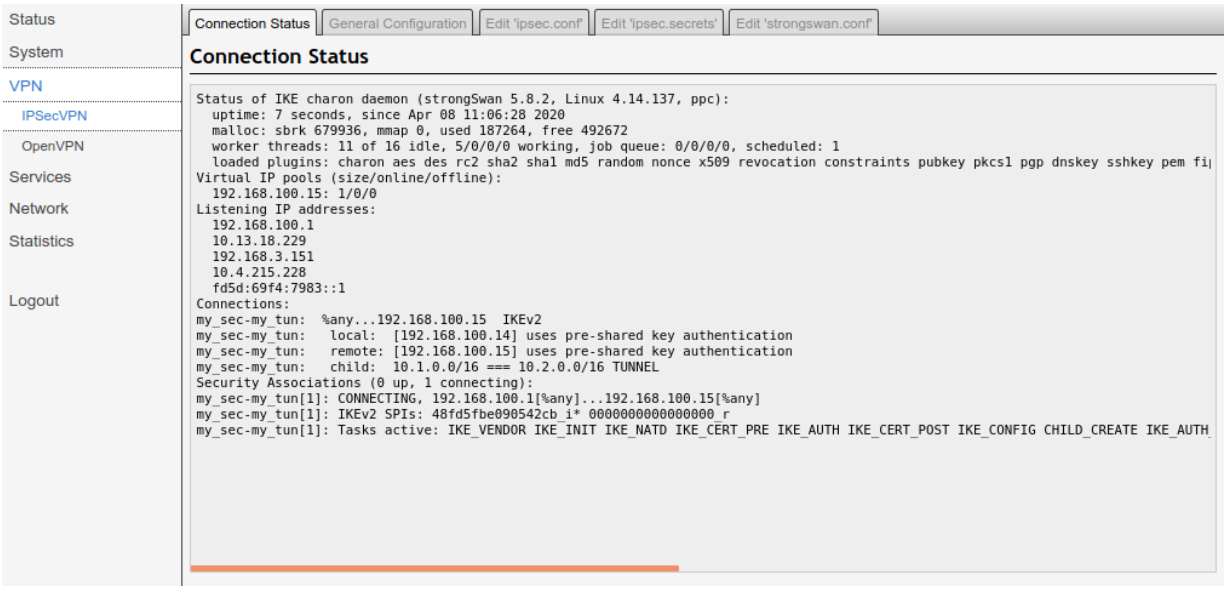
9.7 IPSec Service Start

If the `Enable service` box is activated and new settings are applied, the service will restart.



IPSec service is automatically restarted

The IPSec service connection status can ob observed in the `Connection Status` menu tab.



Status of IPSec service waiting for connection

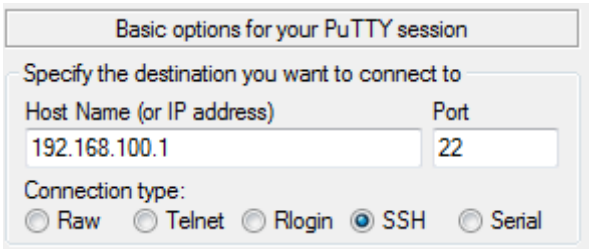
10 SSH / SERIAL CONSOLE

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:

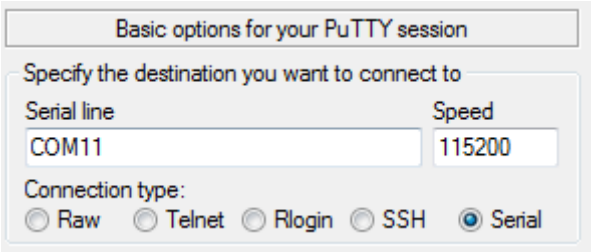


PuTTY - SSH connection

b. Serial cable

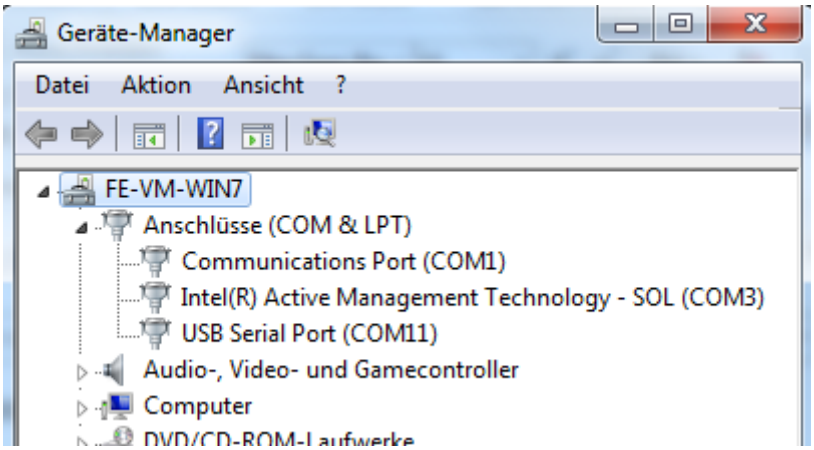
Ensure that a serial cable is connected between your PC and the access point (a specific CyBox adapter plugged in the USB port is required).

- 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.

10.1 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.

10.1.1 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.

10.1.2 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.

10.2 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.

11 SYSTEM MAINTENANCE

11.1 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.

11.1.1 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"
   ```

11.1.2 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

11.2 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
```

11.3 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

12 APPENDIX: GPL LICENSE

```
GNU GENERAL PUBLIC LICENSE

Version 3, 29 June 2007

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13 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.----
```

14 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 AP 3
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 AP 3

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	

Network	Status
LAN_ALIAS eth0	**Uptime:** 0h 0m 60s **MAC-Address:** 00:00:5B: **RX:** 34.58 KB (416 Pkts.) **TX:** 149.14 KB (297 Pkts.) **IPv4:** 10.7.138.70/8
LAN_DHCP eth0	**Uptime:** 0h 0m 0s **MAC-Address:** 00:00:5B: **RX:** 34.58 KB (416 Pkts.) **TX:** 149.14 KB (297 Pkts.)
LAN_MAC eth0	**Uptime:** 0h 0m 60s **MAC-Address:** 00:00:5B: **RX:** 34.58 KB (416 Pkts.) **TX:** 149.14 KB (297 Pkts.) **IPv4:** 10.3.180.190/8
LAN eth0	**Uptime:** 0h 0m 60s **MAC-Address:** 00:00:5B: **RX:** 34.58 KB (416 Pkts.) **TX:** 149.14 KB (297 Pkts.) **IPv4:** 192.168.100.1/24 **IPv6:** fdff:a58d:4d24::1/60
WAN eth1	**Uptime:** 0h 0m 0s **MAC-Address:** 00:00:5B: **RX:** 0 B (0 Pkts.) **TX:** 0 B (0 Pkts.)
WAN6 eth1	**Uptime:** 0h 0m 0s **MAC-Address:** 00:00:5B: **RX:** 0 B (0 Pkts.) **TX:** 0 B (0 Pkts.)

Default Network Configuration