



Digitalization
Industrie 4.0

Smart Production
E-Mobility
Smart Energy

Energy Efficiency
Smart Infrastructure
Smart Buildings

Renewables

Welcome

PLCnext Technology

Part 3

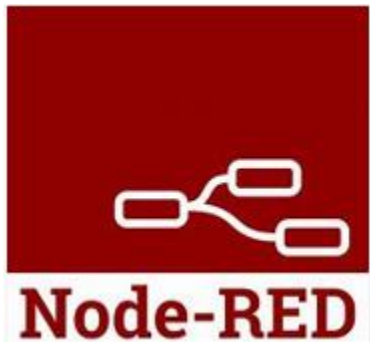
Getting started with OPC - UA

enhance your automation thinking

PLCnext Technology

Part 3

Getting started with OPC-UA



This training assumes you have completed Part 1 of this training series: “Intro To Programming PLCnext IEC611-31” Alternatively, if you have created another program that is currently available, that could be used with this training.

Optionally, Part 2 – “Getting Started with ProfiCloud” may have been completed prior to using this training module.



PLCnext Technology

Part 1 - Getting started and writing your first program



Acknowledgments: Thanks to Loren Brown and Yuri Chamarelli of Phoenix Contact, to Mark Mays of TC Energy, and to Raivir Singh of Code and Compile for their help in revising this presentation.



PLCnext Technology

Part 2

Getting started with ProfiCloud



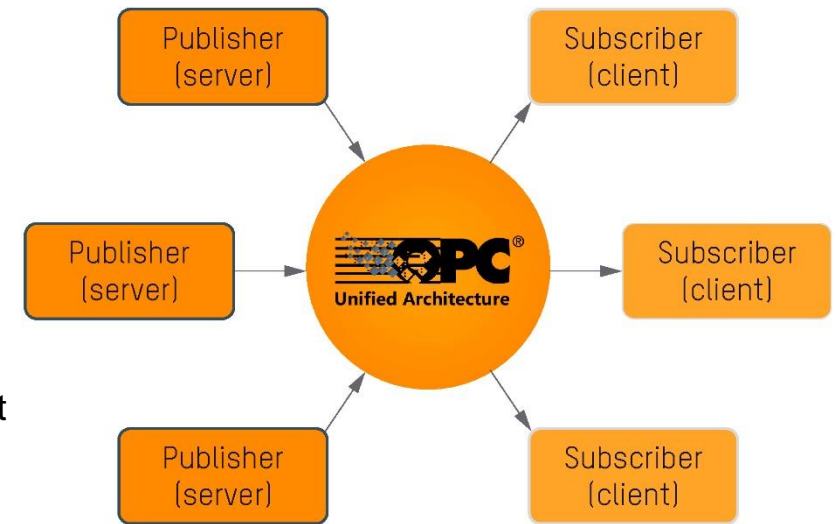
Definitions

➤ What is OPC-UA?

- It is a machine-to-machine communications protocol.
 - OPC = OLE for Process Control
 - OLE = Object Linking and Embedding
 - UA = Unified Architecture
 - It is an encrypted, secure protocol with options for deterministic performance. It is a big part of IOT. Developed by the OPC Foundation.

➤ What is Node-Red?

- It is a flow-based, simple way of “stitching together” javascript programming. The user doesn’t need to know how to program in java. It is a way to link many disparate parts of an IOT solution together. It was developed by IBM and is open source.
-

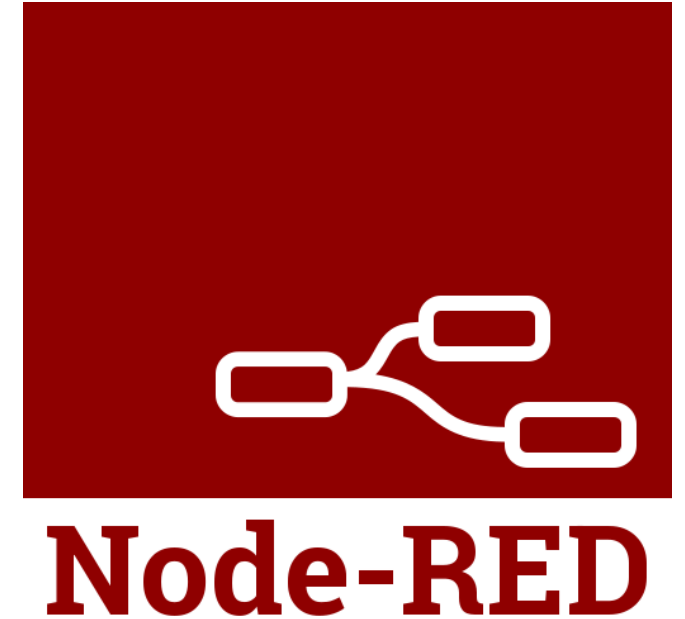


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Using Node-Red and OPCUA

- We will look at how to use Node-Red in two different ways in this training.
 - I. Running Node-Red on the PC that we are using to interact with the PLCnext Controller
 - II. Running Node-Red directly on the PLCnext Controller

We will start the training by performing tasks that are prerequisites for either method.



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Using Node-Red and OPCUA

Additional Resources

Phoenix Contact PLCnext-Community:

➤ <https://www.plcnext-community.net/en/hn-makers-blog.html>


➤ [Rajvir Singh PLCnext OPC UAExpert Video](#)

➤ [Rajvir Singh PLCnext OPCUA Node Red](#)



Continue through *this* training presentation now. If you get stuck, check out the resources listed above to supplement this training presentation. It may help fill in any unintentional gaps you might encounter.

Stories from users for users



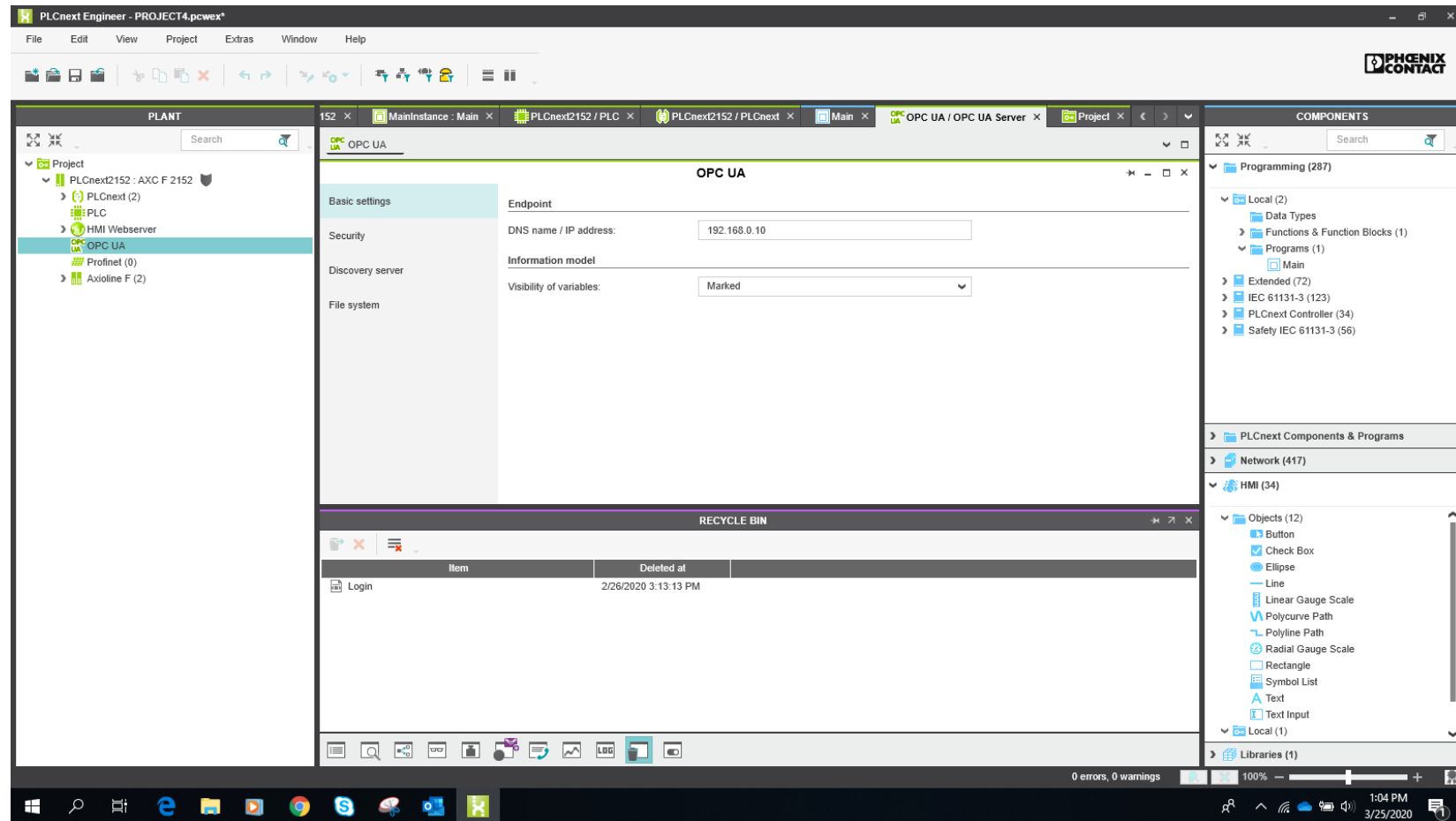
Get inspired or write about your own user story with PLCnext Technology.

MAKERS BLOG

OPC UA

Initial configuration steps – in PLCnext Engineer software

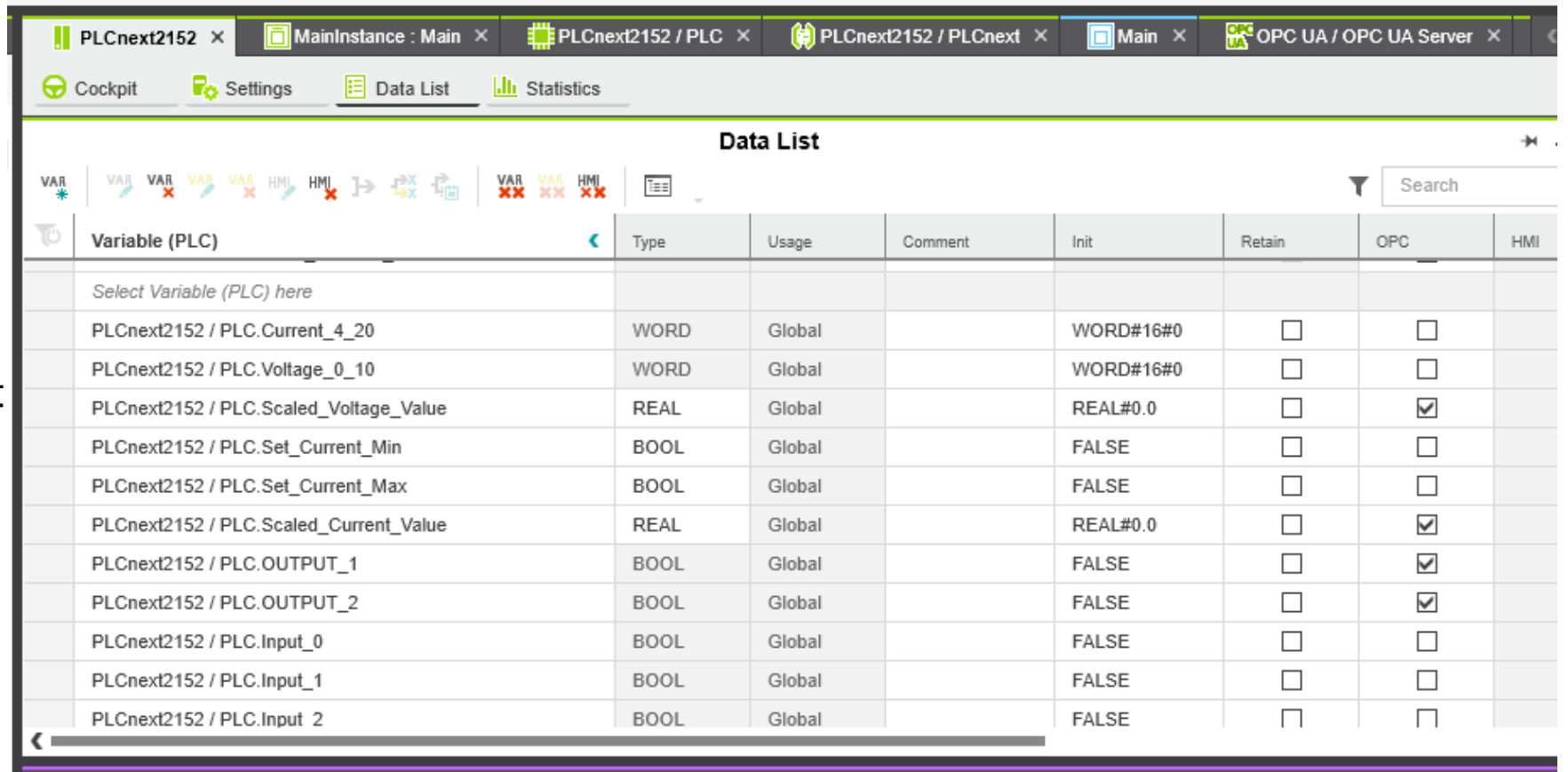
- Open PLCnext Engineer
- Open the project you created in Part 1 of this training (or another project you have created)
- In the PLANT area, open the Project tree and double click on “OPC UA”
- On the basic settings tab, type in the IP address that you have assigned to the PLCnext controller.
- Under “Visibility of variables”, select “Marked” from the drop-down list.
- Save the project



OPC UA

Initial configuration steps – in PLCnext Engineer software

- Click on the controller (immediately below “Project” in the PLAN area.
- Open the “Data List” sub-tab.
- Locate the variables that we want to make available via OPC-UA
- Click the box in the “OPC” column for each of those variables



The screenshot shows the PLCnext Engineer software interface. The top navigation bar includes tabs for 'PLCnext2152', 'MainInstance : Main', 'PLCnext2152 / PLC', 'PLCnext2152 / PLCnext', 'Main', and 'OPC UA / OPC UA Server'. Below the navigation bar, there are icons for 'Cockpit', 'Settings', 'Data List', and 'Statistics'. The main area is titled 'Data List' and contains a table of variables. The table has columns for 'Variable (PLC)', 'Type', 'Usage', 'Comment', 'Init', 'Retain', 'OPC', and 'HMI'. The 'OPC' column contains checkboxes that are checked for several variables, indicating they are configured for OPC-UA access.

Variable (PLC)	Type	Usage	Comment	Init	Retain	OPC	HMI
Select Variable (PLC) here							
PLCnext2152 / PLC.Current_4_20	WORD	Global		WORD#16#0	<input type="checkbox"/>	<input type="checkbox"/>	
PLCnext2152 / PLC.Voltage_0_10	WORD	Global		WORD#16#0	<input type="checkbox"/>	<input type="checkbox"/>	
PLCnext2152 / PLC.Scaled_Voltage_Value	REAL	Global		REAL#0.0	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
PLCnext2152 / PLC.Set_Current_Min	BOOL	Global		FALSE	<input type="checkbox"/>	<input type="checkbox"/>	
PLCnext2152 / PLC.Set_Current_Max	BOOL	Global		FALSE	<input type="checkbox"/>	<input type="checkbox"/>	
PLCnext2152 / PLC.Scaled_Current_Value	REAL	Global		REAL#0.0	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
PLCnext2152 / PLC.OUTPUT_1	BOOL	Global		FALSE	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
PLCnext2152 / PLC.OUTPUT_2	BOOL	Global		FALSE	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
PLCnext2152 / PLC.Input_0	BOOL	Global		FALSE	<input type="checkbox"/>	<input type="checkbox"/>	
PLCnext2152 / PLC.Input_1	BOOL	Global		FALSE	<input type="checkbox"/>	<input type="checkbox"/>	
PLCnext2152 / PLC.Input_2	BOOL	Global		FALSE	<input type="checkbox"/>	<input type="checkbox"/>	

OPC UA

Initial configuration steps – in the PLCnext Controller's WBM

- Go to the PLCnext controller's web-based management configuration page by typing the IP address followed by a slash and "wbm" into your browser.
- Click on the "Security" tab
- Click on the "Enable/Disable" button to disable User Authentication
- Note: This is to facilitate a smooth demo experience. Normally, you would keep User Authentication enabled.

The screenshot shows the web-based management interface (WBM) for a PLCnext controller. The interface is in English and displays the 'Security' configuration page. The top navigation bar includes the language selector (Deutsch/English), the Phoenix Contact logo, and system information: Project Name: PROJECT4, HW: 02 FW: 2020.0 LTS, and MAC: A8:74:1D:02:C1:75. The main content area is titled 'Security' and features a 'User Authentication' section with an 'Enable/Disable' button. Below this is a table listing users, with one user named 'admin' having the role 'Admin'. Action buttons for 'Set Password', 'Modify Roles', and 'Remove User' are visible for the 'admin' user. A sidebar on the left contains navigation tabs for Information, Diagnostics, Configuration, Security, and Administration. The 'Security' tab is currently selected, showing sub-options for User Authentication, Certificate Authentication, Firewall, and SD Card.

User	Roles	
admin	Admin	Set Password Modify Roles Remove User

OPC UA

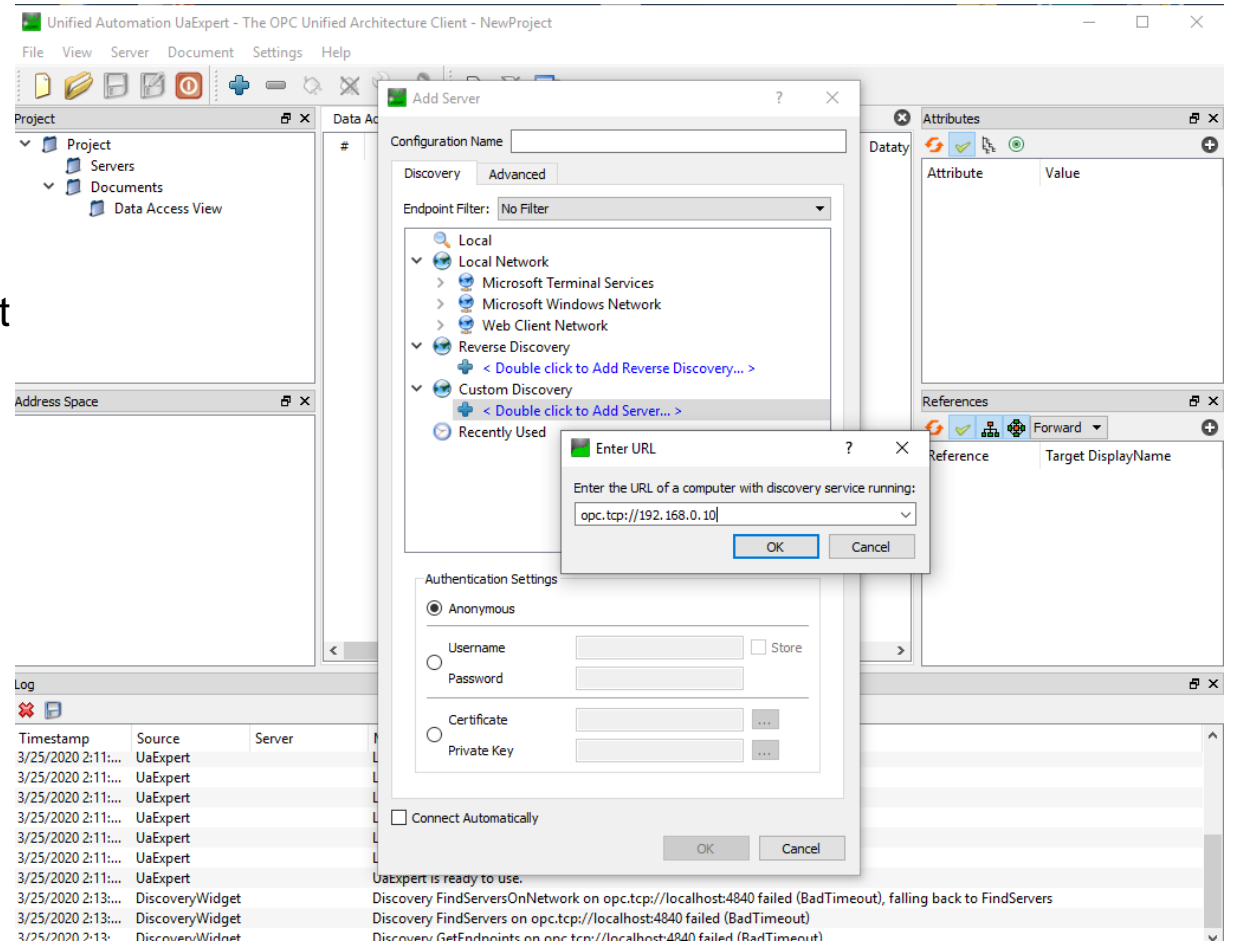
OPC UA – 3rd party test software

- The PLCnext controller acts as the OPCUA **Server**
- We will need an OPCUA **Client** to interact with the PLCnext controller via OPCUA
- As an intermediate step, we will use free software called UAExpert from United Automation, allowing us to:
 - Test and verify connection to the PLCnext controller's OPCUA Server
 - Monitor real-time values
 - Observe Namespace, DataType and other parameters that we can then use in other OPCUA client applications (such as Node Red)



Setting up an OPCUA client - UAExpert

- Download 3rd party OPC UA client software – UA Expert. [Link to download](#)
 - You will need to register for their website before being allowed to download.
 - Be sure to download the version for computers, not mobile devices
 - During the installation process, you'll need to authenticate via certificates. This is straight forward. Just follow the prompts.
 - Open the UA Expert software and log in.
 - Click the big green plus sign at the top.
 - Double click where indicated below “Custom discovery”
 - Type in your PLCnext controller’s IP address.
 - Then add a colon, and the port number 4840.



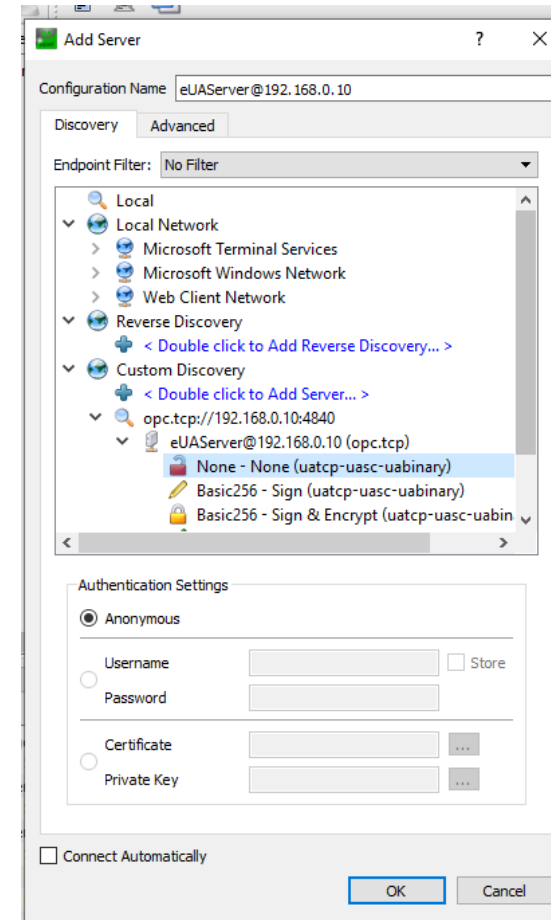
OPCUA

Setting up an OPCUA Client - UAExpert

The new server will appear under “Custom Discovery”

Under “eUAServer@192.168.0.10 (opc.tcp)”

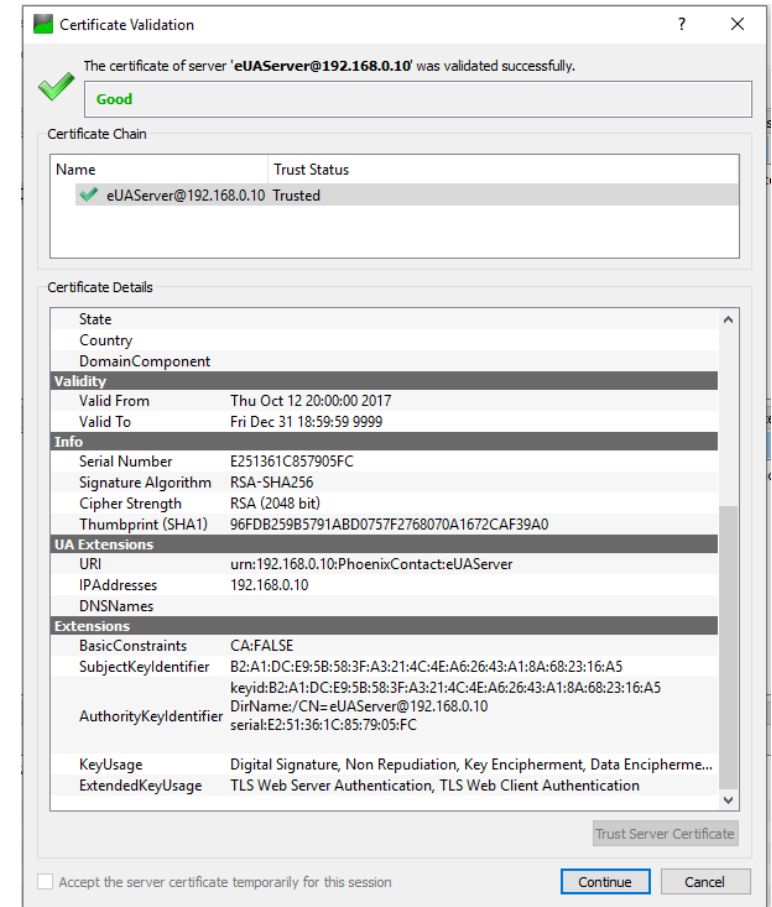
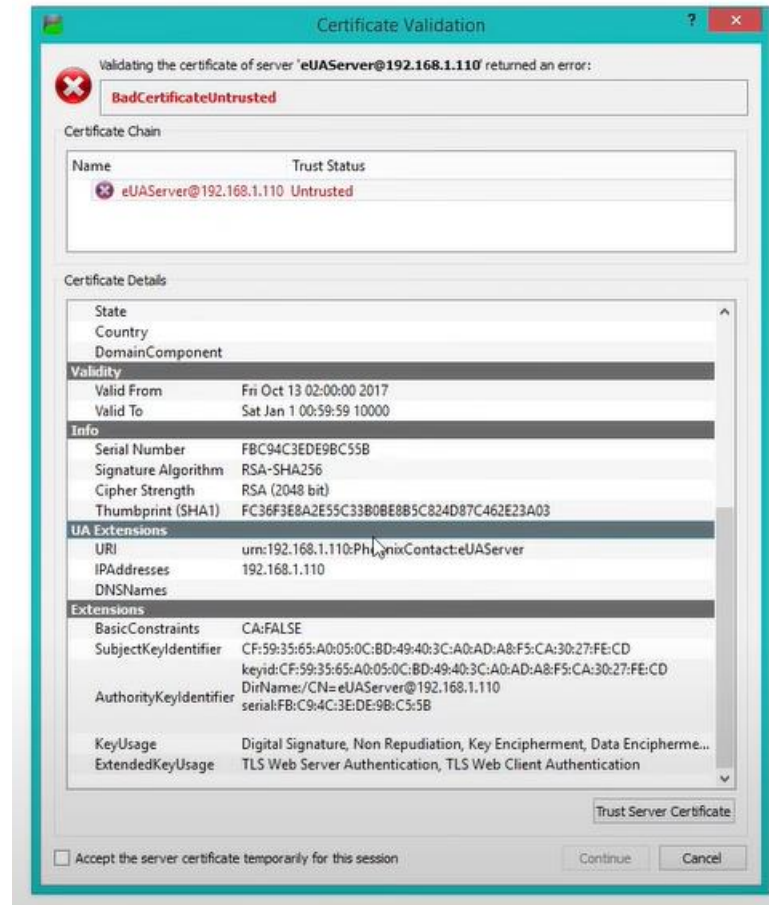
- Click on one of the security settings. We have set up NONE on the PLCnext controller – for demo purposes, to make things easy. For actual applications, you’d want to have security enabled.
- This will prompt a certificate error.
- Click “Trust server certificate” to resolve. (see next slide)



OPCUA

Setting up and OPCUA client - UAExpert

- Click “Trust Server Certificate”
- Then, click “Continue”



OPCUA

Working with an OPCUA client - UAExpert

- Once you have opened a new project in UA Expert, find “PLC next” under the “Objects” folder under the “Root” directory in the bottom/left window.
- Expand the tree under “PLC next” and you will see the variables that you designated in PLCnext Engineer
- Drag and drop any or all of these variables into the “Data Access View” space in the middle of the screen. You will see the real-time values of each variable.
- Click on any variable in the bottom/left window to get a listing of all it’s attributes in the “Attributes” window on the right side of the screen.

The screenshot displays the UAExpert interface with the following components:

- Project Tree (Bottom Left):** Shows a hierarchy starting with 'Project' > 'Servers' > 'eUAServer@192.168.0.10' > 'Documents' > 'Data Access View'.
- Data Access View (Center):** A table with columns: #, Server, Node Id, Display Name, and Value.

#	Server	Node Id	Display Name	Value
1	eUAServer@192...	NSS[String]Arp...	Scaled_Current_...	400.253
2	eUAServer@192...	NSS[String]Arp...	Scaled_Voltage_...	24.9508
3	eUAServer@192...	NSS[String]Arp...	OUTPUT_2	true
4	eUAServer@192...	NSS[String]Arp...	OUTPUT_1	true
- Attributes Window (Right):** Shows detailed metadata for the selected 'Scaled_Current_Value' variable.

Attribute	Value
NodeId	ns=5;s=Arp.Plc.Eclr/Scaled_Current_Value
NamespaceIndex	5
IdentifierType	String
Identifier	Arp.Plc.Eclr/Scaled_Current_Value
NodeClass	Variable
BrowseName	5, "Scaled_Current_Value"
DisplayName	""
Description	"en", "Float32"
WriteMask	0
UserWriteMask	0
RolePermissions	BadAttributeValueInvalid (0x80350000)
UserRolePermissions	BadAttributeValueInvalid (0x80350000)
AccessRestrictions	BadAttributeValueInvalid (0x80350000)
Value	
SourceTimestamp	3/26/2020 1:58:22.846 PM
SourcePicoSeconds	0
ServerTimestamp	3/26/2020 1:58:22.846 PM
ServerPicoSeconds	0
StatusCode	Good (0x00000000)
Value	400.427
DataType	Float
NamespaceIndex	0
IdentifierType	Numeric
Identifier	10 [Float]
ValueRank	-1 (Scalar)
ArrayDimensions	Null
- Address Space (Bottom Left):** Shows a tree structure: Root > Objects > DeviceSet > PLCnext > Arp.Plc.Eclr > High_Level_Counter > OUTPUT_1 > OUTPUT_2 > Scaled_Current_Value (selected) > Scaled_Voltage_Value.
- References (Bottom Right):** Shows a table with columns: Reference, Target DisplayName.

Reference	Target DisplayName
HasTypeDefiniti...	BaseDataVariableType

A blue arrow points from the text "Verify that these values change as you turn the potentiometer on the demo." to the 'Value' column of the Data Access View table.

OPCUA

Working with an OPCUA client - UAExpert

- There are three critically important data points revealed for each variable in this attributes window. These three data are needed to link these variables with a 3rd party software application (such as a SCADA system, etc.).
 - NamespaceIndex
 - Identifier Type
 - Data Type
- The format of this information will look as below – when you type it into Node Red:

```
ns=5;s=Arp.Plc.Eclr/Scaled_Current_Value;datatype=Float
```

The screenshot shows the 'Attributes' window in UAExpert. It displays a list of attributes for a variable. Two specific attributes are highlighted with blue boxes: 'NodeId' and 'DataType'.

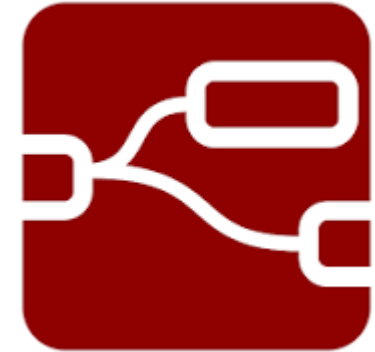
Attribute	Value
▼ NodeId	ns=5;s=Arp.Plc.Eclr/Scaled_Current_Value
NamespaceIndex	5
IdentifierType	String
Identifier	Arp.Plc.Eclr/Scaled_Current_Value
NodeClass	Variable
BrowseName	5, "Scaled_Current_Value"
DisplayName	""
Description	"en", "Float32"
WriteMask	0
UserWriteMask	0
RolePermissions	BadAttributeIdInvalid (0x80350000)
UserRolePermissions	BadAttributeIdInvalid (0x80350000)
AccessRestrictions	BadAttributeIdInvalid (0x80350000)
▼ Value	
SourceTimestamp	3/26/2020 1:58:22.846 PM
SourcePicoSeconds	0
ServerTimestamp	3/26/2020 1:58:22.846 PM
ServerPicoSeconds	0
StatusCode	Good (0x00000000)
Value	400.427
▼ DataType	Float
NamespaceIndex	0
IdentifierType	Numeric
Identifier	10 [Float]
ValueRank	-1 (Scalar)
ArrayDimensions	Null

OPCUA

Try a more useful OPCUA client

- UAExpert is an excellent OPCUA client to perform certain functions.
 - Verify connection to the OPCUA server (PLCnext controller)
 - Monitor real-time variables being sent from the OPCUA server
 - Discover the NodeID, namespace, datatype, etc. of the variables that you may want to interact with in another OPCUA client
- However, if you want to create a dashboard to display these OPCUA variables, or do other work, another OPCUA client will be useful.
 - This could be a 3rd party, commercially available SCADA
 - Or a tool that makes java scripting easy such as Node Red, which can get us into the IIoT world.

Node-RED



Node-RED is a programming tool for wiring together hardware devices, APIs and online services in new and interesting ways.

It provides a browser-based editor that makes it easy to wire together flows using the wide range of nodes in the palette that can be deployed to its runtime in a single-click.

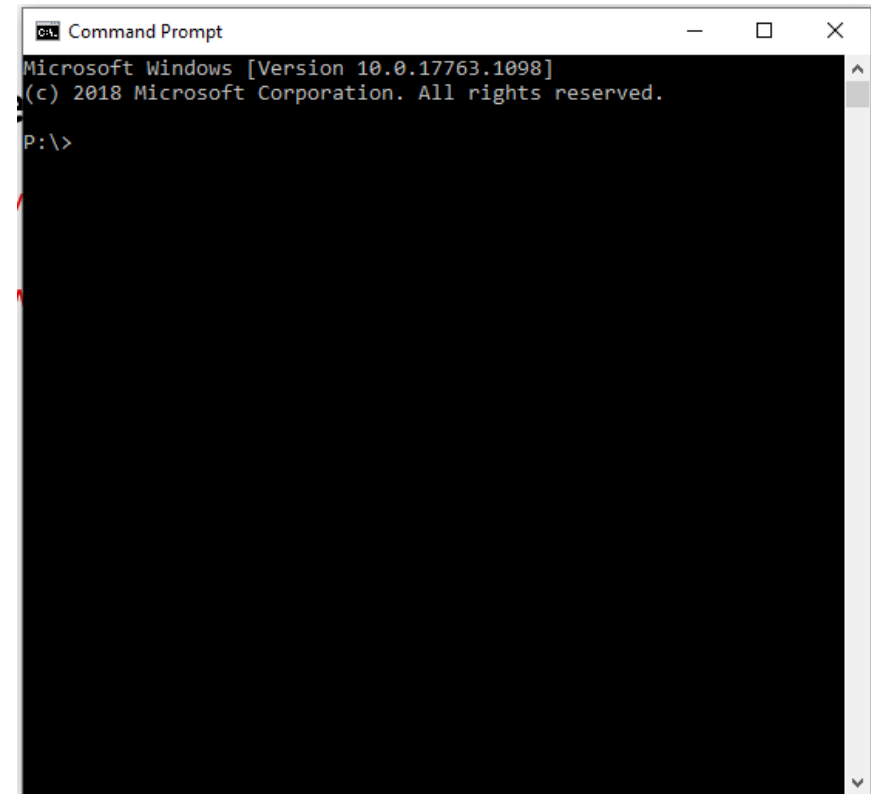
OPCUA – Installing and using Node-Red on your computer

Installing Node Red - prerequisites

Installing Node Red – and its prerequisite, Node.js, on your Windows PC may require administrative privileges.

Installing Node.js and Node Red on your Windows PC will require the user to use Command Prompt, or Powershell.

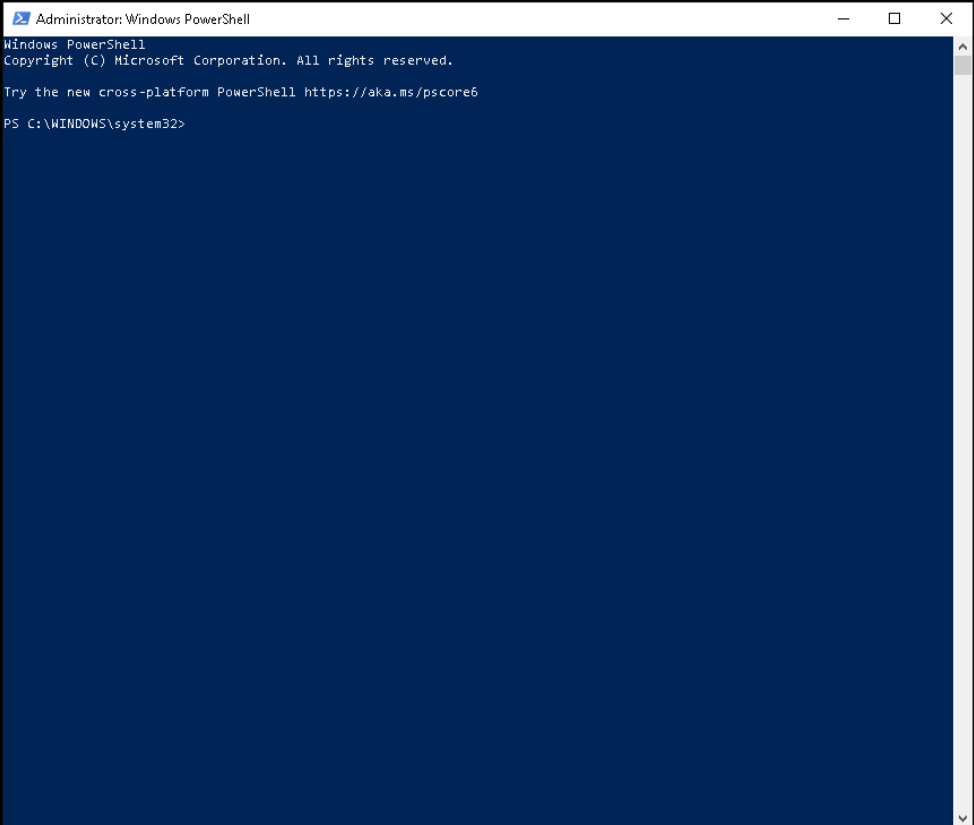
If you are not comfortable in this world... stop here.



OPCUA – Installing and using Node-Red on your computer

Installing Node Red - prerequisites

- Check Nodered.org for instructions on downloading and installing Node Red on a Windows PC.
- Or consult a YouTube video for help doing this.
 - How to install Node-Red on Windows (by electronhacks)
 - How to install Node-Red in Windows (by BD Life Hacks tv)
- If you are not familiar with using the command-line interface, this will be unfamiliar territory.
- If you do not have administrative rights on your PC, this may not be possible for you to execute.



```
Administrator: Windows PowerShell
Windows PowerShell
Copyright (C) Microsoft Corporation. All rights reserved.

Try the new cross-platform PowerShell https://aka.ms/pscore6

PS C:\WINDOWS\system32>
```

OPCUA – Installing and using Node-Red on your computer

“Opening” Node Red

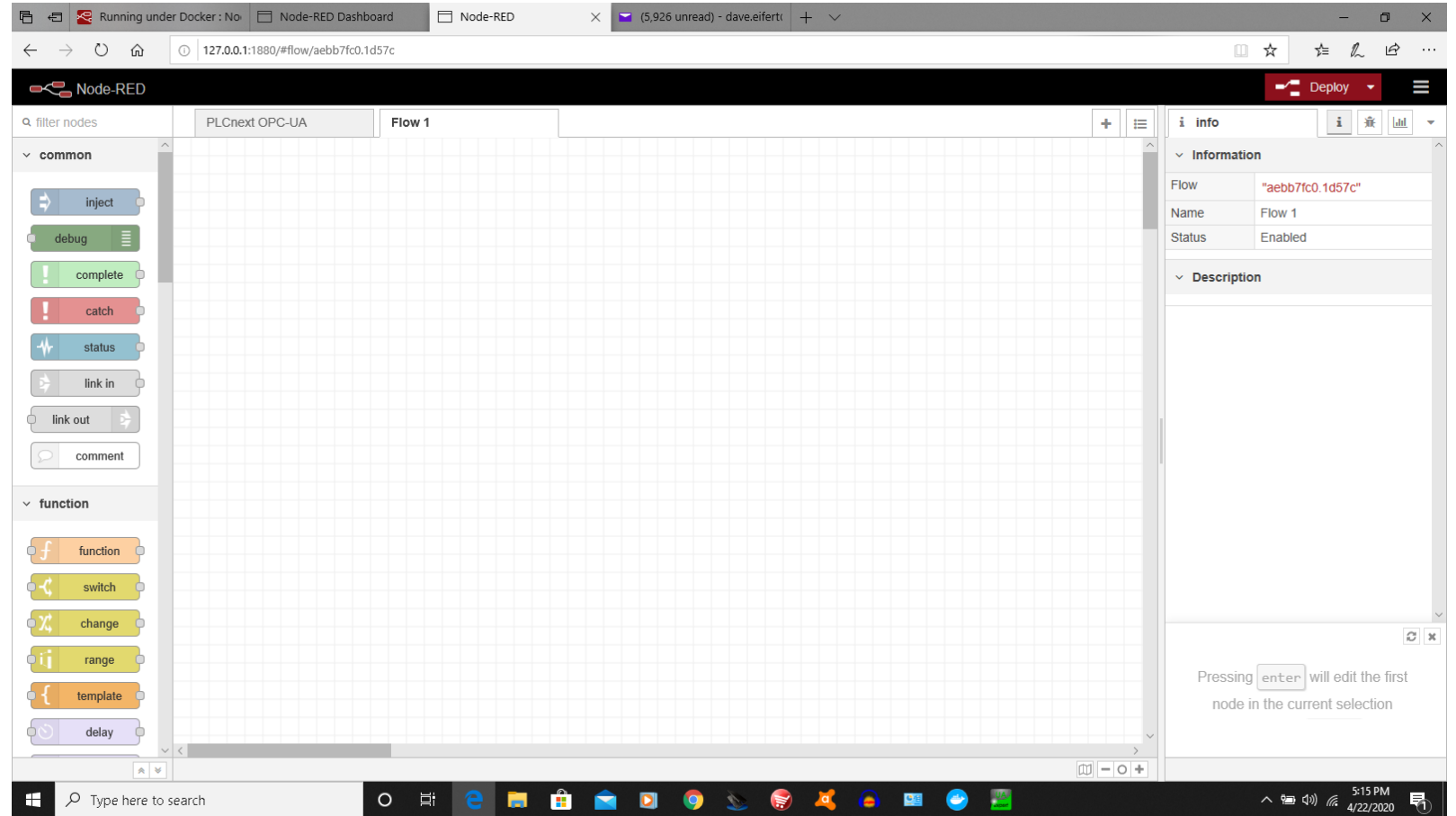
- Node Red is not a program or application that is opened in a traditional way
- Instead copy the information that you discover by starting Node Red in Powershell (or Command Prompt). I have highlighted the information that you will be looking for, so you can copy it.
- Open a browser and paste the contents into the address field.
 - This will open the Node-Red interface
 - See next slide

```
21 Apr 10:29:04 - [info]
21 Apr 10:29:04 - [info] Node-RED version: v1.0.4
21 Apr 10:29:04 - [info] Node.js version: v10.19.0
21 Apr 10:29:04 - [info] Linux 4.19.76-linuxkit x64 LE
21 Apr 10:29:05 - [info] Loading palette nodes
21 Apr 10:29:07 - [info] Dashboard version 2.20.0 started at /ui
21 Apr 10:29:07 - [info] Settings file : /data/settings.js
21 Apr 10:29:07 - [info] Context store : 'default' [module=memory]
21 Apr 10:29:07 - [info] User directory : /data
21 Apr 10:29:07 - [warn] Projects disabled : editorTheme.projects.enabled=false
21 Apr 10:29:07 - [info] Flows file : /data/flows.json
21 Apr 10:29:07 - [warn]
21 Apr 10:29:07 - [info] Starting flows
21 Apr 10:29:07 - [info] [OpcUa-Client:dcf56109.2b3fd] No certificate used.
21 Apr 10:29:07 - [info] [OpcUa-Client:c98e855c.a51f38] No certificate used.
21 Apr 10:29:07 - [info] [OpcUa-Client:5c72d4af.f738fc] No certificate used.
21 Apr 10:29:07 - [info] [OpcUa-Client:8471d526.d9cea8] No certificate used.
21 Apr 10:29:07 - [info] Started flows
21 Apr 10:29:07 - [info] Server now running at http://127.0.0.1:1880/
```

OPCUA – Installing and using Node-Red on your computer

“Opening” Node Red

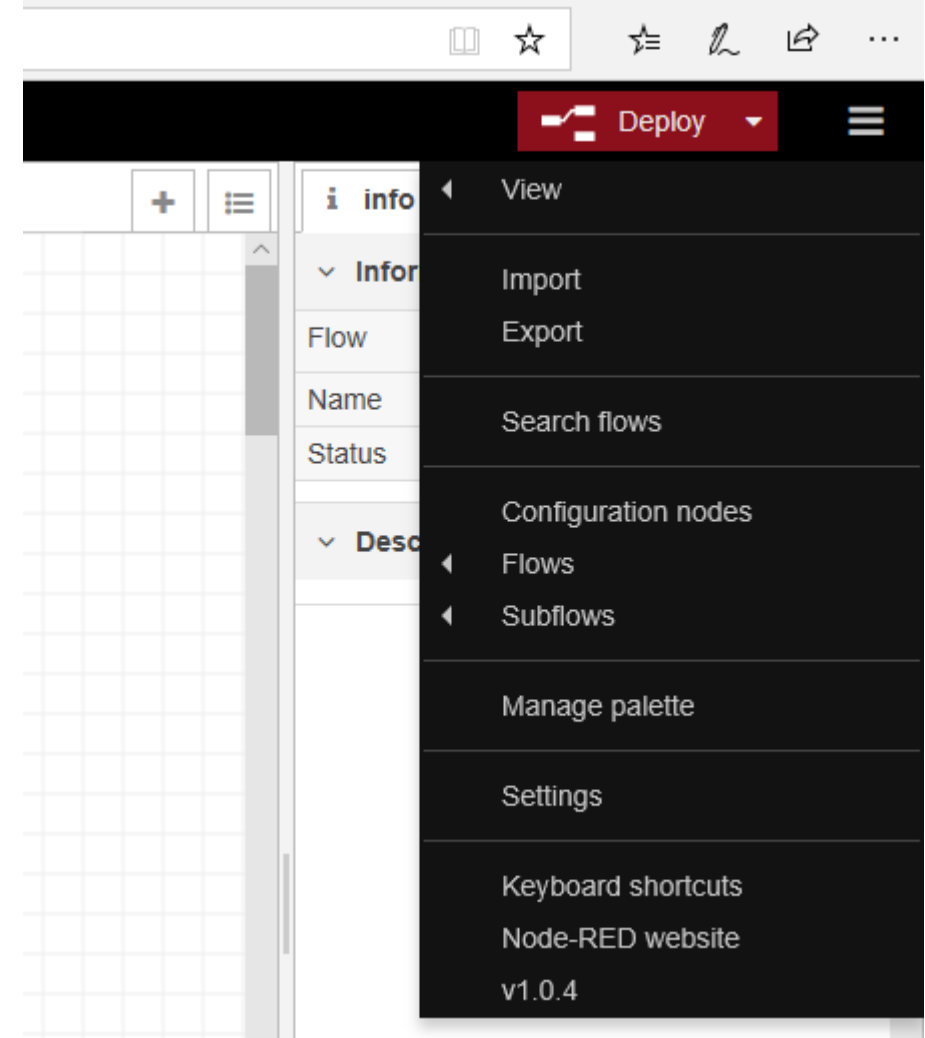
- Paste the server address that you copied from the Command Prompt into your browser’s address field.
- A blank Node Red “Flow” page should open as seen to the right.
- Note the colorful objects along the left side of the screen. These are the nodes that are available on your “palette”.
- Node Red is not equipped to handle OPCUA as standard. We will need to import some additional palettes to get all the nodes we’ll need.



OPCUA – Installing and using Node-Red on your computer

Configuring Node Red

- Click on the menu button (three horizontal lines) at the top right corner of the screen, then on “manage palette”



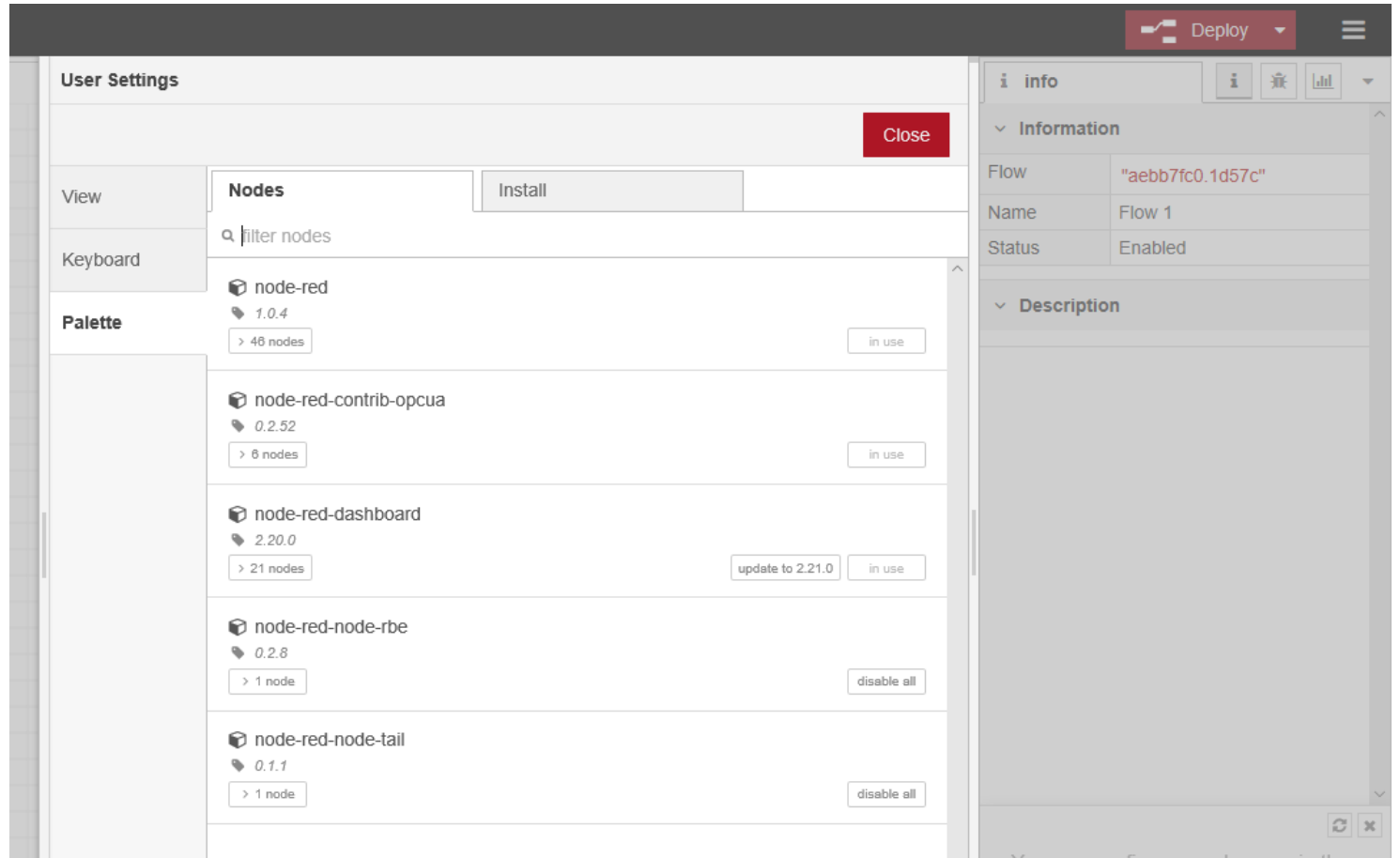
OPCUA

Bringing OPCUA nodes into Node Red

The User Settings page will open, and the Pallet tab will be displayed.

You will see the installed palettes that are already in Node Red (either by default, or because you have previously imported them).

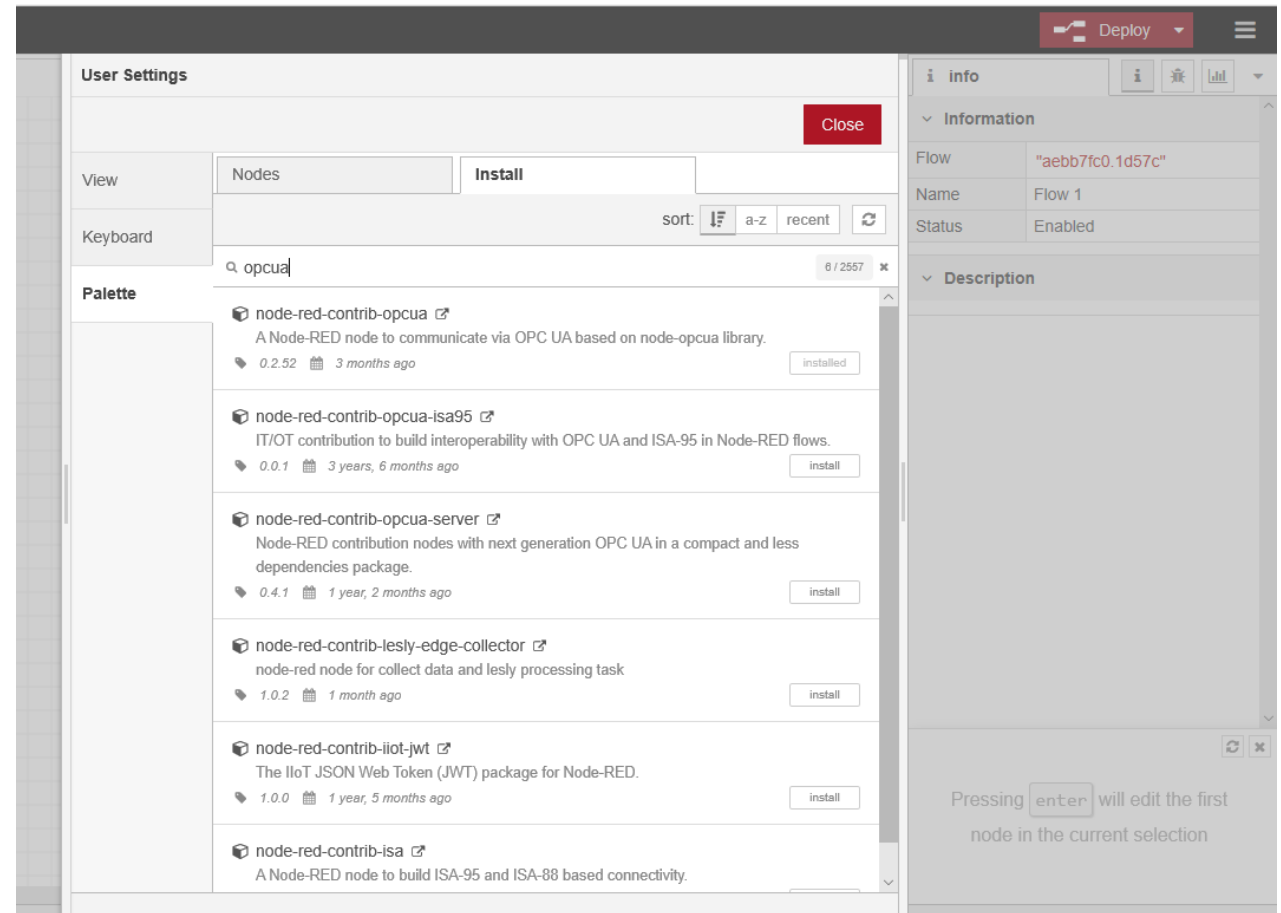
- Click on the “Install” tab
- This will allow you to search the internet for additional palettes that you can import here.



OPCUA – Installing and using Node-Red on your computer

Bringing OPCUA nodes into Node Red

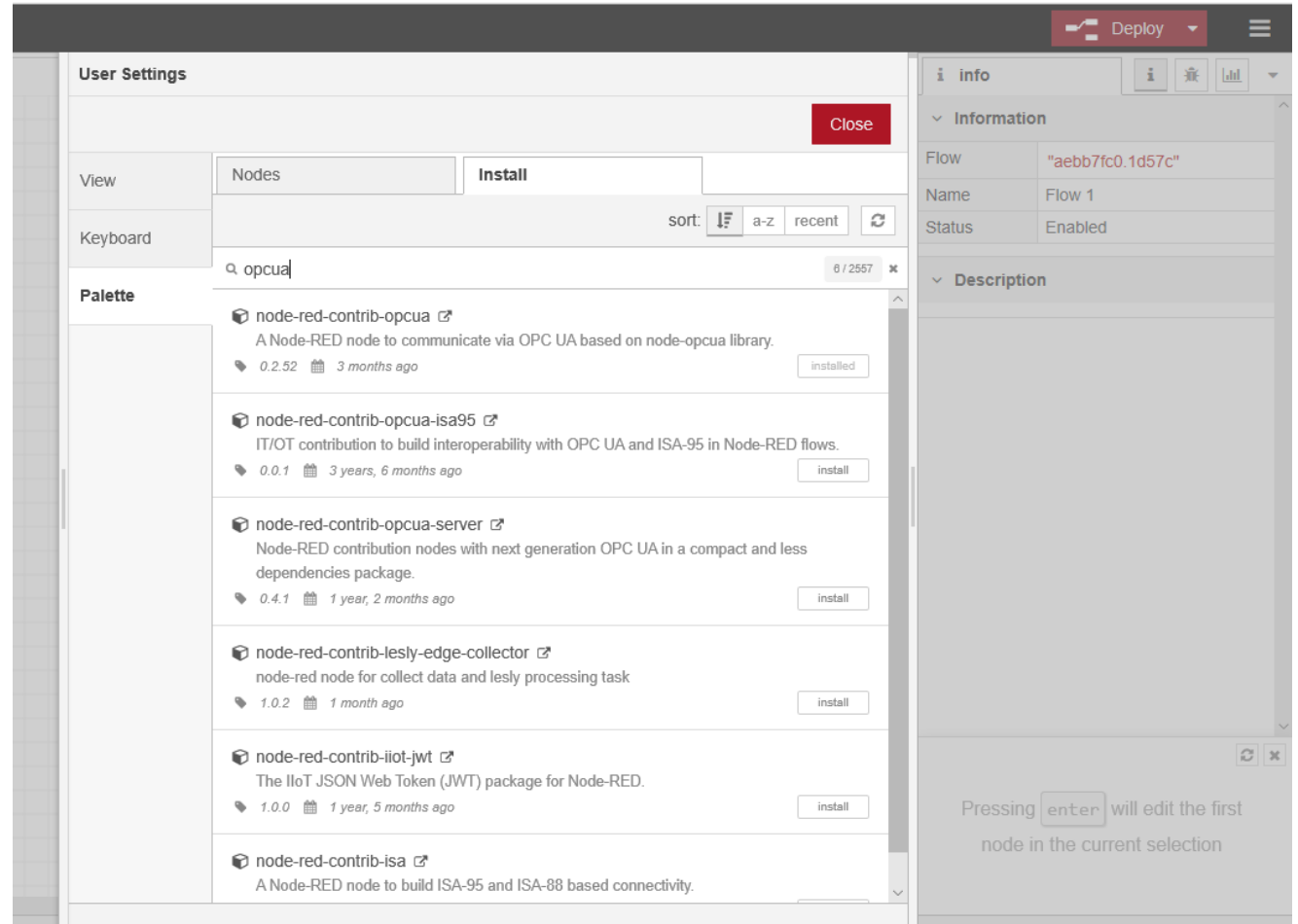
- Type into the search bar some keywords...Notice I have typed in “OPCUA”
- Note the various palettes that appear after the search.
- There is no obvious way to know exactly which palettes to import.
- You can do trial and error, or read about them.
- In our case, we will want to add:
 - Node-red-contrib-opcua
 - Node-red-dashboard



OPCUA – Installing and using Node-Red on your computer

Bringing OPCUA nodes into Node Red

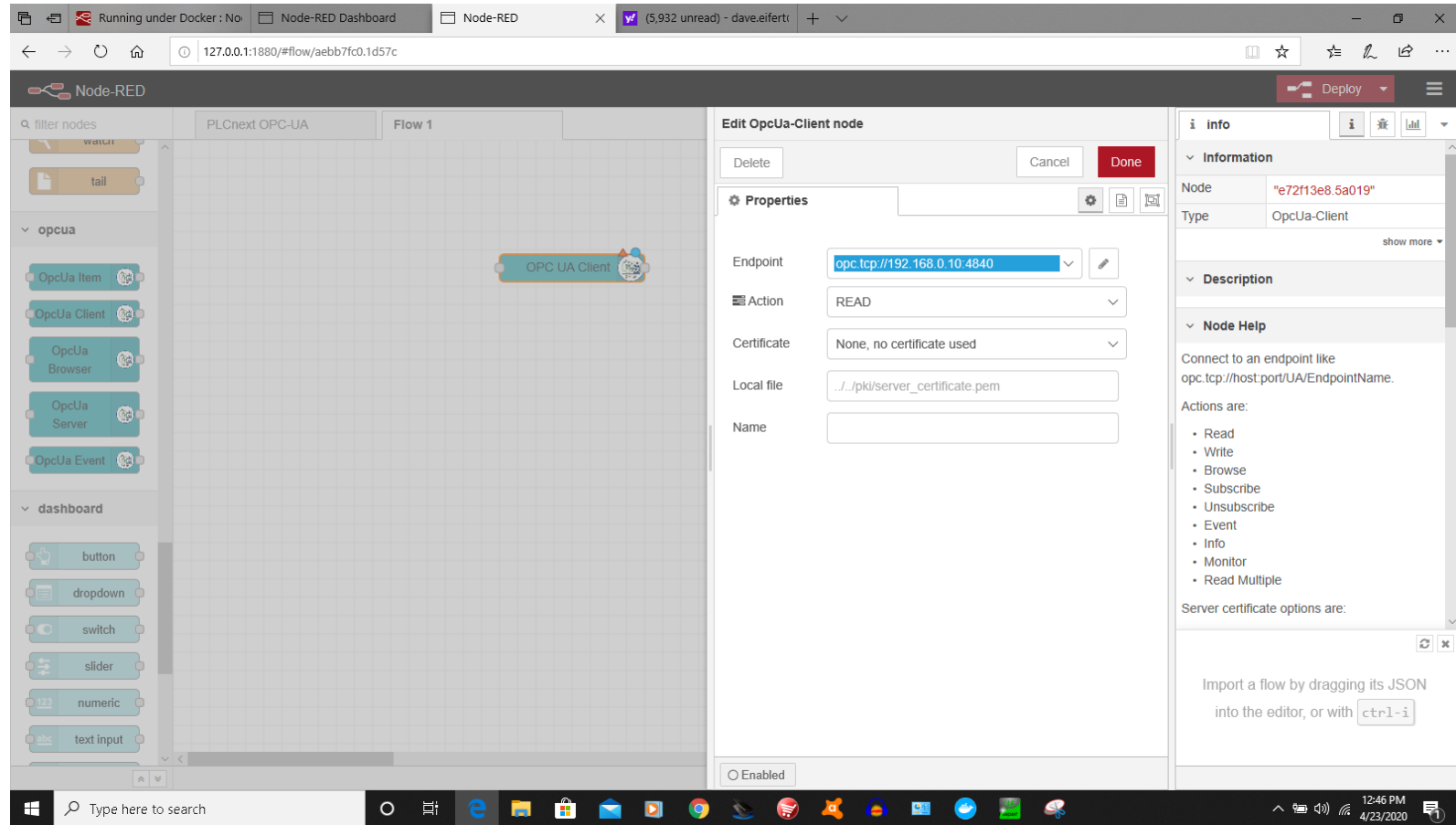
- Be sure to hit the “Install” button beside each palette you want to install.
- It will take several seconds, depending on internet speed.
- Once the nodes from each palette have been installed, you can hit the “Close” button at the top of the User Settings box.
- You will now see all the additional nodes along the left side of the main screen



OPCUA – Installing and using Node-Red on your computer

Creating flows in Node Red

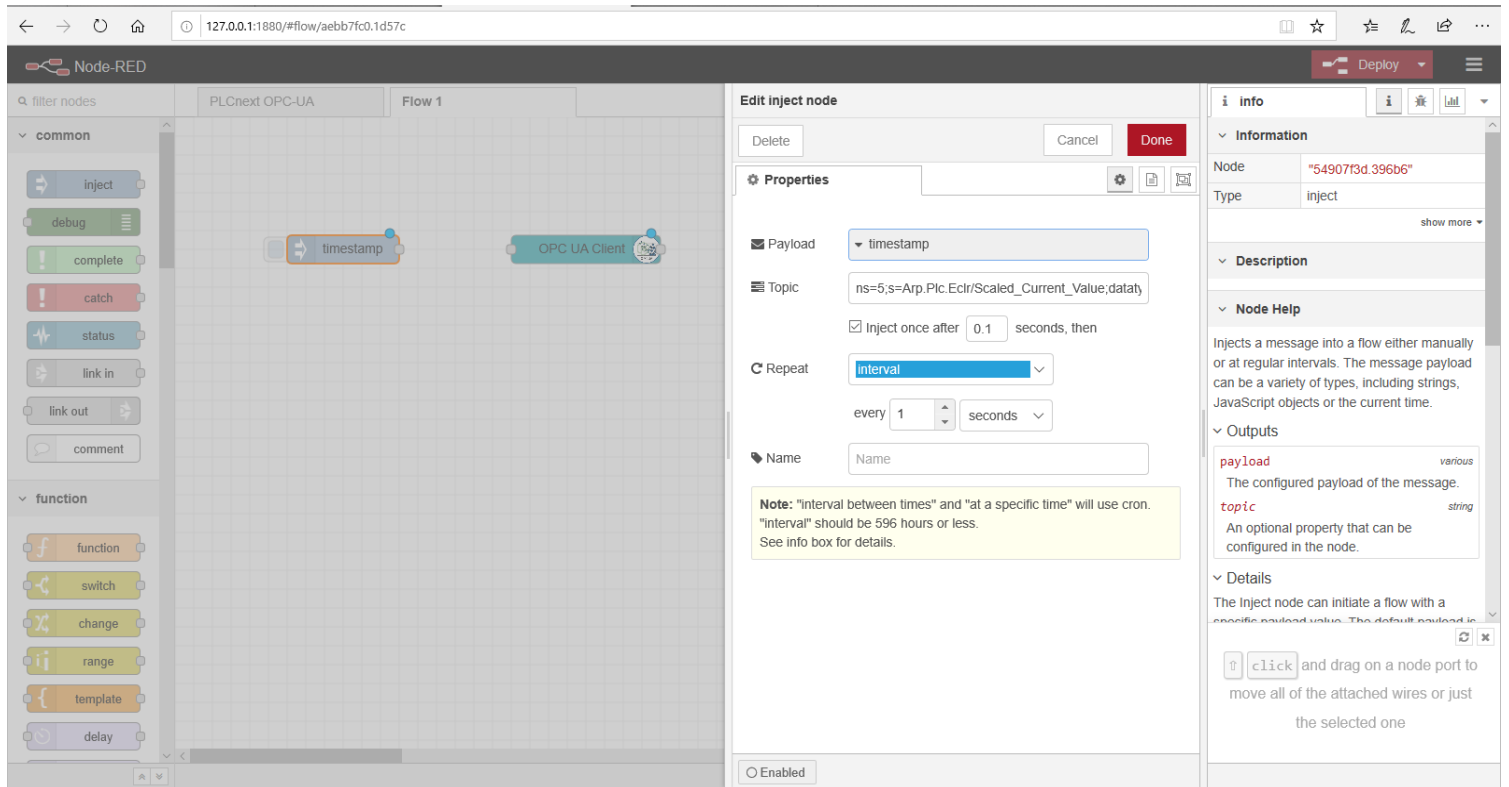
- Scroll down the palette on the left until you see the “OPC UA Client” node.
- Drag and drop it onto the flow sheet.
- Double click on the new node, and an Edit box will appear.
- Enter the same information as you used in UAExpert:
 - `Opc.tcp://ip_address:4840`
 - (the IP address is the IP address of the PLCnext controller)
- Click the “Done” button



OPCUA – Installing and using Node-Red on your computer

Creating flows in Node Red

- Scroll to the top of the palette and then drag and drop an “inject” node onto the flow sheet.
- Double click to open an edit box for it.
- See page 12 of this training to refresh your memory on how to find the info you will need to type or paste into the “Topic” field.
 - UAExpert is a good source for the information you will need here.
- Also check the box to automatically inject, and indicate the interval as shown.



The screenshot displays the Node-RED web interface. On the left, the node palette is visible with the 'inject' node selected. The main workspace shows a flow with a 'timestamp' node and an 'OPC UA Client' node. The 'Edit inject node' dialog is open, showing the following configuration:

- Properties:** Delete, Cancel, Done
- Payload:** timestamp
- Topic:** ns=5,s=Arp.Plc.Eclr.Scaled_Current_Value;datat
- Inject once after:** 0.1 seconds, then
- Repeat:** interval
- every:** 1 seconds
- Name:** Name

A note at the bottom of the dialog states: "Note: 'interval between times' and 'at a specific time' will use cron. 'interval' should be 596 hours or less. See info box for details."

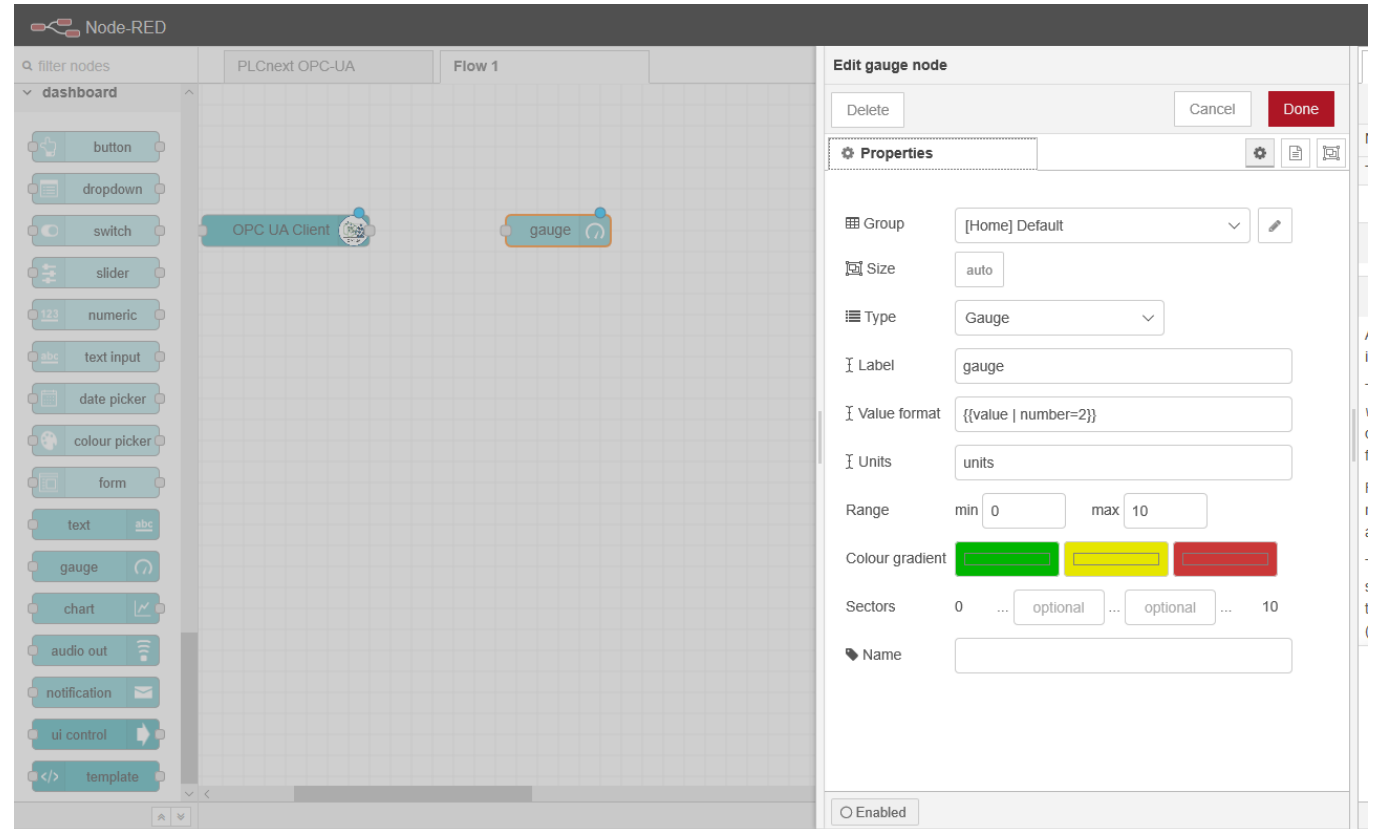
On the right, the 'info' panel is open, showing the following information:

- Information:** Node: "54907f3d.396b6", Type: inject
- Description:** Injects a message into a flow either manually or at regular intervals. The message payload can be a variety of types, including strings, JavaScript objects or the current time.
- Node Help:** payload (various): The configured payload of the message. topic (string): An optional property that can be configured in the node.
- Details:** The Inject node can initiate a flow with a specific payload value. The default payload is [click] and drag on a node port to move all of the attached wires or just the selected one

OPCUA – Installing and using Node-Red on your computer

Creating flows in Node Red

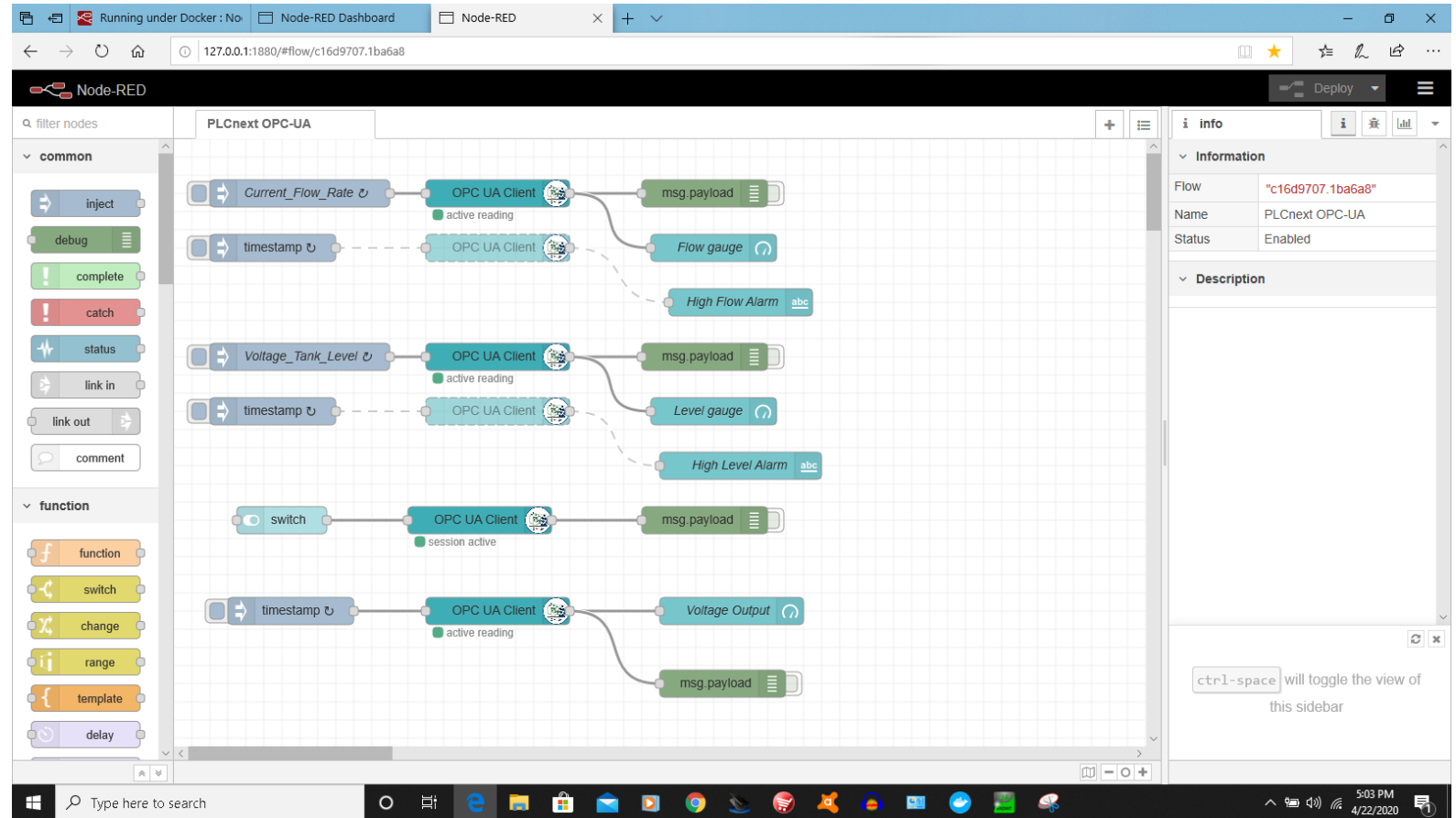
- Scroll to the bottom of the palette. If you imported the dashboard nodes, there will be a dashboard section. One of the nodes will be a gauge.
- Drag and drop the gauge, then double click it to edit it.
- Note the change I made to the “value format”. This is to limit the significant digits after the decimal point to two.
- Indicate a range. I made mine 0 to 400 to reflect the “flow” variable from the original training.
- You can specify between which values the gauge should be green, yellow and red if you desire.



OPCUA – Installing and using Node-Red on your computer

Creating flows in Node Red

- Connect the nodes together by clicking on the dot on one node and dragging a line to the other node.
- I have added more nodes and associated the “inject” nodes in each flow with a different variable.
- Note the switch will write a value to the PLCnext controller – to turn on an output.
- The flows with dotted lines are ones where I have de-activated the nodes.
- [Check out Rajvir Singh's YouTube training on PLCnext with OPCUA – Node Red](#) (bear in mind, his IP addresses are different from the one we are using).



The screenshot displays the Node-RED web interface running in a browser. The main workspace shows a flow titled "PLCnext OPC-UA". The flow consists of several parallel paths:

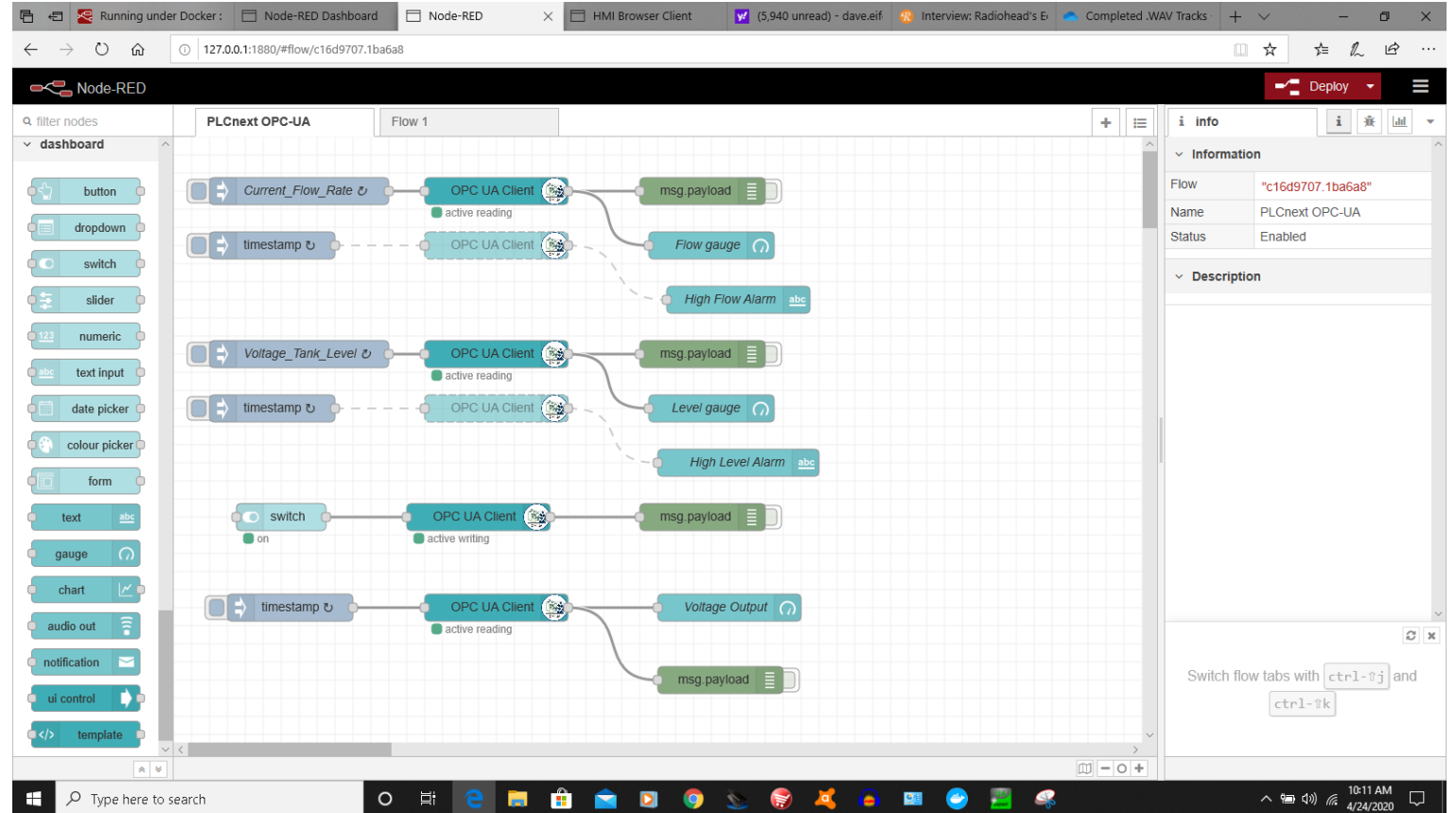
- Flow 1:** An inject node labeled "Current_Flow_Rate" is connected to an active "OPC UA Client" node. This client is connected to a "msg.payload" node, which then feeds into a "Flow gauge" and a "High Flow Alarm" node. A dotted line indicates this path is deactivated.
- Flow 2:** An inject node labeled "Voltage_Tank_Level" is connected to another active "OPC UA Client" node. This client is connected to a "msg.payload" node, which feeds into a "Level gauge" and a "High Level Alarm" node. A dotted line indicates this path is deactivated.
- Flow 3:** A "switch" node is connected to an "OPC UA Client" node with a "session active" status. This client is connected to a "msg.payload" node.
- Flow 4:** A "timestamp" node is connected to an active "OPC UA Client" node. This client is connected to a "msg.payload" node, which feeds into a "Voltage Output" node.

The left sidebar shows a "filter nodes" search bar and a list of node categories: "common" (inject, debug, complete, catch, status, link in, link out, comment) and "function" (function, switch, change, range, template, delay). The right sidebar shows "info" for the current flow, including its ID ("c16d9707.1ba6a8"), name ("PLCnext OPC-UA"), and status ("Enabled").

OPCUA – Installing and using Node-Red on your computer

Deploying flows in Node Red

- Click the red “Deploy” button at the top/right of the screen to create the underlying javascript to make everything work.
- Once that has been done, we can take a look at a Node Red dashboard



The screenshot displays the Node-RED web interface running in a browser. The main workspace shows a dashboard titled "PLCnext OPC-UA" with a "Flow 1" tab. The dashboard contains several nodes: "Current_Flow_Rate", "timestamp", "Voltage_Tank_Level", and "switch". Each of these nodes is connected to an "OPC UA Client" node, which is in turn connected to a "msg.payload" node. The "msg.payload" nodes are connected to various UI elements: "Flow gauge", "High Flow Alarm", "Level gauge", "High Level Alarm", and "Voltage Output". The "OPC UA Client" nodes are labeled "active reading" or "active writing". The "switch" node is labeled "on". The "msg.payload" nodes are labeled "msg.payload". The "Flow gauge" and "Level gauge" nodes are labeled "Flow gauge" and "Level gauge" respectively. The "High Flow Alarm" and "High Level Alarm" nodes are labeled "High Flow Alarm" and "High Level Alarm" respectively. The "Voltage Output" node is labeled "Voltage Output". The "switch" node is labeled "switch". The "timestamp" node is labeled "timestamp". The "Current_Flow_Rate" node is labeled "Current_Flow_Rate". The "Voltage_Tank_Level" node is labeled "Voltage_Tank_Level". The "switch" node is labeled "switch". The "timestamp" node is labeled "timestamp". The "Current_Flow_Rate" node is labeled "Current_Flow_Rate". The "Voltage_Tank_Level" node is labeled "Voltage_Tank_Level". The "switch" node is labeled "switch". The "timestamp" node is labeled "timestamp". The "Current_Flow_Rate" node is labeled "Current_Flow_Rate". The "Voltage_Tank_Level" node is labeled "Voltage_Tank_Level". The "switch" node is labeled "switch". The "timestamp" node is labeled "timestamp".

The right sidebar shows the "info" panel for the selected flow, displaying the following information:

Information	Value
Flow	"c16d9707.1ba6a8"
Name	PLCnext OPC-UA
Status	Enabled

The bottom of the screen shows the Windows taskbar with the search bar and various application icons. The system tray shows the time as 10:11 AM on 4/24/2020.

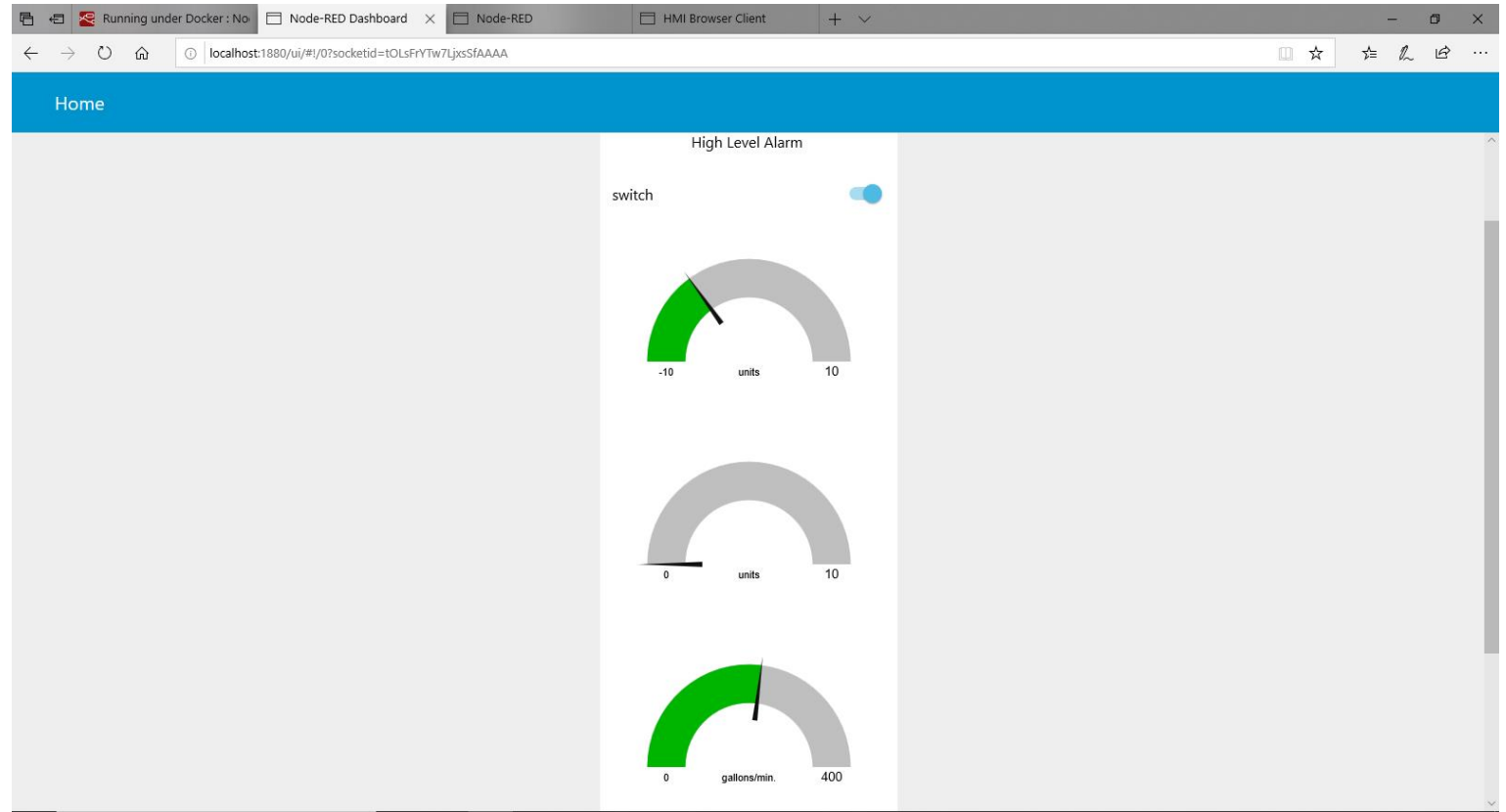
OPCUA – Installing and using Node-Red on your computer

Interacting with a dashboard in Node Red

Since we added dashboard nodes to the palette, and have added gauges to these flows, we now have created a dashboard that will allow us to view (and by using the switch, to control an output) on the PLCnext controller.

- To access this dashboard, go to your web browser, open a new tab, and type:
 - Localhost:1880/ui

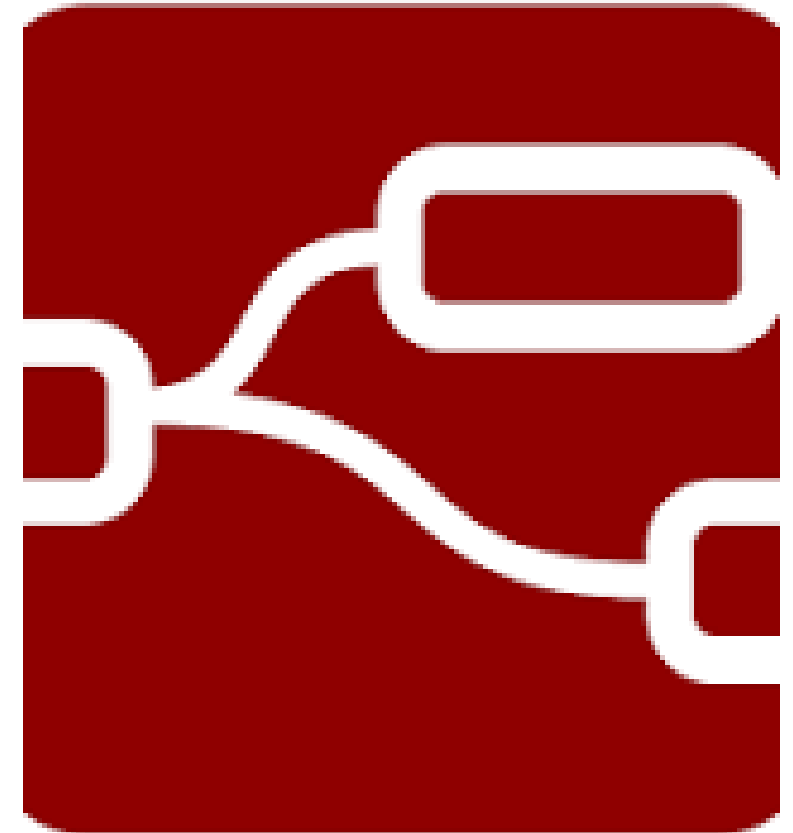
The dashboard should be displayed. Turn the knob on the potentiometer, and the gauge should respond (with a one second delay as we entered).



Installing and using Node-Red on the PLCnext Controller

➤ Installing and using Node-Red on the PLCnext Controller

Since the PLCnext controller has a Linux-based operating system, it can function like a computer. Thus it can host the Node-Red application. With the proper tools we can install Node-Red (and some prerequisite programs) onto the PLCnext Controller/Linux OS.



OPCUA – Installing and using Node-Red on the PLCnext Controller

Install an SD Card in the PLCnext Controller

The PLCnext Controller will need more memory than included onboard to host the Node-Red and associated software.

- Order one of the following SD Cards

Program / configuration memory - SD FLASH 2GB PLCNEXT MEMORY - **1043501**

Program / configuration memory - SD FLASH 8GB PLCNEXT MEMORY - **1061701**

- **important : Node Red will not run without an SD card additional memory, due to Node-Red storage requirements - Minimum 2GB SD card for AXC F 2152 (Part# 1043501 or 1061701)**

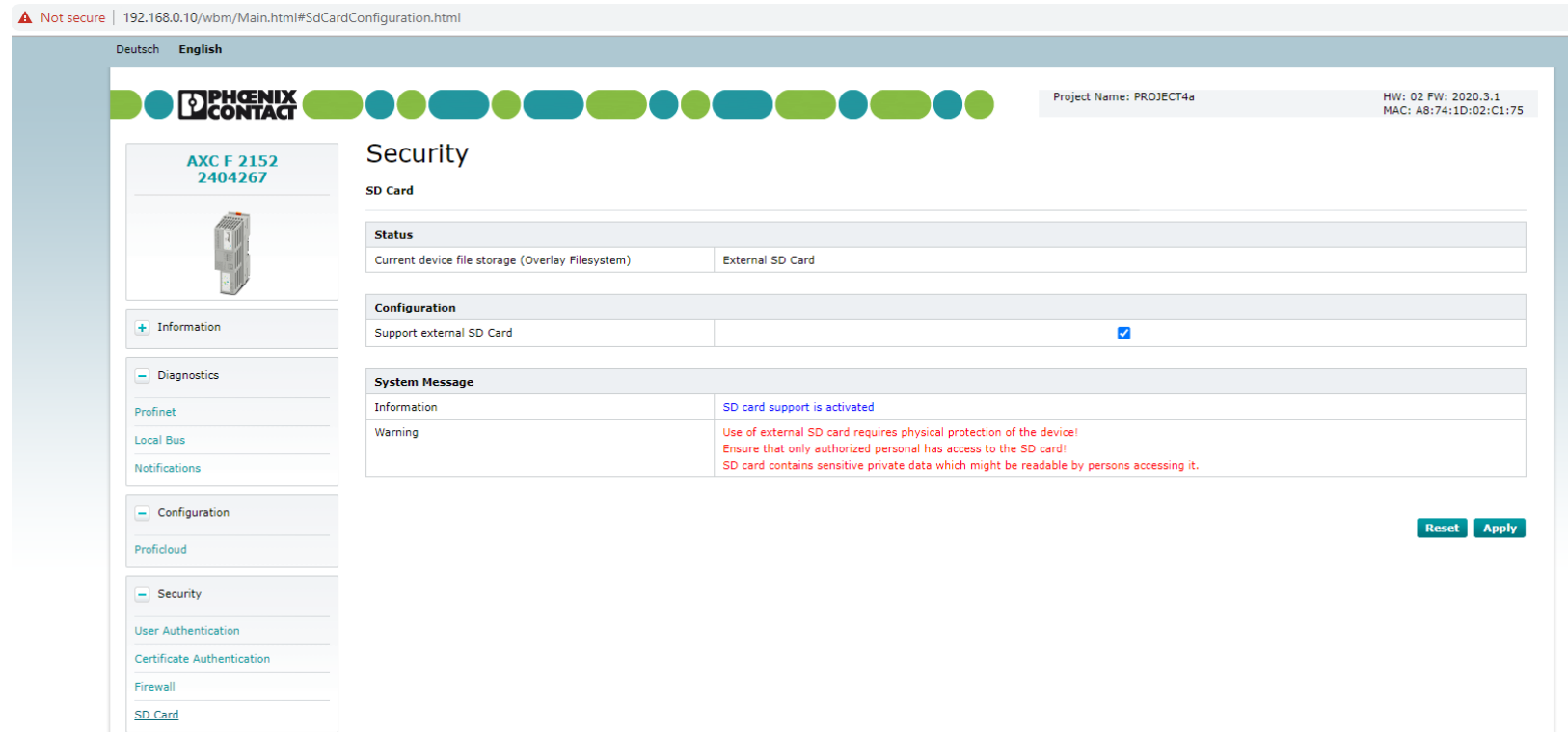


OPCUA – Installing and using Node-Red on your computer

Install an SD Card in the PLCnext Controller

Before inserting the SD card:

- Access the PLCnext Controller's web-based management
- Click on “SD Card” on the menu
- Make sure “Support external SD Card” is checked. Click to check it if necessary.
- Click “Apply” or “Cancel” as appropriate.



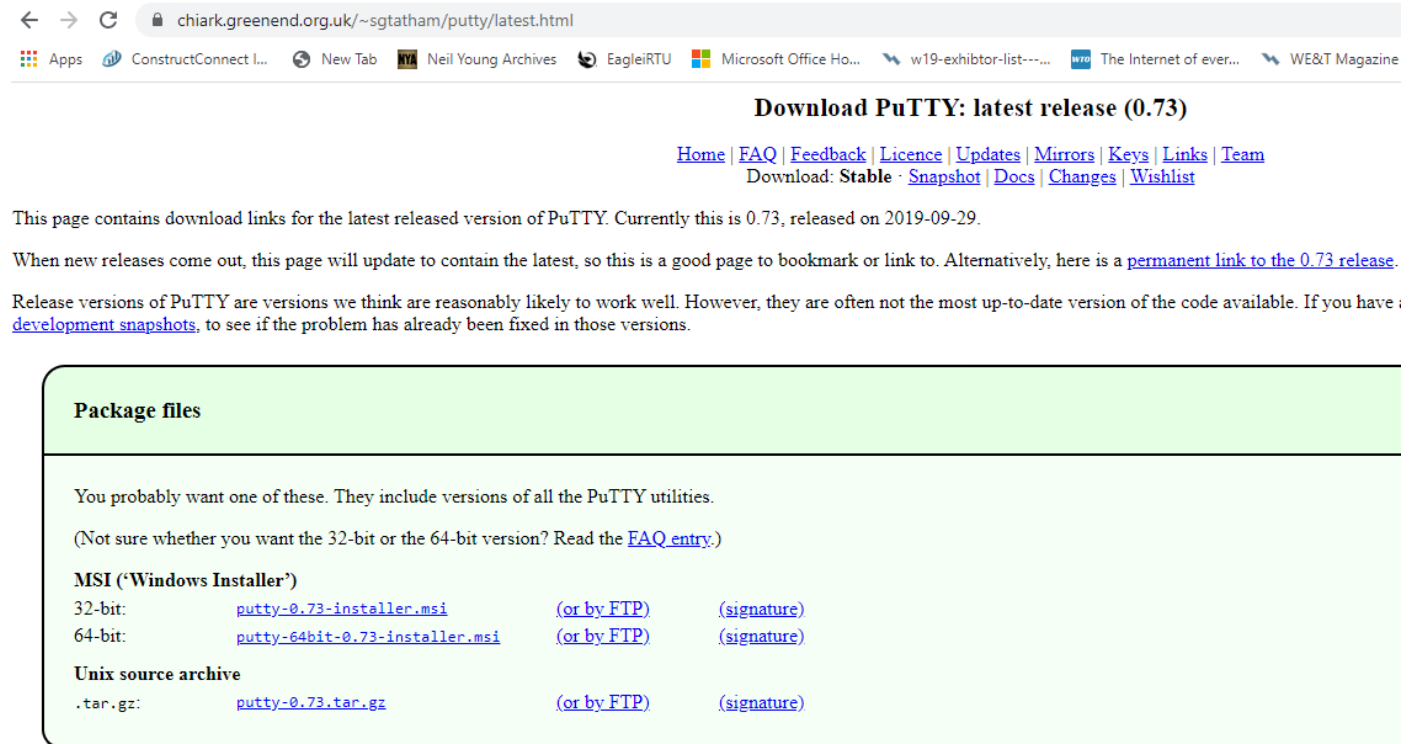
The screenshot shows the web-based management interface of a PLCnext Controller. The browser address bar indicates the URL is 192.168.0.10/wbm/Main.html#SdCardConfiguration.html. The interface is in English and shows the device model as AXC F 2152 2404267. The main content area is titled "Security" and "SD Card". Under the "Status" section, it shows "Current device file storage (Overlay Filesystem)" and "External SD Card". Under the "Configuration" section, the option "Support external SD Card" is checked. Under the "System Message" section, there is a warning message: "Use of external SD card requires physical protection of the device! Ensure that only authorized personal has access to the SD card! SD card contains sensitive private data which might be readable by persons accessing it." There are "Reset" and "Apply" buttons at the bottom right of the configuration area.

OPCUA – Installing and using Node-Red on your computer

Downloading PuTTY

- Google “Putty”, and then download the PuTTY application to your computer.

PuTTY is a free, open-source tool that will allow us to use the laptop to remotely connect with the Linux OS on the PLCnext controller, and to download various software components onto it. Ultimately, we will download Node-Red onto the PLCnext controller, but a few other applications will need to be downloaded and installed first. PuTTY gives a command line interface that allows us to do all this.



The screenshot shows a web browser window with the URL chiark.greenend.org.uk/~sgtatham/putty/latest.html. The page title is "Download PuTTY: latest release (0.73)". Below the title are navigation links: [Home](#), [FAQ](#), [Feedback](#), [Licence](#), [Updates](#), [Mirrors](#), [Keys](#), [Links](#), [Team](#), and download options: [Stable](#), [Snapshot](#), [Docs](#), [Changes](#), [Wishlist](#). A paragraph states: "This page contains download links for the latest released version of PuTTY. Currently this is 0.73, released on 2019-09-29. When new releases come out, this page will update to contain the latest, so this is a good page to bookmark or link to. Alternatively, here is a [permanent link to the 0.73 release](#)." Another paragraph says: "Release versions of PuTTY are versions we think are reasonably likely to work well. However, they are often not the most up-to-date version of the code available. If you have : [development snapshots](#), to see if the problem has already been fixed in those versions." Below this is a section titled "Package files" with a light green background. It contains the text: "You probably want one of these. They include versions of all the PuTTY utilities. (Not sure whether you want the 32-bit or the 64-bit version? Read the [FAQ entry](#).)" followed by two sections: "MSI ('Windows Installer')" and "Unix source archive".

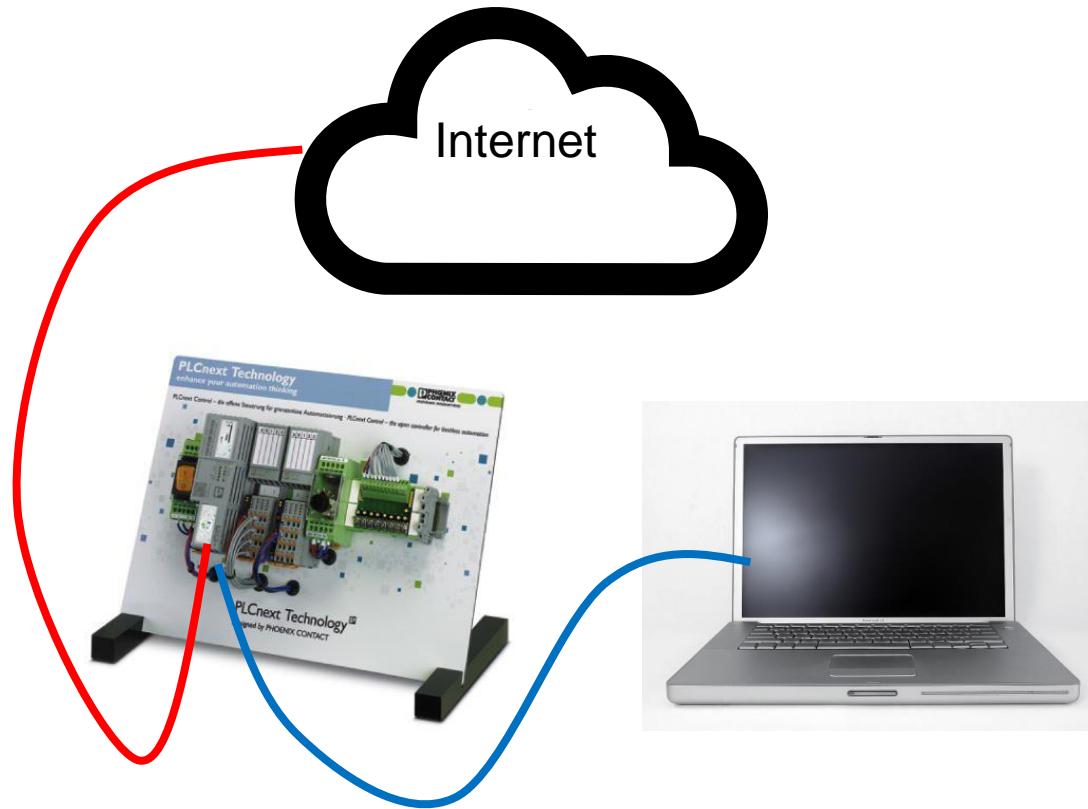
MSI ('Windows Installer')			
32-bit:	putty-0.73-installer.msi	(or by FTP)	(signature)
64-bit:	putty-64bit-0.73-installer.msi	(or by FTP)	(signature)

Unix source archive			
.tar.gz:	putty-0.73.tar.gz	(or by FTP)	(signature)

OPCUA – Installing and using Node-Red on your computer

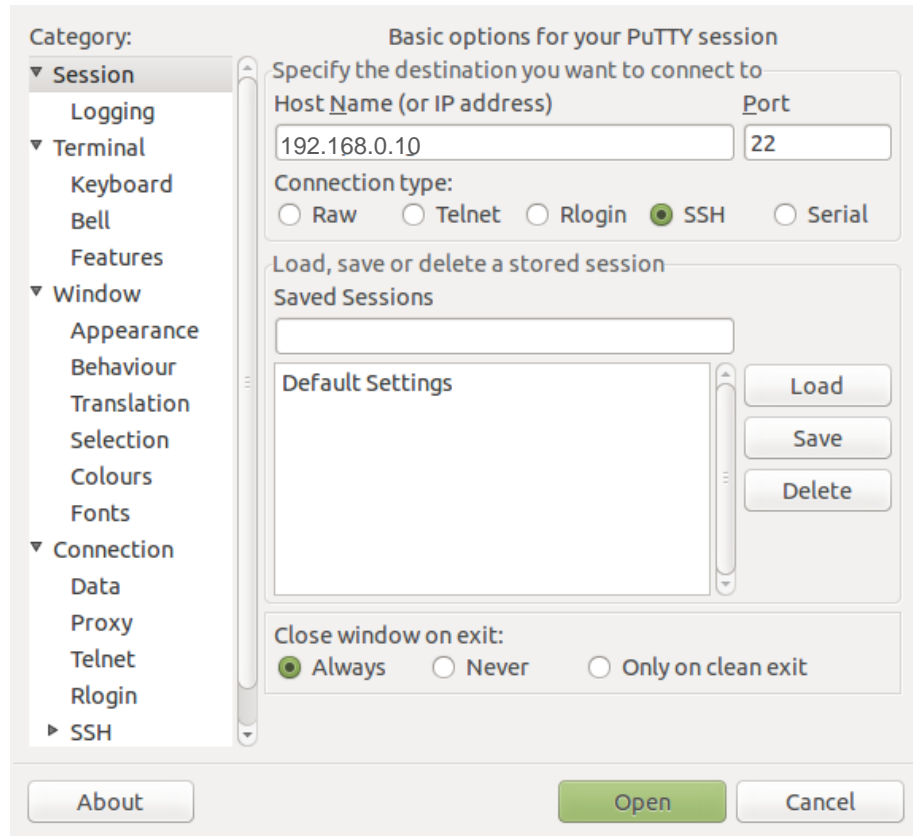
Establishing a connection to the PLCnext Controller via PuTTY

Make sure the PLCnext controller is connected to both the internet (on one Ethernet port), and to your programming PC (on the other Ethernet port).



OPCUA – Installing and using Node-Red on your computer

Using PuTTY

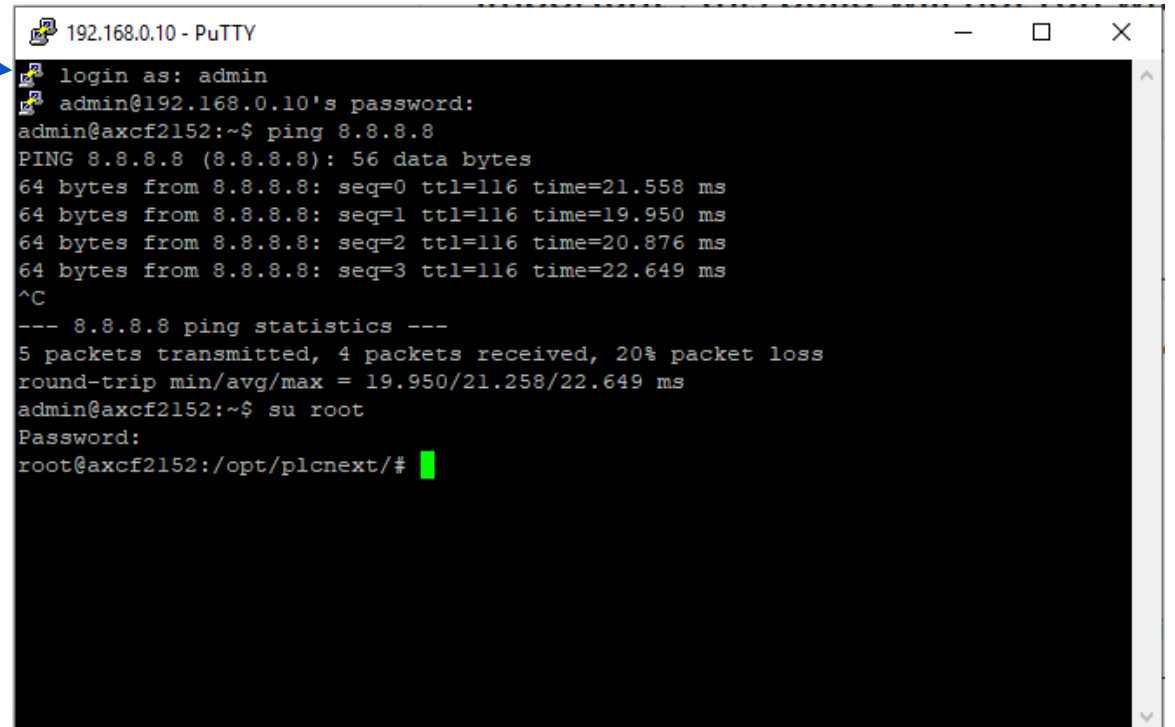


- Open the PuTTY application.
- Type in the IP address of your PLCnext controller, and make sure the port is set to 22. Then click open.

Installing and using Node-Red on the PLCnext Controller

Using PuTTY to install necessary software on the PLCnext Controller

- The top line, to the right, should appear.
- Enter the password from the face of the PLCnext Controller and hit enter.
- Type “ping” and enter
 - You should see successful pinging.
 - Hit Ctrl C to stop pinging
- Type “su root”
 - This will **Switch User** to the Root directory
 - You will be prompted to create a password for the Root account. You will need to enter it three times*...you will not see it as you type it, so type carefully, and **WRITE IT DOWN WHERE YOU WILL NOT LOSE IT!**
 - PuTTY is now prepared to accept the commands you will find on Github’s PLCnext USA page.



```
192.168.0.10 - PuTTY
login as: admin
admin@192.168.0.10's password:
admin@axcf2152:~$ ping 8.8.8.8
PING 8.8.8.8 (8.8.8.8): 56 data bytes
64 bytes from 8.8.8.8: seq=0 ttl=116 time=21.558 ms
64 bytes from 8.8.8.8: seq=1 ttl=116 time=19.950 ms
64 bytes from 8.8.8.8: seq=2 ttl=116 time=20.876 ms
64 bytes from 8.8.8.8: seq=3 ttl=116 time=22.649 ms
^C
--- 8.8.8.8 ping statistics ---
5 packets transmitted, 4 packets received, 20% packet loss
round-trip min/avg/max = 19.950/21.258/22.649 ms
admin@axcf2152:~$ su root
Password:
root@axcf2152:/opt/plcnext/#
```

* You will only enter the Root password once after the initial creation.

OPCUA – Installing and using Node-Red on your computer

Follow instructions on Github

- Visit the Phoenix Contact USA PLCnext site on Github to download and install the software needed.
- <https://github.com/plcnextusa/node-red>

The screenshot shows the GitHub repository page for `plcnextusa/node-red`. The repository is on the `master` branch. The file list includes `LICENSE` (Initial commit, 4 months ago) and `README.md` (Update README.md, 3 months ago). The README content is as follows:

```
node-red

important : this build will not run without an SD card additional memory, due to Node-Red storage requirements -Minimum 2GB Memory stick for AXC F 2152 (Part# 1043501 or 1061701)

Part 1 - Installation of Balena Engine
https://github.com/PLCnext/Docker\_GettingStarted
```

OPCUA – Installing and using Node-Red on your computer

Follow instructions on Github

- We've already completed steps 1-4 under "Establish the Connections".
- Cut and paste* (or type in) the text string that follows the # on the first line under "Download the Project to the controller"
 - Let it run
- Cut and paste* (or type in) the text string that follows the # on the second line.
- Repeat for each of the two lines under "Install Balena"

*Note: To paste into PuTTY, use Shift Insert, (not CTRL V)

Part 1 - Installation of Balena Engine

https://github.com/PLCnext/Docker_GettingStarted

This is part of a series of articles that demonstrate how to install Balena-engine on PLCnext controller and work with OCI containers. In this article, we will install the Balena-engine and start OCI containers.

Installation

Establish the Connections

1. Connect the AXC F 2152 controller to Internet-Provider and Linux OS via LAN-cable.
2. Start the terminal on Linux OS and establish the SSH-Connection to PLC via command line "ssh admin@192.168.1.10".
3. Change to root via "su -" (root password have to be setup LINK)
4. Make sure your Internet connection is intact, via command-line ping 8.8.8.8

Download the Project to the controller

```
root@axcf2152:~# git clone https://github.com/PLCnext/Docker_GettingStarted.git
root@axcf2152:~# cd Docker_GettingStarted
```

Install Balena

To install balena-engine run the setup.sh

```
root@axcf2152:~# chmod -c 777 setup.sh
root@axcf2152:~# ./setup.sh
```

```

login as: admin
admin@192.168.0.10's password:
admin@axcf2152:~$ su root
Password:
root@axcf2152:/opt/plcnext/# git clone https://github.com/PLCnext/Docker_Getting
Started.git
fatal: destination path 'Docker_GettingStarted' already exists and is not an emp
ty directory.
root@axcf2152:/opt/plcnext/# cd Docker_GettingStarted
root@axcf2152:/opt/plcnext/Docker_GettingStarted# chmod -c 777 setup.sh
root@axcf2152:/opt/plcnext/Docker_GettingStarted# ./setup.sh
gzip: invalid magic
tar: Child returned status 1
tar: Error is not recoverable: exiting now
Installing files...
wget: bad address 'ftp.de.debian.org'
(Reading database ... 16 files and directories currently installed.)
Preparing to unpack cgroupfs-mount_1.1_all.deb ...
/var/lib/dpkg/info/cgroupfs-mount.prerm: line 5: invoke-rc.d: command not found
dpkg: warning: old cgroupfs-mount package pre-removal script subprocess returned error exit status 127
dpkg: trying script from the new package instead ...
/var/lib/dpkg/tmp.ci/prerm: line 5: invoke-rc.d: command not found
dpkg: error processing archive cgroupfs-mount_1.1_all.deb (--install):
 new cgroupfs-mount package pre-removal script subprocess returned error exit status 127
/var/lib/dpkg/info/cgroupfs-mount.postinst: line 6: invoke-rc.d: command not found
dpkg: error while cleaning up:
 installed cgroupfs-mount package post-installation script subprocess returned error exit status 127
Errors were encountered while processing:
 cgroupfs-mount_1.1_all.deb
groupadd: group 'docker' already exists
 System startup links for /etc/init.d/cgroupfs-mount already exist.
/etc/rc5.d/S20cgroupfs-mount: line 25: /lib/lsb/init-functions: No such file or directory
 System startup links for /etc/init.d/balena already exist.
Usage: service docker {start|stop}

Installation successful!


the container engine for the IoT
root@axcf2152:/opt/plcnext/Docker_GettingStarted#

```

Note the successful installation of Balena, which is a prerequisite for loading Node.js and Node-Red onto the PLCnext Controller

Follow instructions on Github

- Copy the text to the right of the # from the Github page

Part 2 - Installation of node-red container

Install node-red from the official node-red container hub

<https://hub.docker.com/r/nodered/node-red>

```
root@axcf2152:~# balena-engine run -it -p 1880:1880 --network=host --privileged --name=mynodered nodered/node-
```

This command will install and create your container which will run with the balena-engine from boot by default, and if your unit is connected to the internet so should be Node-Red, allowing to install any contribution you desire from the interface

Now you can start and stop your Node_red container anytime by using the following commands.

```
root@axcf2152:~# balena-engine start mynodered  
root@axcf2152:~# balena-engine stop mynodered
```

```
balena-engine run -it -p 1880:1880 --network=host --privileged --name=mynodered nodered/node-red
```

OPCUA – Installing and using Node-Red on your computer

Paste the Node-Red installation instruction into PuTTY

- Paste it into the PuTTY program, using Shift-insert to paste.
- Hit enter and wait for Node Red to load.

```
192.168.0.10 - PuTTY
login as: admin
admin@192.168.0.10's password:
admin@axcf2152:~$ ping 8.8.8.8
PING 8.8.8.8 (8.8.8.8): 56 data bytes
64 bytes from 8.8.8.8: seq=0 ttl=116 time=21.558 ms
64 bytes from 8.8.8.8: seq=1 ttl=116 time=19.950 ms
64 bytes from 8.8.8.8: seq=2 ttl=116 time=20.876 ms
64 bytes from 8.8.8.8: seq=3 ttl=116 time=22.649 ms
^C
--- 8.8.8.8 ping statistics ---
5 packets transmitted, 4 packets received, 20% packet loss
round-trip min/avg/max = 19.950/21.258/22.649 ms
admin@axcf2152:~$ su root
Password:
root@axcf2152:/opt/plcnex/# ping www.google.com
PING www.google.com (172.217.4.196): 56 data bytes
64 bytes from 172.217.4.196: seq=0 ttl=115 time=20.874 ms
64 bytes from 172.217.4.196: seq=1 ttl=115 time=21.475 ms
64 bytes from 172.217.4.196: seq=2 ttl=115 time=21.265 ms
64 bytes from 172.217.4.196: seq=3 ttl=115 time=21.038 ms
^C
--- www.google.com ping statistics ---
4 packets transmitted, 4 packets received, 0% packet loss
round-trip min/avg/max = 20.874/21.163/21.475 ms
root@axcf2152:/opt/plcnex/# balena-engine start mynodered
mynodered
root@axcf2152:/opt/plcnex/#
root@axcf2152:/opt/plcnex/# balena-engine run -it -p 1880:1880 --network=host --privileged --name=mynodered nodered/node-red
```

```
balena-engine run -it -p 1880:1880 --network=host --privileged --name=mynodered nodered/node-red
```

OPCUA – Installing and using Node-Red on your computer

Follow instructions on Github

- Copy the text to the right of the # from the Github page
- Paste it into PuTTY, again, using Shift-insert to paste.
- Hit enter and wait a minute or two for the software to run.

Now you can start and stop your Node_red container anytime by using the following commands.

```
root@axcf2152:~# balena-engine start mynodered  
root@axcf2152:~# balena-engine stop mynodered
```

balena-engine start mynodered

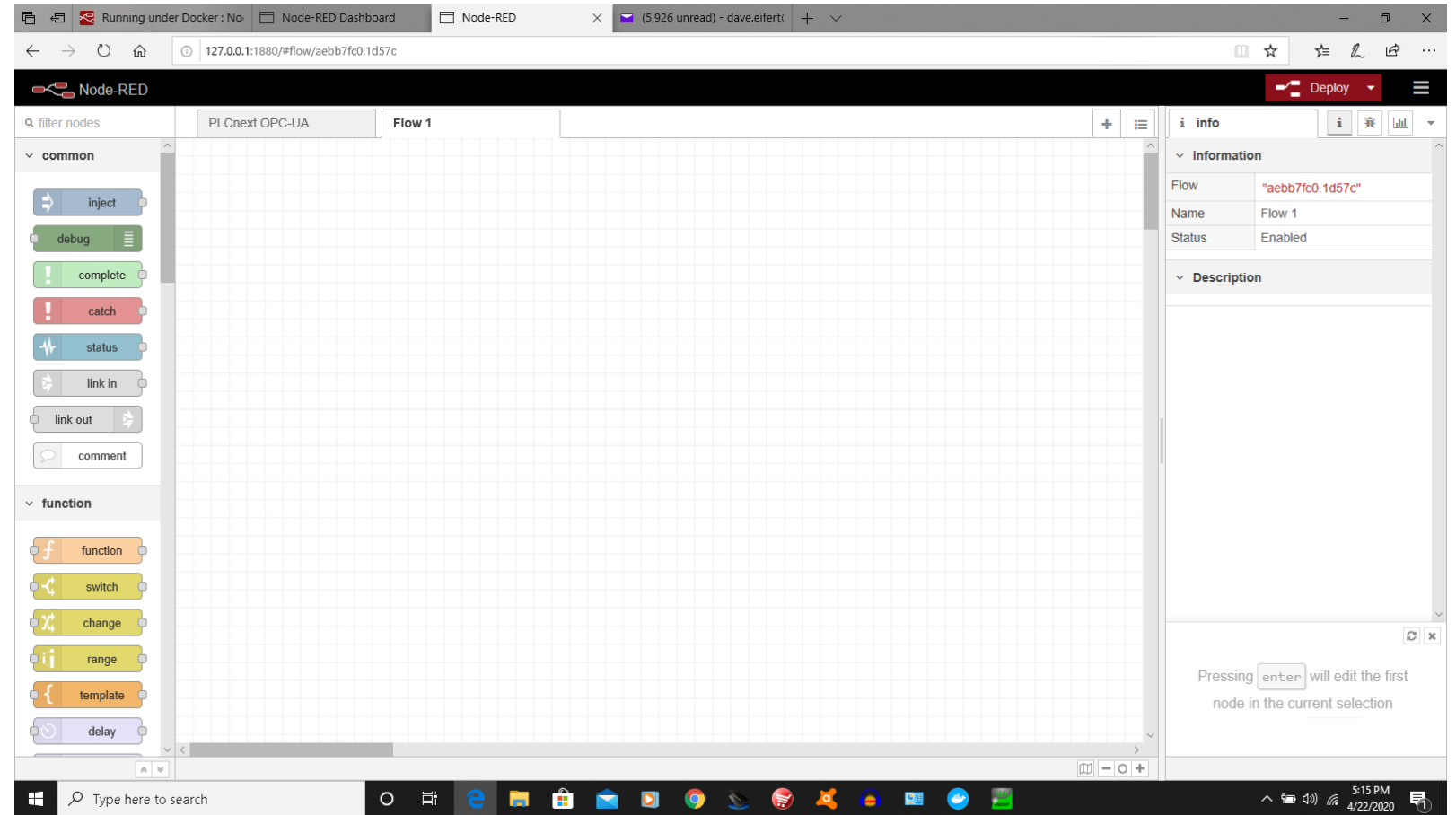
OPCUA – Installing and using Node-Red on the PLCnext Controller

“Opening” Node Red

- Enter the PLCnext Controller’s IP address in your computer’s browser, followed by a colon and “1880”

Not secure | 192.168.0.10:1880/

- From this point, you operate in the same way as you did when Node-Red was hosted on the computer, rather than on the PLCnext Controller.
- Review slides 19-29 of this presentation.



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