ELSETA

WCC Lite

User manual

Elseta

2022/05/19

Doc version: 1.6.2

HW version: 1.4

FW version: 1.6.2

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SAFETY PRECAUTIONS

Any work related to the installation, configuration, commissioning and maintenance of the WCC Lite should be carried out by qualified personnel only. It is implied the person or group responsible for the said duties have adequate engineering knowledge.

It is crucial to adhere to laws and regulations of the jurisdiction the WCC Lite is being installed at. This product should not be implemented or resold to install in high-security areas such as: nuclear power plants, aircraft navigation, military equipment, transport traffic management or in other areas where equipment failure or malfunction can result in hazardous, life-threatening consequences of human injury or harm to environment.

This product is NOT safe to use in an explosive atmosphere.

Any installation or wiring should be carried out with the equipment fully powered off.

In order to prevent damage to the equipment, please carefully check the power supply, input and output ratings, as well as the operating conditions. Failure to observe this information may render input, output, or the whole device inoperable and may also void warranty.

WARRANTY

UAB Elseta has the right to terminate the warranty maintenance:

- If the WCC Lite components obtained mechanical damage.
- If the WCC Lite was disassembled not as described in service and installation manual.
- If the WCC Lite failure was due to deliberate or inadvertent user’s fault.
- If the WCC Lite broke due to natural disasters.

Table of contents

Overview

This document is intended to act as a user manual and explain WCC Lite usage in detail. It is expected the person referring to this manual is experienced in programmable logic controllers (PLC), networking (IPv4, ethernet) and the use of the operating system of choice (Windows, Linux, Mac, etc.). This document might not cover all of the use cases. For usage not described in this document please contact Elseta technical support (contact info available on the last page of this document).

Hardware and software requirements

In order to get the WCC Liteup and running, a PC/Mac is required, capable of running a web browser and an MS Excel compatible spreadsheet editor (e.g. LibreOffice or an online spreadsheet editor such as Google Sheets). A builtin or external Ethernet adapter is also required to connect to the WCC Lite.

Technical information

System	
Processor	ARM CPU (AR9331, 400MHz)
Memory	16 MB Flash/64 MB DDR2 RAM
Wireless	802.11 b/g/n
I/O	1x Binary input (hardware version >=1.4) 1x Relay output
Additional storage SD card (2GB by default)	SD card (2GB by default)
Ethernet	10/100 Base-T RJ45 connector up to 2 independent ports
Serial ports	1x RS485 1x RS485 / RS232 (switchable)
Time synchronization	NTP client + server, IEC 60870-5-101, IEC 60870-5-104

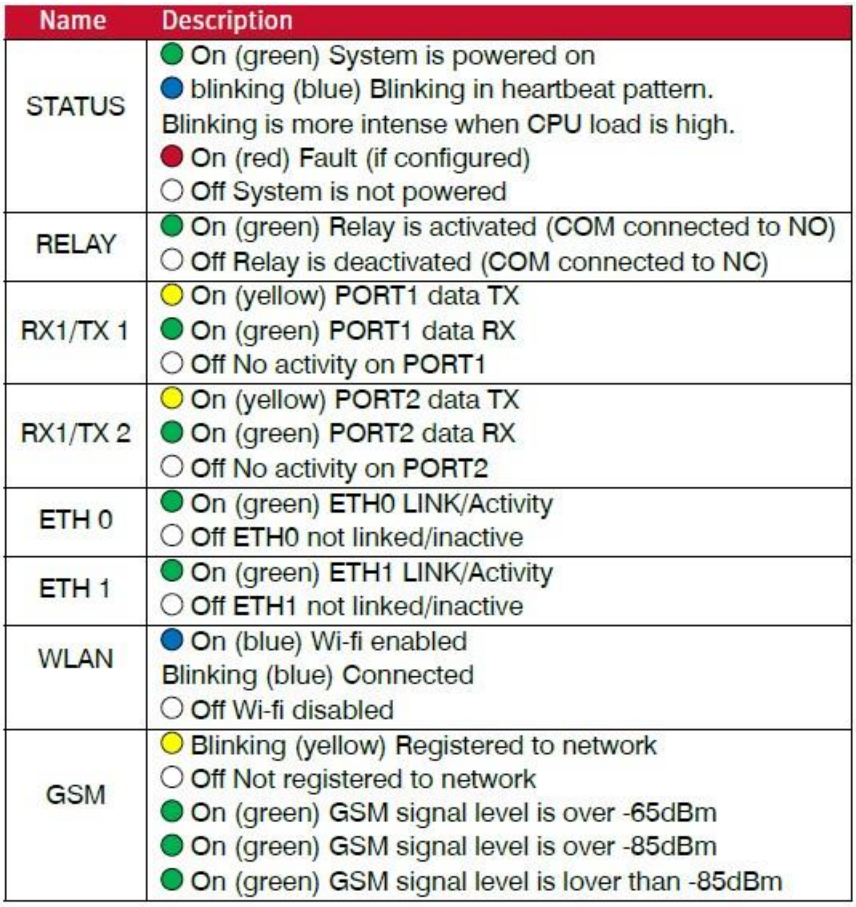
GSM	2G(GPRS, EDGE) / 4G(LTE)
	2G(GPRS, EDGE) / 3G(UMTS, HSDPA, HSUPA)
	2G(GPRS, EDGE) / 3G(UMTS, HSDPA, HSUPA) / 4G(LTE)
	Single OR Dual SIM card modem

Power requirements	
Power supply	12 - 24 VDC
Power consumption	< 6W
Dimensions	101 (H) x 22.5 (W) x 119 (L), mm
Mounting	Wall mount, Din rail
Environmental	
Operating temperature	-40°C to +85°C
Warranty	2 year
Software	
Compatibility with HMI (Human Machine Interface)	Compatible with cloud based SCADA system -CloudIndustries.eu
Routing	• Isolated LAN interface • Isolated LAN interface, but omitted to provide TCP / UDP ports or VPN mergers • Routed LAN internet connection masking data for GSM interfaces • Secure LAN data transfer via VPN • Secure LAN data transmission through VPN access to the Internet • Single OR Dual SIM card modem
Database	• File based database • Data buffering in case of network outage
Data security	• All data between WCC Lite and Cloud based SCADA exchange over secure encrypted VPN tunnel • Firewall to prevent intrusion and DoS attacks • VPN solution with VPN gateway can be used to manage (configure and update) and monitor VPN and WCC devices from a single place
Device maintenance	It is possible to configure and monitor devices and protocols connected to the WCC Lite through Elseta cloud based SCADA system CloudIndustries.eu or 3rd party SCADAs and see devicebased alarms such as communication errors, etc.

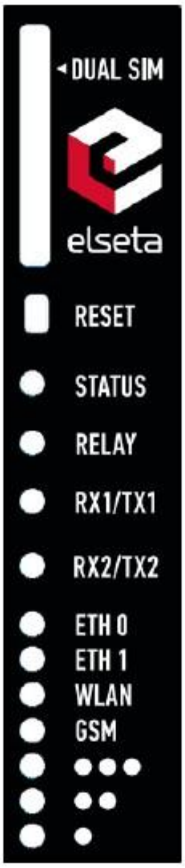
Supported protocols	• Modbus master / slave (RTU / ASCII / TCP) • MBus master (Serial / TCP) • IEC 60870-5-101 master / slave • IEC 60870-5-103 master • IEC 60870-5-104 master / slave • IEC 62056-31 master • IEC 62056-21 (since v1.2.13) • DNP3.0(Serial/LAN/WAN) master / slave • SMA Net • DLMS Cosem (Serial/TCP) (since v1.3.0) • Resol VBus • IEC 61499 (since v1.4.0) • IEC 61850 (v1/v2/v2.1) master / slave (since v1.5.0)
Supported devices	• Other Elseta products • Aurora PV inverters • Delta inverters • Kaco PV inverters • SMA PV inverters • Ginlong PV inverters • Solplus PV inverters • Kostal devices • Windlog data logger • Vestas Wind turbines • Elgama elektronika electricity meters
Network features	• IPsec • OpenVPN • xl2tp • Firewall • Routing • RADIUS • SNMP • ser2net • API • NTP synchronization
Extra features	• Software update • Remote configuration via CloudIndustries.eu administration • Device fault notifications • Internal web page for configuration and diagnostics

WCC Lite status indication and control

Status indication



Name	Description
STATUS	🟢 On (green) System is powered on 🔵 blinking (blue) Blinking in heartbeat pattern. Blinking is more intense when CPU load is high. 🔴 On (red) Fault (if configured) ○ Off System is not powered
RELAY	🟢 On (green) Relay is activated (COM connected to NO) ○ Off Relay is deactivated (COM connected to NC)
RX1/TX 1	🟡 On (yellow) PORT1 data TX 🟢 On (green) PORT1 data RX ○ Off No activity on PORT1
RX1/TX 2	🟡 On (yellow) PORT2 data TX 🟢 On (green) PORT2 data RX ○ Off No activity on PORT2
ETH 0	🟢 On (green) ETH0 LINK/Activity ○ Off ETH0 not linked/inactive
ETH 1	🟢 On (green) ETH1 LINK/Activity ○ Off ETH1 not linked/inactive
WLAN	🔵 On (blue) Wi-fi enabled Blinking (blue) Connected ○ Off Wi-fi disabled
GSM	🟡 Blinking (yellow) Registered to network ○ Off Not registered to network 🟢 On (green) GSM signal level is over -65dBm 🟢 On (green) GSM signal level is over -85dBm 🟢 On (green) GSM signal level is lover than -85dBm



Reset button

The reset button is located on the front panel of WCC Lite, to access it, remove a transparent front panel cover. Different time lengths of button pressing call different behaviour.

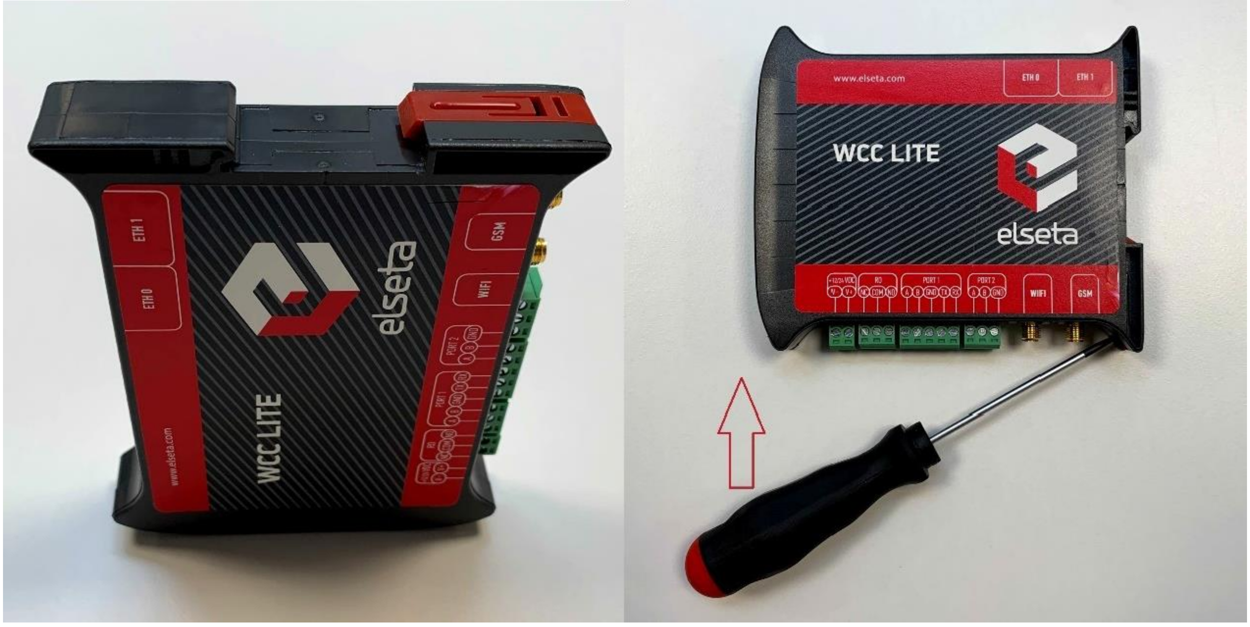
Pressing time	Description	Indication
Short Press	System reboot	Red STATUS LED starts blinking
Long press (>3s)	Reset to factory settings	Red STATUS LED turns on

Installing the WCC Lite

Mounting

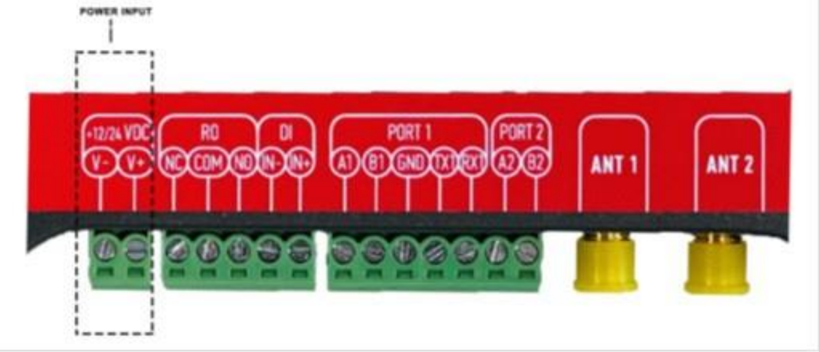
To mount the device:
1. Secure the top of the mounting clip onto a DIN rail.
2. Push the bottom of a device forward to fix the clip in place.

To dismount the device:
1. Pull red coloured clip downwards (found at the bottom side of the DIN rail).
2. Pull back the bottom of the device.
3. Pull device upwards to dismount it.



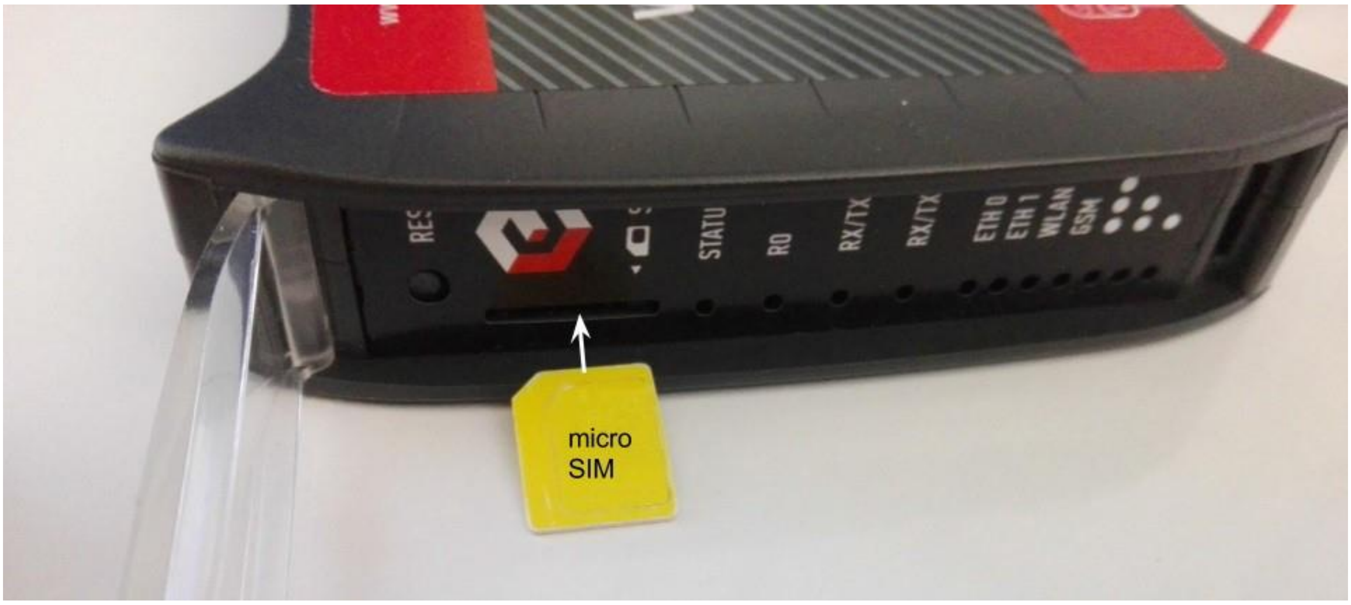
Power

WCC Lite It is recommended to power WCC Lite from 6W (minimum) 12-24V DC power supply. A full range is 5V to 36V.



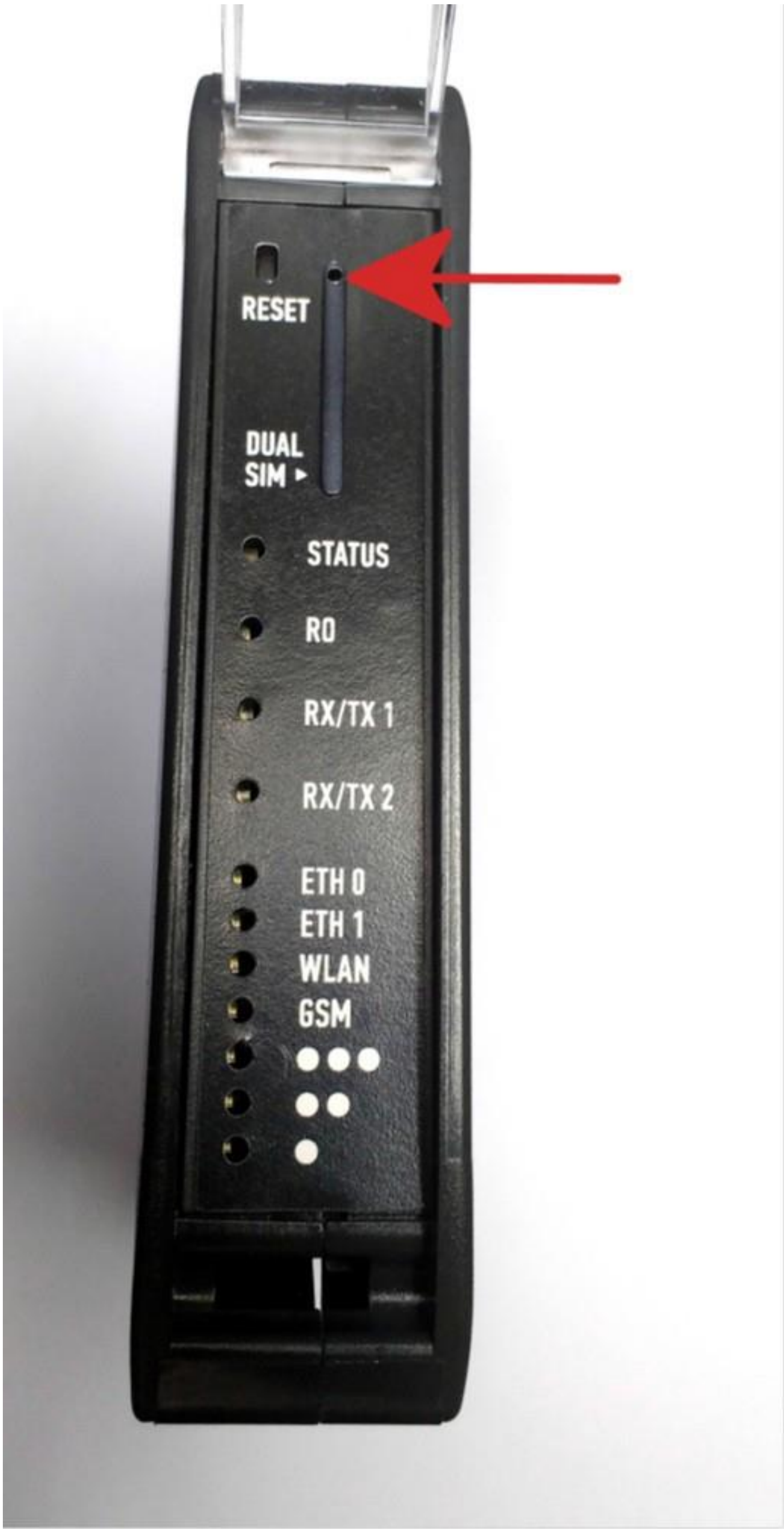
⚠ Note: Make sure that device is compatible with your power source before proceeding! Check the label next to power connector or on the side of device.

SIM card slot (hardware versions older than 1.3)



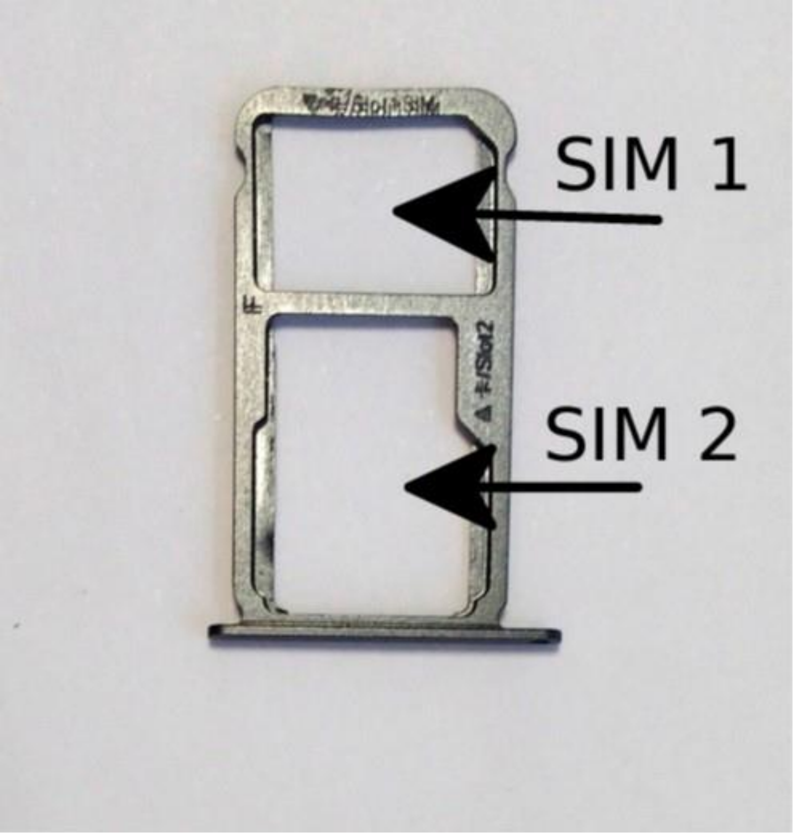
ℹ As of hardware versions 1.3 onwards single SIM modem support for WCC Lite has been discontinued.

WCC Lite has push-push type microSIM card connector with card detection function. The connector is located on the front panel of WCC Lite. To access it, remove a transparent front panel cover. To insert a SIM card gently push it inside (see Figure below) until it locks in place. Press again to release and remove the card.



Dual-SIM card slot

WCC Lite has optional Dual-SIM card modem. To access both SIM cards, remove a transparent front panel cover and press through marked hole with small tool until SIM holder pops out.



To insert SIM cards, remove Dual-SIM holder and fit SIM cards into it. Insert holder with SIM cards into slot.

Note: Be careful when removing or inserting DUAL-SIM holder, as SIM cards can fall out.

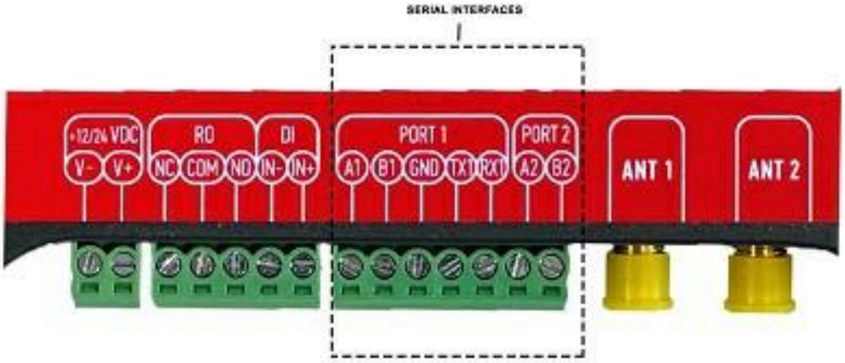
Note: WCC Lite will automatically detect a SIM card insertion or removing.

WCC Lite interfaces

WCC lite supports various interfaces to be acquire data and control external circuitry. That includes two serial port interfaces, relay output, digital input and external cellular connection antennae.

Serial port interfaces

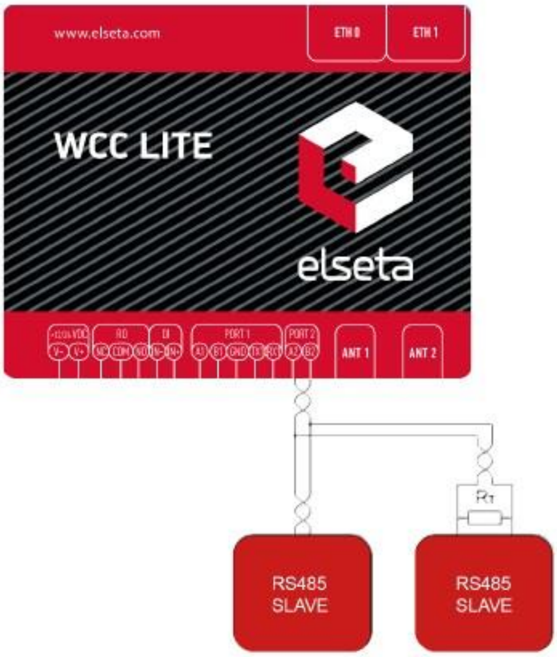
WCC Lite WCC Lite has 2 serial ports (Figure 7). Selectable RS485 (by default) or RS232 interface on PORT1 and RS485 interface on PORT2.

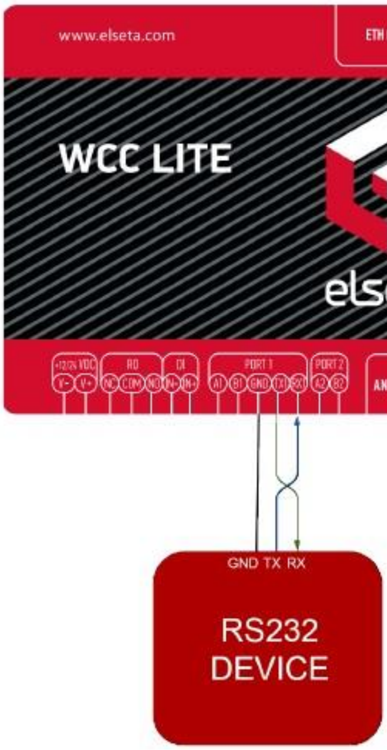


WCC Lite RS485 interface supports baud rates up to 115200 and has an integrated 120 termination resistor. It is recommended to use termination at each end of the RS485 cable. To reduce reflections, keep the stubs (cable distance from main RS485 bus line) as short as possible when connecting device. See typical RS485 connection diagram on figure 8.

Note: Double check if A and B wires are not mixed up.

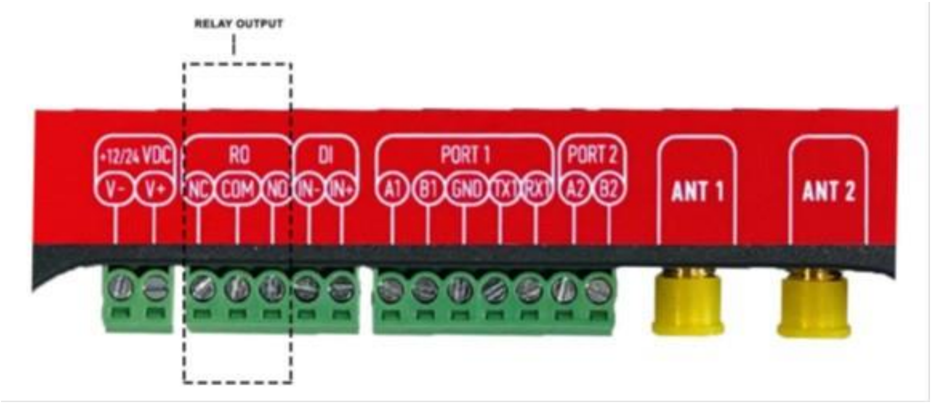
WCC Lite 3-wire RS232 interface is available on PORT1 and can be selected by user (see Port settings). Baud rates up to 115200 are supported. See typical RS232 connection diagram on figure 9.





Relay output

WCC Lite integrates 1 signal relay (3-way RO connector) with COM (common), NC (normally closed) and NO (normally open) signals.

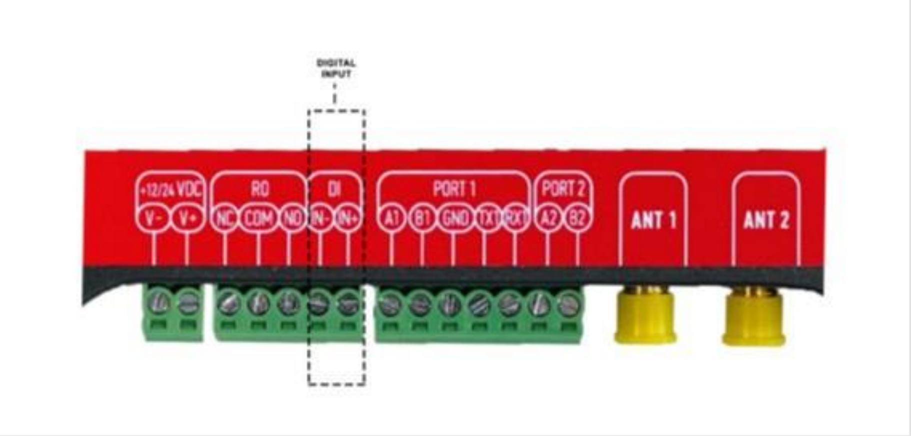


Maximum switching power is 60W, maximum contact current is 2A, maximum switching voltage is 60VDC/60VAC. The lower is switching power, the higher is lifecycle of Relay Output.

Relay electrical endurance:
- resistive load, 30VDC / 1A - 30W min. 1x105 operations;
- resistive load, 30VDC / 2A - 60W min. 1x104 operations.

Digital Input

With WCC Lite hardware version 1.4 a digital input functionality has been introduced. Software configuration guidelines are discussed later in this document.

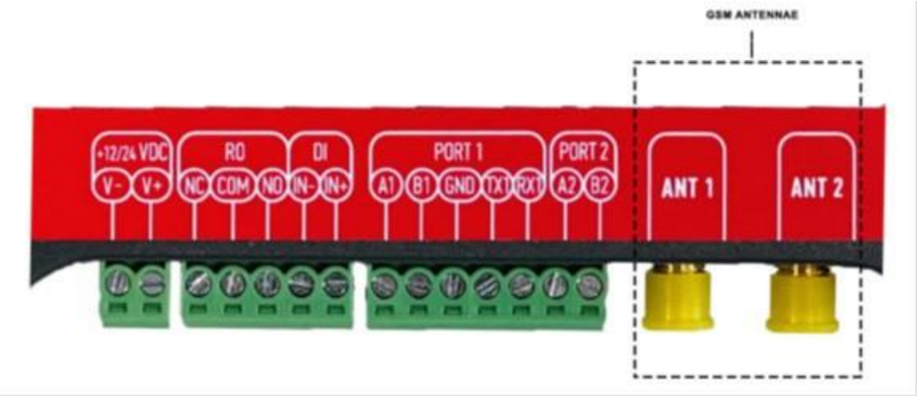


GSM

WCC Lite comes with an optional GSM module.
There are few hardware configurations available:

- Without GSM modem.
- With single SIM modem (HW version 1.0 - 1.2) - 2G/3G (GPRS, EDGE / UMTS, HSDPA, HSUPA) version - 5.76Mb/s upload, 7.2Mb/s download. UMTS/HSPA bands 900, 2100. GSM bands 900, 1800. Modem chip - Ublox Sara-U270.
- With single SIM modem (HW version 1.0 - 1.2) - 2G/4G (GPRS, EDGE / LTE) Cat 1 version - 10.3Mb/s upload, 5.2Mb/s download. LTE bands 3, 7, 20. GSM bands 900, 1800. Modem chip - Ublox Lara-R211.
- With dual SIM modem (HW version 1.0 - 1.2) - 2G/3G (GPRS, EDGE / UMTS, HSDPA, HSUPA) version - 5.76Mb/s upload, 7.2Mb/s download. UMTS/HSPA bands 900, 2100. GSM bands 900, 1800. Modem chip - Ublox Sara-U270.
- With dual SIM modem (HW version 1.0 - 1.2) - 2G/4G (GPRS, EDGE / LTE) Cat 1 version - 10.3Mb/s upload, 5.2Mb/s download. LTE bands 3, 7, 20. GSM bands 900, 1800. Modem chip - Ublox Lara-R211.
- With dual SIM modem (HW version 1.3 - 1.4) - 2G/3G/4G (GPRS, EDGE / UMTS, HSDPA, HSUPA / LTE) Cat 4 version - 50Mb/s (max) upload, 150Mb/s (max) download. LTE bands 1, 3, 5, 7, 8, 20, 38, 40, 41. GSM bands 3, 8. UMTS bands 1, 5, 8. Modem chip - Quectel EC25-E.

They are based on mini PCI-e standard connector and compatible with any other devices. Check label on package for current modification.



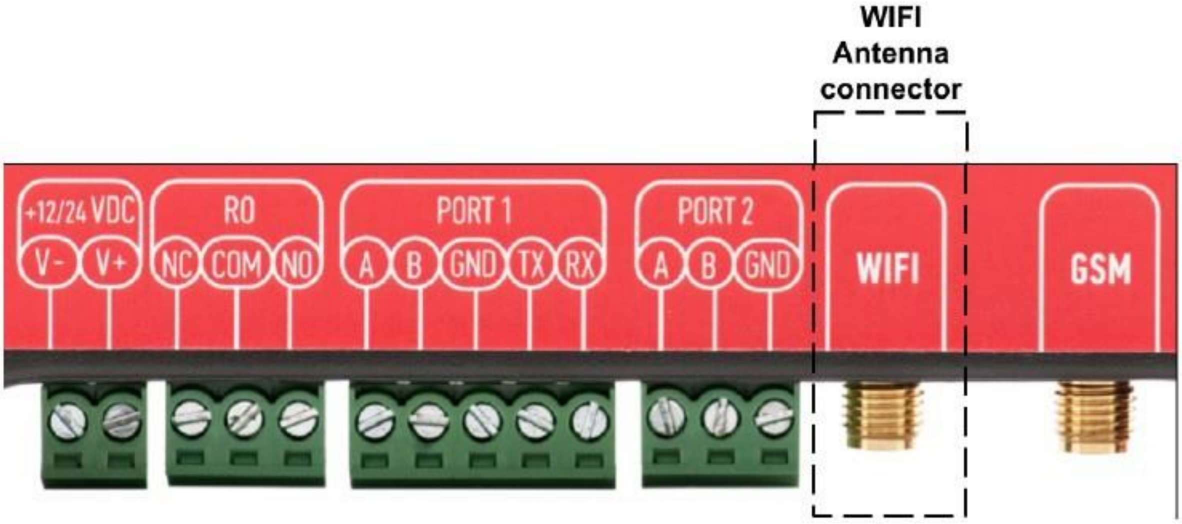
Connect an antenna to the SMA connector labeled "ANT1". Select a good antenna placement spot considering the operation environment and network coverage of your mobile provider in the area. To enable MIMO functionality for 4G (LTE) modems a second antenna should be connected to the SMA connector labeled "ANT2".

> 4G (LTE) Cat 1 version modem both antennas are used for LTE communication. In such case internal WIFI antenna is used. Network can be limited in distance and speed, especially in metal based panels.

Make sure the signal level is over -80dBm to have a stable connection to the network.

Wi-Fi

For hardware version older than version 1.3, in case a Wi-Fi connection is needed, connect a Wi-fi antenna to the SMA connector labeled "WIFI". Select a good antenna placement spot considering the operation environment.



Never hardware versions don’t have an option of connecting an external Wi-Fi antenna as MIMO capability for cellular modems has been introduced. In case stronger reach is needed, a user should contact manufacturer to provide possible solutions.

Make sure the signal level is over -80dBm to have a stable connection to the network.

Tags

Single point

Commonly used in storing digital states single point values have only one bit of information. The value of such tags can be either one or zero. On the internal web of WCC Lite states of this type of tags are shown in colored boxes with customisable label.

Value	Representation
0	OFF
1	ON

Double point

Double point signals contain two bits of information that allow four different states, therefore they contain additional information compared to single point ones. INDETERMINATE state might, for example, mean that part of the equipment has been turned off or a mechanical part which does the switching has stuck between states. ERROR state might mean that both contacts are connected and there might be a short circuit in the equipment.

Value	Representation
00	INDETERMINATE
01	OFF
10	ON
11	ERROR

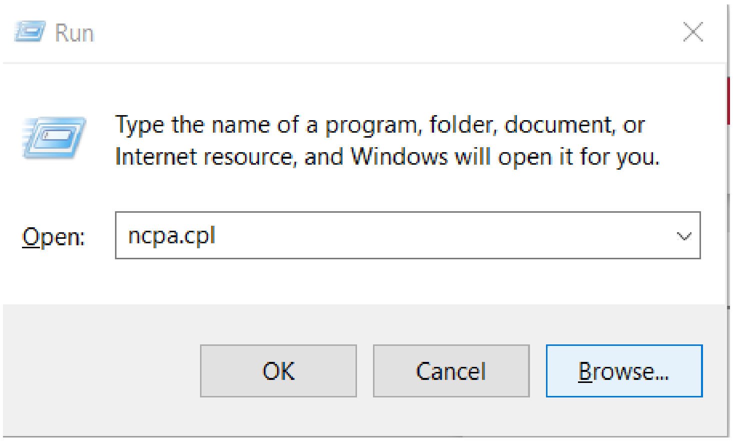
Initial Setup

Initial setup

WCC Lite comes with static network configuration with its IP set to 192.168.1.1. For initial setup set a static IP address on your computer and connect your network card to the WCC Lite with an ethernet cable.

Static IP address setup on Windows

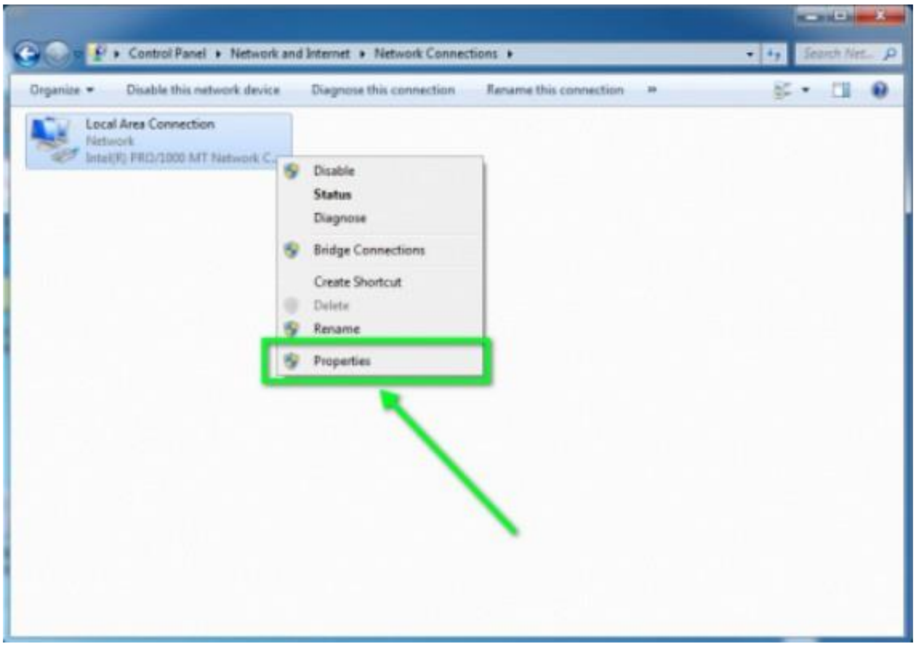
1. Press Win+R on your keyboard. This will open the run window. Enter ncpa.cpl and press OK. This will open the Network Connections window.



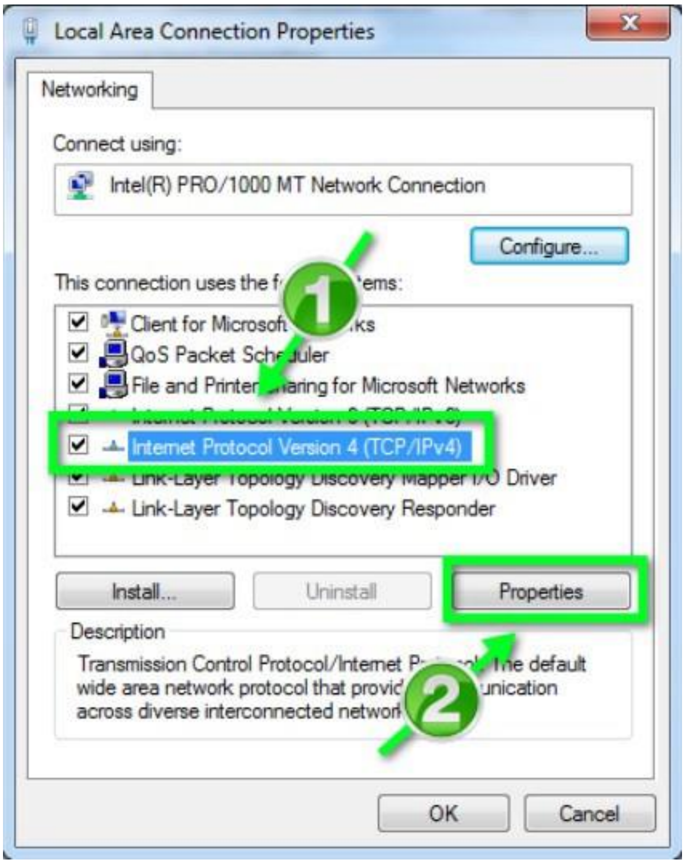
Type the name of a program, folder, document, or Internet resource, and Windows will open it for you.

Open: ncpa.cpl

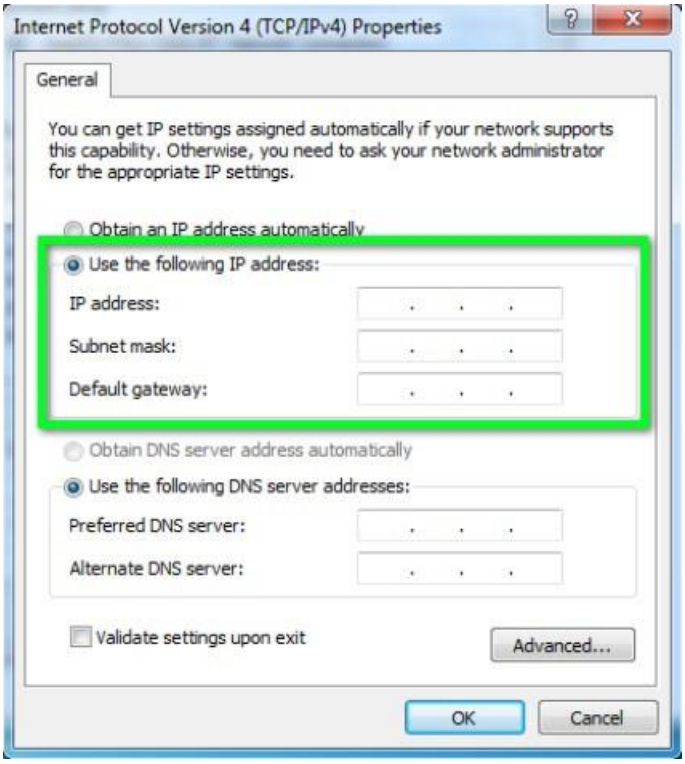
2. Right-click on the Local Area Connection icon, then select Properties



3. In the window that opens, click on the Internet Protocol Version 4 (TCP/IPv4) (you may need to scroll down to find it). Next, click on the Properties button.


Local Area Connection Properties
Networking
Connect using:
Intel(R) PRO/1000 MT Network Connection
Configure...
This connection uses the f ems:
☑ Client for Microsoft ks
☑ QoS Packet Sch uler
☑ File and Printer aring for Microsoft Networks
☑ Internet Protocol Version 6 (TCP/IPv6)
☑ Internet Protocol Version 4 (TCP/IPv4)
☑ Link-Layer Topology Discovery Mapper I/O Driver
☑ Link-Layer Topology Discovery Responder
1
Install...
Uninstall
Properties
Description
Transmission Control Protocol/Internet P The default
wide area network protocol that provid unication
across diverse interconnected networ
2
OK
Cancel

4. In the window that opens, click the Use the following IP address radio button. Fill the following fields and click OK:
- IP address: 192.168.1.2
- Subnet mask: 255.255.255.0
- Default gateway: (leave empty)

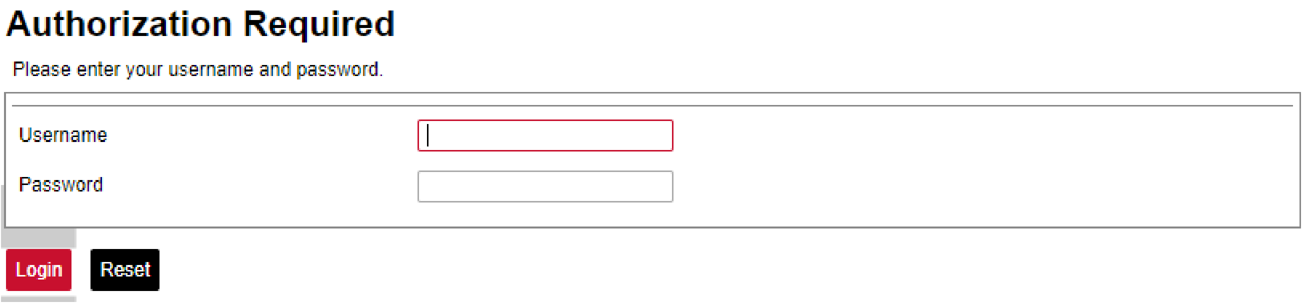

Internet Protocol Version 4 (TCP/IPv4) Properties

You can get IP settings assigned automatically if your network supports this capability. Otherwise, you need to ask your network administrator for the appropriate IP settings.

○ Obtain an IP address automatically
● Use the following IP address:
IP address: . . .
Subnet mask: . . .
Default gateway: . . .
○ Obtain DNS server address automatically
● Use the following DNS server addresses:
Preferred DNS server: . . .
Alternate DNS server: . . .
☐ Validate settings upon exit

Connecting to an internal web page

If your computer IP address is set up and ethernet cable is connected power up the device. Wait a few minutes until the device boots. Then open your web browser and enter the following URL: http://192.168.1.1/
Supported web browsers:
- Google Chrome (recommended)
- Mozilla Firefox
- Internet Explorer 8 or later



Authorization Required

Please enter your username and password.

Login with the root user:

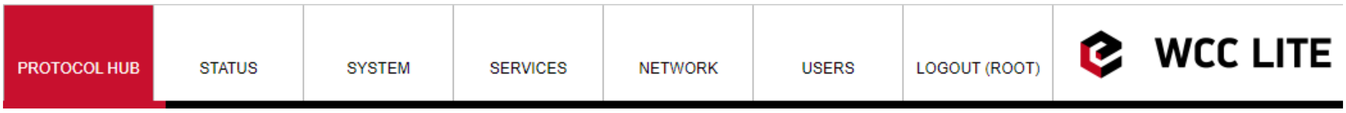
- *Username*: root
- *Password*: wcclite

It is recommended to change the password immediately to avoid any unauthorized access.

Before plugging WCC Lite with a static IP address to the local computer network, make sure to check if such address is not already reserved by other devices.

Site Layout

Site layout



It provides the main navigation through the website. Contains the following sections:

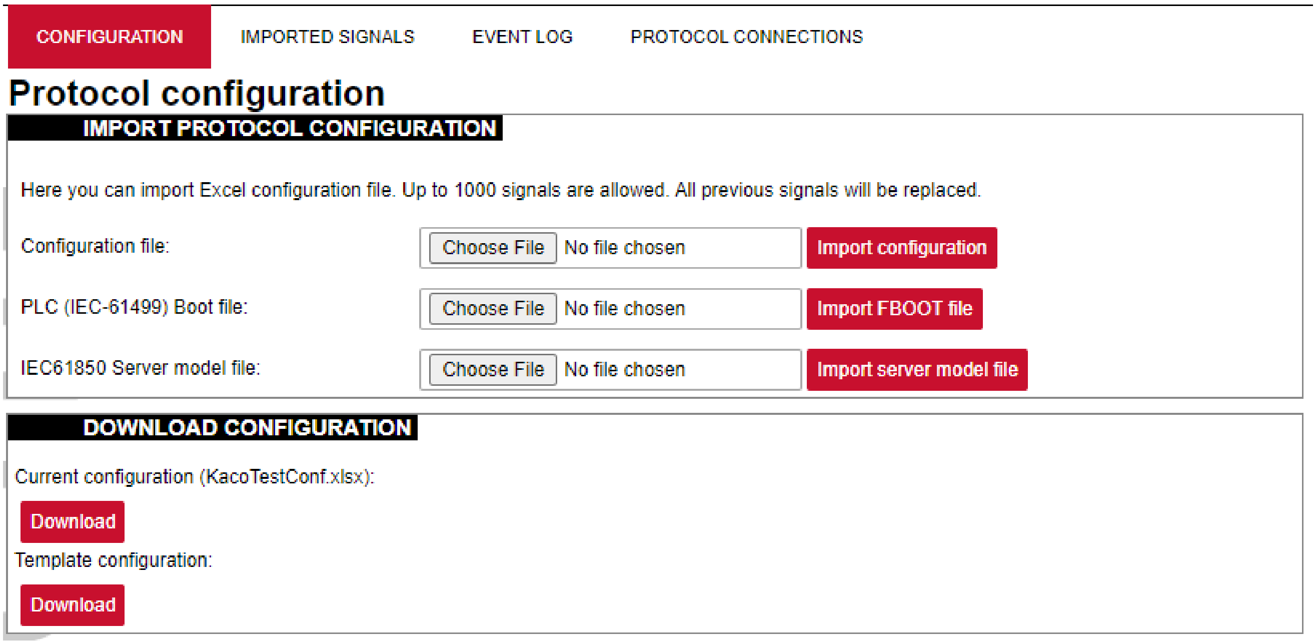
- *PROTOCOL HUB*: configuration related to data exchange between WCC Lite and other devices.
- *STATUS:* system information and diagnostics.
- *SYSTEM*: basic system settings such as time setup.
- *SERVICES:* various other services.
- *NETWORK:* network related settings and services.
- *USERS*: existing user groups and management of their permissions
- *LOGOUT:* user logout.

Protocol Hub

Protocol HUB

Protocol HUB section stores configuration for every connected device. You can configure it by importing settings from an Excel file.

Configuration



Here you can import Excel configuration file. Up to 1000 signals are allowed. All previous signals will be replaced.

Configuration file: Choose File No file chosen

PLC (IEC-61499) Boot file: Choose File No file chosen

IEC61850 Server model file: Choose File No file chosen

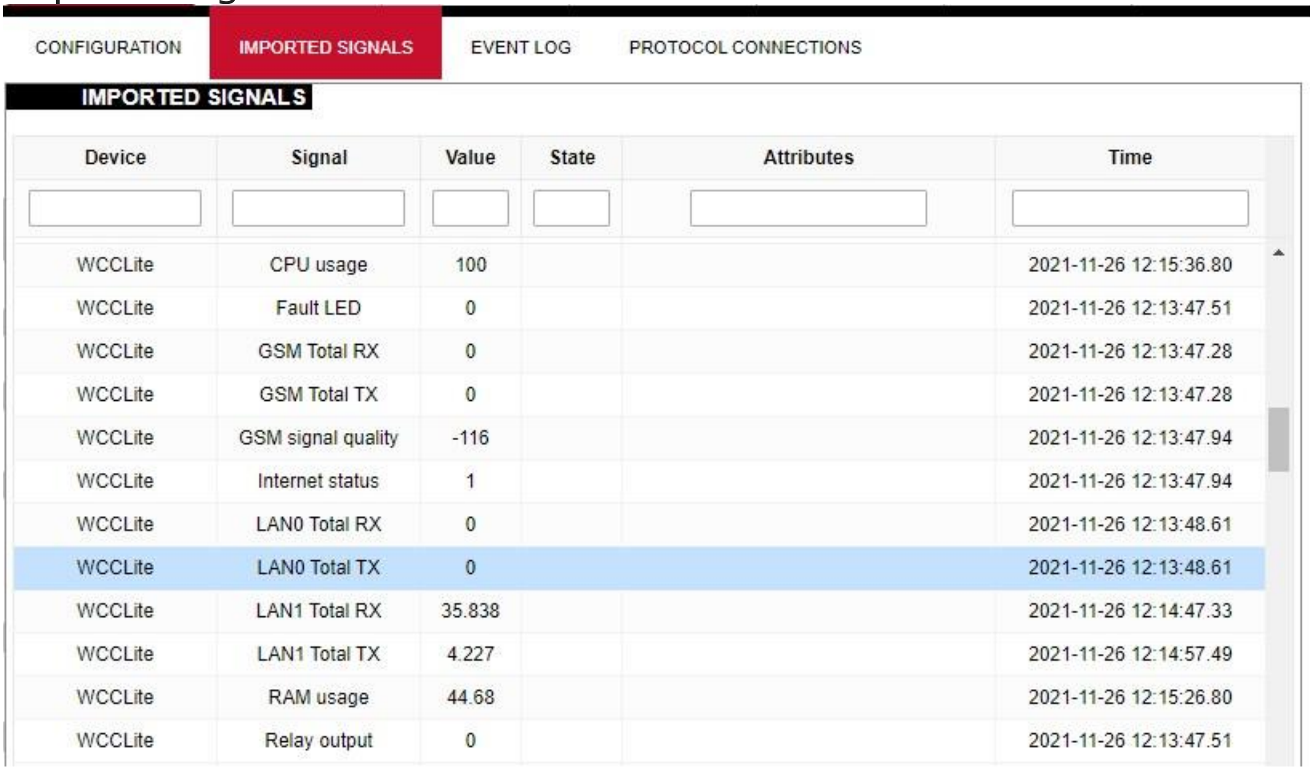
Current configuration (KacoTestConf.xlsx):

Template configuration:

In this tab a user can:

- Import new configuration from Excel file (.xls, .xlsx formats). If any errors in the file are found, device will not be imported and importing process will be stopped.
- Import .fboot file for PLC.
- Import IEC61850 Server model file
- Download current configuration Excel file.
- Download a template configuration Excel file.

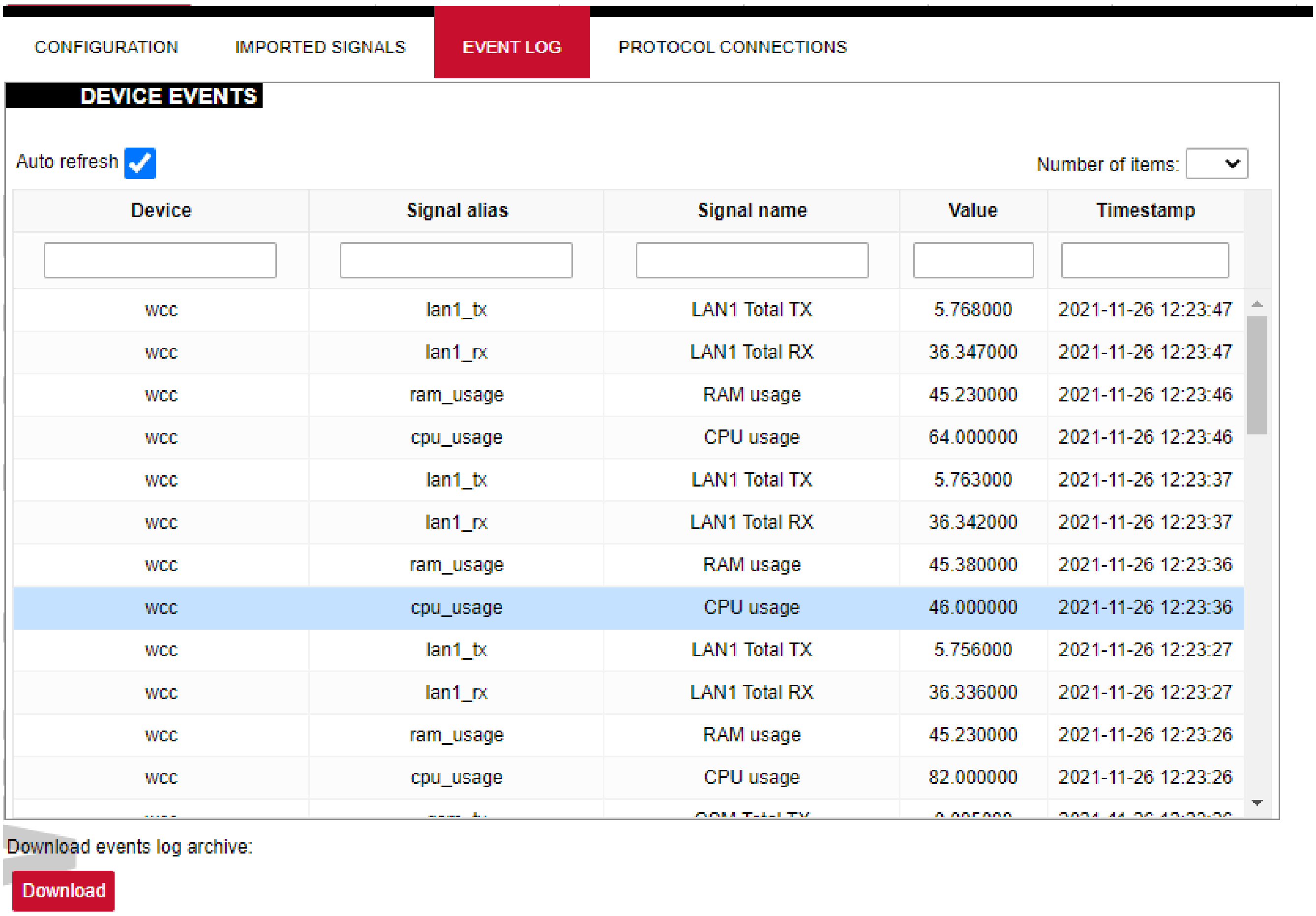
Imported Signals



Device	Signal	Value	State	Attributes	Time
WCCLite	CPU usage	100			2021-11-26 12:15:36.80
WCCLite	Fault LED	0			2021-11-26 12:13:47.51
WCCLite	GSM Total RX	0			2021-11-26 12:13:47.28
WCCLite	GSM Total TX	0			2021-11-26 12:13:47.28
WCCLite	GSM signal quality	-116			2021-11-26 12:13:47.94
WCCLite	Internet status	1			2021-11-26 12:13:47.94
WCCLite	LAN0 Total RX	0			2021-11-26 12:13:48.61
WCCLite	LAN0 Total TX	0			2021-11-26 12:13:48.61
WCCLite	LAN1 Total RX	35.838			2021-11-26 12:14:47.33
WCCLite	LAN1 Total TX	4.227			2021-11-26 12:14:57.49
WCCLite	RAM usage	44.68			2021-11-26 12:15:26.80
WCCLite	Relay output	0			2021-11-26 12:13:47.51

Imported signals section shows basic information about applied configuration. This section is view only.

Event Log



Device	Signal alias	Signal name	Value	Timestamp
wcc	lan1_tx	LAN1 Total TX	5.768000	2021-11-26 12:23:47
wcc	lan1_rx	LAN1 Total RX	36.347000	2021-11-26 12:23:47
wcc	ram_usage	RAM usage	45.230000	2021-11-26 12:23:46
wcc	cpu_usage	CPU usage	64.000000	2021-11-26 12:23:46
wcc	lan1_tx	LAN1 Total TX	5.763000	2021-11-26 12:23:37
wcc	lan1_rx	LAN1 Total RX	36.342000	2021-11-26 12:23:37
wcc	ram_usage	RAM usage	45.380000	2021-11-26 12:23:36
wcc	cpu_usage	CPU usage	46.000000	2021-11-26 12:23:36
wcc	lan1_tx	LAN1 Total TX	5.756000	2021-11-26 12:23:27
wcc	lan1_rx	LAN1 Total RX	36.336000	2021-11-26 12:23:27
wcc	ram_usage	RAM usage	45.230000	2021-11-26 12:23:26
wcc	cpu_usage	CPU usage	82.000000	2021-11-26 12:23:26

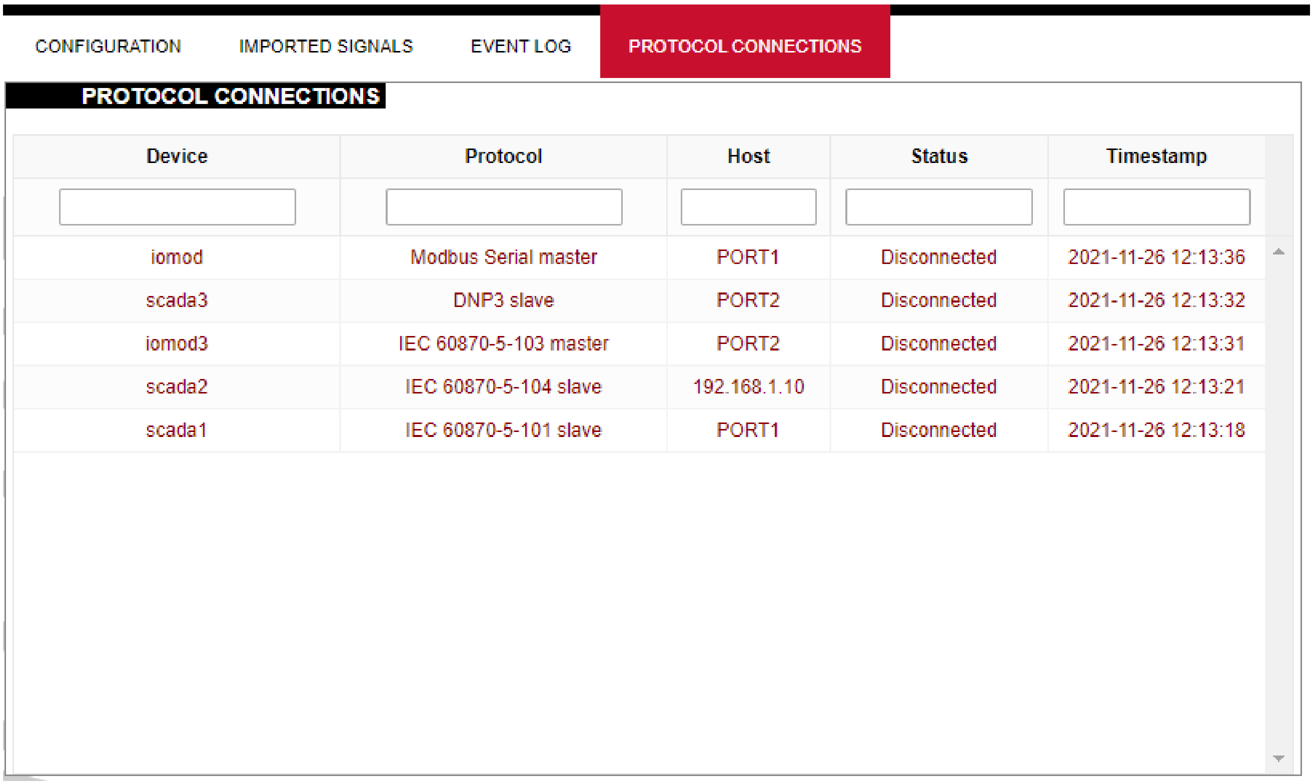
Event Log is the timestamped status data. It allows to review latest events and changes for device’s state changes in chronological order. Newest events are shown at the top of the list. WCC Lite will timestamp the status data with a time resolution of one millisecond.

Initially, all breakers, protection contacts digital status input points in the WCCLite; events captured from IEDs (Intelligent electronic devices) shall be configured as Event Log points. It’s possible to assign any digital status input data point in the WCCLite as SOE point with Excel template during configuration.

Each time a device changes state, the WCClite will save it with timetag in internal storage. WCC Lite will maintain a Event Log buffer within the configured history size limitations. Event Log can also be downloaded by pressing the download button at the bottom of the page.

Events are recorded only for devices that have*log* field set. When log size exceeds its limit, oldest records are deleted.

Protocol Connections



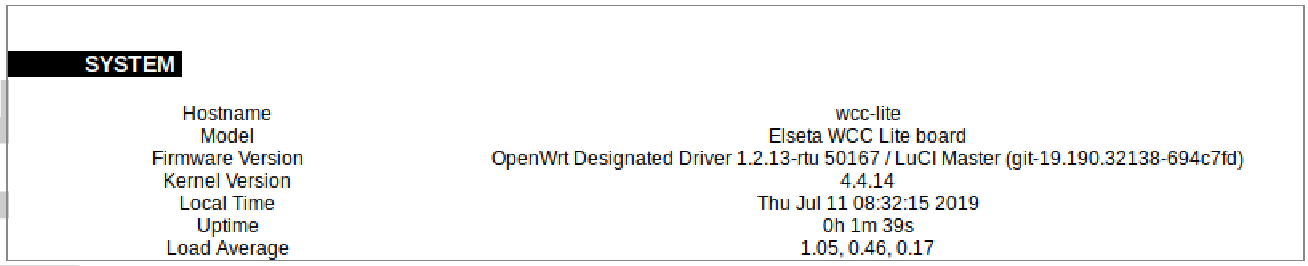
Device	Protocol	Host	Status	Timestamp
iomod	Modbus Serial master	PORT1	Disconnected	2021-11-26 12:13:36
scada3	DNP3 slave	PORT2	Disconnected	2021-11-26 12:13:32
iomod3	IEC 60870-5-103 master	PORT2	Disconnected	2021-11-26 12:13:31
scada2	IEC 60870-5-104 slave	192.168.1.10	Disconnected	2021-11-26 12:13:21
scada1	IEC 60870-5-101 slave	PORT1	Disconnected	2021-11-26 12:13:18

Protocol connections section shows shows configured devices their ports and their status. This section is view only.

Status

Overview

System

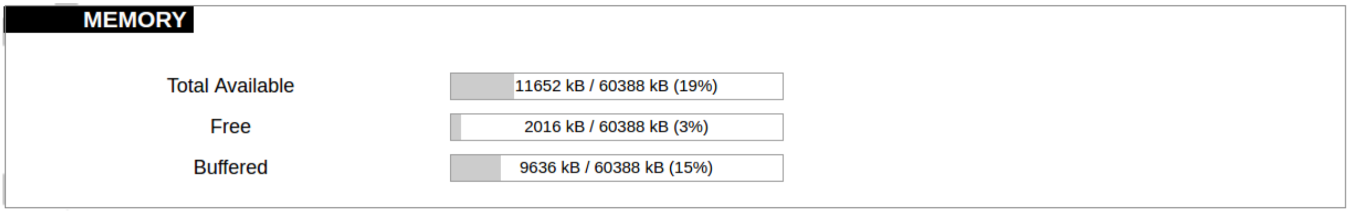


SYSTEM

Hostname	wcc-lite
Model	Elseta WCC Lite board
Firmware Version	OpenWrt Designated Driver 1.2.13-rtu 50167 / LuCI Master (git-19.190.32138-694c7fd)
Kernel Version	4.4.14
Local Time	Thu Jul 11 08:32:15 2019
Uptime	0h 1m 39s
Load Average	1.05, 0.46, 0.17

System section in status tab shows basic information about current status of the system.
Hostname: The label that is used to identify the device in the network.
Model: Model of the device.
Firmware version: Current firmware version.
Kernel version: Current kernel version.
Local Time: Current local time.
Uptime: The time a device has been working.
Load average: Measure CPU utilization of the last 1, 5, and 15 minute periods. Load of 0.5 means the CPU has been 50% utilized over the last period. Values over 1.0 mean the system was overloaded.

Memory

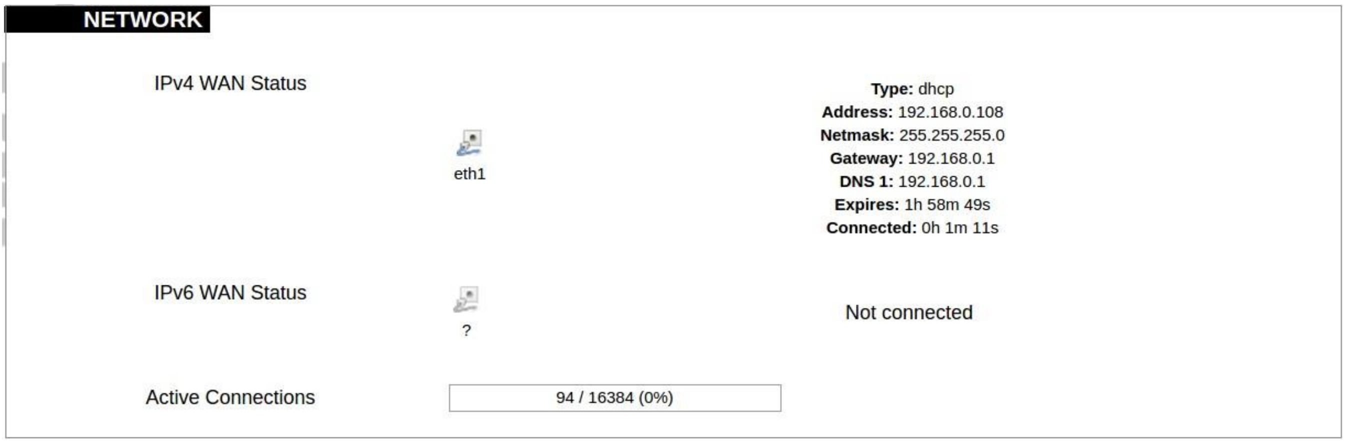


MEMORY

Total Available	11652 kB / 60388 kB (19%)
Free	2016 kB / 60388 kB (3%)
Buffered	9636 kB / 60388 kB (15%)

The ”Memory” window provides memory usage information on the device.
Total available memory: The amount of available memory that could be used over installed physical memory.
Free: The amount of physical memory that is not currently in use over installed physical memory.
Buffered: The amount of buffered memory that is currently in use for active I/O operations over installed physical memory.

Network

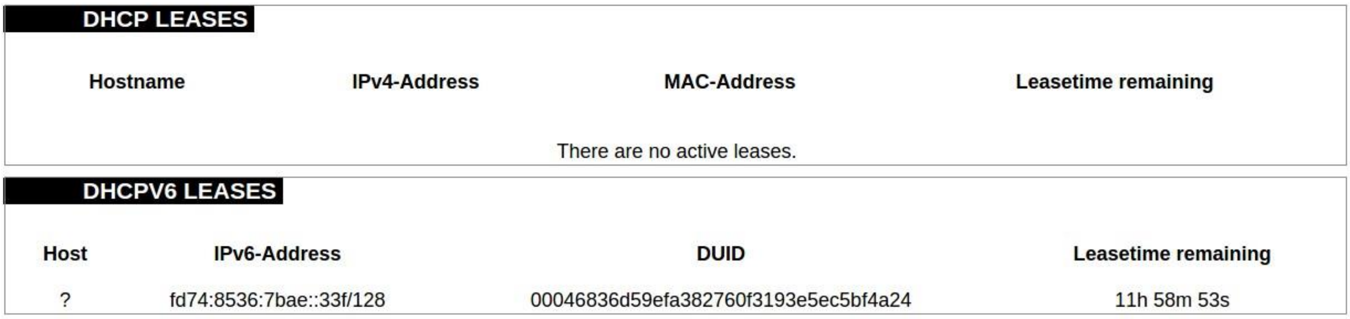


NETWORK

IPv4 WAN Status	eth1	**Type:** dhcp **Address:** 192.168.0.108 **Netmask:** 255.255.255.0 **Gateway:** 192.168.0.1 **DNS 1:** 192.168.0.1 **Expires:** 1h 58m 49s **Connected:** 0h 1m 11s
IPv6 WAN Status	?	Not connected
Active Connections	94 / 16384 (0%)	

IPv4 WAN, IPv6 WAN status and active connections of the device.
Type: Type of addressing of IPv4 network interface – DHCP or static.
Address: IP address of the device.
Netmask: Netmask of the device.
Gateway: IP address of the Gateway.
DNS: IP address of DNS server.
Expires: DHCP lease expiration time of the connection.
Connected: The time a device has been connected.
Active Connections: The number of the active connections with the device.

DHCP leases



DHCP LEASES

Hostname	IPv4-Address	MAC-Address	Leasetime remaining

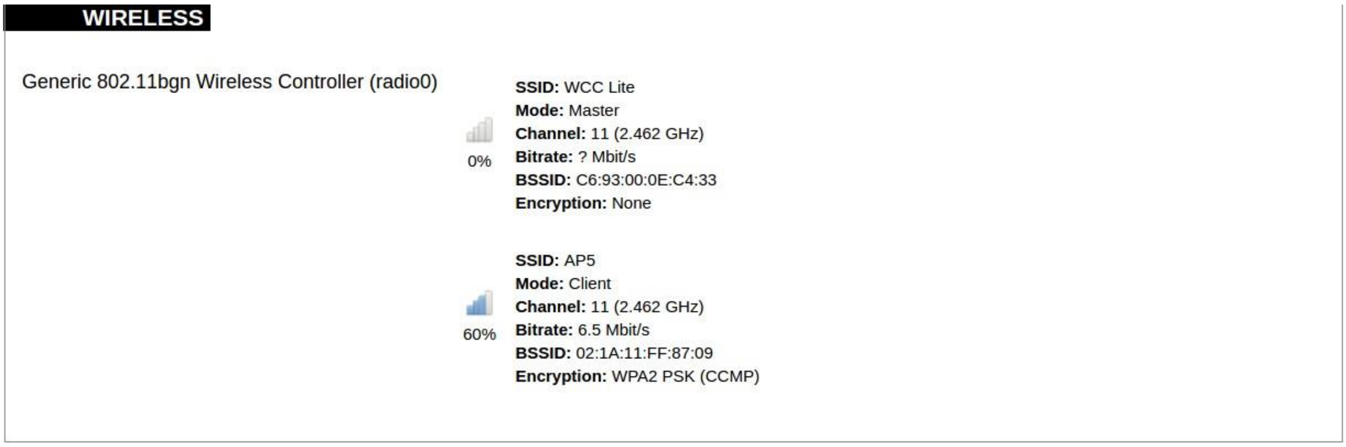
There are no active leases.

DHCPV6 LEASES

Host	IPv6-Address	DUID	Leasetime remaining
?	fd74:8536:7bae::33f/128	00046836d59efa382760f3193e5ec5bf4a24	11h 58m 53s

DHCPv4 and DHCPv6 lease expiration time.
Hostname: The label that is used to identify the device in the network.
IPv4-Address: IPv4 address of network interface.
MAC-Address: The media access control address of IPv4 network interface.
DUID: DHCP Unique Identifier of IPv6 network interface.
Lease Time remaining: The amount of time the device will be allowed connection to the Router.

Wireless



WIRELESS

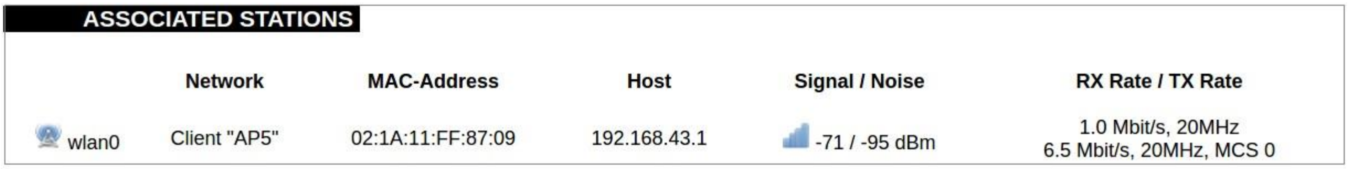
Generic 802.11bgn Wireless Controller (radio0)

0%
SSID: WCC Lite
Mode: Master
Channel: 11 (2.462 GHz)
Bitrate: ? Mbit/s
BSSID: C6:93:00:0E:C4:33
Encryption: None

60%
SSID: AP5
Mode: Client
Channel: 11 (2.462 GHz)
Bitrate: 6.5 Mbit/s
BSSID: 02:1A:11:FF:87:09
Encryption: WPA2 PSK (CCMP)

WiFi interface information window.
SSID: The sequence of characters that uniquely names a wireless local area network.
Mode: Shows how the device is connected to the wireless network – Master or Client.
Channel: The number of channel and radio frequency for connection to access point.
Bitrate: The number of bits that pass the device in a given amount of time.
BSSID: The MAC address of the wireless access point.
Encryption: Security protocol for the wireless network.

Associated stations



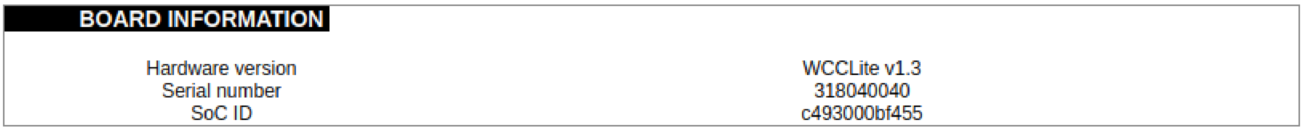
ASSOCIATED STATIONS

	Network	MAC-Address	Host	Signal / Noise	RX Rate / TX Rate
wlan0	Client "AP5"	02:1A:11:FF:87:09	192.168.43.1	-71 / -95 dBm	1.0 Mbit/s, 20MHz 6.5 Mbit/s, 20MHz, MCS 0

List of associated stations (clients).

Network: Mode and SSID of network point.
MAC-Address: The media access control address of IPv4 network interface.
Hostname: The label or IP address that is used to identify the device in the network.
Signal/Noise: Received signal level over the background noise level. -30 dBm is the maximum achievable signal strength, -70 dBm is the minimum signal strength for reliable packet delivery in the wireless network.
RX Rate/TX rate: Used measure data transmission in the wireless network over bandwidth. RX Rate represents the rate at which data packets being received by the device, TX Rate represents the rate at which data packets being sent from the device.

Board information



BOARD INFORMATION

Hardware version	WCCLite v1.3
Serial number	318040040
SoC ID	c493000bf455

Board information provides the following details:

Hardware version: Current hardware version;
Serial number: Serial number of the board;
SoC ID: Unique identifier of CPU unit;

Firewall

IPv4 Firewall

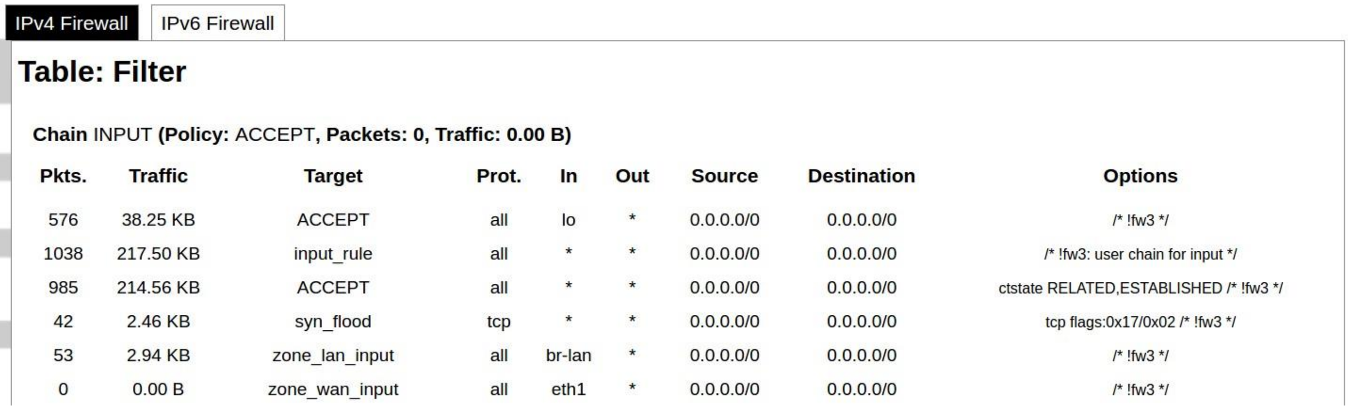


Table: Filter

Chain INPUT **(Policy:** ACCEPT**, Packets: 0, Traffic: 0.00 B)**

Pkts.	Traffic	Target	Prot.	In	Out	Source	Destination	Options
576	38.25 KB	ACCEPT	all	lo	*	0.0.0.0/0	0.0.0.0/0	/* !fw3 */
1038	217.50 KB	input_rule	all	*	*	0.0.0.0/0	0.0.0.0/0	/* !fw3: user chain for input */
985	214.56 KB	ACCEPT	all	*	*	0.0.0.0/0	0.0.0.0/0	ctstate RELATED,ESTABLISHED /* !fw3 */
42	2.46 KB	syn_flood	tcp	*	*	0.0.0.0/0	0.0.0.0/0	tcp flags:0x17/0x02 /* !fw3 */
53	2.94 KB	zone_lan_input	all	br-lan	*	0.0.0.0/0	0.0.0.0/0	/* !fw3 */
0	0.00 B	zone_wan_input	all	eth1	*	0.0.0.0/0	0.0.0.0/0	/* !fw3 */

Firewall rule list for IPv4 traffic.
Table: The four distinct tables which store rules regulating operations on the packet. Filter concerns filtering rules. NAT concerns translation of source or destination addresses and ports of packages. Mangle table is for specialized packet alteration. The raw table is for configuration exceptions.

Chain: The list of rules. Filter table has the following built-in chains: Input – concerns packets whose destination is the firewall itself, Forward – concerns packets transiting through the firewall, Output – concerns packets emitted by the firewall, Reject – reject the packet, Accept – allow the packet to go on its way. NAT table has the following built-in chains: Prerouting – to modify packets as soon as they arrive, Postrouting – to modify packets when they are ready to go on their way. Mangle table has one built-in chain: Forward for transiting packets through the firewall.

Pkts.: The packets processed by the firewall.

Traffic: The amount of data processed by the firewall.

Target: The chain of the table of the firewall.

Prot.: The transport layer protocol processed by the firewall.

In: The network interface for the input chain processed by the firewall.

Out: The network interface for the output chain processed by the firewall.

Source: IPv4 address of the device that the packet comes from.

Destination: IPv4 address of the device that the packet goes to.

Options: The options for configuring the firewall.

IPv6 Firewall

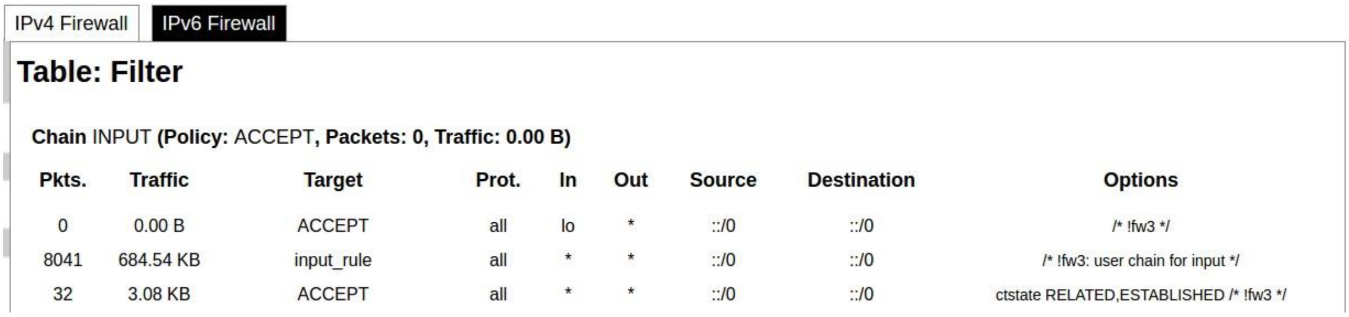


Table: Filter

Chain INPUT **(Policy:** ACCEPT**, Packets: 0, Traffic: 0.00 B)**

Pkts.	Traffic	Target	Prot.	In	Out	Source	Destination	Options
0	0.00 B	ACCEPT	all	lo	*	::/0	::/0	/* !fw3 */
8041	684.54 KB	input_rule	all	*	*	::/0	::/0	/* !fw3: user chain for input */
32	3.08 KB	ACCEPT	all	*	*	::/0	::/0	ctstate RELATED,ESTABLISHED /* !fw3 */

Firewall rule list for IPv6 traffic.

Table: The three distinct tables which store rules regulating operations on the packet. Filter concerns filtering rules. Mangle table is for specialized packet alteration. The raw table is for configuration exceptions.

Chain: The list of rules. Filter table has the following built-in chains: Input – concerns packets whose destination is the firewall itself, Forward – concerns packets transiting through the firewall, Output – concerns packets emitted by the firewall, Reject – reject the packet, Accept – allow the packet to go on its way. Mangle table has one built-in chain: Forward for transiting packets through the firewall.

Pkts.: The packets processed by the firewall.

Traffic: The amount of data processed by the firewall.

Target: The chain of the table of the firewall.

Prot.: The transport layer protocol processed by the firewall.

In: The network interface for the input chain processed by the firewall.

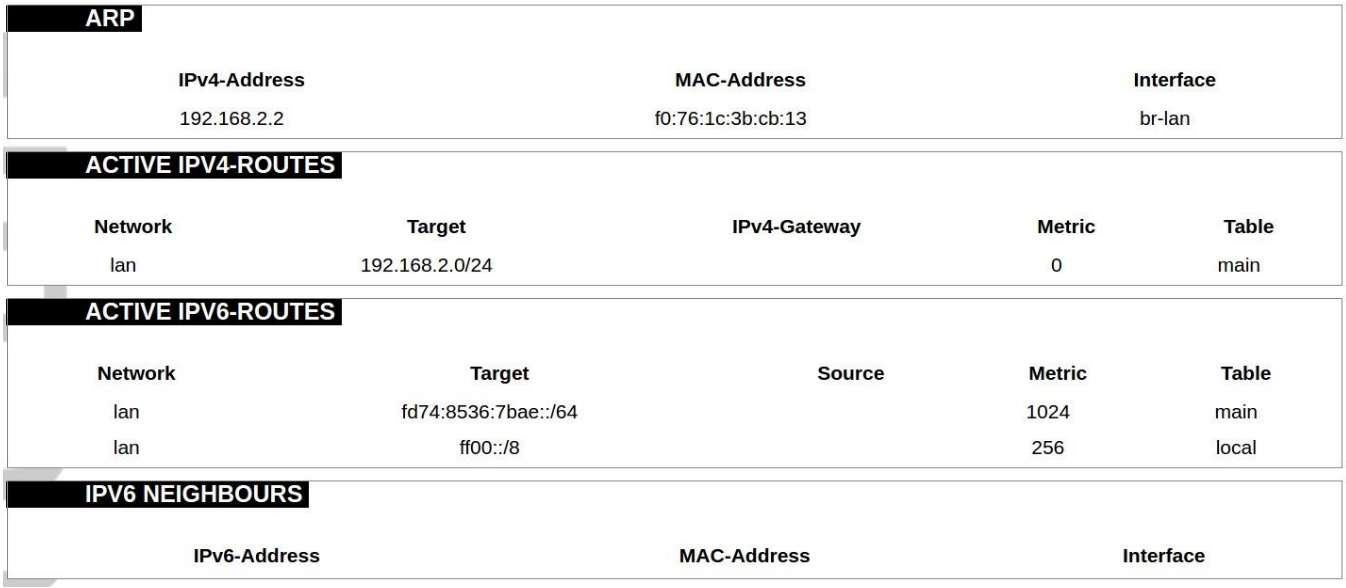
Out: The network interface for the output chain processed by the firewall.

Source: IPv6 address of the device that the packet comes from.

Destination: IPv6 address of the device that the packet goes to.

Options: The options for configuring the firewall.

Routes



ARP

IPv4-Address	MAC-Address	Interface
192.168.2.2	f0:76:1c:3b:cb:13	br-lan

ACTIVE IPV4-ROUTES

Network	Target	IPv4-Gateway	Metric	Table
lan	192.168.2.0/24		0	main

ACTIVE IPV6-ROUTES

Network	Target	Source	Metric	Table
lan	fd74:8536:7bae::/64		1024	main
lan	ff00::/8		256	local

IPV6 NEIGHBOURS

IPv6-Address	MAC-Address	Interface

The routing tables provide information on how datagrams are sent to their destinations.

ARP: An address Resolution Protocol which defines how IP address is converted to a physical hardware address needed to deliver packets to the devices.

Interface: The type of Network interface. br-lan refers to the virtual bridged interface: to make multiple network interfaces act as if they were one network interface.

Network: The type of network through which the traffic will be sent to the destination subnet.

Target: An address of the destination network. The prefix /24 refers the subnet mask 255.255.255.0.

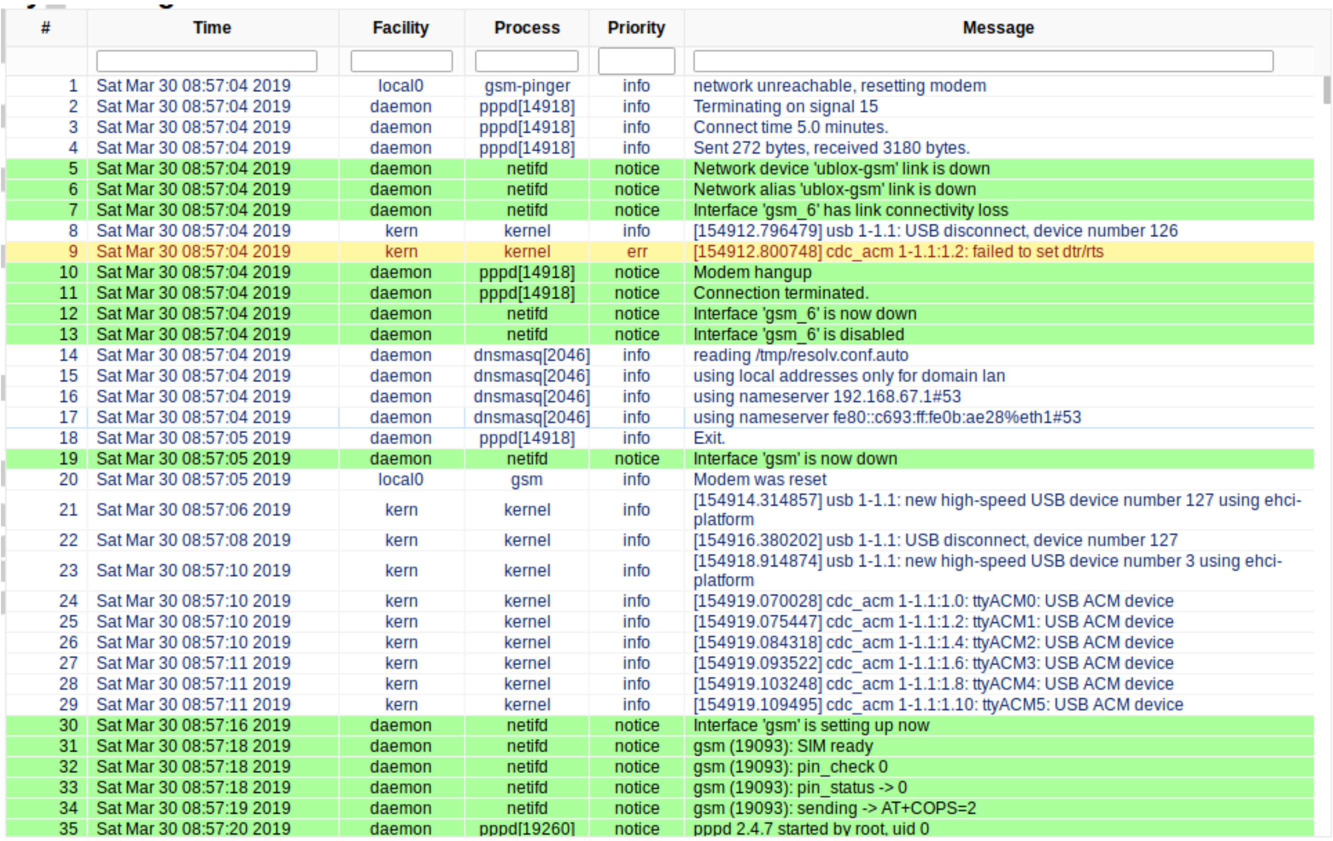
IPv4-Gateway: IP address of the gateway to which traffic intended for the destination subnet will be sent.

Metric: The number of hops required to reach destinations via the gateway.

Table: The type of routing tables: main (default), local (maintained by the kernel).

IPv6 Neighbours: The devices on the same network with IPv6 addresses.

System Log



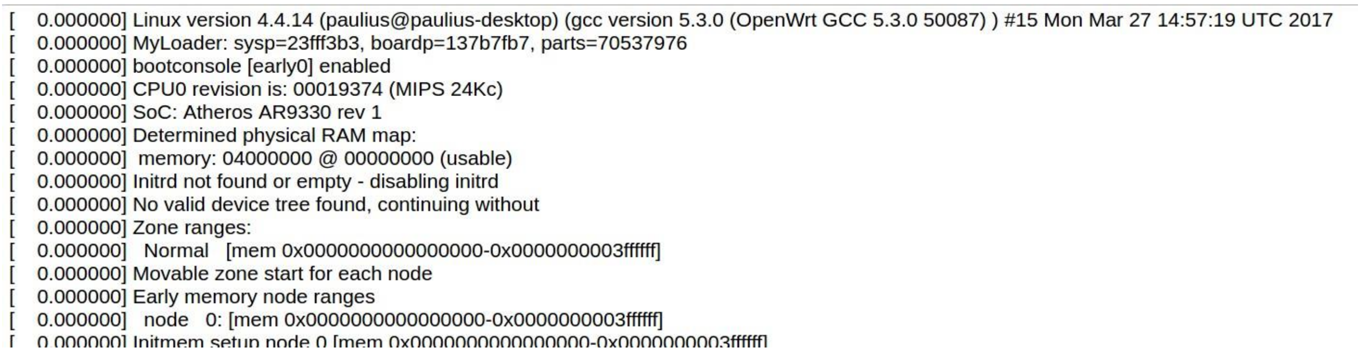
#	Time	Facility	Process	Priority	Message
1	Sat Mar 30 08:57:04 2019	local0	gsm-pinger	info	network unreachable, resetting modem
2	Sat Mar 30 08:57:04 2019	daemon	pppd[14918]	info	Terminating on signal 15
3	Sat Mar 30 08:57:04 2019	daemon	pppd[14918]	info	Connect time 5.0 minutes.
4	Sat Mar 30 08:57:04 2019	daemon	pppd[14918]	info	Sent 272 bytes, received 3180 bytes.
5	Sat Mar 30 08:57:04 2019	daemon	netifd	notice	Network device 'ublox-gsm' link is down
6	Sat Mar 30 08:57:04 2019	daemon	netifd	notice	Network alias 'ublox-gsm' link is down
7	Sat Mar 30 08:57:04 2019	daemon	netifd	notice	Interface 'gsm_6' has link connectivity loss
8	Sat Mar 30 08:57:04 2019	kern	kernel	info	[154912.796479] usb 1-1.1: USB disconnect, device number 126
9	Sat Mar 30 08:57:04 2019	kern	kernel	err	[154912.800748] cdc_acm 1-1.1:1.2: failed to set dtr/rts
10	Sat Mar 30 08:57:04 2019	daemon	pppd[14918]	notice	Modem hangup
11	Sat Mar 30 08:57:04 2019	daemon	pppd[14918]	notice	Connection terminated.
12	Sat Mar 30 08:57:04 2019	daemon	netifd	notice	Interface 'gsm_6' is now down
13	Sat Mar 30 08:57:04 2019	daemon	netifd	notice	Interface 'gsm_6' is disabled
14	Sat Mar 30 08:57:04 2019	daemon	dnsmasq[2046]	info	reading /tmp/resolv.conf.auto
15	Sat Mar 30 08:57:04 2019	daemon	dnsmasq[2046]	info	using local addresses only for domain lan
16	Sat Mar 30 08:57:04 2019	daemon	dnsmasq[2046]	info	using nameserver 192.168.67.1#53
17	Sat Mar 30 08:57:04 2019	daemon	dnsmasq[2046]	info	using nameserver fe80::c693:ff:fe0b:ae28%eth1#53
18	Sat Mar 30 08:57:05 2019	daemon	pppd[14918]	info	Exit.
19	Sat Mar 30 08:57:05 2019	daemon	netifd	notice	Interface 'gsm' is now down
20	Sat Mar 30 08:57:05 2019	local0	gsm	info	Modem was reset
21	Sat Mar 30 08:57:06 2019	kern	kernel	info	[154914.314857] usb 1-1.1: new high-speed USB device number 127 using ehci-platform
22	Sat Mar 30 08:57:08 2019	kern	kernel	info	[154916.380202] usb 1-1.1: USB disconnect, device number 127
23	Sat Mar 30 08:57:10 2019	kern	kernel	info	[154918.914874] usb 1-1.1: new high-speed USB device number 3 using ehci-platform
24	Sat Mar 30 08:57:10 2019	kern	kernel	info	[154919.070028] cdc_acm 1-1.1:1.0: ttyACM0: USB ACM device
25	Sat Mar 30 08:57:10 2019	kern	kernel	info	[154919.075447] cdc_acm 1-1.1:1.2: ttyACM1: USB ACM device
26	Sat Mar 30 08:57:10 2019	kern	kernel	info	[154919.084318] cdc_acm 1-1.1:1.4: ttyACM2: USB ACM device
27	Sat Mar 30 08:57:11 2019	kern	kernel	info	[154919.093522] cdc_acm 1-1.1:1.6: ttyACM3: USB ACM device
28	Sat Mar 30 08:57:11 2019	kern	kernel	info	[154919.103248] cdc_acm 1-1.1:1.8: ttyACM4: USB ACM device
29	Sat Mar 30 08:57:11 2019	kern	kernel	info	[154919.109495] cdc_acm 1-1.1:1.10: ttyACM5: USB ACM device
30	Sat Mar 30 08:57:16 2019	daemon	netifd	notice	Interface 'gsm' is setting up now
31	Sat Mar 30 08:57:18 2019	daemon	netifd	notice	gsm (19093): SIM ready
32	Sat Mar 30 08:57:18 2019	daemon	netifd	notice	gsm (19093): pin_check 0
33	Sat Mar 30 08:57:18 2019	daemon	netifd	notice	gsm (19093): pin_status -> 0
34	Sat Mar 30 08:57:19 2019	daemon	netifd	notice	gsm (19093): sending -> AT+COPS=2
35	Sat Mar 30 08:57:20 2019	daemon	pppd[19260]	notice	pppd 2.4.7 started by root, uid 0

System log window shows a table containing the events that are logged by the device. It has the following columns:

- # (sequence number);
- Time (day of the week, month, day of the month, time and year);
- facility;
- process (who generated the message);
- priority level;
- message.

Messages can be sorted and filtered to extract a particular set of messages. This might be useful when debugging kernel or protocol level problems.

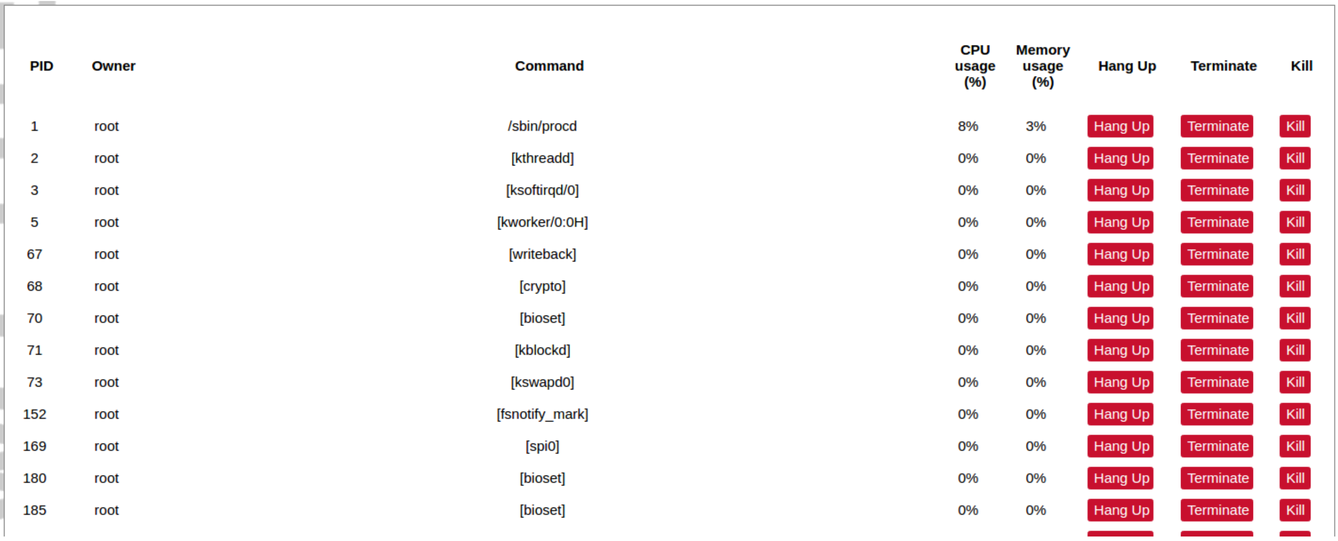
Kernel Log



```
[    0.000000] Linux version 4.4.14 (paulius@paulius-desktop) (gcc version 5.3.0 (OpenWrt GCC 5.3.0 50087) ) #15 Mon Mar 27 14:57:19 UTC 2017
[    0.000000] MyLoader: sysp=23fff3b3, boardp=137b7fb7, parts=70537976
[    0.000000] bootconsole [early0] enabled
[    0.000000] CPU0 revision is: 00019374 (MIPS 24Kc)
[    0.000000] SoC: Atheros AR9330 rev 1
[    0.000000] Determined physical RAM map:
[    0.000000]  memory: 04000000 @ 00000000 (usable)
[    0.000000] Initrd not found or empty - disabling initrd
[    0.000000] No valid device tree found, continuing without
[    0.000000] Zone ranges:
[    0.000000]   Normal   [mem 0x0000000000000000-0x0000000003ffffff]
[    0.000000] Movable zone start for each node
[    0.000000] Early memory node ranges
[    0.000000]   node   0: [mem 0x0000000000000000-0x0000000003ffffff]
[    0.000000] Initmem setup node 0 [mem 0x0000000000000000-0x0000000003ffffff]
```

Kernel log shows a list of the events that are logged by the kernel of the device. Log format: time in seconds since the kernel started and message.

Processes



PID	Owner	Command	CPU usage (%)	Memory usage (%)	Hang Up	Terminate	Kill
1	root	/sbin/procd	8%	3%	Hang Up	Terminate	Kill
2	root	[kthreadd]	0%	0%	Hang Up	Terminate	Kill
3	root	[ksoftirqd/0]	0%	0%	Hang Up	Terminate	Kill
5	root	[kworker/0:0H]	0%	0%	Hang Up	Terminate	Kill
67	root	[writeback]	0%	0%	Hang Up	Terminate	Kill
68	root	[crypto]	0%	0%	Hang Up	Terminate	Kill
70	root	[bioset]	0%	0%	Hang Up	Terminate	Kill
71	root	[kblockd]	0%	0%	Hang Up	Terminate	Kill
73	root	[kswapd0]	0%	0%	Hang Up	Terminate	Kill
152	root	[fsnotify_mark]	0%	0%	Hang Up	Terminate	Kill
169	root	[spi0]	0%	0%	Hang Up	Terminate	Kill
180	root	[bioset]	0%	0%	Hang Up	Terminate	Kill
185	root	[bioset]	0%	0%	Hang Up	Terminate	Kill

List of processes running on the system.

PID: Process ID.

Owner: User to whom the process belongs.

Command: Process.

CPU usage: It is CPU usage of the individual process. CPU usage above 90 % is an indicator of insufficient processing power.

Memory usage: Memory usage of the individual process.

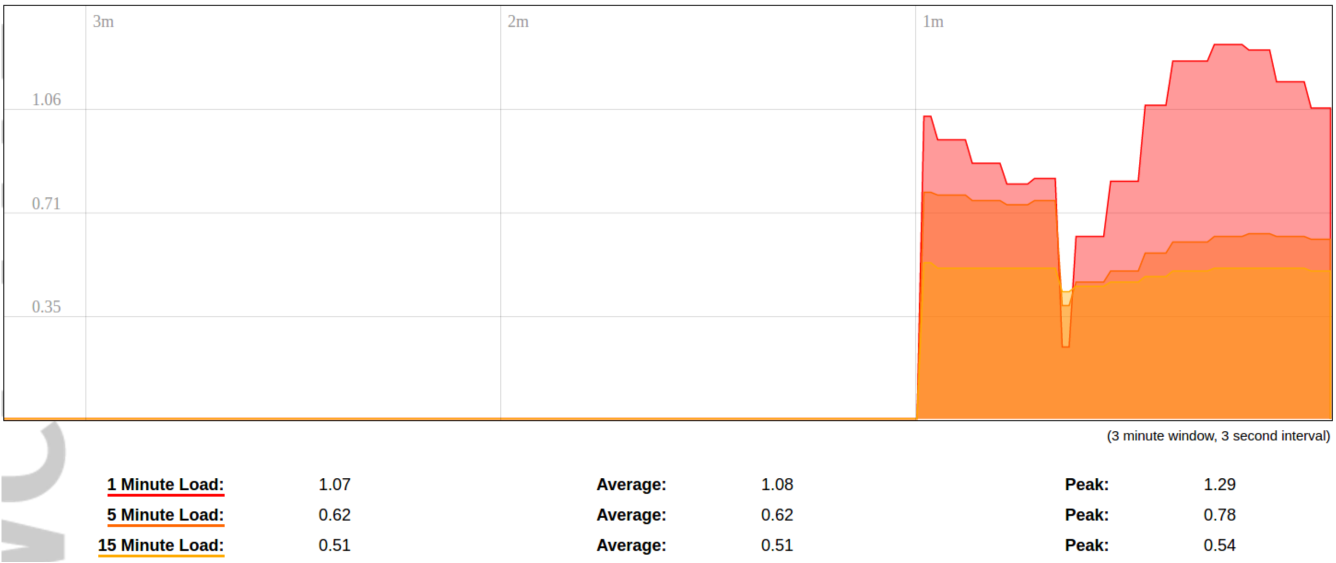
Hang Up: To freeze the process.

Terminate: To end the process cleanly.

Kill: To end the process immediately.

Realtime graph

Realtime Load

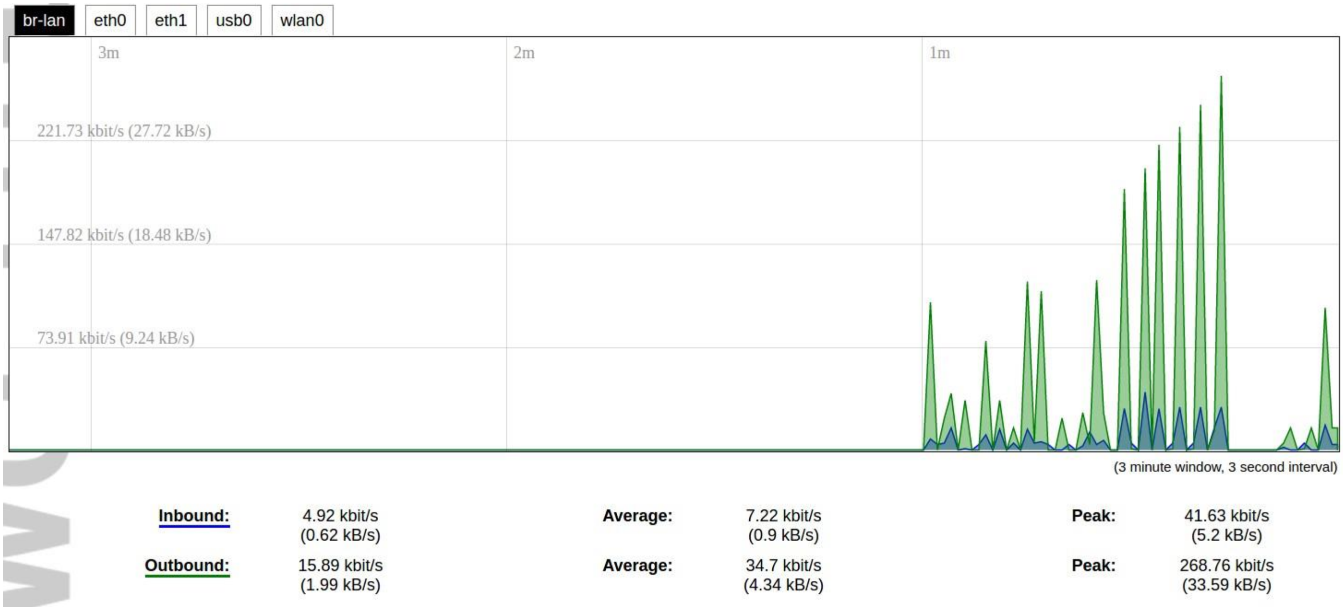


(3 minute window, 3 second interval)

1 Minute Load:	1.07	**Average:**	1.08	**Peak:**	1.29
5 Minute Load:	0.62	**Average:**	0.62	**Peak:**	0.78
15 Minute Load:	0.51	**Average:**	0.51	**Peak:**	0.54

CPU utilization graph. Load of 0.5 means the CPU has been 50% utilized over the last period. Values over 1.0 mean the system was overloaded.

Realtime Traffic


br-lan
eth0
eth1
usb0
wlan0
3m
2m
1m
221.73 kbit/s (27.72 kB/s)
147.82 kbit/s (18.48 kB/s)
73.91 kbit/s (9.24 kB/s)
(3 minute window, 3 second interval)

Inbound:	4.92 kbit/s (0.62 kB/s)	**Average:**	7.22 kbit/s (0.9 kB/s)	**Peak:**	41.63 kbit/s (5.2 kB/s)
Outbound:	15.89 kbit/s (1.99 kB/s)	**Average:**	34.7 kbit/s (4.34 kB/s)	**Peak:**	268.76 kbit/s (33.59 kB/s)

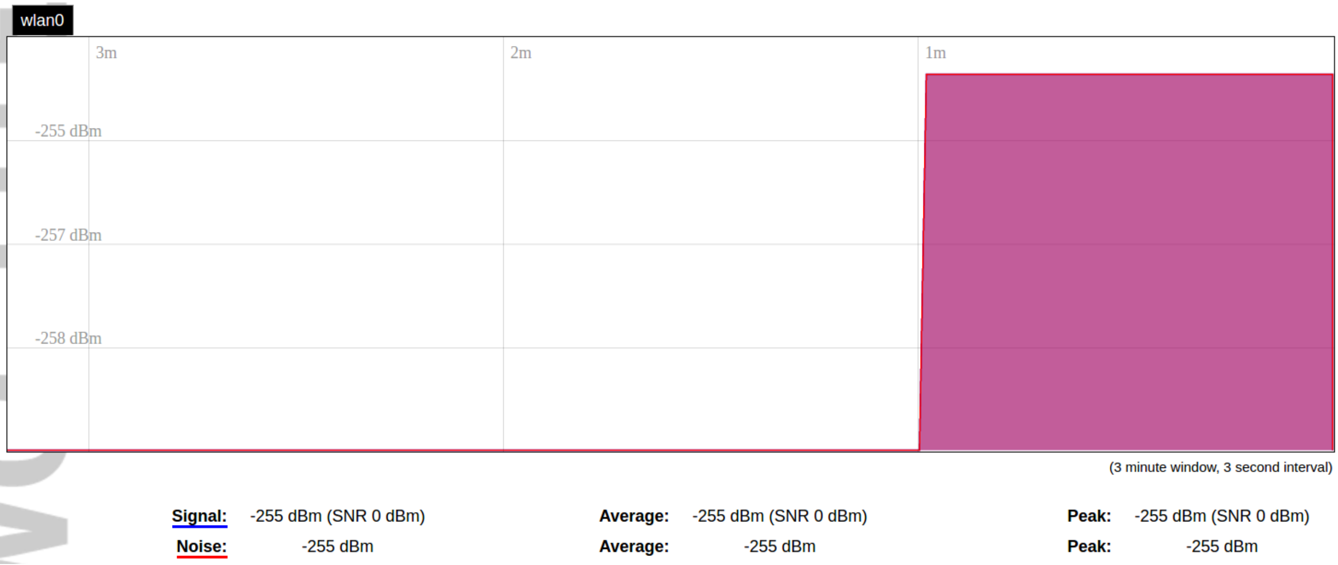
Graphs representing the status of the virtual and physical network interfaces of the device.

Inbound: The speed at which the incoming packets arrive at the device.

Outbound: The speed of the packets which were originated by the device.

Phy. Rate: The speed at which bits can be transmitted over the physical layer.

Realtime Wireless



Signal:	-255 dBm (SNR 0 dBm)	**Average:**	-255 dBm (SNR 0 dBm)	**Peak:**	-255 dBm (SNR 0 dBm)
Noise:	-255 dBm	**Average:**	-255 dBm	**Peak:**	-255 dBm

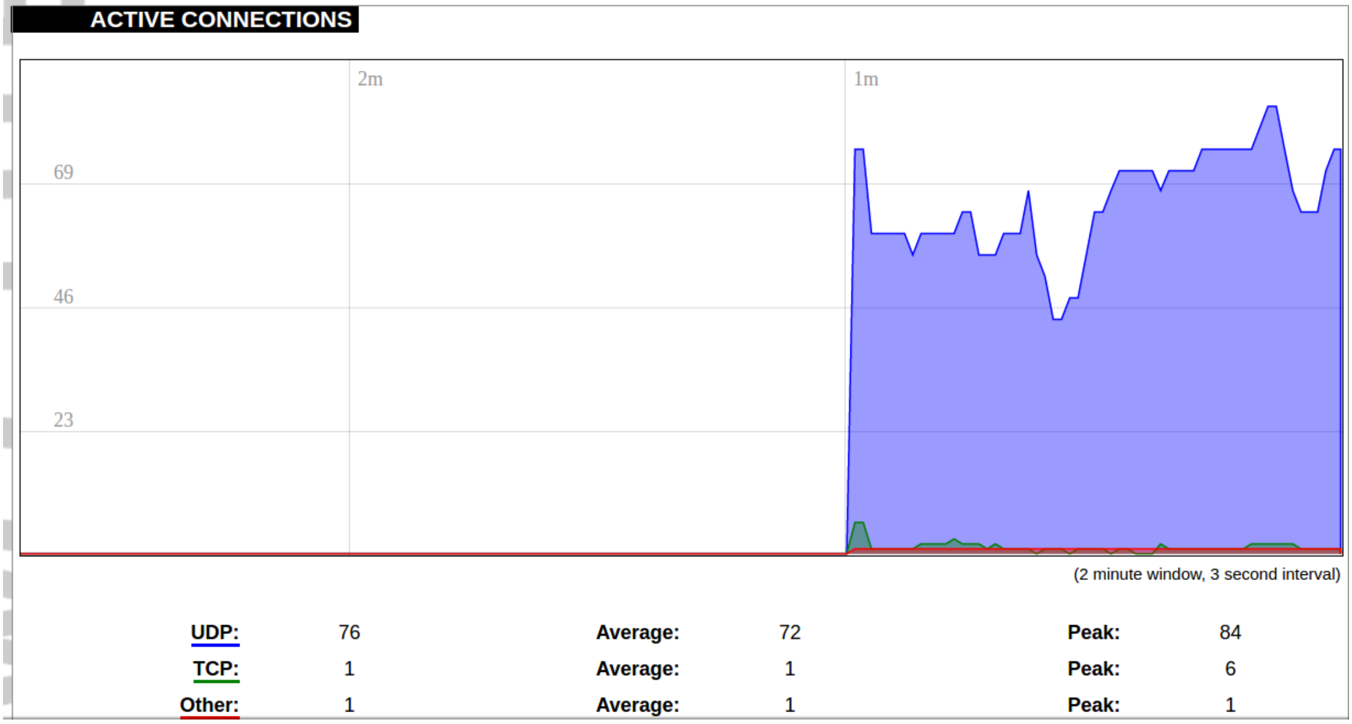
WiFi status graph.

Signal: Signal strength level.

Noise: Noise level.

Phy. Rate: The speed at which bits can be transmitted on the physical layer.

Active connections



ACTIVE CONNECTIONS

(2 minute window, 3 second interval)

UDP:	76	**Average:**	72	**Peak:**	84
TCP:	1	**Average:**	1	**Peak:**	6
Other:	1	**Average:**	1	**Peak:**	1

Graph representation of active connections with the device.

UDP: Transport layer – User Datagram Protocol.

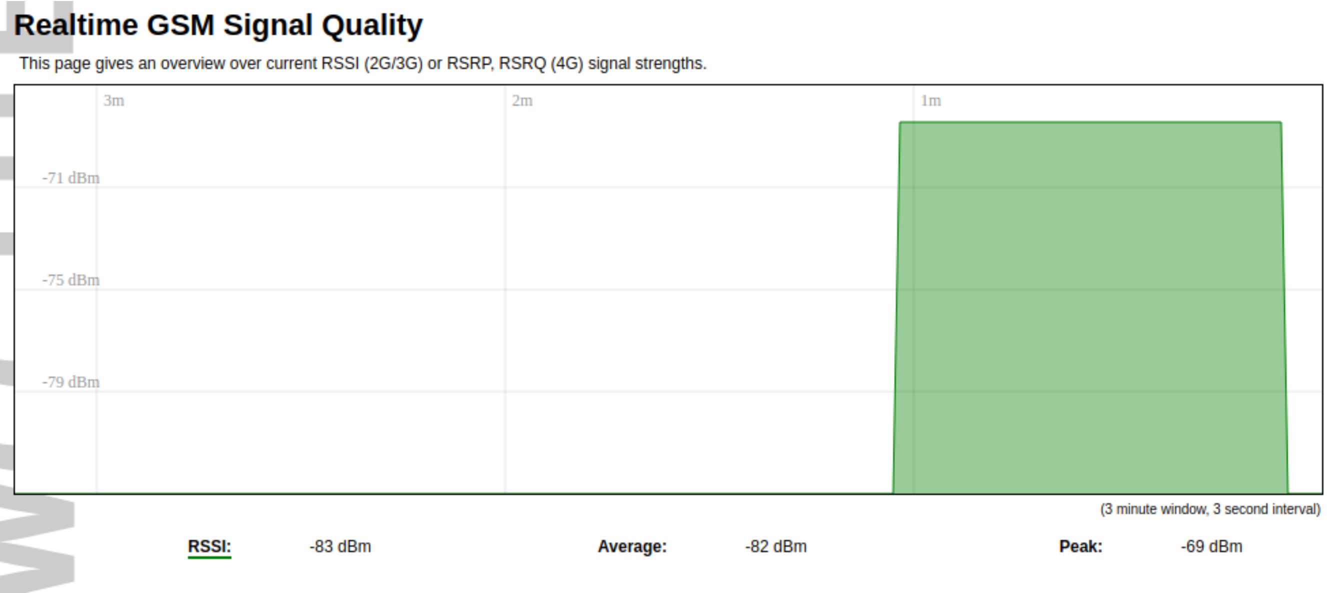
TCP: Transport layer – Transmission Control Protocol.

Network: Type of the network layer – IPv4 or IPv6.

Source, Destination: IP address and the port number.

Transfer: The amount of the transferred data in kB and packets.

GSM signal quality

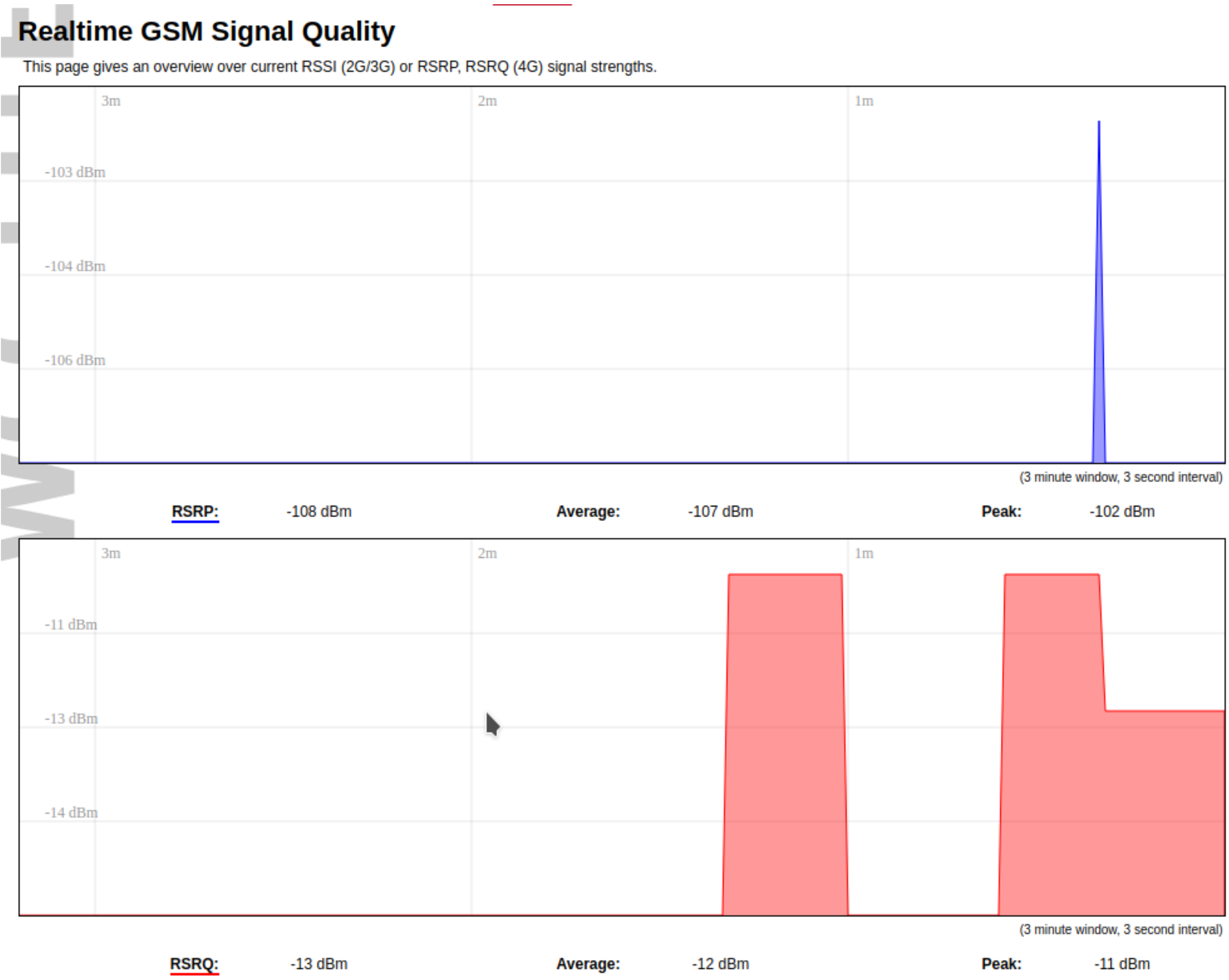


Realtime GSM Signal Quality

This page gives an overview over current RSSI (2G/3G) or RSRP, RSRQ (4G) signal strengths.

(3 minute window, 3 second interval)

RSSI:	-83 dBm	**Average:**	-82 dBm	**Peak:**	-69 dBm



Realtime GSM Signal Quality

This page gives an overview over current RSSI (2G/3G) or RSRP, RSRQ (4G) signal strengths.

(3 minute window, 3 second interval)

RSRP: -108 dBm **Average:** -107 dBm **Peak:** -102 dBm

(3 minute window, 3 second interval)

RSRQ: -13 dBm **Average:** -12 dBm **Peak:** -11 dBm

Graph representation of gsm modem receiving signal quality. RSRP - RSRQ graph is showed, when connected to 4G/LTE network, RSSI - when 2G/3G networks are used.

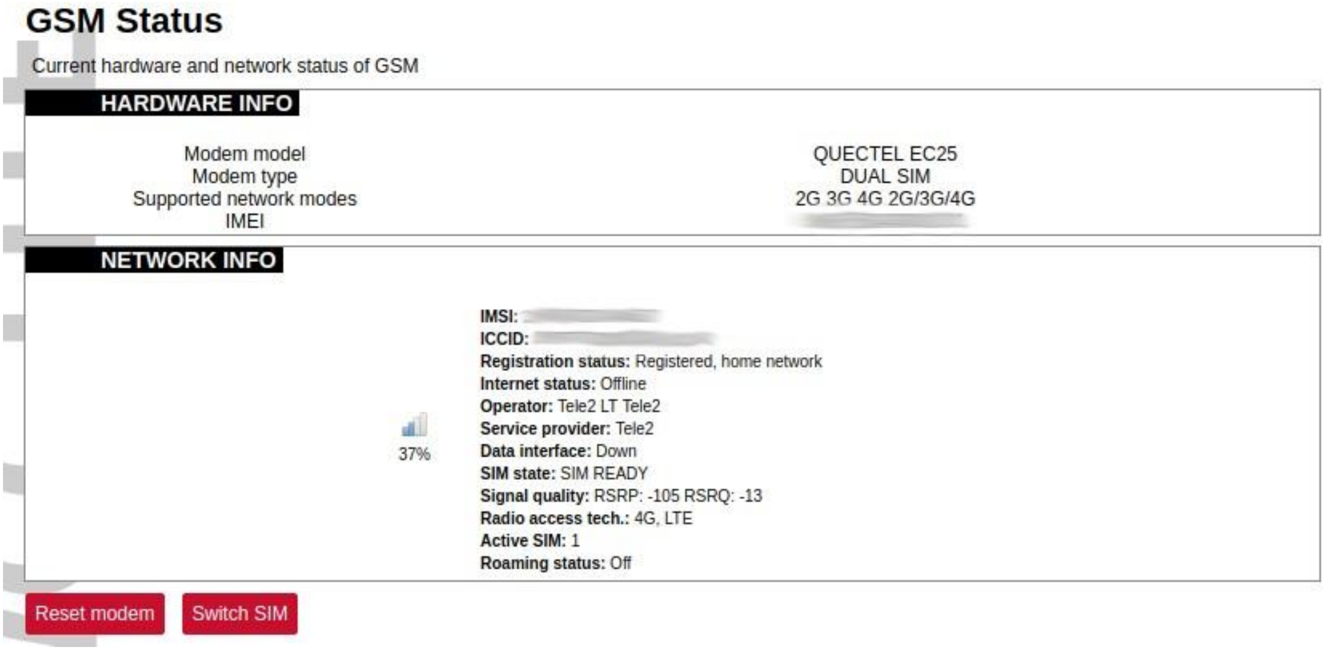
RSSI: Received Signal Strength Indicator in dBm.

RSRP: Received Signal Reference Power in dBm.

RSRQ: Received Signal Reference Quality in dBm.

GSM status

This page shows all information that is related to GSM modem.



GSM Status

Current hardware and network status of GSM

HARDWARE INFO

Modem model	QUECTEL EC25
Modem type	DUAL SIM
Supported network modes	2G 3G 4G 2G/3G/4G
IMEI	[redacted]

NETWORK INFO

37%

IMSI: [redacted]
ICCID: [redacted]
Registration status: Registered, home network
Internet status: Offline
Operator: Tele2 LT Tele2
Service provider: Tele2
Data interface: Down
SIM state: SIM READY
Signal quality: RSRP: -105 RSRQ: -13
Radio access tech.: 4G, LTE
Active SIM: 1
Roaming status: Off

Hardware info

All static information on GSM modem.

Modem model: Manufacturer and model of present modem.

Modem type: Single SIM or Double SIM modem.

Supported network modes: Shows which network modes (or their combinations) are supported (e.g. 2G 4G 2G/4G).

IMEI: IMEI (International Mobile Equipment Identity number).

Network info

All dynamic information on GSM modem and connected network.

IMSI: IMSI (International Mobile Subscriber Identity) number related to current SIM card user.

ICCID: ICCID (Integrated Circuit Card Identifier) number related to physical SIM card.

Registration status: Curren status of network connection.

Internet status: Status of connection to internet (valid, when gsm-pinger is enabled and can reach provided hosts).

Operator: Operator’s name, to which modem is currently connected.

Service provider: IMEI (Service provider for SIM card. Data interface: Shows, whether wcc-lite have a data connection through gsm or not (possible values: ”Up”, ”Down”).

SIM state: Shows current status of SIM card (needs PIN, needs PUK, not-inserted and etc.).

Signal quality: Shows current signal strength value in dBms. RSSI value is shown, when connected to 2G/3G networks, RSRP-RSRQ values - when connected to 4G network.

Radio access tech.: Current radio technology used (2G, 3G or 4G).

Active SIM: Shows which SIM card is active (if the modem is Dual SIM).

Roaming status: Current status of roaming (”Off”, ”On”).

Little bars with percentage at the center left shows signal strength. It is calculated with the respect to current radio access technology used (RSSI or RSRP). Two buttons at the bottom can reset (cold-reset) modem or manually switch SIM cards (if it is Dual SIM modem and both cards are enabled).

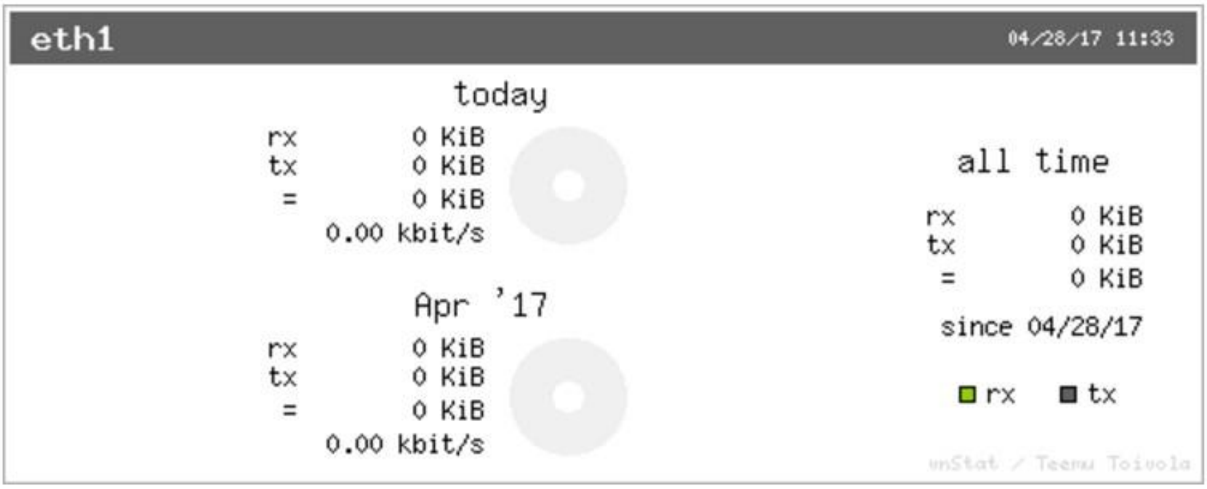
Signal quality is described in different ways for different type for different mobile services: Received Signal Strength Indication (RSSI) in GSM (2G) and UMTS (3G), the Reference Signal Received Quality (RSRQ) in LTE RAT.

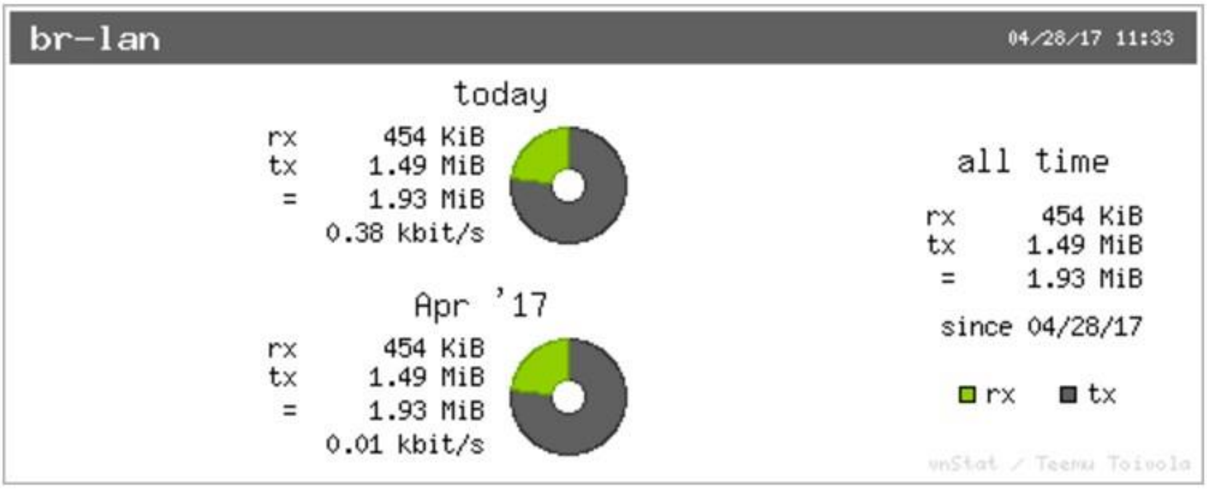
The Reference Signal Received Power (RSRP) is a LTE specific measure that averages the power received on the subcarriers carrying the reference signal. The RSRP measurement bandwidth is equivalent to a single LTE subcarrier: its value is therefore much lower than the total received power usually referred to as RSSI. In LTE the RSSI depends on the currently allocated bandwidth, which is not pre-determined. Therefore the RSSI is not useful to describe the signal level in the cell.

VNSTAT Traffic monitor

To monitor the traffic of various network interfaces VNSTAT Traffic monitor can be used. Traffic tracking can be useful if user wants to have a precise information on how much data is used because it can have a dependance with data transmission costs, for example, mobile (cellular) data.

Graph





An example graph shows the statistics gathered for two network interfaces. In these graphs:

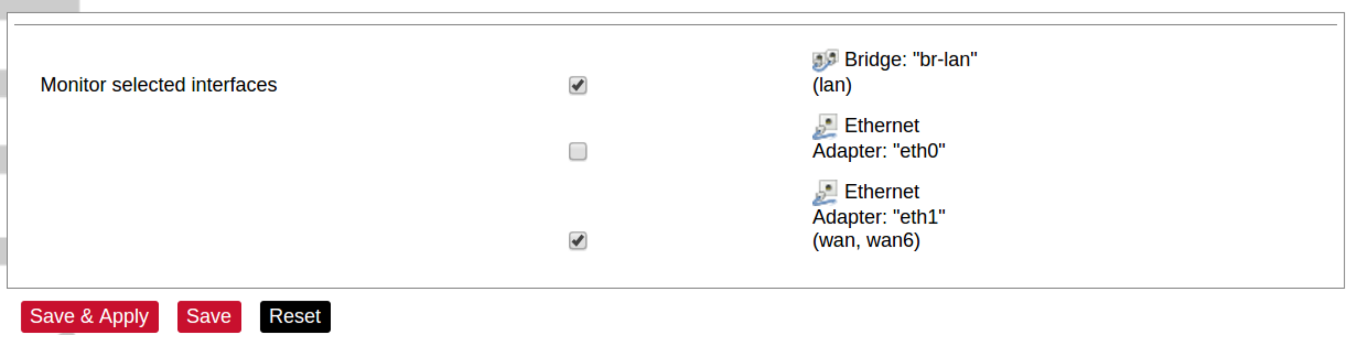
eth1: Network interface (e.g. Ethernet).

br-lan: Virtual network interface (bridge).

rx: Data packets received by the device.

tx: Data packets sent from the device.

Configuration



Monitor selected interfaces

☑ Bridge: "br-lan" (lan)

☐ Ethernet Adapter: "eth0"

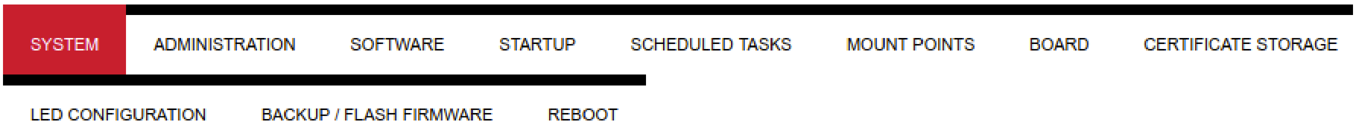
☑ Ethernet Adapter: "eth1" (wan, wan6)

Interfaces to be monitored can be selected in a configuration screen. It includes all the network interfaces configured in a system. To start or stop monitoring user should either select or unselect respective checkbox and save settings by pressing Save & Apply.

System

System

System tab includes various properties, configuration, and settings of the system and contains the following pages:

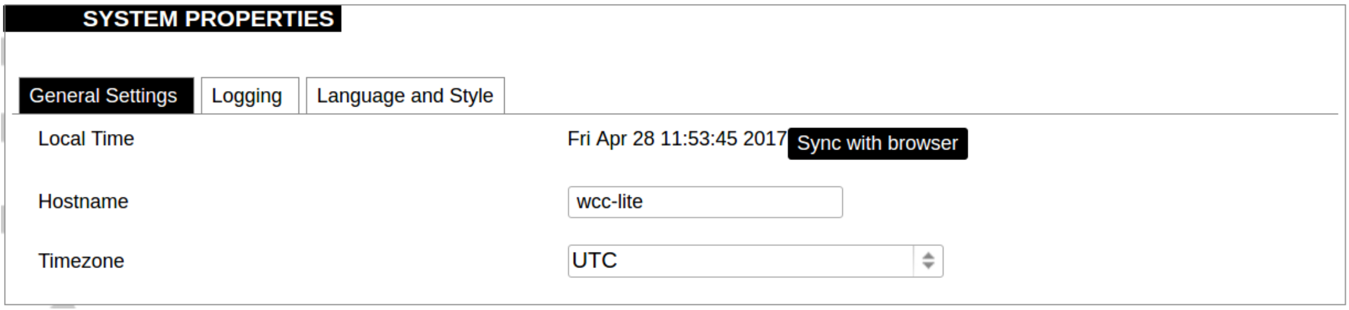


- SYSTEM: properties and settings of the system.
- ADMINISTRATION: settings of the administration for various services.
- SOFTWARE: settings of the packages.
- STARTUP: process management.
- SCHEDULED TASKS: settings of the scheduled tasks.
- MOUNT POINTS: settings for the mount points.
- BOARD: board configuration.
- CERTIFICATE STORAGE: certificate management panel.
- LED CONFIGURATION: settings for the LEDs.
- BACKUP/FLASH FIRMWARE: management of the configuration files and firmware image upgrade.
- REBOOT: device reboot page.

System

Basic aspects of the device can be configured. These include time settings, hostname, system event logging settings, language and theme selection.

System properties

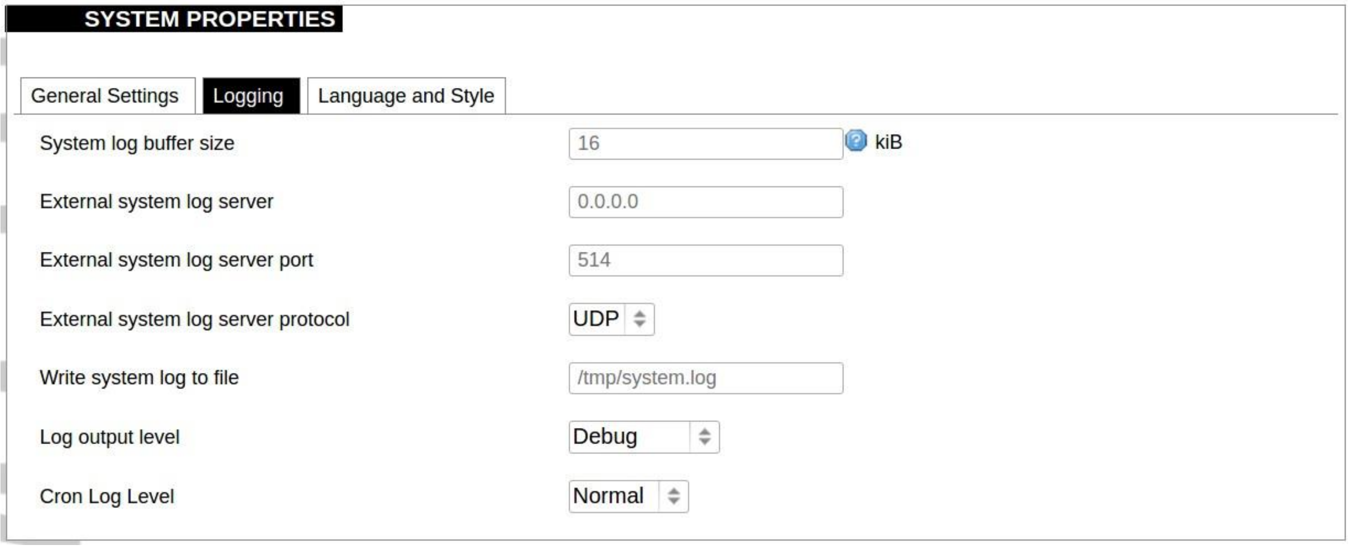


Local Time: Fri Apr 28 11:53:45 2017

Hostname: wcc-lite

Timezone: UTC

General settings of the WCC Lite device are defined as follows:
Local Time: Current local time.
Hostname: The label that is used to identify the device in the network.
Timezone: A region of the globe that observes a uniform standard time. The time zone number indicates the number of hours by which the time is shifted ahead of or behind UTC – Coordinated
Universal Time. Some zones are, however, shifted by 30 or 45 minutes.



System log buffer size: 16 kiB

External system log server: 0.0.0.0

External system log server port: 514

External system log server protocol: UDP

Write system log to file: /tmp/system.log

Log output level: Debug

Cron Log Level: Normal

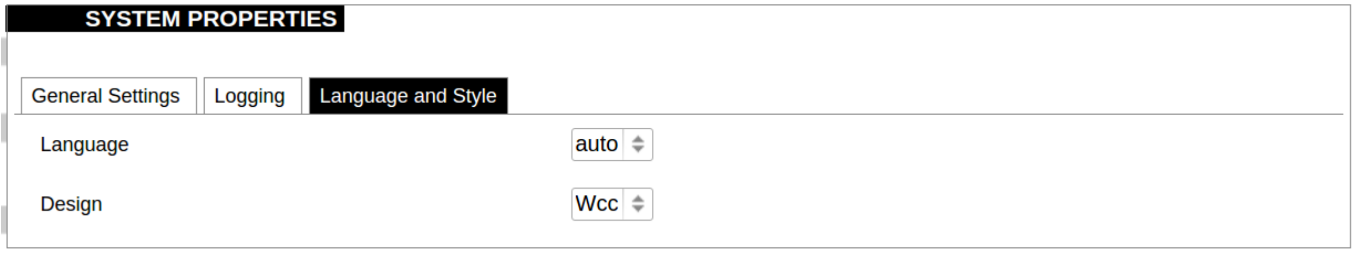
Logging settings of the WCC Lite device are defined as follows:

System log buffer size: The amount of the records before writing these data to the disk.
External system log server: IP address of the server.
External system log server port: An endpoint of communication with the server.
External system log server protocol: A standard that defines how to establish and maintain a network connection: UDP - User Datagram Protocol, TCP - Transmission Control Protocol.
Write system log to file: The name of the file with the path to it.
Log output level: Log output messages can be grouped by their importance to the user. Levels are described in a table below.

Log output level	**Description**
Emergency	System is unusable
Alert	Action must be taken immediately
Critical	Critical conditions
Error	Error conditions
Warning	Potentially hazardous conditions
Notice	Normal conditions that might need action
Info	Information messages
Debug	Debugging messages

Cron Log Level: Cron has three output levels to choose from to write to its logs. Possible options are described in a table below.

Cron log level	**Description**
Debug	Debugging messages
Normal	General administrative messages
Warning	Potentially hazardous conditions

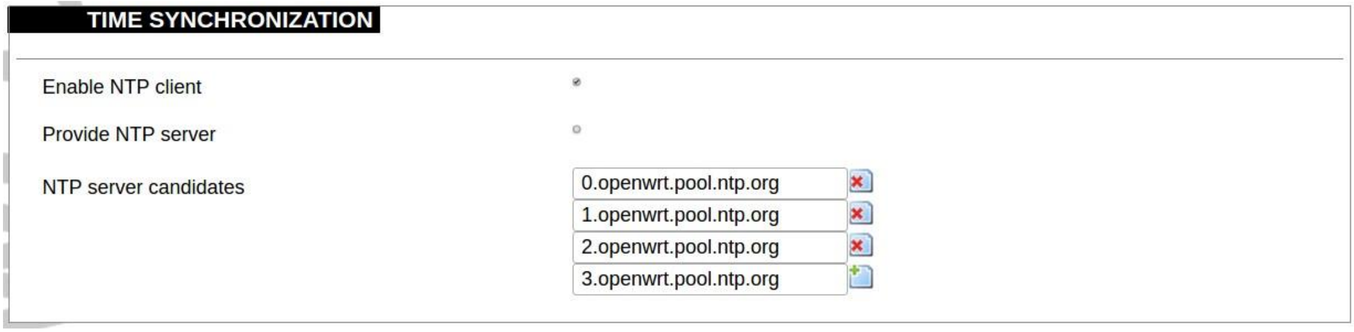


Language: auto
Design: Wcc

Language and Style settings are defined as follows:
Language: The language of the Web interface of the device.
Design: The theme of the Web interface of the device.

Time synchronization

WCC Lite has an NTP client to synchronize date and time with external sources. It is not the only source for synchronization, it can also be done using methods defined in IEC-60870-5 protocols.



TIME SYNCHRONIZATION

Enable NTP client ☑

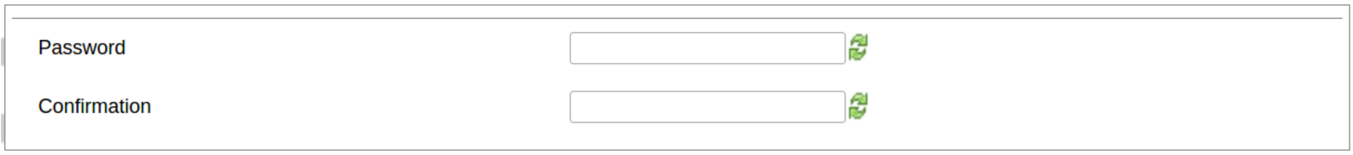
Provide NTP server ☐

NTP server candidates:
- 0.openwrt.pool.ntp.org
- 1.openwrt.pool.ntp.org
- 2.openwrt.pool.ntp.org
- 3.openwrt.pool.ntp.org

> Please take care choosing a time sync method. If both NTP and IEC 60870-5 protocol slave interface time sync methods are activated simultaneously, they can interfere if there is a time difference. We strongly recommend to use single time sync method to prevent time interference.

Time synchronization options are defined as:
Enable NTP client: The local time of the device will sync with external time servers.
Provide NTP server: Turn the device into a local NTP server.
NTP server candidates: The network time protocol servers.

Administration



Password:

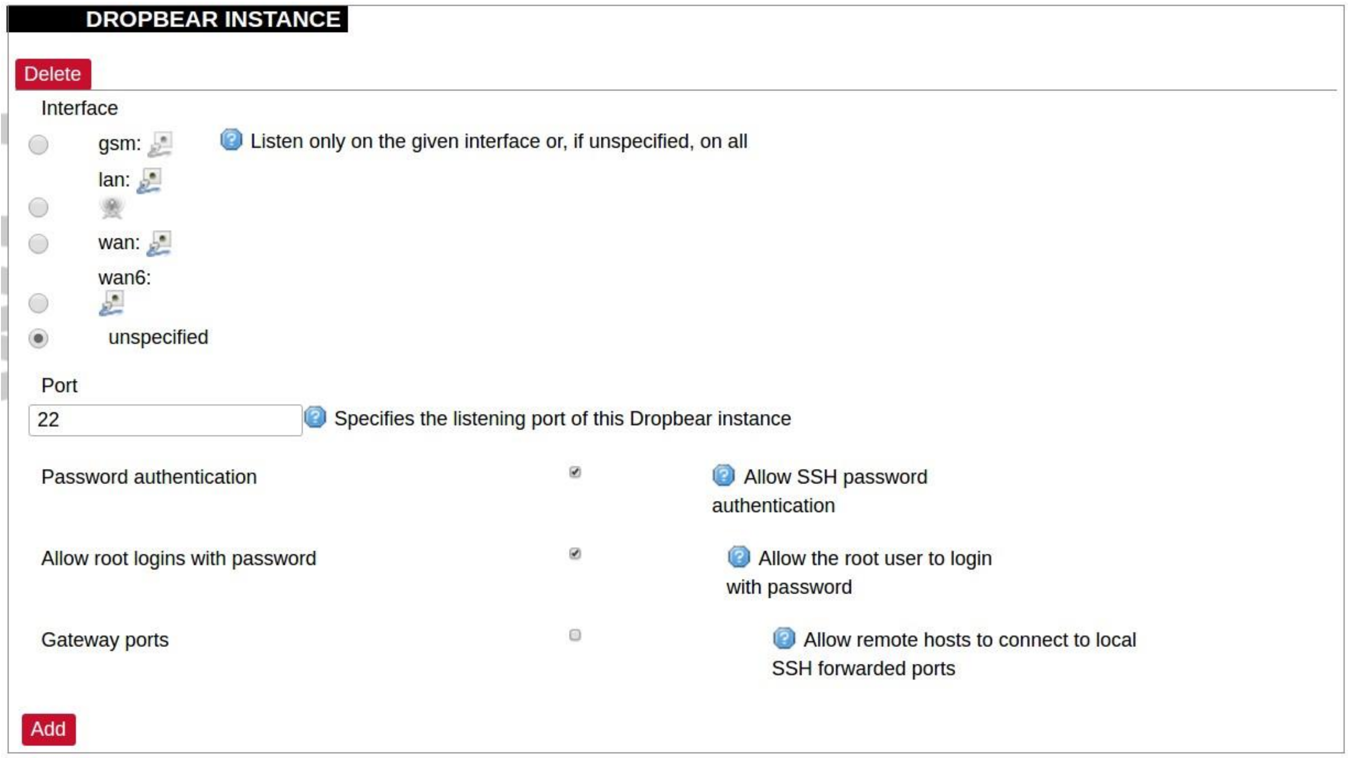
Confirmation:

Administrator password can be changed. To change it the combination of digits and letters of the alphabet should be entered and then confirmed in Confirmation field by typing in again.

> It is advised not to use the default password.

Dropbear instance

WCC Lite has a compact secure shell (SSH) server named Dropbear. Multiple options are, however, available to be changed via WCC Lite web interface, ranging from automatic firewall rules to authentification flexibility.



DROPBEAR INSTANCE

Interface
- ○ gsm:
- ○ lan:
- ○ wan:
- ○ wan6:
- ● unspecified

Listen only on the given interface or, if unspecified, on all

Port: 22 — Specifies the listening port of this Dropbear instance

Password authentication ☑ — Allow SSH password authentication

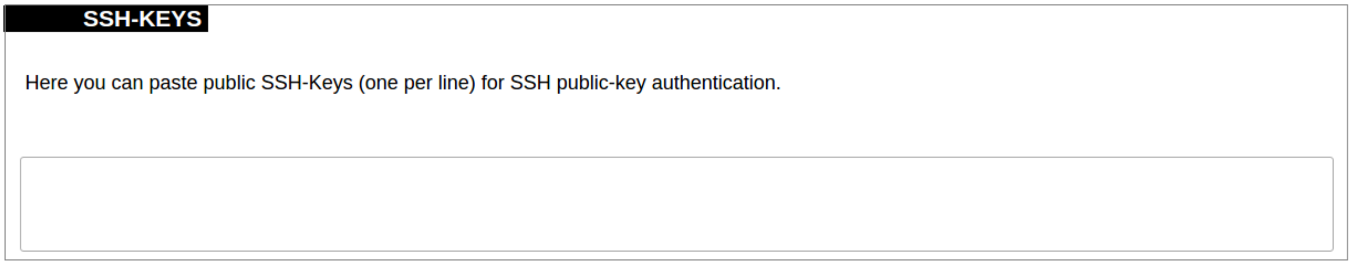
Allow root logins with password ☑ — Allow the root user to login with password

Gateway ports ☐ — Allow remote hosts to connect to local SSH forwarded ports

Dropbear options are defined as follows:

Interface: Listen only on the given interface or on all, in unspecified.
Port: Specifies the listening port of this interface.
Password authentication: Allow SSH password authentication.
Allow roots logins with password: Allow the root user to login with the password.
Gateway ports: Allow remote hosts to connect to local SSH forwarded ports.

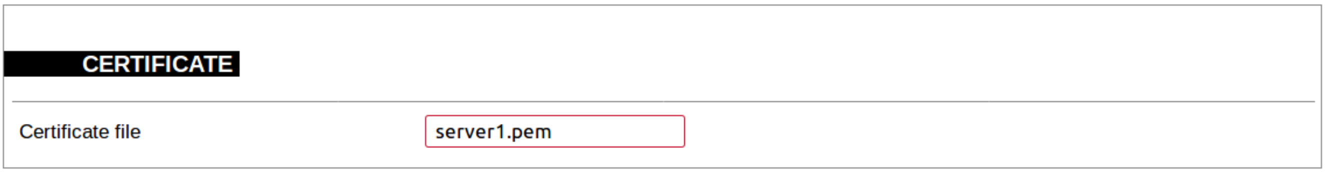
SSH-keys



Here you can paste public SSH-Keys (one per line) for SSH public-key authentication.

SSH keys can be added via WCC Lite web interface. They might be helpful if the user logs into device frequently and does not want to always have to write his credentials.

HTTPS certificate



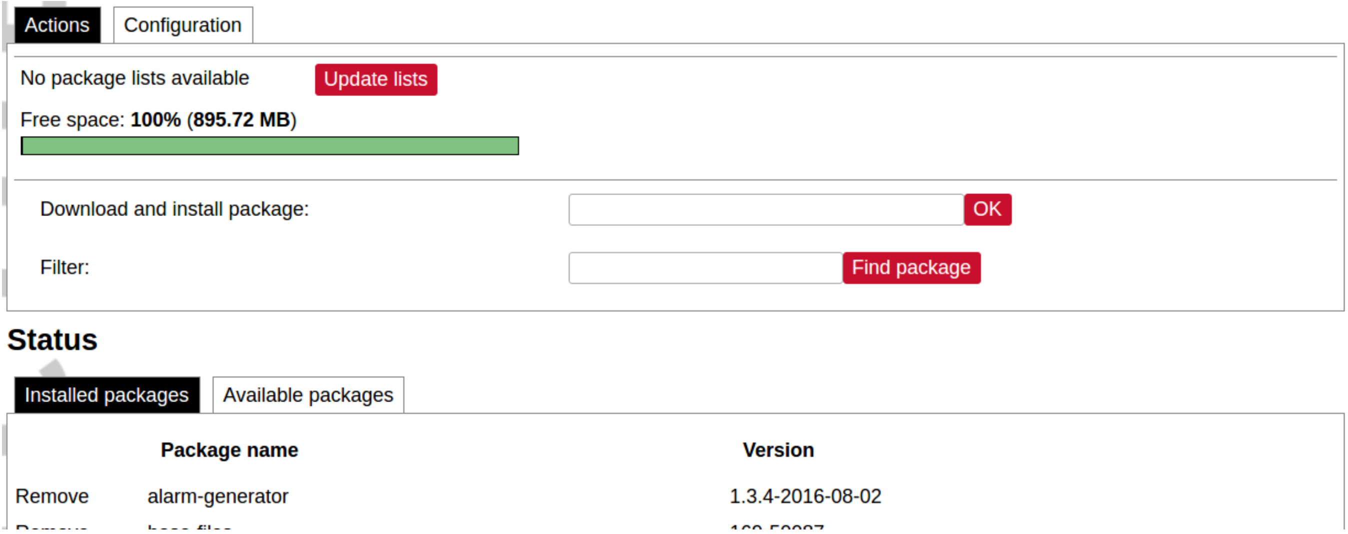
Certificate file: server1.pem

WCC Lite by default is shipped with a default certificate for HTTPS connection. This certificate only enables connecting to device via web interface and might cause warnings from a web browser. To eliminate them, user can use his own certificate to secure access to web interface.

User can use certificates uploaded to a certificate storage. It should be noted that only valid certificates with *.pem extension can be used. Certificate to be used is validated every time device is restarted.
If validation fails, default certificate is used. This is done to prevent user from losing device access via web interface.
For new certificate to come to effect user should restart the device.

Software

Individual packages can be installed via WCC Lite web interface. They can either be installed using web link or selected from the pre-defined feeds.



No package lists available

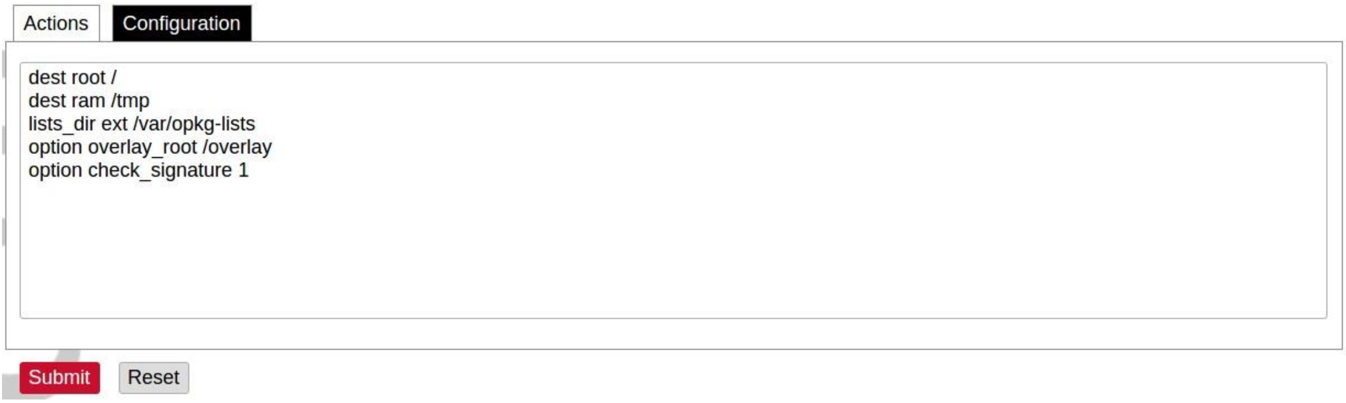
Free space: **100% (895.72 MB)**

Download and install package:

Filter:

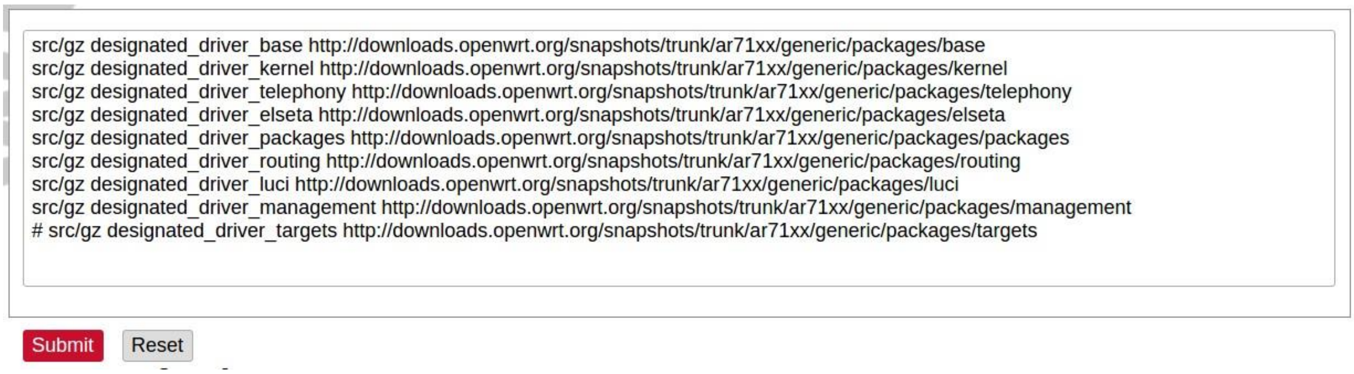
	Package name	Version
Remove	alarm-generator	1.3.4-2016-08-02

Various options can be selected when installing packages, however, default ones should work well enough and it’s advised to only change them for advanced users.



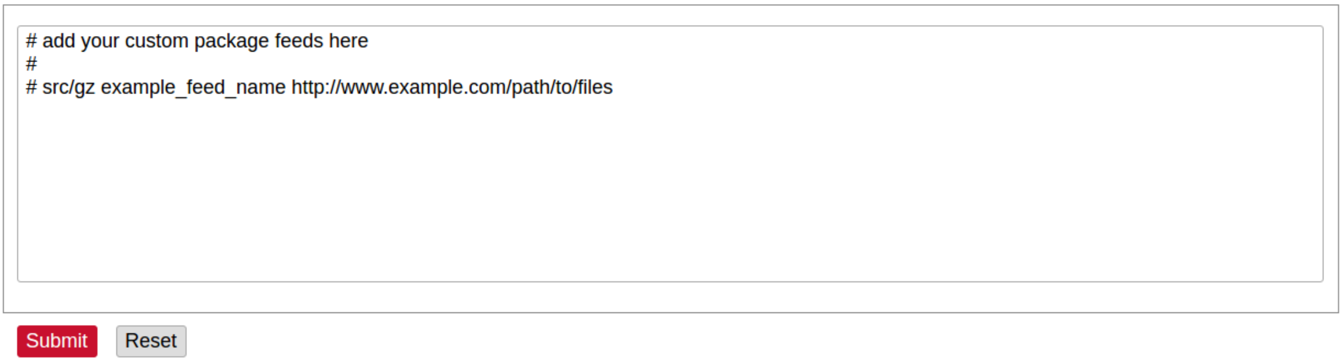
```
dest root /
dest ram /tmp
lists_dir ext /var/opkg-lists
option overlay_root /overlay
option check_signature 1
```

Feeds from which packages are listed for update are defined in Open PacKaGe management (OPKG) configuration that can be changed easily from user interface.



```
src/gz designated_driver_base http://downloads.openwrt.org/snapshots/trunk/ar71xx/generic/packages/base
src/gz designated_driver_kernel http://downloads.openwrt.org/snapshots/trunk/ar71xx/generic/packages/kernel
src/gz designated_driver_telephony http://downloads.openwrt.org/snapshots/trunk/ar71xx/generic/packages/telephony
src/gz designated_driver_elseta http://downloads.openwrt.org/snapshots/trunk/ar71xx/generic/packages/elseta
src/gz designated_driver_packages http://downloads.openwrt.org/snapshots/trunk/ar71xx/generic/packages/packages
src/gz designated_driver_routing http://downloads.openwrt.org/snapshots/trunk/ar71xx/generic/packages/routing
src/gz designated_driver_luci http://downloads.openwrt.org/snapshots/trunk/ar71xx/generic/packages/luci
src/gz designated_driver_management http://downloads.openwrt.org/snapshots/trunk/ar71xx/generic/packages/management
# src/gz designated_driver_targets http://downloads.openwrt.org/snapshots/trunk/ar71xx/generic/packages/targets
```

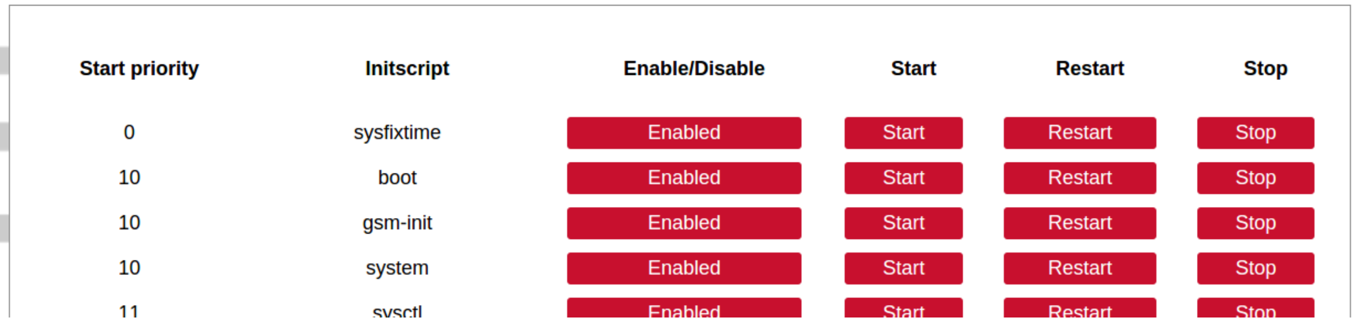
Specific distribution feeds can also be added for special cases if standard ones do not fit the needs.



```
# add your custom package feeds here
#
# src/gz example_feed_name http://www.example.com/path/to/files
```

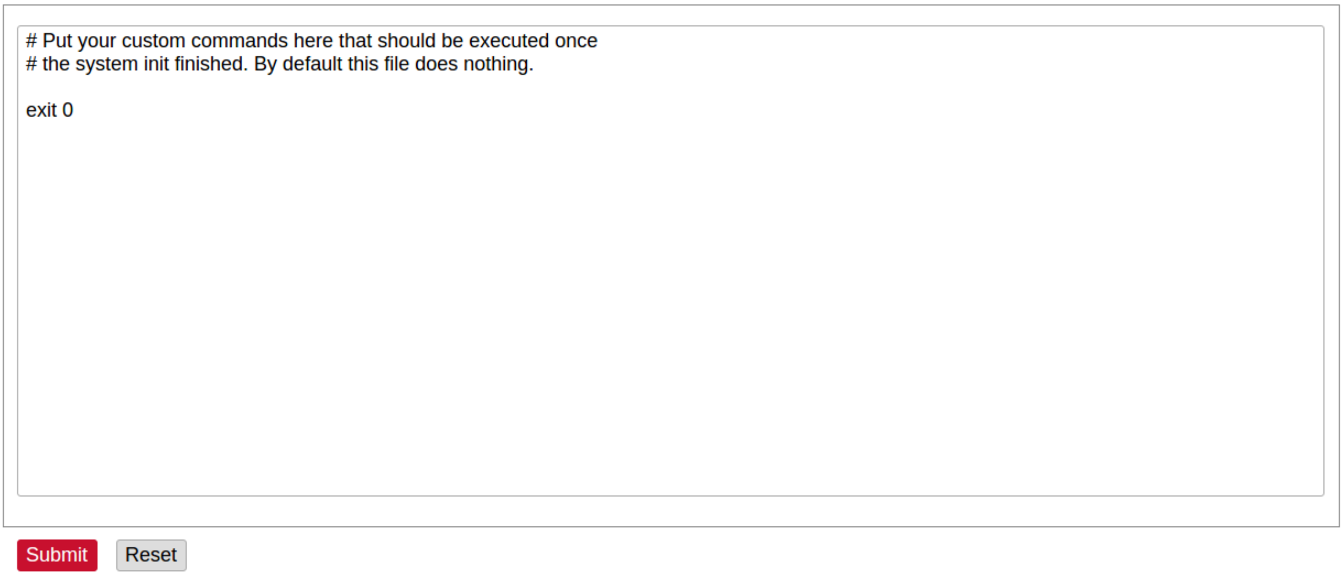
Startup

All of the processes that have init.d scripts can optionally enabled or disabled. This can be very useful if user only intends to use only part of the processes.



Start priority	Initscript	Enable/Disable	Start	Restart	Stop
0	sysfixtime	Enabled	Start	Restart	Stop
10	boot	Enabled	Start	Restart	Stop
10	gsm-init	Enabled	Start	Restart	Stop
10	system	Enabled	Start	Restart	Stop
11	sysctl	Enabled	Start	Restart	Stop

User should not disable processes that are essential for device operation as it can render the device unusable.

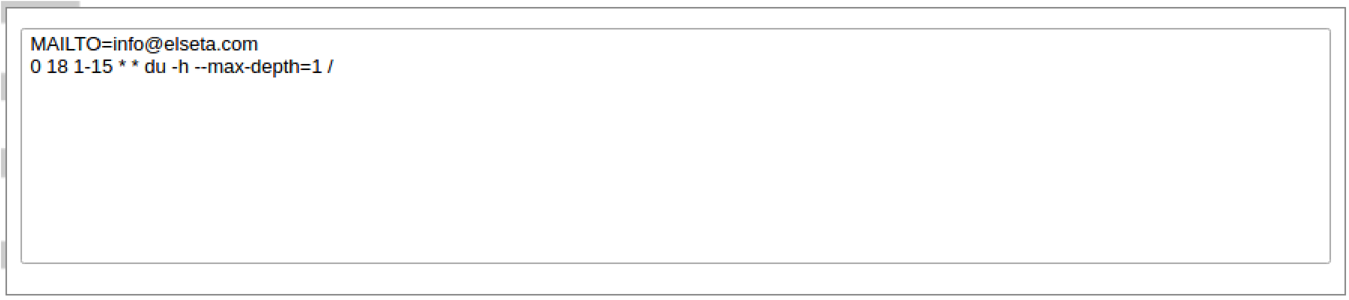


```
# Put your custom commands here that should be executed once
# the system init finished. By default this file does nothing.

exit 0
```

User can optionally run scripts and programs on device startup by putting them into a /etc/rc.local file. This file can be updated from WCC Web interface.

Scheduled tasks



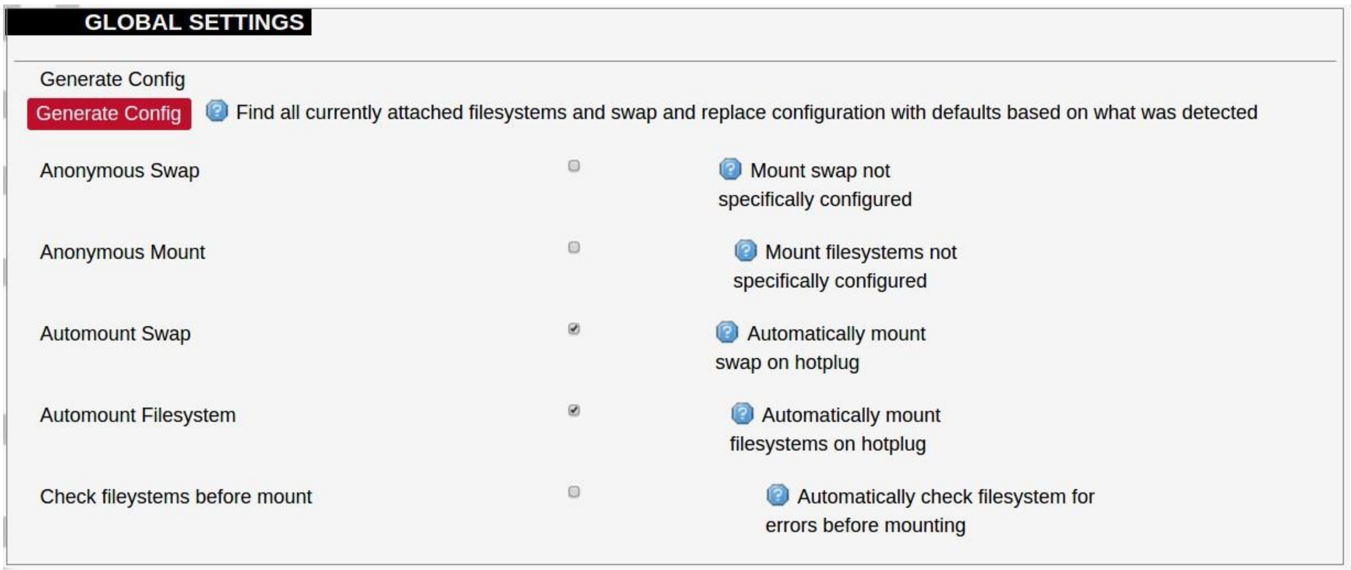
```
MAILTO=info@elseta.com
0 18 1-15 * * du -h --max-depth=1 /
```

Various tasks can be scheduled with the system crontab. New tasks can be included by creating and saving new rules conforming to cron rules. WCC Lite accepts full cron configuration functionality.

Example in the pictures shows how to execute the disk usage command to get the directory sizes every 6 p.m. on the 1st through the 15th of each month. E-mail is sent to the specified email address.

Mount points

Global settings



Find all currently attached filesystems and swap and replace configuration with defaults based on what was detected

Anonymous Swap ☐ Mount swap not specifically configured

Anonymous Mount ☐ Mount filesystems not specifically configured

Automount Swap ☑ Automatically mount swap on hotplug

Automount Filesystem ☑ Automatically mount filesystems on hotplug

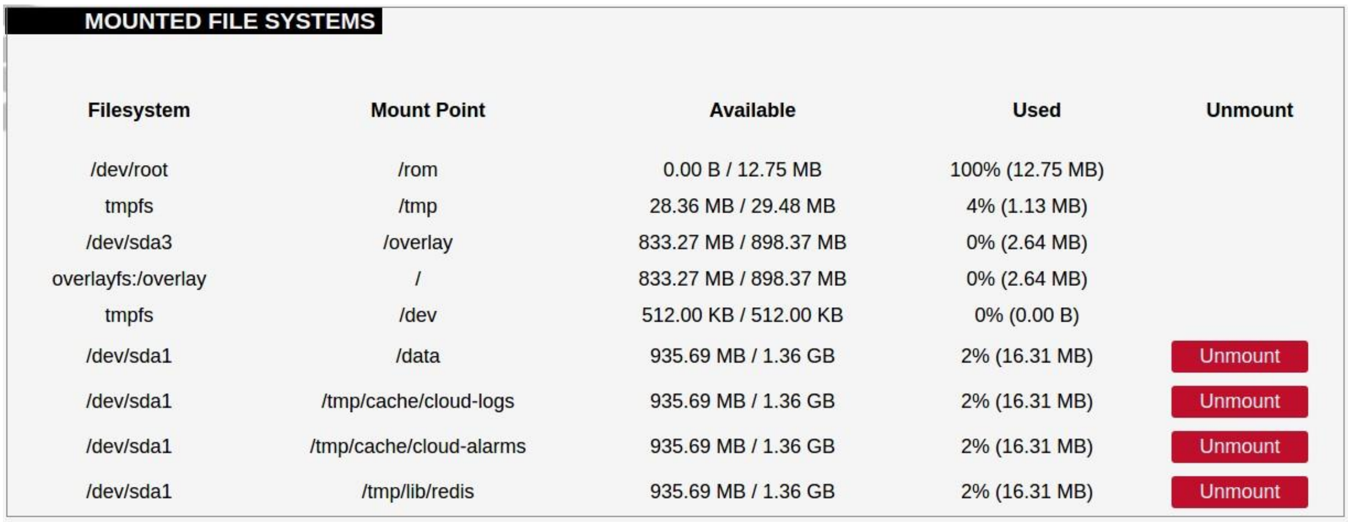
Check fileystems before mount ☐ Automatically check filesystem for errors before mounting

File system mount point configuration window.

Generate Config: Find all currently attached filesystems and swap and replace configuration with defaults based on

what was detected.
Anonymous Swap: Mount swap not specifically configured.
Anonymous Mount: Mount filesystems not specifically configured.
Automount Swap: Automatically mount swap on hotplug.
Automount Filesystem: Automatically mount filesystems on hotplug.
Check filesystems before mount: Automatically check filesystem for errors before mounting.

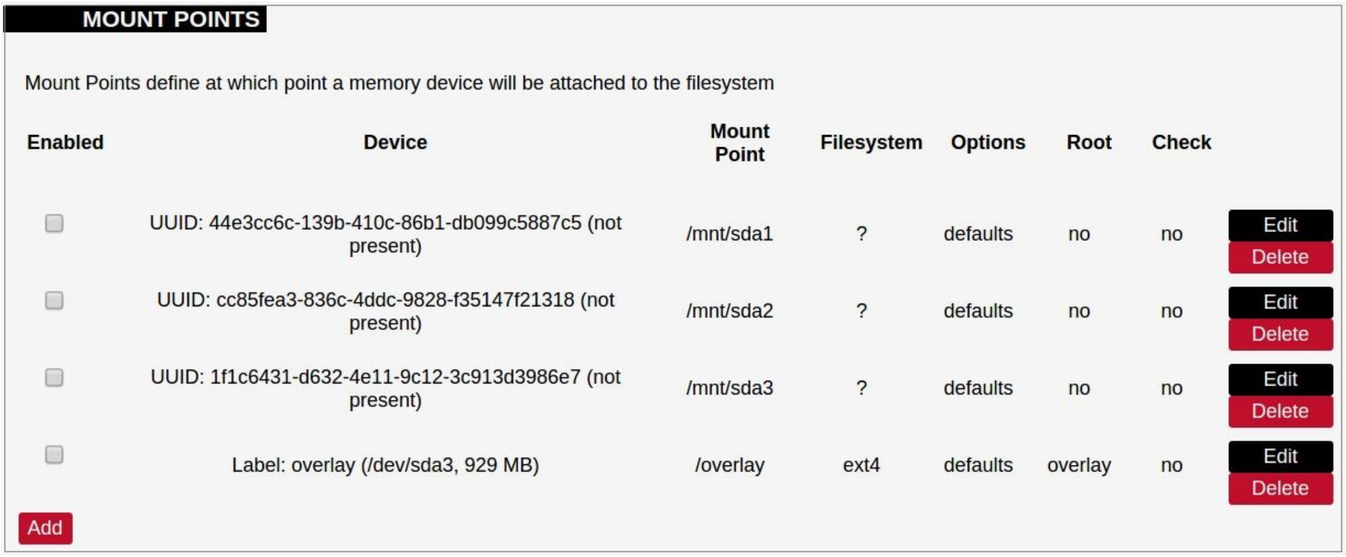
Mounted file systems



Filesystem	Mount Point	Available	Used	Unmount
/dev/root	/rom	0.00 B / 12.75 MB	100% (12.75 MB)	
tmpfs	/tmp	28.36 MB / 29.48 MB	4% (1.13 MB)	
/dev/sda3	/overlay	833.27 MB / 898.37 MB	0% (2.64 MB)	
overlayfs:/overlay	/	833.27 MB / 898.37 MB	0% (2.64 MB)	
tmpfs	/dev	512.00 KB / 512.00 KB	0% (0.00 B)	
/dev/sda1	/data	935.69 MB / 1.36 GB	2% (16.31 MB)	Unmount
/dev/sda1	/tmp/cache/cloud-logs	935.69 MB / 1.36 GB	2% (16.31 MB)	Unmount
/dev/sda1	/tmp/cache/cloud-alarms	935.69 MB / 1.36 GB	2% (16.31 MB)	Unmount
/dev/sda1	/tmp/lib/redis	935.69 MB / 1.36 GB	2% (16.31 MB)	Unmount

List of mounted file systems, some of which can be dismounted manually.

Mount points



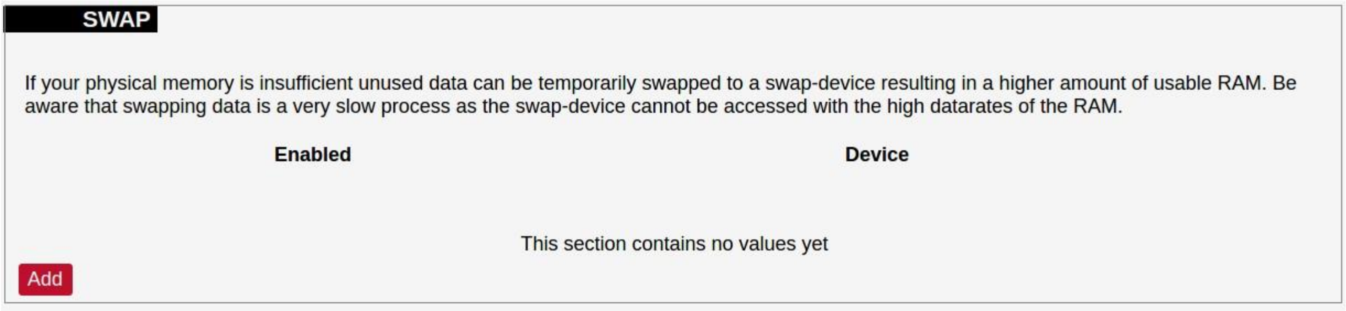
Mount Points define at which point a memory device will be attached to the filesystem

Enabled	Device	Mount Point	Filesystem	Options	Root	Check	
☐	UUID: 44e3cc6c-139b-410c-86b1-db099c5887c5 (not present)	/mnt/sda1	?	defaults	no	no	Edit Delete
☐	UUID: cc85fea3-836c-4ddc-9828-f35147f21318 (not present)	/mnt/sda2	?	defaults	no	no	Edit Delete
☐	UUID: 1f1c6431-d632-4e11-9c12-3c913d3986e7 (not present)	/mnt/sda3	?	defaults	no	no	Edit Delete
☐	Label: overlay (/dev/sda3, 929 MB)	/overlay	ext4	defaults	overlay	no	Edit Delete

List of mount points which can be enabled, disabled or deleted.

Swap

Swap section is used to describe the virtual memory that can be used if there’s a lack of main memory. WCC Lite does not use any virtual memory by default.



If your physical memory is insufficient unused data can be temporarily swapped to a swap-device resulting in a higher amount of usable RAM. Be aware that swapping data is a very slow process as the swap-device cannot be accessed with the high datarates of the RAM.

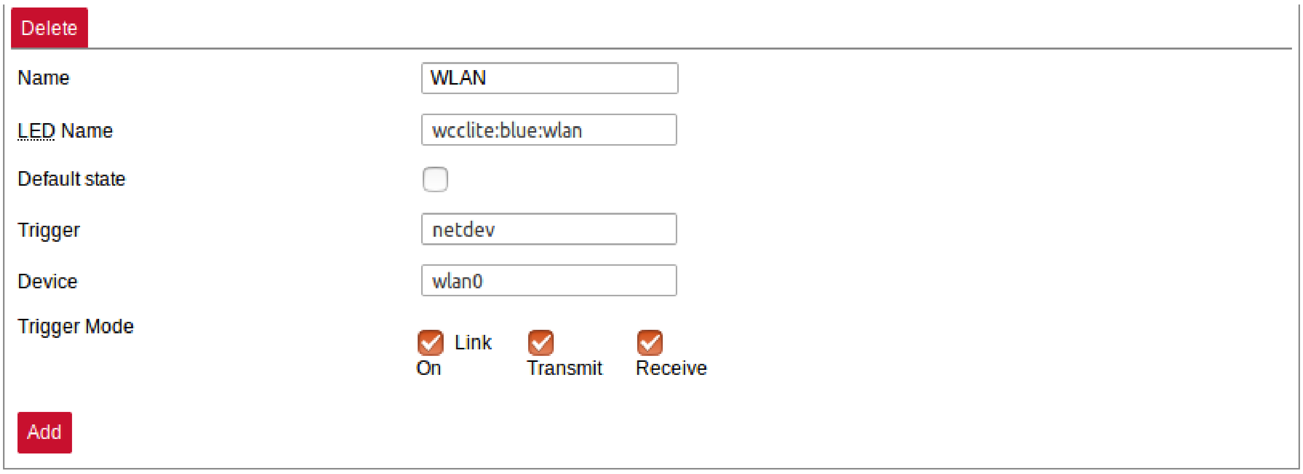
Enabled	Device

This section contains no values yet

It should be noted that virtual memory might do a lot of reading and writing operations. As WCC Lite uses SD card as an additional flash memory, it is highly advised to not use swap to reduce wearing.

LED configuration

WCC Lite has three LEDs that can be configured: WAN, LAN and WLAN. All of the LEDs have a default configuration which should fit most of the cases.



Name: WLAN
LED Name: wcclite:blue:wlan
Default state: ☐
Trigger: netdev
Device: wlan0
Trigger Mode: ☑ Link On ☑ Transmit ☑ Receive

All possible LED configuration options: Name: Name of the LED configuration.

LED Name: Colour and location of the LED. These can be changed, however, normally they should be left unchanged.

Default state of the LED: On/Off.
Trigger: One of the various triggers can be assigned to an LED to changes its states. Possible values are shown in a table below.

Table. Possible trigger for an LED:

Trigger type	Description
none	No blinking function assigned to LED
defaulton	LED always stays on
timer	Blinking according to predefined timer pattern
heartbeat	Simulating actual heart beats
nand-disk	Flashed as data is written to flash memory
netdev	Flashes according to link status and send/receive activity
phy0rx, phy0tx, phy0radio, phy0tpt, phy0assoc	Flashed on WiFi activity events
usbdev	Turned on when USB device is connected. Applicable for modems

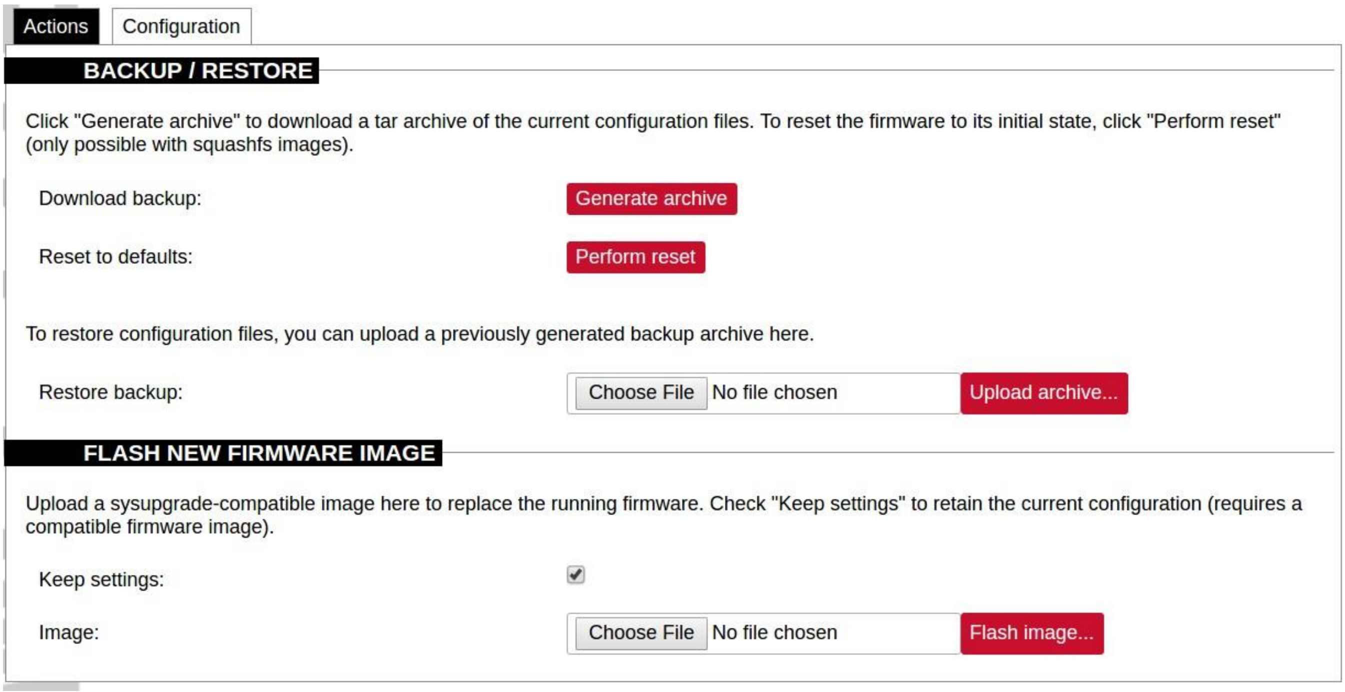
Device: Network interface which is going to be tracked.

Backup/flash firmware

Software update allows to upgrade the software running in WCC Lite. It is recommended to keep the device up to date to receive the latest features and stability fixes.

Backup archives contain complete WCC Lite configuration that can be restored at any time. A file will be downloaded by your browser when creating a backup. This file can be later uploaded to the web page to restore configuration.

⚠ Generated backup archive should only be applied to the same firmware version it was generated. Applying backup to a different firmware version might render some parts of operating system unstable or even unusable



BACKUP / RESTORE

Click "Generate archive" to download a tar archive of the current configuration files. To reset the firmware to its initial state, click "Perform reset" (only possible with squashfs images).

Download backup: Generate archive

Reset to defaults: Perform reset

To restore configuration files, you can upload a previously generated backup archive here.

Restore backup: Choose File No file chosen Upload archive...

FLASH NEW FIRMWARE IMAGE

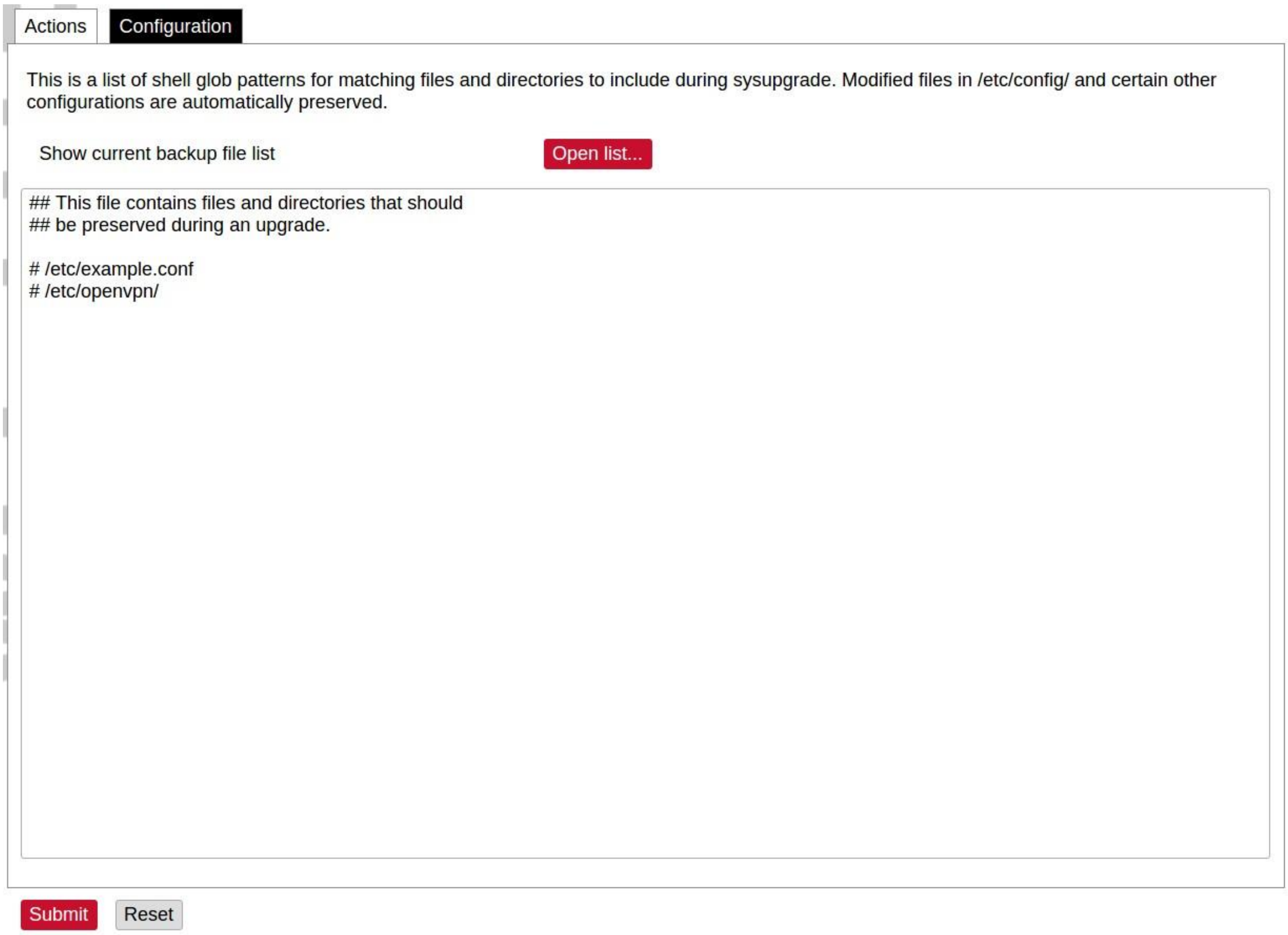
Upload a sysupgrade-compatible image here to replace the running firmware. Check "Keep settings" to retain the current configuration (requires a compatible firmware image).

Keep settings: ☑

Image: Choose File No file chosen Flash image...

A user can choose to keep existing settings after an upgrade. Marking Keep Settings checkbox preserves files listed in /etc/sysupgrade.conf and /lib/upgrade/keep.d/. It is advised to do a clean install and use backup files to restore settings later if a user intends to make a major system upgrade.

ℹ Uploading firmware image, to preserve RAM memory, will stop all Protocol HUB processes. After upload, you will have 2 minutes to proceed with firmware flash or to cancel it. After 2 minutes, firmware file will be deleted and Protocol HUB processes will be restarted.



This is a list of shell glob patterns for matching files and directories to include during sysupgrade. Modified files in /etc/config/ and certain other configurations are automatically preserved.

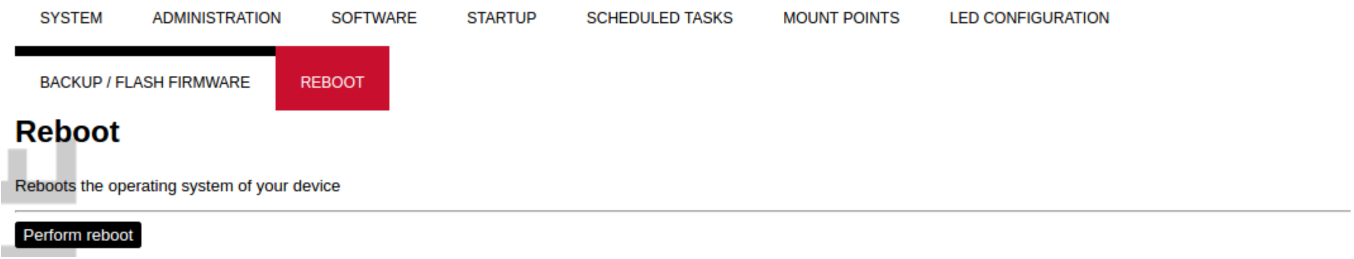
Show current backup file list

```
## This file contains files and directories that should
## be preserved during an upgrade.

# /etc/example.conf
# /etc/openvpn/
```

A file name /etc/sysupgrade.conf can be updated via WCC Web interface. To preserve additional file user should add them to backup file and press Submit. To get the whole list files that would be backed up press Open list.... It is advised to check it before doing a back-up or an upgrade while keeping settings.

Reboot



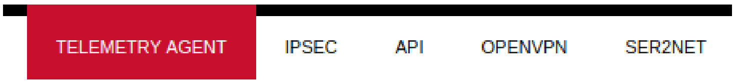
Reboots the operating system of your device

This reboots the operating system of the device.

Services

Introduction

Services tab shows the services of the device and contains the following subsections:



Services tab shows the services of the device and contains the following subsections:

- TELEMETRY AGENT: device telemetry sending to a remote server;
- IPSEC: encrypted virtual private network (VPN) configuration.
- OPENVPN: shows the open-source software application that implements virtual private network (VPN).
- SER2NET: network-to-serial proxy;

Telemetry agent

Having data about the device helps to easily maintain it. Telemetry agent gathers information in a compact and easily decodable way. It uses UDP packets therefore only small overhead is introduced.

However, UDP does not guarantee the arrival of sent packets therefore not every message might reach the server saving these messages.

To start using Telemetry agent a user should configure and enable it. Four options are available:

- Enable agent;
- Server address;
- Port (UDP);
- Period (s).

Every time timer of period length expires, a message is sent to a server of configured server if service is enabled .

⚠ Telemetry agent doesn’t start as a service if Enable agent checkbox is unchecked.

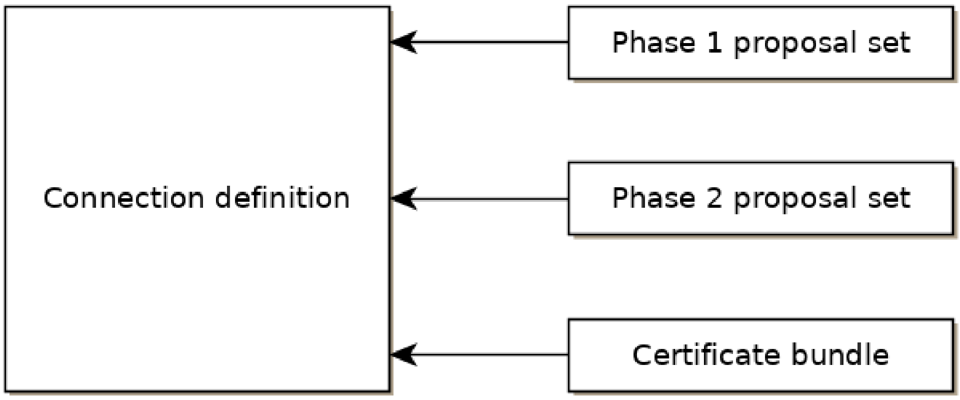
ℹ Enabling agent and saving the configuration automatically starts the process with the new configuration.

IPsec

Background

WCC Lite supports ipsec vpn, thus is able to deliver data securely over encrypted link. To establish ipsec vpn, a connection definition must be created by entering appropriate configuration settings.

For advanced connection description auxiliary settings sets can be defined. They can be joined to the connection and can be reusable several times according to the need. Each configuration record is identified by a unique name, which is assigned in time of creation. The following diagram shows relations between connection and auxiliary sets.



Ipsec settings

Connection description

Options supported by wcclite is described below.

Item	Type	Description
Gateway	string	Host name or IP address of the remote peer.
Type	selector	Tunnel mode: full packet encryption, covers host-to-host, host-to-subnet, subnet-to-subnet situations or transport mode: ip payload encryption, secures host-to-host data only.
Local subnet	string	Specifies local network, in form network/netmask, for example 192.168.11.0/24
Remote subnet	string	Specifies remote network at another side of a tunnel.
Authentication	selector	Pre-shared key or RSA certificate
Pre-shared key	string	Available if Authentication set to Pre-shared key
Certificate set	selector	Available if Authentication set to RSA certificate. Selectable from configured auxiliary set.
Phase 1 proposal (IKE)	selector	Authentication-encryption schema, selectable from configured auxiliary set.
Phase 2 proposal (ESP)	selector	Authentication-encryption schema, selectable from configured auxiliary set.
Local ID	string	Specifies the identity of the local endpoint
Remote ID	string	Specifies the identity of the remote endpoint
Key exchange	selector	Sets method of key exchange IKEv2 or IKEv1. Default IKEv2.

Exchange mode	selector	Main or aggressive. Available if key exchange is set to IKEv1.
Use compression	checkbox	If selected a compression ability will be proposed to the peer.
DPD action	selector	Controls the use of dead peer detection protocol, values: • none – default, disables sending of DPD messages. • clear – the connection closed with no action. • hold – keeps description, tries re-negotiate connection on demand. • restart – will try to re-negotiate immediately.
DPD delay	string	Time interval in seconds between peer check. Default 30.
DPD timeout	string	Time in seconds after which peer consider to be unusable. IKEv1 only. Default 150.
Key lifetime	string	Lifetime of data channel in seconds . Default 10800.
IKE lifetime	string	Lifetime of keying channel in seconds. Default 3600.

Auxiliary settings

Phase 1 proposals - IKE/ISAKMP cipher suite components:

Item	Type	Description	Note
Encryption algorithm	selector	Encryption algorithm – 3DES, AES128, AES192, AES256.	required
Hash algorithm	selector	Hash algorithm – MD5, SHA1, SHA256, SHA384 or SHA512.	required
DH exponentiation	selector	Specifies Diffie-Hellman groups – 1,2,5,14,15,16,18	required

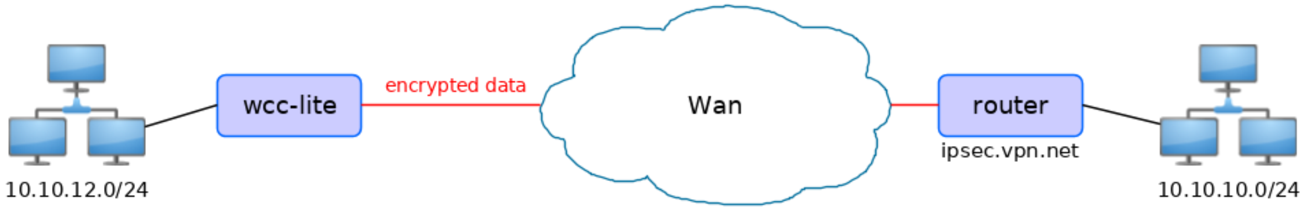
Phase 2 proposals - ESP cipher suite components:

Item	Type	Description	Note
Encryption algorithm	selector	Encryption algorithm – 3DES, AES128, AES192, AES256.	required
Hash algorithm	selector	Hash algorithm – MD5, SHA1, SHA256, SHA384 or SHA512.	required
DH exponentiation	selector	Specifies Diffie-Hellman groups – 1,2,5,14,15,16,18	optional

The following specification and topology map corresponds to settings used in further configuration walk-through example.

Creating a connection description

Site-to-Site VPN scenario



VPN connection details

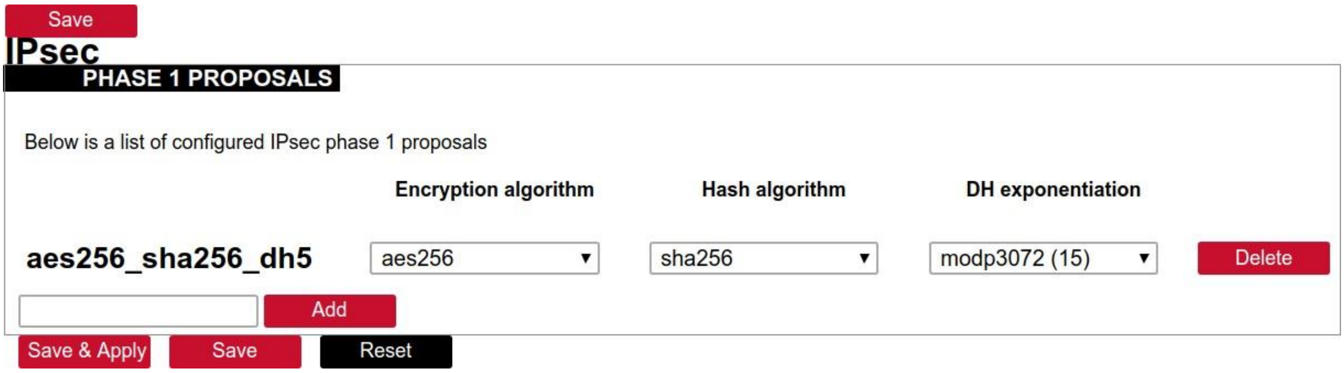
Tunnel: demoo

```
IPSec peer: ipsec.vpn.net
Pre-shared key: thebigsecret
Mode: tunnel
Remote network: 10.10.10.10/24
Local network: 10.10.12.0/24
Local ID: wcclite
IKE authentication: aes256
IKE hash: sha256
IKE DH group: 5 (modp1536)
ESP authentication: aes128
ESP hash: sha1
```

If auxiliary data is needed, it is recommended to check or define it first.

Creation of Phase 1 proposal

- Enter section "Phase 1 proposals".
- Create a new record by assigning new name, for example "aes256-sha256-dh5" and click the button "Add".
- Choose corresponding values: encryption, hash algorithm and DH exponentiation.
- Push "save" to save the data.

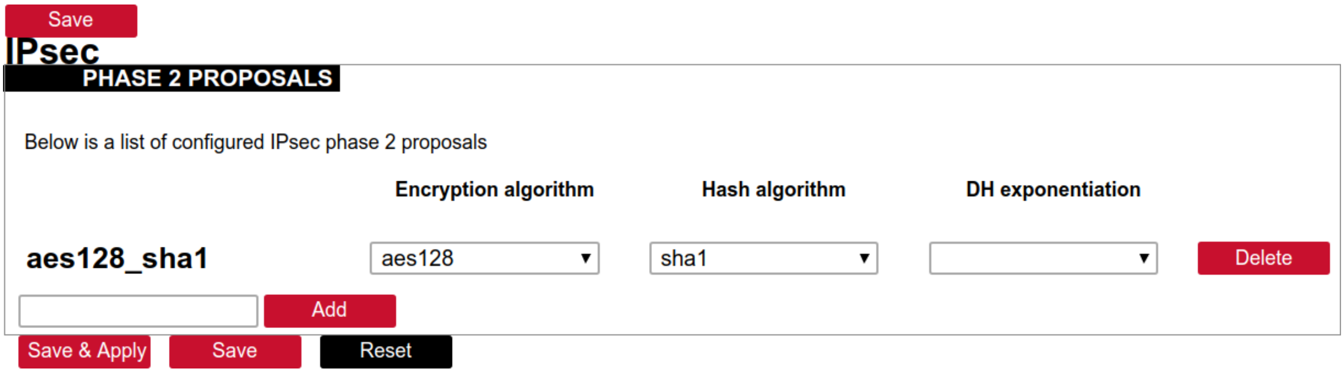


Below is a list of configured IPsec phase 1 proposals

	Encryption algorithm	Hash algorithm	DH exponentiation
aes256_sha256_dh5	aes256	sha256	modp3072 (15)

Creation of Phase 2 proposal

- Enter section "Phase 2 proposals".
- Create a new record by assign new name for example "aes128-sha1" and click the button "Add".
- Choose corresponding values: encryption, hash algorithm.
- Push "save" to save the data.



Below is a list of configured IPsec phase 2 proposals

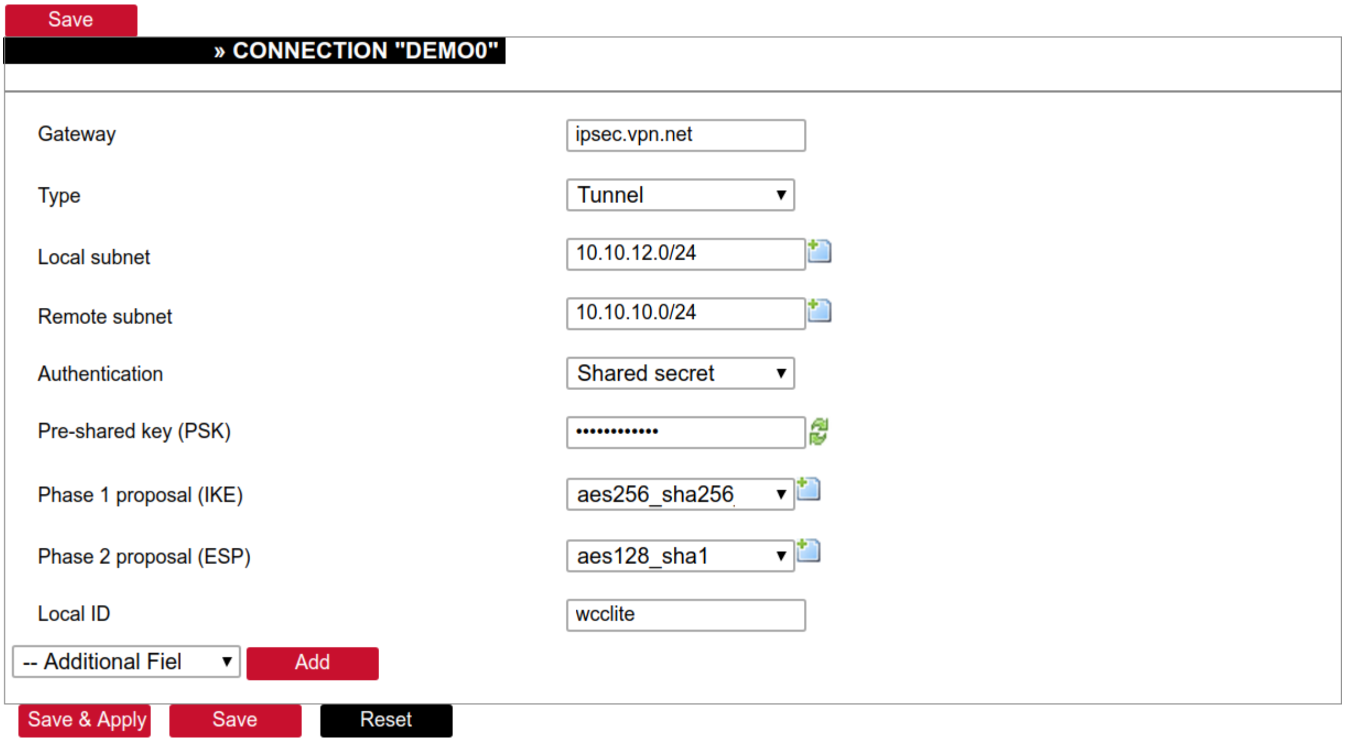
	Encryption algorithm	Hash algorithm	DH exponentiation
aes128_sha1	aes128	sha1	

Creation of tunnel definition

Enter section connections

- Create a new record by assigning new name (e.g."demo0") and clicking "Add".
- Call a detail form by pushing the button "edit".
- Enter peer address into "Gateway": "ipsec.vpn.net".
- Ensure "Type" is set to: "Tunnel".
- Fill local subnet to: 10.10.12.0/24.
- Fill remote subnet to: 10.10.10.0/24.
- Make sure authentication is set to: "Shared secret".
- Enter Pre-shared key (PSK): thebigsecret.
- "Phase 1 proposal (IKE)", choose a value: aes256_sha256_dh5.
- "Phase 2 proposal (ESP)", choose a value: aes128_sha1.

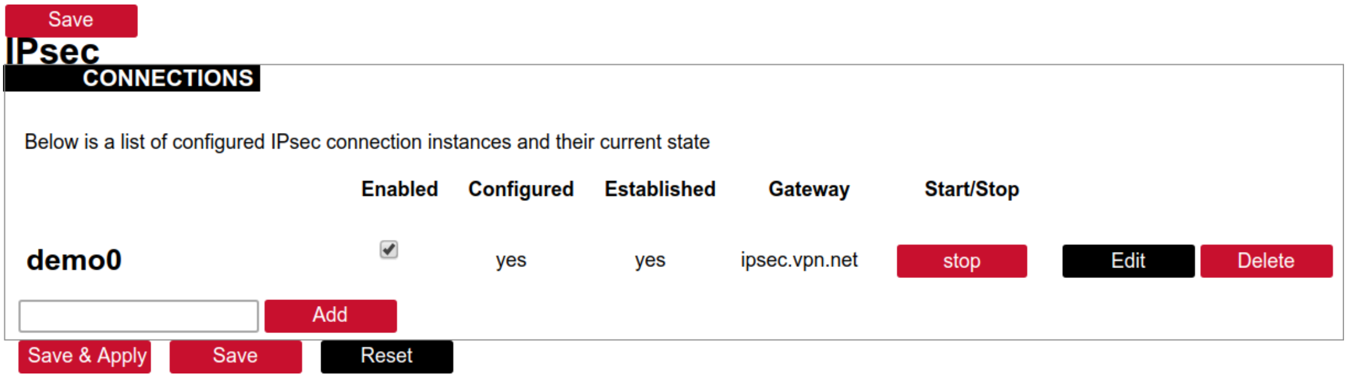
- Locate combo box "additional field", select "Local ID", then set value to: wcclite.
- Push "Save".



Gateway: ipsec.vpn.net
Type: Tunnel
Local subnet: 10.10.12.0/24
Remote subnet: 10.10.10.0/24
Authentication: Shared secret
Pre-shared key (PSK): ••••••••••••
Phase 1 proposal (IKE): aes256_sha256
Phase 2 proposal (ESP): aes128_sha1
Local ID: wcclite

Activating the tunnel

- Return to the section "connections".
- Check the checkbox "Enabled".
- Push the button "save & apply".
- Examine indicator "configured", it should be "yes", if not, review settings just entered.
- The tunnel should be prepared for operation and will be established on demand.
- Optionally, it is possible to establish tunnel operation by pressing button "start".



Below is a list of configured IPsec connection instances and their current state

	Enabled	Configured	Established	Gateway	Start/Stop
demo0	☑	yes	yes	ipsec.vpn.net	stop

L2TP/IPsec

Because of the lack of confidentiality inherent in the L2TP protocol, it is often implemented along with IPsec. This is referred to as L2TP/IPsec, and is standardized in IETFRFC 3193. The process of setting up an L2TP/IPsec VPN is as follows:

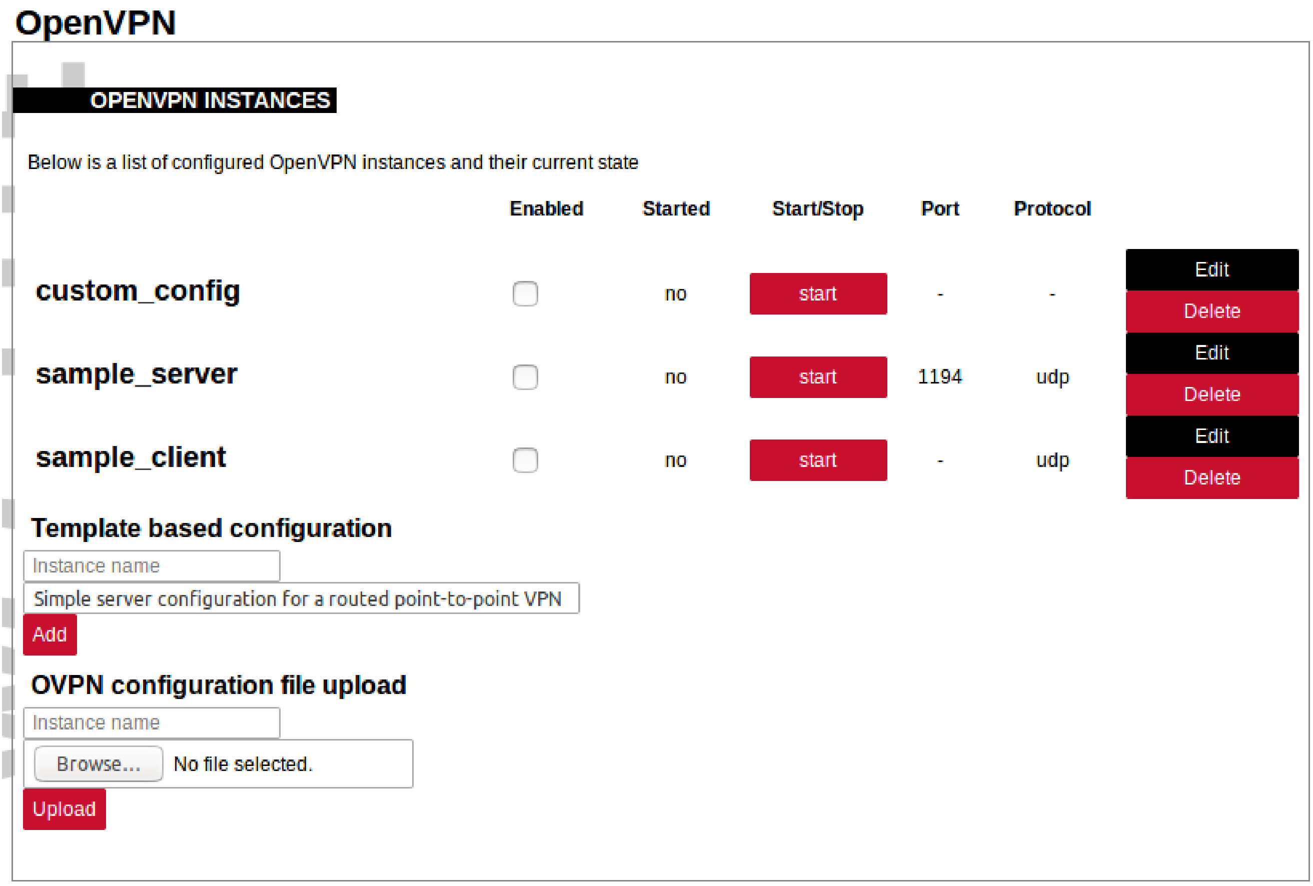
- Negotiation of IPsec security association (SA), typically through Internet key exchange (IKE). This is carried out over UDP port 500, and commonly uses either a shared password (so-called "pre-shared keys"), public keys, or X.509 certificates on both ends, although other keying methods exist.
- Establishment of Encapsulating Security Payload (ESP) communication in transport mode. The IP protocol number for ESP is 50 (compare TCP's 6 and UDP's 17). At this point, a secure channel has been established, but no tunneling is taking place.
- Negotiation and establishment of L2TP tunnel between the SA endpoints. The actual negotiation of parameters takes place over the SA's secure channel, within the IPsec encryption. L2TP uses UDP port 1701.

When the process is complete, L2TP packets between the endpoints are encapsulated by IPsec. Since the L2TP packet itself is wrapped and hidden within the IPsec packet, no information about the internal private network can be gathered from the encrypted packet. Also, it is not necessary to open UDP port 1701 on firewalls between the endpoints, since the inner packets are not acted upon until after IPsec data has been decrypted and stripped, which only takes place at the endpoints. A potential point of confusion in L2TP/IPsec is the use of the terms tunnel and secure channel. The term tunnel refers to a channel which allows untouched packets of one network to be transported over another network. In the case of L2TP/PPP, it allows L2TP/PPP packets to be transported over IP. A secure channel refers to a connection within which the confidentiality of all data is guaranteed. In L2TP/IPsec, first IPsec provides a secure channel, then L2TP provides a tunnel.

OpenVPN

OpenVPN Instances

The primary goal is to get a working WCC Lite tunnel and establish a basic platform for further customisation. Most users will require further configuration tailored to their individual needs. If you are creating an OpenVPN server (either type), you must create security certificates using the instructions below. If you are using OpenVPN as a client, the required certificates should have been provided with your configuration details. OpenVPN can be configured either by using WCC Lite Web interface or uploading the OVPN file containing necessary parameters. OpenVPN will automatically attempt to load all *.conf files placed in the /etc/openvpn folder. Several OpenVPN recipes are suggested containing most used configurations that may only require minor changes. If a user intends setting up OpenVPN without OVPN file, it is highly advised to use these recipes and tweaking them up to individual needs.



OpenVPN

OPENVPN INSTANCES

Below is a list of configured OpenVPN instances and their current state

	Enabled	Started	Start/Stop	Port	Protocol	
custom_config	☐	no	start	-	-	Edit Delete
sample_server	☐	no	start	1194	udp	Edit Delete
sample_client	☐	no	start	-	udp	Edit Delete

Template based configuration

Instance name

Simple server configuration for a routed point-to-point VPN

OVPN configuration file upload

Instance name

Browse... No file selected.

OpenVPN instances page contains parameters to be configured.

Enabled: Flag to specify if a particular configuration should be enabled;

Started: Specifies if a particular configuration has been started by OpenVPN;

Start/Stop: Button to manually start or stop any configured tunnels;

Port: Specifies the listening port of this service;

Protocol: A standard that defines how to establish and maintain a network connection: UDP - User Datagram Protocol, TCP - Transmission Control Protocol.

More parameters for every instance can be changed by pressing Edit button, configuration can be removed with Delete button. Pressing Edit takes the user to main configuration screen containing the options usually used in particular OpenVPN recipes. To do more specific changes user should further select Switch to advanced configuration.

OVPN files contain configuration in a textual form therefore changing parameters requires having prior knowledge about different OpenVPN parameters. It is advised to used OVPN files, however, if configuration has been pre-built beforehand and is used without further changes.

ser2net

The ser2net daemon allows telnet and tcp sessions to be established with a device’s serial ports. The program comes up normally as a daemon, opens the TCP ports specified in the configuration file, and waits for connections. Once a connection occurs, the program attempts to set up the connection and open the serial port. If another user is already using the connection or serial port, the connection is refused with an error message.

API

The firmware of the WCC Lite features a built-in API which is accessible via the web interface.

⚠ As of version 1.2.11, it does not implement any access restriction features apart from those provided by the firewall functionality.

Individual API endpoints can be enabled or disabled via the web configuration interface at Services->API.

ℹ All endpoints are disabled by default.

Available API endpoints are shown in the table below.

Table. Available API endpoints:

Endpoint	Description
/api/version	Version of the API
/api/actions	List of available points
/api/syncVersion	Version of the sync service
/api/sync	Protocol hub configuration sync (name=”file”)*
/api/syslog	Prints out the syslog
/api/systemInfo	General system info
/api/gsmInfo	GSM modem information
/api/devices	List of configured devices
/api/device/info	Device information (name=”device_alias”)**
/api/device/tags	List of tags on particular device (name=”device_alias”)**
/api/device/tag/value	Tag value (name=”device_alias”, name=”signal_alias”)**
/api/tags	List of configured tags
/api/sysupgrade	Firmware upgrade (name=”file”)*

* Endpoints accepting files

** Endpoints accepting field data

The API accepts data and files as POST requests encoded as ”multipart/form-data”.

SNMP

SNMP (Simple Network Management Protocol) is an internet-standard protocol for managing devices on IP networks. SNMP exposes management data in the form of a hierarchy of variables in a MIB (Management Information Base). WCC Lite supports SNMP service which is not added to default build of firmware but can be installed as a module. It enables user to collect data on various parameters of system:

- CPU time - time spent for calculations of various processes:

user - time for user processes;
system - time for system processes;
idle - time spent idling;
interrupts - time spent handling interrupts.

- CPU load average - CPU load average for 1, 5 and 15 minutes respectively;
- Disk usage:

total - total amount of storage in the device (in kB)
available - amount of storage available to store data (in kB)
used - amount of storage used in the device (in KB)
blocks used percentage - blocks (sectors) used to store data in a disk (in kB)
inodes used percentage - the inode (index node) is a data structure in a Unix-style file system that describes a file-system object such as a file or a directory. Each inode stores the attributes and disk block location(s) of the object's data.

- Memory usage - RAM usage statistics:

total - total amount of RAM in the device (in kB);
available - unused amount of RAM in the device (in kB);
shared - shared amount of RAM between multiple processes (in kB);
buffered - refers to an electronic buffer placed between the memory and the memory controller;
cached - a portion of memory made of high-speed static RAM (SRAM) instead of the slower dynamic RAM (DRAM) used for main memory;

- Network interfaces:

MTU - maximum transmission unit to be sent over network;
speed - rate of network transmission;
physical address - unique MAC address assigned to a device;
tx/rx: byte, packet, drop, error count;

- System properties:

uptime - time since the device was turned on;
process uptime - time since the process has been started;
hostname - a label that is assigned to a device connected to a computer network;
name - name of the device (if defined);
location - location of the device (if defined).

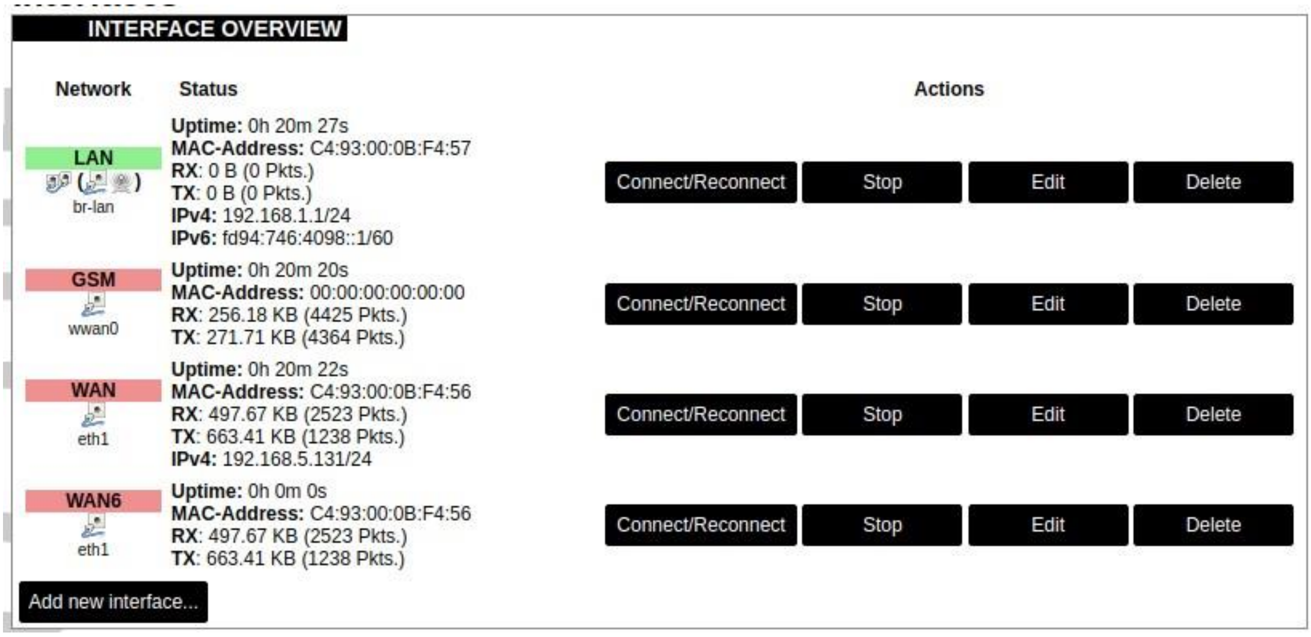
Network

INTERFACES WIRELESS DHCP AND DNS HOSTNAMES STATIC ROUTES DIAGNOSTICS FIREWALL GSM

The page shows information about current interface status, its configurations, provides various interface, network properties configuration capabilities and contains the following subsections:

- INTERFACES: shows information about current interface status, allows to create new and configure them.
- WIRELESS: shows information about wireless radio stations, covers physical settings of the wireless hardware.
- DHCP AND DNS: allows management of DHCP and DNS servers.
- HOSTNAMES: allows management of host names.
- STATIC ROUTES: allows management of IPv4 and IPv6 static routes.
- FIREWALL: allows management of firewall zones and various firewall properties.
- DIAGNOSTICS: provides network diagnostics utilities.
- GSM: allows management of gsm modem and SIM cards.

Interfaces



INTERFACE OVERVIEW

Network	Status
LAN br-lan	**Uptime:** 0h 20m 27s **MAC-Address:** C4:93:00:0B:F4:57 **RX**: 0 B (0 Pkts.) **TX**: 0 B (0 Pkts.) **IPv4:** 192.168.1.1/24 **IPv6:** fd94:746:4098::1/60
GSM wwan0	**Uptime:** 0h 20m 20s **MAC-Address:** 00:00:00:00:00:00 **RX**: 256.18 KB (4425 Pkts.) **TX**: 271.71 KB (4364 Pkts.)
WAN eth1	**Uptime:** 0h 20m 22s **MAC-Address:** C4:93:00:0B:F4:56 **RX**: 497.67 KB (2523 Pkts.) **TX**: 663.41 KB (1238 Pkts.) **IPv4:** 192.168.5.131/24
WAN6 eth1	**Uptime:** 0h 0m 0s **MAC-Address:** C4:93:00:0B:F4:56 **RX**: 497.67 KB (2523 Pkts.) **TX**: 663.41 KB (1238 Pkts.)

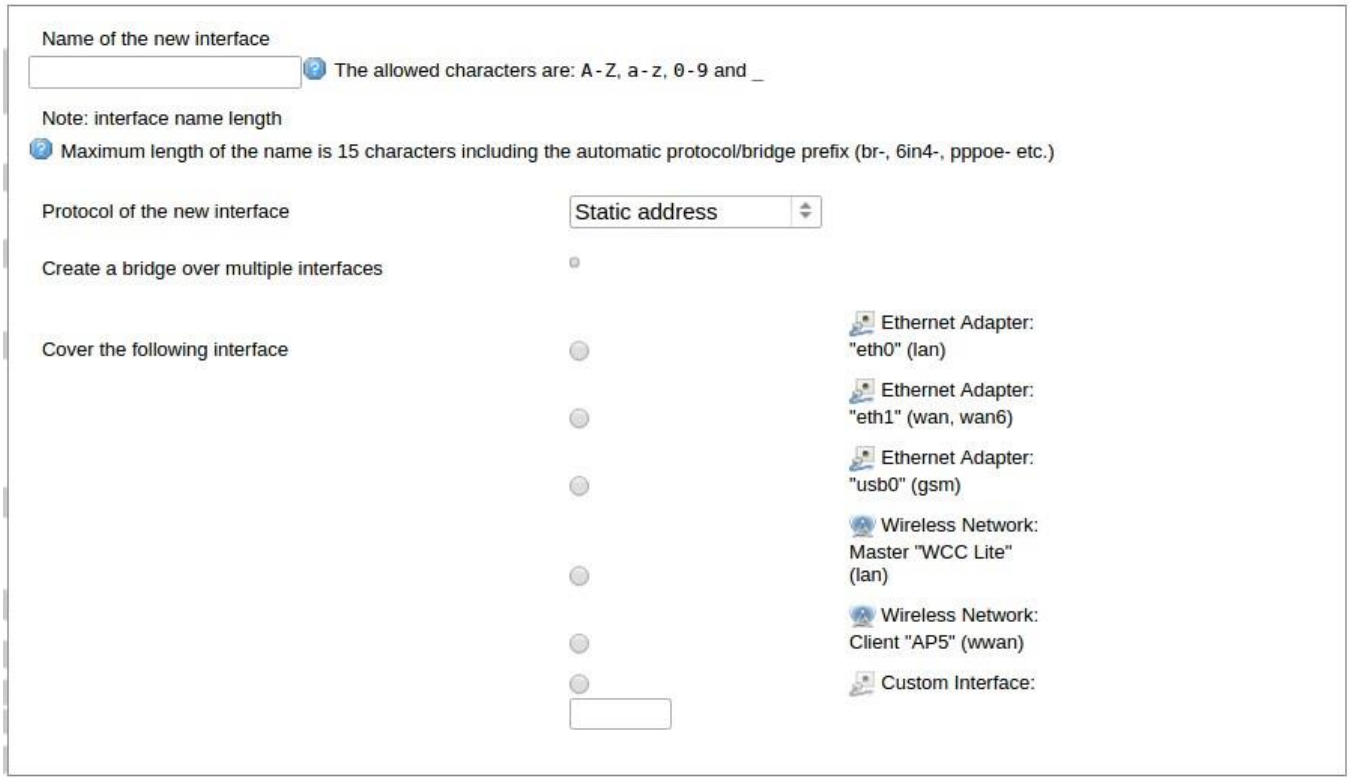
Current information and status of various network interfaces (GSM, LAN, WAN).
Uptime: Current interface uptime in hours, minutes and seconds.
MAC address: Physical interface address.
RX: Received data in bytes (packet count).
TX: Transmitted data in bytes (packet count).
IPv4: Internet protocol version 4 address.
IPv6: Internet protocol version 6 address.

In addition to the network interface status, several actions may be performed:
Connect/Reconnect: Connect to configured interface network if it does not do it automatically. If it already connected to the network it will be trying to reconnect to it.
Stop: Shutdown interface. If you are connected through this interface the connection may be lost.
Edit: Edit interface settings.
Delete: Delete interface.
Add new interface: Adding new Ethernet, GSM or wireless interface with the custom name, protocol and etc.

	etho	eth1
Type	Static	DHCP
Address	192.168.1.1	
Subnet mask	255.255.255.0	
Gateway		

Changes will only take effect after device reboots.

Network interfaces can be configured on the common page, which can be accessed through add new interface or edit button.



Name of the new interface

The allowed characters are: `A-Z`, `a-z`, `0-9` and _

Note: interface name length

Maximum length of the name is 15 characters including the automatic protocol/bridge prefix (br-, 6in4-, pppoe- etc.)

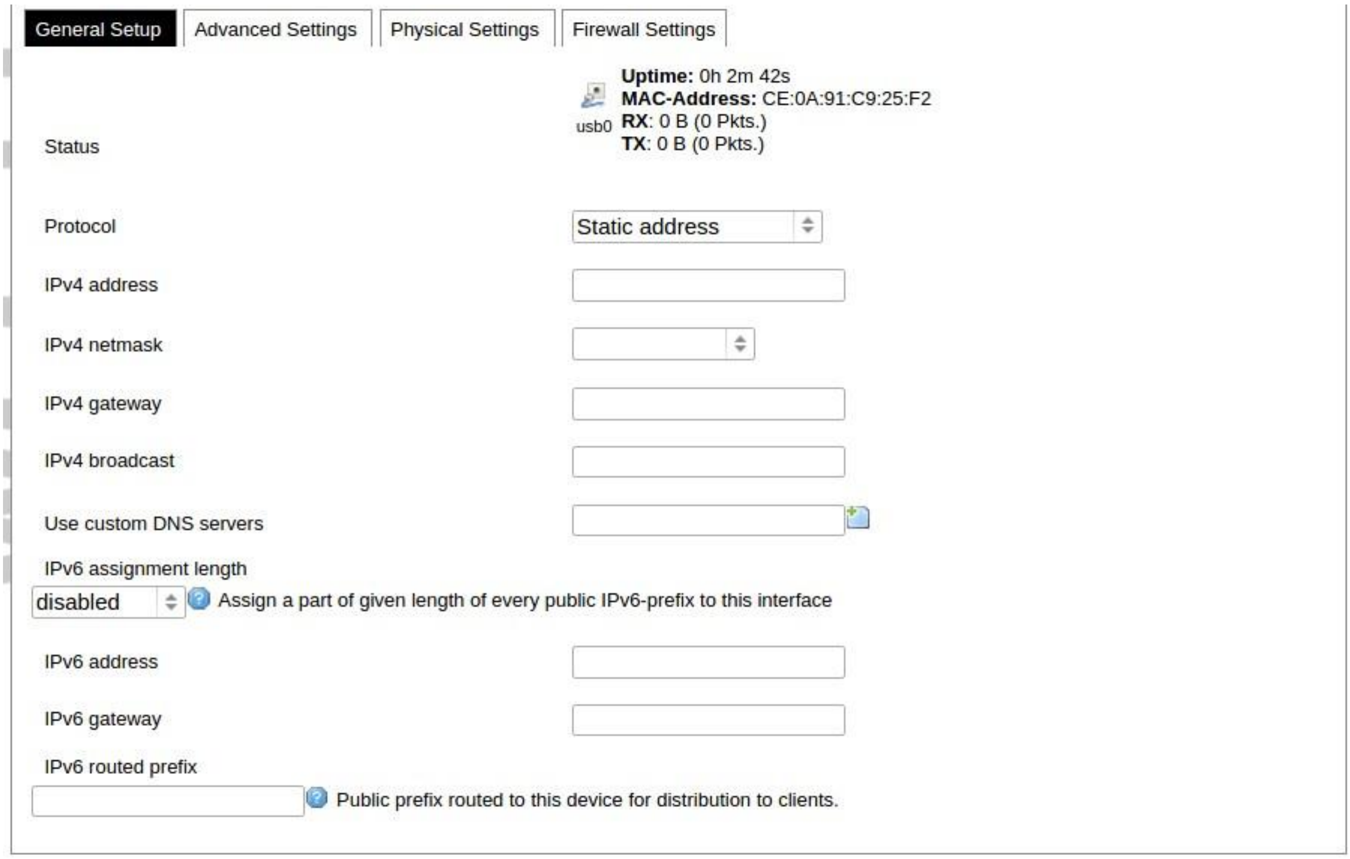
Protocol of the new interface: Static address

Create a bridge over multiple interfaces ☐

Cover the following interface

- ○ Ethernet Adapter: "eth0" (lan)
- ○ Ethernet Adapter: "eth1" (wan, wan6)
- ○ Ethernet Adapter: "usb0" (gsm)
- ○ Wireless Network: Master "WCC Lite" (lan)
- ○ Wireless Network: Client "AP5" (wwan)
- ○ Custom Interface:

The following options can be defined in the interface creation panel: name of the interface, protocol, coverage of a particular interface or bridging with other interfaces. After the general setup is done, more detailed settings can be set.



Status: usb0 **Uptime:** 0h 2m 42s **MAC-Address:** CE:0A:91:C9:25:F2 **RX**: 0 B (0 Pkts.) **TX**: 0 B (0 Pkts.)

Protocol: Static address

IPv4 address

IPv4 netmask

IPv4 gateway

IPv4 broadcast

Use custom DNS servers

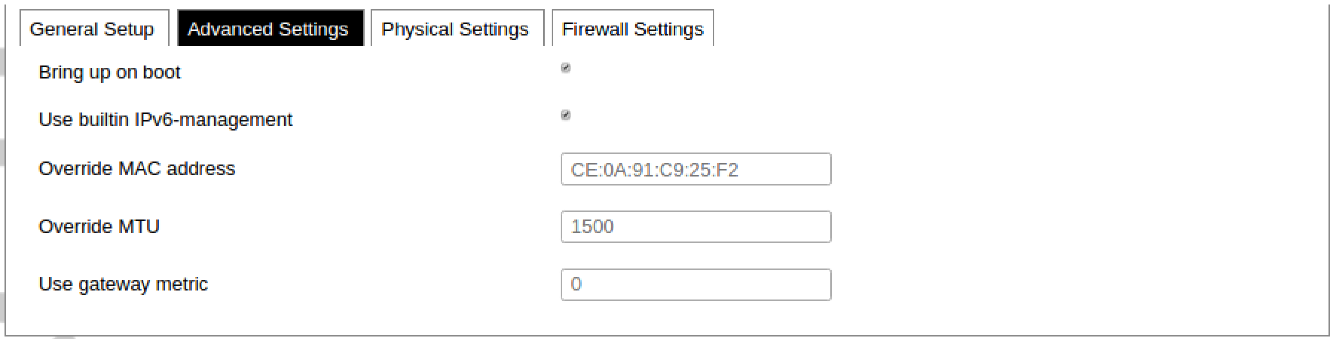
IPv6 assignment length: disabled — Assign a part of given length of every public IPv6-prefix to this interface

IPv6 address

IPv6 gateway

IPv6 routed prefix — Public prefix routed to this device for distribution to clients.

General common interface setup panel.



Bring up on boot ☑

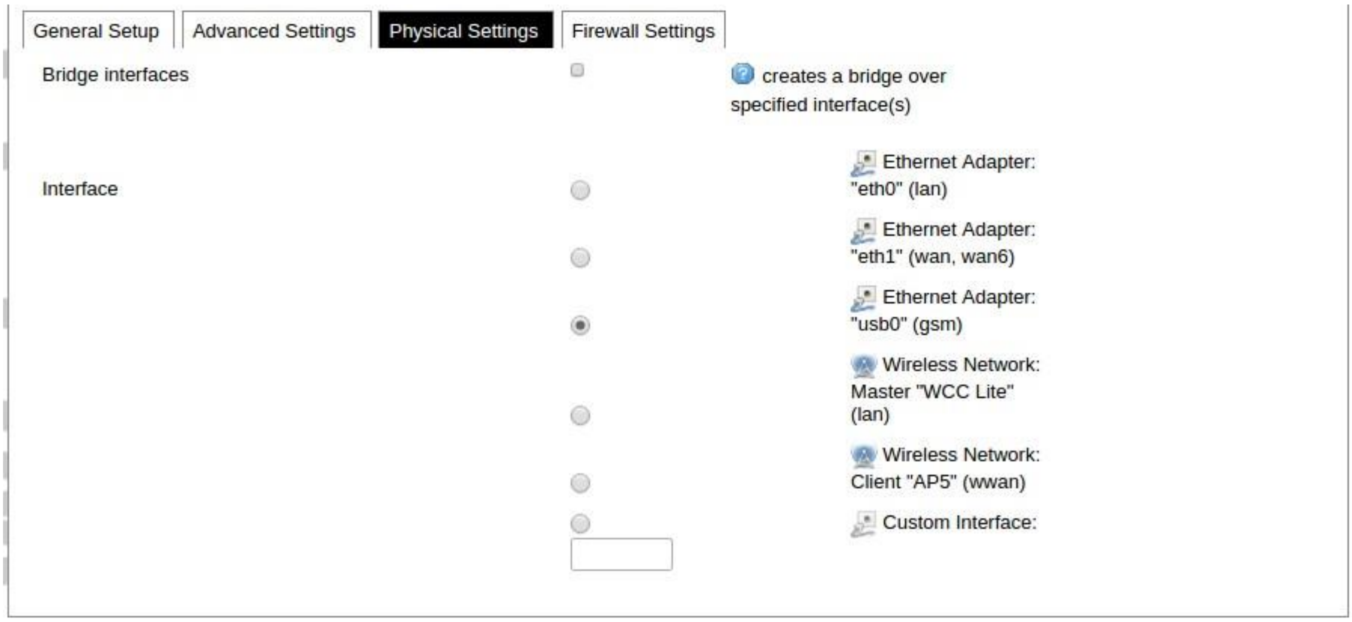
Use builtin IPv6-management ☑

Override MAC address: CE:0A:91:C9:25:F2

Override MTU: 1500

Use gateway metric: 0

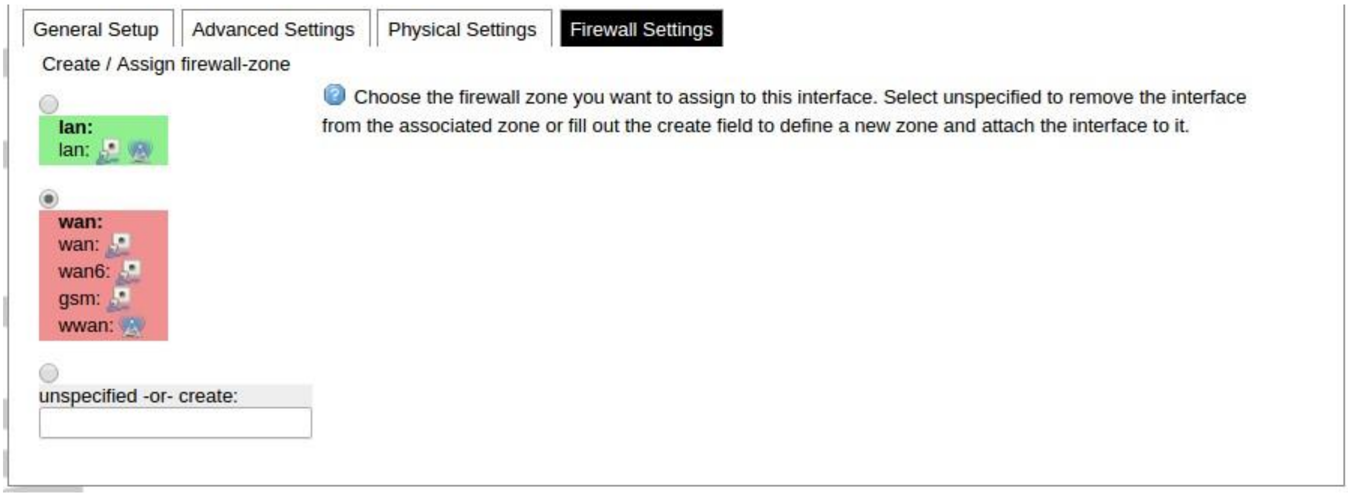
Advanced common interface setup panel.



Bridge interfaces ☐ creates a bridge over specified interface(s)

Interface
- ○ Ethernet Adapter: "eth0" (lan)
- ○ Ethernet Adapter: "eth1" (wan, wan6)
- ● Ethernet Adapter: "usb0" (gsm)
- ○ Wireless Network: Master "WCC Lite" (lan)
- ○ Wireless Network: Client "AP5" (wwan)
- ○ Custom Interface:

Physical common interface setup panel.



Create / Assign firewall-zone

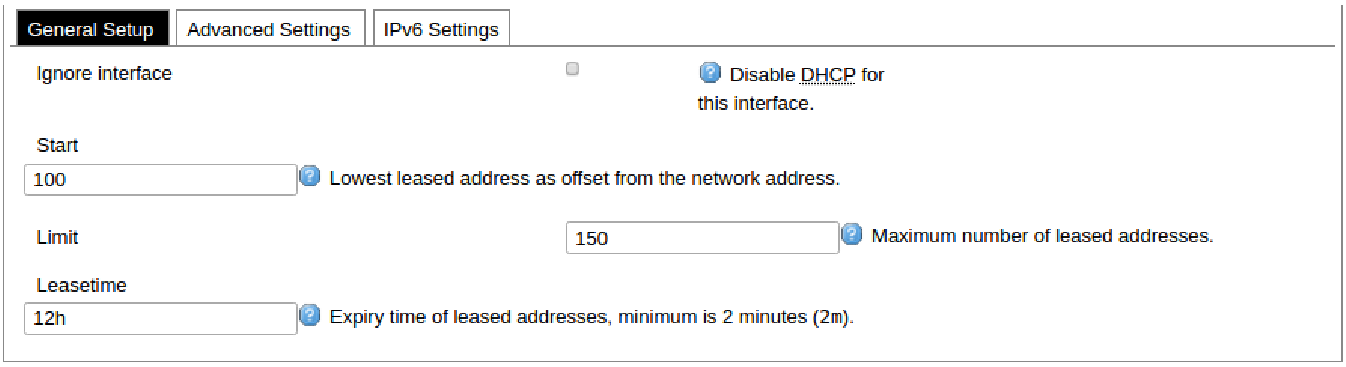
○ **lan:** lan:

● **wan:** wan: wan6: gsm: wwan:

○ unspecified -or- create:

Choose the firewall zone you want to assign to this interface. Select unspecified to remove the interface from the associated zone or fill out the create field to define a new zone and attach the interface to it.

Firewall common interface setup panel.



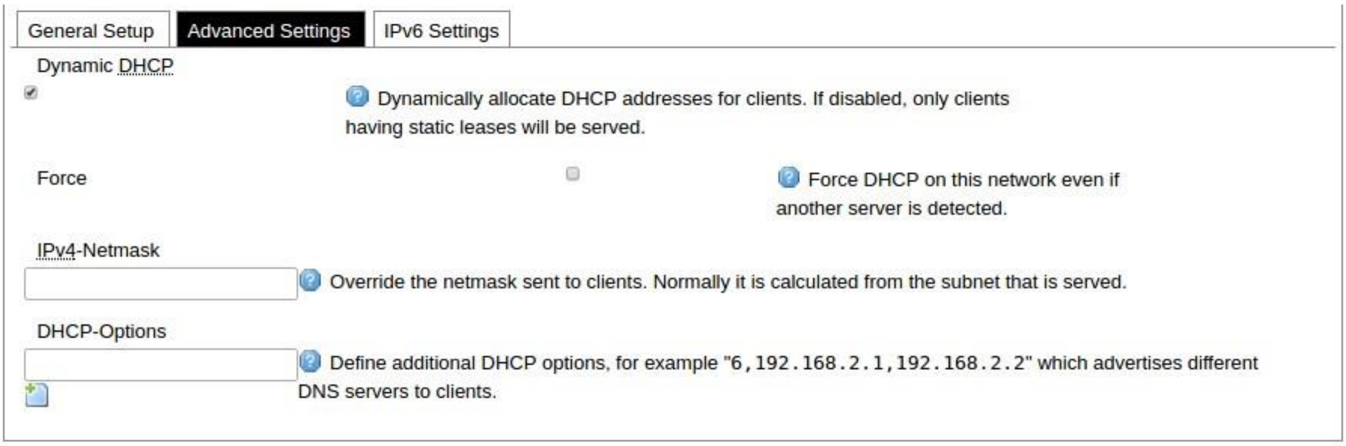
Ignore interface ☐ Disable DHCP for this interface.

Start: 100 — Lowest leased address as offset from the network address.

Limit: 150 — Maximum number of leased addresses.

Leasetime: 12h — Expiry time of leased addresses, minimum is 2 minutes (`2m`).

DHCP server general setup panel.



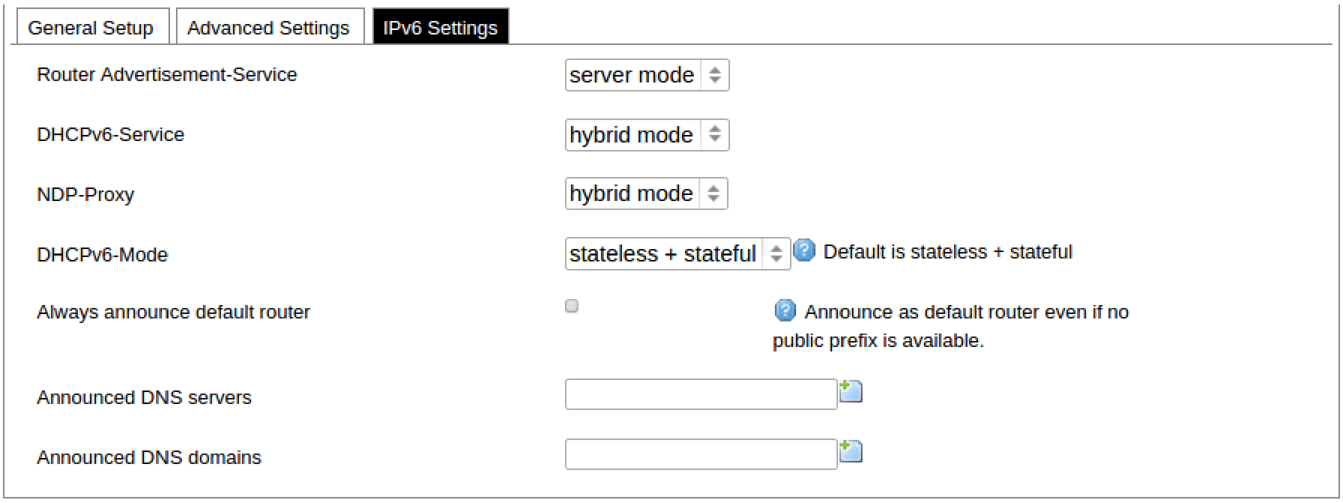
Dynamic DHCP ☑ Dynamically allocate DHCP addresses for clients. If disabled, only clients having static leases will be served.

Force ☐ Force DHCP on this network even if another server is detected.

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

DHCP-Options: Define additional DHCP options, for example "`6,192.168.2.1,192.168.2.2`" which advertises different DNS servers to clients.

DHCP server advanced setup panel.



Router Advertisement-Service: server mode

DHCPv6-Service: hybrid mode

NDP-Proxy: hybrid mode

DHCPv6-Mode: stateless + stateful — Default is stateless + stateful

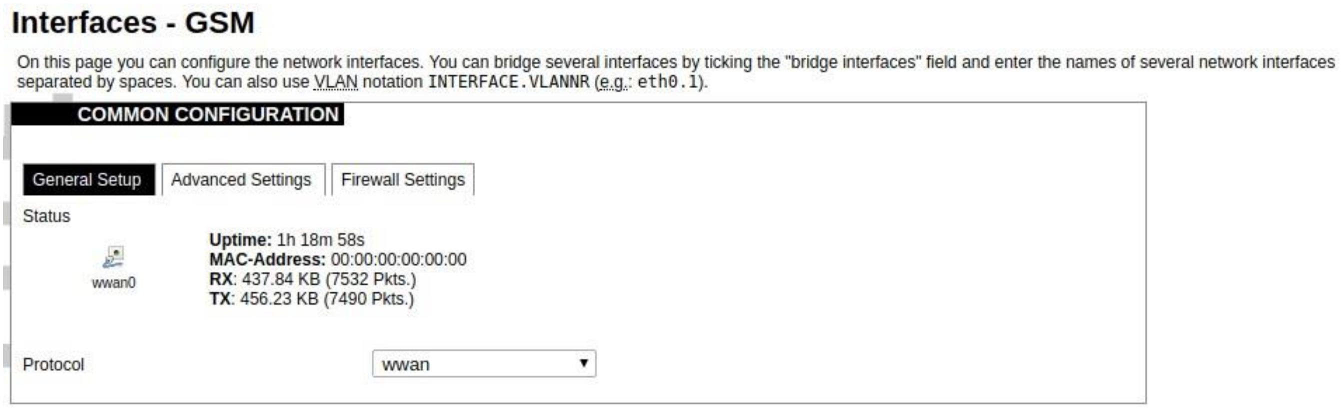
Always announce default router ☐ Announce as default router even if no public prefix is available.

Announced DNS servers

Announced DNS domains

DHCP server IPv6 settings setup panel.

GSM


Interfaces - GSM

On this page you can configure the network interfaces. You can bridge several interfaces by ticking the "bridge interfaces" field and enter the names of several network interfaces separated by spaces. You can also use VLAN notation `INTERFACE.VLANNR` (e.g.: `eth0.1`).

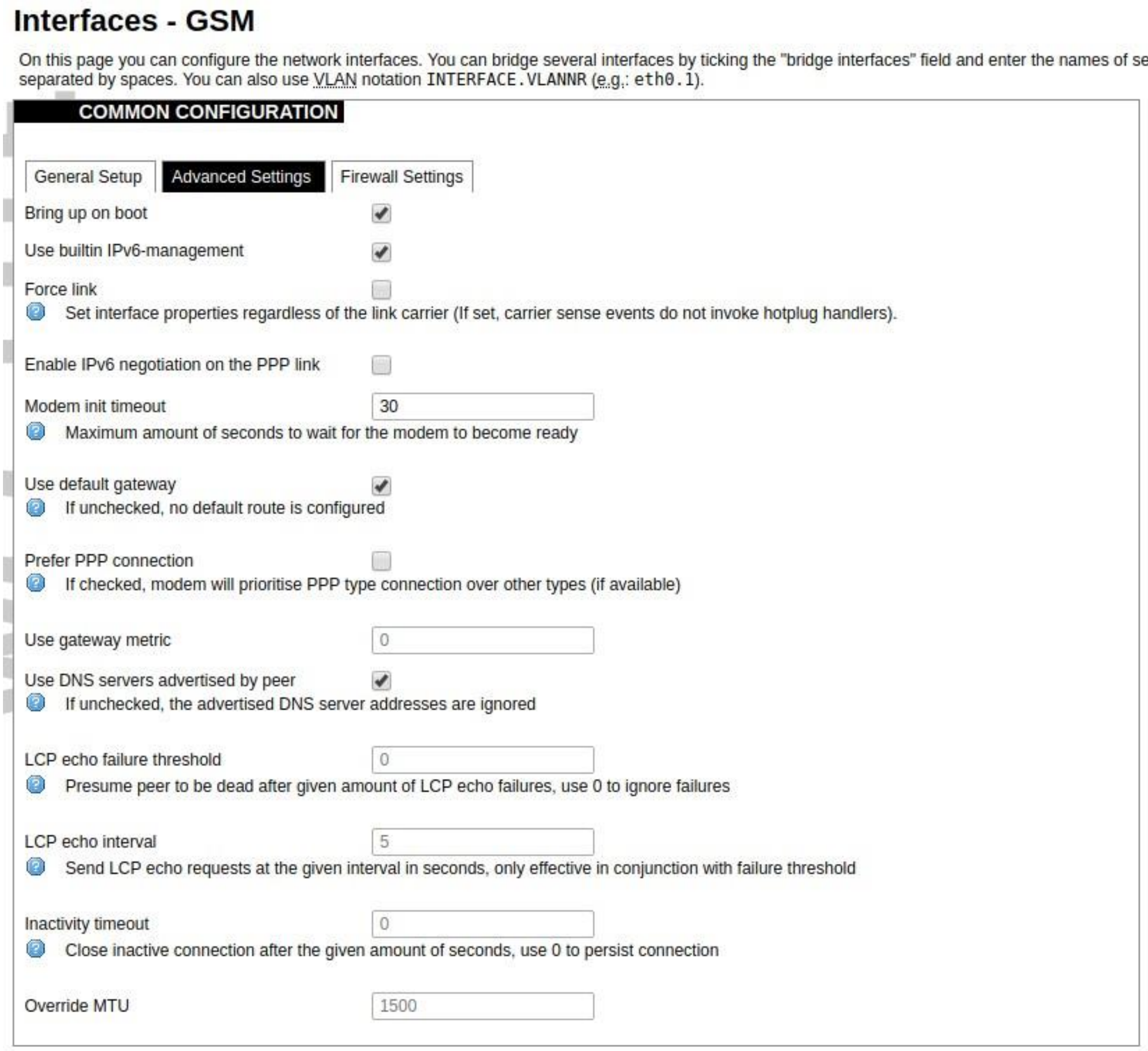
Status: wwan0

Uptime: 1h 18m 58s
MAC-Address: 00:00:00:00:00:00
RX: 437.84 KB (7532 Pkts.)
TX: 456.23 KB (7490 Pkts.)

Protocol: wwan

General Settings Information tab. Gives you name of physical GSM interface, lets you choose protocol (not recomended!).

Note: Make sure you won't change GSM interafce's protocol, which is set by default to WWAN. Changing this parameter will lead to undefined GSM modem behaviour.



Interfaces - GSM

On this page you can configure the network interfaces. You can bridge several interfaces by ticking the "bridge interfaces" field and enter the names of several network interfaces separated by spaces. You can also use VLAN notation `INTERFACE.VLANNR` (e.g.: `eth0.1`).

COMMON CONFIGURATION

Bring up on boot ☑

Use builtin IPv6-management ☑

Force link ☐
Set interface properties regardless of the link carrier (If set, carrier sense events do not invoke hotplug handlers).

Enable IPv6 negotiation on the PPP link ☐

Modem init timeout: 30
Maximum amount of seconds to wait for the modem to become ready

Use default gateway ☑
If unchecked, no default route is configured

Prefer PPP connection ☐
If checked, modem will prioritise PPP type connection over other types (if available)

Use gateway metric: 0

Use DNS servers advertised by peer ☑
If unchecked, the advertised DNS server addresses are ignored

LCP echo failure threshold: 0
Presume peer to be dead after given amount of LCP echo failures, use 0 to ignore failures

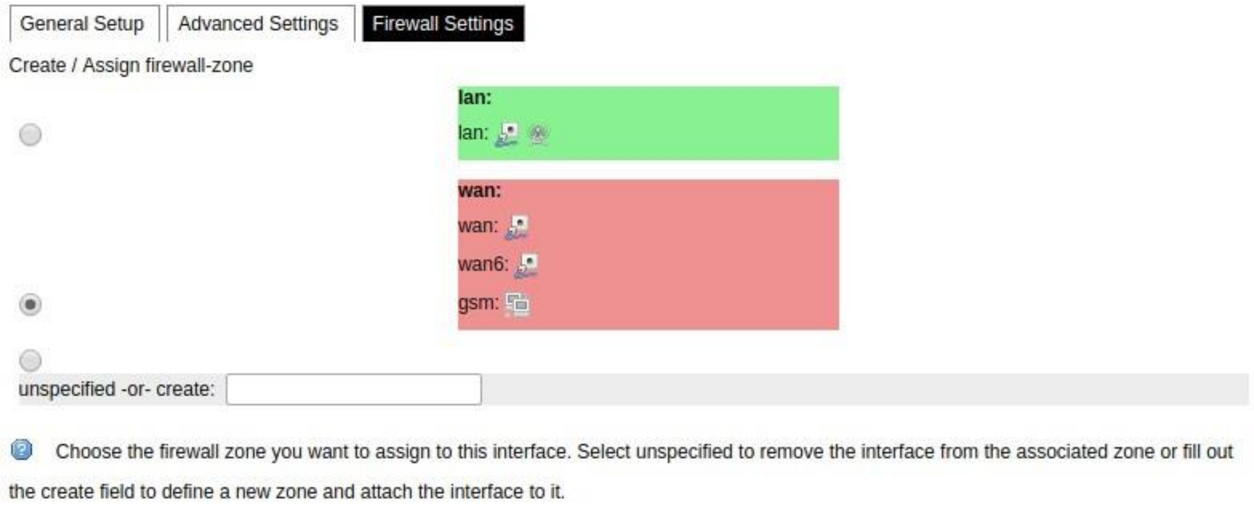
LCP echo interval: 5
Send LCP echo requests at the given interval in seconds, only effective in conjunction with failure threshold

Inactivity timeout: 0
Close inactive connection after the given amount of seconds, use 0 to persist connection

Override MTU: 1500

Advanced Settings tab enables user to configure advanced settings for mobile communication. It includes the following options:
Bring up on boot: Checkbox to start a GSM interface on startup;
Use builtin IPv6-management: Checkbox to select if the device is going to use its own tools to manage IPv6 transport layer messages;
Force link: Specifies whether IP address, route, and gateway are assigned to the interface regardless of the link being active or only after the link has become active; when active, carrier sense events do not invoke hotplug handlers;
IPv6 support: User can select if IPv6 support is handled automatically, manually or disabled altogether;
Modem init timeout: Maximum amount of seconds before the device gives up on finishing initialization;
Use default gateway: Uses the default gateway obtained through DHCP. If left unchecked, no default route is configured;
Prefer PPP connection: If ,the modem, supports PPP and any other communication protocol (e.g. QMI, RNDIS and etc.), prioritise PPP type connection;
Use gateway metric: The WAN configuration by default generates a routing table entry. In this field you can alter the metric of that entry. Higher metric means higher priority;
Use DNS servers advertised by peer: Uses DNS servers obtained from DHCP. If left unchecked, the advertised DNS server addresses are ignored;
LCP echo failure threshold: LCP (link control protocol) is a part of PPP (Point-to-Point Protocol) and helps to determine the quality of data transmission. If enough failures happen, LCP presumes link to be dead. 0 disables failure count checking;
LCP echo interval: Determines the period of LCP echo requests. Only effective if LCP echo failure threshold is more than zero;
Inactivity timeout: Station inactivity limit in seconds: if a station does not send anything, the connection will be dropped. A value of 0 can be used to persist connection.
Override MTU: Set custom MTU to gsm interface.

Note: If modem uses QMI connection protocol and user haven't defined custom MTU setting, the MTU on interface will be set to operator's defined MTU value.



Create / Assign firewall-zone

○ **lan:** lan:

● **wan:** wan: wan6: gsm:

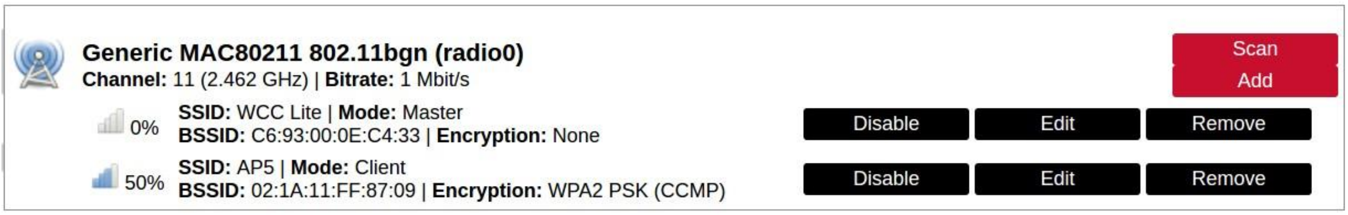
○ unspecified -or- create:

Choose the firewall zone you want to assign to this interface. Select unspecified to remove the interface from the associated zone or fill out the create field to define a new zone and attach the interface to it.

GSM configuration ends with firewall settings. A user can assign an already defined firewall zone or create a new one.

Wireless

The wireless network interface parameters and configuration are described in this section.

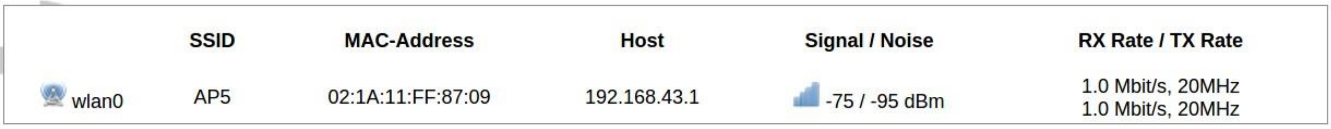


Generic MAC80211 802.11bgn (radio0)
Channel: 11 (2.462 GHz) | **Bitrate:** 1 Mbit/s

0% **SSID:** WCC Lite | **Mode:** Master
BSSID: C6:93:00:0E:C4:33 | **Encryption:** None

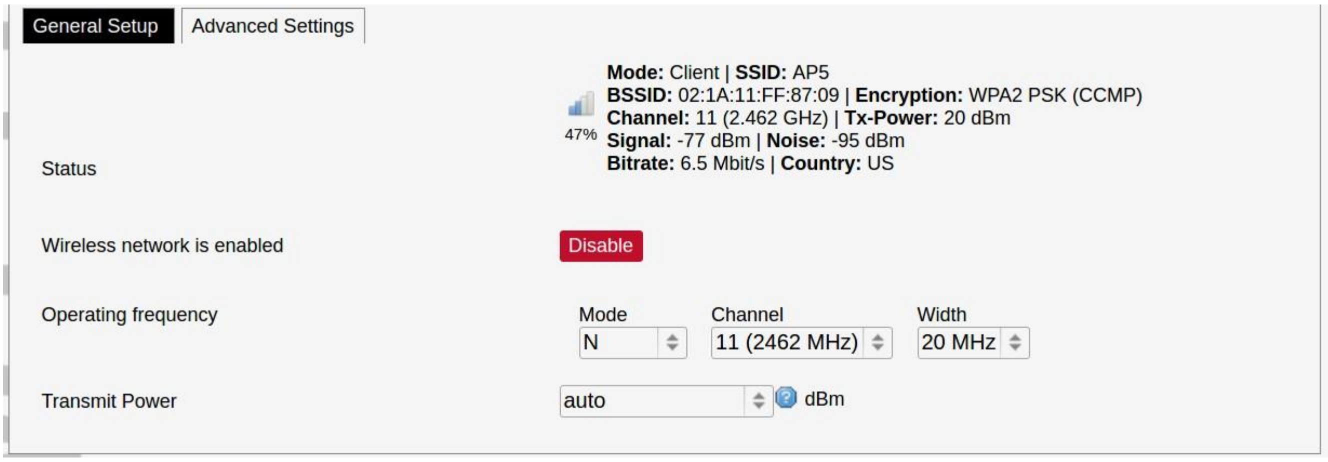
50% **SSID:** AP5 | **Mode:** Client
BSSID: 02:1A:11:FF:87:09 | **Encryption:** WPA2 PSK (CCMP)

Configured interfaces for the physical radio device.
Channel: Specifies the wireless channel to use.
Bitrate: Specifies transfer rate in Mbit/s.
SSID: The broadcasted service set identifier of the wireless network.
Mode: Selects the operation mode of the wireless network interface controller.
BSSID: The basic service set identification of the network, only applicable in adhoc or STA mode.
Encryption: Wireless encryption method.



	SSID	MAC-Address	Host	Signal / Noise	RX Rate / TX Rate
wlan0	AP5	02:1A:11:FF:87:09	192.168.43.1	-75 / -95 dBm	1.0 Mbit/s, 20MHz 1.0 Mbit/s, 20MHz

List of associated wireless stations.
The Device Configuration section covers physical settings of the radio hardware such as channel, transmit power or antenna selection which are shared among all defined wireless networks (if the radio hardware is multi-SSID capable). Per network settings like encryption or operation mode are grouped in the Interface Configuration.



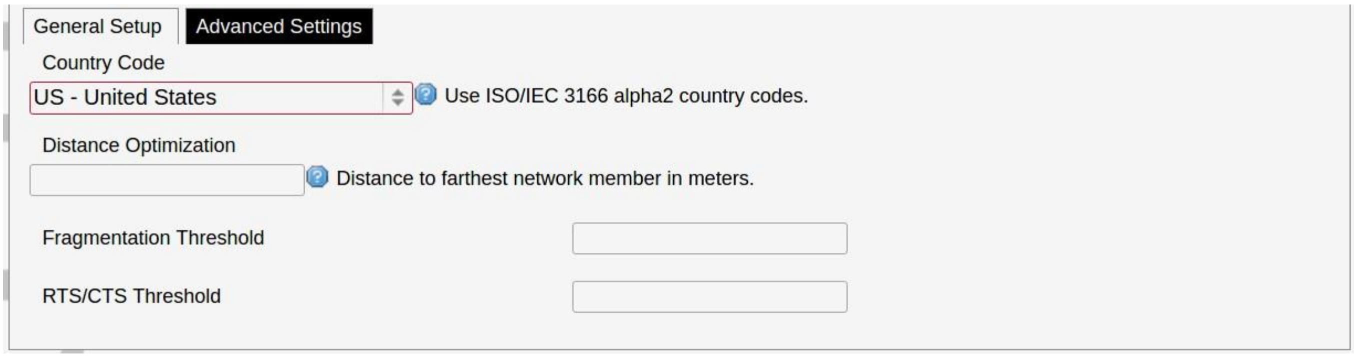
Status: 47% **Mode:** Client | **SSID:** AP5
BSSID: 02:1A:11:FF:87:09 | **Encryption:** WPA2 PSK (CCMP)
Channel: 11 (2.462 GHz) | **Tx-Power:** 20 dBm
Signal: -77 dBm | **Noise:** -95 dBm
Bitrate: 6.5 Mbit/s | **Country:** US

Wireless network is enabled

Operating frequency: Mode N, Channel 11 (2462 MHz), Width 20 MHz

Transmit Power: auto dBm

General device settings.



Country Code

US - United States

Use ISO/IEC 3166 alpha2 country codes.

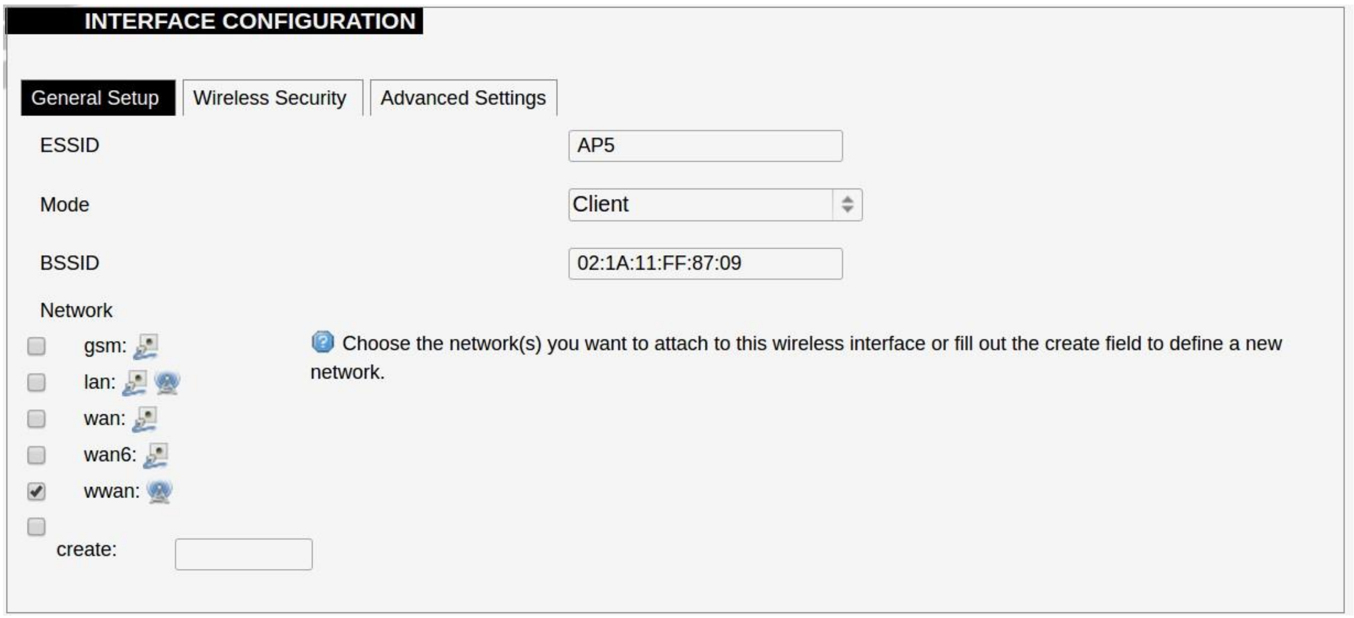
Distance Optimization

Distance to farthest network member in meters.

Fragmentation Threshold

RTS/CTS Threshold

Advanced device settings.



ESSID: AP5

Mode: Client

BSSID: 02:1A:11:FF:87:09

Network

☐ gsm:

☐ lan:

☐ wan:

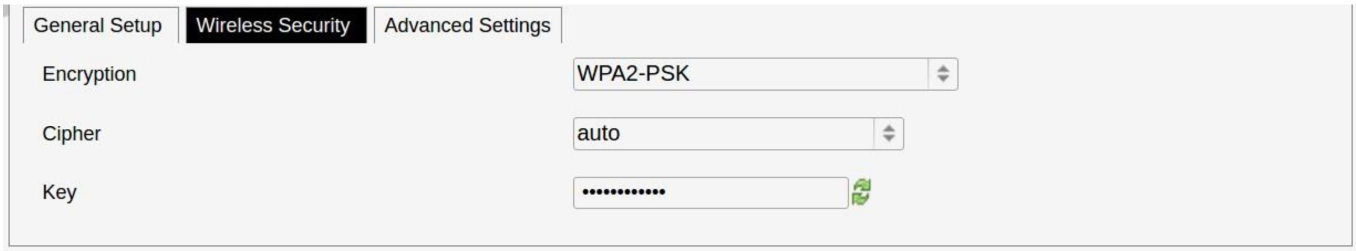
☐ wan6:

☑ wwan:

☐ create:

Choose the network(s) you want to attach to this wireless interface or fill out the create field to define a new network.

General interface settings.

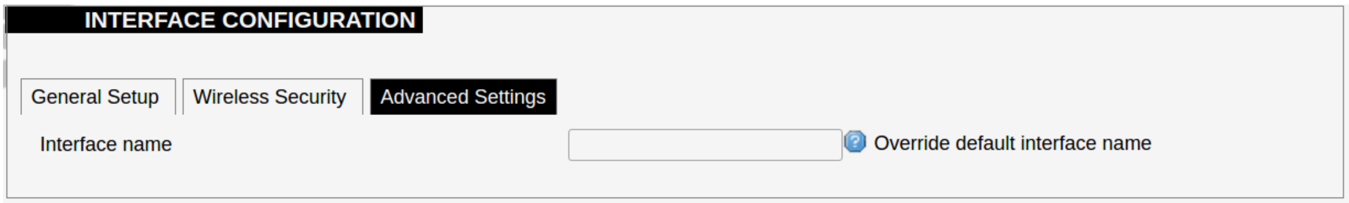


Encryption: WPA2-PSK

Cipher: auto

Key: ••••••••••••

Wireless security interface settings.



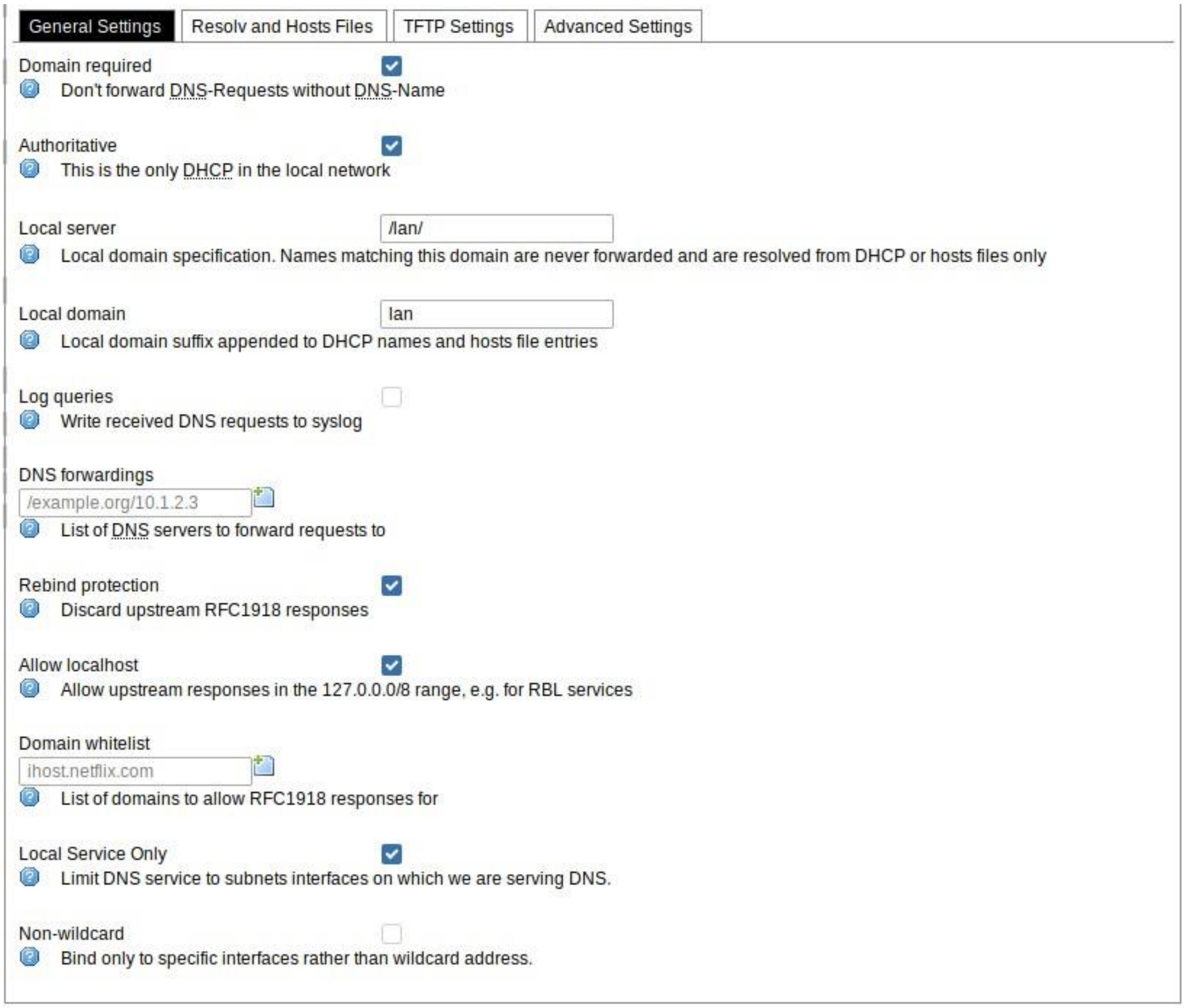
Interface name

Override default interface name

Advanced interface settings.

DHCP and DNS

DHCP server and DNS forward for NAT firewalls is described in this section.



Domain required ☑
Don't forward DNS-Requests without DNS-Name

Authoritative ☑
This is the only DHCP in the local network

Local server /lan/
Local domain specification. Names matching this domain are never forwarded and are resolved from DHCP or hosts files only

Local domain lan
Local domain suffix appended to DHCP names and hosts file entries

Log queries ☐
Write received DNS requests to syslog

DNS forwardings
/example.org/10.1.2.3
List of DNS servers to forward requests to

Rebind protection ☑
Discard upstream RFC1918 responses

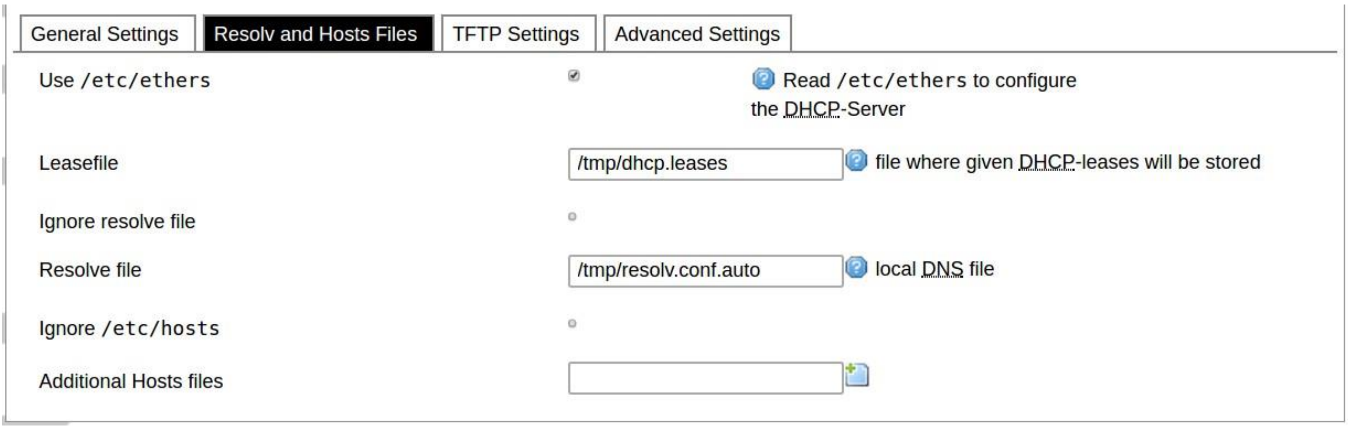
Allow localhost ☑
Allow upstream responses in the 127.0.0.0/8 range, e.g. for RBL services

Domain whitelist
ihost.netflix.com
List of domains to allow RFC1918 responses for

Local Service Only ☑
Limit DNS service to subnets interfaces on which we are serving DNS.

Non-wildcard ☐
Bind only to specific interfaces rather than wildcard address.

General DHCP settings.



Use `/etc/ethers` ☑ Read `/etc/ethers` to configure the DHCP-Server

Leasefile /tmp/dhcp.leases file where given DHCP-leases will be stored

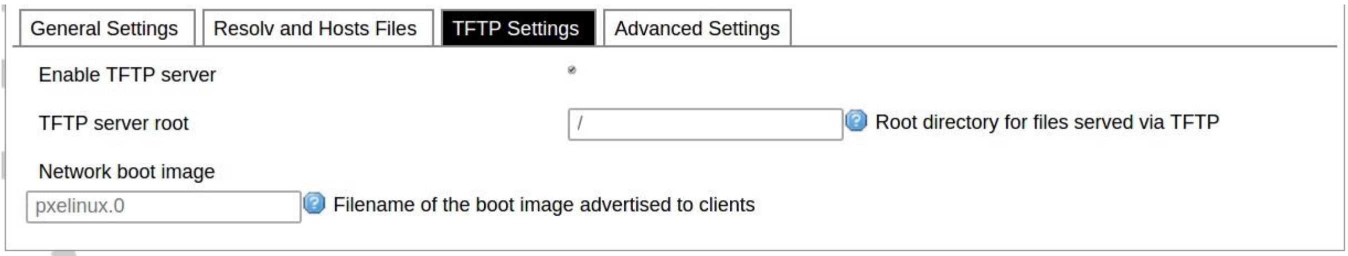
Ignore resolve file ☐

Resolve file /tmp/resolv.conf.auto local DNS file

Ignore `/etc/hosts` ☐

Additional Hosts files

Resolve and hosts files settings.

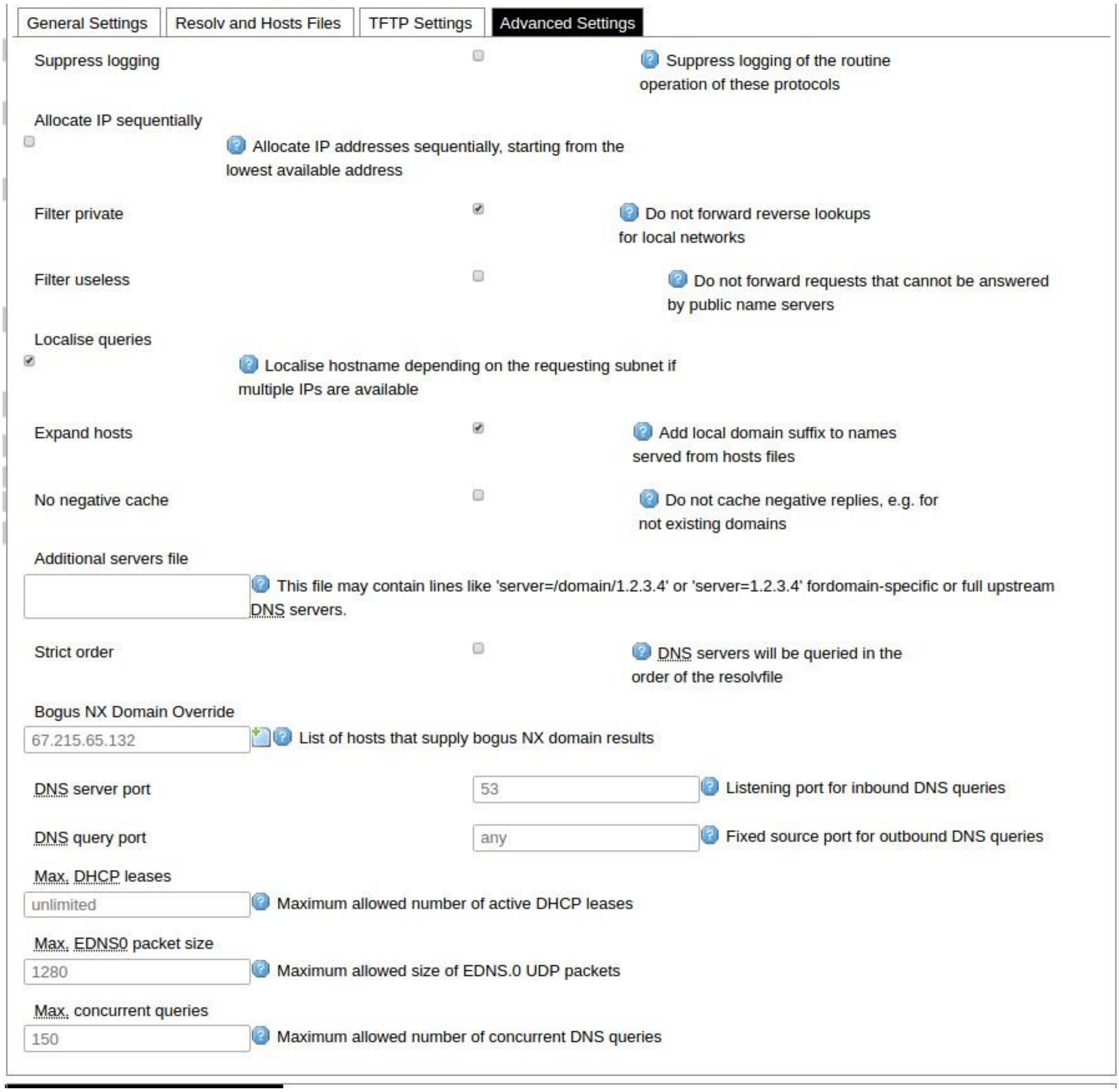


Enable TFTP server ☑

TFTP server root / Root directory for files served via TFTP

Network boot image
pxelinux.0 Filename of the boot image advertised to clients

TFTP server settings.



Suppress logging ☐ Suppress logging of the routine operation of these protocols

Allocate IP sequentially ☐ Allocate IP addresses sequentially, starting from the lowest available address

Filter private ☑ Do not forward reverse lookups for local networks

Filter useless ☐ Do not forward requests that cannot be answered by public name servers

Localise queries ☑ Localise hostname depending on the requesting subnet if multiple IPs are available

Expand hosts ☑ Add local domain suffix to names served from hosts files

No negative cache ☐ Do not cache negative replies, e.g. for not existing domains

Additional servers file: This file may contain lines like 'server=/domain/1.2.3.4' or 'server=1.2.3.4' fordomain-specific or full upstream DNS servers.

Strict order ☐ DNS servers will be queried in the order of the resolvfile

Bogus NX Domain Override: 67.215.65.132 List of hosts that supply bogus NX domain results

DNS server port: 53 Listening port for inbound DNS queries

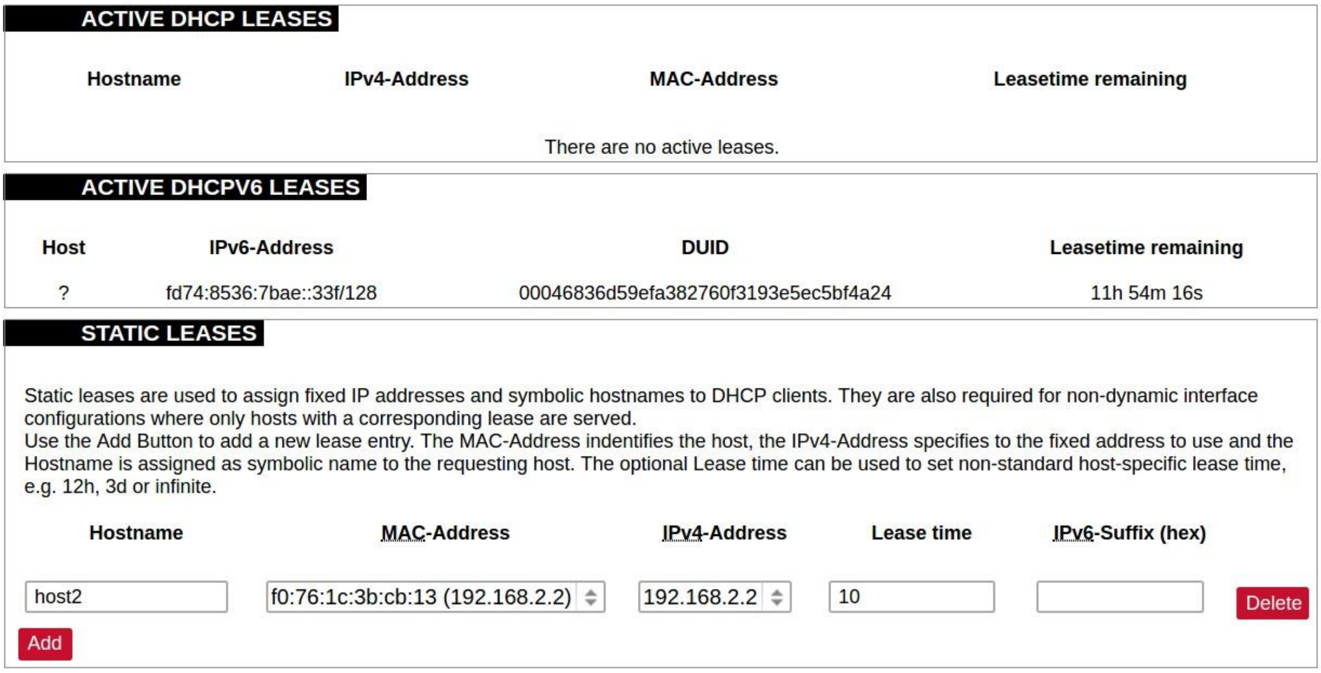
DNS query port: any Fixed source port for outbound DNS queries

Max. DHCP leases: unlimited Maximum allowed number of active DHCP leases

Max. EDNS0 packet size: 1280 Maximum allowed size of EDNS.0 UDP packets

Max. concurrent queries: 150 Maximum allowed number of concurrent DNS queries

Advanced settings.



ACTIVE DHCP LEASES

Hostname	IPv4-Address	MAC-Address	Leasetime remaining

There are no active leases.

ACTIVE DHCPV6 LEASES

Host	IPv6-Address	DUID	Leasetime remaining
?	fd74:8536:7bae::33f/128	00046836d59efa382760f3193e5ec5bf4a24	11h 54m 16s

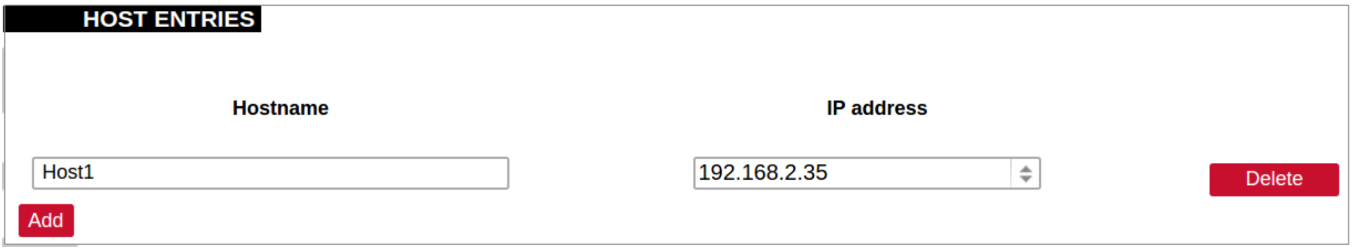
STATIC LEASES

Static leases are used to assign fixed IP addresses and symbolic hostnames to DHCP clients. They are also required for non-dynamic interface configurations where only hosts with a corresponding lease are served.
Use the Add Button to add a new lease entry. The MAC-Address indentifies the host, the IPv4-Address specifies to the fixed address to use and the Hostname is assigned as symbolic name to the requesting host. The optional Lease time can be used to set non-standard host-specific lease time, e.g. 12h, 3d or infinite.

Hostname	MAC-Address	IPv4-Address	Lease time	IPv6-Suffix (hex)	
host2	f0:76:1c:3b:cb:13 (192.168.2.2)	192.168.2.2	10		Delete

List of active DHCP and static leases. It is also possible to assign fixed IP addresses to hosts on the network, based on their MAC (hardware) address.

Hostnames

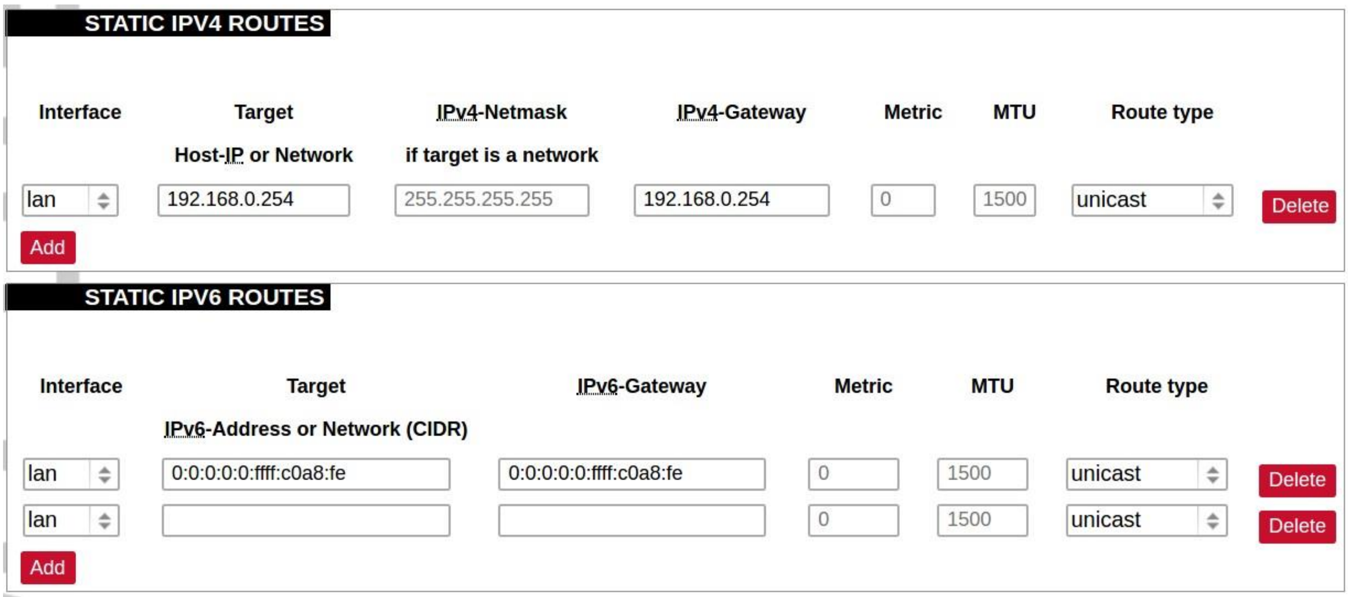


Hostname	IP address
Host1	192.168.2.35

List of existing host names. Addition or deletion is allowed for the user.

Static routes

Routes specify over which interface and gateway a certain host or network can be reached.



Interface	Target Host-IP or Network	IPv4-Netmask if target is a network	IPv4-Gateway	Metric	MTU	Route type
lan	192.168.0.254	255.255.255.255	192.168.0.254	0	1500	unicast

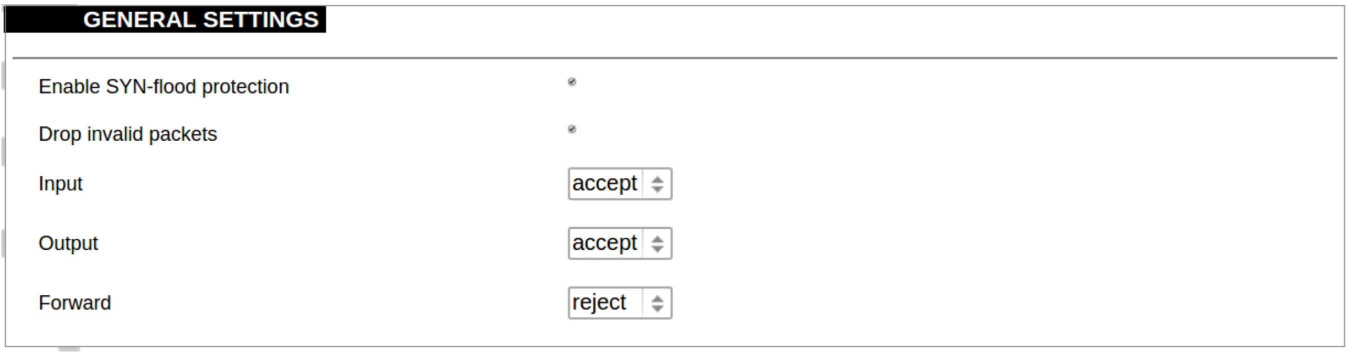
Interface	Target IPv6-Address or Network (CIDR)	IPv6-Gateway	Metric	MTU	Route type
lan	0:0:0:0:0:ffff:c0a8:fe	0:0:0:0:0:ffff:c0a8:fe	0	1500	unicast
lan			0	1500	unicast

Current IPv4 and IPv6 static routes configuration.
Interface: Lets to chose for which interface static route is created.
Target: Defines target host IP or network.
IPv4 Netmask: Defines netmask if the target is a network.
IPv4/IPv6 Gateway: Defines IPv4 or IPv6 gateway.
Metric: Specifies the route metric to use for the route.
MTU: Maximum Transmit/Receive Unit, in bytes.
Route type: All incoming packets can be: accepted, rejected, dropped.

Firewall

This subsection is divided into four categories: general settings, port forwards, traffic rules and custom rules.

General settings



GENERAL SETTINGS

Enable SYN-flood protection ●

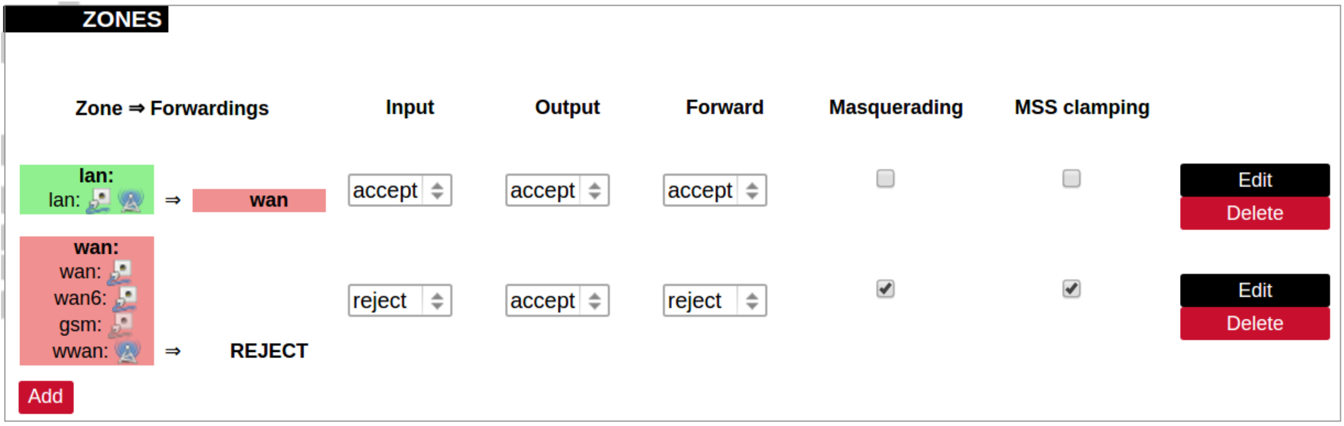
Drop invalid packets ●

Input: accept

Output: accept

Forward: reject

General Settings for firewall can be changed in General Settings screen. These settings are defined as follows:
Input: All incoming packets can be: accepted, rejected, dropped.
Output: All outgoing packets can be: accepted, rejected, dropped.
Forward: All packets being sent to another device can be: accepted, rejected, dropped.

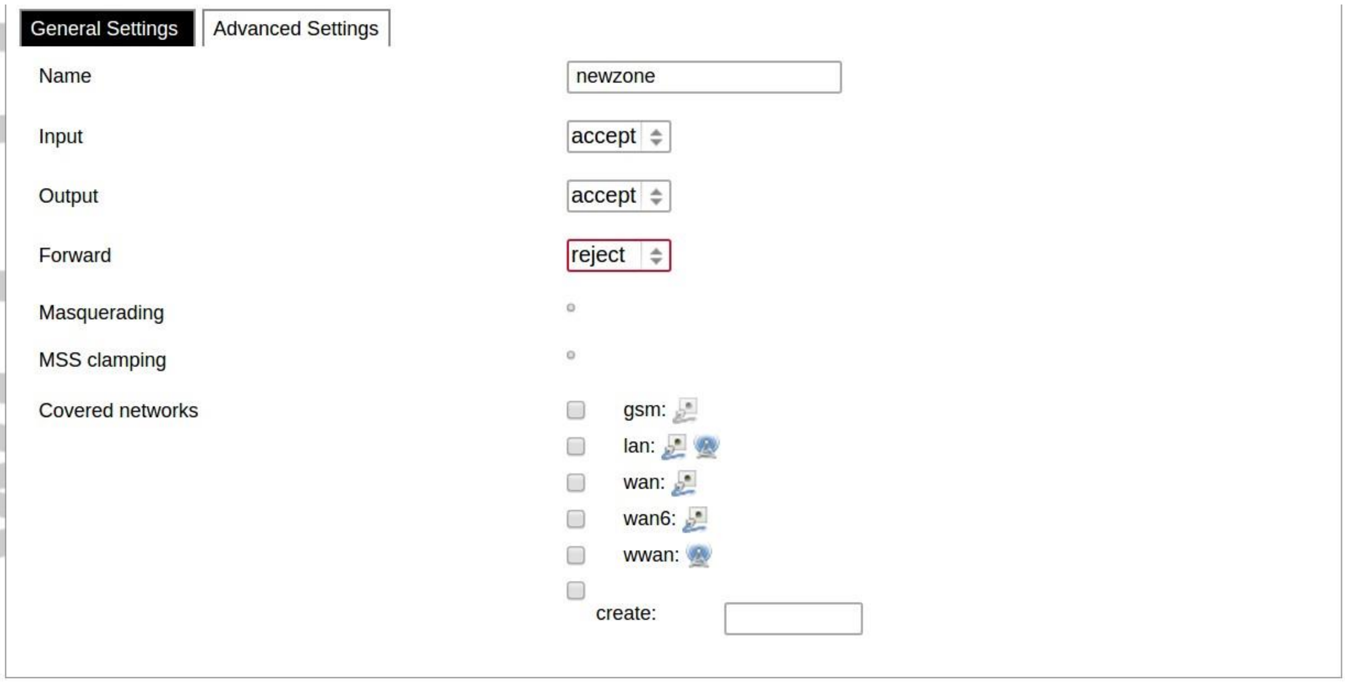


ZONES

Zone ⇒ Forwardings		Input	Output	Forward	Masquerading	MSS clamping	
lan: lan:	⇒ wan	accept	accept	accept	☐	☐	Edit Delete
wan: wan: wan6: gsm: wwan:	⇒ REJECT	reject	accept	reject	☑	☑	Edit Delete

Additional zones for firewall can be created, edited or deleted.
Zone => Forwardings: Defines zones and their traffic flow.
Input: All incoming packets can be: accepted, rejected, dropped.
Output: All outgoing packets can be: accepted, rejected, dropped.
Forward: All packets being sent to another device can be: accepted, rejected, dropped.
Masquerading: Allows one or more devices in a zones network without assigned IP addresses to communicate with the Internet.
MSS clamping: Change the maximum segment size (MSS) of all TCP connections passing through this zone with MTU lower than the Ethernet default of 1500.

Additional actions can be performed with zones: add, edit, delete.



Name: newzone

Input: accept

Output: accept

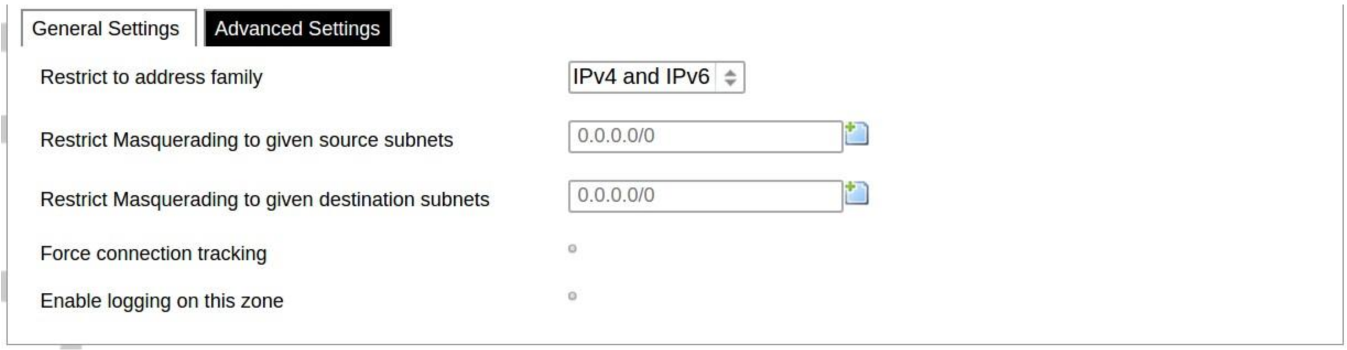
Forward: reject

Masquerading ○

MSS clamping ○

Covered networks:
☐ gsm:
☐ lan:
☐ wan:
☐ wan6:
☐ wwan:
☐ create:

Common properties of newly created or edited zones chan be edited in this panel. The input and output options set the default policies for traffic entering and leaving this zone while the forward option describes the policy for forwarded traffic between different networks within the zone. Covered networks specify which available networks are members of this zone.



Restrict to address family: IPv4 and IPv6

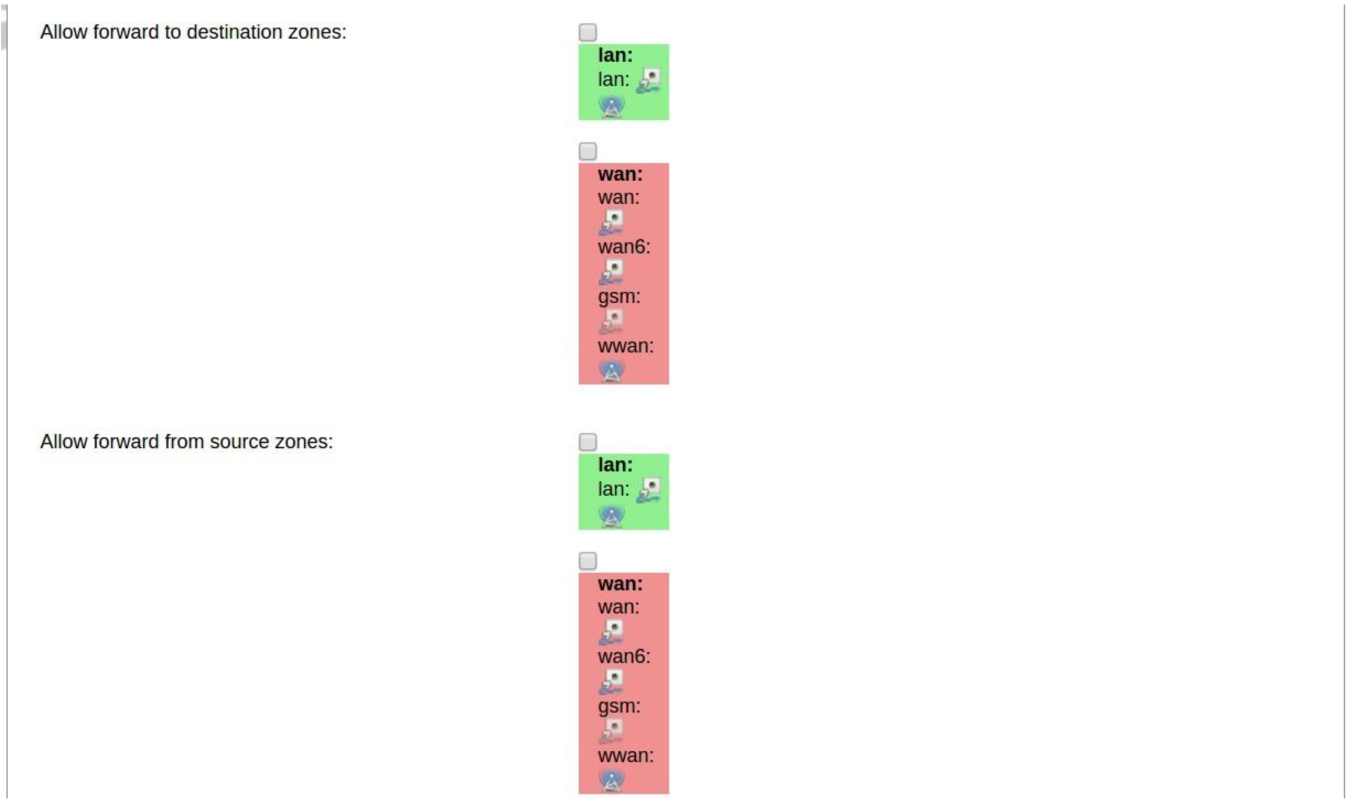
Restrict Masquerading to given source subnets: 0.0.0.0/0

Restrict Masquerading to given destination subnets: 0.0.0.0/0

Force connection tracking: ○

Enable logging on this zone: ○

Advanced settings of new created or edited zone. Restrict to address family option defines to what IP families the zone belongs to IPv4, IPv6 or both. Restrict masquerading to given source/destination subnets defines one or more subnets for which the masquerading option is applied to. Connection tracking and logging options enable additional information gathering on the zone.


Allow forward to destination zones:

☐ **lan:** lan:

☐ **wan:** wan: wan6: gsm: wwan:

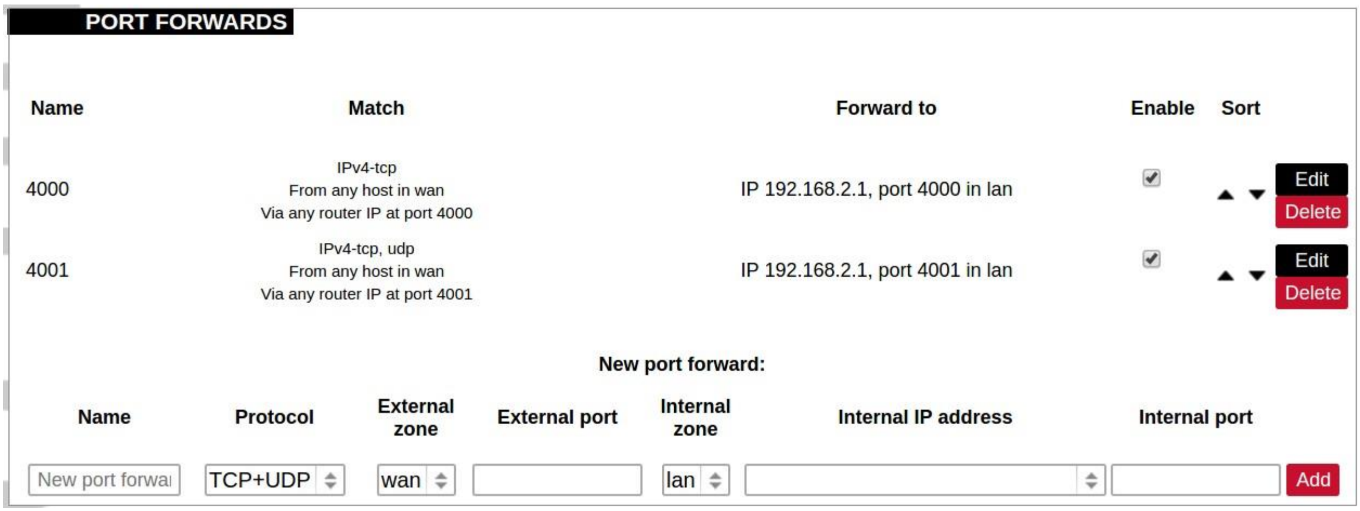
Allow forward from source zones:

☐ **lan:** lan:

☐ **wan:** wan: wan6: gsm: wwan:

Controls of the forwarding policies between new/edited zone and other zones. Destination zones cover forwarded traffic originating from the new/edited zone. Source zones match forwarded traffic from other zones targeted at the new/edited zone. The forwarding rule is unidirectional, e.g. a forward from LAN to WAN does not imply a permission to forward from WAN to LAN as well.

Port forwards



PORT FORWARDS

Name	Match	Forward to	Enable	Sort	
4000	IPv4-tcp From any host in wan Via any router IP at port 4000	IP 192.168.2.1, port 4000 in lan	☑	▲ ▼	Edit Delete
4001	IPv4-tcp, udp From any host in wan Via any router IP at port 4001	IP 192.168.2.1, port 4001 in lan	☑	▲ ▼	Edit Delete

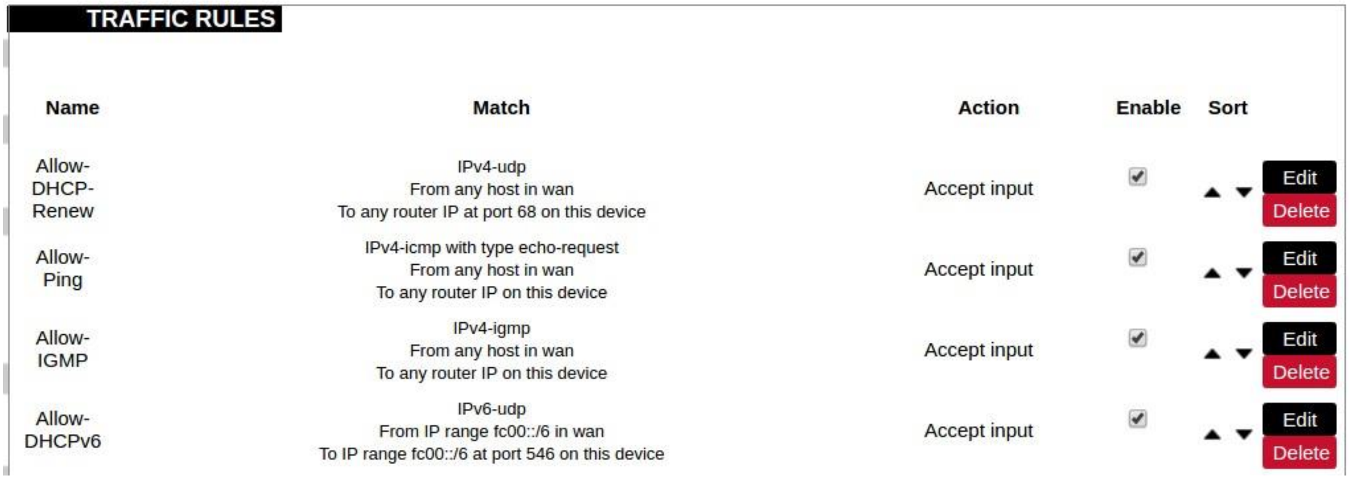
New port forward:

Name	Protocol	External zone	External port	Internal zone	Internal IP address	Internal port	
New port forwai	TCP+UDP	wan		lan			Add

Port forwarding allows remote computers on the Internet to connect to a specific computer or service within the private LAN. It is done in a way of routing network packets within a private network created by the device. Settings for the port forwarding of the device are defined as follows:

Name: The name of the port forwarding rule.
Match: Informs what port forward is matched to.
Forward to: Informs where the port is forwarded to.
Enable: Enable (checked) or disable port forward.
Sort: Allows to sort port forwarding.
The user can add, edit or delete port forwarding rules.

Traffic rules

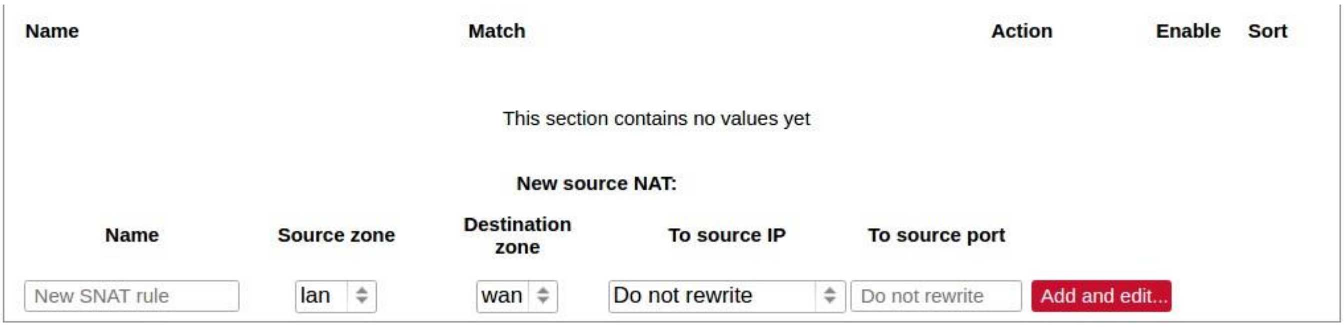


TRAFFIC RULES

Name	Match	Action	Enable	Sort	
Allow-DHCP-Renew	IPv4-udp From any host in wan To any router IP at port 68 on this device	Accept input	☑	▲ ▼	Edit Delete
Allow-Ping	IPv4-icmp with type echo-request From any host in wan To any router IP on this device	Accept input	☑	▲ ▼	Edit Delete
Allow-IGMP	IPv4-igmp From any host in wan To any router IP on this device	Accept input	☑	▲ ▼	Edit Delete
Allow-DHCPv6	IPv6-udp From IP range fc00::/6 in wan To IP range fc00::/6 at port 546 on this device	Accept input	☑	▲ ▼	Edit Delete

Traffic rules which define policies for packets traveling between different zones.
Name: The name of the traffic rule.
Match: Informs what ICMP types are matched.
Action: Informs what action would be performed.
Enable: Enable (checked) or disable the rule.
Sort: Allows to sort rules.

The user can add, edit or delete traffic rules. For every rule can be defined these options: name,restrict to address family, protocol, match ICMP type, source and destination zones, source MAC, IP addresses and port, destination IP address and port, action and extra arguments, month and weekdays for which rule will apply, start/stop dates and times, time in UTC.



Name	Match	Action	Enable	Sort

This section contains no values yet

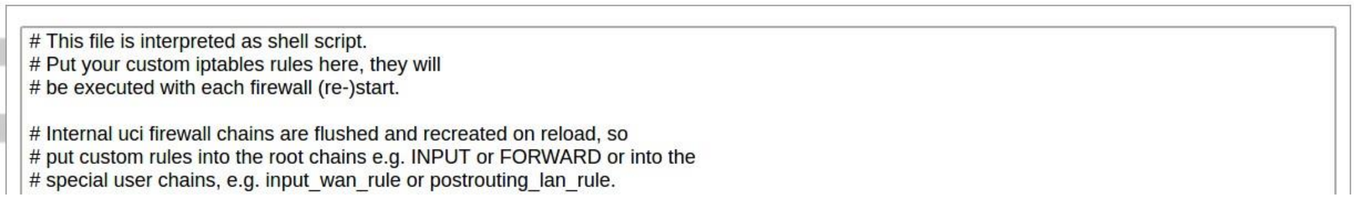
New source NAT:

Name	Source zone	Destination zone	To source IP	To source port	
New SNAT rule	lan	wan	Do not rewrite	Do not rewrite	Add and edit...

Source NAT, which is a specific form of masquerading which allows fine grained control over the source IP used for

outgoing traffic, for the example to map multiple WAN addresses to internal subnets.
The user can add, edit or delete source NAT rules. For every rule can be defined these options: name, protocol, source and destination zones, source, destination, SNAT IP addresses, ports, extra arguments, month and weekdays for which rule will apply, start/stop dates and times, time in UTC.

Custom rules

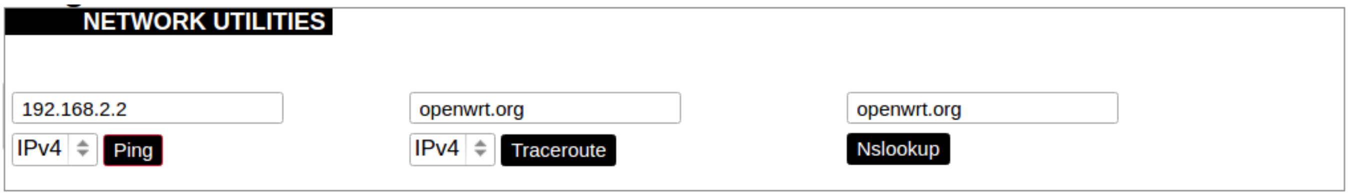


```
# This file is interpreted as shell script.
# Put your custom iptables rules here, they will
# be executed with each firewall (re-)start.

# Internal uci firewall chains are flushed and recreated on reload, so
# put custom rules into the root chains e.g. INPUT or FORWARD or into the
# special user chains, e.g. input_wan_rule or postrouting_lan_rule.
```

Custom rules allow to executing arbitrary iptables commands which are not otherwise covered by the firewall framework. The commands are executed after each firewall restart, right after the default ruleset has been loaded.

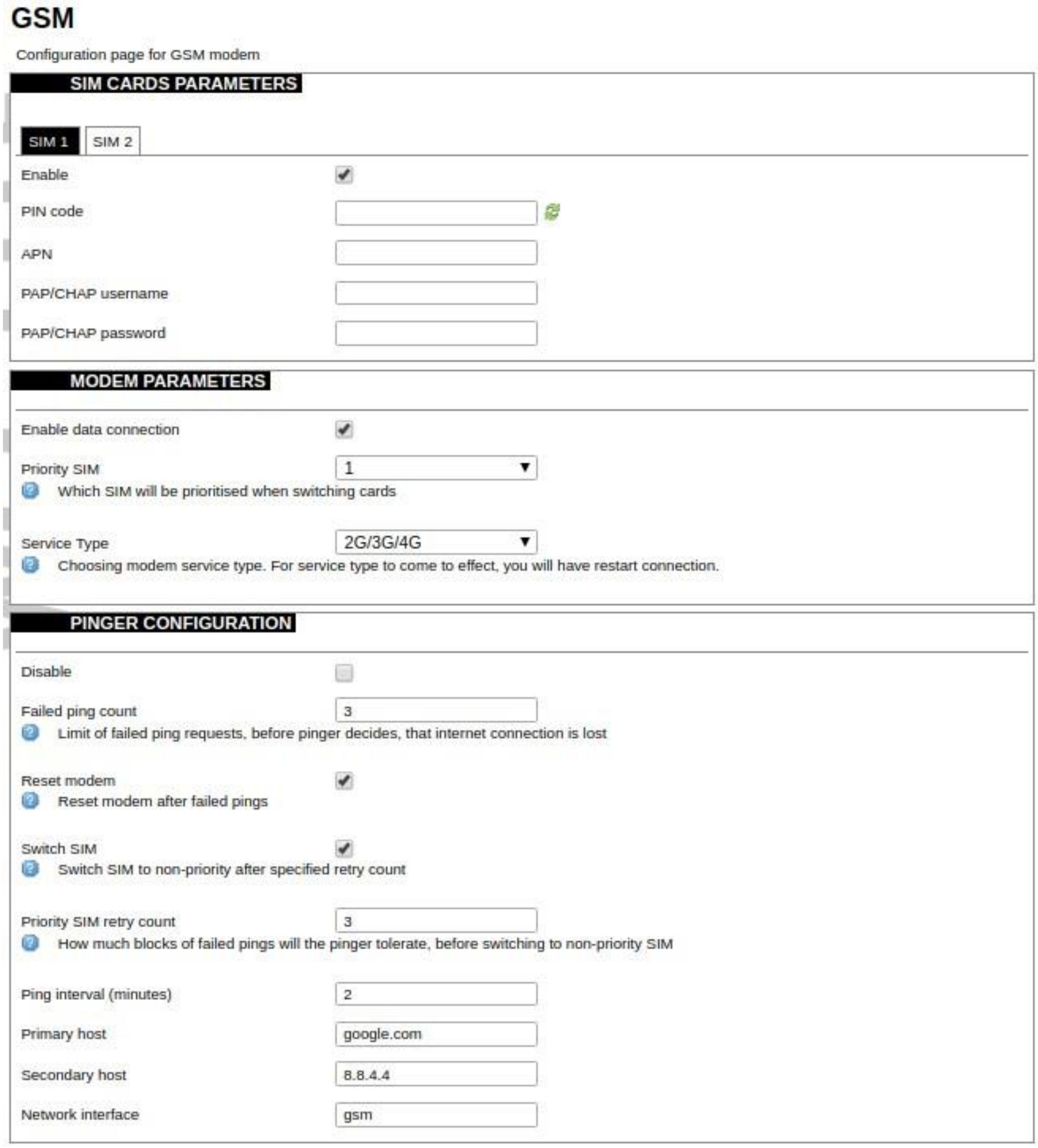
Diagnostics



192.168.2.2 IPv4
openwrt.org IPv4
openwrt.org

Diagnostics tools which can be used to diagnose some of the networking problems: ping, traceroute and nslookup.

GSM



GSM

Configuration page for GSM modem

SIM CARDS PARAMETERS

SIM 1 | SIM 2

Enable ☑

PIN code

APN

PAP/CHAP username

PAP/CHAP password

MODEM PARAMETERS

Enable data connection ☑

Priority SIM: 1

Which SIM will be prioritised when switching cards

Service Type: 2G/3G/4G

Choosing modem service type. For service type to come to effect, you will have restart connection.

PINGER CONFIGURATION

Disable ☐

Failed ping count: 3

Limit of failed ping requests, before pinger decides, that internet connection is lost

Reset modem ☑

Reset modem after failed pings

Switch SIM ☑

Switch SIM to non-priority after specified retry count

Priority SIM retry count: 3

How much blocks of failed pings will the pinger tolerate, before switching to non-priority SIM

Ping interval (minutes): 2

Primary host: google.com

Secondary host: 8.8.4.4

Network interface: gsm

SIM cards parameters

Parameters for SIM card. If single SIM modem is used, there won't be "SIM 1" and "SIM 2" tabs.
Enable: Enable or disable this SIM card.
PIN code: PIN code to use on that SIM card.
APN: APN to use on that SIM car.
PAP/CHAP username: Username (optional).
PAP/CHAP password: Password (optional).

Modem parameters

Enable data connection: Enable or disable data connection through gsm modem.
Priority SIM: Primary SIM card (if Dual SIM modem is used). Mainly used for pinger configuration.
Service Type: Which radio access technology will be used when connecting to the gsm network.

Pinger configuration

Pinger is a service which pings defined hosts to check internet connection. If both of these hosts are unreachable pinger will wait and restart modem (or switch SIM card, if Dual-SIM modem is installed in WCC Lite)
Disable: Disable pinger functionality.
Failed ping count: Limit of failed ping requests, before pinger decides that internet connection is lost.
Reset modem: If checked, pinger resets gsm modem after "Failed ping count".
Switch SIM: If checked, pinger switches SIM to non-priority after "Priority SIM retry count". If internet connection is not available with non-priority SIM as well, pinger switches back to priority SIM after one failed ping attempt.
Priority SIM retry count: How many blocks of failed pings will the pinger tolerate, before switching to non-priority SIM.
Ping interval (minutes): Interval between ping requests.
Primary host: The host that will be pinged first.
Secondary host: The host that will be pinged second, if the primary host fails.
Network interface: GSM network interface name.

GSM Pinger is used to detect the status of network connection via cellular network. This status is written to file (/var/run/board/internet-status) and can be configured to be sent to SCADAs. If pinger is disabled, status is always set equal to zero and should not be trusted to represent internet status. Additionally, this status is reflected in the ”Status”->”GSM Status” window.

This is Pinger functionality described step by step:
- Pinger will ping the primary host every 2 minutes.
- If the primary host fails, pinger redirects to the secondary host immediately.
- If either primary or secondary host is responding to ping requests, pinger will continue testing connection every ”Ping interval (minutes)” parameter and no further action is taken.
- If both primary and secondary hosts are unreachable, pinger will start pinging these hosts every ”Ping interval (minutes) / 2” minute for ”Failed ping count” times.
- If hosts are still unreachable, pinger will try to switch SIM and restart modem (if corresponding parameters are set) or will restart immediately if single SIM modem is used.
- SIM card is switched to non-priority SIM after ”Priority SIM retry count” failed modem restarts with priority SIM. If a non-priority SIM fails, it is switched to priority SIM in the next pinger action.

Dual SIM start procedure

Table below shows, which card is expected on boot, when selectiom is made between Enable/Disable SIM cards and Primary card.

SIM 1 Enabled	SIM 2 Enabled	Priority SIM	SIM on boot
X		1	1
X		2	1
	X	1	2
	X	2	2
X	X	1	1
X	X	2	2
		1	Undefined
		2	Undefined

Layer 2 Tunneling Protocol

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

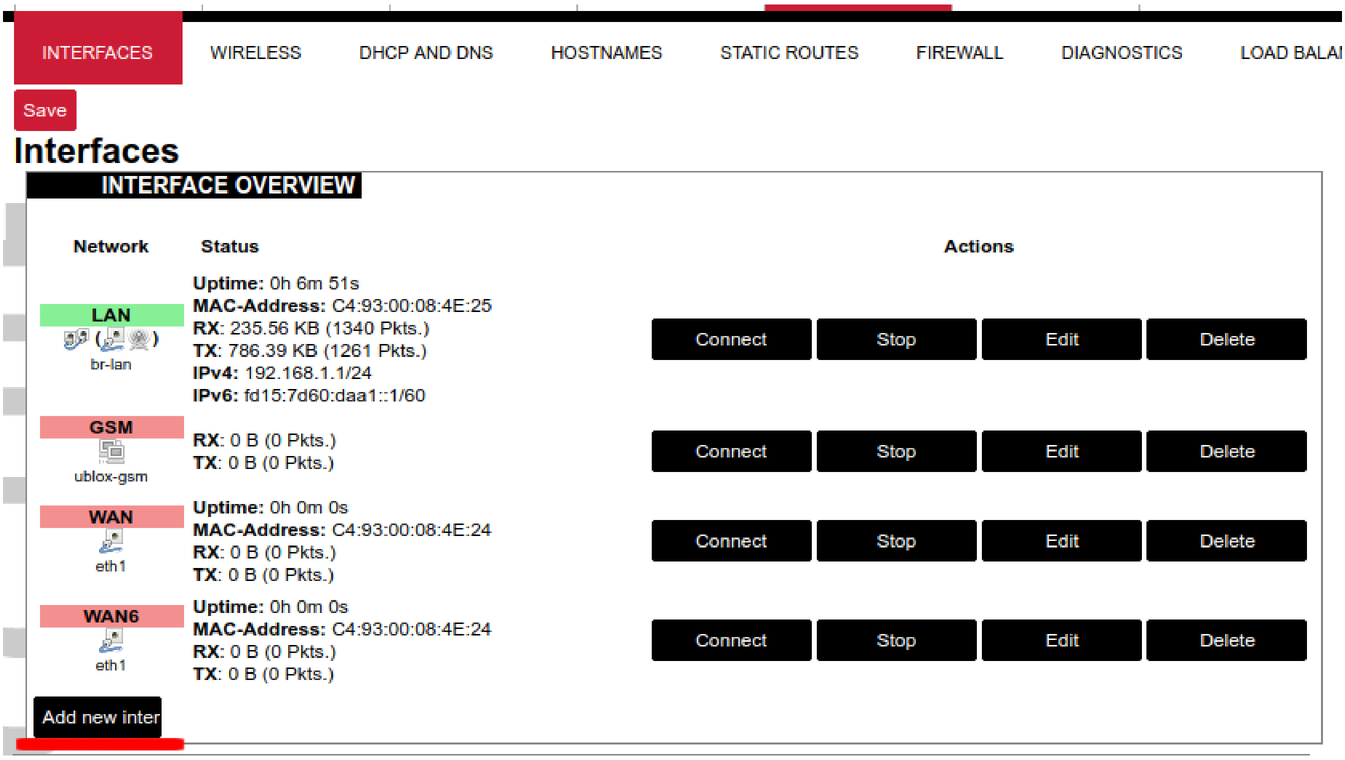
Description

The entire L2TP packet, including payload and L2TP header, is sent within a User Datagram Protocol (UDP) datagram. It is common to carry PPP sessions within an L2TP tunnel. L2TP does not provide confidentiality or strong authentication by itself. IPsec is often used to secure L2TP packets by providing confidentiality, authentication and integrity. The combination of these two protocols is generally known as L2TP/IPsec (discussed below). The two endpoints of an L2TP tunnel are called the LAC (L2TP Access Concentrator) and the LNS (L2TP Network Server). The LNS waits for new tunnels. Once a tunnel is established, the network traffic between the peers is bidirectional. To be useful for networking, higher-level protocols are then run through the L2TP tunnel. To facilitate this, an L2TP session (or ’call’) is established within the tunnel for each higher-level protocol such as PPP. Either the LAC or LNS may initiate sessions. The traffic for each session is isolated by L2TP, so it is possible to set up multiple virtual networks across a single tunnel. MTU should be considered when implementing L2TP. The packets exchanged within an L2TP tunnel are categorized as either control packets or data packets. L2TP provides reliability features for the control packets, but no reliability for data packets. Reliability, if desired, must be provided by the nested protocols running within each session of the L2TP tunnel. L2TP allows the creation of a virtual private dialup network (VPDN) to connect a remote client to its corporate network by using a shared infrastructure, which could be the Internet or a service provider’s network.

Setting up L2TP interface

In order to create a L2TP tunnel following steps are required:

1. Go to **Network > Interfaces > Add new interface:**

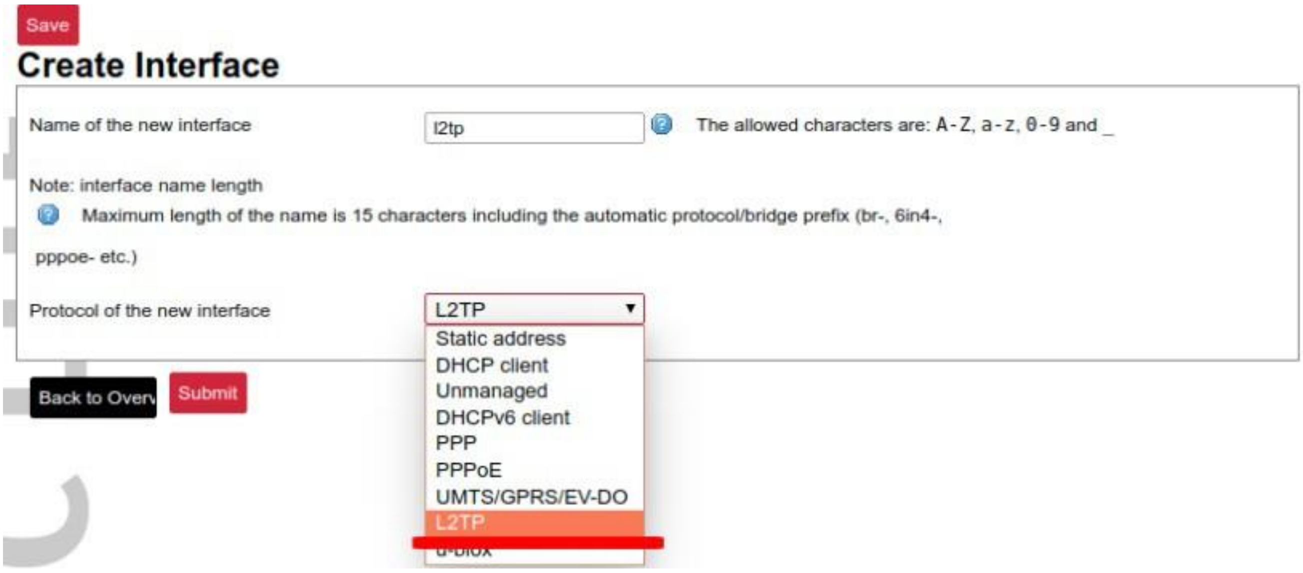


Interfaces

INTERFACE OVERVIEW

Network	Status	Actions
LAN br-lan	**Uptime:** 0h 6m 51s **MAC-Address:** C4:93:00:08:4E:25 **RX**: 235.56 KB (1340 Pkts.) **TX**: 786.39 KB (1261 Pkts.) **IPv4:** 192.168.1.1/24 **IPv6:** fd15:7d60:daa1::1/60	Connect Stop Edit Delete
GSM ublox-gsm	**RX**: 0 B (0 Pkts.) **TX**: 0 B (0 Pkts.)	Connect Stop Edit Delete
WAN eth1	**Uptime:** 0h 0m 0s **MAC-Address:** C4:93:00:08:4E:24 **RX**: 0 B (0 Pkts.) **TX**: 0 B (0 Pkts.)	Connect Stop Edit Delete
WAN6 eth1	**Uptime:** 0h 0m 0s **MAC-Address:** C4:93:00:08:4E:24 **RX**: 0 B (0 Pkts.) **TX**: 0 B (0 Pkts.)	Connect Stop Edit Delete

2. Enter interface name and selet L2TP protocol:



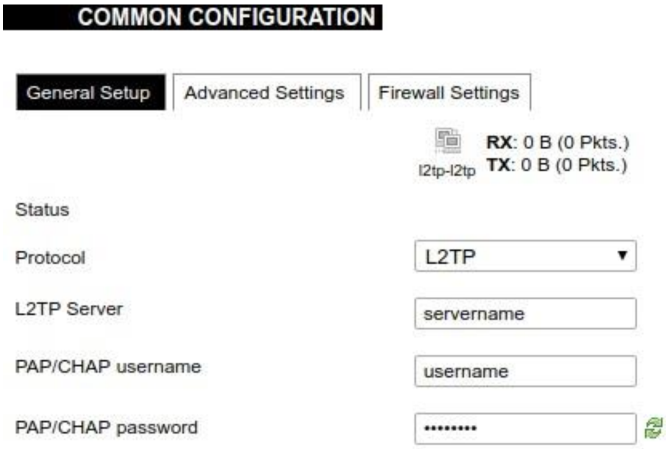
Create Interface

Name of the new interface: l2tp — The allowed characters are: A-Z, a-z, 0-9 and _

Note: interface name length
Maximum length of the name is 15 characters including the automatic protocol/bridge prefix (br-, 6in4-, pppoe- etc.)

Protocol of the new interface: L2TP

3. Enter server name and authorization parameters:


COMMON CONFIGURATION

Status: l2tp-l2tp **RX**: 0 B (0 Pkts.) **TX**: 0 B (0 Pkts.)

Protocol: L2TP

L2TP Server: servername

PAP/CHAP username: username

PAP/CHAP password: ••••••••

4. Save and apply the new configuration. A new network interface will appear.

Logout

To log out of the device graphical user interface a logout button in interface's upper right corner should be pressed. A user is automatically disconnected after ten minutes of inactivity. This ensures that the device would not be suspect to any deliberate damage made by unauthorized access.

API

The firmware of the WCC Lite features a builtin API which is accessible via the web interface. As of version 1.2.11, it does not implement any access restriction features apart from those provided by the firewall functionality.

Individual API endpoints can be enabled or disabled via the web configuration interface at Services>API.

All endpoints are disabled by default. Available API endpoints are shown in the table below.

Path	Description
/api/version	Version of the API
/api/actions	List of available points
/api/syncVersion	Version of the sync service
/api/sync Protocol	hub configuration sync (name=”file”)*
/api/syslog	Prints out the syslog
/api/systemInfo	General system info
/api/gsmInfo	GSM modem information
/api/devices	List of configured devices
/api/device/info	Device information (name=”device_alias”)**
/api/device/tags	List of tags on particular device (name=”device_alias”)**
/api/device/tag/value	Tag value (name=”device_alias”, name=”signal_alias”)**
/api/tags	List of configured tags
/api/sysupgrade	Firmware upgrade (name=”file”)*

* Endpoints accepting files
** Endpoints accepting field data

The API accepts data and files as POST requests encoded as ”multipart/formdata”.

SNMP

SNMP (Simple Network Management Protocol) is an internetstandard protocol for managing devices on IP networks. SNMP exposes management data in the form of a hierarchy of variables in a MIB (Management Information Base).

WCC Lite supports SNMP service which is not added to default build of firmware but can be installed as a module. It enables user to collect data on various parameters of system:

- CPU time time spent for calculations of various processes:
    - *user* - time for user processes;
    - *system* - time for system processes;
    - *idle* - time spent idling;
    - *interrupts* - time spent handling interrupts.
- *CPU load average* - CPU load average for 1, 5 and 15 minutes respectively; Disk
- usage:
    - *total* - total amount of storage in the device (in kB) *available*
    - - amount of storage available to store data (in kB) *used* -
    - amount of storage used in the device (in KB)
    - *blocks used percentage* - blocks (sectors) used to store data in a disk (in kB)
    - *inodes used percentage* - the inode (index node) is a data structure in a Unixstyle file system that describes a filesystem object such as a file or a directory. Each inode stores the attributes and disk block location(s) of the object's data.
- *Memory usage* - RAM usage statistics:
    - *total* - total amount of RAM in the device (in kB);
    - *available* - unused amount of RAM in the device (in kB);
    - *shared* - shared amount of RAM between multiple processes (in kB);
    - *buffered* - refers to an electronic buffer placed between the memory and the memory controller;
    - *cached* - a portion of memory made of highspeed static RAM (SRAM) instead of the slower dynamic RAM (DRAM) used for main memory;
- *Network interfaces*:
    - *MTU* - maximum transmission unit to be sent over network;
    - *speed* - rate of network transmission;
    - *physical address* - unique MAC address assigned to a device;
    - *tx/rx*: byte, packet, drop, error count;
- *System properties*:
    - *uptime* - time since the device was turned on;
    - *process uptime* - time since the process has been started;
    - *hostname* - a label that is assigned to a device connected to a computer network;
    - *name* - name of the device (if defined);
    - *location* - location of the device (if defined).

DNP 3.0

Introduction

DNP3 (Distributed Network Protocol) is a set of communications protocols used between components in process automation systems. Its main use is in utilities such as electric and water companies. It was developed for communications between various types of data acquisition and control equipment. It plays a crucial role in SCADA systems, where it is used by SCADA Master Stations (a.k.a. Control Centers), Remote Terminal Units (RTUs), and Intelligent Electronic Devices (IEDs). It is primarily used for communications between a master station and RTUs or IEDs. ICCP, the InterControl Center Communications Protocol (a part of IEC-608706), is used for intermaster station communications.

Elseta’s DNP3 stack has both Master and Slave protocols implemented. Both of them are able to serve multiple serial (over physical RS485 line), TCP or TLS (over TCP) connections with high efficiency.

IEEE1815 defines 4 subset levels (14) that consist of the objects and function codes that must be supported by the master and outstation. Levels 13 are supported fully and level 4 is supported partially. To get more information about how DNP3 works and what capabilities are supported one should get a copy of protocol specification and/or check Slave Interoperability List/Configuration guides for both Master and Slave protocols.

To set up TLS connection for both DNP3 Master and Slave, refer to sections Excel configuration and Certificates. All keys and certificates should be provided in the PEM format.

If no configuration is set up, DNP3 Master and Slave services are not started.

DNP 3.0 Master

Default group and variation sets are used to send commands. If slave devices support different groups and variations, they can be adjusted in Excel configuration. For more information check section Excel configuration.

Configuring datapoints

To use DNP3 Master in WCC Lite, it has to be configured via an Excel configuration. This configuration contains two Excel sheets where parameters have to be filled in Devices and Signals.

DNP3 Master parameters for Devices tab

Parameter	**Type**	**Description**	**Required**	**Default value** (when not specified)	**Range**	
					Min	Max
name	string	User-friendly device name	Yes			
description	string	Description of a device	No			
device_alias	string	Alphanumeric string to identify a device	Yes			
enable	boolean	Enabling/disabling of a device	No	1	0	1
protocol	string	Protocol to be used (”dnp3 serial”/”dnp3 tcp” (case insensitive))	Yes			
mode	string	Choosing between TCP, TLS and SERIAL modes . If protocol provided DNP3 TCP mode defaults to tcp and if DNP3 serial is provided mode defaults to serial	No	TCP or SERIAL	TCP, SERIAL	
host	string	IP address of TCP slave device	Yes (for TCP).			

bind_address	string	IP address of network adapter used to connect to slave device	No (for TCP)	0.0.0.0		
port	integer	TCP communication port	No (for TCP)	20000		
device	integer	Communication port (”PORT1” or ”PORT2”)	Yes (for SERIAL)			
baudrate	integer	Communication speed, bauds/s	No (for SERIAL)	9600	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600,115200	
databits	integer	Data bit count for communication	No (for SERIAL)	8	6	9
stopbits	integer	Stop bit count for communication	No (for SERIAL)	1	0	2
parity	string	Communication parity option	No (for SERIAL)	none	none, even, odd	
flowcontrol	string	Communication device flow control option.	No (for SERIAL)	none	none	
tls	boolean	Enable/disable use of TLS	Yes (for TLS)	0	0	1
tls_local_certificate	string	Local certificate for TLS connection	Yes (for TLS)			
tls_peer_certificate	string	Certificate authority file for TLS connection	No (for TLS)			
tls_private_key	string	File consisting of private key for TLS connection	No (for TLS)			
max_rx_frag_size	integer	Maximum size of a received fragment.	No	2048	0	2048
destination_address	integer	Address of a master station	No	1	0	65535
source_address	integer	Address of a slave (local) station.	No	1	0	65535
unsol_disable	bool	Disables unsolicited messages on startup. Overrides **unsol_classes** parameter.	No	0	0	1
unsol_classes	string	Defines which classes will have unsolicited actions on startup. Can be overriden with **unsol_disable**. (Example: "1,3,2")	No	no class	1	3
groups_scan_mask	integer	Bitmask for enabling separate group scans with x06 qualifier (all objects): 0 - Binary, 1 - Doublebit Binary, 2 - Binary Output Status, 3 - Counter, 4 - Frozen Counter, 5 - Analog, 6 - Analog Output Status, 7 - Octet String	No	0	0	7
groups_scan_interval	integer, string	Time between separate groups scans intervals in seconds. Set to 0 to disable.	No	0	0	

exception_scan_interval	integer, string	Time between exception scan (classes 1,2,3) intervals in seconds. Set to 0 to disable.	No	0	0	
integrity_scan_interval	integer, string	Time between integrity scan (classes 0,1,2,3) intervals in seconds (general interrogation). Set to 0 to disable.	No	0	0	
timesync_mode	string	Will override masters default setting for choosing timesync procedure	No	NON-LAN(for Serial) LAN (for tcp)	LAN, NON-LAN	
time_sync_interval_sec	integer, string	Periodic time sync interval in seconds. If 0 < - time syncs are forced and periodic. If = 0 - time syncs react to IIN bits from slave. If < 0 - time syncs are disabled.	No	0	0	
select_ms	integer	Select command timeout. Valid for all signals.	No	10000		
timeout_ms	integer	Response timeout in milliseconds	No	2000		
keep_alive_timeout	integer	Time interval for sending a keep alive packet in milliseconds.	No	60		

DNP3 Master parameters for Signals tab

Parameter	**Type**	**Description**	**Required**	**Default value** (when not specified)	**Range**	
					Min	Max
signal_name	string	User-friendly signal name	Yes			
device_alias	string	Device alias from a Devices tab	Yes			
signal_alias		Unique alphanumeric name of the signal to be used	Yes			
enable	boolean	Enabling/disabling of a device	No	1	0	1
index	integer	Index of a signal.	Yes		0	65535
log	boolean	Enable logging in event log	No	0	0	
signal_type	string	DNP3 signal type. (case insensitive)	Yes		”BINARY”, ”ANALOG”, ”DOUBLEBITBINARY” ”BINARYOUTPUTSTATUS”, ”COUNTER”, ”FROZENCOUNTER”, ”ANALOGOUTPUTSTATUS, ”OCTETSTRING”, ”TIMEANDINTERVAL”, ”BINARYOUTPUTCOMMAND”, ”ANALOGOUTPUTCOMMAND”	
command_variation	integer	DNP3 command variation. *Supported variations depend on signal type and are provided in table below*	No	0	0	4

static_variation	integer	DNP3 command variation (). Supported variations depend on signal type and are provided in table below.	No		0, 1, 2, 3, 4, 5, 6, 9, 10	
event_variation	integer	DNP3 command variation. Supported variations depend on signal type and are provided in table below.	No		0	8
control_code	integer	DNP3 control model code of CROB signal. TripClose and Pulse controlmodel requires **PulseOn/off** times to be set	No		LATCH, PULSE, TRIPCLOSE	
pulse_on_time_ms	integer	Pulse ON time in milliseconds, when using Pulse or TripClose control models must be set	No			
pulse_off_time_ms	integer	Pulse OFF time in milliseconds, when using Pulse or TripClose control models must be set	No			
class_num	integer	Class assignment of this signal.	No	0	0	3
operate_type	integer		No	1	-1	1
job_todo	string	Device status signal can be configured by providing one of the given values.	No		COMMUNICATION_STATUS, DEVICE_RUNNING, DEVICE_ERROR, UNKNOWN_ERROR	

Debugging the DNP3 Master service

If configuration for DNP3 devices is set up, handler for protocol will start automatically. If configuration is missing or contains errors, protocol will not start. It is done intentionally decrease unnecessary memory usage.

DNP3 protocol runs a service called **dnp3-master**. If DNP3 does not work properly (e.g. no communication between devices, data is corrupted, etc.), a user can launch a debug session from command line interface and find out why link is not functioning properly. To launch a debugging session, a user should stop **dnp3-master** process and run **dnp3-master** command with respective flags as in the table given below.

Procedure for DNP3 Master protocol service debugging:

- **Step 1**: Service must be stopped by entering the following command into the wcclite: **/etc/init.d/dnp3-master stop**
- **Step 2**: After service is stopped it must be started with the preferred configuration file (JSON files found in /etc/ folder) and a debug level 7: **dnp3-master -c /etc/dnp3-master/dnp3master.json -d7**Additional output forming options described in the table below.
- **Step 3**: Once the problem is diagnosed normal operations can be resumed with the following command: **/etc/init.d/dnp3-master start**

dnp3-master command line debugging options

Option	Description
-h [–help]	Display help information
-V [–version]	Show version
-p [–port]	Show output for one port only
-d <debug level>	Set debugging level

-c [–config]	Config path
-a [–app]	Show application layer data
–l [–link]	Show link layer data
–t [–transport]	Show transport layer data
-r [–redis]	Show Redis messages
-R [–readyfile]	Ready notification file

DNP 3.0 Slave

Default group and variation sets are used to send static and event values. If master devices support different groups and variations, they can be adjusted in Excel configuration. Wcc-Lite supported variations are provided in: *Static and Event variations* and *Command variations*.

DNP3 Slave parameters for Devices tab

Parameter	**Type**	**Description**	**Required**	**Default value** (when not specified)	**Range**	
					Min	Max
name	string	User-friendly device name	Yes			
description	string	Description of a device	No			
device_alias	string	Alphanumeric string to identify a device	Yes			
enable	boolean	Enabling/disabling of a device	No	1	0	1
protocol	string	Protocol to be used.	Yes		dnp3 tcp slave dnp3 serial slave	
mode	string	Choosing between TCP, TLS and SERIAL modes. If protocol provided DNP3 TCP mode defaults to tcp and if DNP3 serial is provided mode defaults to SERIAL	No	TCP or SERIAL	TCP, SERIAL, TLS	
host	string	IP address of TCP slave device	Yes (for TCP).			
bind_address	string	IP address of network adapter used to connect to slave device	No (for TCP)	0.0.0.0		
port	integer	TCP communication port	No (for TCP)	20000		
device	integer	Communication port (”PORT1” or ”PORT2”)	Yes (for SERIAL)			
baudrate	integer	Communication speed, bauds/s	No (for SERIAL)	9600	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600,115200	
databits	integer	Data bit count for communication	No (for SERIAL)	8	6	9
stopbits	integer	Stop bit count for communication	No (for SERIAL)	1	0	2
parity	string	Communication parity option	No (for SERIAL)	none	none, even, odd	

flowcontrol	string	Communication device flow control option.	No (for SERIAL)	none	none	
tls	boolean	Enable/disable use of TLS	Yes (for TLS)	0	0	1
tls_local_certificate	string	Local certificate for TLS connection	Yes (for TLS)			
tls_peer_certificate	string	Certificate authority file for TLS connection	No (for TLS)			
tls_private_key	string	File consisting of private key for TLS connection	No (for TLS)			
max_tx_frag_size	integer	Maximum size of a received fragment.	No	2048	0	2048
destination_address	integer	Address of a master station	No	1	0	65535
source_address	integer	Address of a slave (local) station.	No	1	0	65535
unsol_classes	string	Defines which classes will have unsolicited actions on startup. Can be overriden with **unsol_disable**. (Example: "1,3,2")	No	no class	1	3
time_sync_interval_sec	integer, string	Periodic time sync interval in seconds. If 0 < - time syncs are forced and periodic. If = 0 - time syncs react to IIN bits from slave. If < 0 - time syncs are disabled.	No	0	0	
select_ms	integer	Select command timeout. Valid for all signals.	No	10000		
timeout_ms	integer	Response timeout in milliseconds	No	2000		
keep_alive_timeout	integer	Time interval for sending a keep alive packet in milliseconds.	No	60		

DNP3 Slave parameters for Signals tab

Parameter	**Type**	**Description**	**Required**	**Default value** (when not specified)	**Range**	
					Min	Max
signal_name	string	User-friendly signal name	Yes			
device_alias	string	Device alias from a Devices tab	Yes			
signal_alias		Unique alphanumeric name of the signal to be used	Yes			
enable	boolean	Enabling/disabling of a device	No	1	0	1
index	integer	Index of a signal.	Yes		0	65535
log	bolean	Enable logging in event log	No	0	0	
deadband	double	Deadband for Analog, Analog Output Status, Counter, Frozen Counter signals.	No	0		

signal_type	string	DNP3 signal type. (case insensitive)	Yes		”BINARY”, ”ANALOG”, ”DOUBLEBITBINARY” ”BINARYOUTPUTSTATUS”, ”COUNTER”, ”FROZENCOUNTER”, ”ANALOGOUTPUTSTATUS, ”OCTETSTRING”, ”TIMEANDINTERVAL”, ”BINARYOUTPUTCOMMAND”, ”ANALOGOUTPUTCOMMAND”	
command_variation	integer	DNP3 command variation. *Supported variations depend on signal type and are provided in table below*	No	0	0	4
static_variation	integer	Override default signal’s static variation. Valid for Status mode signals.	No		0, 1, 2, 3, 4, 5, 6, 9, 10	
event_variation	integer	Override default signal’s event variation. Valid for Status mode signals.	No		0	8
control_code	integer	DNP3 control model code of CROB signal. TripClose and Pulse controlmodel requires **PulseOn/off** times to be set	No		LATCH, PULSE, TRIPCLOSE	
pulse_on_time_ms	integer	Pulse ON time in milliseconds, when using Pulse or TripClose control models must be set	No			
pulse_off_time_ms	integer	Pulse OFF time in milliseconds, when using Pulse or TripClose control models must be set	No			
class_num	integer	Class assignment of this signal.	No	0	0	3
operate_type	integer	Default command behaviour. IF selected ”**-I**” - DirectOperateNoAck, **”0”** - DirectOperate, "**I**" **-**- SelectBeforeOperate.	No	1	-1	1
job_todo	string	Device status signal can be configured by providing one of the given values.	No		COMMUNICATION_STATUS, DEVICE_RUNNING, DEVICE_ERROR, UNKNOWN_ERROR	

Command variations

Signal Type	Available Command Variation	Default Command Variation
Binary Output Command (Group12)	0, 1	1
Analog Output Command (Group41)	0, 1, 2, 3, 4	1

Static and Event variations

Signal Type	Available Variations	Default Variations

Binary	Static variation (Group1) 1, 2 Event variation (Group2) 1, 2, 3	Static variation 2 Event variation 1
Double Binary	Static variation (Group3) 1, 2 Event variation (Group4) 1, 2, 3	Static variation 2 Event variation 1
Binary Output Status	Static variation (Group10) 2 Event variation (Group11) 1, 2	Static variation 2 Event variation 1
Counter	Static variation (Group20) 1, 2, 5, 6 Event variation (Group22) 1, 2, 5, 6	Static variation 1 Event variation 1
Frozen Counter	Static variations (Group21) 1, 2, 5, 6, 9,10 Event variation (Group23) 1, 2, 5, 6	Static variation 1 Event variation 1
Analog	Static variation (Group30) 1, 2, 3, 4, 5, 6 Event variation (Group32) 1, 2, 3, 4, 5, 6, 7, 8	Static variation 1 Event variation 1
Analog Output Status	Static variation (Group40) 1, 2, 3, 4 Event variation (Group42) 1, 2, 3, 4, 5, 6, 7, 8	Static variation 1 Event variation 1
Time and Interval	Static variation (Group50) 1	Static variation 1
Octet String	Static variation (Group110) 0 Event variation (Group111) 0	Static variation 0 Event variation 0

Debugging the DNP3 Slave service

If configuration for DNP3 devices is set up, handler for protocol will start automatically. If configuration is missing or contains errors, protocol will not start. It is done intentionally decrease unnecessary memory usage.

DNP3 protocol runs a service called **dnp3-slave** . If DNP3 does not work properly (e.g. no communication between devices, data is corrupted, etc.), a user can launch a debug session from command line interface and find out why link is not functioning properly. To launch a debugging session, a user should stop **dnp3-slave** process and run **dnp3-slave** command with respective flags as in the table given below.

Procedure for DNP3 Master protocol service debugging:

- **Step 1**: Service must be stopped by entering the following command into the wcclite: **/etc/init.d/dnp3-slave stop**
- **Step 2**: After service is stopped it must be started with the preferred configuration file (JSON files found in /etc/ folder) and a debug level 7: **dnp3-slave -c /etc/dnp3-slave/dnp3slave.json -d7** Additional output forming options described in the table below.
- **Step 3**: Once the problem is diagnosed normal operations can be resumed with the following command: **/etc/init.d/dnp3-slave start**

dnp3-slave command line debugging options

Option	Description
-h [–help]	Display help information
-V [–version]	Show version
-p [–port]	Show output for one port only
-d <debug level>	Set debugging level
-c [–config]	Config path
-a [–app]	Show application layer data
–l [–link]	Show link layer data
–t [–transport]	Show transport layer data
-r [–redis]	Show Redis messages
-R [–readyfile]	Ready notification file

SMS sender

General

SMS sender is a service that lets user configure WCC Lite to send SMS on a set tag trigger.s

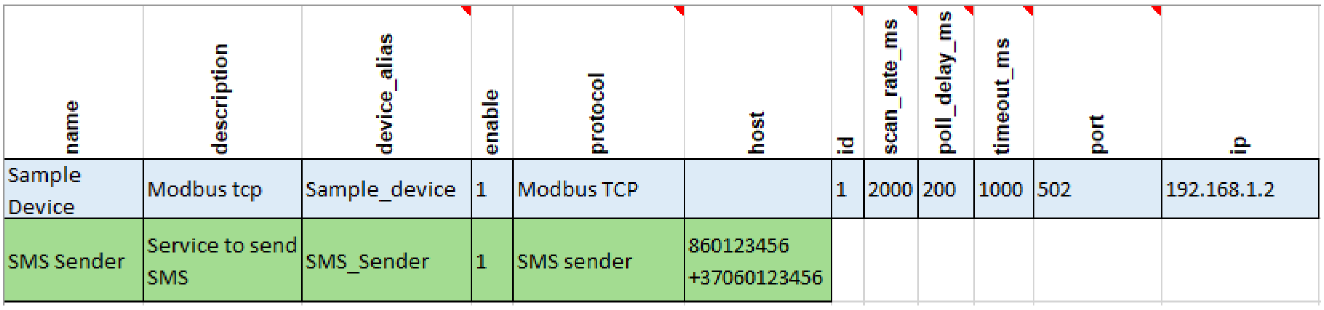
SMS sender functionality is available since firmware version v1.5.4, of WCC Lite.

Configuring SMS sender

To configure WCC Lite to use SMS sender user must fill in the needed parameters in Excel configuration. These parameters are shown in the tables below.

SMS sender parameters for Devices tab:

Parameter	**Type**	**Description**	**Required**	**Default value** (when not specified)	**Range**	
					Min	Max
name	string	User-friendly device name	Yes			
description	string	Description of the device	No			
device_alias	string	Device alias to be used in configuration	Yes			
enable	boolean	Enabling/disabling of a device	No	1	0	1
protocol	string	Selection of protocol	Yes		**SMS sender**	
host	string	List of phone numbers to send SMS to, separated by space.	Yes			



name	description	device_alias	enable	protocol	host	id	scan_rate_ms	poll_delay_ms	timeout_ms	port	ip
Sample Device	Modbus tcp	Sample_device	1	Modbus TCP		1	2000	200	1000	502	192.168.1.2
SMS Sender	Service to send SMS	SMS_Sender	1	SMS sender	860123456 +37060123456						

SMS sender parameters for Signals tab:

Parameter	**Type**	**Description**	**Required**	**Default value** (when not specified)	**Range**	
					Min	Max
signal_name	string	User-friendly signal name	Yes			
device_alias	string	Device alias from a Devices tab	Yes			
signal_alias	string	Unique signal name to be used	Yes			
source_device_alias	string	device_alias of the source device	No			
source_signal_alias	string	source_alias of the source signal	No			

enable	boolean	Enabling/disabling of a signal	No	1	0	1
log	integer	Enable logging in event log	No	0	0	
job_todo	string	Specific SMS sender tag type	Yes		send-sms, device-control, device-status	
tag_job_todo	string	SMS sender tag for **send-sms**: *text message*	Yes			
trigger	string	Trigger expression for the SMS to be sent	No (Only for send_sms)	value!=0		

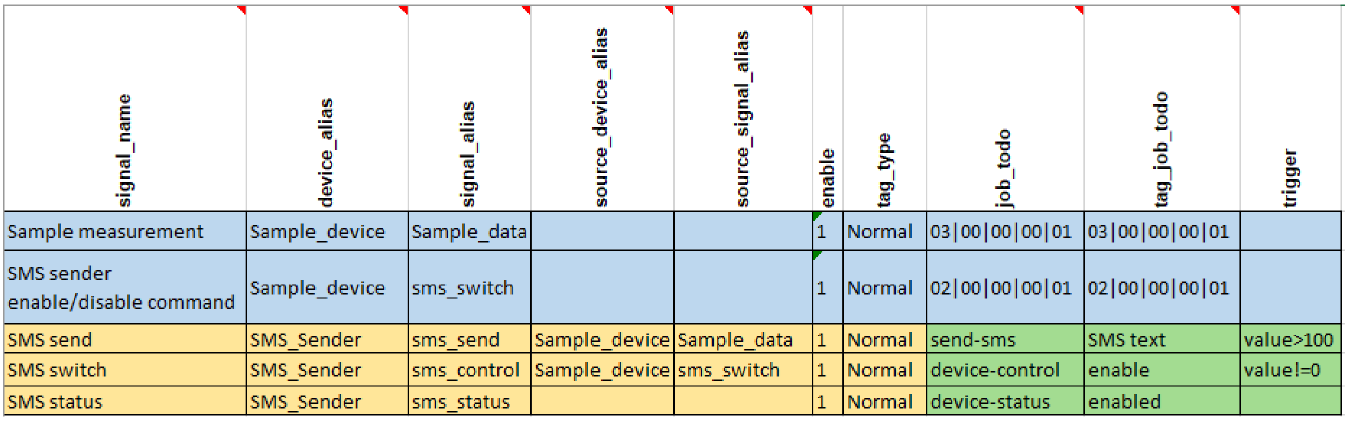
To configure SMS sender, 3 types of signals are mandatory. These values should be written inside the *job_todo* field for each signal:

- **send-sms** - This signal takes value from the provided *source_signal_alias* field and checks if the value evaluates as true against the *trigger* field. If its true, the SMS sender will send the text from the *tag_job_todo* field to the specified phone numbers.
- **device-control** - This signal controls if the SMS sender is enabled or disabled. Its *tag_job_todo* parameter should be set to enable. It takes value from the *source_signal_alias* field and evaluates it against the *trigger* field. If the *trigger* is evaluated as true, the SMS sender will be enabled, otherwise it will disable the SMS sender.
- **device-status** - This signal indicates if the service is enabled or not. Its *tag_job_todo* parameter should be set to *enabled*.

Trigger expressions can be configured with basic comparison operators:

- Less than **<**
- Greater than **>**
- Less than or equal to **<=**
- Greater than or equal to **>=**
- Equal **==**
- Not equal **!=**

Example configuration of SMS sender:



signal_name	device_alias	signal_alias	source_device_alias	source_signal_alias	enable	tag_type	job_todo	tag_job_todo	trigger
Sample measurement	Sample_device	Sample_data			1	Normal	03|00|00|00|01	03|00|00|00|01	
SMS sender enable/disable command	Sample_device	sms_switch			1	Normal	02|00|00|00|01	02|00|00|00|01	
SMS send	SMS_Sender	sms_send	Sample_device	Sample_data	1	Normal	send-sms	SMS text	value>100
SMS switch	SMS_Sender	sms_control	Sample_device	sms_switch	1	Normal	device-control	enable	value!=0
SMS status	SMS_Sender	sms_status			1	Normal	device-status	enabled	

DLMS/COSEM

Introduction

IEC 62056 is a set of standards for electricity metering data exchange byInternational Electrotechnical Commission.

The IEC 62056 standards are the international standard versions of the DLMS/COSEM specification.

DLMS or **Device Language Message Specification** (originally Distribution Line Message Specification),[1] is the suite of standards developed and maintained by the DLMS User Association (DLMS UA) and has been adopted by the IEC TC13 WG14 into the IEC 62056 series of standards. The DLMS User Association maintains a D Type liaison with IEC TC13 WG14 responsible for international standards for meter data exchange and establishing the IEC 62056 series. In this role, the DLMS UA provides maintenance, registration and compliance certification services for IEC 62056 DLMS/COSEM.

COSEM or **Companion Specification for Energy Metering**, includes a set of specifications that defines the transport and application layers of the DLMS protocol. The DLMS User Association defines the protocols into a set of four specification documents namely Green Book, Yellow Book, Blue Book and White Book. The Blue Book describes the COSEM meter object model and the OBIS object identification system, the Green Book describes the architecture and protocols, the Yellow Book treats all the questions concerning conformance testing, the White Book contains the glossary of terms. If a product passes the conformance test specified in the Yellow Book, then a certification of DLMS/COSEM compliance is issued by the DLMS UA.

The IEC TC13 WG14 groups the DLMS specifications under the common heading: "Electricity metering data exchange - The DLMS/COSEM suite". DLMS/COSEM protocol is not specific to electricity metering, it is also used for gas, water and heat metering.

Source: https://en.wikipedia.org/wiki/IEC_62056

DLMS Master

Overview

DLMS (Device Language Message Specification) is a suite of standards developed and maintained by the DLMS User Association. COSEM (Companion Specification for Energy Metering) includes a set of specifications that define the transport and application layers of the DLMS protocol.

In DLMS/COSEM all the data in electronic utility meters and devices are represented by means of mapping them to appropriate classes and related attribute values.

Objects are identified with the help of OBIS (Object Identification System) codes (as per IEC 62056-61).

The DLMS driver allows only for readout and displaying only numeric values of DLMS object data fields. Connection via TCP (HDLC or WRAPPER) or serial (RS232/RS485) port are supported.

The setup of the DLMS driver consists of communication and tag configuration. Protocol specific parameters (except for DLMS/IEC handshake mode) apply for both serial and IP connections.

Configuration

Devices section

serialnumber, **server_address** and **id** define the meter addressing parameters. Either **serialnumber** (meter serial number) or a combination of **server_address** (physical server address) and **id** (logical server address) is used. If a serial number is provided, physical and logical server addresses are ignored.

⚠ Before configuring the Device section it is best to first check the connection parameters with a 3rd party DLMS utility.

master_address defines the client address. This usually depends on the authentication used. Most meters support 16 for no authentication.

type defines the object referencing. SN should be used for short name referencing and LN for logical name referencing.

mode defines the communications mode. If IEC is used along with comms settings for serial readout, the connection is initiated as per IEC 62056-21, at the default initial baud rate (300 7E1). DLMS-HDLC shall be used for HDLC connections via IP. DLMS-WRAPPER is also supported for IP connections. The default setting is DLMS-HDLC.

timeout_ms defines the reply timeout for telegrams both via serial and TCP.

auth and **password** define the authentication mode and password. This can be set to None, or other authentication variant (see table below), depending on the mode configured and supported by the particular meter.
ip and **port** define the IP address and TCP port for DLMS communication via IP. To use TCP/IP communication set protocol to **DLMS TCP** and for serial use **DLMS serial**

> ⚠ Connection parameters are device specific and can differ between makes, models and utility companies. For initial connection settings please refer to the configuration of the particular meter.

> ℹ When ip and port are configured, any serial port settings are ignored and connection is initiated only via IP.

Device configuration parameters for DLMS meters acquisition:

Parameter	**Type**	**Description**	**Required**	**Default value** (when not specified)	**Range**	
name	string	User-friendly name for a device	Yes			
description	string	Description of a device	No			
device_alias	string	Alphanumeric string to identify a device	Yes			
enable	boolean	Enabling/disabling of a device	No	1	0	1
protocol	string	Protocol to be used	Yes		DLMS serial, DLMS TCP	
serialnumber	integer	Meter serial number	No	0		
slave_address	integer	Meter physical server address	No	1600		
id	integer	Meter logical server address	No	0		
address_size	integer	Meter address size in bytes	No	1	1	4
master_address	integer	Client address	Yes			
type	string	Meter object referencing: SN - short referencing, LN - logical referencing	No	SN	SN, LN	
mode	string	Initial handshake mode.	Yes	DLMS-HDLC	DLMS, IEC, DLMS-DLC or DLMS-RAPPER	
timeout_ms	integer	Timeout in milliseconds	No	2500		
auth	string	Authentication.	No	None	None, Low, High, HighMd5, HighSha1, HighSha256, HighGmac HighEcdsa	
password	string	Password for authentication	No when auth is None			
ip	string	IP address	Yes (For TCP)			
port	integer	TCP port	Yes (For TCP)			

device		Communication port	Yes (For Serial)		PORT1	PORT2
baudrate	integer	Communication speed, bauds/s	No (For Serial)	9600	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200	
databits	integer	Data bit count for communication	No (For Serial)	8	6	9
stopbits	integer	Stop bit count for communication	No (For Serial)	1	1	2
parity	string	Communication parity option	No (For Serial)	none	none, even, odd	
flowcontrol	string	Communication device flow control option.	No (For Serial)	none	none	
retry_counter	integer	Number of requests, before link is considered lost (device status signals are changed) and reconnect attempt will be issued	No	3		
scan_rate_ms	integer	If provided and positive all reads and writes will be executed within the timeframe in milliseconds	No	10000		
poll_delay_ms	integer	Minimum time delay in milliseconds to wait before sending any data on port.	No	200		

Signals section

The tag_job defines the tag job. A list of comma-separated OBIS codes (or a single OBIS) should be used. Attribute indexes for objects of types register and extended register are selected automatically. Any other object types should include the attribute index in the form of OBIS:index.
tag_job_todo defines the job sub-job. This field should contain an OBIS code from within the list of the tag_job.

DLMS configuration parameters creating signals:

Parameter	**Type**	**Description**	**Required**	**Default value** (when not specified)	**Range**	
signal_name	string	User-friendly signal name	Yes			
device_alias	string	Device alias from a Devices tab	Yes			
signal_alias	string	Unique alphanumeric name of the signal to be used	Yes			
enable	boolean	Enabling/disabling of an individual signal	No	1	0	1
log	boolean	Enable logging in event log	No	0		
SN	integer	Address of value to read (Short name).	No			

job_todo	string	Tag job as single or multiple comma separated OBIS codes	Yes			
tag_job_todo	string	Tag sub job	Yes			
number_type	string	Type of a number (FLOAT, DOUBLE, DIGITAL, etc.)	Yes			
pulse_short_time_ms	string	Time interval for short output pulse to stay active	No			
pulse_long_time_ms	integer	Time interval for long output pulse to stay active	No			

Debugging the DLMS service

If configuration for DLMS devices is set up, handler for protocol will start automatically. If configuration is missing or contains errors, protocol will not start. It is done intentionally decrease unnecessary memory usage.

DLMS protocol runs a service called pooler. If DLMS does not work properly (e.g. no communication between devices, data is corrupted, etc.), a user can launch a debug session from command line interface and find out why link is not functioning properly. To launch a debugging session, a user should stop pooler process and run pooler command with respective flags as in the table shown below.

Procedure for DLMS Master protocol service debugging:

- **Step 1**: Service must be stopped by entering the following command into the wcclite: **/etc/init.d/pooler stop**
- **Step 2**: After service is stopped it must be started with the preferred configuration file (JSON files found in /etc/ folder) and a debug level 7: **pooler -c /etc/pooler.json -d7 -dlms**
  Additional output forming options are described in the table below.

- **Step 3**: Once the problem is diagnosed normal operations can be resumed with the following command: **/etc/init.d/pooler start**

DLMS command line debugging options

Option	Description
-h [–help]	Display help information
-V [–version]	Show version
-p [–port]	Show output for one port only
-d <debug level>	Set debugging level
-c [–config]	Config path
-a [–app]	Show application layer data
–l [–link]	Show link layer data
–t [–transport]	Show transport layer data
-r [–redis]	Show Redis messages
-R [–readyfile]	Ready notification file

Aurora

Overview

The Aurora Protocol is a link layer communications protocol for use on pointtopoint serial links. It is intended for use in highspeed (gigabits/second and more) connections internally in a computer or in an embedded system. It uses either 8b/10b encoding or 64b/66b encoding

Aurora parameters for Device tab:

Parameter	**Type**	**Description**	**Required**	**Default value** (when not specified)	**Range**	
					Min	Max
name	string	User-friendly device name	Yes			
description	string	Description of the device	No			
device_alias	string	Device alias to be used in configuration	Yes			
enable	boolean	Enabling/disabling of a device	No	1	0	1
protocol	string	Selection of protocol	Yes		Aurora	
baudrate	integer	Communication speed, bauds/s (See values 33.1.2)	No	9600	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200	
databits	integer	Data bit count for communication	No	8	6	9
stopbits	integer	Stop bit count for communication	No	1	1	2
parity	string	Communication parity option ("none"/"even"/"odd")	No	none		
flowcontrol	string	Communication device flow control option.	No	none		
scan_rate_ms	integer	If provided and positive all reads and writes will be executed within the timeframe in miliseconds.	No	10000		
poll_delay_ms	integer	Minimum time delay in miliseconds to wait before sending any data on port.	No	200		
timeout_ms	integer	Timeout in milliseconds	No	2500		
id	integer	Inverter ID	No	0		
device	string	Communication port	Yes		PORT1	PORT2

Aurora parameters for Signals tab:

Parameter	**Type**	**Description**	**Required**	**Default value** (when not specified)	**Range**	

					Min	Max
signal_name	string	User-friendly device name	Yes			
device_alias	string	Device alias from a Devices tab	Yes			
enable	boolean	Enabling/disabling of an individual signal	No	1	0	1
log	integer	Enable logging in event log (Default: 0)	No	0	0	
signal_alias	string	Unique alphanumeric name of the signal to be used	Yes			
job_todo	boolean	Define tag-function	Yes			
tag_job_todo	string	Define tag action that depends on tag function	Yes			
number_type	integer	Type of a number (FLOAT, DOUBLE, DIGITAL, etc.)	Yes			
pulse_short_time_ms	integer	Time interval for short output pulse to stay active	No	0		
pulse_long_time_ms	integer	Time interval for long output pulse to stay active	No	0		

Elgama

Overview

Elgama protocol is used for communications with Elagama*elektronika electricity meters*.

Configuration

Available meter types (use number only):

- 0 EPQM/LZQM
- 1 EPQS
- 2 GAMA300
- 3 GAMA100
- 4 ITS cl

Elgama parameters for *Device* tab

Parameter	**Type**	**Description**	**Required**	**Default value** (when not specified)	**Range**	
					Min	Max
name	string	User-friendly device name	Yes			
description	string	Description of a device	No			
device_alias	string	Alphanumeric string to identify a device	Yes			
enable	boolean	Enabling/disabling of a device	No	1	0	1
protocol	string	Protocol to be used.	Yes		Elgama	
device	string	Communication port	Yes		PORT1	PORT2
baudrate	integer	Communication speed, bauds/s	No	9600	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600,115200	
serial_close_delay	integer	Delay before closing serial port in milliseconds	No	400		
timeout_ms	integer	Timeout of waiting for incoming request in milliseconds	Yes			
id	integer	Meter serial number	Yes			
meter_model	integer	Meter type (See 15.2)	Yes		0	4
use_time	boolean	Use system/meter (0/1) time (Default: 0)	No	0	0	1

Elgama parameters for *Signals* tab

Parameter	**Type**	**Description**	**Required**	**Default value** (when not specified)	**Range**	
					Min	Max
signal_name	string	User-friendly signal name	Yes			
device_alias	string	Device alias from a Devices tab	Yes			
signal_alias	string	Unique alphanumeric name of the signal to be used	Yes			
enable	boolean	Enabling/disabling of an individual signal	No	1	0	1
log	integer	Enable logging in event log	No	0		
number_type	string	Type of number (FLOAT, DOUBLE, DIGITAL, etc.)	Yes			
job_todo	string	Tag job as single or multiple comma separated OBIS codes	Yes			
tag_job_todo	string	Tag sub job	Yes			

SMA NET

Overview

SMA Net can transfer SMA Data, TCP/IP and many more telegrams due to its multiprotocol capability. Thus, it is the preferred telegram frame in case of new developments.

Configuration

SMA NET parameters for *Device* tab

Parameter	**Type**	**Description**	**Required**	**Default value** (when not specified)	**Range**	
					Min	Max
name	string	User-friendly device name	Yes			
description	string	Description of a device	No			
device_alias	string	Alphanumeric string to identify a device	Yes			
enable	boolean	Enabling/disabling of a device	No	1	0	1
protocol	string	Protocol to be used.	Yes		sma net	
baudrate	integer	Communication speed, bauds/s	No	9600	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600,115200	
databits	integer	Data bit count for communication	No	8	6	9
stopbits	integer	Stop bit count for communication	No	1	1	2
parity	string	Communication parity option	No	none	none, even, odd	
flowcontrol	string	Communication device flow control option.	No	none	none	
scan_rate_ms	integer	Delay before closing serial port in miliseconds	No	10000		
poll_delay_ms	integer		No	200		
timeout_ms	integer	Timeout of waiting for incoming request in miliseconds	No	2500		
serial_number	integer	Inverter serial number	Yes			
device		Communication port	Yes		PORT1	PORT2
serial_close_delay	integer	Delay before closing serial port	No	400		

SMA NET parameters for *Signals* tab

Parameter	**Type**	**Description**	**Required**	**Default value** (when not specified)	**Range**	
signal_name	string	User-friendly signal name	Yes			
device_alias	string	Device alias from a Devices tab	Yes			
signal_alias	string	Unique alphanumeric name of the signal to be used	Yes			
enable	boolean	Enabling/disabling of an individual signal	No	1	0	1
log	integer	Enable logging in event log	No	0		
number_type	string	Type of a number (FLOAT, DOUBLE, DIGITAL, etc.)	Yes			
job_todo	string	Tag job as single or multiple comma separated OBIS codes	Yes			
tag_job_todo	string	Tag sub job	Yes			
pulse_short_time_ms	integer	Time interval for short output pulse to stay active	No			
pulse_long_time_ms	integer	Time interval for long output pulse to stay active	No			

Windlog

Overview

Windlog protocol is used for communications with*Windlog data logger*.

Configuration

Windlog parameters for *Device* tab

Parameter	**Type**	**Description**	**Required**	**Default value** (when not specified)	**Range**	
					Min	Max
name	string	User-friendly device name	Yes			
description	string	Description of a device	No			
device_alias	string	Alphanumeric string to identify a device	Yes			
enable	boolean	Enabling/disabling of a device	No	1	0	1
protocol	string	Protocol to be used.	Yes		Windlog	
device	string	Communication port	Yes		PORT1	PORT2
baudrate	integer	Communication speed, bauds/s	No	115200	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600,115200	
databits	integer	Data bit count for communication	No	8	6	9
stopbits	integer	Stop bit count for communication	No	1	1	2
parity	string	Communication parity option	No	none	none, even, odd	
flowcontrol	string	Communication device flow control option.	No	none	none	
timeout_ms	integer	Timeout of waiting for incoming request in miliseconds	Yes		0	60000
serial_close_delay	integer	Delay before closing serial port	No	400		

Windlog parameters for *Signals* tab

Parameter	**Type**	**Description**	**Required**	**Default value** (when not specified)	**Range**	
signal_name	string	User-friendly signal name	Yes			
device_alias	string	Device alias from a Devices tab	Yes			
signal_alias	string	Unique alphanumeric name of the signal to be used	Yes			
enable	boolean	Enabling/disabling of an individual signal	No	1	0	1
log	integer	Enable logging in event log	No	0		
number_type	string	Type of a number (FLOAT, DOUBLE, DIGITAL, etc.)	Yes			

job_todo	string	Tag job as single or multiple comma separated OBIS codes	Yes			
tag_job_todo	string	Tag sub job	Yes			

At command

Overview

At command protocol is used for communications with AT Commands.

Configuration

At command parameters for *Device* tab

Parameter	**Type**	**Description**	**Required**	**Default value** (when not specified)	**Range**	
					Min	Max
name	string	User-friendly device name	Yes			
description	string	Description of a device	No			
device_alias	string	Alphanumeric string to identify a device	Yes			
enable	boolean	Enabling/disabling of a device	No	1	0	1
protocol	string	Protocol to be used.	Yes		at command	
device	string	Communication port	Yes		PORT1	PORT2
baudrate	integer	Communication speed, bauds/s	No	9600	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600,115200	
databits	integer	Data bit count for communication	No	8	6	9
stopbits	integer	Stop bit count for communication	No	1	1	2
parity	string	Communication parity option	No	none	none, even, odd	
flowcontrol	string	Communication device flow control option.	No	none	none	
timeout_ms	integer	Timeout of waiting for incoming request in miliseconds	Yes		0	60000
serial_close_delay	integer	Delay before closing serial port	No	400		

At command parameters for *Signals* tab

Parameter	**Type**	**Description**	**Required**	**Default value** (when not specified)	**Range**	
signal_name	string	User-friendly signal name	Yes			
device_alias	string	Device alias from a Devices tab	Yes			

signal_alias	string	Unique alphanumeric name of the signal to be used	Yes			
enable	boolean	Enabling/disabling of an individual signal	No	1	0	1
log	integer	Enable logging in event log	No	0		
number_type	string	Type of a number (FLOAT, DOUBLE, DIGITAL, etc.)	Yes			
job_todo	string	Tag job as single or multiple comma separated OBIS codes	Yes			
tag_job_todo	string	Tag sub job	Yes			

SOLPLUS

Overview

Solplus protocol is used to download inverter data from Solplus inverters using a http client.

Configuration

Solplus parameters for *Device* tab

Parameter	**Type**	**Description**	**Required**	**Default value** (when not specified)	**Range**	
					Min	Max
name	string	User-friendly device name	Yes			
description	string	Description of a device	No			
device_alias	string	Alphanumeric string to identify a device	Yes			
enable	boolean	Enabling/disabling of a device	No	1	0	1
protocol	string	Protocol to be used.	Yes		Solplus	
scan_rate_ms	integer	All reads and writes will be executed within thetimeframe in miliseconds	No	10000		
poll_delay_ms	integer	Minimum time delay in miliseconds to wait before sending any data on port.	No	200		
timeout_ms	integer	Timeout of waiting for incoming request in miliseconds	No	2500	0	60000
url	string	HTTP server location URL	Yes			

Solplus parameters for *Signals* tab

Parameter	**Type**	**Description**	**Required**	**Default value** (when not specified)	**Range**	
signal_name	string	User-friendly signal name	Yes			
device_alias	string	Device alias from a Devices tab	Yes			
signal_alias	string	Unique alphanumeric name of the signal to be used	Yes			
enable	boolean	Enabling/disabling of an individual signal	No	1	0	1

log	integer	Enable logging in event log	No	0		
number_type	string	Type of a number (FLOAT, DOUBLE, DIGITAL, etc.)	Yes			
job_todo	string	Tag job as single or multiple comma separated OBIS codes	Yes			
tag_job_todo	string	Tag sub job	Yes			
pulse_short_time_ms	integer	Time interval for short output pulse to stay active	No			
pulse_long_time_ms	integer	Time interval for long output pulse to stay active	No			

GINLONG

Overview

Ginlong protocol is used to communicate with Ginlong inverters over serial communication.

GINLONG parameters for *Device* tab:

Parameter	**Type**	**Description**	**Required**	**Default value** (when not specified)	**Range**	
					Min	Max
name	string	User-friendly device name	Yes			
description	string	Description of the device	No			
device_alias	string	Device alias to be used in configuration	Yes			
enable	boolean	Enabling/disabling of a device	No	1	0	1
protocol	string	Selection of protocol	Yes		Ginlong	
baudrate	integer	Communication speed, bauds/s (See values 33.1.2)	No	9600	300	115200
databits	integer	Data bit count for communication	No	8	6	9
stopbits	integer	Stop bit count for communication	No	1	1	2
parity	string	Communication parity option (”none”/”even”/”odd”)	No	none		
flowcontrol	string	Communication device flow control option. (Default: (case-sensitive): ”none”)	No	none		
scan_rate_ms	integer	If provided and positive all reads and writes will be executed within the timeframe in miliseconds.	No	10000		
poll_delay_ms	integer	Minimum time delay in miliseconds to wait before sending any data on port.	No	200		
timeout_ms	integer	Timeout in milliseconds	No	2500		
id	integer	Inverter ID	Yes	0		

device	string	Communication port	Yes		PORT1	PORT2

GINLONG parameters for Signals tab:

Parameter	**Type**	**Description**	**Required**	**Default value** (when not specified)	**Range**	
					Min	Max
signal_name	string	User-friendly device name	Yes			
device_alias	string	Device alias from a Devices tab	Yes			
signal_alias	string	Unique alphanumeric name of the signal to be used	Yes			
enable	boolean	Enabling/disabling of an individual signal	No	1	0	1
log	integer	Allow signal to be logged.	No	0		
job_todo	boolean	Define tag-function	Yes			
tag_job_todo	string	Define tag action that depends on tag function	Yes			
number_type	integer	Type of a number (FLOAT, DOUBLE, DIGITAL, etc.)	Yes			
pulse_short_time_ms	integer	Time interval for short output pulse to stay active	No	0		
pulse_long_time_ms	integer	Time interval for long output pulse to stay active	No	0		

Delta

Overview

Delta protocol is used to communicate with Delta inverters over serial communication.

Configuration

Delta parameters for *Device* tab

Parameter	**Type**	**Description**	**Required**	**Default value** (when not specified)	**Range**	
					Min	Max
name	string	User-friendly device name	Yes			
description	string	Description of the device	No			
device_alias	string	Device alias to be used in configuration	Yes			
enable	boolean	Enabling/disabling of a device	No	1	0	1
protocol	string	Selection of protocol	Yes		Delta	
baudrate	integer	Communication speed, bauds/s	No	9600	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200	
databits	integer	Data bit count for communication	No	8	6	9
stopbits	integer	Stop bit count for communication	No	1	1	2
parity	string	Communication parity option (”none”/”even”/”odd”)	No	none		
flowcontrol	string	Communication device flow control option. (Default: (case-sensitive): ”none”)	No	none		
scan_rate_ms	integer	If provided and positive all reads and writes will be executed within the timeframe in miliseconds.	No	10000		
poll_delay_ms	integer	Minimum time delay in miliseconds to wait before sending any data on port.	No	200		
timeout_ms	integer	Timeout in milliseconds	No		0	60000
id	integer	Inverter ID	Yes	0		
device	string	Communication port	Yes		PORT1	PORT2

Delta parameters for *Signals* tab

Parameter	**Type**	**Description**	**Required**	**Default value** (when not specified)	**Range**	
signal_name	string	User-friendly signal name	Yes			
device_alias	string	Device alias from a Devices tab	Yes			
signal_alias	string	Unique alphanumeric name of the signal to be used	Yes			
enable	boolean	Enabling/disabling of an individual signal	No	1	0	1
log	integer	Enable logging in event log	No	0		
number_type	string	Type of a number (FLOAT, DOUBLE, DIGITAL, etc.)	Yes			
job_todo	string	Tag job as single or multiple comma separated OBIS codes	Yes			
tag_job_todo	string	Tag sub job	Yes			
pulse_short_time_ms	integer	Time interval for short output pulse to stay active	No			
pulse_long_time_ms	integer	Time interval for long output pulse to stay active	No			

COMLYNX

Overview

Comlynx protocol is used to communicate with Comlynx inverters over serial communication.

Comlynx parameters for *Device* tab:

Parameter	**Type**	**Description**	**Required**	**Default value** (when not specified)	**Range**	
					Min	Max
name	string	User-friendly device name	Yes			
description	string	Description of the device	No			
device_alias	string	Device alias to be used in configuration	Yes			
enable	boolean	Enabling/disabling of a device	No	1	0	1
protocol	string	Selection of protocol	Yes		Comlynx	
address	integer	Device address	No	1		
subnet	integer	Subnet address	No	0		
network	integer	Network address	No	0		
device	string	Communication port	Yes		PORT1	PORT2
baudrate	integer	Communication speed, bauds/s	No	19200	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200	
databits	integer	Data bit count for communication	No	8	6	9
stopbits	integer	Stop bit count for communication	No	1	1	2
parity	string	Communication parity option (”none”/”even”/”odd”)	No	none		
flowcontrol	string	Communication device flow control option. (Default: (case-sensitive): ”none”)	No	none		
scan_rate_ms	integer	If provided and positive all reads and writes will be executed within the timeframe in miliseconds.	No	10000		
poll_delay_ms	integer	Minimum time delay in miliseconds to wait before sending any data on port.	No	200		
timeout_ms	integer	Timeout in milliseconds	Yes		0	60000

Comlynx parameters for *Signals* tab:

Parameter	**Type**	**Description**	**Required**	**Default value** (when not specified)	**Range**	
					Min	Max
signal_name	string	User-friendly device name	Yes			
device_alias	string	Device alias from a Devices tab	Yes			
signal_alias	string	Unique alphanumeric name of the signal to be used	Yes			
enable	boolean	Enabling/disabling of an individual signal	No	1	0	1
log	integer	Allow signal to be logged.	No	0		
job_todo	boolean	Define tag-function	Yes			
tag_job_todo	string	Define tag action that depends on tag function	Yes			
number_type	integer	Type of a number (FLOAT, DOUBLE, DIGITAL, etc.)	Yes			
pulse_short_time_ms	integer	Time interval for short output pulse to stay active	No	0		
pulse_long_time_ms	integer	Time interval for long output pulse to stay active	No	0		

POWERONE

Overview

PowerOne protocol is used to communicate with Aurora inverters over serial communication. Serial communication parameters (baudrate, parity, etc.) are handled automatically by the protocol.

Configuration

PowerOne parameters for *Device* tab

Parameter	**Type**	**Description**	**Required**	**Default value** (when not specified)	**Range**	
					Min	Max
name	string	User-friendly device name	Yes			
description	string	Description of a device	No			
device_alias	string	Alphanumeric string to identify a device	Yes			
enable	boolean	Enabling/disabling of a device	No	1	0	1
protocol	string	Protocol to be used.	Yes		powerone	
serialnumber	integer	Inverter serial number	Yes			
type	integer	Inverter type : • CU - Collecting unit • CB - Normal CB • HID - HID with integrated CB	No	CU		
device		Communication port	Yes		PORT1	PORT2
baudrate	integer	Communication speed, bauds/s	No	9600	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600,115200	
scan_rate_ms	integer	Delay before closing serial port in miliseconds	No	10000		
poll_delay_ms	integer	Minimum time delay in miliseconds to wait before sending any data on port.	No	200		
timeout_ms	integer	Timeout of waiting for incoming request in miliseconds	No	1000	0	60000

PowerOne parameters for *Signals* tab

Parameter	**Type**	**Description**	**Required**	**Default value** (when not specified)	**Range**	
signal_name	string	User-friendly signal name	Yes			
device_alias	string	Device alias from a Devices tab	Yes			
signal_alias	string	Unique alphanumeric name of the signal to be used	Yes			
enable	boolean	Enabling/disabling of an individual signal	No	1	0	1
log	integer	Enable logging in event log	No	0		
number_type	string	Type of a number (FLOAT, DOUBLE, DIGITAL, etc.)	Yes			
job_todo	string	Tag job as single or multiple comma separated OBIS codes	Yes			
tag_job_todo	string	Tag sub job	Yes			
pulse_short_time_ms	integer	Time interval for short output pulse to stay active	No	0		
pulse_long_time_ms	integer	Time interval for long output pulse to stay active	No	0		

KOSTAL

Overview

Kostal protocol is used to communicate with Kostal devices over serial communication.

Configuration

Kostal parameters for *Device* tab

Parameter	**Type**	**Description**	**Required**	**Default value** (when not specified)	**Range**	
					Min	Max
name	string	User-friendly device name	Yes			
description	string	Description of a device	No			
device_alias	string	Alphanumeric string to identify a device	Yes			
enable	boolean	Enabling/disabling of a device	No	1	0	1
protocol	string	Protocol to be used.	Yes		kostal	
id	integer	Kostal device id	Yes			
device		Communication port	Yes		PORT1	PORT2
baudrate	integer	Communication speed, bauds/s	No	9600	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600,115200	
databits	integer	Data bit count for communication	No	8	6	9
stopbits	integer	Stop bit count for communication	No	1	1	2
parity	string	Communication parity option	No	none	none, even, odd	
scan_rate_ms	integer	Delay before closing serial port in miliseconds	No	10000		
poll_delay_ms	integer	Minimum time delay in miliseconds to wait before sending any data on port.	No	200		
timeout_ms	integer	Timeout of waiting for incoming request in miliseconds	Yes		0	60000

Kostal parameters for *Signals* tab

Parameter	**Type**	**Description**	**Required**	**Default value** (when not specified)	**Range**	
signal_name	string	User-friendly signal name	Yes			

device_alias	string	Device alias from a Devices tab	Yes			
signal_alias	string	Unique alphanumeric name of the signal to be used	Yes			
enable	boolean	Enabling/disabling of an individual signal	No	1	0	1
log	integer	Enable logging in event log	No	0		
number_type	string	Type of a number (FLOAT, DOUBLE, DIGITAL, etc.)	Yes			
job_todo	string	Tag job as single or multiple comma separated OBIS codes	Yes			
tag_job_todo	string	Tag sub job	Yes			
pulse_short_time_ms	integer	Time interval for short output pulse to stay active	No			
pulse_long_time_ms	integer	Time interval for long output pulse to stay active	No			

VBUS

Overview

Vbus is a protocol used for communication with solar station automation via serial link.

Configuration

VBUS parameters for *Device* tab

Parameter	**Type**	**Description**	**Required**	**Default value** (when not specified)	**Range**	
					Min	Max
name	string	User-friendly device name	Yes			
description	string	Description of the device	No			
device_alias	string	Device alias to be used in configuration	Yes			
enable	boolean	Enabling/disabling of a device	No	1	0	1
protocol	string	Selection of protocol	Yes		Vbus	
slave_address	integer	Slave device address	Yes		0	255
master_address	integer	Master device address	Yes		0	255
device	string	Communication port	Yes		PORT1	PORT2
baudrate	integer	Communication speed, bauds/s	No	9600	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200	
databits	integer	Data bit count for communication	No	8	6	9
stopbits	integer	Stop bit count for communication	No	1	1	2
parity	string	Communication parity option	No	none	none, even, odd	
flowcontrol	string	Communication device flow control option.	No	none	none	
scan_rate_ms	integer	If provided and positive all reads and writes will be executed within the timeframe in miliseconds.	No	10000		
poll_delay_ms	integer	Minimum time delay in miliseconds to wait before sending any data on port.	No	200		
timeout_ms	integer	Timeout in milliseconds	No	2500	0	60000

VBUS parameters for *Signals* tab:

Parameter	**Type**	**Description**	**Required**	**Default value** (when not specified)	**Range**	
					Min	Max
signal_name	string	User-friendly device name	Yes			

device_alias	string	Device alias from a Devices tab	Yes			
signal_alias	string	Unique alphanumeric name of the signal to be used	Yes			
enable	boolean	Enabling/disabling of an individual signal	No	1	0	1
log	integer	Allow signal to be logged.	No	0	0	
job_todo	boolean	Define tag-function	Yes			
tag_job_todo	string	Define tag action that depends on tag function	Yes			
number_type	integer	Type of a number (FLOAT, DOUBLE, DIGITAL, etc.)	Yes			
pulse_short_time_ms	integer	Time interval for short output pulse to stay active	No	0		
pulse_long_time_ms	integer	Time interval for long output pulse to stay active	No	0		

VESTAS

Overview

Vestas is a protocol used for communication with solar station automation via serial link.

Configuration

Vestas parameters for *Device* tab

Parameter	Type	Description	Required	Default value (when not specified)	Range	
					Min	Max
name	string	User-friendly device name	Yes			
description	string	Description of the device	No			
device_alias	string	Device alias to be used in configuration	Yes			
enable	boolean	Enabling/disabling of a device	No	1	0	1
protocol	string	Selection of protocol	Yes		Vestas	
slave_address	integer	Slave device address	Yes		0	255
master_address	integer	Master device address	No	0	0	255
device	string	Communication port	Yes		PORT1	PORT2
baudrate	integer	Communication speed, bauds/s	No	9600	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200	
databits	integer	Data bit count for communication	No	8	6	9
stopbits	integer	Stop bit count for communication	No	1	1	2
parity	string	Communication parity option (”none”/”even”/”odd”)	No	none	none, even, odd	
flowcontrol	string	Communication device flow control option. (Default: (case-sensitive): ”none”)	No	none		
scan_rate_ms	integer	If provided and positive all reads and writes will be executed within the timeframe in miliseconds.	No	10000		
poll_delay_ms	integer	Minimum time delay in miliseconds to wait before sending any data on port.	No	200		
timeout_ms	integer	Timeout in milliseconds	No	2500		

Vestas parameters for *Signals* tab:

Parameter	Type	Description	Required	Default value (when not specified)	Range	
					Min	Max
signal_name	string	User-friendly device name	Yes			

device_alias	string	Device alias from a Devices tab	Yes			
signal_alias	string	Unique alphanumeric name of the signal to be used	Yes			
enable	boolean	Enabling/disabling of an individual signal	No	1	0	1
log	integer	Allow signal to be logged.	No	0		
job_todo	boolean	Define tag-function	Yes			
tag_job_todo	string	Define tag action that depends on tag function	Yes			
number_type	integer	Type of a number (FLOAT, DOUBLE, DIGITAL, etc.)	Yes			
pulse_short_time_ms	integer	Time interval for short output pulse to stay active	No	0		
pulse_long_time_ms	integer	Time interval for long output pulse to stay active	No	0		

Kaco

Overview

This protocol is meant to be used by inverters that convert the DC power generated by the photovoltaic (PV) modules into AC power and feed this into the power grid.

ℹ This protocol handles serial communication parameters (baudrate, databits, stopbits, etc.) automatically.

Configuration

Kaco parameters for *Device* tab

Parameter	**Type**	**Description**	**Required**	**Default value** (when not specified)	**Range**	
					Min	Max
name	string	User-friendly device name	Yes			
description	string	Description of a device	No			
device_alias	string	Alphanumeric string to identify a device	Yes			
enable	boolean	Enabling/disabling of a device	No	1	0	1
protocol	string	Protocol to be used.	Yes		Kaco	
scan_rate_ms	integer	All reads and writes will be executed within the timeframe in miliseconds.	No	10000		
poll_delay_ms	integer	Minimum time delay in miliseconds to wait before sending any data on port.	No	200		
timeout_ms	integer	Timeout of waiting for incoming request in miliseconds	No	2500	0	60000
subid	integer	Inverter serial number display	No	0		
ext_device	boolean	0 - Inverter is connected directly 1 - Inverter is connected via remote terminal	No	0	0	1
id	integer	Inverter serial number	Yes			
device	string	Communication port	Yes		PORT1	PORT2

Kaco parameters for *Signals* tab

Parameter	Type	Description	Required	**Default value** (when not specified)	Range

signal_name	string	User-friendly signal name	Yes			
device_alias	string	Device alias from a Devices tab	Yes			
signal_alias	string	Unique alphanumeric name of the signal to be used	Yes			
enable	boolean	Enabling/disabling of an individual signal	No	1	0	1
log	integer	Enable logging in event log	No	0		
number_type	string	Type of a number (FLOAT, DOUBLE, DIGITAL, etc.)	Yes			
job_todo	string	Tag job as single or multiple comma separated OBIS codes	Yes			
tag_job_todo	string	Tag sub job	Yes			
pulse_short_time_ms	integer	Time interval for short output pulse to stay active	No			
pulse_long_time_ms	integer	Time interval for long output pulse to stay active	No			

M-Bus

Overview

M-Bus or Meter-Bus is a protocol for the remote reading of water, gas, or electricity meters. M-Bus is also usable for other types of consumption meters, such as heating systems or water meters. The M-Bus interface is made for communication on two wires, making it cost-effective. M-bus over TCP is also supported. When configured, meters will deliver the data they have collected to a WCCLite RTU that is connected at periodic intervals (scan_rate_ms) to read all utility meters.

Configuration

M-Bus parameters for *Device* tab

Parameter	**Type**	**Description**	**Required**	**Default value** (when not specified)	**Range**	
					Min	Max
name	string	User-friendly device name	Yes			
description	string	Description of a device	No			
device_alias	string	Alphanumeric string to identify a device	Yes			
enable	boolean	Enabling/disabling a device	No	1	0	1
protocol	string	Protocol to be used.	Yes		mbus serial, mbus tcp	
scan_rate_ms	integer	All reads and writes will be executed within the timeframe in milliseconds.	No	10000		
poll_delay_ms	integer	Minimum time delay in milliseconds to wait before sending any data on port.	No	200		
timeout_ms	integer	Timeout of waiting for an incoming response in milliseconds	Yes		0	60000
address	integer	Device address	Yes			
device	string	Communication port	Yes (for serial)		PORT1	PORT2
baudrate	integer	Communication speed, baud/s	No (for serial)	9600	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200	
databits	integer	Data bit count for communication	No (for serial)	8	6	9
stopbits	integer	Stop bit count for communication	No (for serial)	1	1	2

parity	string	Communication parity option	No (for serial)	none	none, even, odd	
serial_close_delay	integer	Delay before closing the serial connection.	No (for serial)	400		
ip	string	The IP address of the TCP slave device	Yes (for TCP).			
port	integer	TCP communication port	Yes (for TCP)		0	65535

M-Bus parameters for the *Signals* tab

Parameter	**Type**	**Description**	**Required**	**Default value** (when not specified)	**Range**	
					Min	Max
signal_name	string	User-friendly signal name	Yes			
device_alias	string	Device alias from a Devices tab	Yes			
signal_alias	string	Unique alphanumeric name of the signal to be used	Yes			
enable	boolean	Enabling/disabling of an individual signal	No	1	0	1
log	integer	Enable logging in the event log	No	0		
number_type	string	Type of a number (FLOAT, DOUBLE, DIGITAL, etc.)	Yes			
job_todo	string	Tag job as single or multiple comma-separated OBIS codes	Yes			
tag_job_todo	string	Tag sub job	Yes			

Modbus

Introduction

Modbus is a serial communications protocol for use with its programmable logic controllers (PLCs). Modbus has become a de facto standard communication protocol and is now a commonly available means of connecting industrial electronic devices. It was developed for industrial applications, is relatively easy to deploy and maintain compared to other standards, and places few restrictions other than size on the format of the data to be transmitted.

Modbus enables communication among many devices connected to the same network, for example, a system that measures temperature and humidity and communicates the results to a computer. Modbus is often used to connect a supervisory computer with a remote terminal unit (RTU) in supervisory control and data acquisition (SCADA) systems. Many of the data types are named from industry usage of Ladder logic and its use in driving relays: a single-bit physical output is called a coil, and a single-bit physical input is called a discrete input or a contact.

WCC Lite supports both Modbus Master and Slave protocols. One can select between transmission over TCP/IP or serial connection (RS-485/RS232). Bytes to transmit can either be encoded according to both RTU and ASCII parts of standard.

Modbus Master

Modbus communication contains a single Master and may include more than 1, but not more than 247 devices. To gather data from peripheral devices, master device request a cluster of slave devices for data. If any device understand that this message is addressed for it, replies with data. As no timestamp is sent along with data, having recent data requires frequent polling. WCC Lite can be configured to acquire data periodically in custom-defined intervals.

Configuring datapoints

To use Modbus Master in WCC Lite, it has to be configured via an Excel configuration. This configuration contains two Excel sheets where parameters have to be filled in - Devices and Signals

Modbus Master parameters for Devices tab

Parameter	**Type**	**Description**	**Required**	**Default Value** (when not specified)	**Range**	
					Min	Max
name	string	User-friendly name for a device	Yes			
description	string	Description of a device	No			
device_alias	string	Alphanumeric string to identify a device	Yes			
enable	boolean	Enabling/disabling of a device	No	1	0	1
protocol	string	Protocol to be used	Yes		Modbus RTU, Modbus TCP	
ip	string	IP address of TCP slave device	Yes (for TCP).			
port	integer	TCP communication port	No (for TCP)	502		
bind_address	string	IP address of network adapter used to connect to slave device (Default: "0.0.0.0")	No (for TCP)	0.0.0.0		
id	integer	Modbus Slave ID	Yes			

mode	string	Choosing between RTU(”rtu”), ASCII (”ascii”) and TCP(”tcp”) modes. ASCII is the same as RTU, but with ASCII symbols.	No	TCP (for TCP) RTU (for Serial)	rtu, ascii, tcp	
timeout_ms	integer	Response timeout in milliseconds	No	10000		
device	string	Communication port (”PORT1”/”PORT2”)	Yes (for RTU/ASCII)		PORT1	PORT2
baudrate	integer	Communication speed, baud/s	No (for RTU/ASCII)	9600	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200	
databits	integer	Data bit count for communication	No (for RTU/ASCII)	8	6	9
stopbits	integer	Stop bit count for communication	No (for RTU/ASCII)	1	1	2
parity	string	Communication parity option	No (for RTU/ASCII)	none	none, even, odd	
flowcontrol	string	Number of requests, before link is considered lost (device status signals are changed) and reconnect attempt will be issued	No (for RTU/ASCII)	none	none	
scan_rate_ms	integer	If provided and positive - all jobs will have similar scan rate - all reads and writes will be executed within this timeframe (parameter scan_rate_ms in Signals tab will be ignored)	No	300		
retry_count	integer	Number of requests, before link is considered lost (device status signals are changed) and reconnect attempt will be issued	No	3		
serial_delay	integer	RS485 delay between read and write operations in milliseconds	No (for RTU/ASCII)	50		
keep_alive_timeout	integer	Time interval for sending a keep alive packet (in milliseconds)	No (for TCP)	60		
modbus_multi_write	boolean	Use 15/16 functions to write 1 register/coil (Default: 0)	No	0	0	1
comm_restart_delay	integer	Time delay between disconnecting from slave device and restarting connection (in milliseconds) (Default: 500)	No (for TCP)	500		

Modbus Master parameters for Signals tab

Parameter	**Type**	**Description**	**Required**	**Default Value** (when not specified)	**Range**	
					Min	Max
signal_name	string	User-friendly signal name	Yes			

device_alias	string	Alphanumeric string to identify a device	Yes			
signal_alias	string	Unique alphanumeric name of the signal to be Yes used	Yes			
enable	boolean	Enabling/disabling of an individual signal	No	1	0	1
job_todo	string	Request to send according to modbus specification without device address and checksum. This field can be identical on several tags to fetch them in single request	Yes			
tag_job_todo	string	Similar format to job_todofield. Address and length must be a subset of job field. Defines the individual tag's resgister(s) or coil(s). Can be described in HEX or DEC formats	Yes			
number_type	string	Type of a number (FLOAT, DOUBLE, DIGITAL, etc.)	Yes			
log	integer	Size of this signal's log in Event log.	No	0		
pulse_short_time_ms	integer	Time interval for short output pulse to stay active	No			
pulse_long_time_ms	integer	Time interval for long output pulse to stay active	No			

Different device vendors can have different implementations of a Modbus protocol stack. A register table can be a one of the primary differences. WCC Lite Modbus Master transmits the most significant word (byte) first, however, devices from some vendors might require transmitting the least significant word (byte) first. If that is the case, make sure to switch bytes as needed. To find out more about setting a correct number format, one should consult a section `number_type`.

Modbus job or tag (as a task to be completed) can be built in a two different formats - user can select a more convenient way for him:

- hexadecimal format with every single byte separated by | symbol. Device address, bytes containing output information and CRC (LRC) bytes should be excluded from the message;
- decimal format containing function number, first address and address count, separated by ; symbol. All other information should be excluded from the message;

`job_todo` can group several `tag_job_todo`'s. That way one Modbus message can be used to extract several tags. Grouping is accomplished dynamically meaning that if several identical jobs are found, their tags are grouped automatically.

Modbus Master has an additional signal which can be configured to show communication status. It is used to indicate if the slave device has disconnected from master (WCC Lite). To configure such signal, two columns should be filled with particular values. To a newly created additional signal one should make `job_todo` equal to `device_status` and `tag_job_todo` equal to communication_status. Communication error status is set when a predefined count of messages (three by default, defined in `poll_retry_count` column) fail to be received or are considered invalid.

Debugging a Modbus Master application

If configuration for Modbus Master is set up, handler for protocol will start automatically. If configuration is missing or contains errors, protocol will not start. It is done intentionally to decrease unnecessary memory usage.

Modbus Master command line debugging options

`modbus-master`

```
 -h [ –help ] Display help information
```

```
-V [ -version ] Show version
-d<debug level> Set debugging level
-c [ -config ] Config path
-r [ -raw ] Show raw telegram data
-f [ -frame ] Show frame data
-s [ -serial ] Show serial port data
-tcp Show tcp packets
-ascii Show ASCII messages
-rtu Show RTU messages
-e [ -redis ] Show redis debug information
-R [ -readyfile ] Ready notification file
```

If Modbus Master does not work properly (e.g. no communication between devices, data is corrupted, etc.), a user can launch a debug session from command line interface and find out why link is not functioning properly. To launch a debugging session, a user should stop modbus-master process and run modbus-master command with respective flags as shown above.

Modbus Slave

WCC Lite can act as one (or several) of slave devices in a communication line. This can be used to transmit data to SCADA systems or other RTU devices. It can reply to a messages from Modbus Master with matching device and register addresses.

Configuring datapoints

To use Modbus Slave in WCC Lite, it has to be configured via an Excel configuration. This configuration contains two Excel sheets where parameters have to be filled in - Devices and Signals

> ⚠ If TCP/IP is used as a trasmission medium, only devices with IPs predefined in host column are allowed to connect. All other connections are rejected

Modbus Slave parameters for Devices tab

Parameter	**Type**	**Description**	**Required**	**Default Value** (when not specified)	**Range**	
					Min	Max
name	string	User-friendly name for a device	Yes			
description	string	Description of a device	No			
device_alias	string	Alphanumeric string to identify a device	Yes			
enable	boolean	Enabling/disabling of a device	No	1	0	1
protocol	string	Protocol to be used	Yes		Modbus serial Slave, Modbus TCP Slave	
host	string	Space separated host IP addresses of master device	Yes (for TCP).			
port	integer	TCP port to listen for incoming connections	Yes (for TCP)			
bind_address	string	IP address of network adapter used to connect to slave device (Default: ”0.0.0.0”)	No (for TCP)	0.0.0.0		
keep_alive_timeout	integer	Minimum time a connection can be idle without being closed in miliseconds	No (for TCP)	60		

mode	string	Choosing between RTU(”rtu”), ASCII (”ascii”) and TCP(”tcp”) modes. ASCII is the same as RTU, but with ASCII symbols.	No	TCP (for TCP) RTU (for Serial)	rtu, ascii, tcp	
device	string	Communication port (”PORT1”/”PORT2”)	Yes (for serial)		PORT1	PORT2
baudrate	integer	Communication speed, baud/s	No (for serial)	9600	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200	
databits	integer	Data bit count for communication	No (for serial)	8	6	9
stopbits	integer	Stop bit count for communication	No for serial)	1	1	2
parity	string	Communication parity option	No (for serial)	none	none, even, odd	
flowcontrol	string	Communication device’s flow control option.	No (for serial)	none	none	

Modbus Slave parameters for Signals tab

Parameter	**Type**	**Description**	**Required**	**Default Value** (when not specified)	**Range**	
					Min	Max
signal_name	string	User-friendly signal name	Yes			
device_alias	string	Alphanumeric string to identify a device	Yes			
signal_alias	string	Unique alphanumeric name of the signal to be Yes used	Yes			
enable	boolean	Enabling/disabling of an individual signal	No	1	0	1
number_type	string	Type of a number (FLOAT, DOUBLE, DIGITAL, etc.)	Yes			
log	integer	Size of this signal’s log in Event log.	No	0		
common_address	integer	Address of a slave device	Yes			
function	integer	Function number	Yes			
info_address	integer	Register address	Yes			
size	integer	Register/Coil size	Yes			

Mapping values to registers

Internally stored values aren’t organised in a register-like order, therefore mapping should be done by the user. This mapping includes setting an address of the device WCC Lite is simulating as well as function number, register number and how much 16-bit registers are used to store a value. These values should be set in `common_address`, `function`, `info_address` and `size` columns respectively in the Excel configuration.

To find out how many register should be used for storing a values, how values can have their values swapped, a user should consult a section `number_type` (18.2.4).

⚠ If a Modbus master device requests a data from a register that is mapped but doesn’t yet have initial value, ILLEGAL DATA ADDRESS error code will be returned. The same error code is returned if a requested size of value is bigger that defined or if register is not configured at all.

Debugging a Modbus Slave application

If configuration for Modbus Slave is set up, handler for protocol will start automatically. If configuration is missing or contains errors, protocol will not start. It is done intentionally to decrease unnecessary memory usage.

Modbus Slave command line debugging options

`modbus-slave`

```
-h [ -help ] Display help information
-V [ -version ] Show version
-d<debug level> Set debugging level
-c [ -config ] Config path
-r [ -raw ] Show raw telegram data
-f [ -frame ] Show frame data
-s [ -serial ] Show serial port data
-tcp Show tcp packets
-ascii Show ASCII messages
-rtu Show RTU messages
-e [ -redis ] Show redis debug information
-R [ -readyfile ] Ready notification file
```

⚠ If Modbus Slave does not work properly (e.g. no communication between devices, data is corrupted, etc.), a user can launch a debug session from command line interface and find out why link is not functioning properly.

ℹ To launch a debugging session, a user should stop `modbus-slave` process and run `modbus-slave` command with respective flags as shown above.

IEC 60870-5

Introduction

IEC 60870 part 5 is one of the IEC 60870 set of standards which define systems used for telecontrol (supervisory control and data acquisition) in electrical engineering and power system automation applications. Part 5 provides a communication profile for sending basic telecontrol messages between two systems, which uses permanent directly connected data circuits between the systems. The IEC Technical Committee 57 (Working Group 03) have developed a protocol standard for telecontrol, teleprotection, and associated telecommunications for electric power systems. The result of this work is IEC 60870-5. Five documents specify the base IEC 60870-5:

- IEC 60870-5-1 Transmission Frame Formats
- IEC 60870-5-2 Data Link Transmission Services
- IEC 60870-5-3 General Structure of Application Data
- IEC 60870-5-4 Definition and Coding of Information Elements
- IEC 60870-5-5 Basic Application Functions
- IEC 60870-5-6 Guidelines for conformance testing for the IEC 60870-5 companion standards
- IEC TS 60870-5-7 Security extensions to IEC 60870-5-101 and IEC 60870-5-104 protocols (applying IEC 62351)

The IEC Technical Committee 57 has also generated companion standards:

- IEC 60870-5-101 Transmission Protocols - companion standards especially for basic telecontrol tasks
- IEC 60870-5-102 Transmission Protocols - Companion standard for the transmission of integrated totals in electric power systems (this standard is not widely used)
- IEC 60870-5-103 Transmission Protocols - Companion standard for the informative interface of protection equipment
- IEC 60870-5-104 Transmission Protocols - Network access for IEC 60870-5-101 using standard transport profiles
- IEC TS 60870-5-601 Transmission protocols - Conformance test cases for the IEC 60870-5-101 companion standard
- IEC TS 60870-5-604 Conformance test cases for the IEC 60870-5-104 companion standard

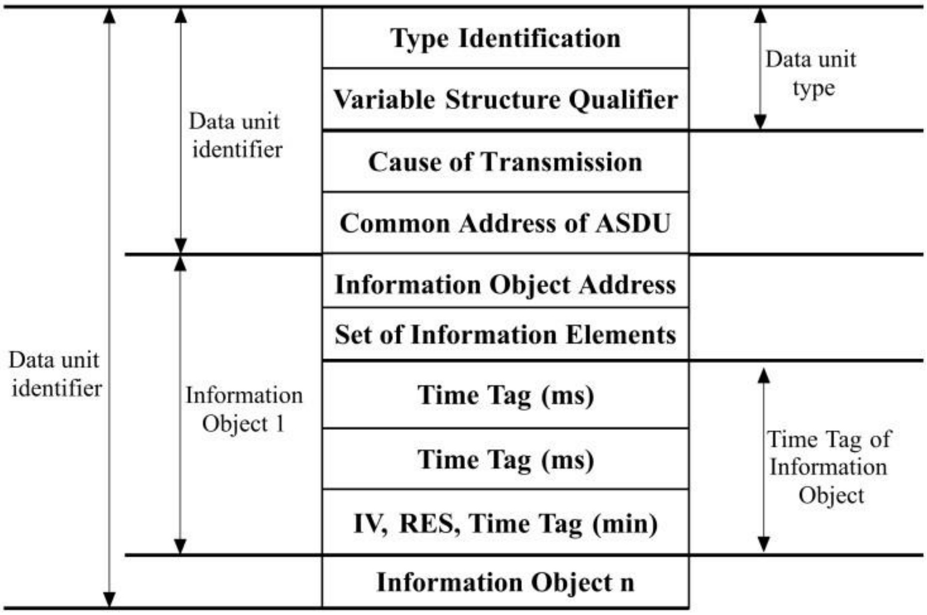
IEC 60870-5-101/102/103/104 are companion standards generated for basic telecontrol tasks, transmission of integrated totals, data exchange from protection equipment & network access of IEC101 respectively.

Source: https://en.wikipedia.org/wiki/IEC_60870-5

IEC 60870-5-101

The IEC 60870-5-101 protocol is a companion standard for power system monitoring, control associated communications for telecontrol, teleprotection, and associated telecommunications for electric power systems. Standard IEC 608705101 was prepared by IEC technical committee 57 (Power system control and associated communications).

Standard IEC 60870-5-101 defines an **Application Service Data Unit** (**ASDU** Figure below). In ASDU there is ASDU identifier(with type of ASDU in it) and information objects.

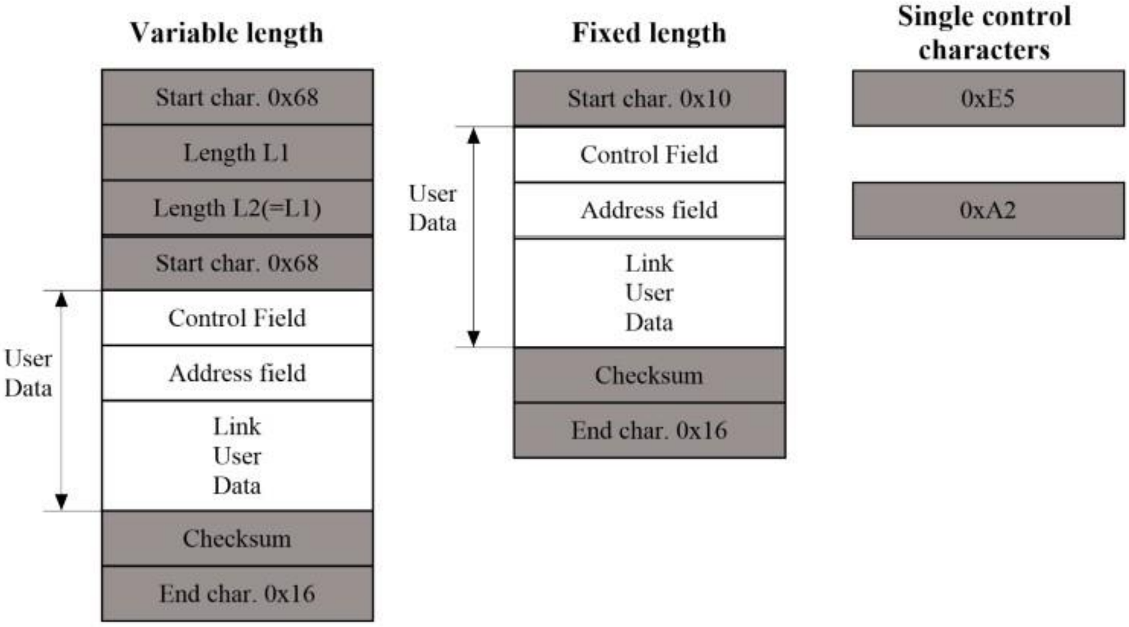


IEC 60870-5-101 ASDU structure

Common Address of ASDU Defines the stations address and can be configured in Devices asdu_address field for source and *Signals* common_address field for destination.

Information Object Address Used as destination object address in the control direction and as source object address in monitor direction can be configured in Signals info_address field.

Standard IEC 60870-5-101 transmission frames are separated into 3 different types: **frame with variable length, frame with fixed length** and **single control characters**



IEC 60870-5-101 ASDU structure

Control field provides information about the message direction, type of service and checksum.

Address field specifies the link address which points to the messages destination. WCC Lite supports IEC 60870-5-101

Master protocol over serial link (according EIA RS485). Its full functionality list can be found in a IEC 60870-5-101 PID Interoperability List which can be downloaded separately from this user manual.

Configuring datapoints (master)

To use IEC 60870-5-101 Master in WCC Lite, it has to configured via an Excel configuration. This configuration contains two Excel sheets where parameters have to be filled in Devices and Signals.

IEC 60870-5-101 master parameters for *Devices* tab

Parameter	**Type**	**Description**	**Required**	**Default Value** (when not specified)	**Range**	
					Min	Max
name	string	User-friendly name for a device	Yes			
description	string	Description of a device	No			
device_alias	string	Alphanumeric string to identify a device	Yes			
enable	boolean	Enabling/disabling of a device	No	1	0	1
protocol	string	Protocol to be used	Yes		IEC 60870-5-101 master	
device	string	Communication port	Yes		PORT1	PORT2
baudrate	integer	Communication speed, baud/s	No	9600	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200	
databits	integer	Data bit count for communication	No	8	6	9
stopbits	integer	Stop bit count for communication	No	1	1	2
parity	string	Communication parity option	No	none	none, even, odd	
flowcontrol	string	Number of requests, before link is considered lost (device status signals are changed) and reconnect attempt will be issued	No	none	none	
link_address	integer	Destination address when in transmit and source address when broadcasting	Yes		0	65535
link_size	integer	Link address size in bytes	No	1	1	2

asdu_address	integer	Application Service Data Unit address	Yes		0	65535
asdu_size	integer	Common address size in bytes	No	1	1	3
ioa_size	integer	Information object address (IOA) size in bytes	No	2	1	3
cot_size	integer	Cause of transmission (COT) size in bytes	No	1	1	2
time_sync_interval_sec	integer	Defines how often (in seconds) slave will request time synchronization. **If greater than 0** - slave will request synchronizations, will reset timer if master did it earlier. **If 0** slave won’t request timesyncs, but will allow them. **If I** - timesyncs are not supported - requests will be dropped.	No	60		
gi_interval_sec	integer	Time frame between General Interrogation requests in seconds, if 0 requests are disabled	No	300		
scan_rate_ms	integer	Polling interval in milliseconds. Time frame between two telegrams from master	No	100		
timeout_ms	integer	Response timeout in milliseconds	No	1000		
retry_count	integer	Number of retries of failed requests before announcing that device is in Error state	No	1		

IEC 60870-5-101 master parameters for Signals tab

Parameter	**Type**	**Description**	**Required**	**Default Value** (when not specified)	**Range**	
					Min	Max
signal_name	string	User-friendly signal name	Yes			
device_alias	string	Alphanumeric string to identify a device	Yes			
signal_alias	string	Unique alphanumeric name of the signal to be Yes used	Yes			
source_device_alias	string	device_alias of a source device	For commands			
source_signal_alias	string	signal_alias of a source signal	For commands			

enable	boolean	Enabling/disabling of an individual signal	No	1	0	1
log	integer	Allow signal to be logged. If **log is 0 signal** will not be logged. If **log is more than 0** signal will be logged	No	0		
gi	boolean	Including/excluding (1 or 0) signal from General Interrogation	No	0	0	1
common_address	integer	Address of a destination device	Yes			
info_address	integer	Information object address	Yes			
data_type	integer	ASDU type identificator	Yes			

IEC 60870-5-101 has an additional signal which can be configured to show communication status. It is used to indicate if the slave device has disconnected from master (WCC Lite). To configure such signal, two columns should be filled with particular values. To a newly created additional signal one should make **job_todo** equal to device_status and **tag_job_todo** equal to communication_status.

Debugging a IEC 60870-5-101 Master application

If configuration for IEC 60870-5-101 devices is set up, handler for protocol will start automatically. If the configuration is missing or contains errors, protocol will not start. It is done intentionally decrease unnecessary memory usage.

If IEC 60870-5-101 does not work properly (e.g. no communication between devices, data is corrupted, etc.), a user can launch a debug session from command line interface and find out why link is not functioning properly. To launch a debugging session, a user should stop *iec101-master* process and run *iec101-master* command with respective flags as shown in the table below.

Procedure for IEC 60870-5-101 master service debugging:

- **Step 1**: Service must be stopped by entering the following command into the wcclite: **/etc/init.d/iec101-master stop**
- **Step 2**: After service is stopped it must be started with the preferred configuration file (JSON files found in /etc/ folder) and a debug level 7:**iec101-master -c /etc/iec101-master/iec101master.json -d7**
  Additional output forming options described here: Command line arguments.
- **Step 3**: Once the problem is diagnosed normal operations can be resumed with the following command: **/etc/init.d/iec101-master start**

IEC 60870-5-101 command line debugging options

```
-h [ –help ] Display help information
-V [ –version ] Show version
-d<debug level> Set debugging level
-c [ –config ] Config path
-r [ –raw ] Show raw telegram data
-f [ –frame ] Show frame data
-R [ –readyfile ] Ready notification file
```

Configuring datapoints (slave)

To use IEC 60870-5-101 Slave in WCC Lite, it has to configured via an Excel configuration. This configuration contains two Excel sheets where parameters have to be filled in *Devices* and *Signals*.

IEC 60870-5-101 slave parameters for Devices tab

Parameter	**Type**	**Description**	**Required**	**Default Value** (when not specified)	**Range**	
					Min	Max
name	string	User-friendly name for a device	Yes			

description	string	Description of a device	No			
device_alias	string	Alphanumeric string to identify a device	Yes			
enable	boolean	Enabling/disabling of a device	No	1	0	1
protocol	string	Protocol to be used	Yes		IEC 60870-5-101 slave	
device	string	Communication port	Yes		PORT1	PORT2
baudrate	integer	Communication speed, baud/s	No	9600	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200	
databits	integer	Data bit count for communication	No	8	6	9
stopbits	integer	Stop bit count for communication	No	1	1	2
parity	string	Communication parity option	No	none	none, even, odd	
flowcontrol	string	Number of requests, before link is considered lost (device status signals are changed) and reconnect attempt will be issued	No	none	none	
link_address	integer	Destination address when in transmit and source address when broadcasting	Yes		0	65535
link_size	integer	Link address size in bytes	No	1	1	2
asdu_size	integer	Common address size in bytes	No	1	1	3
ioa_size	integer	Information object address (IOA) size in bytes	No	2	1	3
cot_size	integer	Cause of transmission (COT) size in bytes	No	1	1	2
time_sync	boolean	Allow time synchronization, 1 to enable and 0 to disable	No	0	0	1
sp_time	boolean	Add CP56Time2a information to single point signals, 1 to enable and 0 to disable	No	0	0	1

dp_time	boolean	Add CP56Time2a information to double point signals, 1 to enable and 0 to disable	No	0	0	1
me_time	boolean	Add CP56Time2a information to measurements, 1 to enable and 0 to disable	No	0	0	1
message_size	integer	Maximum length of a message	Yes		0	255
cache_size	integer	Maximum number of events to store in a buffer	No	100	0	1000
respond_delay	integer	Time in microseconds to wait before sending responses	Yes		0	1000000
single_byte_ack	boolean	Use single character acknowledge, 1 to enable and 0 to disable	No	0	0	1
keep_alive_timeout	integer	Time interval in seconds before serial connection is considered offline	No	60		

keep_alive_timeout timer is used for connection tracker to display protocol status. This parameter has no effect on protocol functionality and is only used to track it’s status in connection tracker.

IEC 60870-5-101 slave parameters for Signals tab

Parameter	**Type**	**Description**	**Required**	**Default Value** (when not specified)	**Range**	
					Min	Max
signal_name	string	User-friendly signal name	Yes			
device_alias	string	Alphanumeric string to identify a device	Yes			
signal_alias	string	Unique alphanumeric name of the signal to be Yes used	Yes			
source_device_alias	string	device_alias of a source device	For commands			
source_signal_alias	string	signal_alias of a source signal	For commands			
enable	boolean	Enabling/disabling of an individual signal	No	1	0	1
log	integer	Allow signal to be logged. If **log is 0 signal** will not be logged. If **log is more than 0** signal will be logged	No	0		
gi	boolean	Including/excluding (1 or 0) signal from General Interrogation	No	0	0	1
common_address	integer	Address of a destination device	Yes			
info_address	integer	Information object address	Yes			
data_type	integer	ASDU type identificator	Yes			

IEC 608705101 has an additional signal which can be configured to show communication status. It is used to indicate if the slave device has disconnected from master (WCC Lite). To configure such signal, two columns should be filled with particular values. To a newly created additional signal one should make **job_todo** equal to device_status and **tag_job_todo** equal to communication_status.

Debugging a IEC 608705101 Master application

If configuration for IEC 60870-5-101 devices is set up, handler for protocol will start automatically. If the configuration is missing or contains errors, protocol will not start. It is done intentionally decrease unnecessary memory usage.

If IEC 60870-5-101 does not work properly (e.g. no communication between devices, data is corrupted, etc.), a user can launch a debug session from command line interface and find out why link is not functioning properly. To launch a debugging session, a user should stop *iec101-slave* process and run *iec101-slave* command with respective flags as shown in the table below.

Procedure for IEC 60870-5-101 slave service debugging:

- **Step 1**: Service must be stopped by entering the following command into the wcclite: **/etc/init.d/iec101-slave stop**
- **Step 2**: After service is stopped it must be started with the preferred configuration file (JSON files found in /etc/ folder) and a debug level 7:**iec101-slave-c /etc/iec101-slave/iec101slave.json -d7** Additional output forming options described here: Command line arguments.
- **Step 3**: Once the problem is diagnosed normal operations can be resumed with the following command: **/etc/init.d/iec101-slave start**

IEC 60870-5-101 command line debugging options

```
-h [ –help ] Display help information
-V [ –version ] Show version
-d<debug level> Set debugging level
-c [ –config ] Config path
-r [ –raw ] Show raw telegram data
-f [ –frame ] Show frame data
-R [ –readyfile ] Ready notification file
```

IEC 60870-5-103

IEC 60870-5-103

The IEC 60870-5-103 protocol is a companion standard for the informative interface of protection equipment. Standard IEC 60870-5-103 was prepared by IEC technical committee 57 (Power system control and associated communications).It is a companion standard for the basic standards in series IEC 60870-5:

Standard IEC 60870-5-103 defines communication between protection equipment and devices of a control system (supervisor or RTU) in a substation.

Standard IEC 60870-5-103 defines a multipoint communication protocol via which information can be exchanged between a control system (supervisor or RTU) and one or more protection devices. The control system is the master and the protection devices are the slaves. Each slave is identified by a unique address between 1 and 254. Address 255 is reserved for broadcast frames.

IEC 60870-5-103 Master

Configuring datapoints

WCC Lite supports IEC 60870-5-103 Master protocol over serial link (according EIA RS-485). Its full functionality list can be found in a IEC 60870-5-103 PID Interoperability List.

To use IEC 60870-5-103 Master in WCC Lite, it has to configured via an Excel configuration. This configuration contains two Excel sheets where parameters have to be filled in - Devices and Signals.

IEC 60870-5-103 parameters for Devices tab

Parameter	**Type**	**Description**	**Required**	**Default Value** (when not specified)	**Range**	
					Min	Max
name	string	User-friendly name for a device	Yes			
description	string	Description of a device	No			
device_alias	string	Alphanumeric string to identify a device	Yes			
enable	boolean	Enabling/disabling of a device	No	1	0	1
protocol	string	Protocol to be used	Yes		IEC 60870-5-103 master	
device	string	Communication port	Yes		PORT1	PORT2
baudrate	integer	Communication speed, baud/s	No	9600	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200	
databits	integer	Data bit count for communication	No	8	8	
stopbits	integer	Stop bit count for communication	No	1	1	2

parity	string	Communication parity option	No	none	none, even, odd	
flowcontrol	string	Number of requests, before link is considered lost (device status signals are changed) and reconnect attempt will be issued	No	none	none	
link_address	integer	Destination address when in transmit and source address when broadcasting	Yes		0	65535
asdu_address	integer	Application Service Data Unit address	Yes		0	65535
time_sync_interval_sec	integer	Time frame between Time Synchronization requests in seconds	No	60		
gi_interval_sec	integer	Time frame between General Interrogation requests in seconds, if 0 requests are disabled	No	300		
scan_rate_ms	integer	Polling interval in milliseconds. Time frame between two telegrams from master	No	100		
timeout_ms	integer	Response timeout in milliseconds	No	1000		
serial_delay	integer	Communication device’s serial delay in milliseconds. Time frame in which master station is not TX’ing after last RX byte	No	50		
retry_count	integer	Number of retries of failed requests before announcing that device is in Error state	No	3		
retry_delay_ms	integer	Time before the next retry in milliseconds	No	500		

IEC 60870-5-103 master parameters for Signals tab

Parameter	**Type**	**Description**	**Required**	**Default Value** (when not specified)	**Range**	
					Min	Max
signal_name	string	User-friendly signal name	Yes			
device_alias	string	Alphanumeric string to identify a device	Yes			
signal_alias	string	Unique alphanumeric name of the signal to be Yes used	Yes			
source_device_alias	string	device_alias of a source device	For commands			

source_signal_alias	string	signal_alias of a source signal	For commands			
enable	boolean	Enabling/disabling of an individual signal	No	1	0	1
log	integer	Allow signal to be logged. If **log is 0 signal** will not be logged. If **log is more than 0** signal will be logged	No	0		
gi	boolean	Including/excluding (1 or 0) signal from General Interrogation	No	0	0	1
common_address	integer	Address of a destination device	Yes			
function	integer	Function number	No	0		
info_address	integer	Information object address	Yes			
info_number	integer	Information number	Yes			
data_type	integer	ASDU type identificator	No	0		
fleeting	boolean	Mark signal as fleeting type (1 or 0). Fleeting signals have go to DPI::OFF after defined time	No		0	1
normalise_time_ms	integer	Time in milliseconds between station receiving DPI::ON and automatically switching to DPI::OFF	If fleeting is used	100		

IEC 60870-5-103 has an additional signal which can be configured to show communication status. It is used to indicate if the slave device has disconnected from master (WCC Lite). To configure such signal, two columns should be filled with particular values. To a newly created additional signal one should make **job_todo** equal to device_status and **tag_job_todo** equal to communication_status.

Debugging a IEC 60870-5-103 Master aplication

If configuration for IEC 60870-5-103 devices is set up, the handler for the protocol will start automatically. If a configuration is missing or contains errors, the protocol will not start. It is done intentionally to decrease unnecessary memory usage.

If IEC 60870-5-103 does not work properly (e.g. no communication between devices, data is corrupted, etc.), a user can launch a debug session from command-line interface and find out why link is not functioning properly or use WCC Utility to do that.

To launch a debugging session, a user should stop the iec103-master process and run the iec103-master command with respective flags.

- Step 1: Service must be stopped by entering the following command into the wcclite: **/etc/init.d/iec103-master stop**
- Step 2: After service is stopped it must be started with the preferred configuration file (JSON files found in /etc/ folder) and a debug level 7: **iec103-master -c /etc/iec/iec103-master.json -d7**
- Step 3: Once the problem is diagnosed normal operations can be resumed with the following command: **/etc/init.d/iec103-master start**

IEC 60870-5-103 command line debugging options

```
-h [ –help ] Display help information
-V [ –version ] Show version
-d<debug level> Set debugging level
-c [ –config ] Config path
-r [ –raw ] Show raw telegram data
-f [ –frame ] Show frame data
```

```
-R [ –readyfile ] Ready notification file
```

IEC 60870-5-104

IEC 60870-5-104 Master

IEC 60870-5-104 protocol (in short IEC 104) is a part of IEC Telecontrol Equipment and Systems Standard IEC 60870-5 that provides a communication profile for sending basic telecontrol messages between two systems in electrical engineering and power system automation. Telecontrol means transmitting supervisory data and data acquisition requests for controlling power transmission grids.

IEC 104 provides the network access to IEC 60870-5-101 (in short IEC 101) using standard transport profiles. In simple terms, it delivers IEC 101 messages as application data (L7) over TCP, usually port 2404. IEC 104 enables communication between control station and a substation via a standard TCP/IP network. The communication is based on the client-server model.

To set up TLS connection for both IEC104 Master and Slave, refer to sections Excel configuration and Certificates. All keys and certificates should be provided in the PEM format.

If no configuration is set up, IEC104 Master and Slave services are not started.

Configuring IEC 104 Master datapoints

To use IEC 60870-5-104 Master in WCC Lite, it has to be configured via an Excel configuration. This configuration contains two Excel sheets where parameters have to be filled in Devices and Signals.

IEC 60870-5-104 Master parameters for *Devices* tab

Parameter	**Type**	**Description**	**Required**	**Default Value** (when not specified)	**Range**	
					Min	Max
name	string	User-friendly name for a device	Yes			
description	string	Description of a device	No			
device_alias	string	Alphanumeric string to identify a device	Yes			
enable	boolean	Enabling/disabling of a device	No	1	0	1
protocol	string	Protocol to be used	Yes		IEC 60870-5-104 master	
asdu_address	integer	Application Service Data Unit address	Yes		0	65535
asdu_size	integer	Common address size in bytes	No	2	1	3
time_sync_interval_sec	integer	Time frame between Time Synchronization requests in seconds	No	60		
gi_interval_sec	integer	Time frame between General Interrogation requests in seconds, if 0 requests are disabled	No	300		
port	integer	TCP port	Yes		0	65535

ioa_size	integer	Information object address (IOA) size in bytes	No	3	1	3
swt	integer	Send window (SWT)	Yes			
rwt	integer	Receive window (RWT)	Yes			
cot_size	integer	Cause of transmission (COT) size in bytes	No	2	1	2
host	string	Host IP address (ipv4)	Yes			
t1	integer	Acknowledge timeout t1 (sec)	Yes			
t2	integer	Connection ACKRSN clock t2 (sec)	Yes			
t3	integer	Connection TESTFR clock t3 (sec)	Yes			
originator	integer	Provides a means for a controlling station toexplicitly identify itself	No	0	0	255

IEC 60870-5-104 Master parameters for *Signals* tab

Parameter	**Type**	**Description**	**Required**	**Default Value** (when not specified)	**Range**	
					Min	Max
signal_name	string	User-friendly signal name	Yes			
device_alias	string	Alphanumeric string to identify a device	Yes			
signal_alias	string	Unique alphanumeric name of the signal to be Yes used	Yes			
source_device_alias	string	device_alias of a source device	For commands			
source_signal_alias	string	signal_alias of a source signal	For commands			
enable	boolean	Enabling/disabling of an individual signal	No	1	0	1
log	integer	Allow signal to be logged. If **log is 0 signal** will not be logged. If **log is more than 0** signal will be logged	No	0		
gi	boolean	Including/excluding (1 or 0) signal from General Interrogation	No	0	0	1
common_address	integer	Address of a destination device	Yes			
function	integer	Function number	No	0		

info_address	integer	Information object address	Yes			
data_type	integer	ASDU type identificator	No			
select_ms	integer	Time limit in milliseconds for command execution. Command select has to be performed before execution if this parameter is specified. Direct command execution can be performed only if this field is left empty or set to zero.	No	0		

Debugging a IEC 60870-5-104 Master aplication

If configuration for IEC 60870-5-104 devices is set up, the handler for the protocol will start automatically. If a configuration is missing or contains errors, the protocol will not start. It is done intentionally to decrease unnecessary memory usage.

If IEC 60870-5-104 does not work properly (e.g. no communication between devices, data is corrupted, etc.), a user can launch a debug session from command-line interface and find out why link is not functioning properly or use WCC Utility to do that.

To launch a debugging session, a user should stop the *iec104-master* process and run the *iec104-master* command with respective flags.

- Step 1: Service must be stopped by entering the following command into the wcclite: **/etc/init.d/iec104-master stop**
- Step 2: After service is stopped it must be started with the preferred configuration file (JSON files found in /etc/ folder) and a debug level 7: **iec104-master -c /etc/iec104-master/iec104-master.json -d7**
- Step 3: Once the problem is diagnosed normal operations can be resumed with the following command: **/etc/init.d/iec104-master start**

IEC 60870-5-104 command line debugging options

```
-h [ –help ] Display help information
-V [ –version ] Show version
-d<debug level> Set debugging level
-c [ –config ] Config path
-r [ –raw ] Show raw telegram data
-f [ –frame ] Show frame data
-e [ –redis ] Show redis message
-R [ –readyfile ] Ready notification file
```

IEC 60870-5-104 Slave

IEC 60870-5-104 Slave is designed not to lose data acquired from Master protocols. The data that arrives from Master protocols is stored in cache. This data is checked every second to manage further data sending. The data that leaves IEC 60870-5-104 Slave has output caches. They’re built to provide switching between multiple sessions (redundant SCADA). If a new connection arrives, the old one is dropped, but data, that is stored in cache, not sent and not confirmed by SCADA is transfered to new connection.

Configuring IEC 104 Slave datapoints

To use IEC 60870-5-104 Slave in WCC Lite, it has to be configured via an Excel configuration. This configuration contains two Excel sheets where parameters have to be filled in Devices and Signals.

IEC 60870-5-104 Slave parameters for *Devices* tab

Parameter	**Type**	**Description**	**Required**	**Default Value** (when not specified)	**Range**	
					Min	Max

name	string	User-friendly name for a device	Yes			
description	string	Description of a device	No			
device_alias	string	Alphanumeric string to identify a device	Yes			
enable	boolean	Enabling/disabling of a device	No	1	0	1
protocol	string	Protocol to be used	Yes		IEC 60870-5-104 slave	
asdu_size	integer	Common address size in bytes	No	2	1	3
time_sync	boolean	Enable/disable (1 or 0) time synchronization	Yes			
port	integer	TCP port	No	2404	0	65535
ioa_size	integer	Information object address (IOA) size in bytes	No	3	1	3
swt	integer	Send window (SWT)	No	12		
rwt	integer	Receive window (RWT)	No	8		
cot_size	integer	Cause of transmission (COT) size in bytes	No	2	1	2
host	string	Space separated remote host IP addresses (ipv4)	Yes			
bind_address	string	Bind to local IP address (ipv4)	No	0.0.0.0		
t1	integer	Acknowledge timeout t1 (sec)	Yes			
t2	integer	Connection ACKRSN clock t2 (sec)	Yes			
t3	integer	Connection TESTFR clock t3 (sec)	Yes			
sp_time	boolean	Add (1 or 0) CP56Time2a information to single point signals	No	0	0	1
dp_time	boolean	Add (1 or 0) CP56Time2a information to double point signals	No	0	0	1
me_time	boolean	Add (1 or 0) CP56Time2a information to measurements	No	0	0	1
message_size	boolean	Maximum length of a message	Yes		0	255
cache_size	integer		Yes		0	1000
tls	boolean	Enable/disable use of TLS	No	0	0	1

tls_local_certificate	string	Local certificate for TLS connection	Yes (for TLS)			
tls_peer_certificate	string	Certificate authority file for TLS connection	No			
tls_private_key	string	File consisting of private key for TLS connection	No			

IEC 60870-5-104 Slave parameters for *Signals* tab

Parameter	**Type**	**Description**	**Required**	**Default Value** (when not specified)	**Range**	
					Min	Max
signal_name	string	User-friendly signal name	Yes			
device_alias	string	Alphanumeric string to identify a device	Yes			
signal_alias	string	Unique alphanumeric name of the signal to be Yes used	Yes			
source_device_alias	string	device_alias of a source device	For commands			
source_signal_alias	string	signal_alias of a source signal	For commands			
enable	boolean	Enabling/disabling of an individual signal	No	1	0	1
log	integer	Allow signal to be logged. If **log is 0 signal** will not be logged. If **log is more than 0** signal will be logged	No	0	0	1
gi	boolean	Including/excluding (1 or 0) signal from General Interrogation	No	0	0	1
common_address	integer	Address of a destination device	Yes			
info_address	integer	Information object address	Yes			
data_type	integer	ASDU type id. Types are identified automatically if this field is not set.	No	0		
select_ms	integer	Time limit in milliseconds for command execution. Command select has to be performed before execution if this parameter is specified. Direct command execution can be performed only if this field is left empty or set to zero.	No	0		

Debugging a IEC 60870-5-104 Slave aplication

If configuration for IEC 60870-5-104 devices is set up, the handler for the protocol will start automatically. If a configuration is missing or contains errors, the protocol will not start. It is done intentionally to decrease unnecessary memory usage.

If IEC 60870-5-104 does not work properly (e.g. no communication between devices, data is corrupted, etc.), a user can launch a debug session from command-line interface and find out why the link is not functioning properly or use WCC Utility to do that.

To launch a debugging session, a user should stop the *iec104-slave* process and run the *iec104-slave* command with respective flags.

- Step 1: Service must be stopped by entering the following command into the wcclite: **/etc/init.d/iec104-slave stop**
- Step 2: After service is stopped it must be started with the preferred configuration file (JSON files found in /etc/ folder) and a debug level 7: **iec104-slave-c /etc/iec104-slave/iec104-slave.json -d7**
- Step 3: Once the problem is diagnosed normal operations can be resumed with the following command: **/etc/init.d/iec107-slave start**

IEC 60870-5-10 command line debugging options

```
-h [ –help ] Display help information
-V [ –version ] Show version
-d<debug level> Set debugging level
-c [ –config ] Config path
-r [ –raw ] Show raw telegram data
-f [ –frame ] Show frame data
-e [ –redis ] Show redis message
-R [ –readyfile ] Ready notification file
```

IEC 62056-21

Introduction

IEC 61107 or currently IEC 62056-21, was an international standard for a computer protocol to read utility meters. It is designed to operate over any media, including the Internet. A meter sends ASCII (in modes A..D) or HDLC (mode E) data to a nearby hand-held unit (HHU) using a serial port. The physical media are usually either modulated light, sent with an LED and received with a photodiode, or a pair of wires, usually modulated by a 20mA current loop. The protocol is usually half-duplex.

The following exchange usually takes a second or two, and occurs when a person from the utility company presses a meter-reading gun against a transparent faceplate on the meter, or plugs into the metering bus at the mailbox of an apartment building.

The general protocol consists of a "sign on" sequence, in which a handheld unit identifies itself to the metering unit. During sign-on, the handheld unit addresses a particular meter by number. The meter and hand-held unit negotiate various parameters such as the maximum frame length during transmission and reception, whether multiple frames can be sent without acknowledging individual frames (windowing), the fastest communication rate that they can both manage (only in case of mode E switching to HDLC) etc.

Next, the meter informs the handheld unit about the various parameters that are available with it in various security settings viz. the 'no-security logical group', ' the low-security logical groups' and ' the high-security logical groups'.

If the parameter required is in the no-security group, just a get.request will provide the HHU with the desired response. If the parameter required is in the low-security group, a password authentication of the HHU is required before information can be read.

In case of high-security parameters, the meter challenges the handheld unit with a cryptographic password. The handheld unit must return an encrypted password. If the password exchange is correct, the meter accepts the handheld unit: it is "signed on."

After signing on, the handheld unit generally reads a meter description. This describes some registers that describe the current count of metered units (i.e. kilowatt hours, megajoules, litres of gas or water) and the metering unit's reliability (is it still operating correctly?). Occasionally a manufacturer will define a new quantity to measure, and in this case, a new or different data type will appear in the meter definition. Most metering units have special modes for calibration and resetting meter registers. These modes are usually protected by anti-tampering features such as switches that sense if the meter enclosure has been opened.

The HHU may also be given limited rights to set or reset certain parameters in the meter.

The handheld unit then sends a sign-off message. If no sign-off message is sent, the meter automatically signs off after a previously negotiated time interval after the last message.

Source: https://en.wikipedia.org/wiki/IEC_62056#IEC_62056-21

Overview

The IEC 62056-21 standard defines protocol specifications for local meter data exchange.
Data is read out via serial port in modes A, B or C. The default initial serial port settings are 300 bps 7E1, as per standard, but can be user configured.

The driver implementation additionally allows for communication via TCP/IP, which is not described in the standard. In this case, baud rate acknowledgement is allowed however actual switchover between baud rates is not possible.

Mode A: data is requested and read out at the configured baud rate.

Mode B: data is requested at the configured baud rate and mutually switched to the baud rate proposed by the meter. Baud rate confirmation is absent.

Mode C: data is requested at the configured baud rate, new baud rate is proposed by the meter and, if acknowledged, data is read out at the proposed baud rate.

Currently data readout is supported in modes A, B and C.

For data readout it is necessary to know the port settings and the format of OBIS code representation as they can slightly differ (see table) depending on the configuration of the meter.

Configuration

Device section

The serialnumber defines the serial number of the meter. 0 (zero) will result in a '/?!' handshake string and may cause issues if more than one meter is wired to the serial port.

The baudrate defines the initial connection baud rate. In modes B and C this will be switched to what ever baud rate is proposed by the meter.

The meter_model defines the meter profile. This is reserved for future use and should be set to 1. type defines the connection mode. Modes A, B and C are supported.

⚠ If **ip** or **port** parameters are configured, any serial port settings are ignored and connections are initiated via TCP.

IEC 62056-21 device configuration parameters:

Parameter	**Type**	**Description**	**Required**	**Default Value** (when not specified)	**Range**	
					Min	Max
name	string	User-friendly name for a device	Yes			
description	string	Description of a device	No			
device_alias	string	Alphanumeric string to identify a device	Yes			
enable	boolean	Enabling/disabling of a device	No	1	0	1
protocol	string	Protocol to be used	Yes		IEC 62056-21	
poll_delay_ms	integer	Minimum time delay in miliseconds to wait before sending any data on port.	No	200		
scan_rate_ms	integer			10000		
device	string	Communication port	No (for serial)		PORT1	PORT2
baudrate	integer	Communication speed, bauds/s	No (for serial)	6900	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200	
databits	integer	Data bit count for communication	No (for serial)	8	6	9
stopbits	integer	Stop bit count for communication	No (for serial)	1	1	2
parity	string	Communication parity option	No (for serial)	NONE	NONE, EVEN, ODD	
flowcontrol	string	Communication device flow control option	No		NONE	
serialnumber	unsigned long	Meter serial number	Yes		1	
serial_close_delay	integer	Delay before closing serial port	No	400		
timeout_ms	integer	Timeout of waiting for incoming request	No	2500		
type	string	Defines a connection mode	No	C	A,B,C	
t2	integer	Time to wait before acknowledging the suggested baudrate in mode C	No	300	200	1500

ip	string	IP address for TCP connection	Yes (for TCP)			
port	integer	TCP port	Yes (for TCP)		0	65535

Signals section

tag_job_todo defines the job sub-job. This field should contain the exact representation of the OBIS code as it is configured in the meter. E.g. if the parameter of interest is represented as

”1.8.0*24(0147238.4*kWh)”, the value of the configuration field should be ”1.8.0*24” (excluding quotation marks).

IEC 62056-21 tags configuration parameters:

Parameter	**Type**	**Description**	**Required**	**Default Value** (when not specified)	**Range**	
					Min	Max
signal_name	string	User-friendly signal name	Yes			
device_alias	string	Device alias from a Devices tab	Yes			
signal_alias	string	Unique alphanumeric name of the signal to be use	Yes			
enable	boolean		No	1	0	1
log	integer	Allow signal to be logged. If **log is 0 signal** will not be logged. If **log is more than 0** signal will be logged	No	0	0	
number_type	string	Number format type	Yes			
tag_job_todo	string	Tag job in OBIS format	Yes			

For **tag_job_todo** configuration it is best to first manually read the meter via PC or HHU (hand-held unit) to determine the exact OBIS representation format of the parameter as they can differ between meter manufacturers and utility companies.

IEC 61850

Introduction

IEC 61850 is an international standard defining communication protocols for intelligent electronic devices at electrical substations. It is a part of the International Electrotechnical Commission's (IEC) Technical Committee 57 reference architecture for electric power systems. The abstract data models defined in IEC 61850 can be mapped to a number of protocols. Possible mappings in the standard can be MMS (Manufacturing Message Specification), GOOSE (Generic Object Oriented Substation Event), SMV (Sampled Measured Values). These protocols can run over TCP/IP networks or substation LANs using high speed switched Ethernet to obtain the necessary response times below four milliseconds for protective relaying.

✓ As of version v1.5.0, WCC Lite supports MMS type messaging. Logging and groups setting services are not supported.

IEC 61850 Server

WCC Lite can act as a IEC 61850 server to serve data to remote SCADA systems. For example, WCC Lite can be used to acquire data from various protocols (Modbus, IEC 60870-5-103, etc.), this data can be redirected and propagated further to a single or multiple IEC 61850 clients. IEC 61850 Server supports TCP and TLS connection types. TCP connection can be secured with password authentication.

Commands

WCC Lite **IEC 61850 Server** implementation defines four command types which are described by their control model:

- **Case 1**: Direct control with normal security (direct-operate);
- **Case 2**: SBO control with normal security (operate-once or operate-many);
- **Case 3**: Direct control with enhanced security (direct-operate);
- **Case 4**: SBO control with enhanced security (operate-once or operate-many).

Normal security commands are considered for execution if the command signal is found in Excel configuration. There aren't any additional checks in command execution in any master protocol.

Enhanced security commands need feedback from master protocol to either to succeed or fail. If feedback is not received within **command_ack_timeout_ms** timeframe, the command is considered as failed.

Command value attributes (e.g. stVal) must be updated separately (if they need to be updated).

ℹ When using SBO commands, select is not routed to master protocol and select logic is performed only in IEC 61850 Server protocol.

Configuring datapoints

To use IEC 61850 Server in WCC Lite, it has to be configured via an Excel configuration and data model must be uploaded. This configuration contains two Excel sheets where parameters have to befilled in - Devices and Signals.

IEC 61850 Server parameters for Devices tab

Parameter	**Type**	**Description**	**Required**	**Default Value** (when not specified)	**Range**	
					Min	Max
name	string	User-friendly name for a device	Yes			
description	string	Description of a device	No			
device_alias	string	Alphanumeric string to identify a device	Yes			
enable	boolean	Enabling/disabling of a device	No	1	0	1
protocol	string	Protocol to be used	Yes		IEC 61850 Server	

tls	string	Selecting if TLS should be used	No	0	0	1
bind_address	string (IP address format)	IP address of and interface to use with server	No	0.0.0.0		
host	string (IP address format)	IP address list of allowed IPs (separated with spaces)	Yes			
port	integer	TCP communication port	Yes			
tls_local_certificate	string	Local certificate for TLS connection	Yes (for TLS)			
tls_peer_certificate	string	Certificate authority file for TLS connection	Yes (for TLS)			
tls_private_key	string	File consisting of private key for TLS connection	Yes (for TLS)			
event_history_size	integer	Event log size	No			
ied_name	string	Name of an Intelligent Electronic Device	Yes			
authorization	string	Authorization type	No		password	
password	string	Authorization password for server device	Yes (if authorization is yes)			
model_filename	string	Filename of data model uploaded to WCC (with or without file extension)	Yes			
edition	string	Which IEC61850 edition to use.	No	2	1,2, 2.1	
command_ack_timeout_ms	integer	Timeframe (ms) in which enhanced-security commands must be acknowledged (Default: 3000)	No	3000		
report_buffered_size	integer	Report control blocks buffer size in bytes (Default: 65536)	No	65536		
report_unbuffered_size	integer	Unbuffered report control blocks buffer size in bytes (Default: 65513)	No	65513		

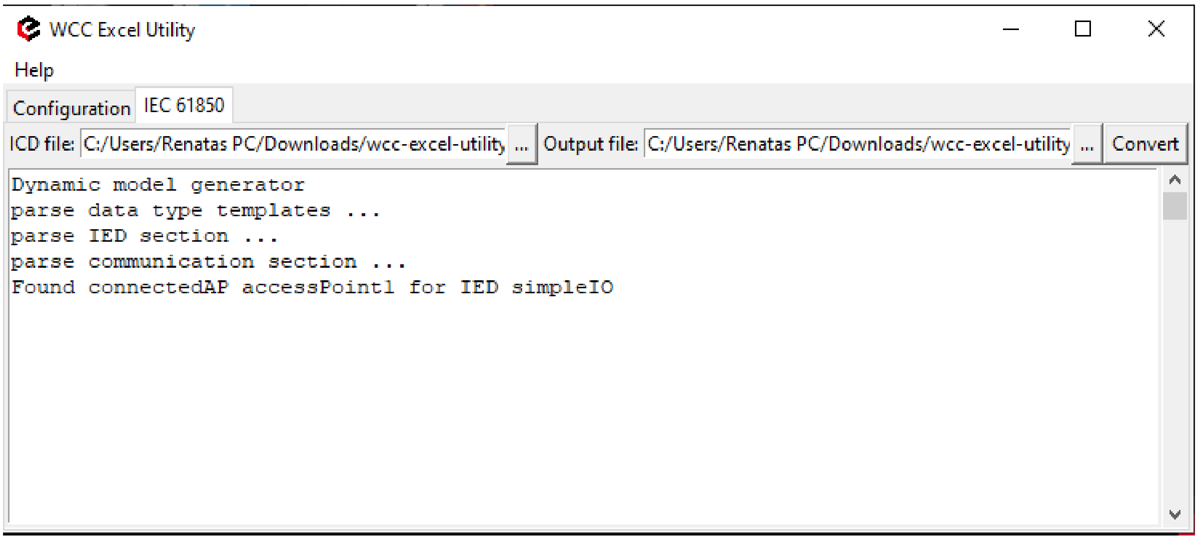
IEC 61850 Server parameters for Signals tab

Parameter	**Type**	**Description**	**Required**	**Default Value** (when not specified)	**Range**	
					Min	Max
signal_name	string	User-friendly signal name	Yes			
device_alias	string	Device alias from a Devices tab	Yes			
signal_alias	string	Unique alphanumeric name of the signal to be used	Yes			
enable	boolean	Enabling/disabling of an individual signal	No	1	0	1

log	boolean	Allow signal to be logged. If **log is 0 signal** will not be logged. If **log is more than 0** signal will be logged	No	0		
number_type	string	Number format type (BOOLEAN, FLOAT, INT16, etc.)	Yes			
ld_instance	string	Instance of a logical device	Yes			
ln_class	string	Logical node class type	Yes			
ln_instance	integer	Instance of a logical node	No			
ln_prefix	string	Prefix of logical node string	No			
cdc	string	Common Data Class (CDC) name	Yes		SPS, DPS, INS, ENS, ACT, ACD, MV, CMV, SAV, SPC, DPC, INC, ENC, BSC, ISC, APC, BAC	
data_object	string	Name of data object in dataset	Yes			
da_value	string	Name of a data attribute value node	Yes			
da_time	string	Name of a data attribute time node	No			
da_quality	string	Name of a data attribute quality node	No			
da_fc	string	Functional constrain for data object	Yes		ST,MX, CO, SP	
control_model	string	Model of output control	No	status-only	status-only, direct-with-normal-security, sbo-with-normal-security, direct-with-enhanced-security, sbo-with-enhanced-security	

Converting and uploading data model

To use IEC61850 Server protocol in WCC Lite, user must upload a data model in specific format (file extension .cfg). These data models can be converted from SCL files (.icd or .cid files). To convert a data model, the user must use WCC Excel Utility. There’s a separate tab for this operation as shown in picture below.

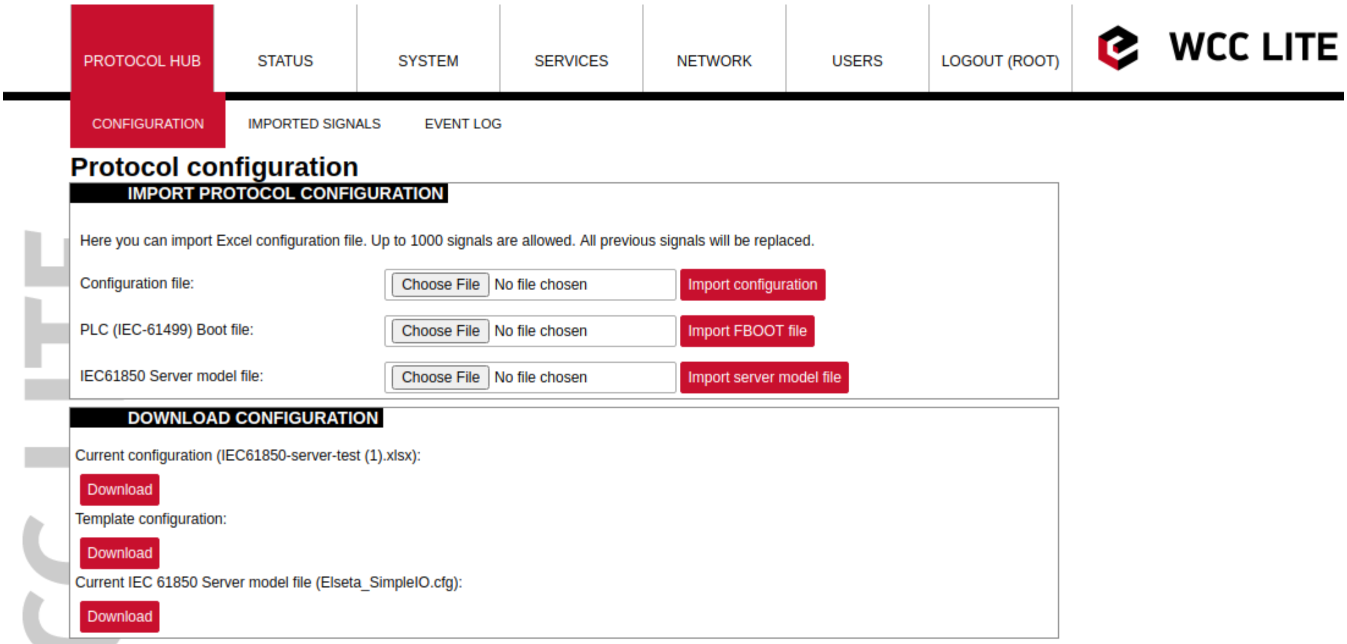


ICD file: C:/Users/Renatas PC/Downloads/wcc-excel-utility

Output file: C:/Users/Renatas PC/Downloads/wcc-excel-utility

```
Dynamic model generator
parse data type templates ...
parse IED section ...
parse communication section ...
Found connectedAP accessPoint1 for IED simpleIO
```

Converted file can be uploaded in WCC Lite web interface, Protocol Hub section. Current model can be also downloaded in the same page as shown in picture below.



Protocol configuration

IMPORT PROTOCOL CONFIGURATION

Here you can import Excel configuration file. Up to 1000 signals are allowed. All previous signals will be replaced.

Configuration file: No file chosen

PLC (IEC-61499) Boot file: No file chosen

IEC61850 Server model file: No file chosen

DOWNLOAD CONFIGURATION

Current configuration (IEC61850-server-test (1).xlsx):

Template configuration:

Current IEC 61850 Server model file (Elseta_SimpleIO.cfg):

Debugging a IEC 61850 server application

If configuration for IEC 61850 Server is set up, handler for protocol will start automatically. If configuration is missing or contains errors, protocol will not start. It is done intentionally to decrease unnecessary memory usage.

⚠ If IEC 61850 Server does not work properly (e.g. no communication between devices, data is corrupted, etc.), a user can launch a debug session from command line interface and find out why link is not functioning properly.

ℹ To launch a debugging session, a user should stop `iec61850-server` process and run `iec61850-server` command with respective flags as you can see below:

`iec61850-server`

```
-h [--help] Show help message
-c [--config] arg Configuration file location
-v [--version] Show version
-d [--debug] arg Set Debug level
-r [--redis] Show Redis messages
-C [--commands] Show command messages
-R [--readyfile] arg Ready notification file
```

IEC 61850 Client

WCC Lite can be used as a master station to collect data from IEC 61850 compatible server devices such as protection relays. As relays require fast, secure and responsive interfaces, WCC Lite can be considered as a valid option. For additional security a user can use encrypted transmission (TLS) or set up a password.

ℹ As TCP (TLS) connection can encounter issues and break, automatic reconnection is implemented. After every failed reconnection attempt the fallback delay is doubled starting from 1 second up until 32 seconds. After that connection reestablishment will be attempted every 32 seconds until a successful connection.

Acquiring data via report control blocks

As per IEC 61850 standard, the report control block controls the procedures that are required for reporting values of data objects from one or more logical nodes to one client. Automatic reporting enables data servers (slave devices) to only send data on its (or its quality) change, thus saving network bandwith. Instances of report control blocks are configured in the server at configuration time.

Report control blocks send information that is defined in their respective datasets. Dataset is a set of data elements grouped to represent some data group. For example, it is a common practice to group measurements and events into different groups.

A server restricts access to an instance of a report control block to one client at a time. That client exclusively shall own that instance and shall receive reports from that instance of report control blocks. There are two classes of report control blocks defined, each with a slightly different behaviour:

- buffered-report-control-block (BRCB) - internal events (caused by trigger options data-change, quality-change, and data-update) issue immediate sending of reports or buffer the events (to some practical limit) for transmission, such that values of data object are not lost due to transport flow control constraints or loss of connection. BRCB provides the sequence-of-events (SOE) functionality;
- unbuffered-report-control-block (URCB) - internal events (caused by trigger options data-change, quality-change, and data-update) issue immediate sending of reports on a best efforts basis. If no association exists, or if the transport data flow is not fast enough to support it, events may be lost.

Buffered report control blocks are therefore useful to keep event data, for example, keeping the last known state of a relay switch where a loss of information might lead to a confusion and even financial losses. Unbuffered report control blocks are particularly useful for data which is useful only momentarily, e.g. measurements of voltages, current or power. This information can change frequently and old measurements might not reflect the real state of a substation.

To allow multiple clients to receive the same values of data object, multiple instances of the report control classes shall be made available.

Buffered report control blocks are usually configured to be used by a specific client implementing a well-defined functionality, for example, a SCADA master. The client may know the ObjectReference of the BRCB by configuration or by the use of a naming convention.

Parsing of report control blocks is based on types of Common Data Class (CDC). Some of these types can have more then one data point of interest. Table below shows what data attributes are supported from various Common Data Classes. To select which data attribute should be used a `da_value` column should be filled with a data attribute name. Common Data Classes consist of data attributes with different Functional Constraints therefore to get the status points of interest correctly the user must fill in a correct value in `da_fc` column.

IEC 61850 Client supported data attributes:

Common Data Class	Function Constraint	Data attributes
SPS DPS INS ENS	ST	stVal
ACT	ST	general phsA phsB phsC neut
ACD	ST	general dirGeneral phsA dirPhsA phsB dirPhsB phsC dirPhsC neut dirNeut
MV	MX	instMag mag
CMV	MX	instCVal cVal
SAV	MX	instMag
SPC DPC INC ENC	ST	stVal
BSC ISC	ST	valWTr
APC BAC	MX	mxVal

Some of data attributes are structures themselves, for example, `mag` attribute is a struct that can hold integer or float values. To select a fitting attribute the user should extend `da_value` parameter with additional attributes, for example, if float magnitude value is to be selected from MV Common Data Class, `da_value` column should be filled with `mag.f` value; if the user intends `cVal` magnitude value in float format from CMV Common Data Class, `da_value` should be filled with `cVal.mag.f` value. See IEC 61850-7-3 for more information about Common Data Classes.

To ensure the integrity of configuration, WCC Lite has additional checks implemented at configuration time. If report control block (or its dataset) with a predefined ObjectReference doesn’t exist, it is considered that IEC 61850 Client has not been configured properly or configuration has been changed in either of IEC 61850 devices and cannot be matched, therefore should be considered invalid.

Number Types

IEC 61580 has a distinct number_type field when compared to other protocols.

number_type
BOOLEAN
INT8
INT16
INT32
INT64
INT128
INT8U
INT24U
INT32U
FLOAT32
FLOAT64
ENUMERATED
OCTET STRING 6
OCTET STRING 8
OCTET STRING 64
VISIBLE STRING 32
VISIBLE STRING 64
VISIBLE STRING 65
VISIBLE STRING 129
UNICODE STRING 255
TIMESTAMP
QUALITY
CHECK
CODEDENUM
GENERIC BITSTRING
CONSTRUCTED
ENTRY TIME

PHYCOMADDR
CURRENCY
OPTFLDS
TRGOPS

Controlling remote equipment via commands

The control model provides a specific way to change the state of internal and external processes by a client. The control model can only be applied to data object instances of a controllable Common Data Class (CDC) and whose ctlModel DataAttribute is not set to status - only. Such data objects can be referred to as control objects. If controls are enabled in a IEC 61850 Server device the user can configure controls by filling control_model column in Excel configuration with a control model (*direct-with-normal-security*, *sbo-with-normal-security*, *direct-with-enhanced-security*, *sbo-with-enhanced-security*) as well as setting functional constraint in `da_fc` column to CO.

Depending on the application, different behaviours of a control object shall be used. Therefore, different state machines are defined. Four cases are defined:

- **Case 1**: Direct control with normal security (direct-operate);
- **Case 2**: SBO control with normal security (operate-once or operate-many);
- **Case 3**: Direct control with enhanced security (direct-operate);
- **Case 4**: SBO control with enhanced security (operate-once or operate-many).

IEC 61850 standard enables the user to plan command transmission in advance - set the timer when the command should be issued. However, as this possibility is rarely used in practice, it is not implemented as of version v1.5.0. All issued commands are executed immediately.

For more information on control class model, please consult IEC 61850-7-2 standard.

If ctlModel is read-only, messages from internal database will be ignored for this point, otherwise a subscribe callback will be launched to handle commands as soon as they are sent. If CDC of a signal does not have means of control, ctlModel parameter is ignored.

Originator identification can be attached to a station so that replies to command requests could be forwarded to only one device. To use this functionality a user should select an origin identificator by filling value in Excel configuration, originator column. Originator category is always enforced to tell that remote control command is issued.

Configuring datapoints

To use IEC 61850 Client in WCC Lite, it has to be configured via an Excel configuration. This configuration contains two Excel sheets where parameters have to be filled in - Devices and Signals tables.

Table IEC 61850 Client parameters for *Devices* tab

Parameter	**Type**	**Description**	**Required**	**Default Value** (when not specified)	**Range**	
					Min	Max
name	string	User-friendly name for a device	Yes			
description	string	Description of a device	No			
device_alias	string	Alphanumeric string to identify a device	Yes			
enable	boolean	Enabling/disabling of a device	No	1	0	1
protocol	string	Protocol to be used	Yes		IEC 61850 Client	
tls	string	Selecting if TLS should be used	No	0	0	1
host	string (IP address format)	IP address of server device	Yes	0.0.0.0		
port	integer	TCP communication port	Yes	102		

tls_local_certificate	string	Local certificate for TLS connection	Yes (for TLS)			
tls_peer_certificate	string	Certificate authority file for TLS connection	Yes (for TLS)			
tls_private_key	string	File consisting of private key for TLS connection	Yes (for TLS)			
event_history_size	integer	Event log size	No			
ied_name	string	Name of an Intelligent Electronic Device	Yes			
authorization	string	Authorization type	No		password	
password	string	Authorization password for server device	No			
originator	string	Origin identificator for device	No			

Table IEC 61850 Client parameters for *Signals* tab

Parameter	**Type**	**Description**	**Required**	**Default Value** (when not specified)	**Range**	
					Min	Max
signal_name	string	User-friendly signal name	Yes			
device_alias	string	Device alias from a Devices tab	Yes			
signal_alias	string	Unique alphanumeric name of the signal to be used	Yes			
enable	boolean	Enabling/disabling of an individual signal	No	1	0	1
log	boolean	Allow signal to be logged. If **log is 0 signal** will not be logged. If **log is more than 0** signal will be logged	No	0		
number_type	string	Number format type	Yes			
ld_instance	string	Instance of a logical device	Yes			
ln_class	string	Logical node class type	Yes			
ln_instance	integer	Instance of a logical node	No			
ln_prefix	string	Prefix of logical node string	No			
cdc	string	Common Data Class (CDC) name	Yes		SPS, DPS, INS, ENS, ACT, ACD, MV, CMV, SAV, SPC, DPC, INC, ENC, BSC, ISC, APC, BAC	
data_object	string	Name of data object in dataset	Yes			
da_value	string	Name of a data attribute value node	Yes			
da_fc	string	Functional constrain for data object	Yes		ST,MX, CO, SP	
control_model	string	Model of output control	No	status-only	status-only, direct-with-normal-security, sbo-with-normal-security, direct-with-enhanced-security, sbo-with-enhanced-security	

dataset	string	Full object reference of a dataset	Yes			
report_control_block	string	Full object reference of a report control block	Yes			
intgPd	integer	Integrity period in milliseconds	No	0		

It should be noted that ACT and ACD messages can only be parsed from report if either only ‘general’ attribute or all attributes attached to all three phases and neutral can be found in report

IEC 61850 Client has an additional signal which can be configured to show communication status. It is used to indicate if the server device has disconnected from client (WCC Lite). To configure such signal, two columns should be filled with particular values. To a newly created additional signal one should make `job_todo` equal to device_status and `tag_job_todo` equal to communication_status. Communication error status is set after a disconnection of a server device.

Debugging a IEC 61850 Client application

If configuration for IEC 61850 Client is set up, handler for protocol will start automatically. If configuration is missing or contains errors, protocol will not start. It is done intentionally to decrease unnecessary memory usage.

IEC 61850 Client command line debugging options

`iec61850-client`

```
-h [ -help ] Show help message
-c [-config] arg Configuration file location
-V [-version] Show version
-d [-debug] arg Set debugging level
-r [-redis] Show Redis messages
-C [-commands] Show command messages
-D [-datasets] Show dataset messages
-report Show report messages
-R [-readyfile] arg Ready notification file
```

If IEC 61850 Client does not work properly (e.g. no communication between devices, data is corrupted, etc.), a user can launch a debug session from command line interface and find out why link is not functioning properly.

To launch a debugging session, a user should stop `iec61850-client` process and run `iec61850-client` command with respective flags as was shown above.

WCC Lite internal signals

Overview

The WCC Lite contains several internal data points for readout and control which can be accessed via the Pooler service.

Configuration

Devices section

In the devices section, only the protocol, scan_rate_ms and poll_delay_ms are to be configured for this type of device.

WCC Lite internal signals

Parameter	**Type**	**Description**	**Required**	**Default Value** (when not specified)	**Range**
name	string	User-friendly device name	Yes		
device_alias	string	Alphanumeric string to identify a device	Yes		
protocol		Protocol identifier Internal data	Yes		**Internal data**
scan_rate_ms	integer	Update rate	No	60000	
poll_delay_ms	integer	Poll delay	No	200	

It is advised to set scan_rate_ms to a value greater than 5000 ms as frequent scans may result in significant overload of the pooler process.

Signals section

`tag_job` defines the tag job. This can be set to `gpio`, `board`, `netstat`, sub job. This field should address the particular point of interest.

and `process`.	`led`	

defines the job	`tag_job_todo`

job_todo	**Description**	**tag_job_todo**	**Description**
gpio	Get GPIO	GPIO number	Use number 11 for onboard digital input; SIM select 12; SIM detect 20
	Set GPIO	[integer]|[1/0]	Set gpio number to high or low
		active-sim-iccid	Active SIM ICCID
		active-sim	Active SIM card
		cpu-usage	CPU usage
		duid	DUID
		fw-version	Firmware version
		gsm-available-rat	GSM available radio access technologies
		gsm-current-rat	GSM current radio access technology
		gsm-current-rat-num	GSM current radio access technology identifier
		gsm-imsi	GSM IMSI number

board	Board info	gsm-internet-status	GSM Internet status
		internet-status	Same as gsm-internet-status
		gsm-network-reg-status	GSM network register status
		gsm-operator	GSM operator
		gsm-operator-num	GSM operator number
		gsm-roaming-status	GSM roaming status
		gsm-selected-rat	GSM selected rat
		gsm-service-provider	GSM service provider
		gsm-signal-quality	GSM signal quality
		gsm-signal-quality-num	GSM signal quality (dBm)
		gsm-sig-quality	Same as gsm-signal-quality-num
		hostname	Hostname
		hw-info	Hardware information
		modem-imei	Modem IMEI number
		modem-manufacturer	Modem manufacturer name
		modem-model	Modem model
		modem-type	Modem type
		ram-usage	RAM usage
		sim-status	SIM card status
		uuid	UUID
netstat|[interface]	Network statistics	TX	Bytes transferred
		RX	Bytes received
smsstat	SMS statistics	received	SMS received
		sent	SMS sent
		call	SMS call
		failed	SMS failed
		ath9k-phy0	WLAN LED
		wcclite:blue:heartbeat	Status LED
		wcclite:blue:wlan	WLAN LED
		wcclite:green:eth0	ETH0 LED

led	LED status/control	wcclite:green:eth1	ETH1 LED
		wcclite:green:signal1	Signal 1 LED
		wcclite:green:signal2	Signal 2 LED
		wcclite:green:signal3	Signal 3 LED
		wcclite:gsm-rst	GSM LED
		wcclite:red:fault	Fault LED
		wcclite:rs232-en	RS LED
		wcclite:relay	Relay LED & Output
process	Check if process is running	[process name]	1 or 0 is returned

⚠ Assigning source signals to tags other than wcclite:relay may cause undesirable effects. Signals other than wcclite:relay should be used for monitoring only.

Devices configuration

Protocol HUB uses configuration in excel file format. Each sheet represents a specific part of configuration:

- **Devices** contains device list and protocol related configuration.
- **Signals** contains a list of signals and their options.

First line on each sheet is a header row that contains parameter name for each column. Header order determines parameter names for each following row. Every line after the header is a new entry. An empty row is interpreted as end of sheet. Any rows after empty row are discarded.

Devices sheet

Devices sheet contains all devices to be configured on gateway. Each row represents one device and its settings. Following options are required for each device:

- **name** - Name of the device. Used for representation only.
- **description** - A short description for the device. Used for representation only.
- **device_alias** - A unique short name for the device. It is used for linking signals to a device.

⚠ Alias can only contain alphanumeric characters and dashes (- and _). Alias must be unique for each device.

- **protocol** - Protocol type to use on device. Exact values of protocols are writen in every protocol documentation. Please look into range of supported protocols:

IEC 61850 MMS:

– IEC 61850 Client (since FW 1.5.0)

– IEC 61850 Server (since FW 1.5.0)

IEC 60870-5:

– IEC 60870-5-101 master

– IEC 60870-5-101 slave

– IEC 60870-5-103 master

– IEC 60870-5-104 master

- IEC 60870-5-104 slave

DNP 3.0 Serial/LAN/WAN:

- DNP3 Master

– DNP3 Slave

Modbus Serial/TCP:

- Modbus RTU/ASCII

– Modbus TCP

Metering protocols:

- DLMS/COSEM (since FW 1.3.0)

– IEC 62056-21 (since FW 1.2.13)

– MBus Serial

– MBus TCP

– Elgama (Meters based on IEC 62056-21 / 31 protocols)

Industrial IOT protocols:

- MQTT

- RESTful API

Specific protocols:

– Aurora (ABB PV inverters protocol)

– PowerOne (ABB PV inverters protocol)

– SMA Net (SMA PV inverters protocol)

– Kaco (Kaco PV inverters protocol)

– Ginlong (Ginlong PV inverters protocol)

– Solplus (Solutronic AG PV inverters protocol)

– ComLynx (Danfoss PV inverters protocol)

– Delta (Delta PV inverters protocol)

– Windlog (Wind sensors from RainWise Inc.)

– Vestas (Wind turbines protocol)

– Internal data

– VBus.

ℹ Although device name rules aren't strictly enforced, it is highly advised to give a unique name for every new device. Identical device names might introduce confusion while searching for signal in Imported Signals tab.

Optional settings

- **enable** - Flag to enable or disable device on system. Can contain values 0 or 1.
- **event_history_size** - Maximum number of signal events to save on device for later review. Older records will be erased. This feature is only available on cloud firmware.

Serial port settings

Required for any protocol that uses serial line communication.

- **device** - Serial port for communication **(PORT1/PORT2)**
- **baudrate** - Serial port speed. Valid values:

– 300

– 600

– 1200

– 2400

– 4800

– 9600

– 19200

– 38400

– 57600

– 115200

- **databits** - Number of data bits (6-9)
- **stopbits** - Number of stop bits (1-2)
- **parity** - Parity mode (none/even/odd)
- **flowcontrol** - Flow control method (none/hardware/software)

TCP/IP settings

Settings for any protocol that uses communication over TCP/IP. Note that all TLS certificates and keys are stored in single folder therefore only name and not the path should be filled in respective fields.

TLS fields are only supported for IEC 61850 Client and Server, IEC-60870-5-104 Slave and DNP3 Master and Slave.

- **ip** - IP address for master protocol to connect to;
- **bind_address** - one of local IP addresses to bind the server to. Connections through other network devices will be ignored;
- **host** - space separated host IP addresses of master devices;
- **port** - TCP port to listen for incoming connections;
- **tls_local_certificate** - name of local TLS certificate;
- **tls_peer_certificate** - name of certificate authority (CA) TLS certificate;
- **tls_private_key** - name of private key for making TLS connections.

Signals Configuration

The signals sheet contains all signals linked to devices. Each signal is defined in a single row. The Signal list can be split into multiple sheets. Each sheet name may start as Signals.

Required attributes

These attributes are mandatory for every configured signal. Every Excel configuration should have specified them in the first row of the Signals sheet:

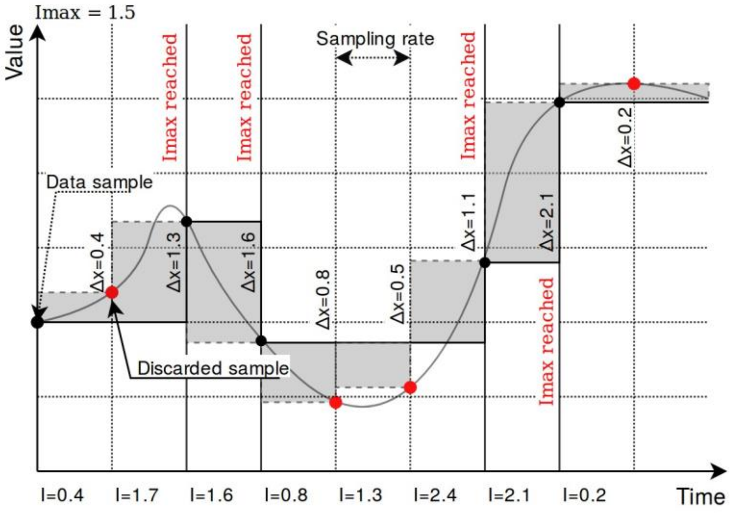
- **signal_name** - Name of the signal. Used for representation only.
- **device_alias** - Alias of a device defined in Devices sheet. A signal is linked to a matching device. **signal_alias**
- - A unique short name for the signal. It is used for linking signals to other signals. The alias can only contain alphanumeric characters and dashes (- and _). Device and signal alias combination must be unique.

Optional attributes

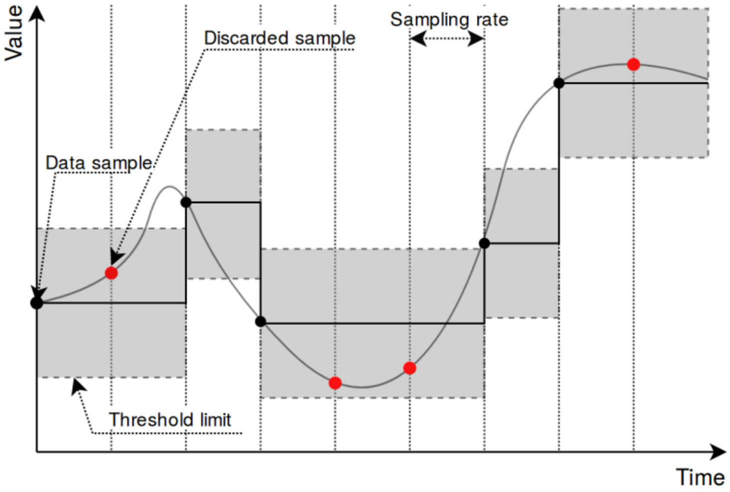
Optional attributes are required depending on the protocol in use and they can be used to extend protocol functionality:

- **source_device_alias** - Alias of a source device defined in Devices sheet. If a user intends to use several signals and combine them via mathematical or logical function, every alias should be separated by a newline symbol (in the same cell). An operation used must also be defined in an operation column. **source_signal_alias**
- - Alias of a source signal defined in Signals sheet. If a user intends to use several signals and combine them via mathematical or logical function, every alias should be separated by a newline symbol (in the same cell). An operation used must also be defined in an operation column. Each `source_signal_alias` should be posted in the same line as its respective `source_device_alias`. Aliases can only contain alphanumeric characters and dashes (- and _). Device and signal alias combination must be unique.
- **enable** - Flag to enable or disable signal on the system. Can contain values 0 or 1.
- **tag_type** - Tag type. Simple signals are polled from the device. Virtual signals are computed internally.
- **off_message** - Message to display when a single point or double point signals are in OFF state.
- **on_message** - Message to display when a single point or double point signals are in ON state. **units**
- - Signal value measurements units.
- **multiply** - Multiply value by this number.
- **add** - Add this number to a value.
- **sum_signals** - Define other signal values to add to the current signal. This field uses following **format**: dev_alias/tag_alias. Multiple signals can be defined using commas.
- **min_value** - Minimum expected value. If the result is lower than this value, the invalid flag is raised.
- **max_value** - Maximum expected value. If the result is higher than this value, the overflow flag is raised.
- **absolute_threshold** - Absolute threshold level.
- **integral_threshold** - Integral threshold level.
- **integral_threshold_interval** - Integral threshold addition interval in milliseconds.
- **threshold_units** - Units used in threshold level fields (percent/real).
- **log_size** - Maximum number of records for this tag to keep in storage for CloudIndustries logging.
- **suppression_values** - Space-separated numeric values to be used in suppression.
- **suppression_time_ms** - Suppression time in milliseconds.
- **operation** - Mathematical or logical operation to be used for signals defined in source_signal_alias column. Following mathematical operations for source signal values can be used: avg (average of all values), min (lowest value), max (highest value), median (median value), and sum (all values accumulated to a single number). Logical operations, intended for unsigned integers only.
- **bit_select** - selecting an individual bit of an integer number; bit numeration starts from zero.
- **math_expression** - a mathematical expression for signal value to be evaluated against. Explained in detail in **Mathematical expressions document**.

Picture. Result of using an absolute threshold:



Picture. Result of using an integral threshold:



Signal recalculation operation priority

A value generated by some protocol usually has to be recalculated in one way or another. This might mean changing the value of an argument as well as adding flags needed for other protocols to correctly interpret results. As recalculation is a sequential process, some actions are done before others. The sequence of operations done to a value is as follows:

- *Edition of attributes*. Attributes for further interpretation are added. This might, for example, include a flag to show that a signal resembles an answer to a command;
- *Mathematical calculations*. **multiply**, **add**, **bit_select**, and **math_expression** columns are evaluated here;
- *Usage of last value*. Decision if last value for a signal should be used if a new value of a signal is not a number (NaN) or contains a non-topical (NT) flag;
- *Limiting of values*. If a value exceeds a lower or higher configured limit, value is approximated not be lower (or higher) than the limit. An additional invalid (IV) or overflow (OV) flag is added as frequently used in IEC-60870-5 protocols;
- *Suppresion of values*. As electrical circuits can be noisy, protocols may generate multiple values in a short amount of time. What is more, some values are considered as intermediary and ideally should not be sent to SCADA unless they stay in the same state for some amount of time. **suppression_values** and **suppression_time_ms** are used to configure this functionality;
- *Threshold* checking. If a new signal doesn't cross a threshold target value, value is supressed and not used in further stages. **absolute_threshold**, **integral_threshold**, **integral_threshold_interval**, **threshold_units** columns are used to configure this functionality.

Not all of the elements in this sequence have to configured, missing operation are skipped and values are fed to a further stage of signal recalculation.

`number_type` field

This field is required for some protocols to determine a method to retrieve a signal value from hexadecimal form. Available values:

- **FLOAT** - 32-bit single precision floating point value according to IEEE 754 standard
- **DOUBLE** - 64-bit double precision floating point value according to IEEE 754 standard
- **DIGITAL** - 1-bit boolean value
- **UNSIGNED8** - 8-bit unsigned integer (0 - 255)
- **SIGNED8** - 8-bit signed integer (-128 - 127)
- **UNSIGNED16** - 16-bit unsigned integer (0 - 65535)
- **SIGNED16** - 16-bit signed integer (-32768 - 32767)
- **UNSIGNED32** - 32-bit unsigned integer (0 - 4294967295)
- **SIGNED32** - 32-bit signed integer (-2147483648 - 2147483647)
- **UNSIGNED64** - 64-bit unsigned integer (0 - 18446744073709551615)
- **SIGNED64** - 64-bit signed integer (-9223372036854775808 - 9223372036854775807)

Number conversion uses **big endian** byte order by default. Converted data will be invalid if byte order on connected device side is different. In such case byte swap operations can be used. Adding swap prefixes to number type will set different a byte order while converting values. Following swap operations are available:

- **SW8** - Swap every pair of bytes (8 bits) (e.g.,**0xAABBCCDD** is translated to **0xBBAADDCC**);
- **SW16** - Swap every pair of words (16 bits) (e.g.,**0xAABBCCDD** is translated to **0xCCDDAABB**);
- **SW32** - Swap every pair of two words (32 bits) (e.g.,**0x1122334455667788** is translated to **0x5566778811223344**);

Table. Example of using different swapping functions:

Address	0	1	2	3	4	5	6	7
Original number	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
SW8	Byte 1	Byte 0	Byte 3	Byte 2	Byte 5	Byte 4	Byte 7	Byte 6
SW16	Byte 4	Byte 5	Byte 6	Byte 7	Byte 1	Byte 6	Byte 4	Byte 5
SW32	Byte 4	Byte 5	Byte 6	Byte 7	Byte 0	Byte 1	Byte 2	Byte 3
SW8.SW16	Byte 3	Byte 2	Byte 1	Byte 0	Byte 7	Byte 6	Byte 5	Byte 4
SW8.SW32	Byte 4	Byte 4	Byte 7	Byte 6	Byte 1	Byte 0	Byte 3	Byte 2
SW8.SW16.SW32	Byte 7	Byte 6	Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte 0

Where Byte x, means bit x position in byte.

Add a dot separated prefix to number format to use byte swapping. Multiple swap operations can be used simultaneously. For example, use `SW8.SW16.SIGNED32` to correctly parse a 32-bit signed integer in a little endian format. Table 35 shows in detail how bytes, words or double words can be swapped and how swapping functions can be combined to make different swapping patterns. Table shows how byte swap is done for 64-bit (8-byte) numbers. It doesn't matter if it is an unsigned/signed integer or double, byte swapping is considered a bit-level operation. If a number is shorter than 64 bits, the same logic applies, the only difference is unavailability of some swapping operations (`SW32` for 32-bit and smaller numbers). Using such unavailable operation might lead to an undefined behaviour.

Linking signals

Signals can be linked together to achieve data transfer between several protocols. If a signal source is defined, all output from that source will be routed to the input of target signal. This way events polled from a modbus device (e.g., Modbus, IEC 60870-5, etc.) can be delivered to external station over a different protocol. A signal source is required if a signal is created on a slave protocol configuration to link events between protocols.

Example 1:

To read a coil state from a Modbus device and transfer it toIEC 60870-5-104 station, following steps may be taken:

1. Create a Modbus master configuration in Devices sheet.
2. Create a IEC 60870-5-104 slave configuration in Devices sheet.

3. Create a signal on master device to read coil status (function 1).
4. Create a signal on slave device with single point type (data_type = 1).
5. Set **source_device_alias** and **source_signal_alias** fields on slave device signal to match**device_alias** and **ignal_alias** on master device's coil signal.

Example 2

To write a coil state to a Modbus device on a command fromIEC 60870-5-104 station, following steps may be taken:

1. Follow steps 1-3 from example 1.
2. Create a signal on slave device with single command type (data_type = 45).
3. Set source_device_alias and source_signal_alias fields on master configuration coil signal to match device_alias and signal_alias on slave device's command signal. Coil will be written to a value received by a command.
4. Set source_device_alias and source_signal_alias fields on command signal to match device_alias and signal_alias on master device's coil signal. A command termination signal will be reported to the station on coil write result.

For additional information regarding the configuration of IEC 60870-5-101/103/104 protocols, please refer to "IEC 60780-5-101/103/104 PID interoperability for WCC Lite devices", accordingly.

Introduction

Signal value might require some recalculation or signal update prior to being sent. Understandably, existing columns in Excel configuration like `multiply`, `add`, `bit_select` might not be flexible enough. To overcome these limitations, symbolic mathematical expressions can be configured to do calculations automatically on every update of a signal.

It should be noted that filling mathematical expression disables other mathematical scalar operations for a single value such as `multiply`, `add` or `bit_select`. Other functions (primarily between several signals) are still available such as operation.

Feature list:

- Optimized for speed
  - High parsing performance
  - if-then-else operator with lazy evaluation
- Default implementaion with many features
  - 25 predefined functions
  - 18 predefined operators
- Unit support
  - Use postfix operators as unit multipliers (3m -> 0.003)

Mathematical functions

Table. Supported mathematical functions:

Name	Argument count	Explanation
sin	1	sine function (rad)
cos	1	cosine function (rad)
tan	1	tangent function (rad)
asin	1	arcus sine function (rad)
acos	1	arcus cosine function (rad)
atan	1	arcus tangens function (rad)
sinh	1	hyperbolic sine function

cosh	1	hyperbolic cosine
tanh	1	hyperbolic tangens function
asinh	1	hyperbolic arcus sine function
acosh	1	hyperbolic arcus tangens function
atanh	1	hyperbolic arcur tangens function
log2	1	logarithm to the base 2
log10	1	logarithm to the base 10
log	1	logarithm to base e (2.71828...)
ln	1	logarithm to base e (2.71828...)
exp	1	e raised to the power of x
sqrt	1	square root of a value
sign	1	sign function -1 if x<0; 1 if x>0
rint	1	round to nearest integer
abs	1	absolute value
min	variable	min of all arguments
max	variable	max of all arguments
sum	variable	sum of all arguments
avg	variable	mean value of all arguments

It should be noted that trigonometric functions (excluding hiperbolic functions) only support arguments in radians. This means that arguments for this function have to be recalculated if angle is defined in degress.

Value recalculation is only triggered on signal change of the preconfigured signal. That means that using other signals (via TagValue() call) does not trigger value update.

Some mathematical expression cannot be mathematically evaluated in some conditions, for example, square root cannot be found for negative numbers. As complex numbers are not supported, result is then equal to Not a Number (NaN). These results are marked with an invalid (IV) flag.

Binary operations

Table. Supported binary operators:

Operator	Description	Priority
=	assignment	-1
»	right shift	0

«	left shift	0
&	bitwise and	0
|	bitwise or	0
&&	logical and	1
||	logical or	2
<=	less or equal	4
>=	greater or equal	4
!=	not equal	4
==	equal	4
>	greater than	4
<	less than	4
+	addition	5
-	subtraction	5
*	multiplication	6
/	division	6
^	raise x to the power of y	7

Ternary operators can be used. This expression can be compared to the operator supported by C/C++ language (Table 39). Condition is written before a question (?) sign. If condition is true, result after question sign is selected. If condition is false, result after colon (:) is selected.

Ternary operations

Table. Supported ternary operators

Operator	Description	Remarks
?:	if then else operator	C++ style syntax

Examples

User can construct his own equation by using the aforementioned operators and functions. These examples can be seen in Table bellow.

Table. Example expressions

Expression	Description
value * 0.0001	Multiply the tag by a constant.
value + TagValue(”tag/dev_alias/sig_alias/out”)	Add value of tag/dev_alias/sig_alias/out to the current tag.
sin(value)	Return a predefined sine function value of the tag.
(value>5)? 1: 0	If value is greater than 5, result should be equal to 1, otherwise - equal to 0

Variable called value is generated or updated on every signal change and represent the signals being configured. If another value from tag list is intended to be used, one should use `TagValue()` function to retrieve its last value.

The inner argument of `TagValue()` function has to described in a Redis topic structure of WCC Lite. That means that it has to be constructed in a certain way. Quotes should be used to feed the topic name value, otherwise expression evaluation will fail.

Every Redis topic name is constructed astag/[device_alias]/[signal_alias]/[direction]. Prefix tag/ is always used before the rest of argument. `device_alias` and `signal_alias` represent columns in Excel configuration. direction can have one of four possible values - rout, out, in, rin; all of which depend on the direction data is sent or acquired device-wise. For example, out keyword marks data sent out of WCC Lite device, whereas in direction represents data that WCC Lite is waiting to receive, for example, commands. Additional r before either direction means that data is raw, it was is presented the way it was read by an individual protocol.

Extra functions

Several functions are defined make tag operations possible:

- `TagValue(key)` - returns last known value of tag identified by redis key;
- `TagFlag(key)` - returns 1 if tag flag exists. Name format is: ”key flag”. For example to check if tag is notopical, name would be ”tag/19xxxxxxx/x/x nt”;
- `TagAttribute(key)` - similar to TagFlag, but returns a numeric value of a tag attribute;
- `TagTime(key)` - returns unix timestamp in milliseconds of a last know tag value.

Uploading configuration

As of WCC Lite version v1.4.0 there are three separate ways to import the configuration: import an Excel file via web interface, generate compressed configuration files and later upload them via web interface; or generate compressed configuration files and upload them via utility application.

For WCC Lite versions v1.4.0, name of the file is shown in Protocol Hub->Configuration. Older versions only allow configuration file to be stored to a file called phub.xlsx and later downloaded with a custom-built name reflecting date of a download. Upgrade process from older version to versions v1.4.0 and above when preserving configuration files automatically makes the neccessary changes to enable this new functionality of WCC Lite.

> If a user intends to **downgrade** firmware to versions older than version v1.4.0 from newer versions, he/she must first download the configuration files and later reupload the configuration after finishing the upgrade process.

Importing an Excel file

Excel file can be imported without any external tools. This option can be used where there is no internet connection or only minor change has to be applied. This way of importing is not suitable for validation of Excel configuration file.

> **Generating configuration is a resource-intensive task.** It might take up to 10 minutes depending on configuration complexity

> Supported types of an Excel configuration: .xlsx, .xlsm, .xltm, .xltx

To upload an Excel file, open Protocol Hub->Configuration screen in Web interface, select Configuration file and press Import configuration.

Generating .zip file

To accelerate a task of generating configuration a computer can be used. For this user should download WCC Excel Utility application. Upon opening an application, user should search for a field called Excel file which lets to choose an Excel file for which a conversion should be made. Output file should be filled out automatically, however, this value can be edited.

To make a conversion press Convert. If there are no errors found in the configuration, output file should contain the generated configuration, otherwise, error message is shown to a user.

This .zip file can be uploaded via Web interface, using the same tools as used for import of an Excel file.

Uploading configuration remotely

As of WCC Lite version v1.4.0 generated configuration files can be uploaded by a click of button in the Excel Utility. There are four parameters (not counting the configuration file itself) that have to be filled in before starting upload:

- *Hostname*: an IP address for device to connect to. This field conforms to hostname rules, therefore, if invalid value is selected, it is reset to default (192.168.1.1);
- *Port*: a PORT number to which a SSH connection can be made; valid values fall into a range between 1 and 65535; if invalid value is selected, it is reset to default (22);
- *Username*: a username which is used to make a SSH connection; make sure this user has enough rights, preferably root;
- *Password*: a password of a user used for establishing a SSH connection;

> Configuration can only be uploaded if a port used for SSH connection is open for IP address filled in hostname entry field. Please check WCC Lite firewall settings in case of connection failure.

To upload a configuration remotely, press Upload configuration. If no errors occur, you should finally be met with text output mentioning configuration has been applied. During the course of upload process the aforementioned button is disabled to prevent spanning multiple concurrent processes.

Programmable logic controller

A programmable logic controller (PLC) is a digital device adapted for control of processes which require high reliability, ease of programming and realtime responses. Such functionality has long since replaced hardwired relays, timers and sequencers which would be required to complete various tasks.

Programmable logic controllers usually had to conform to IEC 611313 standard which defines four programming languages: function block diagram (FBD), ladder diagram (LD), structured text (ST) and sequential function chart (SFC). This standard does not support distributed control systems therefore IEC 61499 standard was published in 2005. The standard is considered an extension of IEC 611313 standard.

WCC Lite supports PLC functionality while conforming to specifications of IEC 61499 standard.

IEC 61499

IEC 61499-1 defines the architecture for distributed systems. In IEC 61499 the cyclic execution model of IEC 61131 is replaced by an event driven execution model. The event driven execution model allows for an explicit specification of the execution order of function blocks. If necessary, periodically executed applications can be implemented by using the E_CYCLE function block for the generation of periodic events.

IEC 61499 enables an application-centric design, in which one or more applications, defined by networks of interconnected function blocks, are created for the whole system and subsequently distributed to the available devices. All devices within a system are described within a device model. The topology of the system is reflected by the system model. The distribution of an application is described within the mapping model. Therefore, applications of a system are distributable but maintained together.

Like IEC 61131-3 function blocks, IEC 61499 function block types specify both an interface and an implementation. In contrast to IEC 61131-3, an IEC 61499 interface contains event inputs and outputs in addition to data inputs and outputs. Events can be associated with data inputs and outputs by WITH constraints. IEC 61499 defines several function block types, all of which can contain a behavior description in terms of service sequences:

Service interface function block – SIFB: The source code is hidden and its functionality is only described by service sequences;
- Basic function block - BFB: Its functionality is described in terms of an Execution Control Chart (ECC), which is similar to a state diagram (UML). Every state can have several actions. Each action references one or zero algorithms and one or zero events. Algorithms can be implemented as defined in compliant standards.
- Composite function block - CFB: Its functionality is defined by a function block network.
- Adapter interfaces: An adapter interface is not a real function block. It combines several events and data connections within one connection and provides an interface concept to separate specification and implementation.
- Subapplication: Its functionality is also defined as a function block network. In contrast to CFBs, subapplications can be distributed.

To maintain the applications on a device IEC 61499 provides a management model. The device manager maintains the lifecycle of any resource and manages the communication with the software tools (e.g., configuration tool, agent) via management commands.

4Diac framework

The PLC functionality in the WCC Lite is implemented using Eclipse 4diac framework, consisting of the 4diac IDE and the 4diac FORTE runtime. The system corresponds to IEC 61499, an extension of IEC 61131-3. For more in-depth instructions and function block reference please see the 4diac manual - this document is merely a quick start guide that emphasizes the specifics of tailoring the applications to run on the WCC Lite.

The 4diac IDE application is used to model logic sequences. An output file, *.fboot, is then generated and either loaded into the runtime for debugging purposes (functionality available from within the IDE), or uploaded into the controller for normal use via web interface.

⚠ During debugging, the output logic is executed directly in the runtime. Any logic loaded during debugging will be discarded after a reboot of the controller. Logic applications for regular use should be uploaded via the web interface.

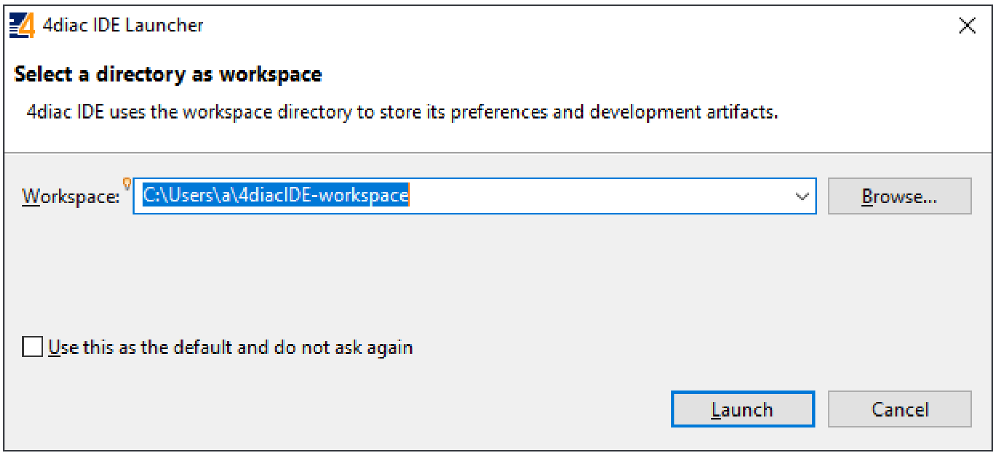
ℹ It is possible to run multiple tasks at once. These tasks can either be implemented in the same screen or split into separate tasks. Please note, however, that all elements should have unique names, even between different tasks. As of 4diac IDE 1.11.3 this is not enforced between separate apps, however, 4Diac runtime application rejects such file purely because of naming issues.

The 4diac FORTE runtime is able to execute the aforementioned fboot files containing the logic. The FORTE runtime can be run on both the WCC Lite and a PC for debugging purposes. The runtime is integrated to interact with the REDIS database.

Example project

The best way to understand basics of 4Diac and WCC Lite collaboration is through an example project. This user manual intends to show the pieces needed to run PLC applications on WCC Lite. It is not intended to be definitive guide on how to use 4Diac IDE or how to interpret IEC 61499 standard.

During (at least) the first start of the IDE user will be asked to select a directory for the workspace as in Figure. Workspace is used to save files needed for projects.

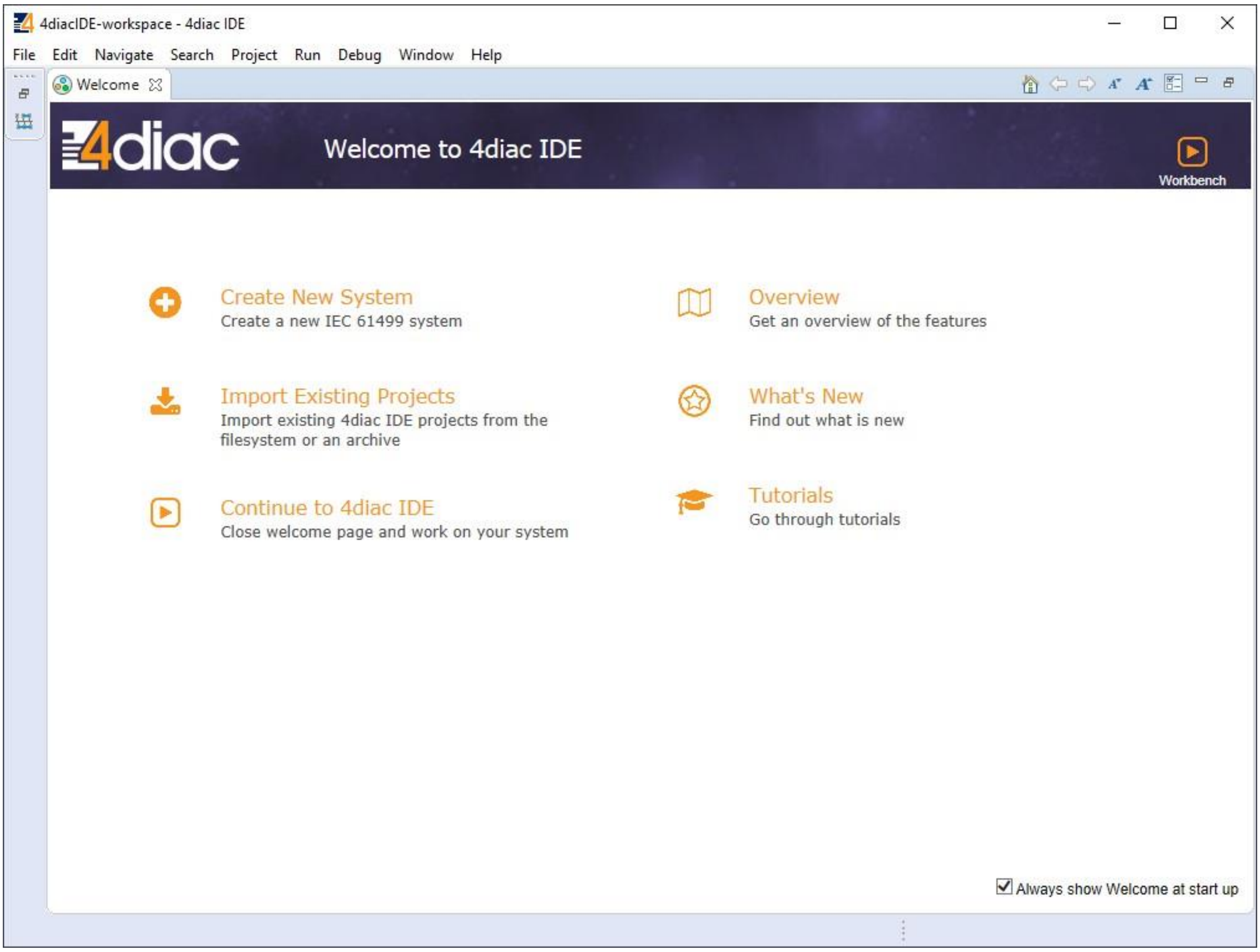


4diac IDE Launcher

Select a directory as workspace

4diac IDE uses the workspace directory to store its preferences and development artifacts.

Workspace: C:\Users\a\4diacIDE-workspace


4diacIDE-workspace - 4diac IDE
File Edit Navigate Search Project Run Debug Window Help
Welcome
4diac
Workbench

Welcome to 4diac IDE

Create New System
Create a new IEC 61499 system

Import Existing Projects
Import existing 4diac IDE projects from the filesystem or an archive

Continue to 4diac IDE
Close welcome page and work on your system

Overview
Get an overview of the features

What's New
Find out what is new

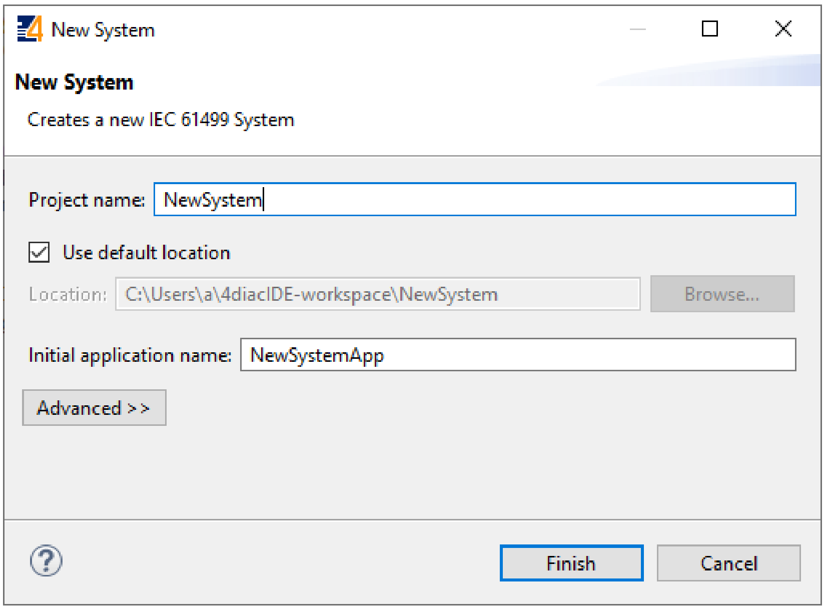
Tutorials
Go through tutorials

☑ Always show Welcome at start up

After that a user should be met by the welcome window as in Figure 20. If such window is not shown, one can create create project by selecting File->New->Project and filling in the required fields (figure 21).

To create a simple application, simply drag and drop objects from the palette to the canvas and wire them accordingly. Event trigger and data pathways cannot be connected to one another. Displayed below is an example of a simple blinker application (figure 22).

> Having less wiring by connecting several signals to same subnet as PCB designer (such as Altium Designer) as of 4Diac IDE 1.11.3 is not supported. However, if some parts are used frequently, it is highly advised to have less wiring by simply compiling several elements into a subapplication. For this, you would have to select elements to be grouped, press right key and select New Subapplication. You can later change names of such elements and its pins.



New System

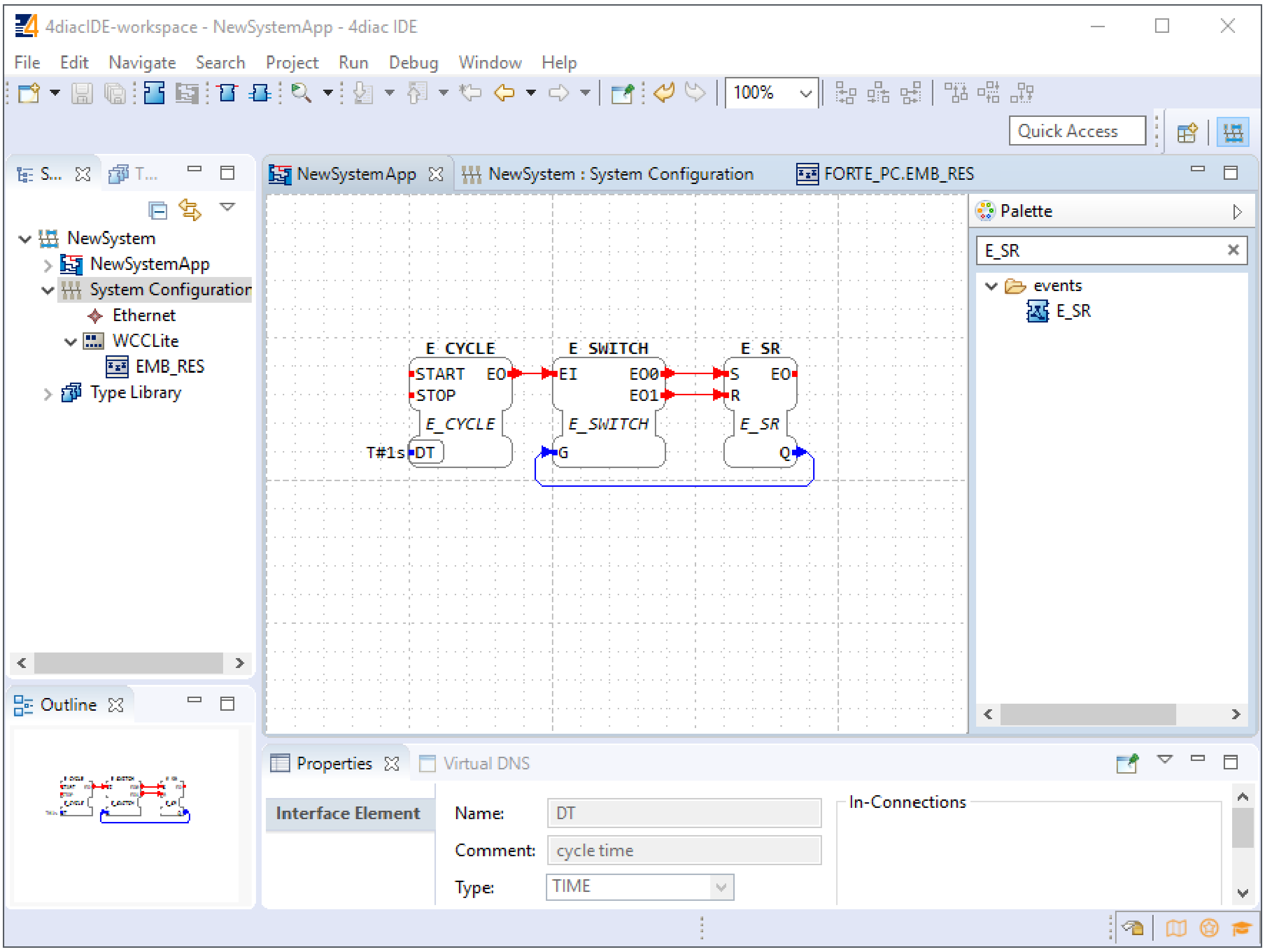
Creates a new IEC 61499 System

Project name: NewSystem

☑ Use default location

Location: C:\Users\a\4diacIDE-workspace\NewSystem

Initial application name: NewSystemApp

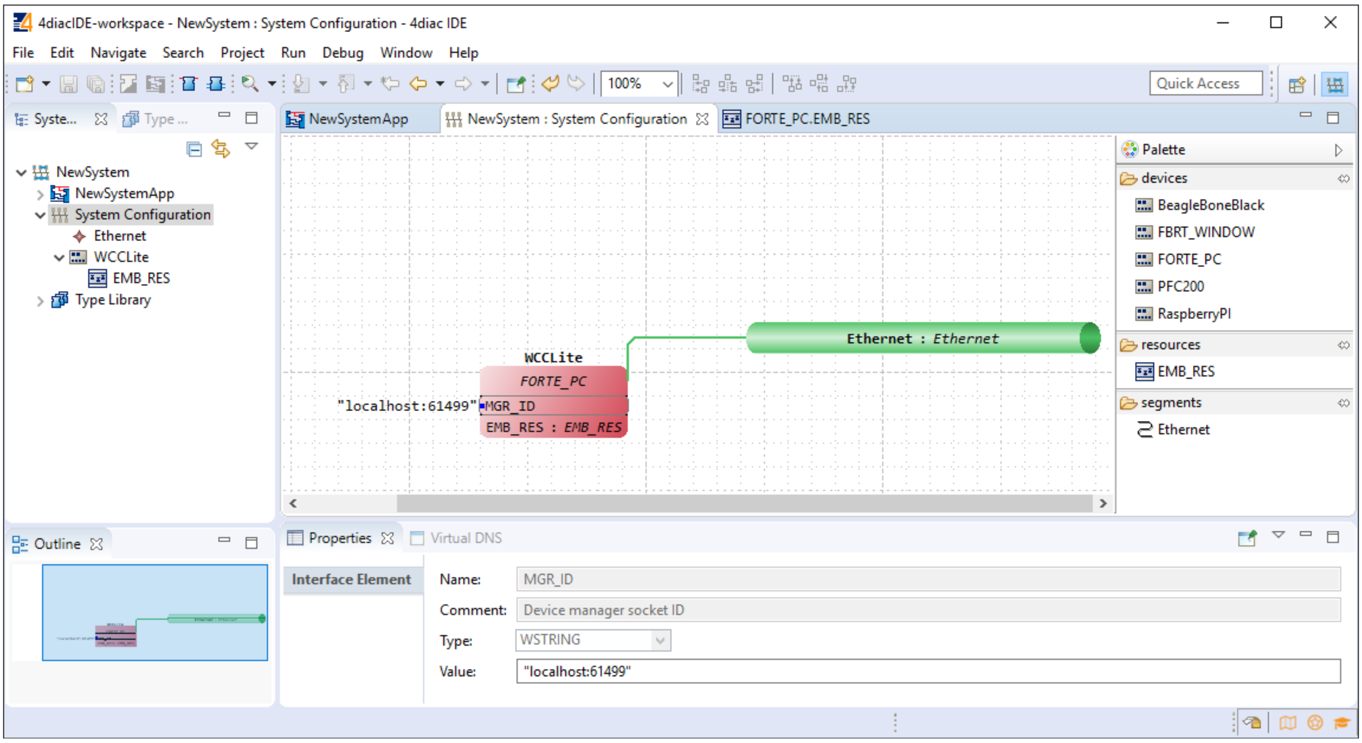


Name: DT

Comment: cycle time

Type: TIME

In the System Configuration section, drag and drop a FORTE_PC device, an Ethernet segment and link them (figure 23). For debugging in the local (PC) runtime, leave the address ”localhost:61499”. For testing on a WCC Lite, enter the IP address of the device, along with the port number (which by default is 61499 as well).



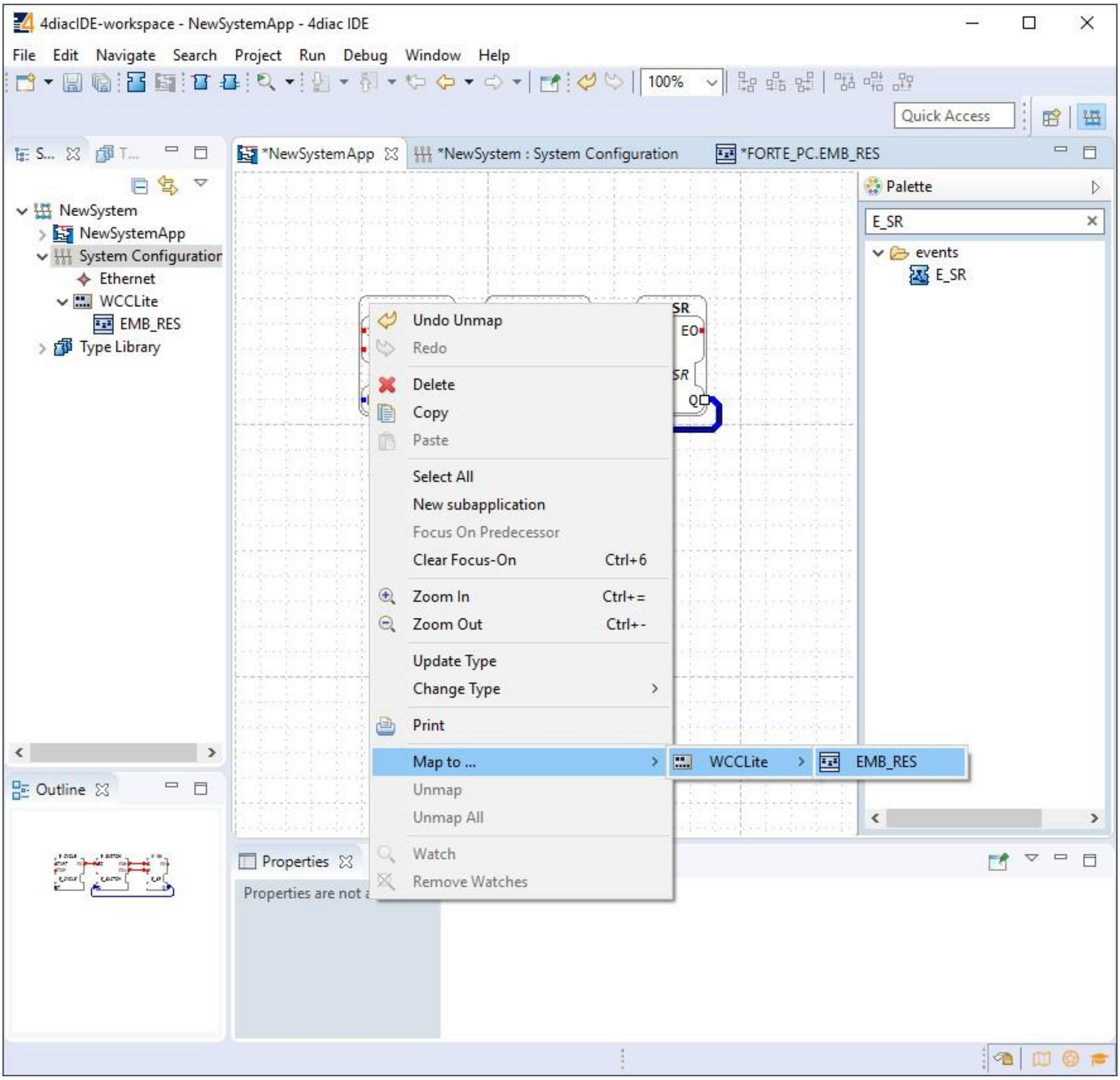
Name: MGR_ID

Comment: Device manager socket ID

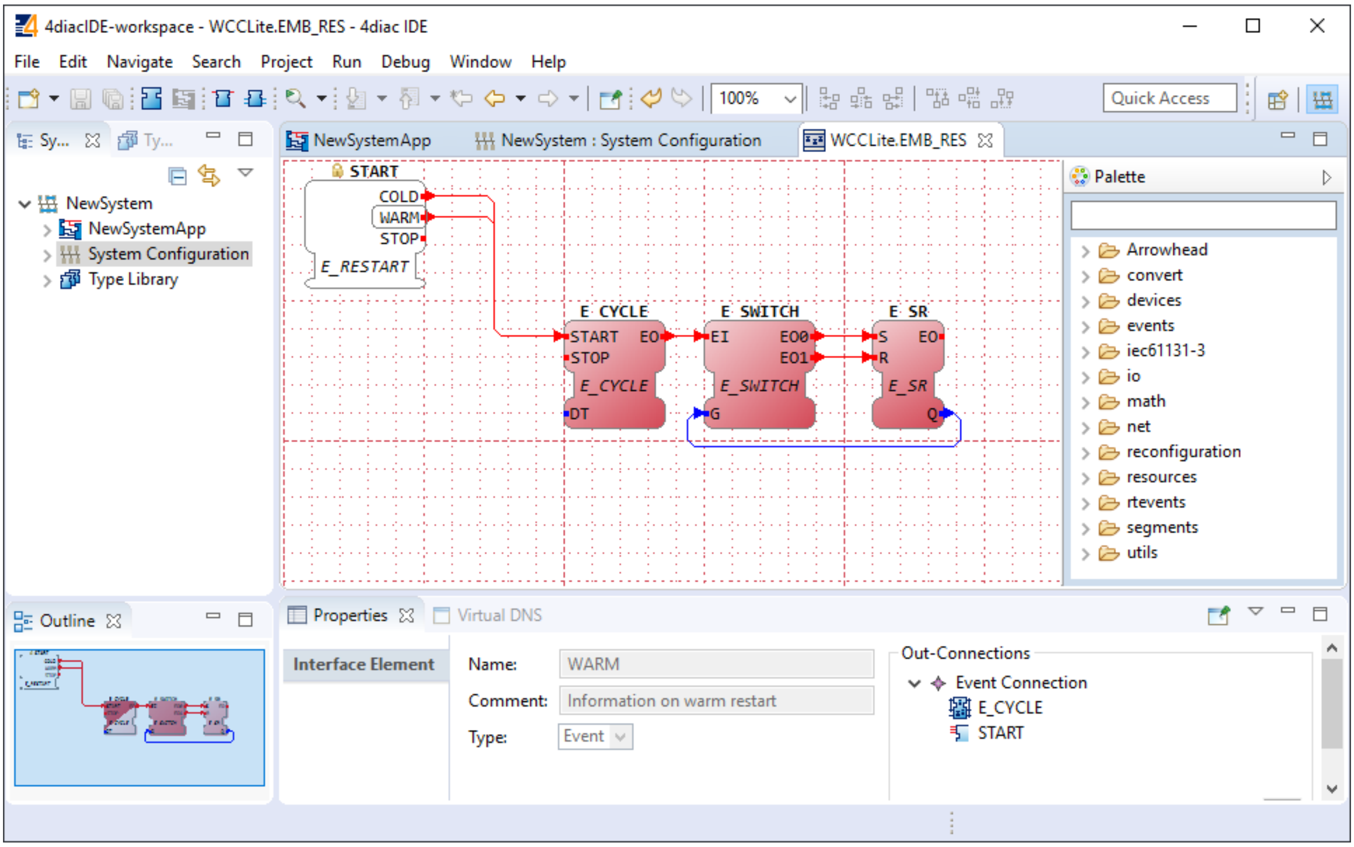
Type: WSTRING

Value: "localhost:61499"

In order to deploy the application, the circuit needs to be mapped to the controller. For a non-distributed application (distributed application cases will not be discussed in this chapter), all the FBs of the application need to be selected and mapped to the configured controller as shown in figure 24.



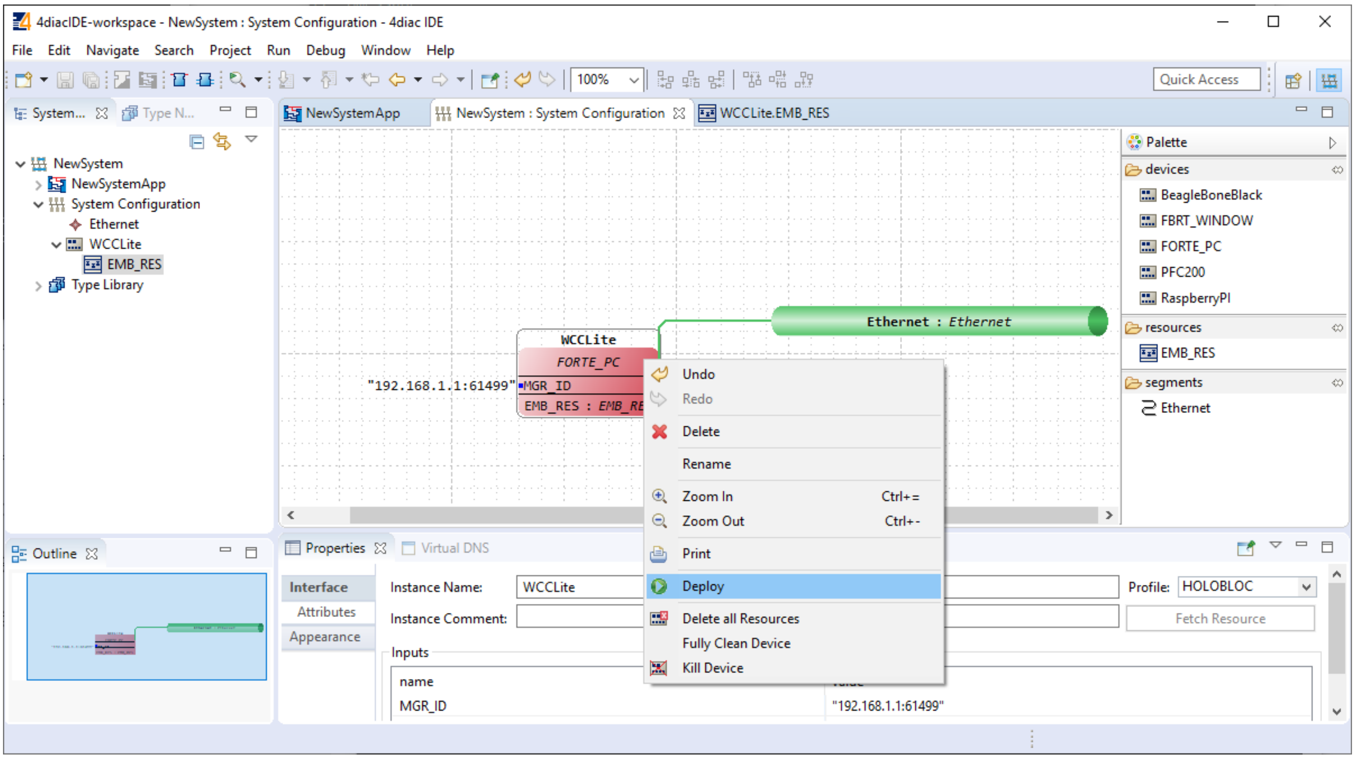
To start the application execution, an initial trigger needs to be present. For a non-distributed application, the initial event trigger needs to be wired from the START function block in the resource section as shown in figure 25.



Name: WARM

Comment: Information on warm restart

Type: Event



"192.168.1.1:61499"

Instance Name: WCCLite

Instance Comment:

Profile: HOLOBLOC

MGR_ID "192.168.1.1:61499"

To deploy the application, go to the System Configuration tab and simply select ”Deploy” from the right-click menu of the controller device (figure 26). If a running application exist in the runtime, you may be asked whether you want to replace it. This will only overwrite the application in the memory and not the storage. If the controller is restarted, the old application will be loaded from the
non-volatile memory of the controller.

Configuring data endpoints

To use WCC Lite as a programmable logic controller, it needs to be configured in a particular way. The PLC functionality of the WCC Lite only allows for the use of data that is has been configured in the Excel configuration spreadsheet. This has been done for security purposes and to preserve transmission medium only for data that is available. Only topics defined in the configuration can post or get data. If a certain data entry exists but it has not been linked to a PLC program, all calls from PLC runtime application to Redis database will be ignored. Therefore it is highly advised to prepare and upload the Excel configuration before using this signal in the PLC application.

Some parameters are mandatory for PLC usage. These parameters are shown in two tables below (one for Devices, one for Signals tab). Please note that other parameters can be used as well, but are not covered because they aren't specific to PLC functionality.

Table. Mandatory parameters for Devices tab

Parameter	Type	Description
name	string	User-friendly device name
device_alias	string	Device alias to used in configuration
enable	boolean	Enabling/disabling of a device
protocol	string	Selection of protocol (IEC 61499)

Table. Mandatory parameters for Signals tab

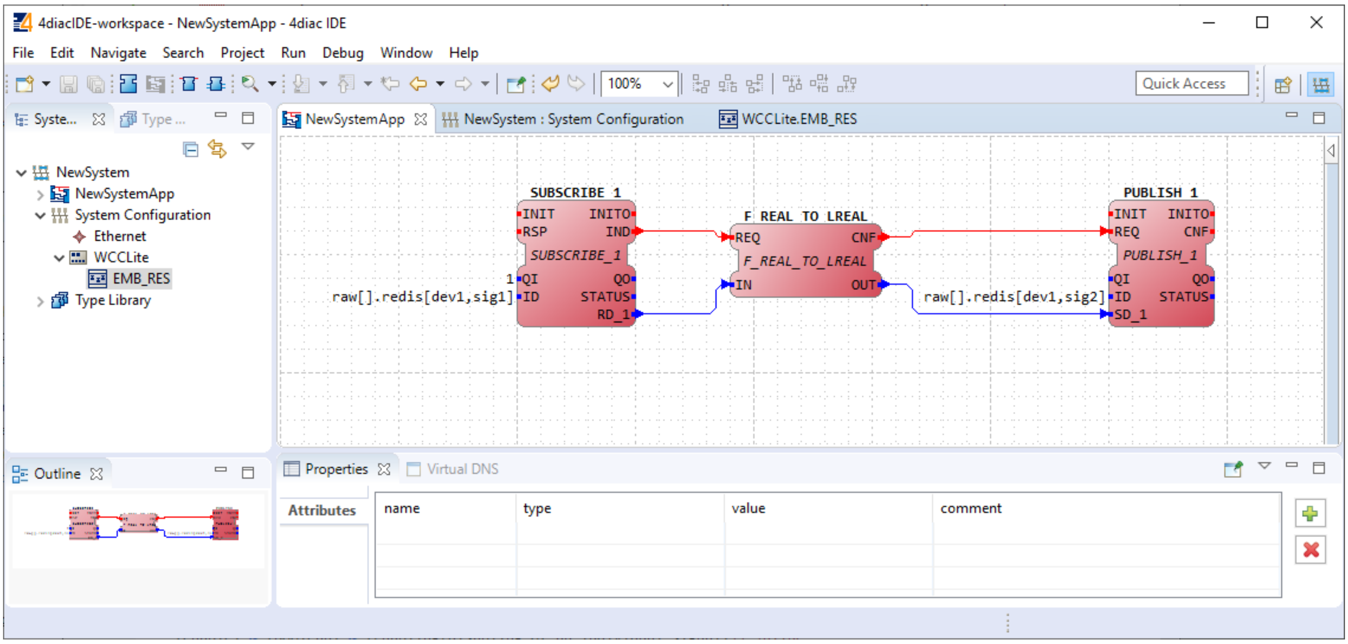
Parameter	Type	Description
signal_name	string	User-friendly signal name
device_alias	string	Device alias from a Devices tab
signal_alias	string	Unique signal name to be used
source_device_alias	string	device_alias of a source device
source_signal_alias	string	signal_alias of a source signal

If an upload consisting of configuration for IEC 61499 has been succesful, one should be able to access a configuration stored in /etc/iec61499.json file where protocol-specific parameters are shown in a JSON format. If the file is missing, make sure you have a correct firmware version installed and haven't made any typing errors.

Parameters mentioned earlier, namely device_alias and signal_alias, are the only parameters one needs to fill to bind Excel configuration to 4Diac framework. Two types of blocks are used for data transmission - PUBLISH blocks to write data to REDIS database and SUBSCRIBE blocks to acquire data from database as soon as it changes its value. Both of them have an ID connection. To connect a block to a datapoint, one should set this pin as raw[].redis[device_alias,signal_alias], e.g. raw[].redis[example_plc_device,example_plc_signal_alias].

An example with SUBSCRIBE and PUBLISH function blocks is shown below in image below.

Subscribe and publish examples



1 QI

raw[].redis[dev1,sig1] ID

raw[].redis[dev1,sig2] ID

⚠ Outputs of variable type ANY cannot be directly wired to inputs of the same type and therefore need to be explicitly typed using transitional function blocks

⚠ No more than 20 tags should be published over a period of 5 seconds, as this may overfill the queue. A "publish only on change" policy is advised.

⚠ Currently only PUBLISH_1 and SUBSCRIBE_1 function blocks are supported.

If every step until now has been succesful, a user could now start debugging a PLC application.

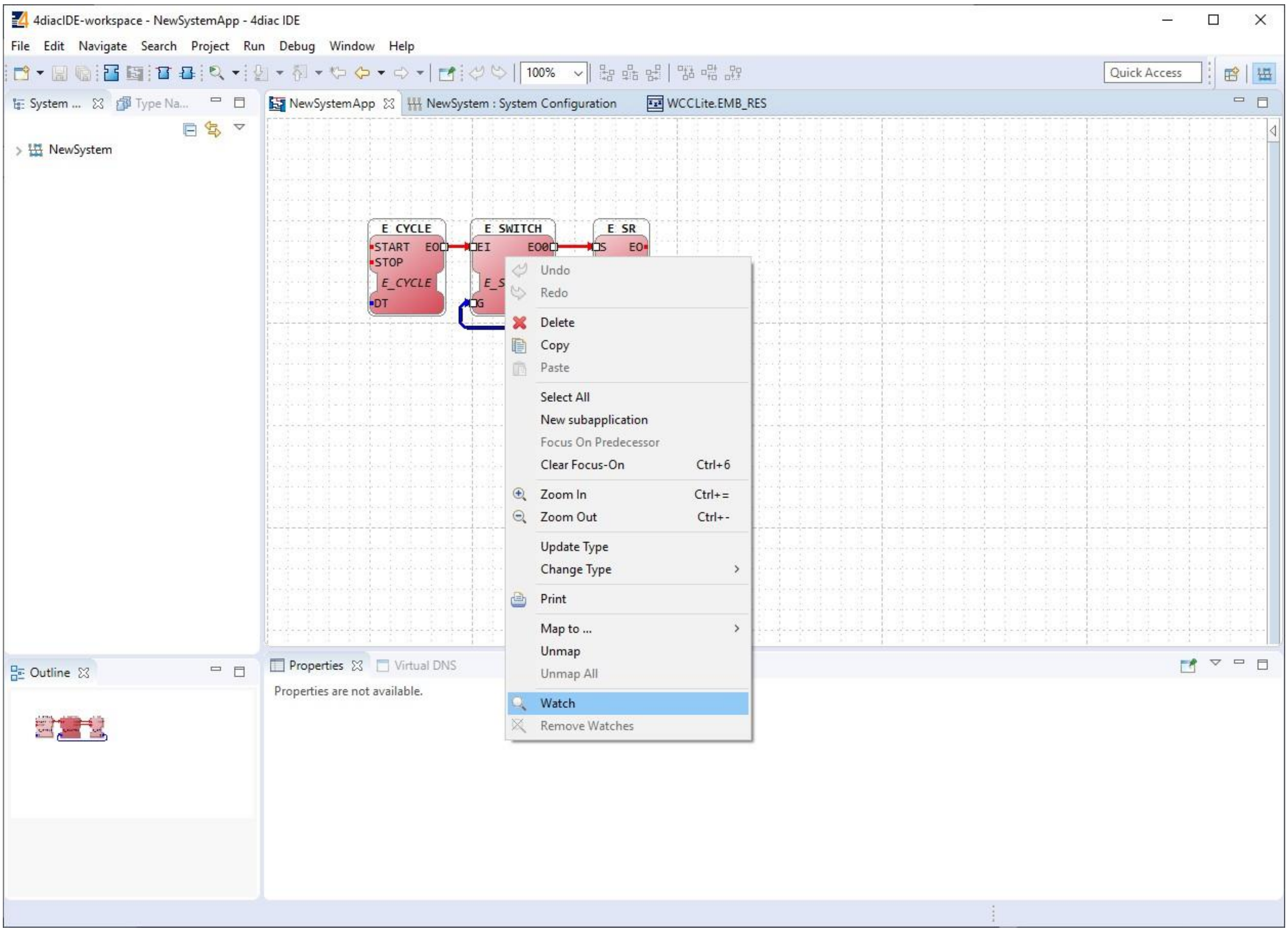
Debugging an IEC 61499 application

After a project has been built and binded to an existing Excel configuration, a user would normally want to check if every part is working according to the prior requirements before compiling finished project and uploading it to production. Both 4Diac framework and WCC Lite offer tools for flexible debugging.

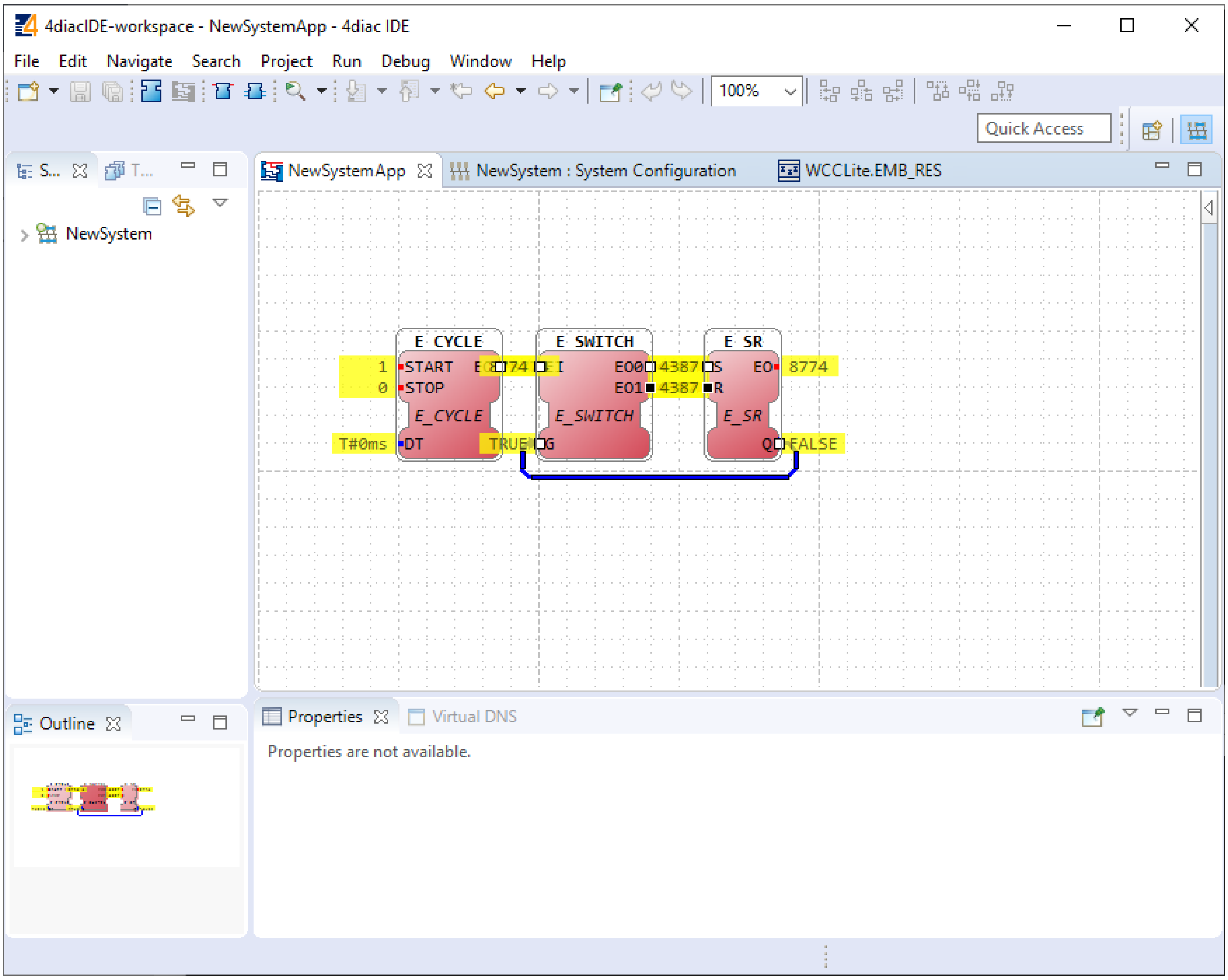
There is a possibility that 4Diac FORTE might not start as a process. It may happen if multiple faults occured and process has stopped. Process is also programmed to not start if no excel configuration file is found, therefore a user should make sure that Excel configuration is uploaded and ready for use.

Individual function blocks can be set to Watch mode: events can be triggered and values can be forced at inputs or outputs (look into images bellow). To monitor the function blocks, the application should be deployed and the IDE should be in Online mode (Debug -> Monitor System -> NewSystem).

Selecting watch mode:



Function blocks in watch mode:



Properties are not available.

Seeing information dynamically updated on 4Diac IDE might be very informative, however, some applications might require accesing WCC Lite via command-line interface. For example, in case of information not being updated one would want to assure that 4Diac FORTE in WCC Lite is not filtering data out but sending it to internal database (Redis). To run 4Diac FORTE debug from command-line interface, a user should write forte and press Enter. All possible choices are shown by adding -h flag. More flags are shown in a Table bellow. Make sure to stop any running process that could use the address that 4Diac framework is going to use.

Table. 4Diac FORTE command line debugging options:

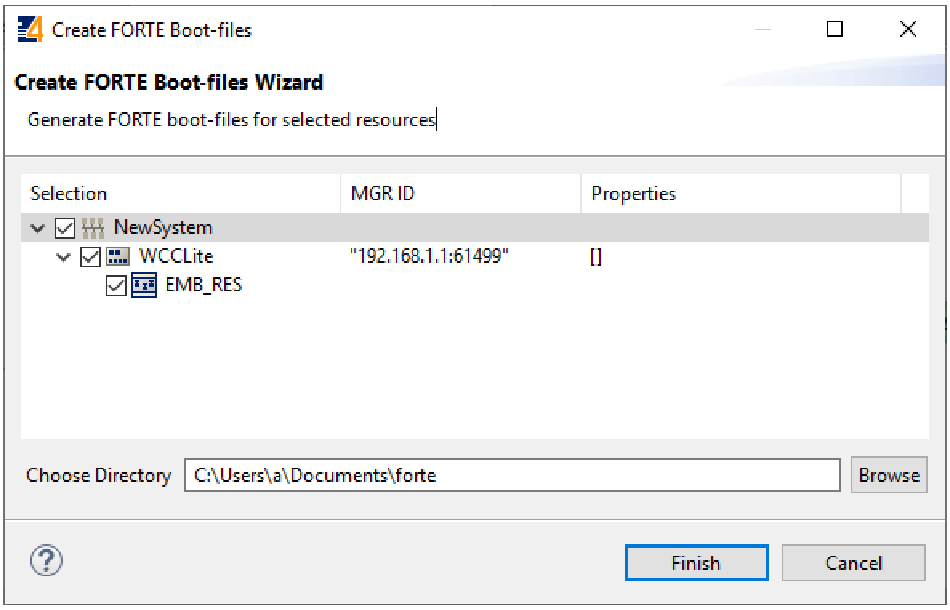
```
-h - Display help information
-c <IP>:<port> - Set the listening IP and port for the incoming connections
-r - Show redis messages
-d <debug level> - Set debugging level
-f - Set the boot-file where to read from to load the applications
```

Generating and uploading FORTE logic file

After the PLC design is finished and debugged, such design can be compiled into FBOOT file and uploaded to one or multiple devices to be used in production. As application being debuggged is not automatically considered as a default application, one should be uploaded explicitly via web interface.

To generate FORTE boot-files a user should select Run->Create FORTE boot-file.... After that one should select devices which should have their boot files created as well as additional devices' properties and directory where these files should be stored as in picture bellow.

Generating FBOOT file:



Create FORTE Boot-files Wizard

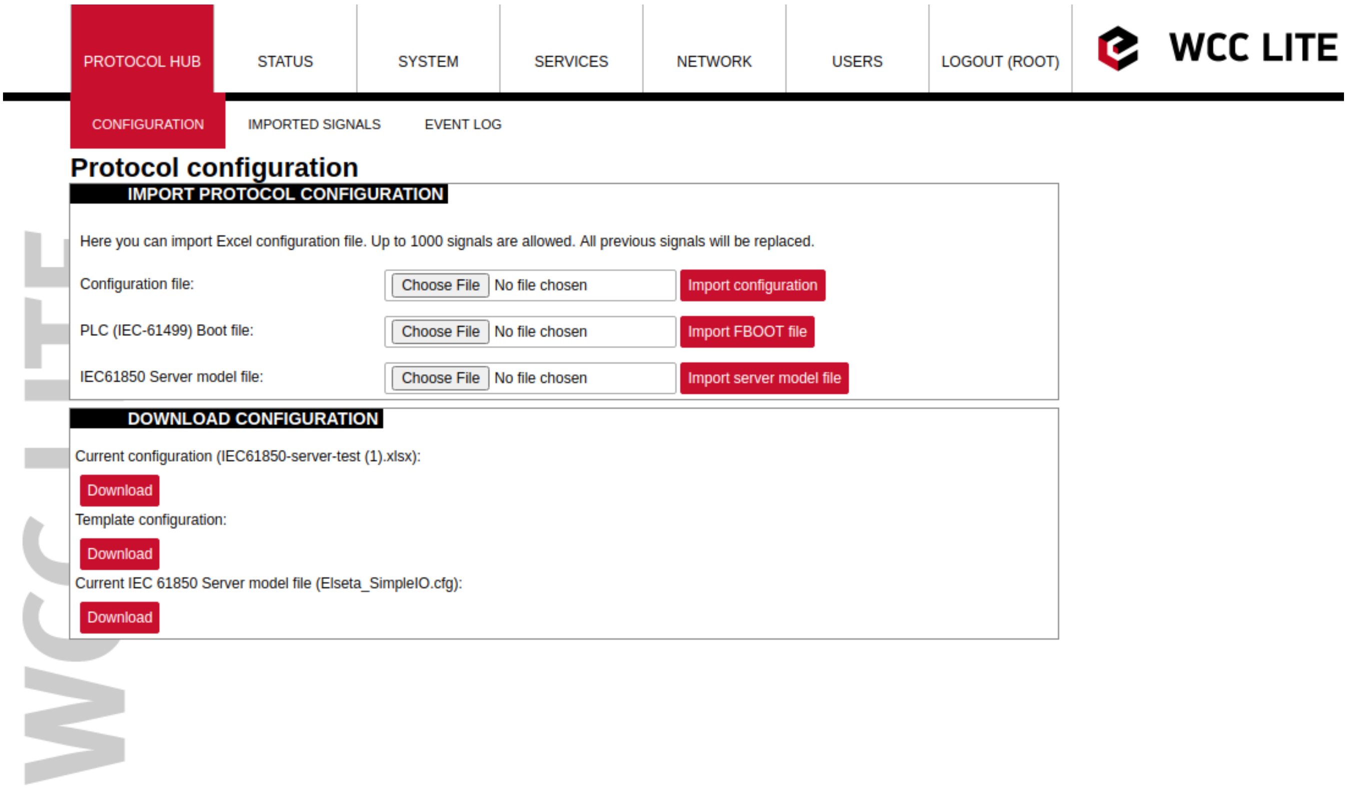
Generate FORTE boot-files for selected resources

Selection	MGR ID	Properties
☑ NewSystem		
☑ WCCLite	"192.168.1.1:61499"	[]
☑ EMB_RES		

Choose Directory C:\Users\a\Documents\forte

Upload button for FORTE file in web interface can be found in Protocol Hub tab, Configuration screen (FORTE boot file upload supported for versions v1.4.0 and above). You should see a view as in picture below.

WCC Lite Web interface. Upload and download of 4Diac configuration files:



Protocol configuration

IMPORT PROTOCOL CONFIGURATION

Here you can import Excel configuration file. Up to 1000 signals are allowed. All previous signals will be replaced.

Configuration file: No file chosen

PLC (IEC-61499) Boot file: No file chosen

IEC61850 Server model file: No file chosen

DOWNLOAD CONFIGURATION

Current configuration (IEC61850-server-test (1).xlsx):

Template configuration:

Current IEC 61850 Server model file (Elseta_SimpleIO.cfg):

After the file has been imported one should be able to download it from the same screen as seen in the picture before.

⚠ Please note that only files with *.fboot extension are allowed.

ℹ Uploading a file saves it's name and shows it in the web interface. It is advised to carefully choose a filename to separate different versions of PLC application files.

Distributed control application

IEC 64199 standard introduced requirements for a distributed control. This means that multiple devices can change information between them and make their own decisions based on the data they receive from other sources. This enables distributed applications between multiple WCC Lite devices and all other devices that support IEC 61499.

Communication between devices can be configured using:

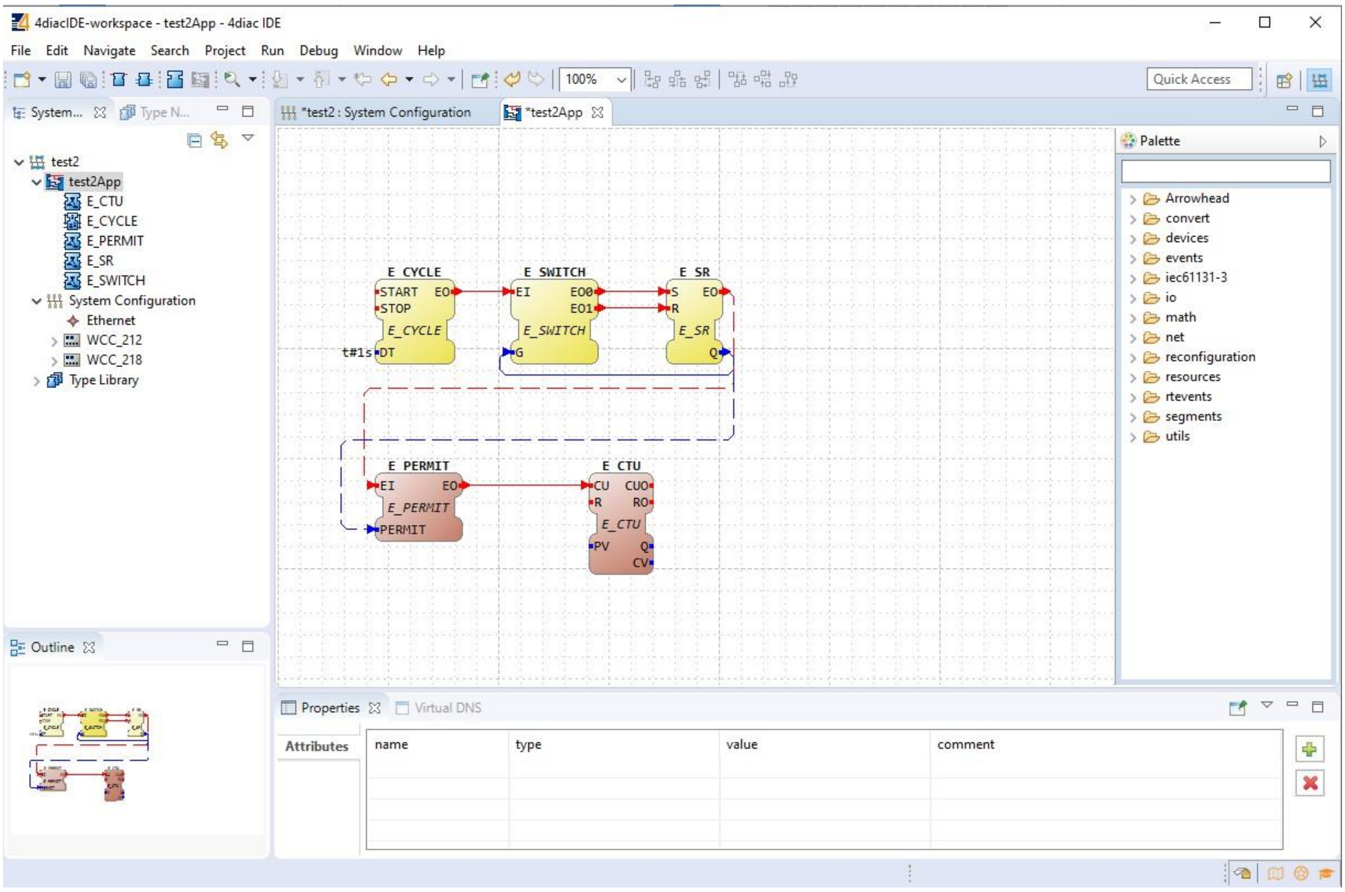
- Publish/Subscribe function blocks (via UDP packets);
- Client/Server function blocks (via TCP packets).

A Publish block can publish data messages using UDP multi-cast addresses meaning that multiple devices would be able to simultaneously get the same data. However, one would have to make sure that all of the devices support multi-cast option.

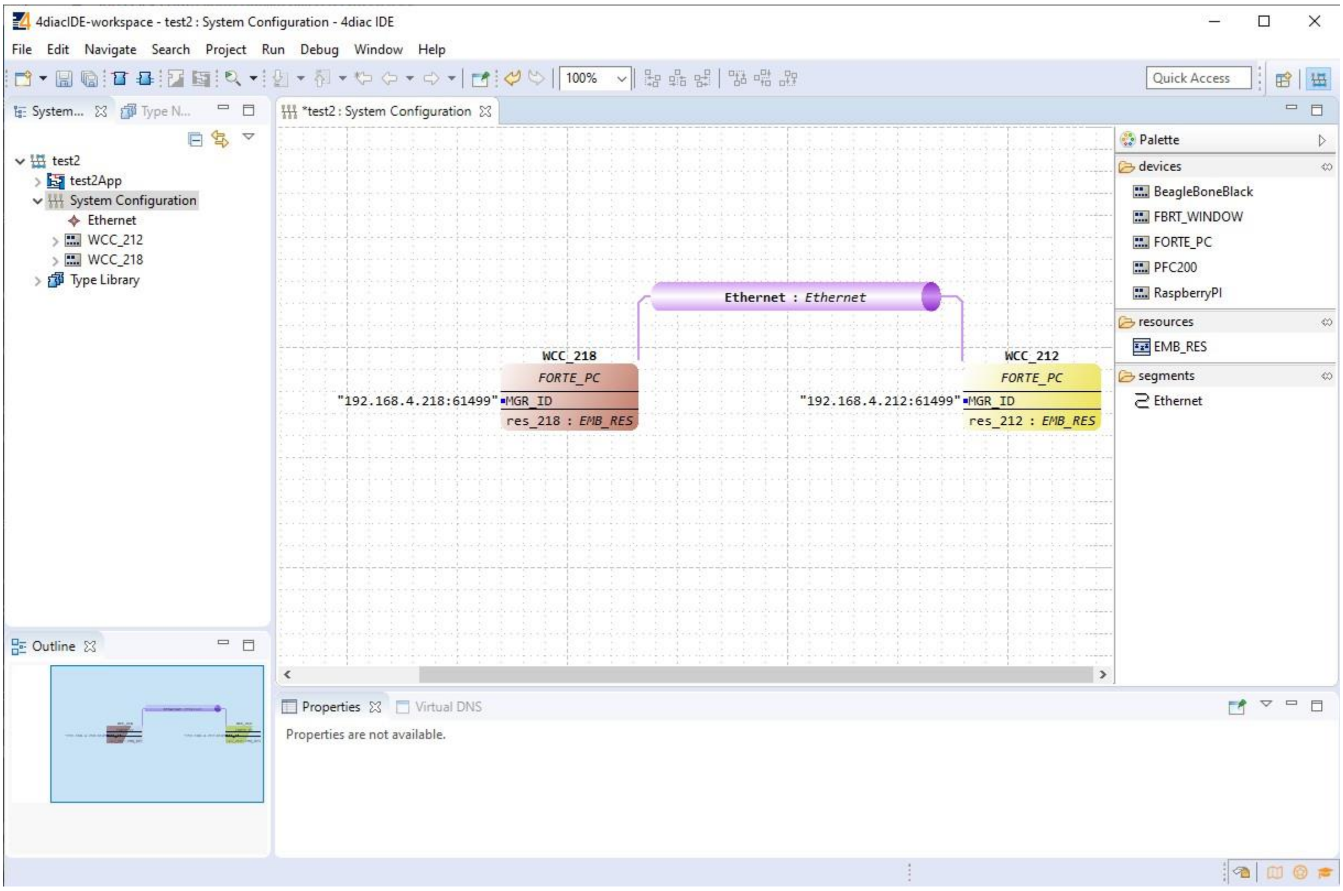
This user manual will only cover setting up point-to-point communication between devices via Publish/Subscribe blocks. For more information on communication between several IEC 61499 devices please check documentation for Eclipse 4diac framework.

Let's say we would like to count how many times the light has been turned on. For this we can add counting functionality to application shown in picture below. The application should run on 2 devices. The blinking part of the application will run on a 4diac FORTE and the count on another 4diac FORTE, see the architecture below. The two different programs running on two separate WCC Lite devices emulate two PLCs. Two different devices can be identified by different colors of function blocks. One can identify device and it properties by accessing System Configuration screen as seen below. Yellow function blocks belong to WCC_212 device which can be accessed through 192.168.4.212 (port number 61499) whereas brown function blocks belong to WCC_218 device which can accessed through 192.168.4.212 (port number 61499).

Example blinking application as a distributed system:

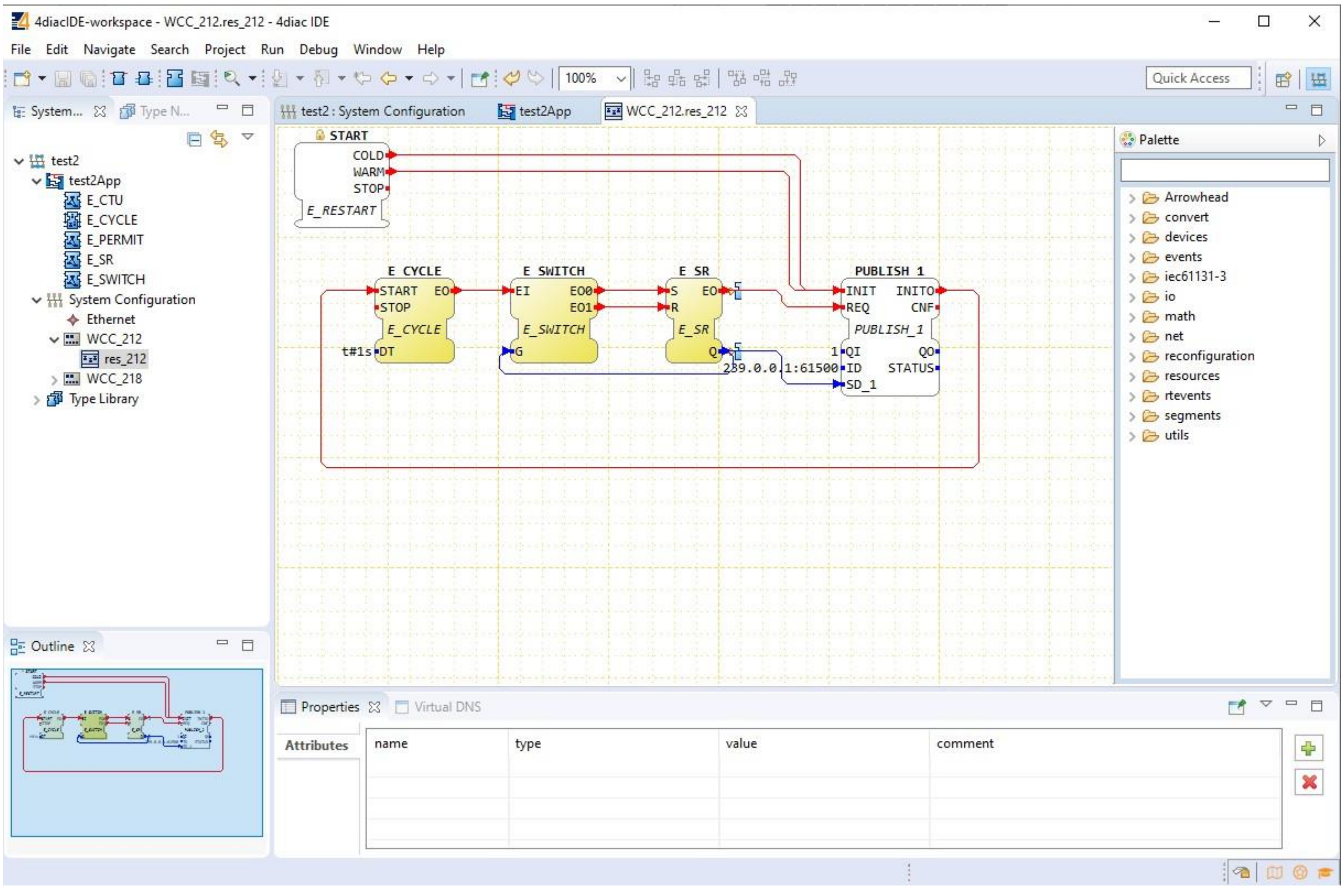


Example system configuration for a distributed system:

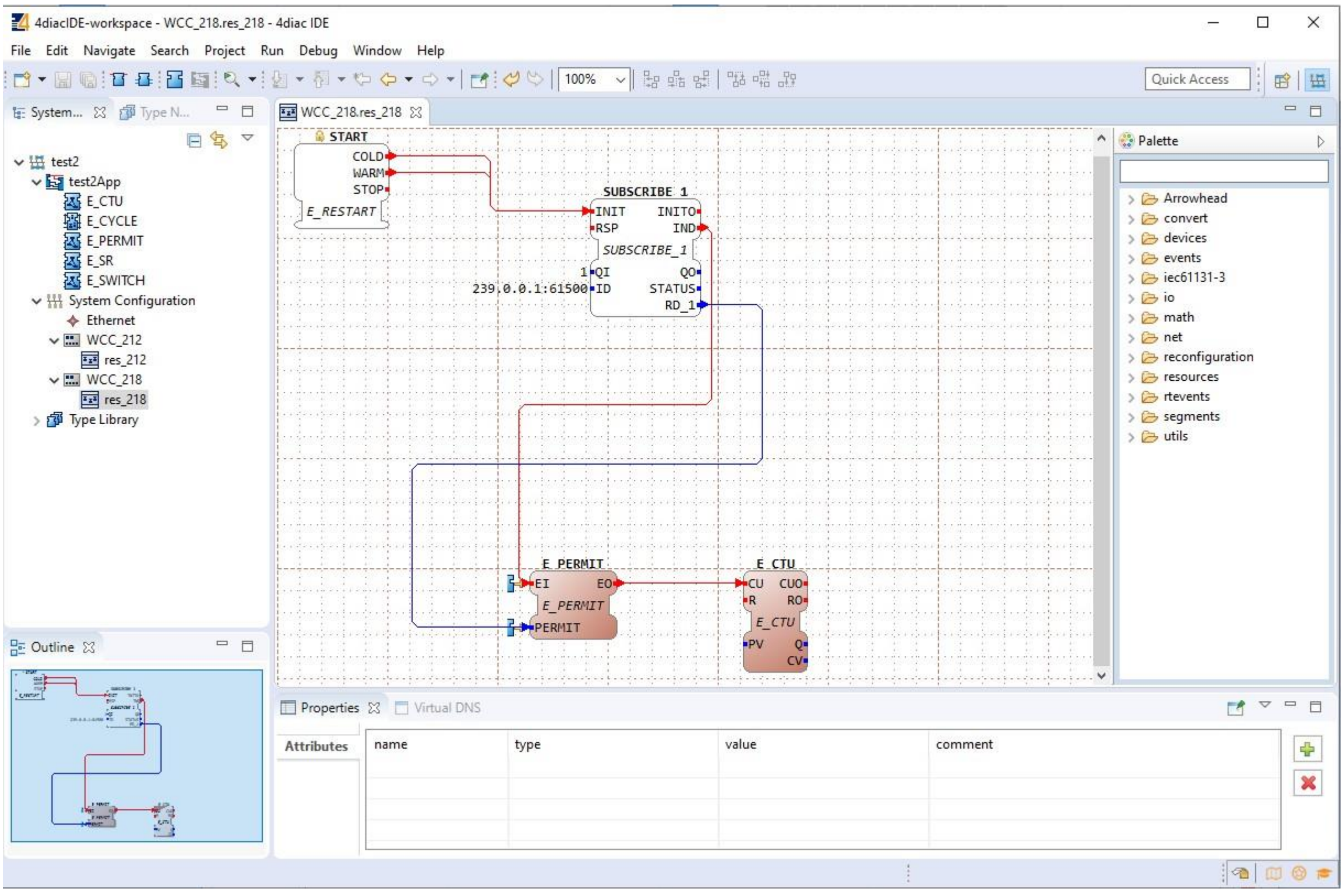


Properties are not available.

Example app for blinking part of a distributed system:



Example app for counting part of a distributed system:



To count the blinking, two new Function Blocks (FBs) have been added to the existing application for a different device (WCC_218):

- E_PERMIT
- E_CTU

To communicate between devices, an additional PUBLISH_X/SUBSCRIBE_X pair must be used. As one can identify, these blocks are not seen when looking at a whole distributed system and should be seen as an intermediary between devices.

The PUBLISH_X FB is used to send messages over the network which are received by an according SUBSCRIBE_X FB. Every time a REQ is triggered, a message is sent according to the ID input. With the value of the ID input you can specify what specific network protocol you would like to use (e.g., MQTT). If you don’t specify a dedicated protocol the default as defined in the ”IEC 61499 Compliance Profile for Feasibility Demonstrations” is used. The number X in PUBLISH_X is the number of data elements that you want to send in the message. Since we are only sending one value we used PUBLISH_1.

The used ID value specifies an IP:PORT pair.

MQTT

Introduction

MQTT (short for MQ Telemetry Transport) is an open OASIS and ISO standard (ISO/IEC PRF 20922) lightweight, publish-subscribe network protocol that transports messages between devices. The protocol usually runs over TCP/IP, although its variant, MQTT-SN, is used over other transports such as UDP or Bluetooth. It is designed for connections with remote locations where a small code footprint is required or the network bandwidth is limited.

The broker acts as a post office, MQTT doesn't use the address of the intended recipient but uses the subject line called "Topic", and anyone who wants a copy of that message will subscribe to that topic. Multiple clients can receive the message from a single broker (one to many capability). Similarly, multiple publishers can publish topics to a single subscriber (many to one).

Each client can both produce and receive data by both publishing and subscribing, i.e. the devices can publish sensor data and still be able to receive the configuration information or control commands. This helps in both sharing data, managing and controlling devices.

With MQTT broker architecture the devices and application becomes decoupled and more secure. MQTT might use Transport Layer Security (TLS) encryption with user name, password protected connections, and optional certifications that requires clients to provide a certificate file that matches with the server's. The clients are unaware of each others IP address.

The broker can store the data in the form of retained messages so that new subscribers to the topic can get the last value straight away.

The main advantages of MQTT broker are:

- Eliminates vulnerable and insecure client connections
- Can easily scale from a single device to thousands
- Manages and tracks all client connection states, including security credentials and certificates
- Reduced network strain without compromising the security (cellular or satellite network)

Each connection to the broker can specify a quality of service measure. These are classified in increasing order of overhead:

- At most once - the message is sent only once and the client and broker take no additional steps to acknowledge delivery (fire and forget).
- At least once - the message is re-tried by the sender multiple times until acknowledgement is received (acknowledged delivery).
- Exactly once - the sender and receiver engage in a two-level handshake to ensure only one copy of the message is received (assured delivery).

Using WCC Lite as MQTT Client

MQTT serves as an alternative for protocols conforming to IEC standards, for example, to send data to a cloud infrastructure that supports MQTT instead of IEC-60870-5-104.

✓ WCC Lite supports MQTT messaging compatible with MQTT v3.1 standard (starting from version **v1.4.0**). Such messaging is possible via mapping of Redis and MQTT data therefore data can be transmitted from any protocol that is supported by WCC Lite.

All standard functions, except for data encryption, are supported. Encrypted messages are not supported yet, therefore to ensure security a user would have to use a VPN service. A user can choose from three different Quality of Service levels, select if messages are to be retained, authenticate users and optionally send Last Will messages.

To configure WCC Lite a user can fill in the needed parameters in Excel configuration. These parameters are shown in two tables below.

Table. MQTT parameters for Devices tab

Parameter	**Type**	**Description**	**Required**	**Default value** (when not specified)	**Range**	
					Min	Max
name	string	User-friendly device name	Yes			

device_alias	string	Device alias to used in configuration	Yes			
enable	boolean	Enabling/disabling of a device	No	0	0	1
protocol	string	Selection of protocol	Yes		MQTT	
host	string	MQTT broker IP address selection	Yes			
port	integer	MQTT broker port selection	No	1883		
enable_threshold	boolean	A parameter to determine if identical values should not be sent multiple times in a row.	No	1	0	1
gi_interval_sec	integer	Parameter to determine how frequently should all values be sent at once. Disabled if equal to 0.	No	0		
mqtt_qos	integer	MQTT Quality of Service for message as in standard	No	0	0	2
mqtt_retain	boolean	Selecting if MQTT broker should retain last received messages	No	0	0	1
user	string	MQTT user name	Yes			
password	string	MQTT user password	Yes			
use_last_will	boolean	Selecting if MQTT should use Last Will and Testament functionality (Default: False)	No	0	0	1
last_will_topic	string	Topic to which an MQTT message would be sent if the device abruptly disconnected message broker	Yes (If use_last_will=True)			
last_will_message	string	Message to be sent over MQTT if the device abruptly disconnected message broker	No			
last_will_qos	integer	MQTT Quality of Service selection as in standard	No	0		
last_will_retain	boolean	Selecting if MQTT broker should retain last will message	No	0	0	1

To map the signal to send through MQTT client, it should have its device_alias and signal_alias mapped to source_device_alias and source_signal_alias respectively.

If MQTT is configured but does not send data, a user can use command line interface to debug transmission. All options for MQTT process which transmits data over MQTT (called mqtt-client as it

Table. MQTT parameters for Signals tab

Parameter	**Type**	**Description**	**Required**	**Default value** (when not specified)	**Range**	
					Min	Max

signal_name	string	User-friendly signal name	Yes			
device_alias	string	Device alias from a Devices tab	Yes			
signal_alias	string	Unique signal name to be used	Yes			
source_device_alias	string	device_alias of a source device	No			
source_signal_alias	string	signal_alias of a source signal	No			
enable	boolean	Enabling/disabling of an individual signal	No	1	0	1
log	integer	Allow signal to be logged. Log signal with 1 and no logging with 0.	No	0		
topic	string	Topic name to override the value built by default	No			

MQTT data format

The format of a MQTT message is a bit different than Redis messages. Redis messages are supported as CSV strings: value,timeStamp,flags (where value can be float, integer or nan; timeStamp - Unix timestamp in milliseconds; flags contain additional information about a measurement). MQTT messages are supported as value,timestamp,quality (where value can be float, integer or nan; timeStamp - Unix timestamp in milliseconds; quality shows if a value is to be considered as valid). Quality parts of a string is always equal to 1 except for Redis messages containing invalid (IV), non-topic (NT) and/or overflow (OV) flags.

As mentioned, MQTT client acts as an adapter between Redis and MQTT, therefore data from topic in Redis is written to a topic in MQTT. Therefore mqtt-client has to know the mapping table before starting. This table is saved at /etc/elseta-mqtt.json. Every Redis topic name is constructed as tag/[device_alias]/[signal_alias]/[direction]. Prefix tag/ is always used before the rest of argument. `device_alias` and `signal_alias` represent columns in Excel configuration. Direction can have one of four possible values - rout, out, in, rin; all of which depend on the direction data is sent or acquired protocol-wise. The same Redis topic structure is preserved in MQTT by default making it easier to find matching signals, however, as no recalculation is done by MQTT and only PUBLISH messages are now supported, only Redis signals with in direction have their MQTT mappings.

A user can create and select his own topic name in Excel configuration, in topic column. As no recalculation is done by MQTT and only PUBLISH messages are now supported, only Redis signals with in direction have their MQTT mappings.

Debugging a MQTT protocol

If configuration for MQTT is set up, handler for protocol will start automatically. If configuration is missing or contains errors, protocol will not start. It is done intentionally to decrease unnecessary memory usage.

MQTT Client command line debugging options

`mqtt-client`

```
-h [ -help ] Display help information
-c [ -config ] Configuration file location (default - /etc/elseta-mqtt.conf)
-V [ -version ] Show version
-d<debug level> [ -debug ] Set debugging level
-r [ -redis ] Show REDIS output
-m [ -mqtt ] Show MQTT output
```

⚠ If MQTT Client does not work properly (e.g. no communication between devices, data is corrupted, etc.), a user can launch a debug session from command line interface and find out why link is not functioning properly.

ℹ To launch a debugging session, a user should stop `mqtt-client` process and run `mqtt-client` command with respective flags as was shown above.

Data Export

General

Various protocols are made to transmit data points as they are generated. This is enough for a lot of systems (e.g. SCADAs) that have their own databases and devices only have to buffer fairly recent messages in case of connection or transmission errors. However, there is frequently a need to save and keep the data in files, grouped in batches, and later transmit these batches to a remote server via HTTP(S) or FTP(S). For this purpose a dedicated protocol has been created and called **Data export.**

✓ Data export functionality is available since firmware version v1.5.0, of WCC Lite.

Overview

Data export service gathers information from other protocols, puts it into files (optionally compressing them) after a timeout or when data buffers fill up; eventually periodically sending them to a server. HTTP(S) and FTP(S) servers with optional authentication are supported. A user can optionally choose between ISO8601 and UNIX timestamp time formats (the latter being the default value). More than one instance can set up, for instance, some of the information can be sent to an FTP server, while other could be transmitted to the HTTP server which is able to handle POST requests.

Using WCC Lite for data export

To configure WCC Lite to use data export server a user can fill in the needed parameters in Excel configuration. These parameters are shown in two tables below. Default values are shown in a bold font.

Data export (data-export) parameters for Devices tab table:

Parameter	**Type**	**Description**	**Required**	**Default value** (when not specified)	**Range**	
					Min	Max
name	string	User-friendly device name	Yes			
device_alias	string	Device alias to be used in configuration	Yes			
enable	boolean	Enabling/disabling of a device	No	1	0	1
protocol	string	Selection of protocol	Yes		Data Export	
timeout	integer	Time frame during which transmission to remote server has to be completed (**in seconds**)	No	5		
type	string	Selection of file format	No	csv-simple	csv-simple, csv-periodic, json-simple, json-samples	
host	string	A URL of remote server where files should be sent	Yes			
upload_rate_sec	integer	Frequency of generated file uploads (**in seconds**)	No	60		

records_buffer_size	integer	A maximum amount of data change entries to hold before initiating logging mechanism	No	100		
logging_period_sec	integer	Describes how frequently data buffer of records_buffer_size is saved to file	No		1	
log_folder	string	A folder in WCC Lite file system to save generated file (**”/var/cache/data-export”**)	No			
timestamp	string	Selection of time format	No		unixtimestamp, iso8601	
compress	string	Selection of file compression mechanism	No	none	none, gz, tar.gz	
compress_password	string	Enable feature of file password protection	No		yes, true	
csv_field_separator	string	Columns separator in .csv file format	No	"," - (comma)	"," - (comma) ";" - (dot) "." - (semicolon) " " - whitespace) "|" - (pipe)	
csv_decimal_separator	string	Decimal separator in values	No	"." - (dot)	"." - (dot) "," - (comma)	

Same symbols cannot be selected for both csv_field_separator and csv_decimal_separator. In such case both of them will be set to default values ”.” and ”,” respectively.

It is possible that data generation rate is going to be bigger than what data buffer can hold (controlled by *records_buffer_size* and *logging_period_sec*). To make sure that no data loss occurs there’s an additional data logging call made in case data buffer reaches a *records_buffer_size* value.

Signals to be sent are configured differently than signals for most other protocols. As data export service only transmits signals and does no data processing, usual signal logic is not used for them. That means that:

- Signals for data export service are not seen in the*Imported Signals* tab;
- Signals for data export service are configured in different Excel sheet called DataExport

Parameters to be filled in the DataExport sheet are shown in a table below.

Data export (data-export) parameters for DataExport tab

Parameter	**Type**	**Description**	**Required**	**Default value** (when not specified)	**Range**	
					Min	Max
device_alias	string	Device alias to be used in configuration Yes	Yes			
device_name	string	User friendly device name as in Device sheet	Yes			
tag_name	string	User friendly signal name	Yes			
source_device_alias	string	device_alias of a source device	Yes			
source_signal_alias	string	source_alias of a source signa	Yes			
enable	boolean	Enabling/disabling of a measurement to be transmitted and logged	No	1	0	1

attribute	string	Additional attribute to be attached to a signal	No			

Debugging data export service

If configuration for Data export service is set up, handler for protocol will start automatically. If configuration is missing or contains errors, protocol will not start. It is done intentionally to decrease unnecessary memory usage.

Data export (data-export) command-line debugging options

The below-described parameters for debugging are accessible over console (SSH).

`-h [--help] Display help information`

`-c [--config] Configuration file location`

`-v [ -version ] Show version`

`-d<debug level> [ -debug ] Set debugging level`

`-R [ -readyfile] Ready notification file`

`-p [ -http ] Show HTTP messages`

`-r [ -redis ] Show Redis output`

If Data export service does not work properly (e.g. data is corrupted, etc.), a user can launch a debug session from command line interface and find out why it is not functioning properly. To launch a debugging session, a user should stop data-export processes and run data-export command with respective flags as in table above.

Host URL format rules

Parameter host is highly configurable and might contain a considerable amount of information:

- *Protocol* - FTP or HTTP (encrypted and encrypted);
- *URL address* - both resolved and non-resolved;
- *Authentication* - pair of user and/or password;
- *Port* - useful when non-standard value is used;
- *Endpoint* - a place in server to which a call is made

The format for host parameter can be summarized as:

`[http(s)/ftp(s)]://[[user]:[password]@] [URL] [:port]/[endpoin]`

Options are printed in square brackets. A protocol has to be selected, otherwise HTTP will be used as a default. User and password pair is optional, but if user:password pair is used, it should proceeded with @ sign.

HTTP and FTP use default or user assigned ports. By default HTTP uses port 80, while HTTPS uses port 443, FTP sends data over port 21, FTPS - over port 990. Make sure that these ports are open in firewall on both server and client side, otherwise data will not be sent succesfully.

Finally, POST request (for HTTP) or upload (for FTP) can be made to a specific place (endpoint). This endpoint should be described after a URL and port (if used).

Format of exported data

For a server to interpret data, a set of rules for a file format have to be established.

Csv-simple format applies to all files by default and is used as in this example:

```
###DUID:3182121xx
#device name; tag name; value; quality; timestamp; atribute
inv1;Ia;236.9,1;1599137189963;Pa
```

Example of additional format *csv-periodic:*

```
###DUID:318212xxx
##DEVICE:inv1
#Time;Upv1;Upv2;Upv3;Upv4;Upv5;Upv6;Ipv1;Ipv2;Ipv3;Ipv4;Ipv5;Ipv6;Status;Error;Temp;cos;fac;Pac;Qac;Eac;E-Day;E-Total;Cycle Time
2020-09-02T15:45:00Z;462.3;462.3;370.2;370.2;371.2;371.2;1.40;1.43;1.35;1.47;1.21;1.26;512;0;26.3;1.000;50.00;3.217;-0.029;0.28;17.41;54284.53;5;
2020-09-02T15:40:00Z;462.3;462.3;370.2;370.2;371.2;371.2;1.40;1.43;1.35;1.47;1.21;1.26;;512;0;26.3;1.000;50.00;3.217;-0.029;0.28;17.41;54284.53;5;
##DEVICE:meter
#Time;Uab;Ubc;Uca;P;Q;S;F;eTOT;Cycle  Time
2020-09-02T15:45:00Z;421.3;421.3;421.3;15000;100;15600;50;246894;5;
2020-09-02T15:40:00Z;421.3;421.3;421.3;15000;100;15600;50;246895;5;
```

Example of additional format json-simple:

```
{
  "metadata": {
    "duid": "318xxxxx",
    "name": "hostname",
    "loggingPeriod": "15min",
    "format": "json"
  },
  "data": [
    {
      "tag_name": "Ia",
      "device_name": "inv1",
      "attribute": "Pa",
      "last": { "value": 12.2, "timestamp": 1213123 },
      "min": { "value": 12, "timestamp": 1213123 },
      "max": { "value": 12, "timestamp": 1213123 },
      "avg": { "value": 12, "timestamp": 1213123 }
    },
    {
      "tagName": "Ib",
      "deviceName": "inv1",
      "attribute": "Pb",
      "last": { "value": -12.3, "timestamp": 1213123 },
      "min": { "value": 12, "timestamp": 1213123 },
      "max": { "value": 12, "timestamp": 1213123 },
      "avg": { "value": 12, "timestamp": 1213123 }
    },
  ]
}
```

Example of additional format json-sample:

```
{
    "metadata": {
      "duid": "318xxxxx",
      "name": "hostname",
      "loggingPeriod": "15min",
      "format": "json-samples"
    },
    "data": [
      {
        "tag_name": "Ia",
        "device_name": "inv1",
        "attribute": "Pa",
        "timestamp":{
            "first": 123123,
            "last": 123236
        },
        "first": { "value": 12.2, "timestamp": 1213123 },
        "last": { "value": 12.2, "timestamp": 1213123 },
        "min": { "value": -12, "timestamp": 1213123 },
        "max": { "value": 12, "timestamp": 1213123 },
        "avg": { "value": 12, "timestamp": 1213123 },
        "samplesCount": 2,
        "samples": [
            {"value": 12, "timestamp": 1213123, "quality": true},
            {"value": -12.3, "timestamp": 1213123, "quality": true}
        ]
      }
    ]
  }
```

Certificates

Devices that send unencrypted data are susceptible to attacks which might cause deliberate damage to the user system. Therefore it is highly advised to use cryptography to secure the sensitive data. WCC Lite offers means to easily store certificates for their later usage.

Some protocols, namely IEC60870-5-104 Slave, DNP v3.0 Slave and Master might be configured to send data over TCP/IP. For these protocols, secured connection over TCP/IP using TLS certificates can be made. For this purpose, certificate storage has been created and is available since firmware version 1.3.0.

To make storage secure, multiple steps have been taken:

- By default certificate storage is only accessible for root user and users with group level 15 permissions;
- By default certificates are not added to backup to avoid private key leakages; private keys should never be revealed to public;
- By default certificates are deleted after system upgrade;
- Only basic information is shown on a web interface; certificates can be uploaded, deleted but not downloaded

Certificates can be split into three parts local (private) certificate, certificate from peer (usually called Certificate Authority (CA)) and private key. It has to be noted that all of these certificates sometimes can be found in one file, therefore ideally a user should have at least minimal understanding about formats in which certificates are stored.

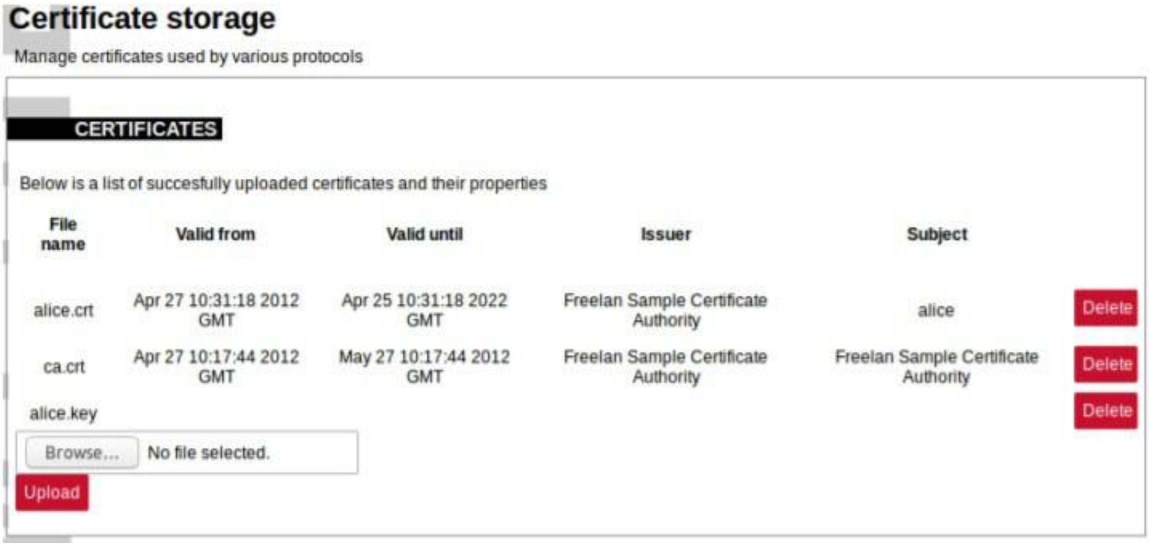
Certificates should conform to the X509 standard. The difference between local certificate and certificate authority certificates is that only certificate authority generates certificates for others. Therefore Issuer and Subject fields are always the same for certificate authority certificate whereas they differ for local certificates. Both of these certificates are usually stored in a device to validate if incoming connections have valid certificates and are to be trusted. Both of the certificates have the public key which together with public key enable having encrypted connections.

The private key is a text file used initially to generate a Certificate Signing Request (CSR), and later to secure and verify connections using the certificate created per that request. It usually contains a unique hash made in a way that chances of guessing it by using brute force are technically infeasible. The private key should be closely guarded, since anyone with access to it use it in nefarious ways. If you lose your private key, or believe it was compromised in any way, it is recommended to rekey your certificate – reissue it with a new private key.

To make certificate upload more intuitive, certain restrictions are imposed. Only files with certain extensions (*.crt, *.pem, *.der, *.key) can be uploaded. Trying to upload other files will result in an error message. Certificate storage should be considered a folder with certain access restrictions, therefore file names should be unique for every file

It should be noted that this chapter only reviews main certificates and suggest means to use them for Protocol Hub services. Certificates can also be used for other causes, e.g. to secure VPN connections. For the sake of simplicity, uploading certificates and their usage are explained in their respective chapters where applicable.

Interface for certificate storage



Certificate storage

Manage certificates used by various protocols

CERTIFICATES

Below is a list of succesfully uploaded certificates and their properties

File name	Valid from	Valid until	Issuer	Subject	
alice.crt	Apr 27 10:31:18 2012 GMT	Apr 25 10:31:18 2022 GMT	Freelan Sample Certificate Authority	alice	Delete
ca.crt	Apr 27 10:17:44 2012 GMT	May 27 10:17:44 2012 GMT	Freelan Sample Certificate Authority	Freelan Sample Certificate Authority	Delete
alice.key					Delete

To get more details about how one could use TLS for Protocol Hub protocols please check section Excel configuration format.

To find out more about why certificates help keep device secure please check section Cyber security or check X.509 and RFC 5755 standard.

Cyber security

WCC Lite is based on OpenWRT operating system. OpenWrt is described as a Linux distribution for embedded devices. WCC Lite has same functionality as Linux OS including user management.

Basic configuration on WCC Lite can be done using web based frontend. More advanced configuration is available over terminal interface. For secure web access, WCC Lite can be accessed via HTTPS (TLS) instead of the unencrypted HTTP protocol. You can use openssl utility to generate your own certificate authority and certificates to be used on web interface. Certificates can also be named or placed in whatever directory you wish by editing /etc/lighttpd/lighttpd.conf.

Terminal is accessible over Telnet or SSH. For security reasons we strongly recommend to use SSH. SSH, also known as Secure Socket Shell, is a network protocol that provides administrators with a secure way to access a remote computer. SSH also refers to the suite of utilities that implement the protocol. Secure shell provides strong authentication and secure encrypted data communications between two computers connecting over an insecure network such as the Internet. SSH is widely used by network administrators for managing systems and applications remotely, allowing them to log in to another computer over a network, execute commands and move files from one computer to another.

User rights

Depending on the user name, different rights are defined: admin is generally entitled to make changes while user does not have any editing permissions, the relevant buttons are disabled. User can be assigned to one of fifteen user groups that can access different amounts of device parameters. Highest (fifteenth) permision level grants the same permission as root user has. User group rights can be edited to give more rights or restrictions, except for highest (15th) level.

User management and rights authentication

WCC Lite provides different authentication mechanisms:

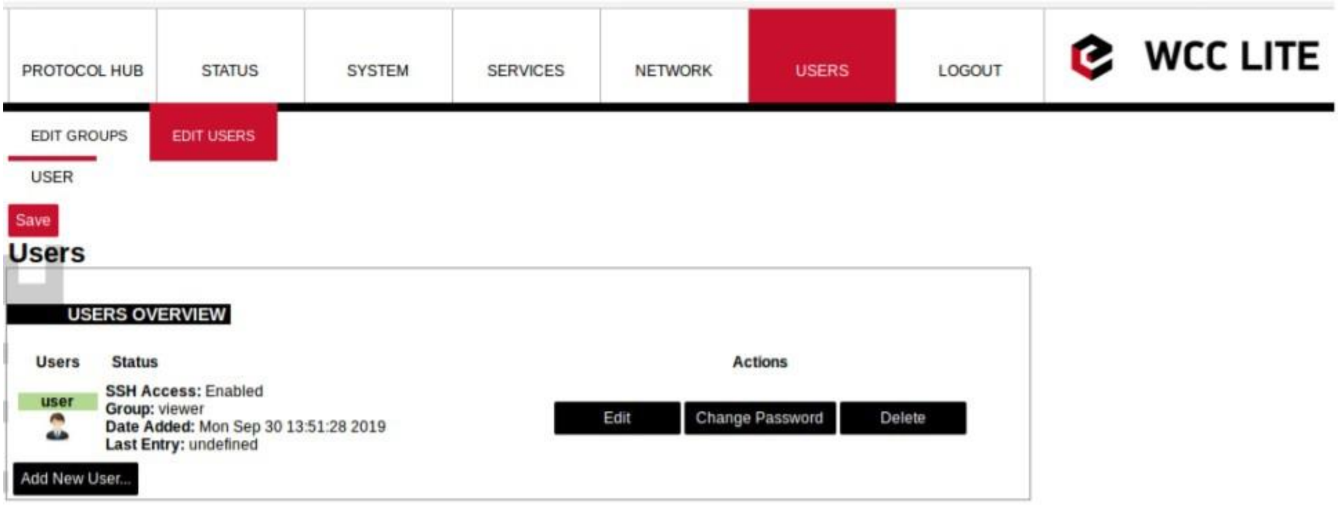
- Authentication via locally stored credentials. In this scenario all users, passwords and permissions are encrypted and stored in internal WCC Lite storage.
- Authentication via external RADIUS Server. In this scenario all users, passwords and permissions (profiles) are defined in remote RADIUS Server. Login into WCC Lite is available only if RADIUS Server will grant authentication and will provide user profile with user rights on that device (more detailed description below). This also means that a password for such user cannot be changed remotely.
- Authentication via external RADIUS Server with fallback option. In this scenario users will be authenticated via RADIUS server. If server fails to respond (configured timeout is passed) WCC will use locally stored credentials. Fallback options are selected with PAM configuration.

By default only authentication via locally stored credentials is allowed. For authentication via external RADIUS server a user should at first enable RADIUS process and configure at least one server.

Locally stored credentials management

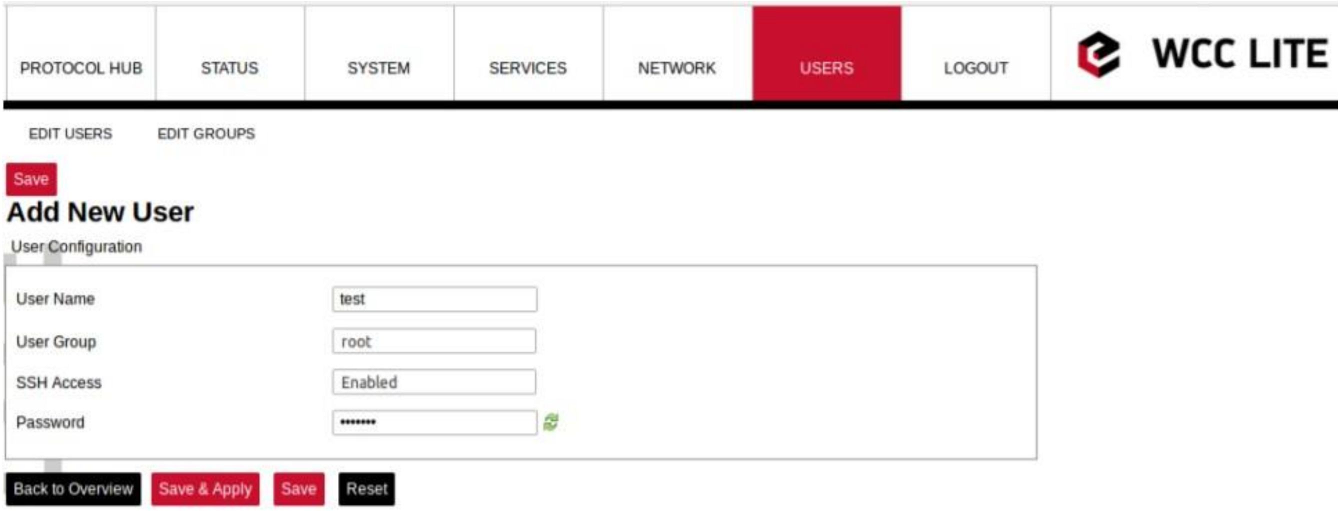
Device has predefined default users like *root* and *user*.

Screen containing all users



SSH Access: Enabled
Group: viewer
Date Added: Mon Sep 30 13:51:28 2019
Last Entry: undefined

Screen for new user configuration



Add New User

User Configuration

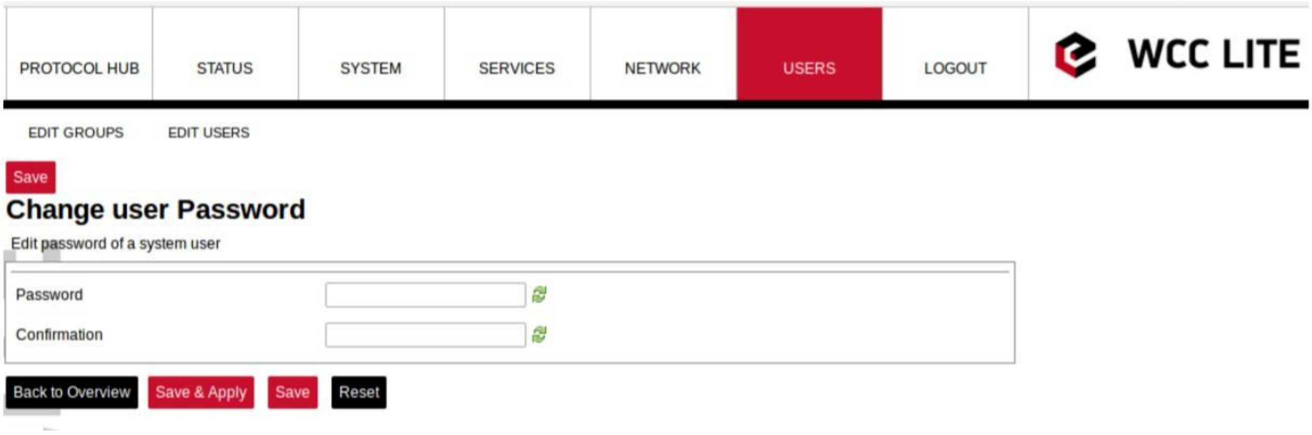
User Name: test
User Group: root
SSH Access: Enabled
Password: •••••••

root user has full permission set to connect to WCC Lite over web interface and SSH or Telnet. This user is default user on WCC Lite and cannot be deleted. However, it is highly advised to change the default password to a different one less susceptible for attacks.

user is limited user on system and can't get root rights. A default password for access via commandline interface and web interface is wcclite. It is advised to change this password to increase a level of security.

System allows customer to set up even more users with well known commands like*adduser*, *passwd* and *userdel*. More users can also be added or edited via web interface as shown in the figures above. User should enter user name, user groups for which the user should belong (the group must be preconfigured first), SSH access permision as well as password. When editing user settings, only *User Group* and *SSH Access* permission can be changed. To change user password, *Change Password* button should be pressed as seen in figure above to lead user to a screen seen in the figure below.

Changing user password



Change user Password

Edit password of a system user

Password:
Confirmation:

A user needs to be assigned to**root** group for admin rights and have root access

It should be noted that assigning user to a root group only gives complete authority over web interface. Permissions for a commandline interface should be given by a root user via commandline interface.

Following commands may be used in comamnd line interface for user control:

adduser - create a new user or update default new user information

When invoked without the**-D** option, the *adduser* command creates a new user account using the values specified on the command line plus the default values from the system. Depending on command line options, the useradd command will update system files and may also create the new user's home directory and copy initial files.

passwd - change user password

The *passwd* command changes passwords for user accounts. A normal user may only change the password for his/her own account, while the superuser may change the password for any account. *passwd* also changes the account or associated password validity period.

deluser - delete a user account and related files
The *deluser* command modifies the system account files, deleting all entries that refer to the user name LOGIN. The named user must exist.

If a user intends to use newly created user account via both commandline interface and web interface he should create and delete users via web interface and not using adduser and deluser commands as they don’t create uci entries.

For more information about controlling users via command line interface one should refer to Linux documentation

Authentication via external service

WCC Lite support external authentification via RADIUS service. Remote Authentication DialIn User Service (RADIUS) is a networking protocol that provides centralized Authentication, Authorization, and Accounting (AAA or Triple A) management for users who connect and use a network service. RADIUS is a client/server protocol that runs in the application layer, and can use either TCP or UDP as transport. Network access servers, the gateways that control access to a network, usually contain a RADIUS client component that communicates with the RADIUS server. RADIUS is often the backend of choice for 802.1X authentication as well. The RADIUS server is usually a background process running on a UNIX or Microsoft Windows server. In WCC Lite RADIUS Client is implemented since WCC Lite software version v1.2.4. The user sends a request to a WCC Lite to gain access to get access using access credentials posted in an HTTP/HTTPS WCCLite web login form

This request includes access credentials, typically in the form of username and password. Additionally, the request may contain other information which the Device knows about the user, such as its network address or information regarding the user’s physical point of attachment to the device. The RADIUS server checks that the information is correct using authentication schemes such as PAP, CHAP or EAP. The user’s proof of identification is verified, along with, optionally, other information related to the request, such as the user’s network address, account status, and specific network service access privileges. Historically, RADIUS servers checked the user’s information against a locally stored flat file database. Modern RADIUS servers can do this, or can refer to external sources—commonly SQL, Kerberos, LDAP, or Active Directory servers—to verify the user’s credentials. The RADIUS server then returns one of two responses to the WCC Lite:

1. **Access-Reject** - The user is unconditionally denied access to all requested resources. Reasons may include failure to provide proof of identification or an unknown or inactive user account.
2. **Access-Accept** - The user is granted access. Once the user is authenticated, the RADIUS server will periodically check if the user is authorized to use the service requested. A given user may be allowed to get admin rights or user rights depending on permissions set on RADIUS Server. Again, this information may be stored locally on the RADIUS server, or may be looked up in an external source such as LDAP or Active Directory.

To use this mechanism a RADIUS server must be configured. The parameter Radius Authentication must be Enabled on WCC Lite.

As of firmware version 1.2.13, the RADIUS service is disabled by default. The service can be enabled at System->Startup.

If the RADIUS authentication is enabled, WCC Lite uses the RADIUS server IP address and the RADIUS shared secret key for communication with External RADIUS Server. After entering the login credentials and login attempt, WCC Lite sends these credentials to the RADIUS server for authentication. If the RADIUS server is available, it compares the login credentials:

- If the comparison is successful, the RADIUS server returns the specific user role and Access-Accept;
- If the login credentials are invalid, Radius Server returns Access-Reject and the logon fails.
- If the RADIUS server is not available and fallback option is disabled login into WCC Lite will be imposible. If RADIUS server is not available and timeout occurs, login will be attempted via local login credentials.

Enabled: Enables or disables this server.
Hostname/IP: Hostname or IP address of RADIUS server.
Timeout: Timeout in seconds to wait for server response.
Shared secret: Key shared between RADIUS server and RADIUS client.
Add: Adds auxiliary (backup) server.

Audit Log

WCC Lite OS with version >1.2.0 has integrated Audit logging for important events such as:

- Login/logout.
- Wrong password attempts to login into system.
- Device boot event, when system was started.
- Device reboot/halt event.
- Configuration changes.
- Firmware changes.
- Date and time changes in system (excluding automatic system time updates over NTP or IEC 60870510x protocol)

Enabling external system log server setup in System properties > Logging is recomended. System stores logs in RAM memory by default due to limited flash storage. Rebooting or powering off the device will result in loss of log history.

Secure your device’s access

There are some possibilities to grant access to the device (or to any PC/Server):

1. ask for nothing: anybody who can establish a connection gets access
2. ask for username and password on an unsecured connection (e.g. telnet)
3. ask for username and password on an encrypted connection (e.g. SSH) (e.g. by following firstlogin)
4. ask for username and merely a signature instead of a password (e.g. SSH with signature.authentication)

If you ask for username/password, an attacker has to guess the combination. If you use an unencrypted connection, he could eavesdrop on you and obtain them.

If you use an encrypted connection, any eavesdropper would have to decrypt the packets first. This is always possible. How long it takes to decrypt the content, depends on the algorithm and key length you used.

Also, as long as an attacker has network access to the console, he can always run a bruteforce attack to find out username and password. He does not have to do that himself: he can let his computer(s) do the guessing. To render this option improbable or even impossible you can:

- not offer access from the Internet at all, or restrict it to certain IP addresses or IP address ranges
  - by letting the SSH server dropbear and the webServer lighttpd not listen on theexternal/WAN port
  - by blocking incoming connections to those ports (TCP 22, 80 and 443 by default) in yourfirewall
- make it more difficult to guess:
  - don’t use the username root
  - don’t use a weak password with 8 or less characters
  - don’t let the SSH server dropbear listen on the default port (22)
- use the combination of:
  - username different than root
  - tell dropbear to listen on a random port (should be >1024):**System > Administration >Dropbear Instance > Port**
  - public key authentication. Your public keys can be specified in**Administation > System > SSHkeys**. An older guide to DropBear SSH public key authentication has detailed information on generating SSH keypairs which include the public key(s) you should upload to your configuration.

Groups rights

If user is logged on via external server, its authentification level is acquired. As no direct mapping to existing users is used, authentification levels are a way to grant proper permissions for external users. WCC Lite uses a CISCOlike authentification system, meaning that there are fifteen different permission set level settings, of which the first 14 can be configured to enable or disable View and Edit permissions

SSH Access

SSH Access of WCC Lite is made by Dropbear software package. To extend the basic functionality, Pluggable Authentification Module (PAM) for RADIUS is used. This enables user to add his own authentification modules as long as they are properly configured.

Fifteen levels of authorization are mapped for SSH access, meaning that user should be able to access SSH with credentials used to log into web interface. However, one should note that permissions in command line interface are not configurable via web interface. This means that first fourteen levels are restricted to basic permissions made my creating group by default. Highest level
user has all the permissions root user has.

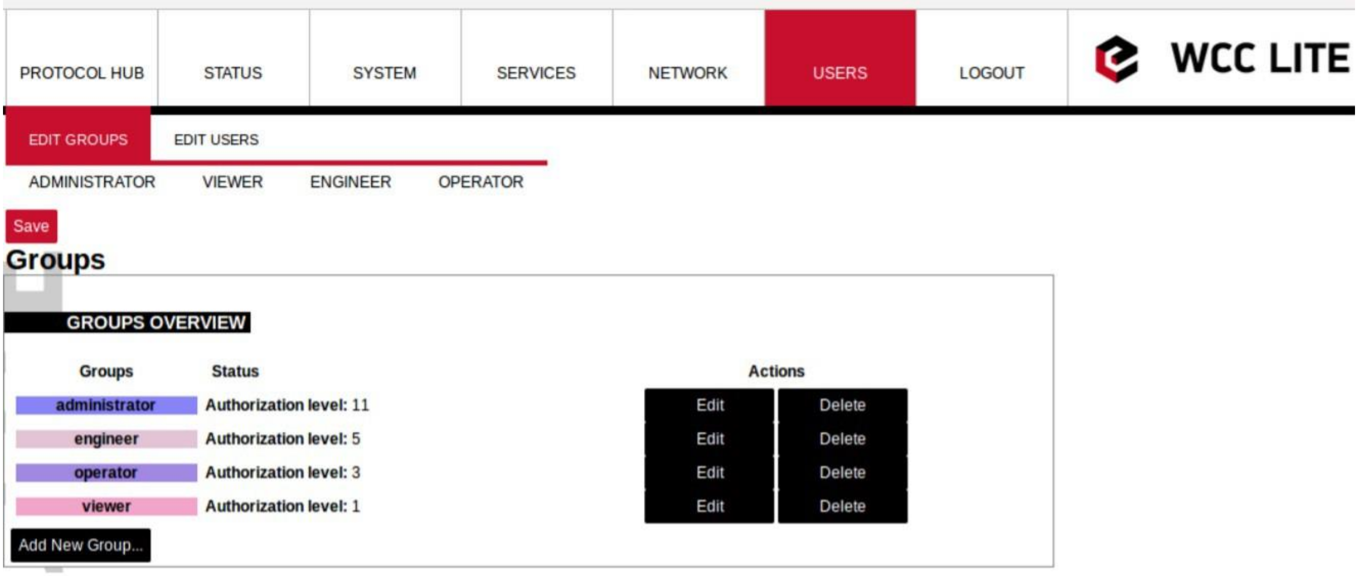
If a user intends to change permissions for user groups, it should be done via command line interfaces. It is only advised for advanced users.

Web interface permissions

Fifteen levels of authorization permission are mapped for web interface access, meaning that user should be able to access web interface with credentials used to log into command line interface. User assigned to a highest authorization level group is able to access every possible screen therefore this groups cannot be edited.

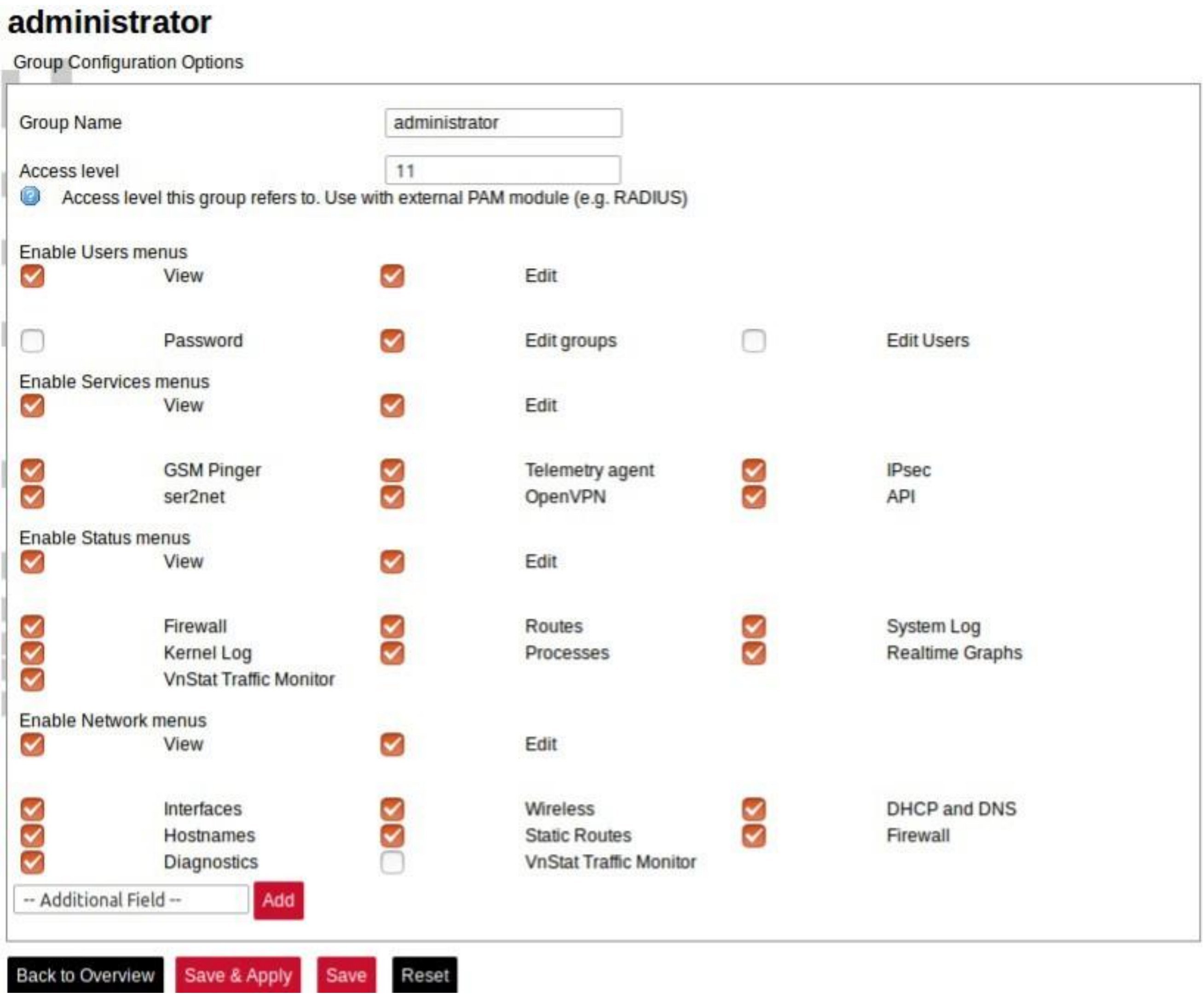
Figure below shows a screen containing already existing groups in a device. Pressing*Add New Group...* guides user to an *Edit group* screen, with *Edit* and *Delete* buttons respectively user can Edit and Delete configuration of a given user group.

Screen showing existing user groups



Groups	Status	Actions	
administrator	**Authorization level:** 11	Edit	Delete
engineer	**Authorization level:** 5	Edit	Delete
operator	**Authorization level:** 3	Edit	Delete
viewer	**Authorization level:** 1	Edit	Delete

Screen for user group editing



Group Name: administrator

Access level: 11

Access level this group refers to. Use with external PAM module (e.g. RADIUS)

Enable Users menus
☑ View ☑ Edit
☐ Password ☑ Edit groups ☐ Edit Users

Enable Services menus
☑ View ☑ Edit
☑ GSM Pinger ☑ Telemetry agent ☑ IPsec
☑ ser2net ☑ OpenVPN ☑ API

Enable Status menus
☑ View ☑ Edit
☑ Firewall ☑ Routes ☑ System Log
☑ Kernel Log ☑ Processes ☑ Realtime Graphs
☑ VnStat Traffic Monitor

Enable Network menus
☑ View ☑ Edit
☑ Interfaces ☑ Wireless ☑ DHCP and DNS
☑ Hostnames ☑ Static Routes ☑ Firewall
☑ Diagnostics ☐ VnStat Traffic Monitor

-- Additional Field --

Edit group screen for an individual group can be seen in Figure above. Group name doesn’t have any specific purpose for RADIUS, but it enables naming groups with words most meaningful for a given context. Access level values can only be integers between 1 and 14, other values will result in an error messages; only unconfigured levels are shown in a dropdown list when configuring. Other fields are dedicated for an individual menu configuration. To add more first level menus user should select from a dropdown list at the bottom named -*Additional Field*- and press Add.

Permissions for web interface are split into to parts:*View* and *Edit*.

View permissions can be assigned to second level menus meaning that only allowed subtabs are shown for a user. Selecting *View* checkbox show more parameters containing all the subtabs (submenus). If a user can access a given screen, it means all of the actions in that screen are available to be executed. Therefore, if a user with a lot of restrictions shouldn't, for example, import Excel configuration to WCC Lite, a tab containing this action (*Protocol Hub->Configuration*) should be disabled in his groups' configuration.

Edit permissions can be assigned to first level menus meaning that if this permission is given, every configuration in the first level menu can be saved and applied succesfully

Conformance to IEC 62351 standard

IEC 62351 is a standard developed by WG15 of IEC TC57. This is developed for handling the security of TC 57 series of protocols including IEC 608705 series, IEC 608706 series, IEC 61850 series, IEC 61970 series and IEC 61968 series. The different security objectives include authentication of data transfer through digital signatures, ensuring only authenticated access, prevention of eavesdropping, prevention of playback and spoofing, and intrusion detection.

Conformance to IEC 62351 standard of WCC Lite devices is described in a table below.

Conformance to IEC 62351 standard

Standard	**Description**	**Topic**	**Implemented**	**Version**
IEC 62351-3	Security for any profiles including TCP/IP	TLS Encryption	Yes	>=1.3
		Node Authentication by means of X.509 certificates	Yes	>=1.3
		Message Authentication	Yes	>=1.3
IEC 62351-4	Security for any profiles including MMS	Authentication for MMS	Yes	>=1.5
		TLS (RFC 2246)is inserted between RFC 1006 & RFC 793 to provide transport layer security	Yes	>=1.5
IEC 62351-5	Security for any profiles including IEC 608705	TLS for TCP/IP profiles and encryption for serial profiles	No	
IEC 62351-6	Security for IEC 61850 profiles	VLAN use is made as mandatory for GOOSE	No	
		RFC 2030 to be used for SNTP	No	
IEC 62351-7	Security through network and system management	Defines Management Information Base (MIBs) that are specific for the power industry, to handle network and system management through SNMP based methods	No	
IEC 62351-8	Role-based access control	Covers the access control of users and automated agents to data objects in power systems by means of rolebased access control (RBAC)	Yes	>=1.2.6
IEC 62351-9	Key Management	Describes the correct and safe usage of safety--critical parameters, e.g. passwords, encryption keys.	No	
		Covers the whole life cycle of cryptographic information (enrolment, creation, distribution, installation, usage, storage and removal)	No	
		Methods for algorithms using asymmetric cryptography	No	

		A secure distribution mechanism based on GDOI and the IKEv2 protocol is presented for the usage of symmetric keys, e.g. session keys	No	
IEC 62351-10	Security Architecture	Explanation of security architectures for the entire IT infrastructure	No	
		Identifying critical points of the communication architecture, e.g. substation control center, substation automation	No	
		Appropriate mechanisms security requirements, e.g. data encryption, user authentication	No	
		Applicability of wellproven standards from the IT domain, e.g. VPN tunnel, secure FTP, HTTPS	No	
IEC 62351-11	Security for XML Files	Embedding of the original XML content into an XML container	No	
		Date of issue and access control for XML data	No	
		X.509 signature for authenticity of XML data	No	
		Optional data encryption	No	

Information about the equipment manufacturer

Office address:
L. Zamenhofo g. 3
LT-06332 Vilnius
Lithuania
Tel.: +370 5 2032302
Email: info@elseta.com
Support email: support@elseta.com
In the web: elseta.com
Work hours: I-V 8:00 - 17:00