DLMS Serial to IEC61850-server protocol conversion (Wcc Lite FW: 1.7.0)

Description

The article describes WCC Lite configuration steps to enable DLMS Serial protocol conversion to IEC 61850-server.

Fig 1. Connecting Meter with DLMS serial protocol to Wcc Lite and IEC61850 server

First steps

Before you begin, make sure you have completed all physical installation work according to the manufacturer's installation instructions.

Set up your computer and connect Ethernet cable to WCC Lite ETH0 port. Login with default credentials and setup basic required settings (name, network, users, etc.). You can find configuration tutorials in How to articles.

To prepare configuration fill information in both - Devices and Signals sheets:

Configure devices (excel "Devices" sheet)

Add required information for connected Gama meter with **DLMS Serial** protocol:

name	description	device_alias	protocol	serial_number	device	databits	stopbits	baudrate	parity
DLMS Serial	DLMS Serial	DLMS_Meter	DLMS	2250259	PORT1	8	1	4800	none

flowcontrol	enable	auth	logical_address	address_size	client_address	type	mode
none	1	LOW	1	2	32	SN	DLMS-HDLC

More information concerning DLMS protocol configuration is provided in DLMS/COSEM article.

Add **IEC 61850 server** protocol required information:

name	description	device_alias	protocol	bind_address
IEC 61850 Server	IEC 61850 Server	iec_61850_server	iec 61850 server	0.0.0.0

ied_name	access_point	port	auth	host	model_filename
WCCLITE	LD0	102	NONE	192.168.1.2	WCC

More information concerning IEC 61850 server protocol configuration is provided in IEC 61850 server article.

Configure signals (Excel "Signals" sheet)

The signals for all devices can be separated to different excel sheets for different device or listed in one excel sheet. In this case signals will be separated to **SignalsDLMS** and **SignalsIEC61850** excel sheets. Make sure that these excel sheet names for different device signals always must start with word **Signals.** The example template for this case is added at the end of this article.

Add signals information for connected meter with DLMS Serial protocol (Excel **SignalsDLMS** sheet):

signal_name	device_alias	signal_alias	obis_job
Voltage L1-N	DLMS_Meter	Voltage_L1-N	1.0.32.7.0.255
Voltage L2-N	DLMS_Meter	Voltage_L2-N	1.0.52.7.0.255
Voltage L3-N	DLMS_Meter	Voltage_L3-N	1.0.72.7.0.255
Frequency	DLMS_Meter	Frequency	1.0.14.7.0.255
Current L3	DLMS_Meter	Current_L3	1.0.71.7.0.255

obis_job - Objects are identified with the help of OBIS (Object Identification System) codes.

1. The first number of OBIS code defines the media (energy type) to which the metering is related. Nonmedia related information is handled as abstract data. For example all obis_jobs in the table above starts with numbers 1 which stands for "Electricity related objects".
2. The second number defines the channel number, i.e. the number of the input of a metering equipment having several inputs for the measurement of energy of the same or different types (e.g. in data concentrators, registration units). Data from different sources can thus be

identified. The definitions for this value group are independent from the value of the first number. In all obis_jobs from the table above second number is set to zero which means that no channel is specified.
3. The third number defines the abstract or physical data items related to the information source concerned, for example current, voltage, power, volume, temperature. The definitions depend on the value of the first number. For example in obis_jobs from the table above number 72 means voltage L3 and number 14 means frequency.
4. The forth number defines types, or the result of the processing of physical quantities identified with the numbers 1 and 3, according to various specific algorithms. The algorithms can deliver energy and demand quantities as well as other physical quantities. In all obis_jobs from the table above forth number is set to 7 which stands for "Instantaneous value".
5. The value of the fifth number defines further processing or classification of quantities identified by numbers 1 to 4. In case of the first obis_job number 0 means that all harmonics of the signal along with its fundamental frequency are going to be taken into consideration.
6. The value of the sixth number defines the storage of data, identified by numbers 1 to 5, according to different billing periods. Where this is not relevant, this value group can be used for further classification. In all obis_jobs from the table above last number is set to 255 which means that data is not used.

Add signals information for **IEC 61850 server** (Excel **SignalsIEC61850** sheet):

signal_name	device_alias	signal_alias	source_device_alias	source_signal_alias
LD0__GGIO_5_AnIn1_mag.f	iec_61850_server	LD0__GGIO_5_AnIn1_mag.f	DLMS_Meter	Voltage_L1-N
LD0__GGIO_5_AnIn2_mag.f	iec_61850_server	LD0__GGIO_5_AnIn2_mag.f	DLMS_Meter	Voltage_L2-N
LD0__GGIO_5_AnIn3_mag.f	iec_61850_server	LD0__GGIO_5_AnIn3_mag.f	DLMS_Meter	Voltage_L3-N
LD0__GGIO_5_AnIn4_mag.f	iec_61850_server	LD0__GGIO_5_AnIn4_mag.f	DLMS_Meter	Frequency
LD0__GGIO_5_AnIn5_mag.f	iec_61850_server	LD0__GGIO_5_AnIn5_mag.f	DLMS_Meter	Current_L3

ld_instance	ln_class	ln_instance	cdc	data_object	da_fc	number_type	da_value	Log
LD0	GGIO	5	MV	AnIn1	MX	FLOAT32	mag.f	1
LD0	GGIO	5	MV	AnIn2	MX	FLOAT32	mag.f	1
LD0	GGIO	5	MV	AnIn3	MX	FLOAT32	mag.f	1
LD0	GGIO	5	MV	AnIn4	MX	FLOAT32	mag.f	1
LD0	GGIO	5	MV	AnIn5	MX	FLOAT32	mag.f	1

From the table above it can be seen that IEC 61850 server signals has **source_device_alias** and **source_signal_alias** in which device_alias and signal_alias of DLMS meter signals are described. That is how DLMS meter signals are linked to IEC61850 server signals, so the measurements of the DLMS meter could be transported to IEC 61850 server.

For more detailed DLMS protocol communication analysis Gurux DLMS Director application can be used.

ICD file for IEC 61850 server

IED Capability Description (ICD) files are a specific type of Substation Configuration Language (SCL) file, containing a generic description of the whole capability range of a given device, including the functions and objects it can support. These ICD files can be found on internet, edited and adapted for current project. In this case the ICD file with 2 analog signals was edited, so it could have 5 analog signals for DLMS measurements. For that purpose, 3 additional signals was described in ICD file, so 5 analog signals could be linked with signals from DLMS. The ICD file and added signals are shown in Fig. 2. If it is needed to have more analog or other type of signals, the ICD file must be analyzed and signals added to the correct place of the file.

WCC.icd

```
<?xml version="1.0" encoding="UTF-8"?>
<SCL xmlns="http://www.iec.ch/61850/2003/SCL">
  <Header id="ID" version="2003" revision="A" nameStructure="IEDName" />
  <Communication>
    <SubNetwork name="WA1" desc="Subnetwork" type="8-MMS">
      <ConnectedAP iedName="WCCLITE" apName="LD0">
      </ConnectedAP>
    </SubNetwork>
  </Communication>

  <IED name="WCCLITE" desc="RTU" type="WCC LITE" manufacturer="Elseta" configVersion="001">
    <Services>
      <DynAssociation />
      <GetDirectory />
      <GetDataObjectDefinition />
      <GetDataSetValue />
      <DataSetDirectory />
      <ReadWrite />
      <GetCBValues />
      <ConfLNs fixPrefix="true" fixLnInst="true" />
    </Services>

    <AccessPoint name="LD0">
      <Server>
        <Authentication />
        <LDevice desc="Gateway" inst="LD0">
          <LN0 lnClass="LLN0" lnType="LLN01" inst="">
            <DataSet name="Events_SP1" desc="Events_SP1">
              <FCDA ldInst="LD0" prefix="" lnClass="GGIO" fc="ST" lnInst="1" doName="SPS1"/>
              <FCDA ldInst="LD0" prefix="" lnClass="GGIO" fc="ST" lnInst="1" doName="SPS2"/>
              <FCDA ldInst="LD0" prefix="" lnClass="GGIO" fc="ST" lnInst="2" doName="SPC1"/>
              <FCDA ldInst="LD0" prefix="" lnClass="GGIO" fc="ST" lnInst="2" doName="SPC2"/>
            </DataSet>
            <DataSet name="Events_SP2" desc="Events_SP2">
              <FCDA ldInst="LD0" prefix="" lnClass="GGIO" fc="ST" lnInst="3" doName="DPS1"/>
              <FCDA ldInst="LD0" prefix="" lnClass="GGIO" fc="ST" lnInst="3" doName="DPS2"/>
              <FCDA ldInst="LD0" prefix="" lnClass="GGIO" fc="ST" lnInst="4" doName="DPC1"/>
              <FCDA ldInst="LD0" prefix="" lnClass="GGIO" fc="ST" lnInst="4" doName="DPC2"/>
            </DataSet>

            <DataSet name="AnalogValues" desc="analog values">
              <FCDA ldInst="LD0" prefix="" lnClass="GGIO" fc="MX" lnInst="5" doName="AnIn1" />
              <FCDA ldInst="LD0" prefix="" lnClass="GGIO" fc="MX" lnInst="5" doName="AnIn2" />
              <FCDA ldInst="LD0" prefix="" lnClass="GGIO" fc="MX" lnInst="5" doName="AnIn3" />
              <FCDA ldInst="LD0" prefix="" lnClass="GGIO" fc="MX" lnInst="5" doName="AnIn4" />
              <FCDA ldInst="LD0" prefix="" lnClass="GGIO" fc="MX" lnInst="5" doName="AnIn5" />
            </DataSet>

            <ReportControl name="Events_SP1_RCB" confRev="1" datSet="Events_SP1" rptID="Events_SP1" buffered="true" intgPd="1000" bufTime="100">
              <TrgOps dchg="true" qchg="true" />
              <OptFields seqNum="true" timeStamp="true" dataSet="true" reasonCode="true" configRef="true" />
              <RptEnabled max="4" />
            </ReportControl>
  </IED>

  <DataTypeTemplates>
    <LNodeType id="LLN01" lnClass="LLN0">
      <DO name="Mod" type="INC_1_Mod" />
      <DO name="Beh" type="INS_1_Beh" />
      <DO name="Health" type="INS_1_Beh" />
      <DO name="NamPlt" type="LPL_1_NamPlt" />
    </LNodeType>

    <LNodeType id="LPHD1" lnClass="LPHD">
      <DO name="PhyNam" type="DPL_1_PhyNam" />
      <DO name="PhyHealth" type="INS_1_Beh" />
      <DO name="Proxy" type="SPS_1_Proxy" />
    </LNodeType>

    <LNodeType id="GGIO1" lnClass="GGIO">
      <DO name="SPS1" type="SPS_1_SPSSO1" />
      <DO name="SPS2" type="SPS_1_SPSSO1" />
    </LNodeType>

    <LNodeType id="GGIO2" lnClass="GGIO">
      <DO name="SPC1" type="SPC_1_SPCSO4" />
      <DO name="SPC2" type="SPC_1_SPCSO4" />
    </LNodeType>

    <LNodeType id="GGIO3" lnClass="GGIO">
      <DO name="DPS1" type="DPS_1_DPSSO1" />
      <DO name="DPS2" type="DPS_1_DPSSO1" />
    </LNodeType>

    <LNodeType id="GGIO4" lnClass="GGIO">
      <DO name="DPC1" type="DPC_1_DPCSO1" />
      <DO name="DPC2" type="DPC_1_DPCSO1" />
    </LNodeType>

    <LNodeType id="GGIO5" lnClass="GGIO">
      <DO name="AnIn1" type="MV_1_AnIn1" />
      <DO name="AnIn2" type="MV_1_AnIn1" />
      <DO name="AnIn3" type="MV_1_AnIn1" />
      <DO name="AnIn4" type="MV_1_AnIn1" />
      <DO name="AnIn5" type="MV_1_AnIn1" />
    </LNodeType>
```

Fig. 2 Editing the ICD file

This ICD file will be used for creating the IEC 61850 server model file, which later will be uploaded to Wcc Lite. Also the ICD file will be uploaded to IEDscout app, for simulating the client. Other apps for simulation of client can be used as well.

Generating Server Model file for Wcc Lite

For this step, Wcc Excel Utility app will be used. Firstly open Wcc Excel Utility app and choose **version 1.7** in "Configuration" tab**.**

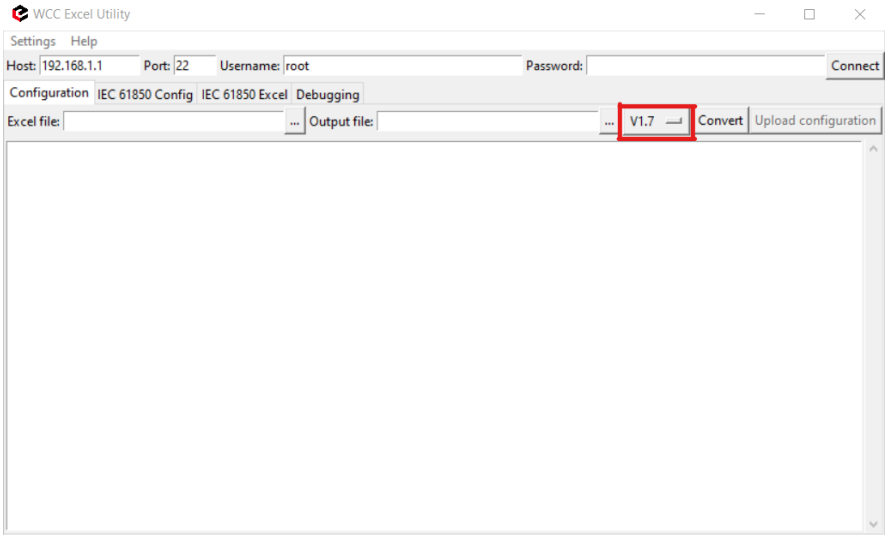


Fig. 3 Choosing the right version

Second step is to go to IEC61850 Config tab, choose the ICD file that is needed and Output file directory of Server Model file. The name of output file should be the same as the name specified in the Excel configuration "Devices" tab "**model_filename**" for IEC 61850 server. The extension of Server Model file using**Wcc Lite 1.7.0** firmware should be **.cfg** but using newer version of Wcc Excel Utility the extension**.server** can be created by default. This can be changed by editing the Server Model file name. Now "convert" button needs to be pressed and the Server Model file will be generated (Fig. 4). After that, this Server Model file needs to be uploaded to Wcc Lite WEB (Fig. 5).

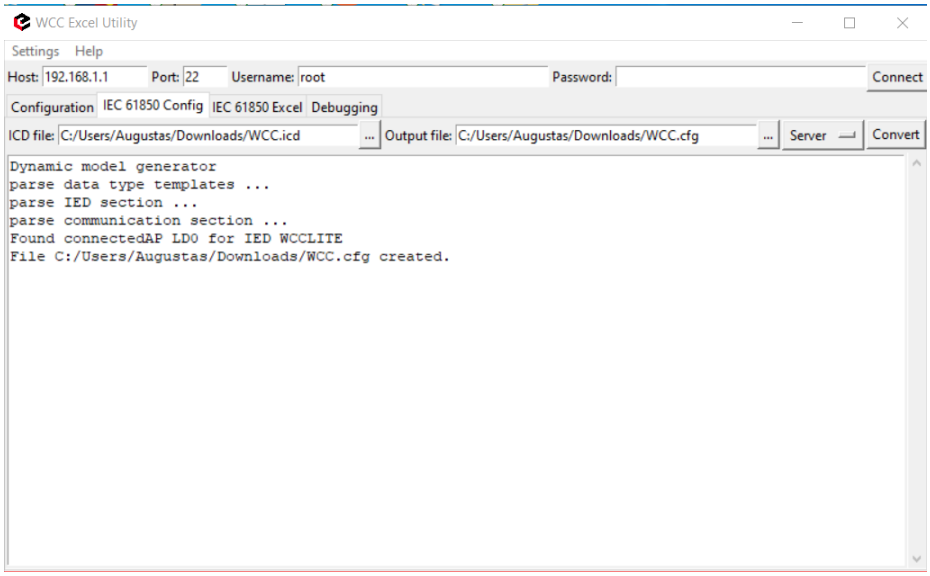


Fig. 4 Generating Server Model file

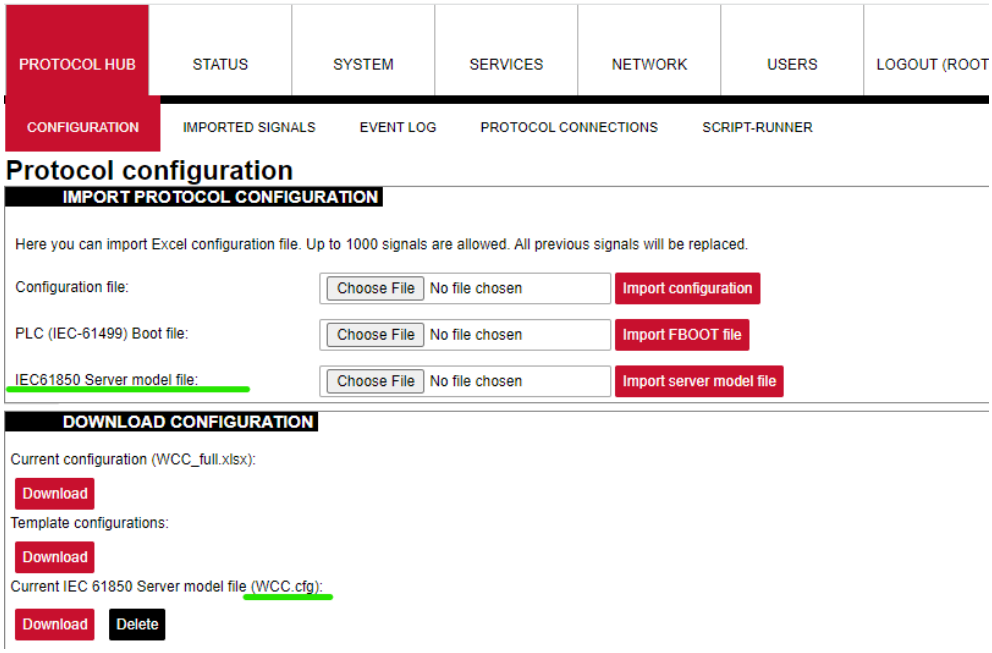


Fig. 5 Uploading IEC 61850 Server Model file to Wcc Lite WEB

Uploading Wcc Lite configuration

After the Server Model file is uploaded, and made sure that Server Model file name matches the one specified in excel configuration we are now able to upload excel configuration to Wcc Lite. One more thing to notice, in Excel configuration "Devices" sheet "host" parameter for IEC61850 server is 192.168.1.2. This IP should match the PC Ethernet IP, to which Wcc Lite ETH0 port is connected via ETH cable and can be set manually. This is shown in Fig. 6.

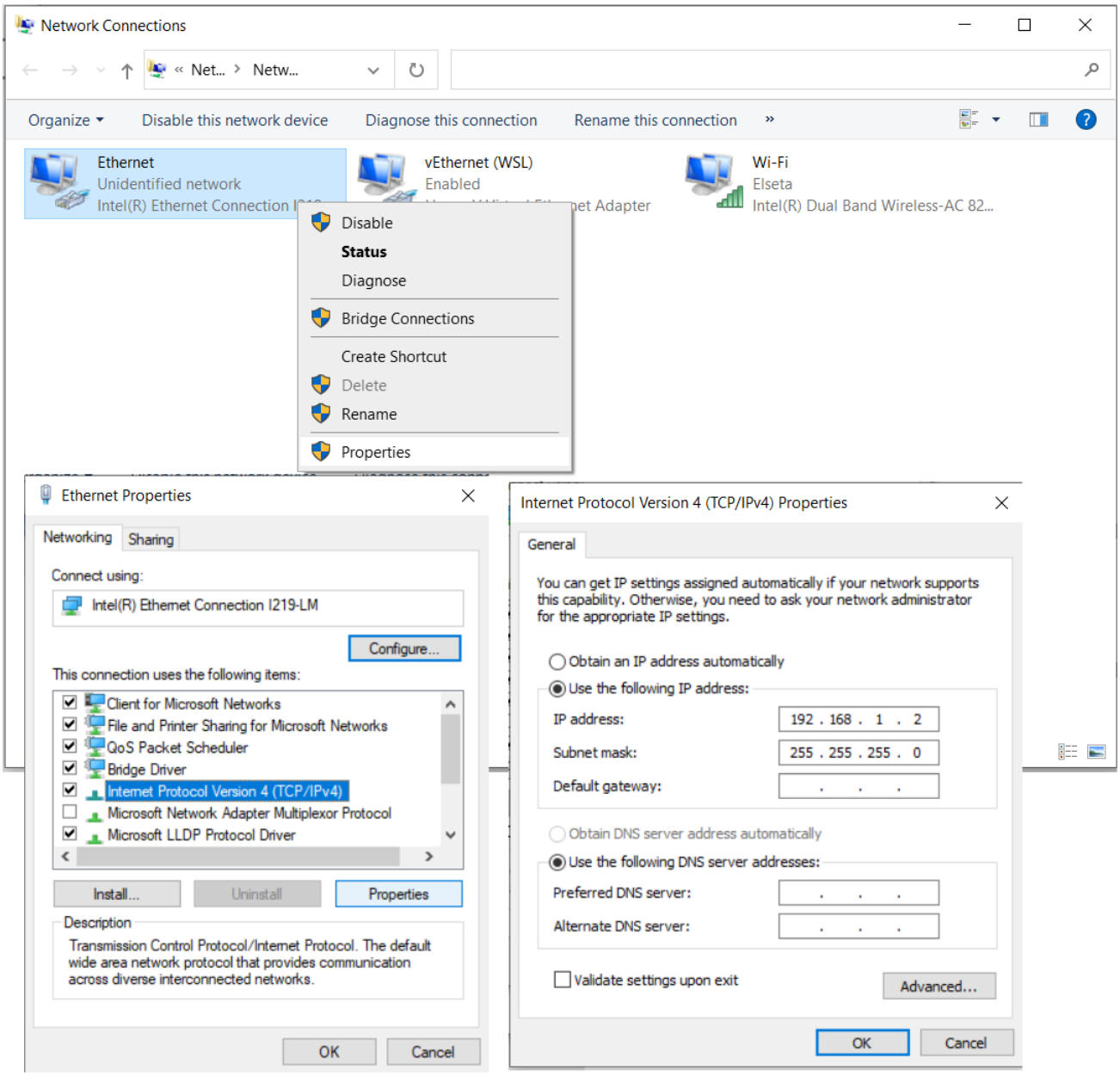


Fig. 6 Changing PC IP (TCP/IPv4) to match the Host IP in configuration

When all parameter described earlier matches the ones specified in configuration, we can upload the configuration to Wcc Lite WEB. It is shown in Fig. 7. Simply choose the Excel configuration and press "import configuration". The upload may take several minutes.

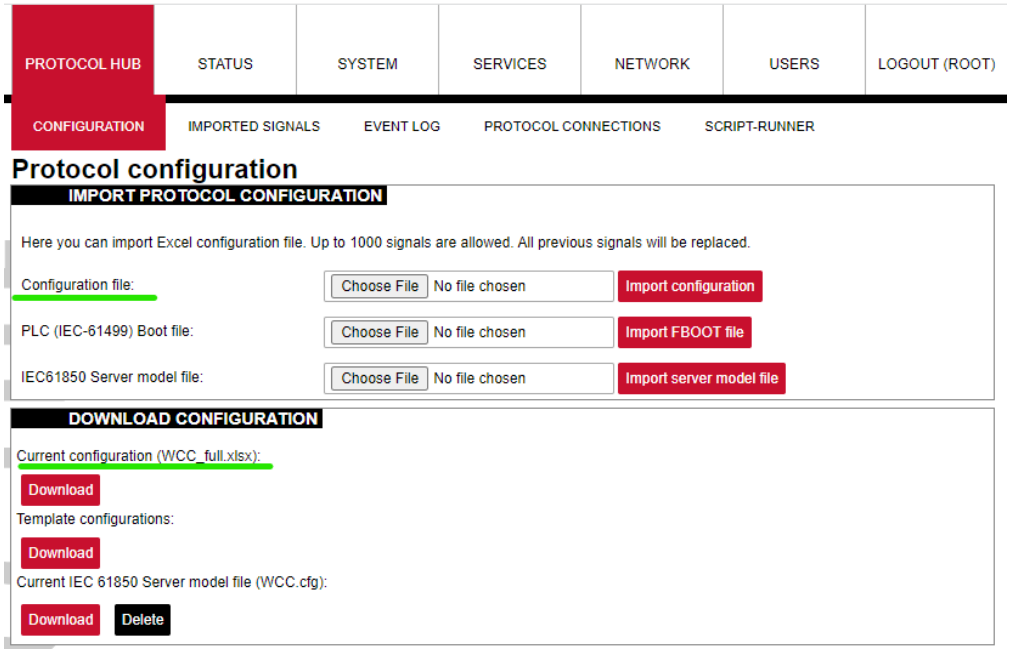


Fig. 7 Uploading Excel configuration to Wcc Lite.

Starting IEC 61850 server

Now, when needed files were uploaded to Wcc Lite, we can start IEC61850 server. For this step the debugger interface will be needed. We prefer using terminal window with installed linux subsystem or other debugger interfaces like PuTTY app. These apps can be found and downloaded on the internet. Firstly we need to connect to Wcc Lite through SSH (using PuTTY, SSH connection type should be chosen and Wcc Lite IP 192.168.1.1 entered). Following commands should be entered in the debugger window:

1. Connecting to Wcc Lite:**ssh root@192.168.1.1**

2. Login: **root** Password: **your Wcc Lite pasword**

3. Stopping the IEC 61850 service: **/etc/init.d/iec61850-server stop**

4. Starting IEC61850 server in debugger mode:**iec61850-server -c /etc/iec61850-server/iec61850-server.json -d7**

After these commands are executed, the IEC 61850 server is started, it is shown in Fig. 8.

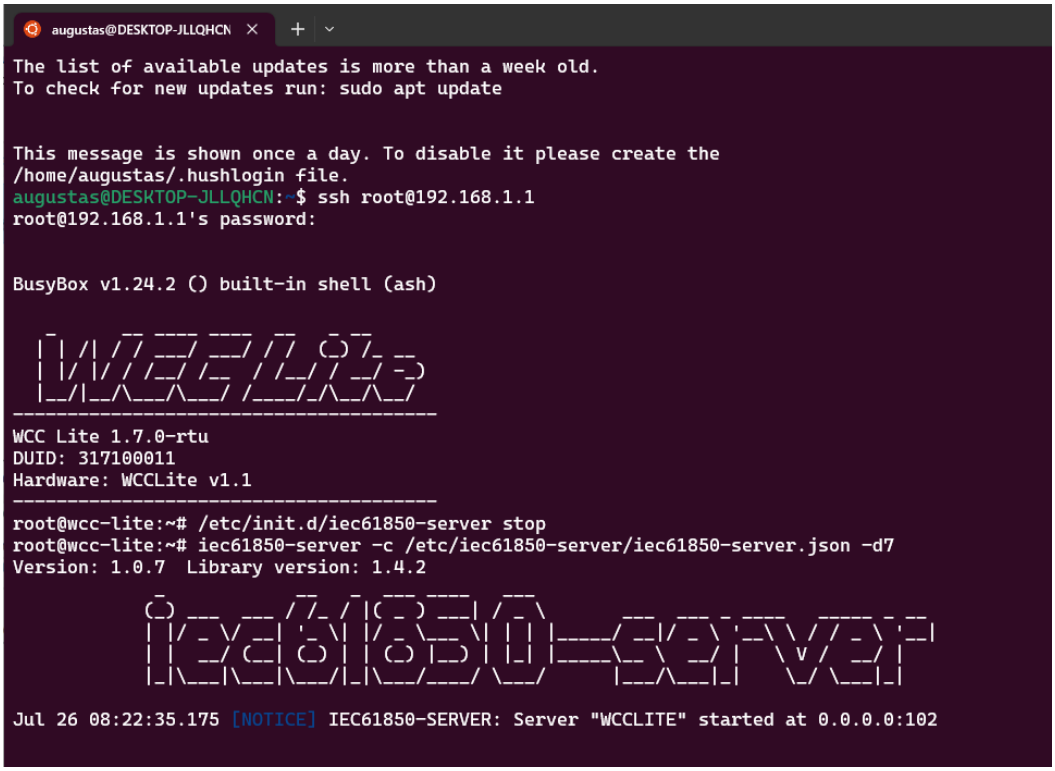


Fig. 8 Connecting to Wcc Lite through SSH and starting IEC61850 server

Connecting to Wcc Lite (server) on IEDscout (client)

For this step, IEDscout will be needed. IEDScout is an ideal tool for protection and substation automation engineers working with IEC 61850 devices. It provides access to the IEDs (Intelligent Electronic Devices) and performs numerous useful functions when working with them. The software can simulate entire Ed. Also any different but similar functionality software can be used as well. Following steps are done using IEDscout software.

1. Open IEDscout software, then choose and open ICD file that is needed.

2. In opened IEDscout Browser window click "Discover IED", then in opened window enter Wcc Lite IP (192.168.1.1) and press "discover" (Fig. 9).

3. If the Wcc Lite did not connect when "discover" was pressed, then it is needed to press "Online". The indication, that IEC61850 server and Meter with DLMS serial protocol are connected correctly can be seen in Wcc Lite WEB "protocol connections" tab (Fig. 10).

Now Wcc Lite IEC61850 server and IEC61850 client on IEDscout are connected and after few moments we should see measurement from the Meter in the debugger window. When measurements from the Meter appears in debugger window (Fig. 11), press "Read" on IEDscout to update values (Fig. 12).

All these measurements are also represented in Wcc Lite WEB. There you can see that it has DLMS serial Meter signals and IEC 61850 server signals all in one place in "Imported signals" tab (Fig. 13).

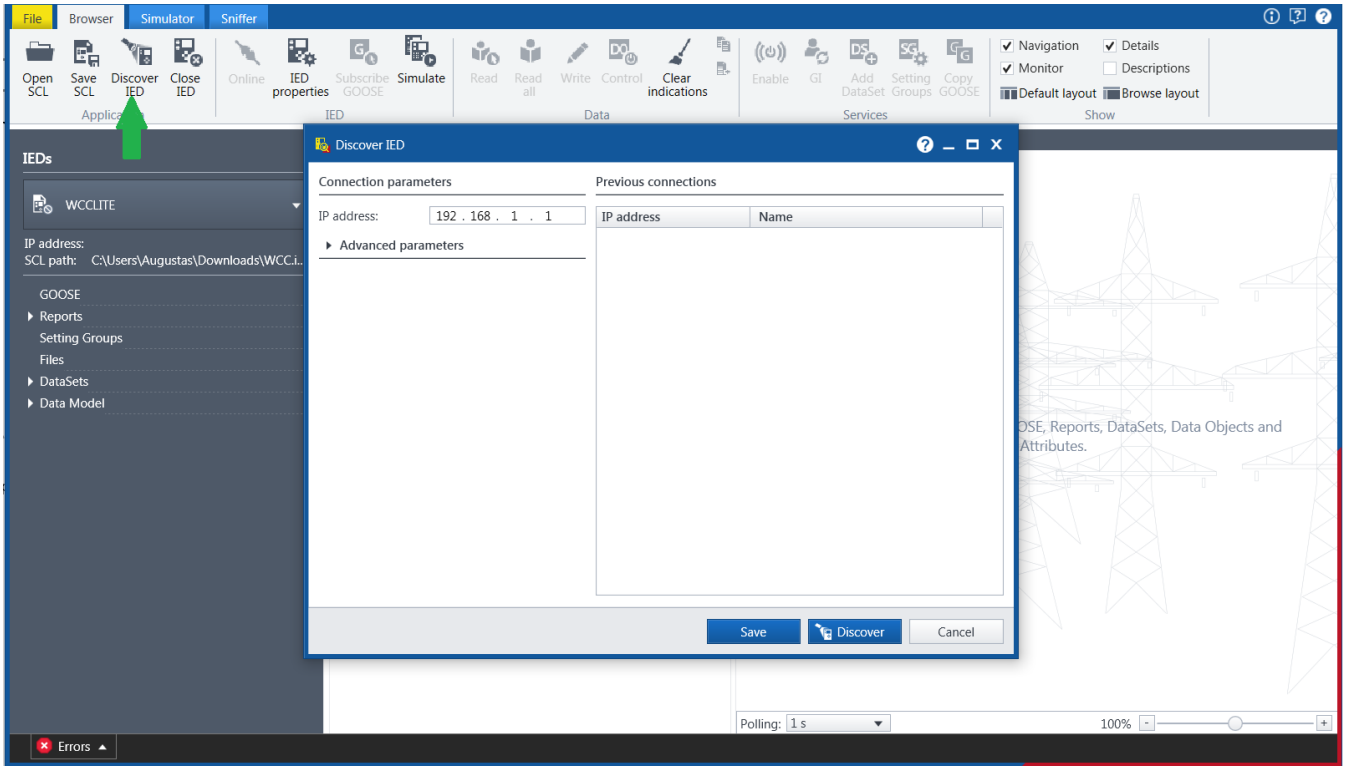


Fig. 9 Starting IED on IEDscout

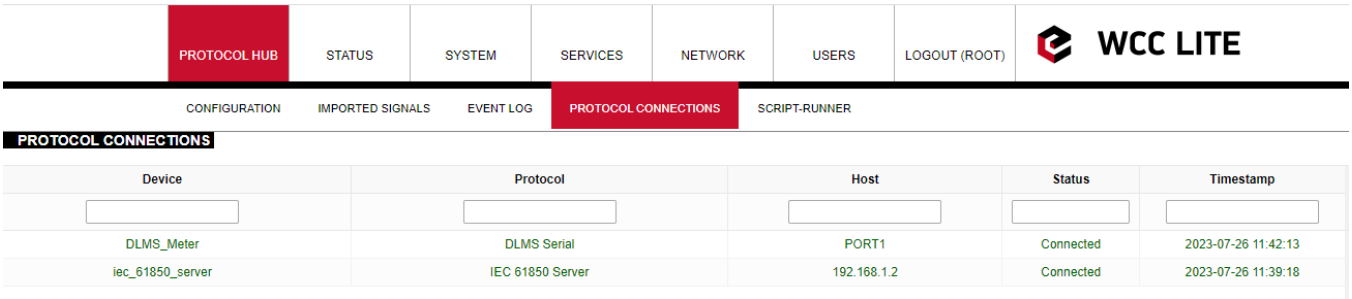


Fig. 10 Protocol connections

Fig. 11 Measurements from Meter linked to IEC61850 server signals

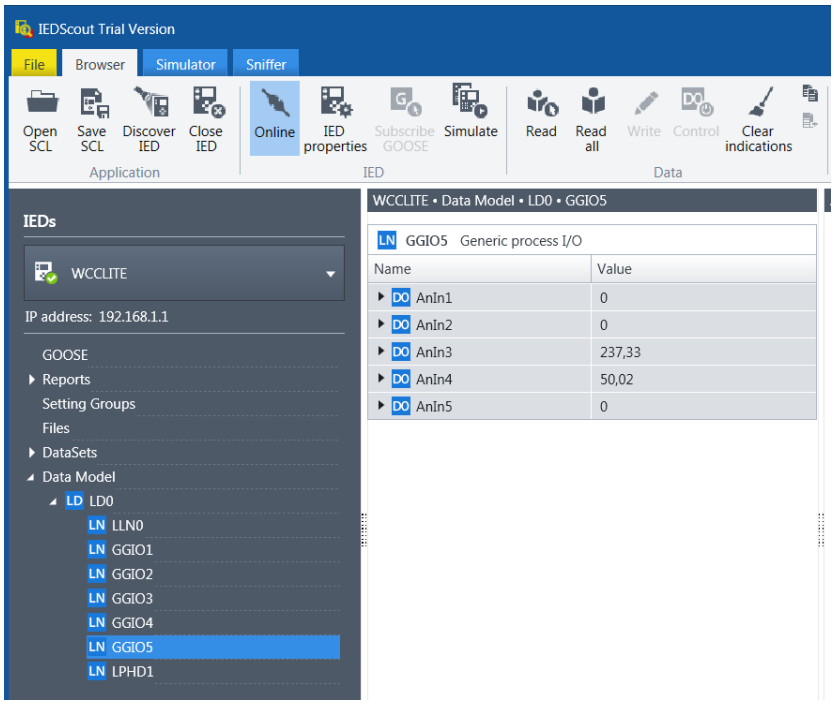
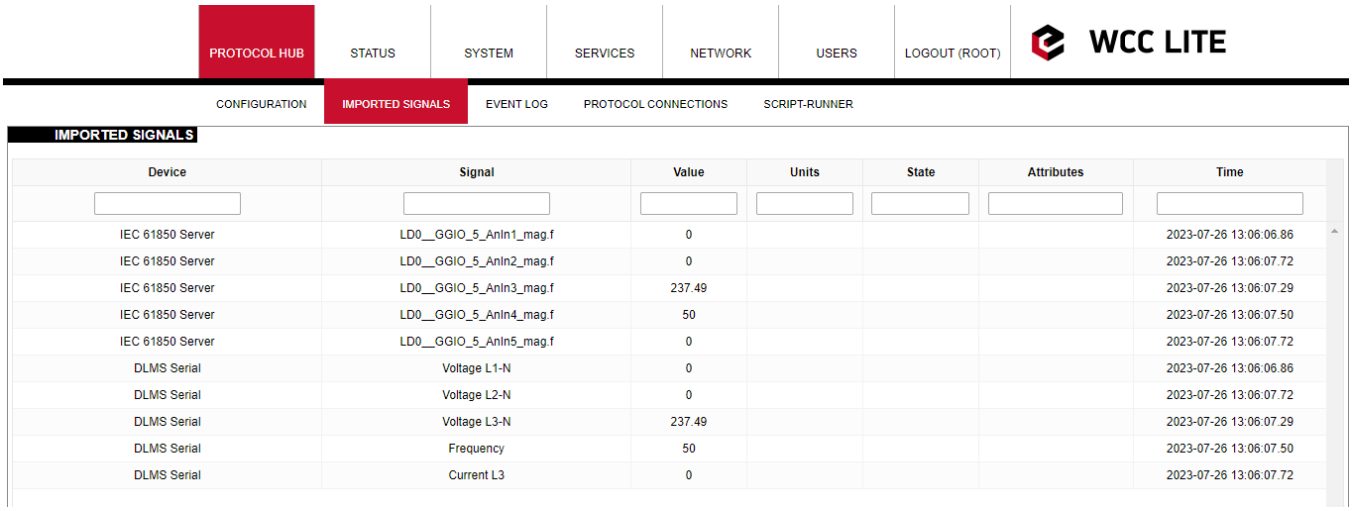


Fig. 12 Measurements appeared in IEDscout software



Device	Signal	Value	Units	State	Attributes	Time
IEC 61850 Server	LD0__GGIO_5_AnIn1_mag.f	0				2023-07-26 13:06:06.86
IEC 61850 Server	LD0__GGIO_5_AnIn2_mag.f	0				2023-07-26 13:06:07.72
IEC 61850 Server	LD0__GGIO_5_AnIn3_mag.f	237.49				2023-07-26 13:06:07.29
IEC 61850 Server	LD0__GGIO_5_AnIn4_mag.f	50				2023-07-26 13:06:07.50
IEC 61850 Server	LD0__GGIO_5_AnIn5_mag.f	0				2023-07-26 13:06:07.72
DLMS Serial	Voltage L1-N	0				2023-07-26 13:06:06.86
DLMS Serial	Voltage L2-N	0				2023-07-26 13:06:07.72
DLMS Serial	Voltage L3-N	237.49				2023-07-26 13:06:07.29
DLMS Serial	Frequency	50				2023-07-26 13:06:07.50
DLMS Serial	Current L3	0				2023-07-26 13:06:07.72

Fig. 13 Measurements represented in Wcc Lite WEB "Imported signals" tab.

Files used in this article:

1. ICD file: WCC.icd

2. Server Model file: WCC.cfg

3. Excel configuration file: WCC_full.xlsx

4. Excel Utility software: Excel Utility

5. Wcc Lite firmware: Wcc 1.7.0 RTU

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