Welcome

PLCnext Technology
Part 3
Getting started with OPC - UA

PHOENIX CONTACT
INSPIRING INNOVATIONS

PLCnext Technology

Part 3

Getting started with OPC-UA

Node-RED

PHOENIX CONTACT
INSPIRING INNOVATIONS

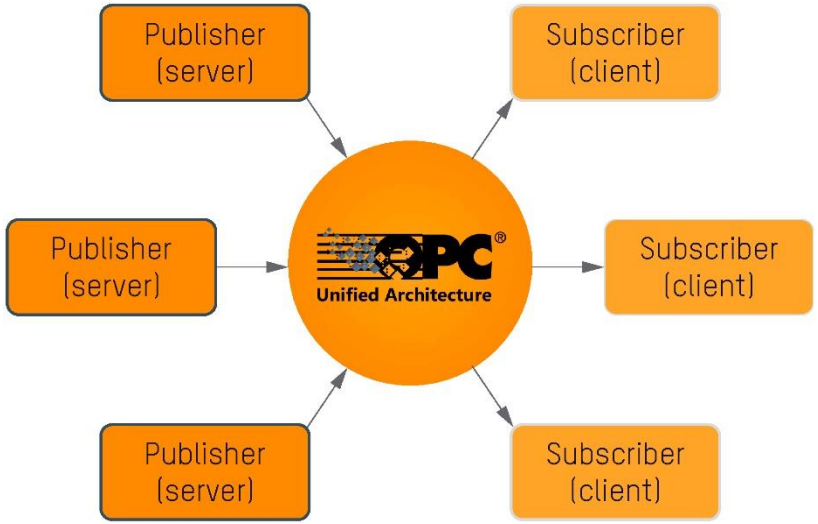
This training assumes you have completed Part 1 of this training series: “Intro To Programming PLCnext IEC611-31” Alternatively, if you have created another program that is currently available, that could be used with this training.

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

PHOENIX CONTACT
INSPIRING INNOVATIONS

Definitions

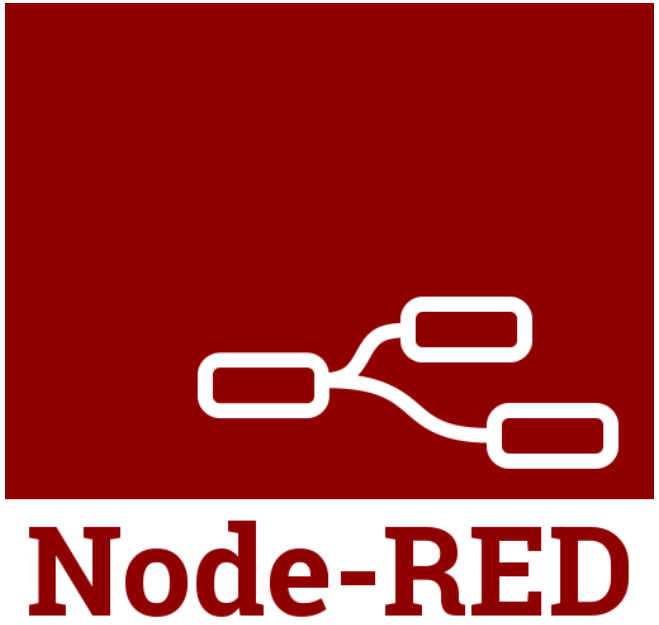
- What is OPC-UA?
  - It is a machine-to-machine communications protocol.
    - OPC = OLE for Process Control
    - OLE = Object Linking and Embedding
    - UA = Unified Architecture
    - It is an encrypted, secure protocol with options for deterministic performance. It is a big part of IOT. Developed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



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.



Additional Resources

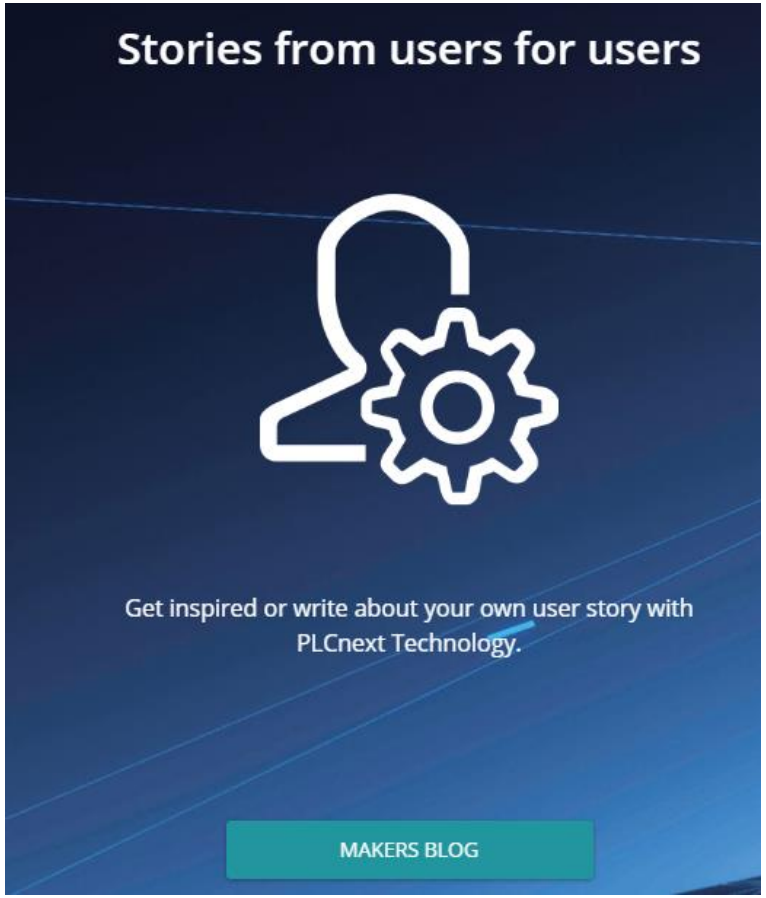
Phoenix Contact PLCnext-Community:

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

- Rajvir_Singh_PLCnext_OPC_UAExpert_Video

- Rajvir_Singh_PLCnext_OPCUA_Node_Red

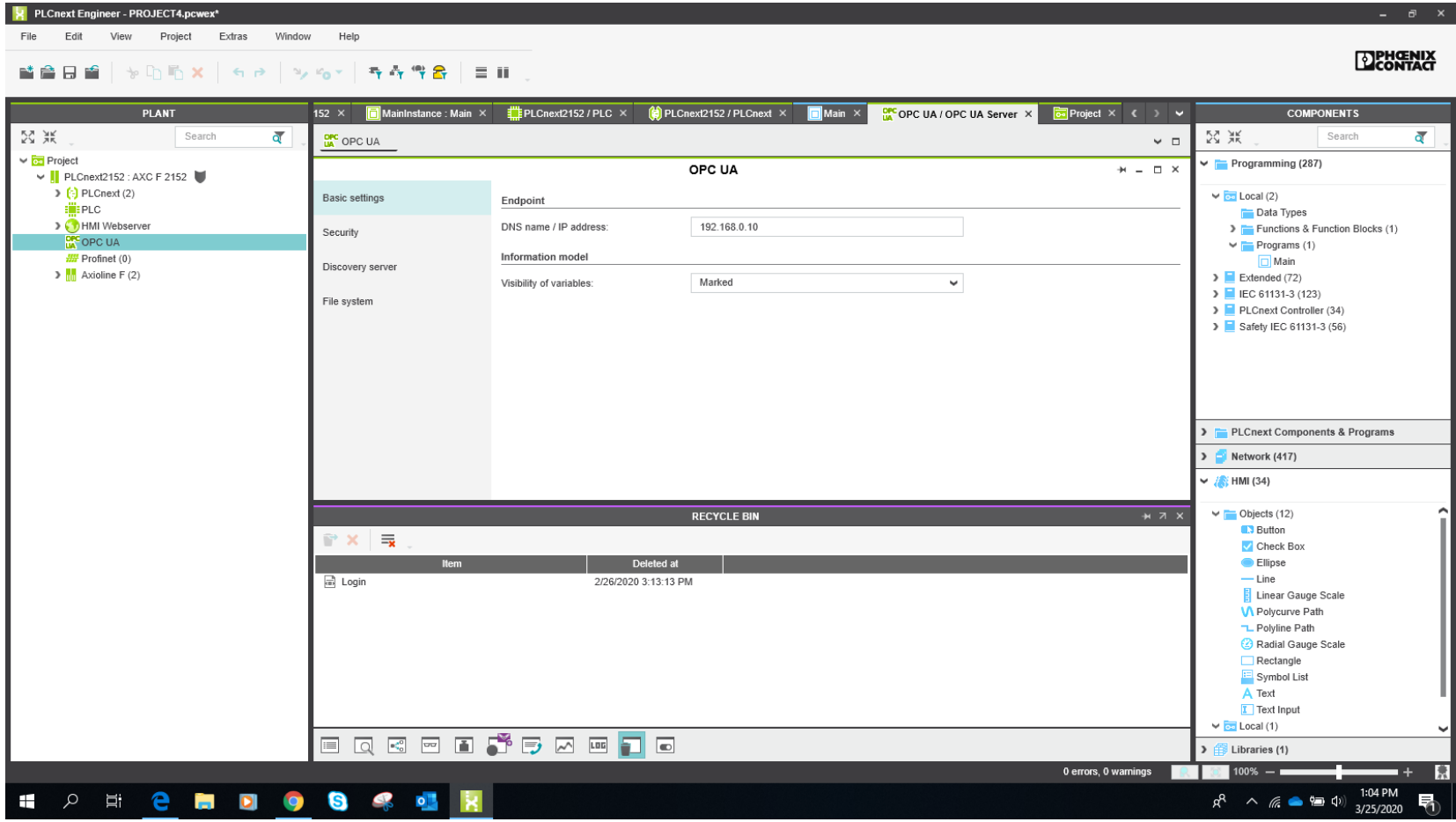
Continue through *this* training presentation now. If you get stuck, check out the resources listed above to supplement this training presentation. It may help fill in any unintentional gaps you might encounter.



PHOENIX CONTACT
INSPIRING INNOVATIONS

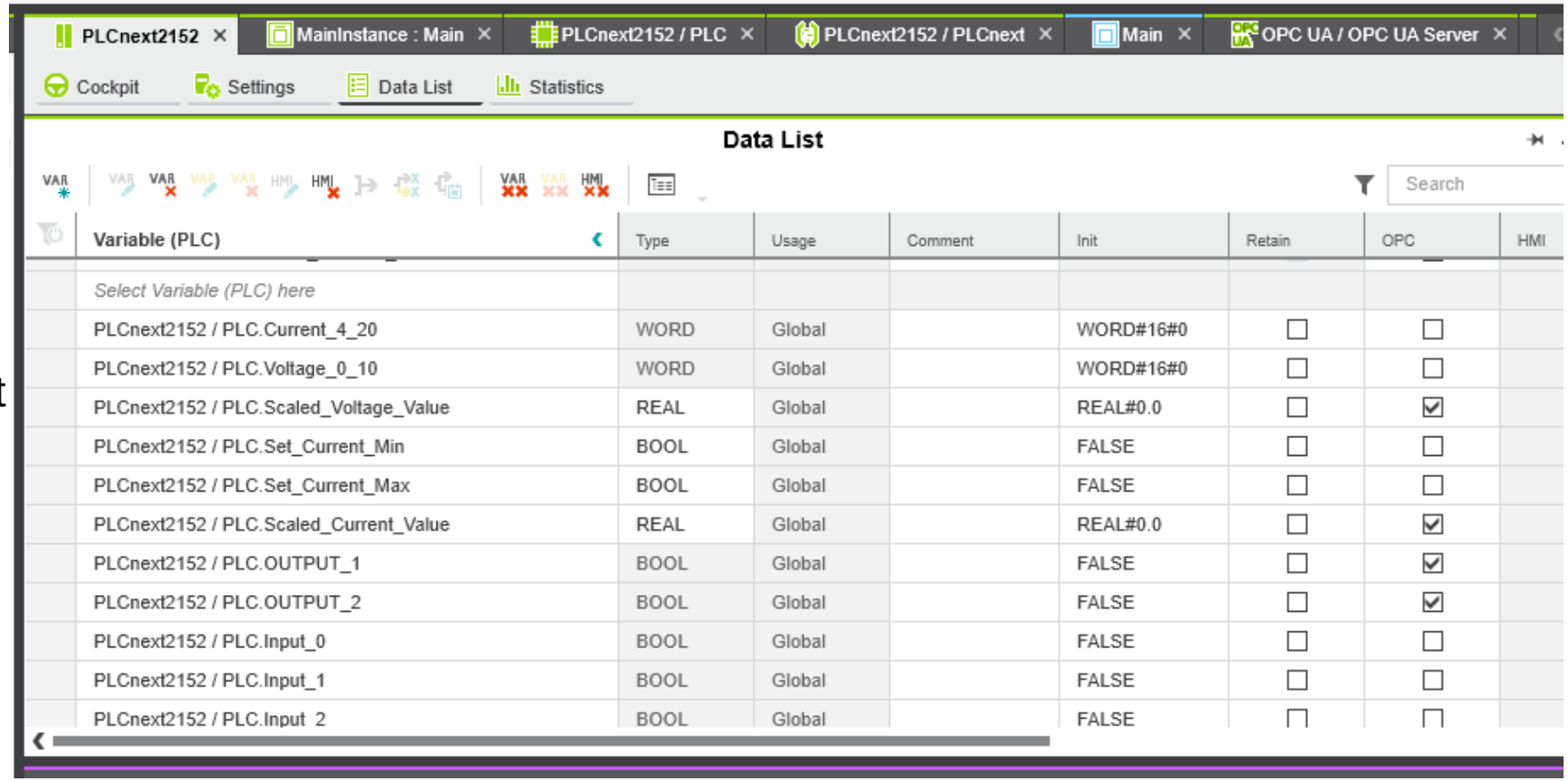
Initial configuration steps – in PLCnext Engineer software

- 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



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



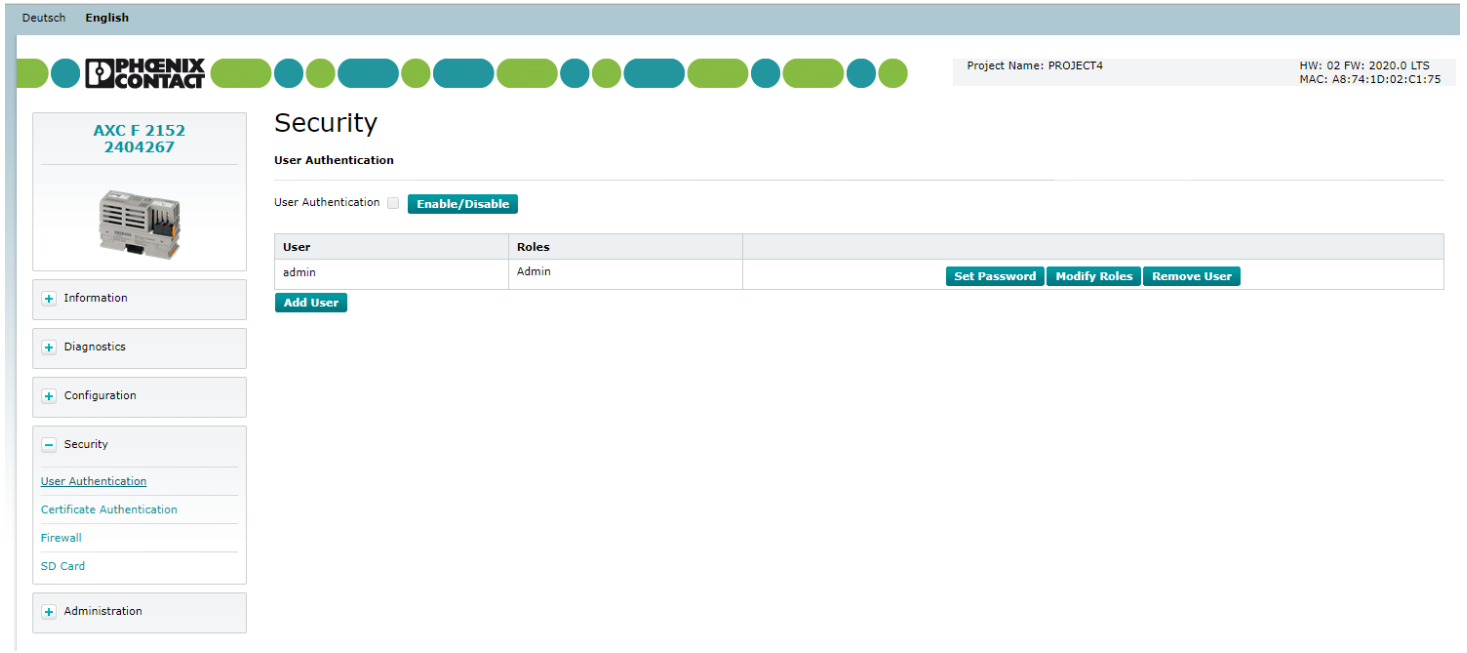
Variable (PLC)	Type	Usage	Comment	Init	Retain	OPC	HMI
Select Variable (PLC) here							
PLCnext2152 / PLC.Current_4_20	WORD	Global		WORD#16#0	☐	☐	
PLCnext2152 / PLC.Voltage_0_10	WORD	Global		WORD#16#0	☐	☐	
PLCnext2152 / PLC.Scaled_Voltage_Value	REAL	Global		REAL#0.0	☐	☑	
PLCnext2152 / PLC.Set_Current_Min	BOOL	Global		FALSE	☐	☐	
PLCnext2152 / PLC.Set_Current_Max	BOOL	Global		FALSE	☐	☐	
PLCnext2152 / PLC.Scaled_Current_Value	REAL	Global		REAL#0.0	☐	☑	
PLCnext2152 / PLC.OUTPUT_1	BOOL	Global		FALSE	☐	☑	
PLCnext2152 / PLC.OUTPUT_2	BOOL	Global		FALSE	☐	☑	
PLCnext2152 / PLC.Input_0	BOOL	Global		FALSE	☐	☐	
PLCnext2152 / PLC.Input_1	BOOL	Global		FALSE	☐	☐	
PLCnext2152 / PLC.Input_2	BOOL	Global		FALSE	☐	☐	

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.



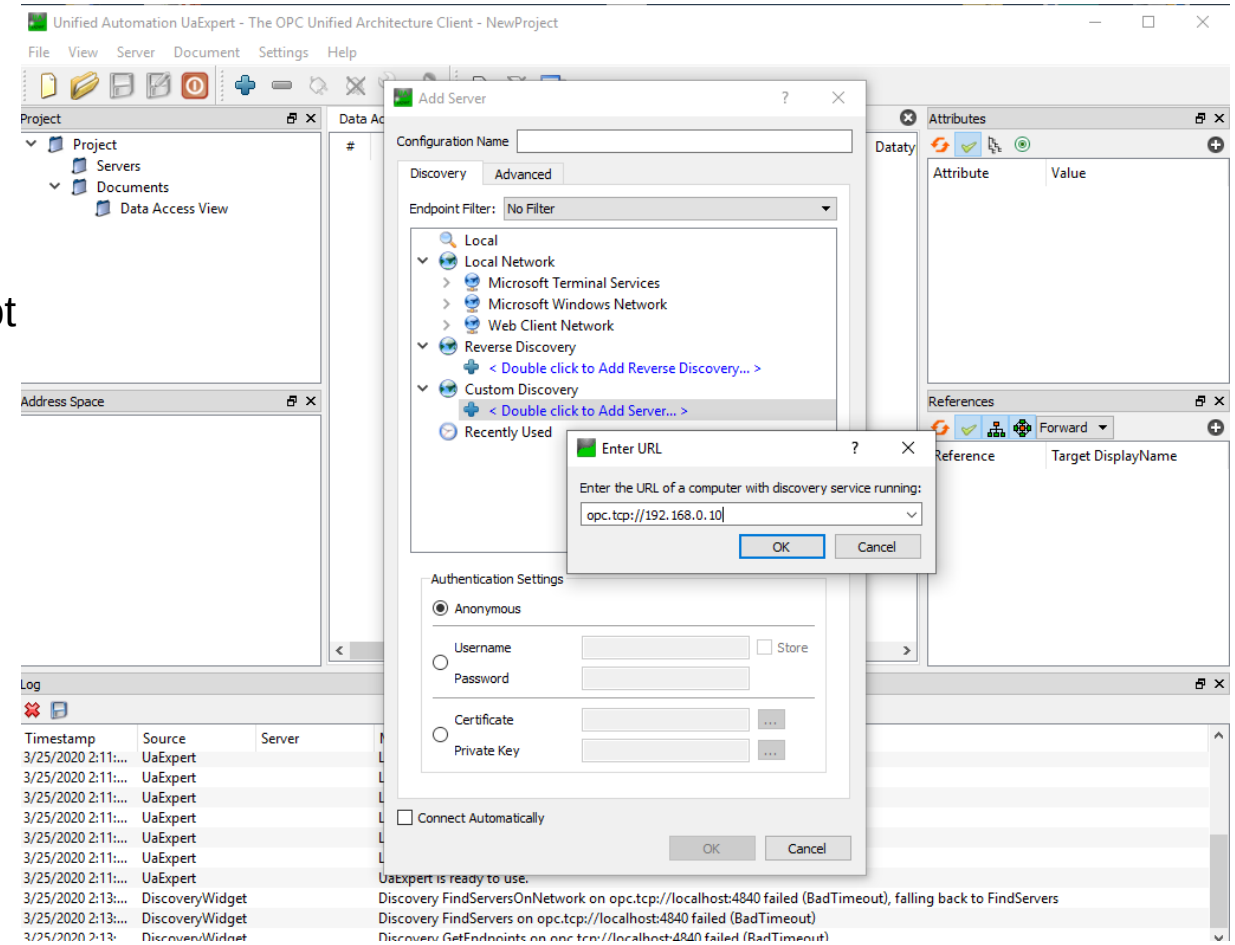
PHOENIX CONTACT
INSPIRING INNOVATIONS

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.



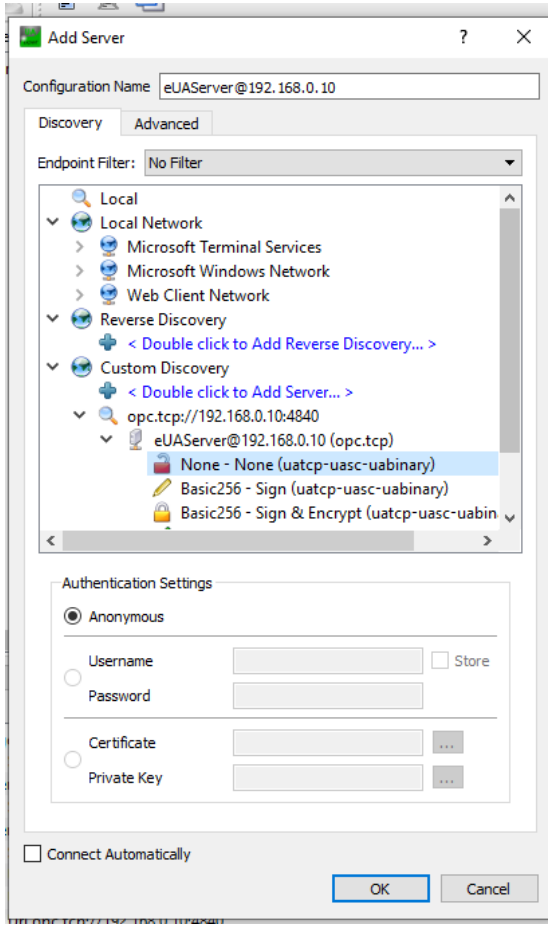
PHOENIX CONTACT
INSPIRING INNOVATIONS

Setting up an OPCUA Client - UAExpert

The new server will appear under “Custom Discovery”

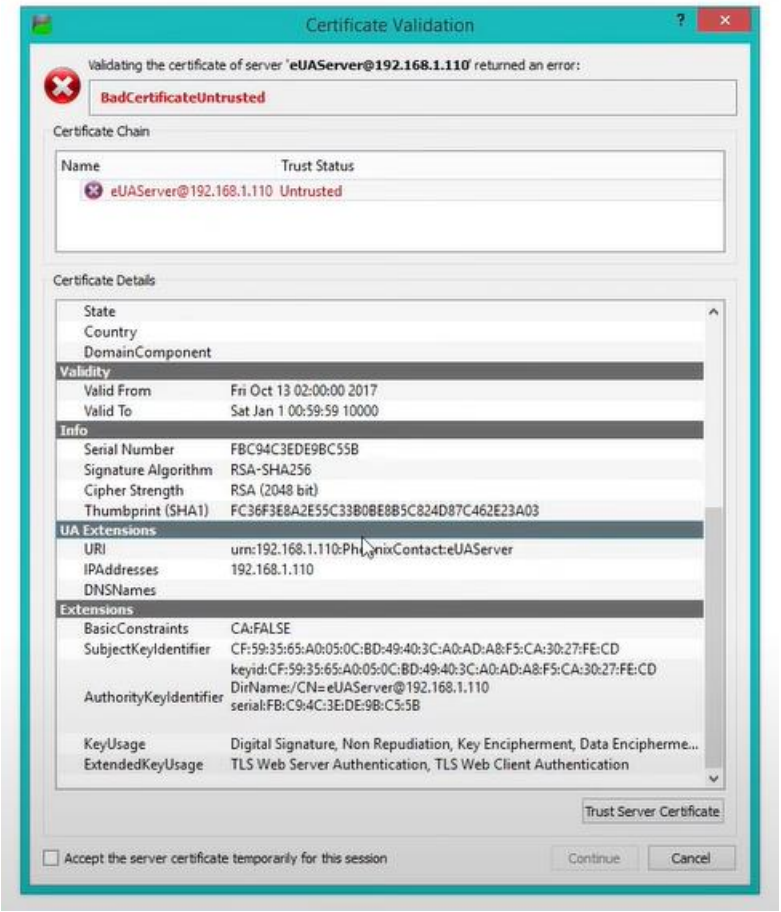
Under “eUAServer@192.168.0.10 (opc.tcp)

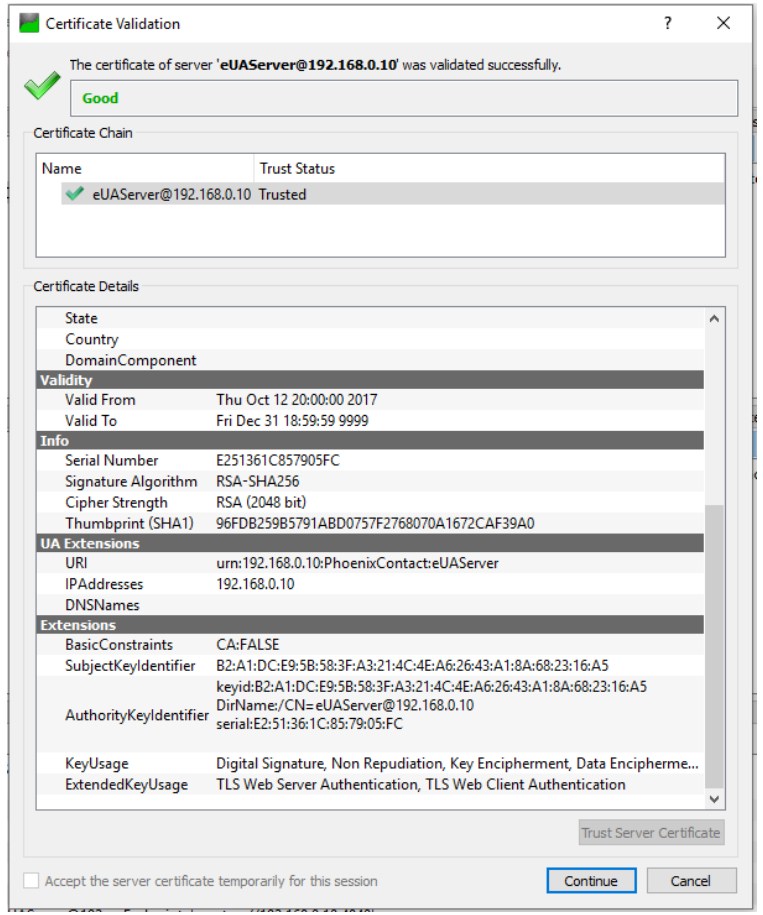
- Click on one of the security settings. We have set up NONE on the PLCnext controller – for demo purposes, to make things easy. For actual applications, you’d want to have security enabled.
- This will prompt a certificate error.
- Click “Trust server certificate” to resolve. (see next slide)



Setting up and OPCUA client - UAExpert

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

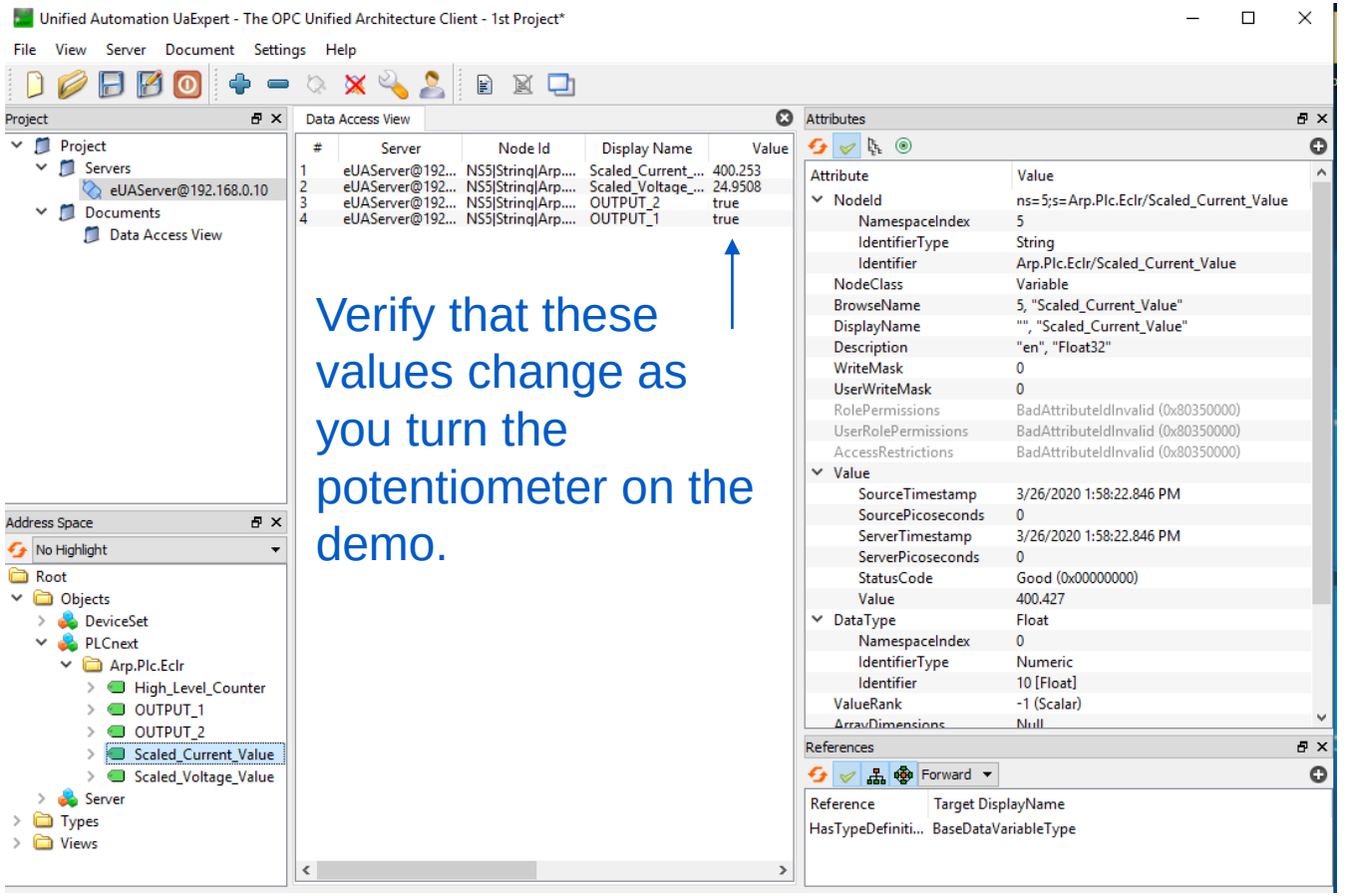




PHOENIX CONTACT
INSPIRING INNOVATIONS

Working with an OPCUA client - UAExpert

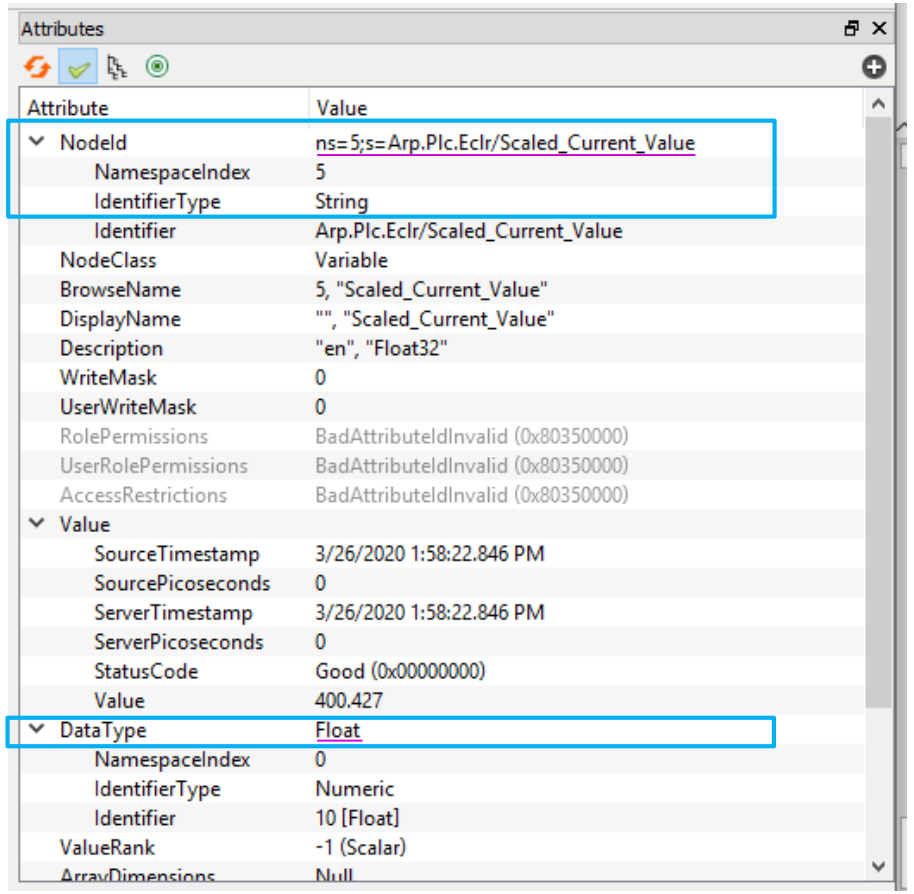
- Once you have opened a new project in UA Expert, find “PLC next” under the “Objects” folder under the “Root” directory in the bottom/left window.
- Expand the tree under “PLC next” and you will see the variables that you designated in PLCnext Engineer
- Drag and drop any or all of these variables into 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.



PHOENIX CONTACT
INSPIRING INNOVATIONS

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



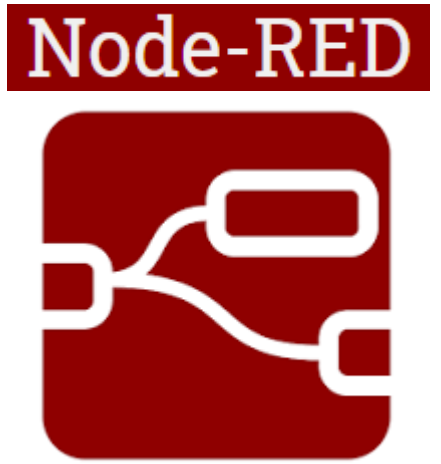
- The format of this information will look as below – when you type it into Node Red:

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

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

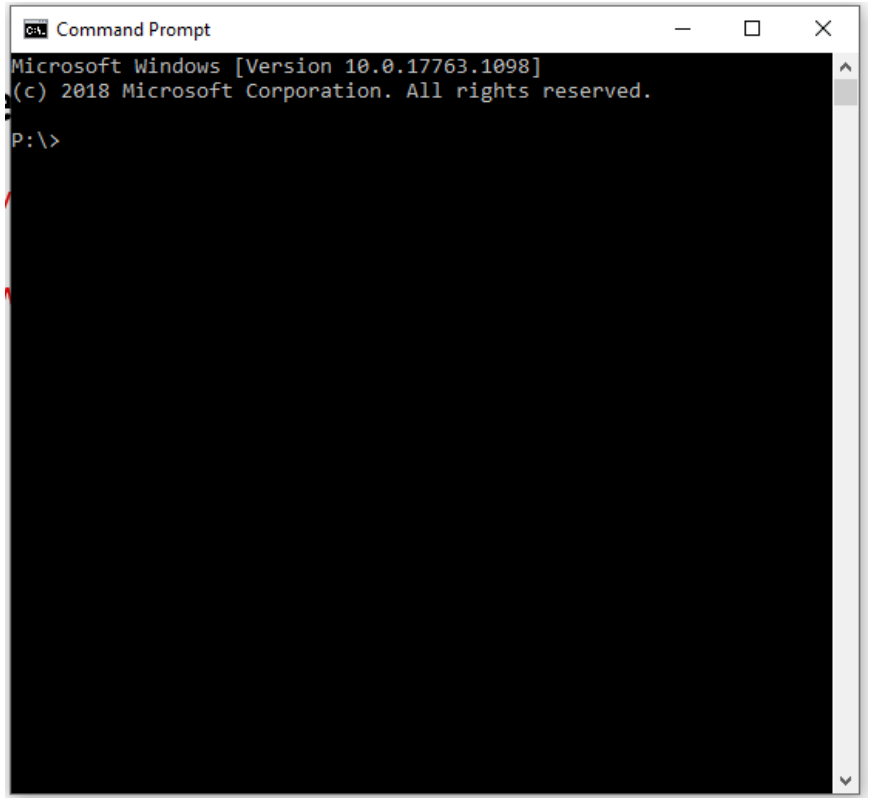
It provides a browser-based editor that makes it easy to wire together flows using the wide range of nodes in the palette that can be deployed to its runtime in a single-click.

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.

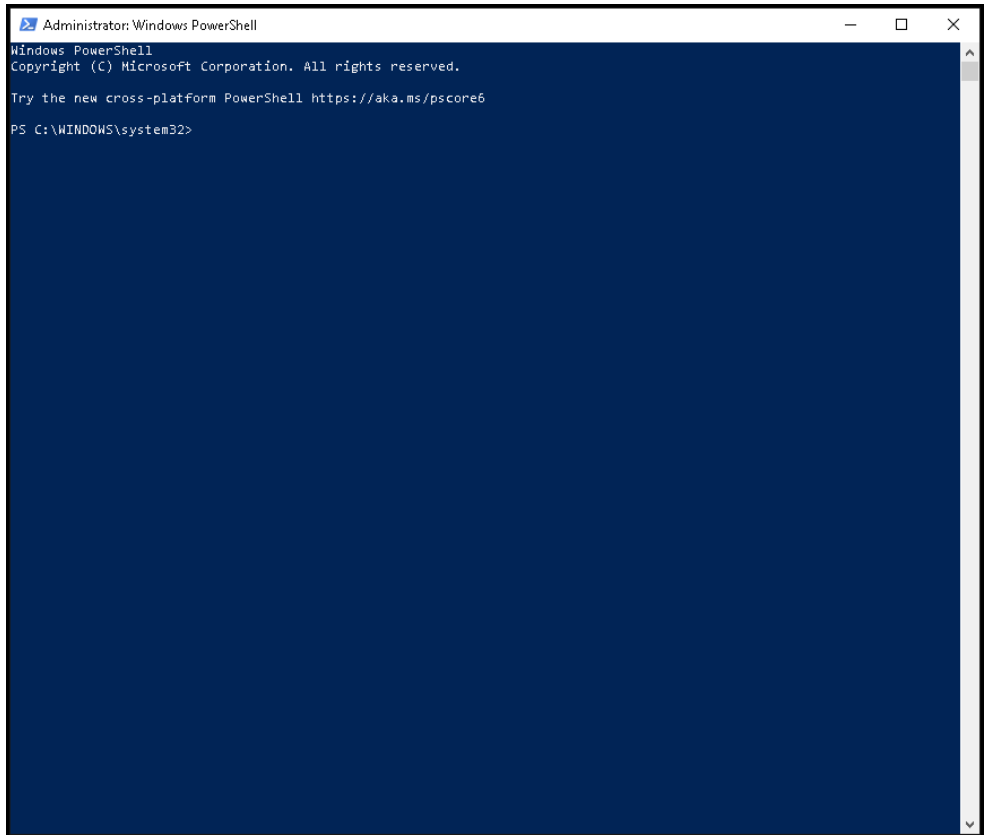
If you are not comfortable in this world… stop here.



Installing Node Red - prerequisites

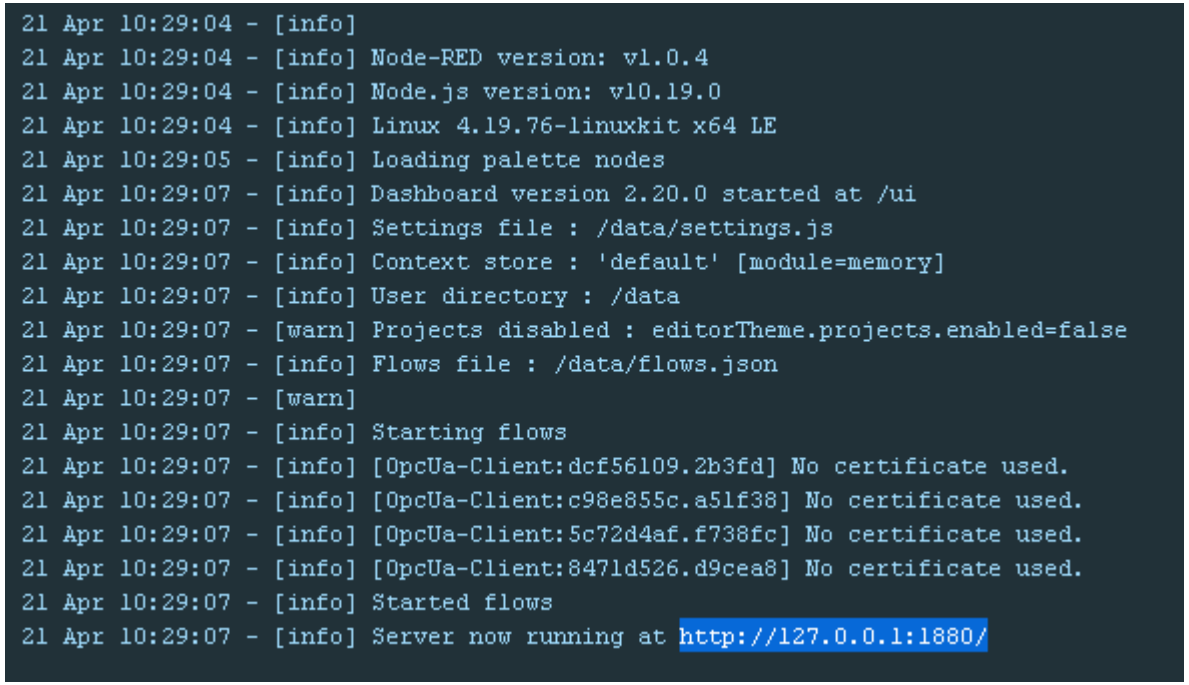
- Check Nodered.org for instructions on downloading and installing Node Red on a Windows PC.
- Or consult a YouTube video for help doing this.
  - How to install Node-Red on Windows (by electronhacks)
  - How to install Node-Red in Windows (by BD Life Hacks tv)

- 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.



“Opening” Node Red

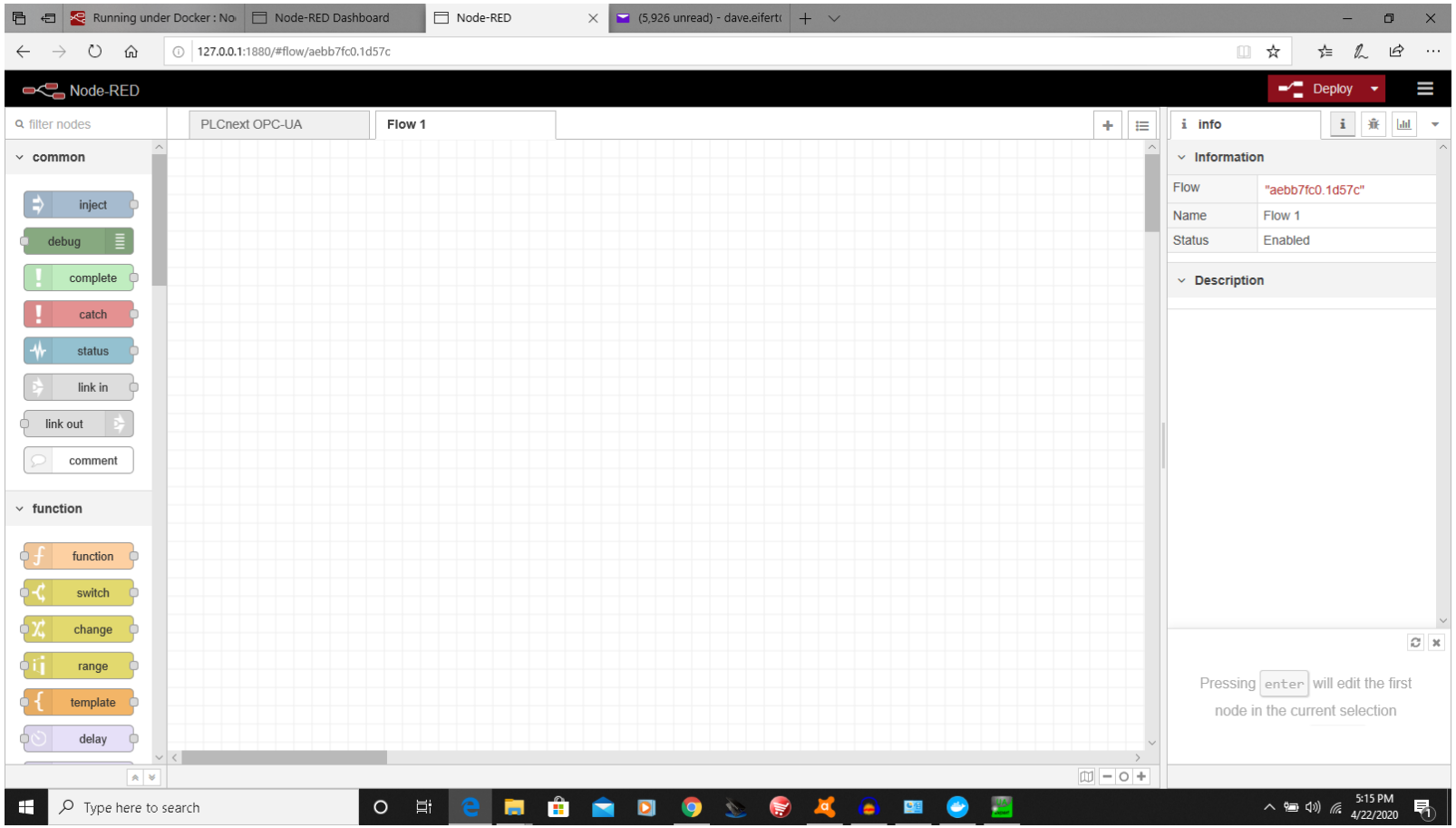
- Node Red is not a program or application that is opened in a traditional way
- Instead copy the information that you discover by starting Node Red in Powershell (or Command Prompt). I have highlighted the information that you will be looking for, so you can copy it.
- Open a browser and paste the contents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



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.

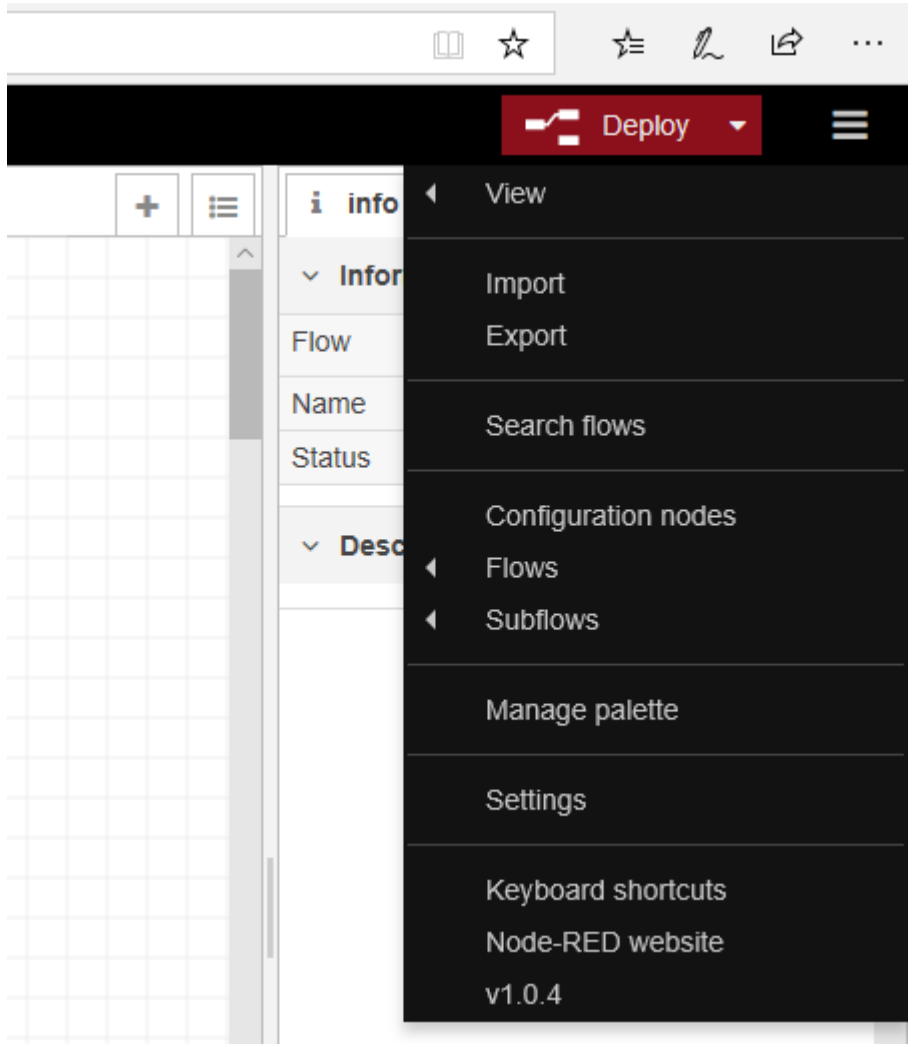


PHOENIX CONTACT
INSPIRING INNOVATIONS

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”



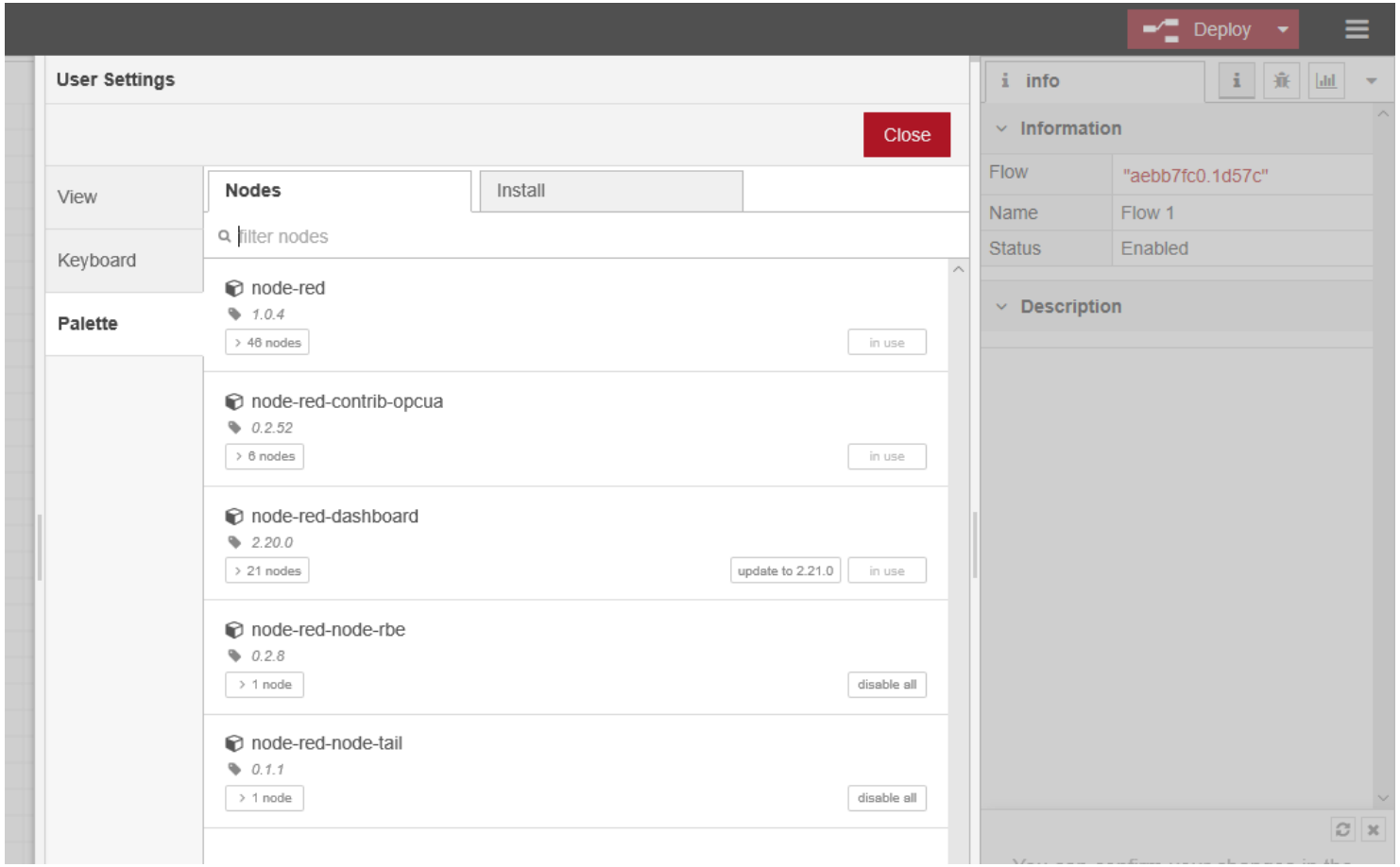
PHOENIX CONTACT
INSPIRING INNOVATIONS

Bringing OPCUA nodes into Node Red

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

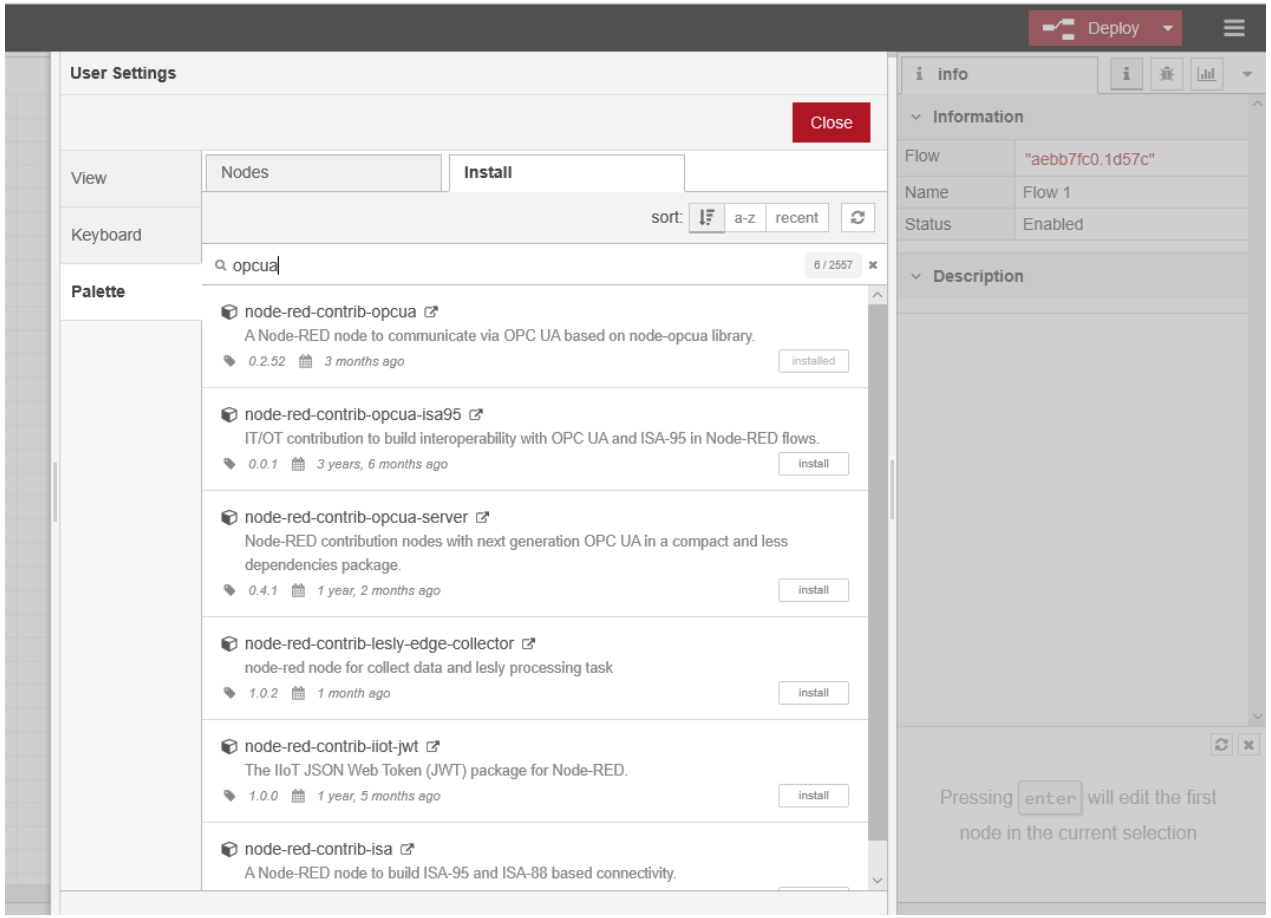
You will see the installed palettes that are already in Node Red (either by default, or because you have previously imported them).

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



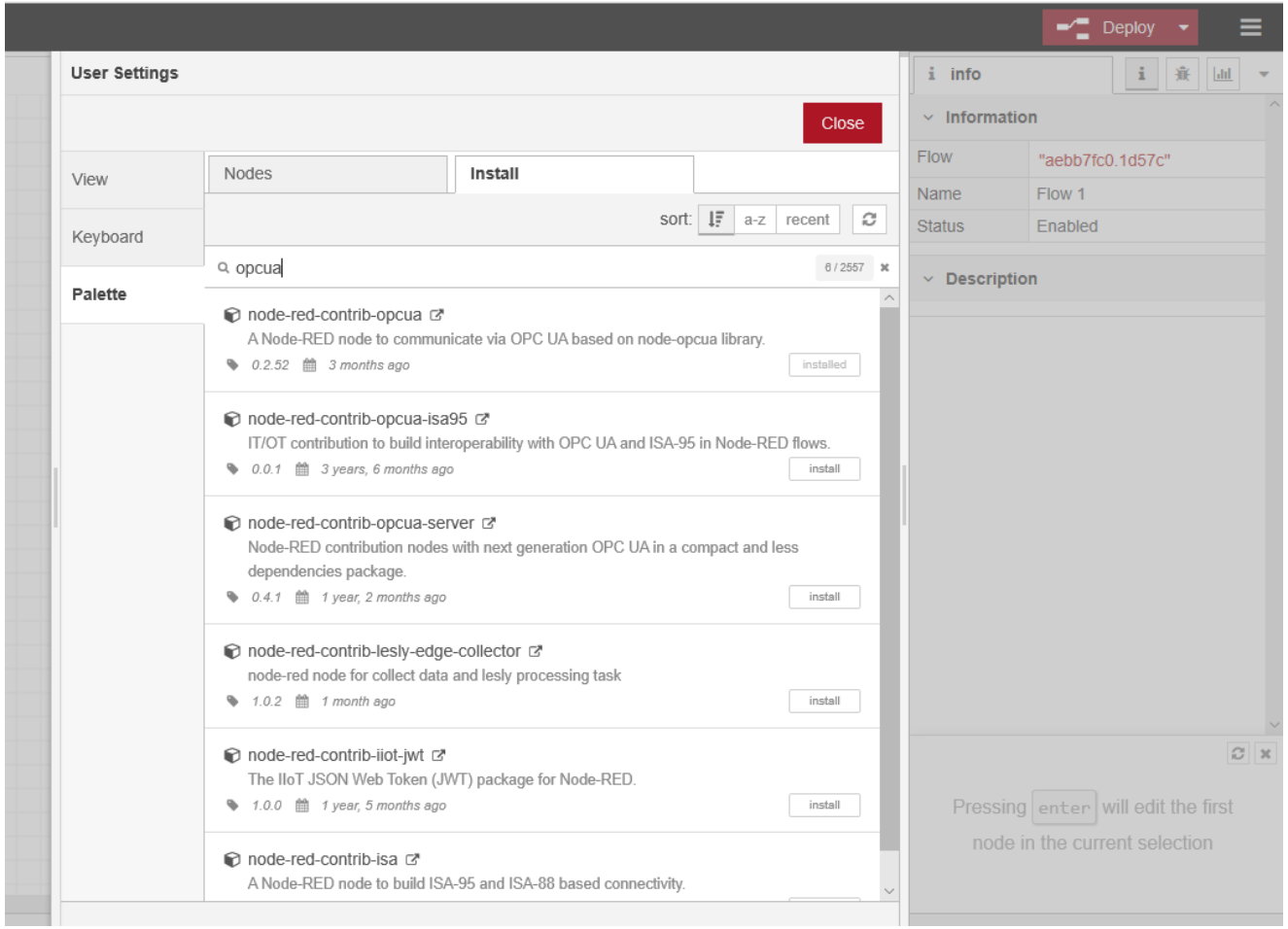
Bringing OPCUA nodes into Node Red

- 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



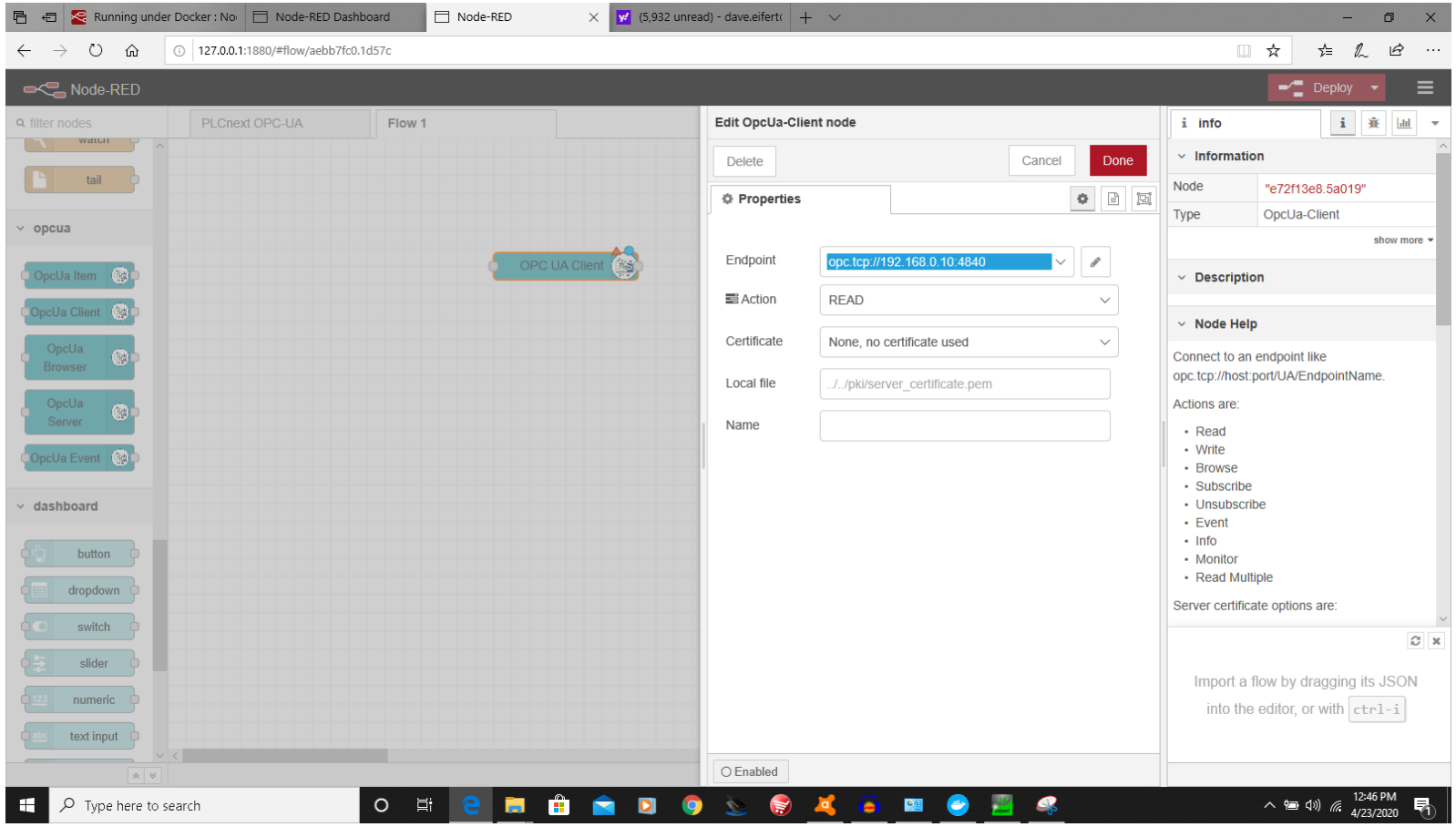
Bringing OPCUA nodes into Node Red

- 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



Creating flows in Node Red

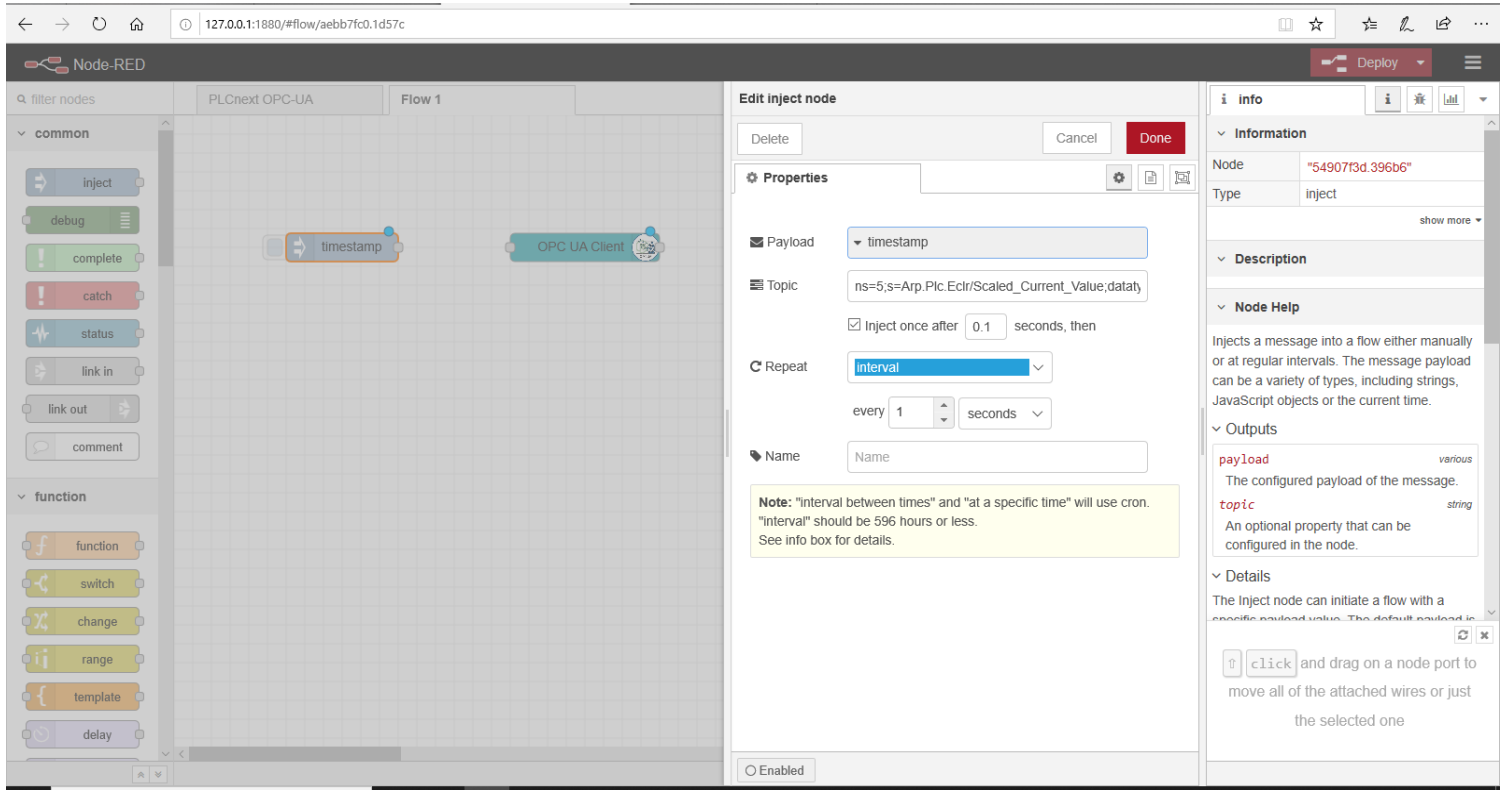
- Scroll down the palette on the left until you see the “OPC UA Client” node.
- Drag and drop it onto the flow sheet.
- Double click on the new node, and an Edit box will appear.
- Enter the same information as you used in UAExpert:
  - Opc.tcp://ip_address:4840
  - (the IP address is the IP address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



PHOENIX CONTACT
INSPIRING INNOVATIONS

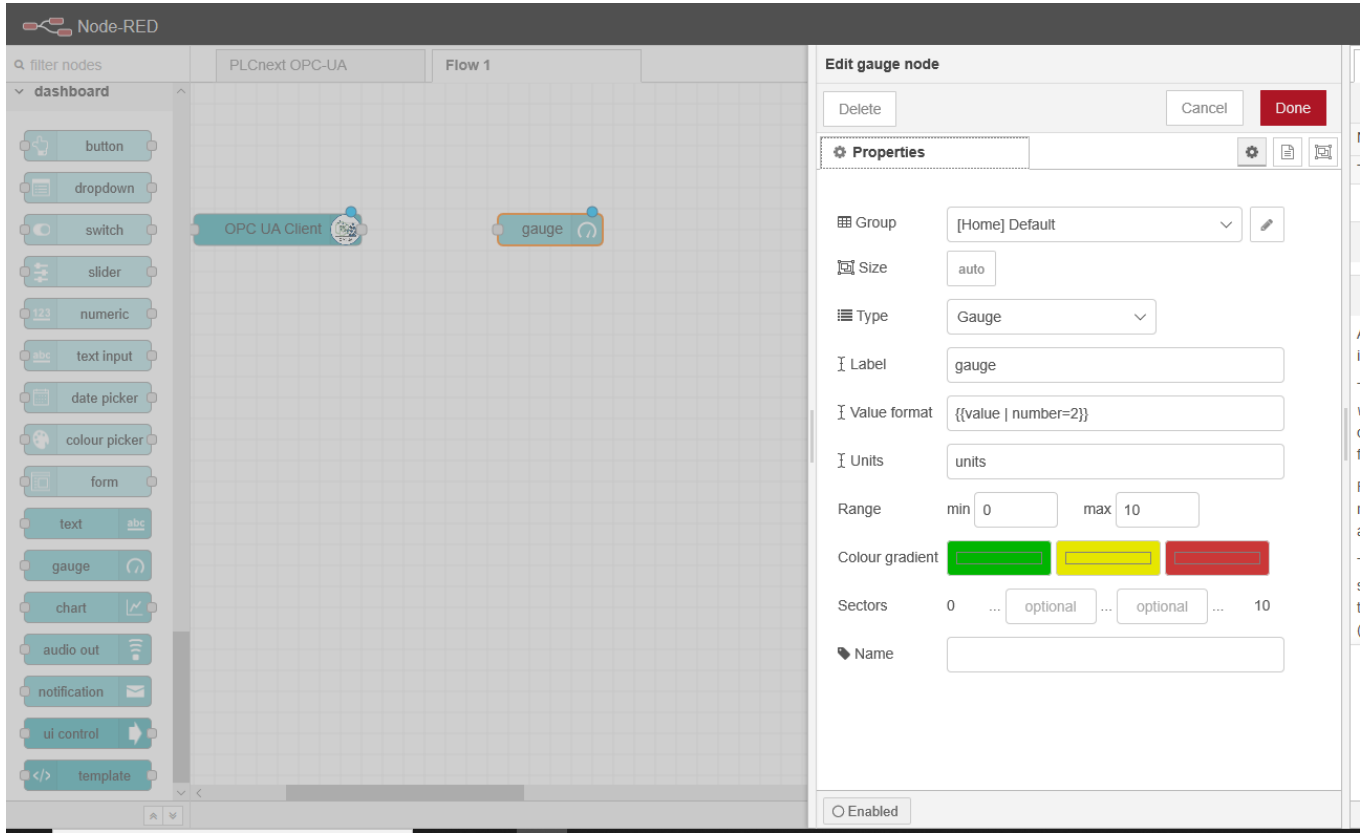
Creating flows in Node Red

- 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.



Creating flows in Node Red

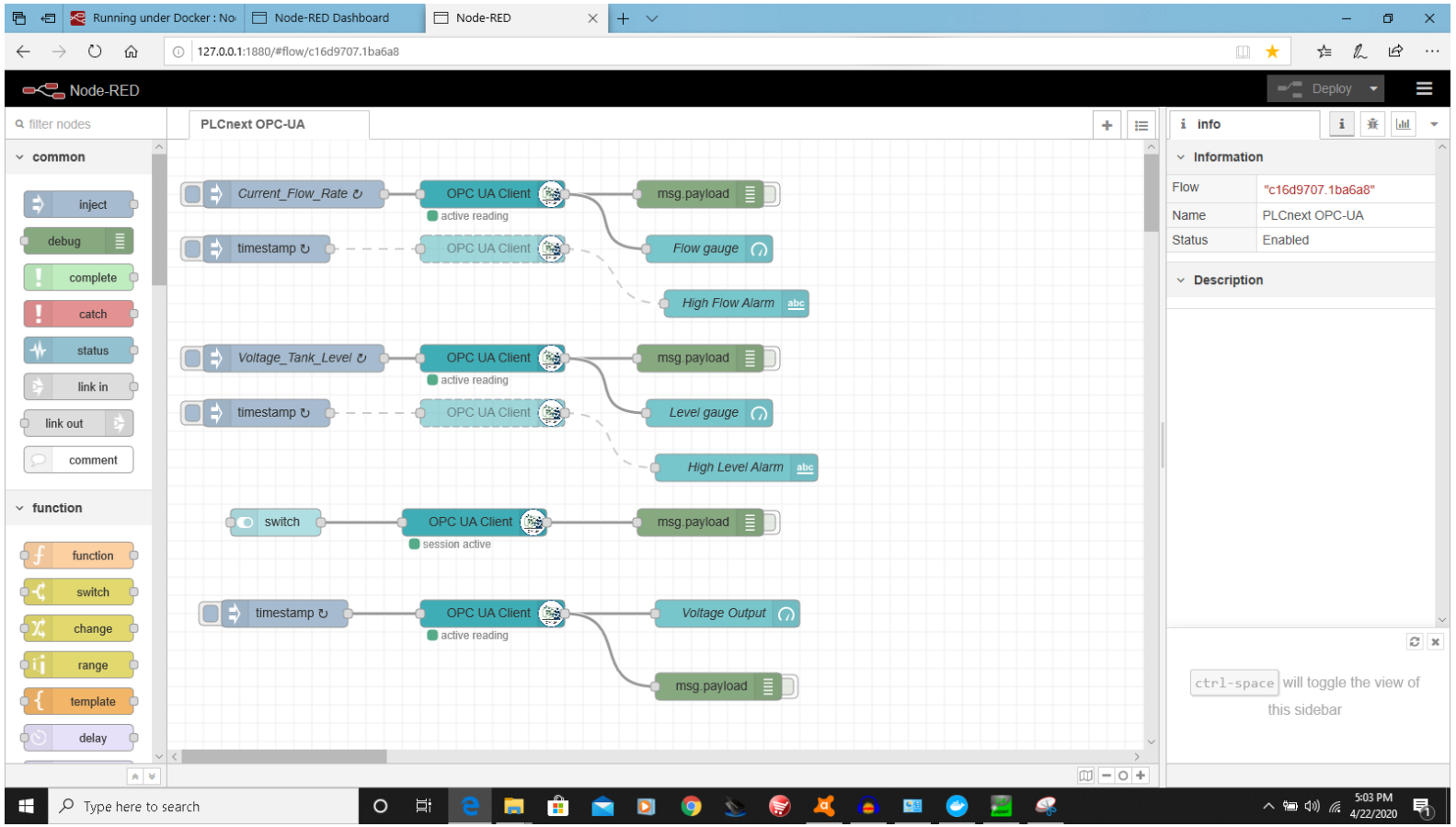
- Scroll to the bottom of the palette. If you imported the dashboard nodes, there will be a dashboard section. One of the nodes will be a gauge.
- Drag and drop the gauge, then double click it to edit it.
- Note the change I made to the “value format”. This is to limit the significant digits after the 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

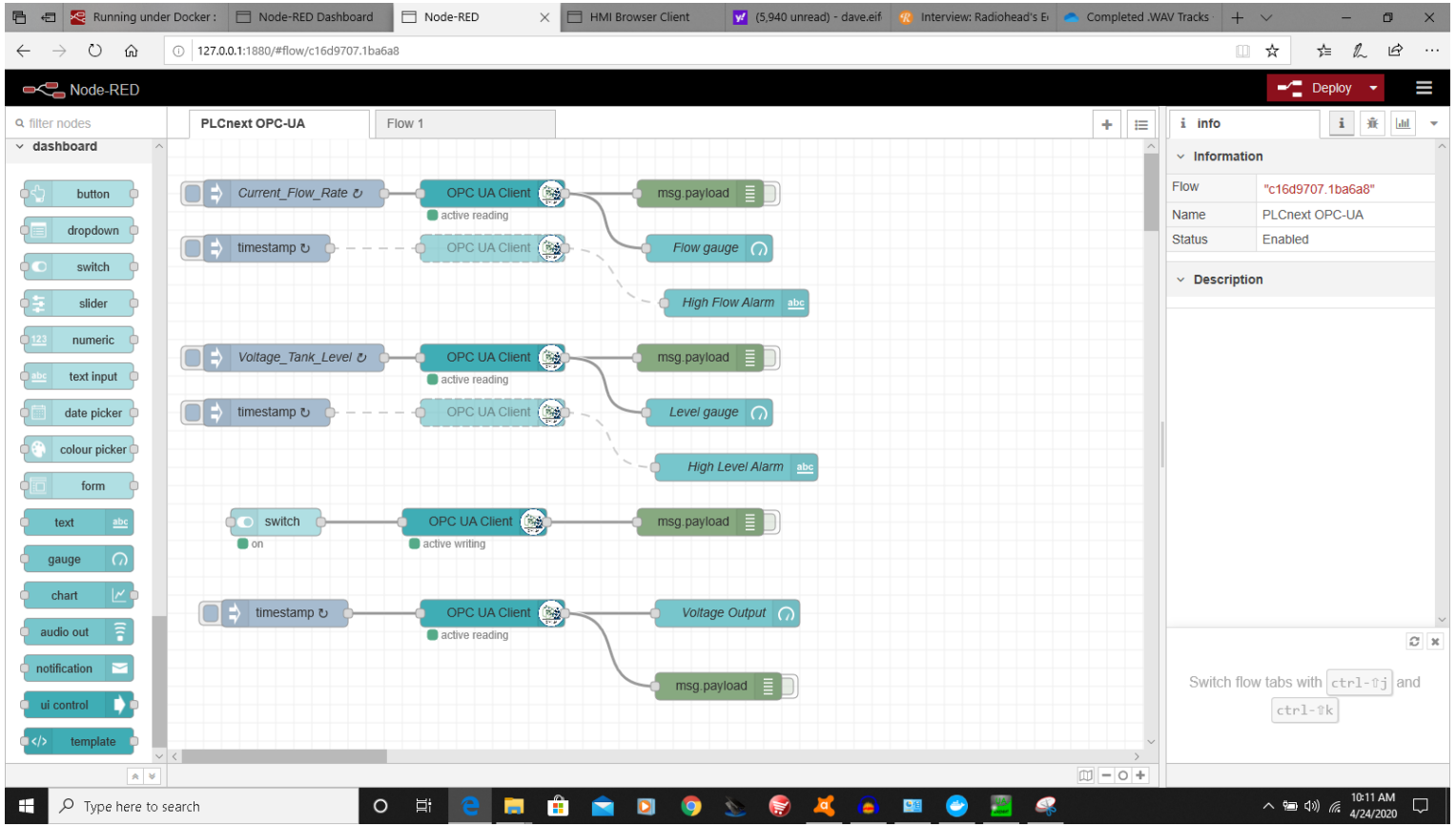
- Connect the nodes together by clicking on the dot on one node and dragging a line to the other node.
- I have added more nodes and associated the “inject” nodes in each flow with a different variable.
- Note the switch will write a value to the PLCnext controller – to turn on an output.
- The flows 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).



PHOENIX CONTACT
INSPIRING INNOVATIONS

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



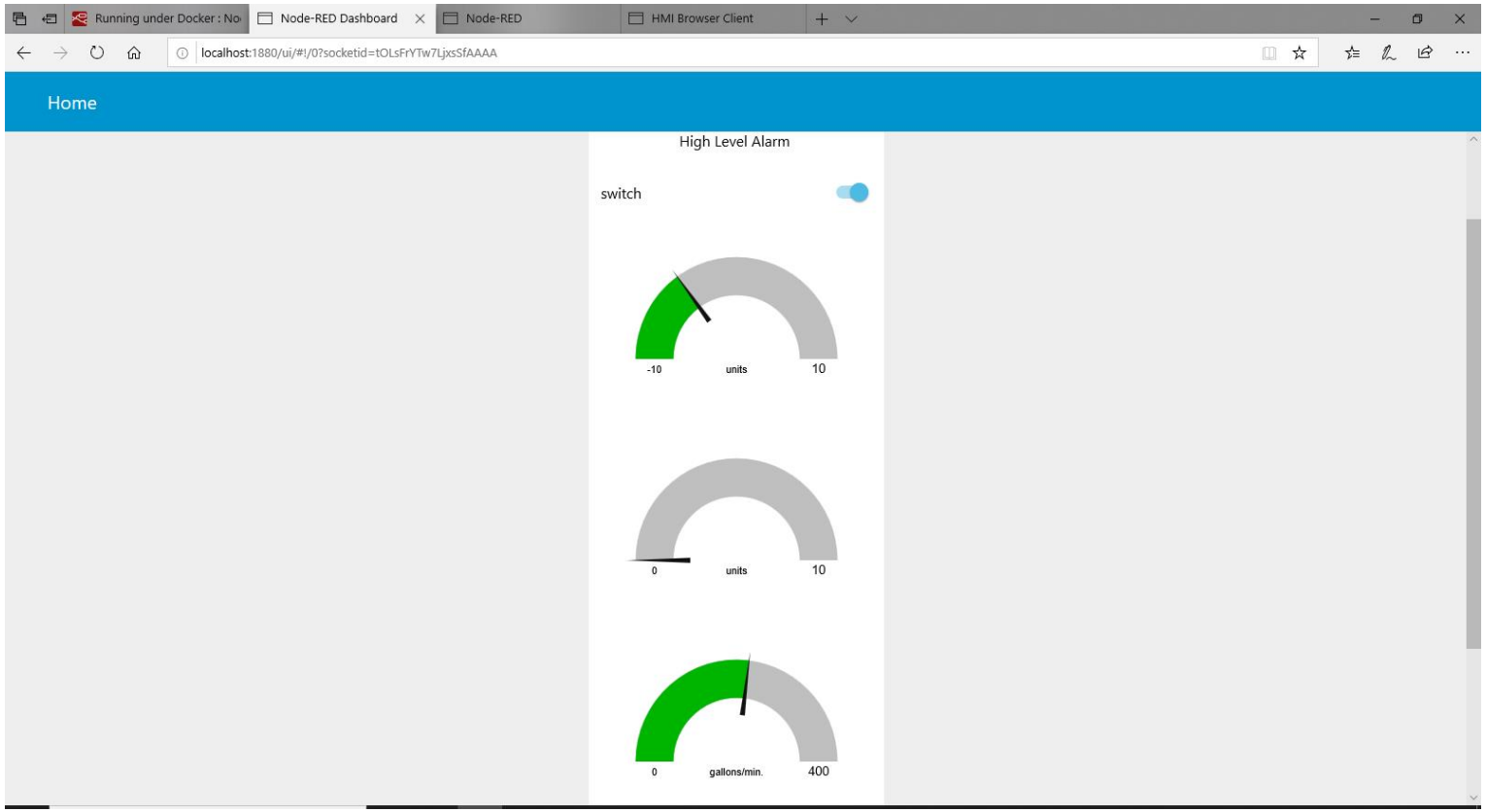
PHOENIX CONTACT
INSPIRING INNOVATIONS

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

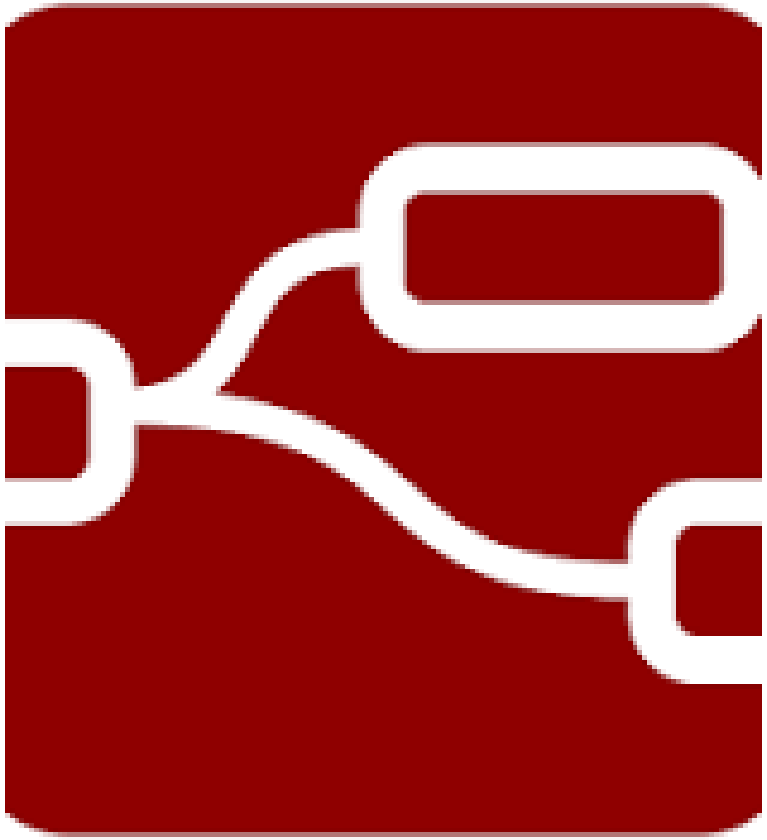
The dashboard should be displayed. Turn the knob on the potentiometer, and the gauge should respond (with a one second delay as we entered).



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.



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**

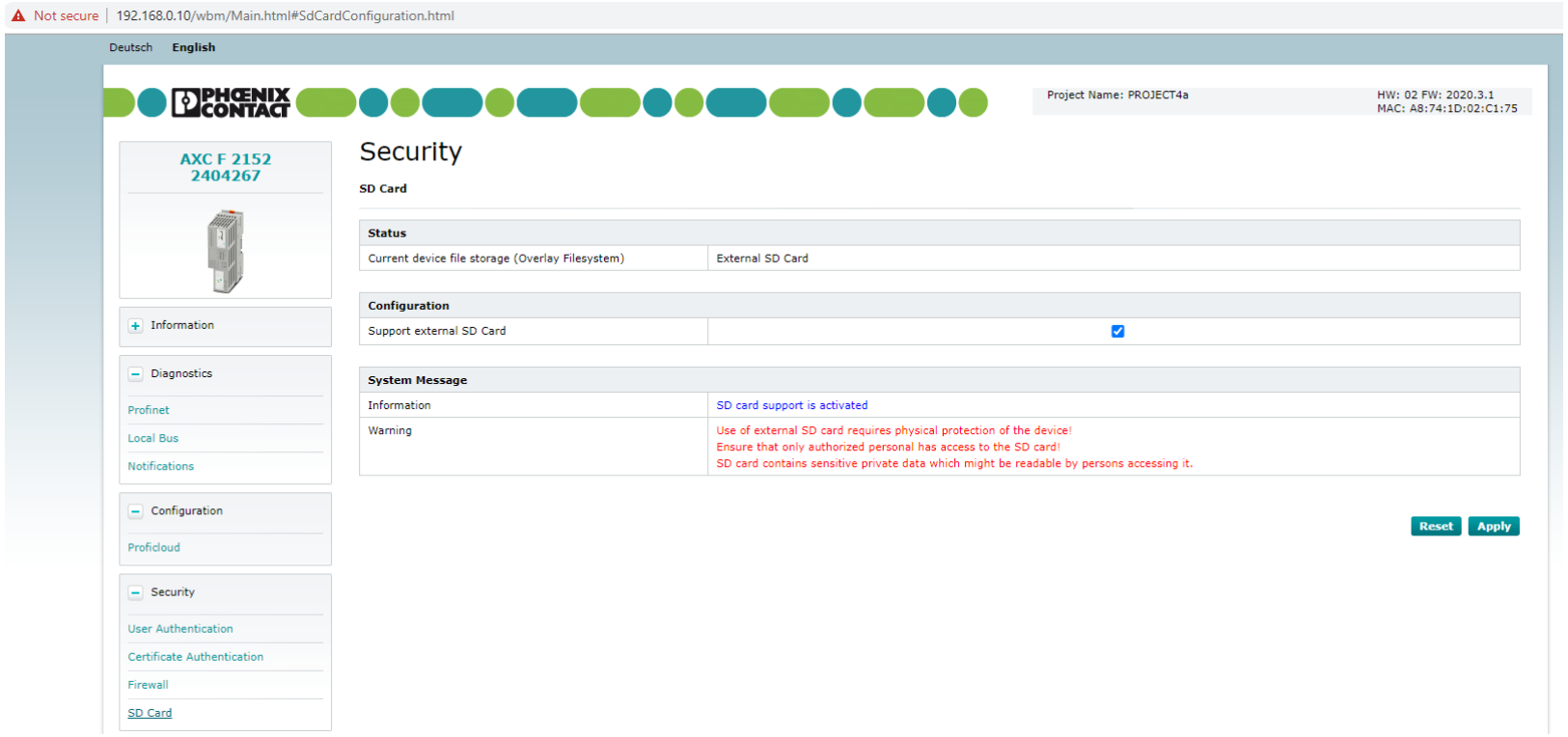
- **important : Node Red will not run without an SD card additional memory, due to Node-Red storage requirements - Minimum 2GB SD card for AXC F 2152 (Part# 1043501 or 1061701)**

PHOENIX CONTACT
INSPIRING INNOVATIONS

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.

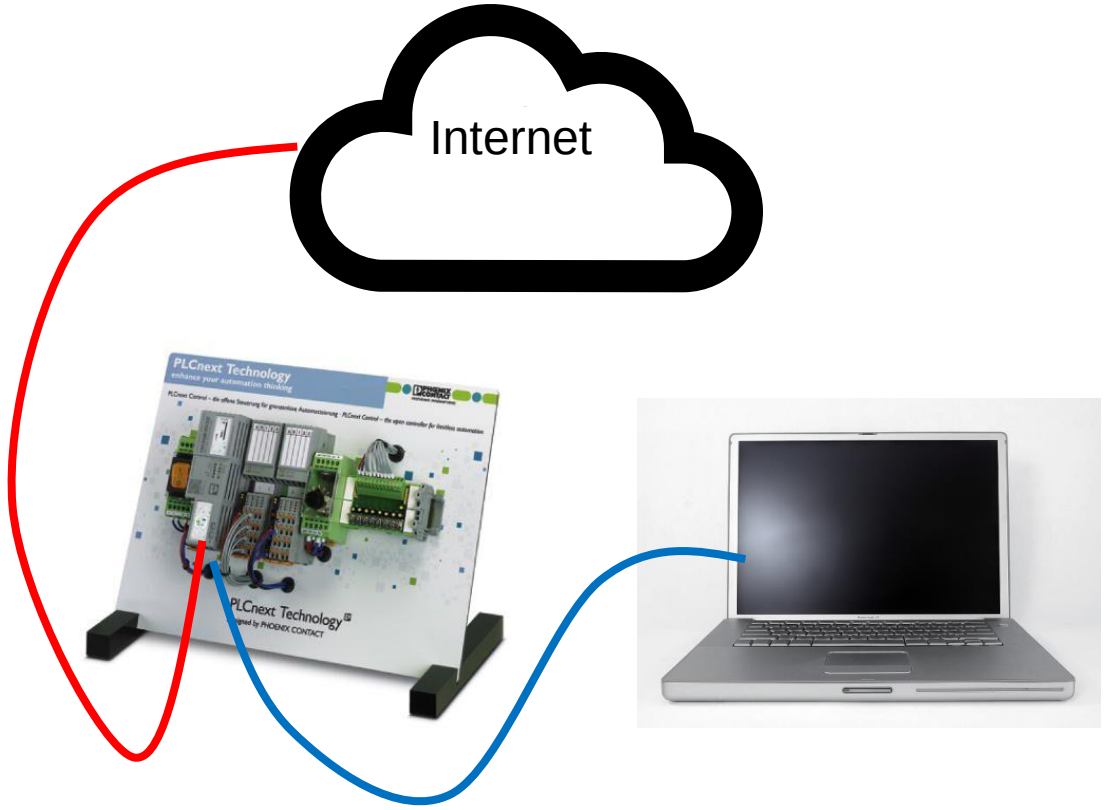


Downloading PuTTY

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

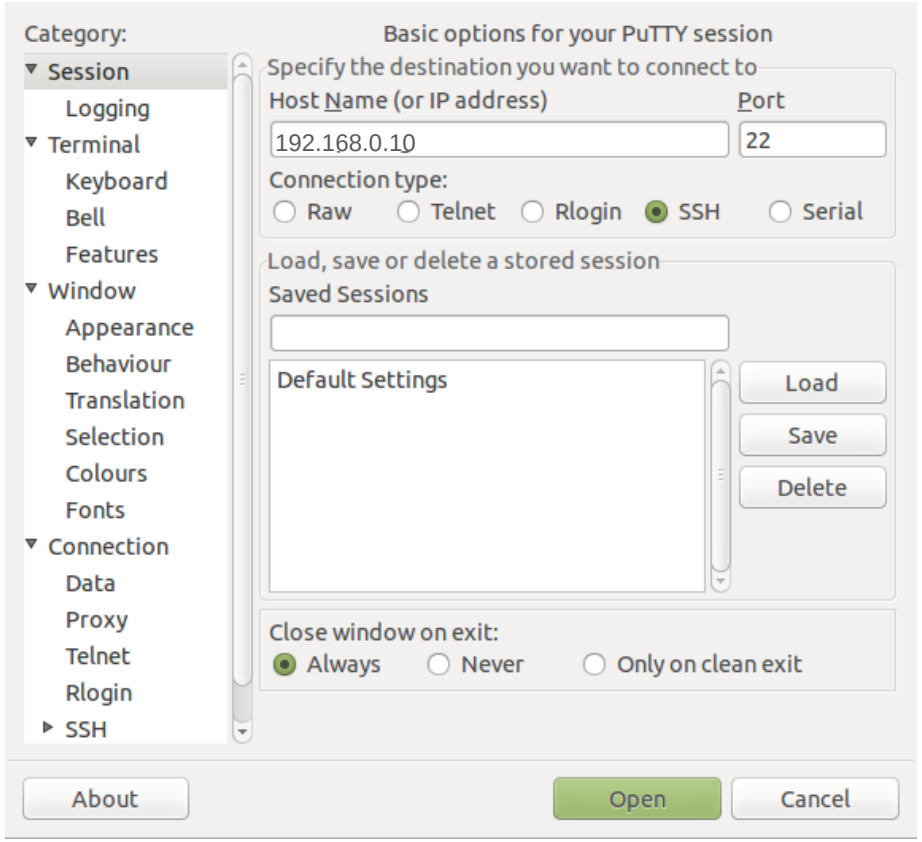
PuTTY is a free, open-source tool that will allow us to use the laptop to remotely connect with the Linux OS on the PLCnext controller, and to download various software components onto it. Ultimately, we will download Node-Red onto the PLCnext controller, but a few other applications will need to be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

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).

Using PuTTY

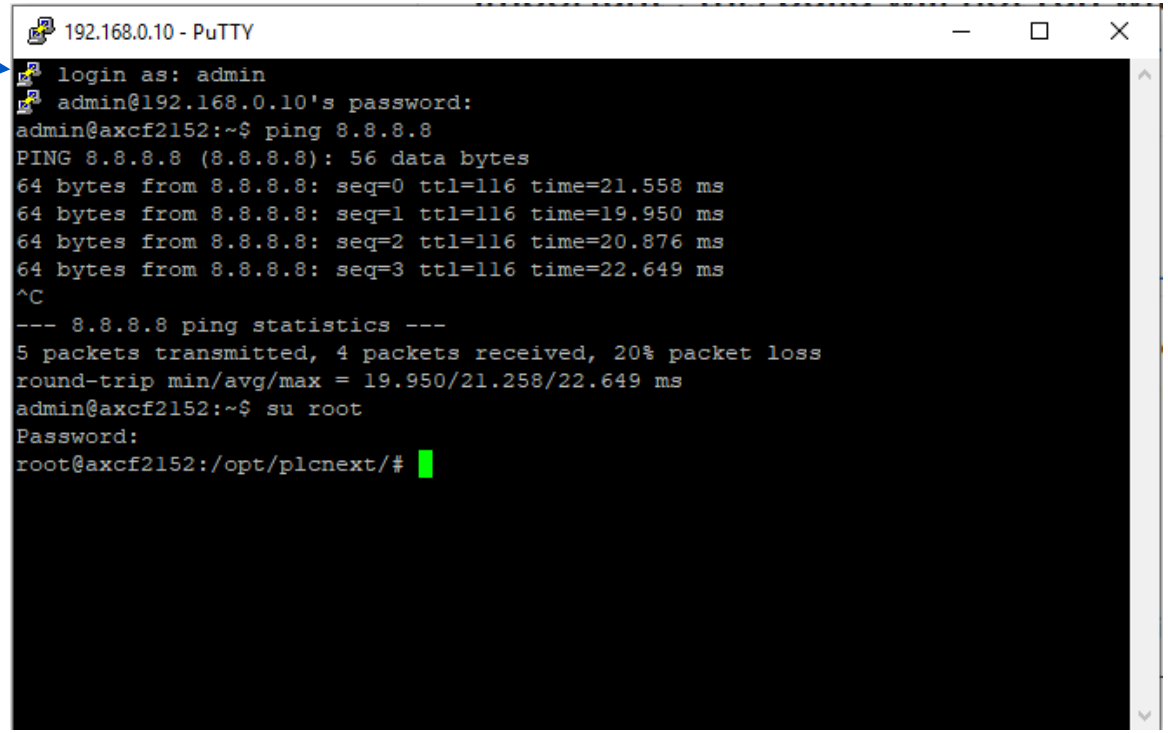


- Open the PuTTY application.
- Type in the IP address of your PLCnext controller, and make sure the port is set to 22. Then click open.

PHOENIX CONTACT
INSPIRING INNOVATIONS

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 **S**witch **U**ser 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.



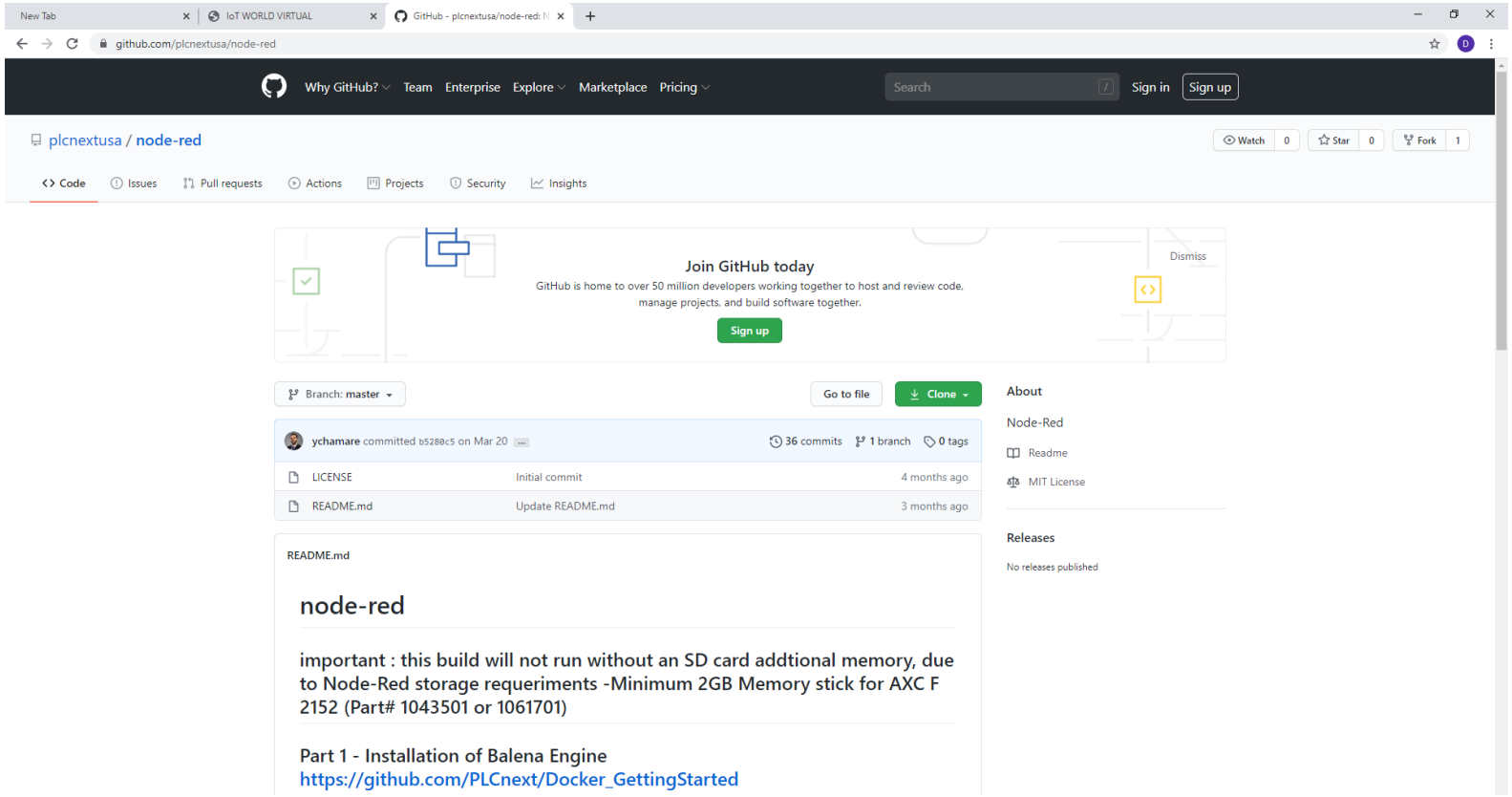
* You will only enter the Root password once after the initial creation.

PHOENIX CONTACT
INSPIRING INNOVATIONS

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



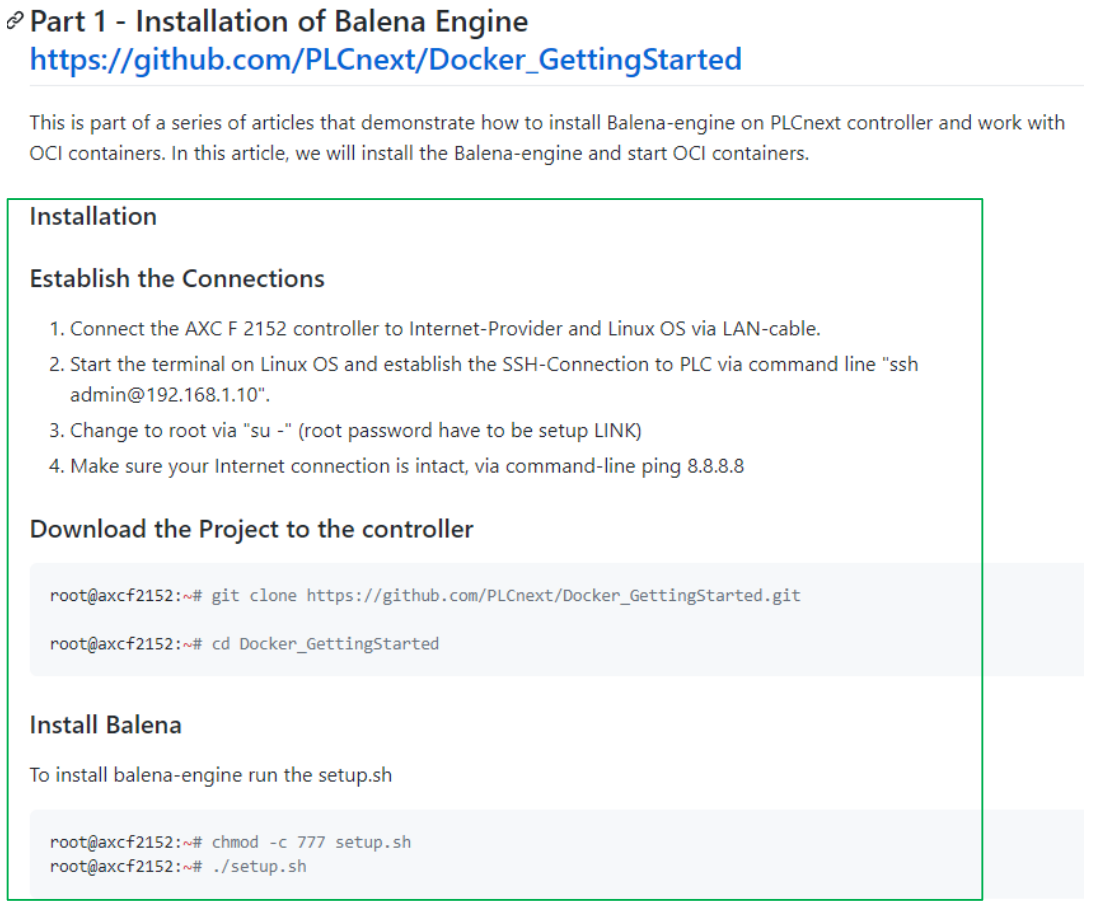
PHOENIX CONTACT
INSPIRING INNOVATIONS

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

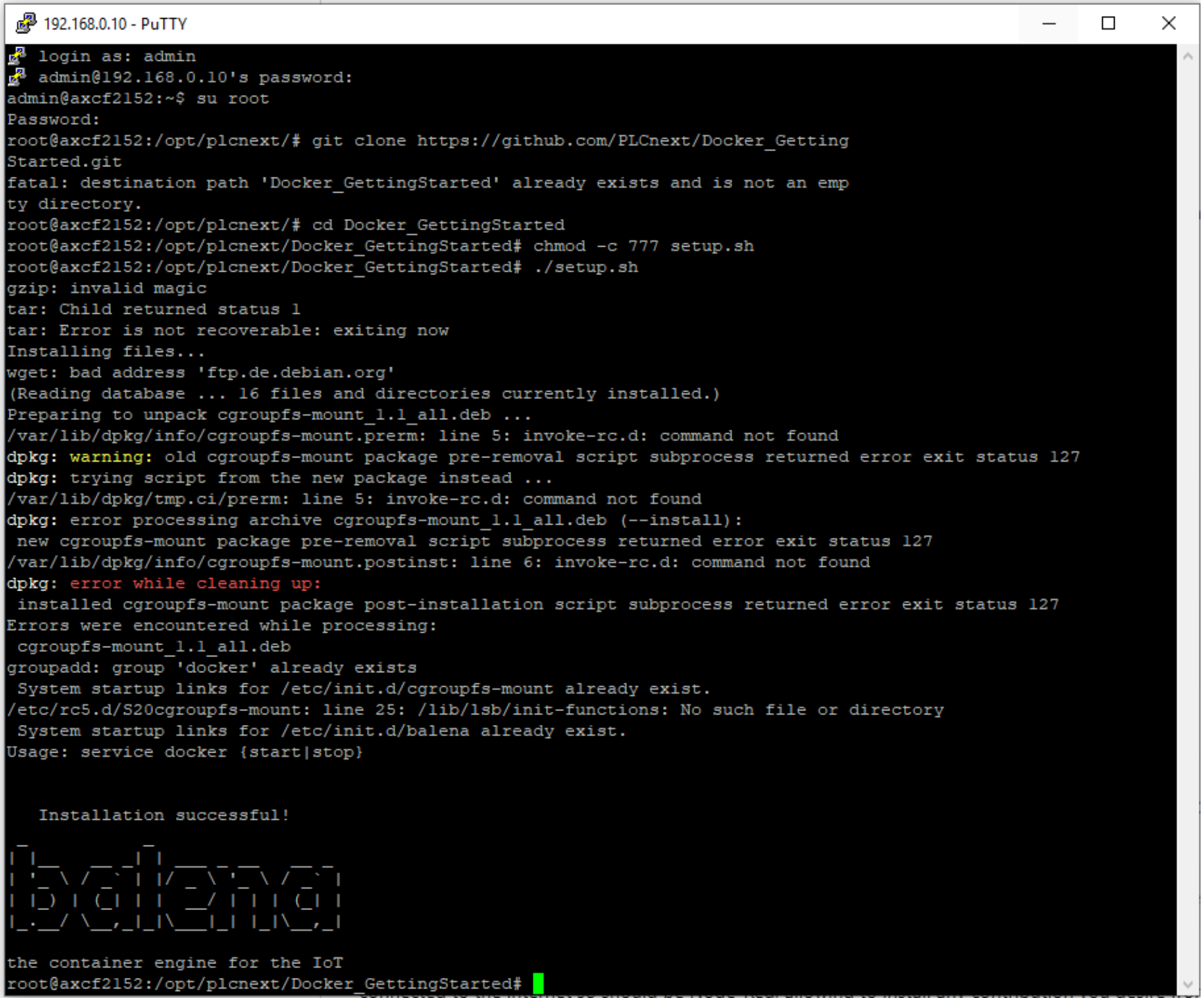
```
root@axcf2152:~# git clone https://github.com/PLCnext/Docker_GettingStarted.git

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
```

PHOENIX CONTACT
INSPIRING INNOVATIONS

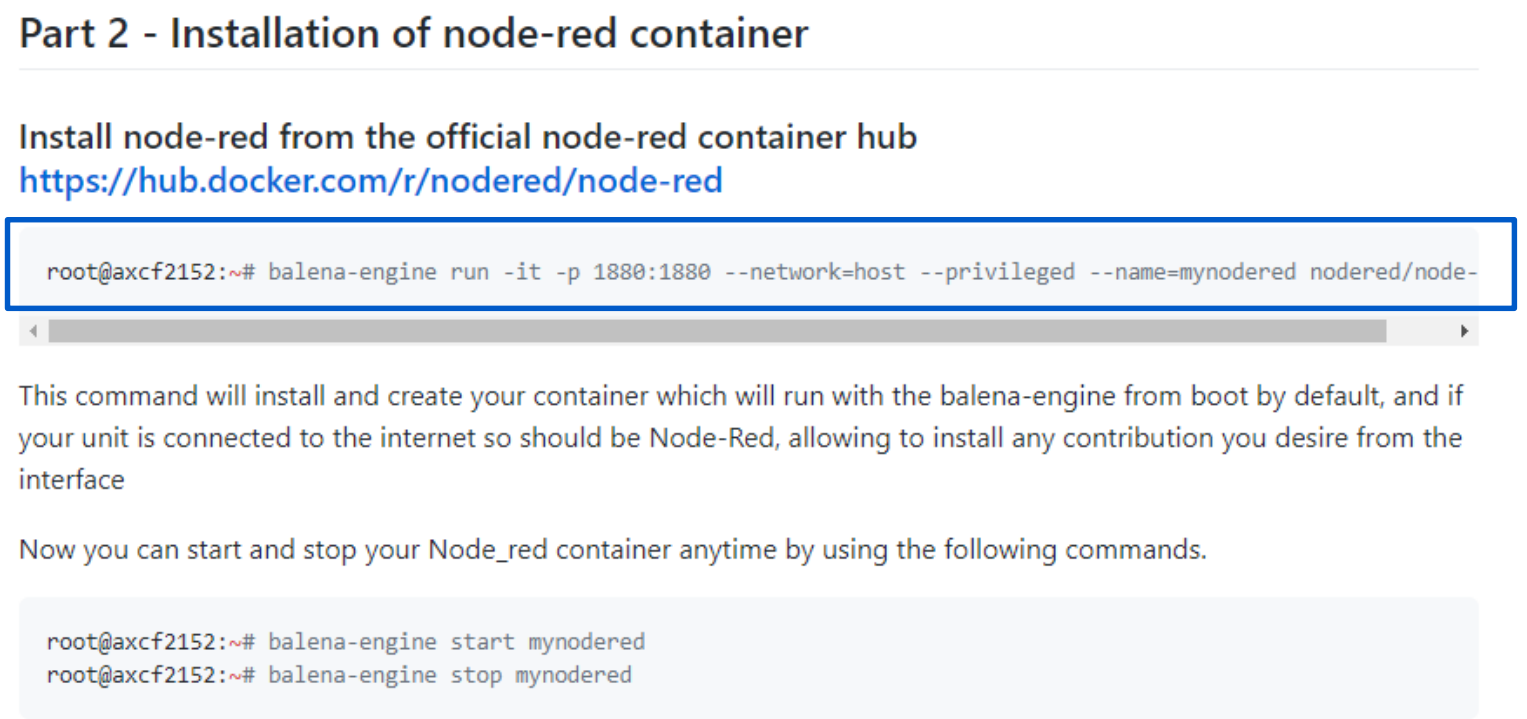


Note the successful installation of Balena, which is a prerequisite for loading Node.js and Node-Red onto the PLCnext Controller

PHOENIX CONTACT
INSPIRING INNOVATIONS

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

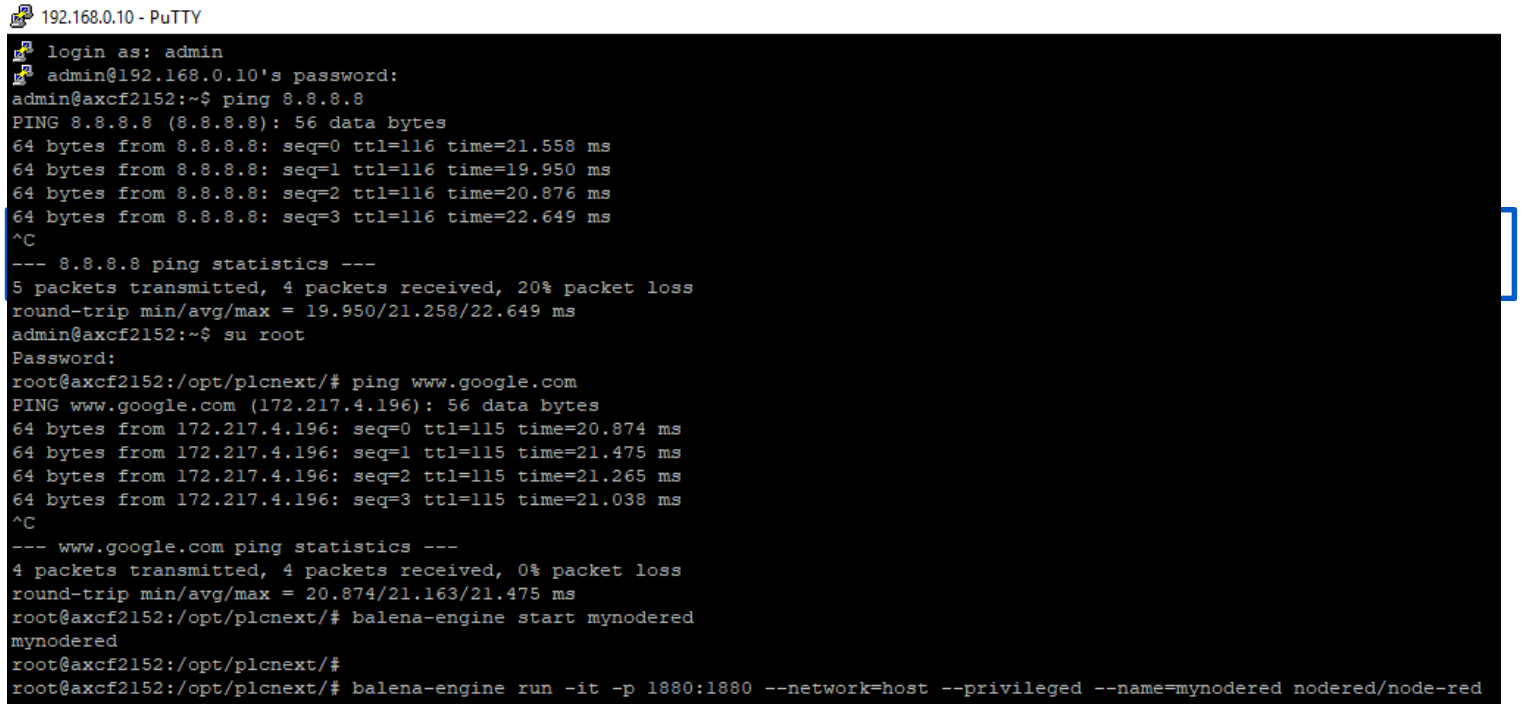
Now you can start and stop your Node_red container anytime by using the following commands.

```
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

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.



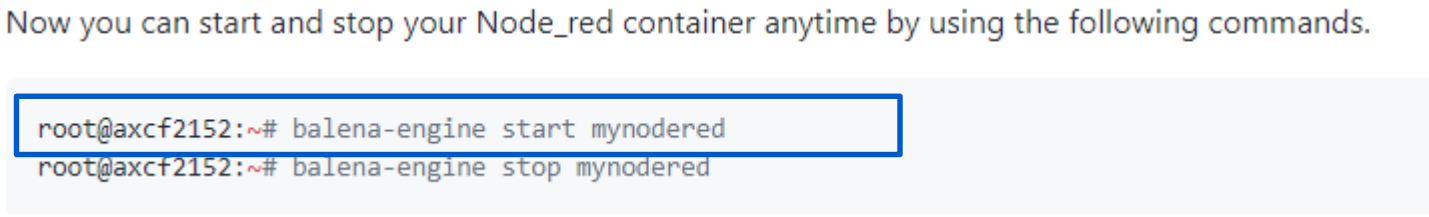

```
balena-engine run -it -p 1880:1880 --network=host --privileged --name=mynodered nodered/node-red
```

PHOENIX CONTACT
INSPIRING INNOVATIONS

OPCUA – Installing and using Node-Red on your computer

Follow instructions on Github

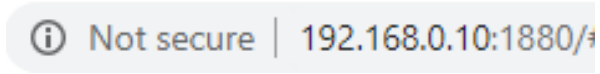
- Copy the text to the right of the # from the Github page
- Paste it into PuTTY, again, using Shift-insert to paste.
- Hit enter and wait a minute or two for the software to run.



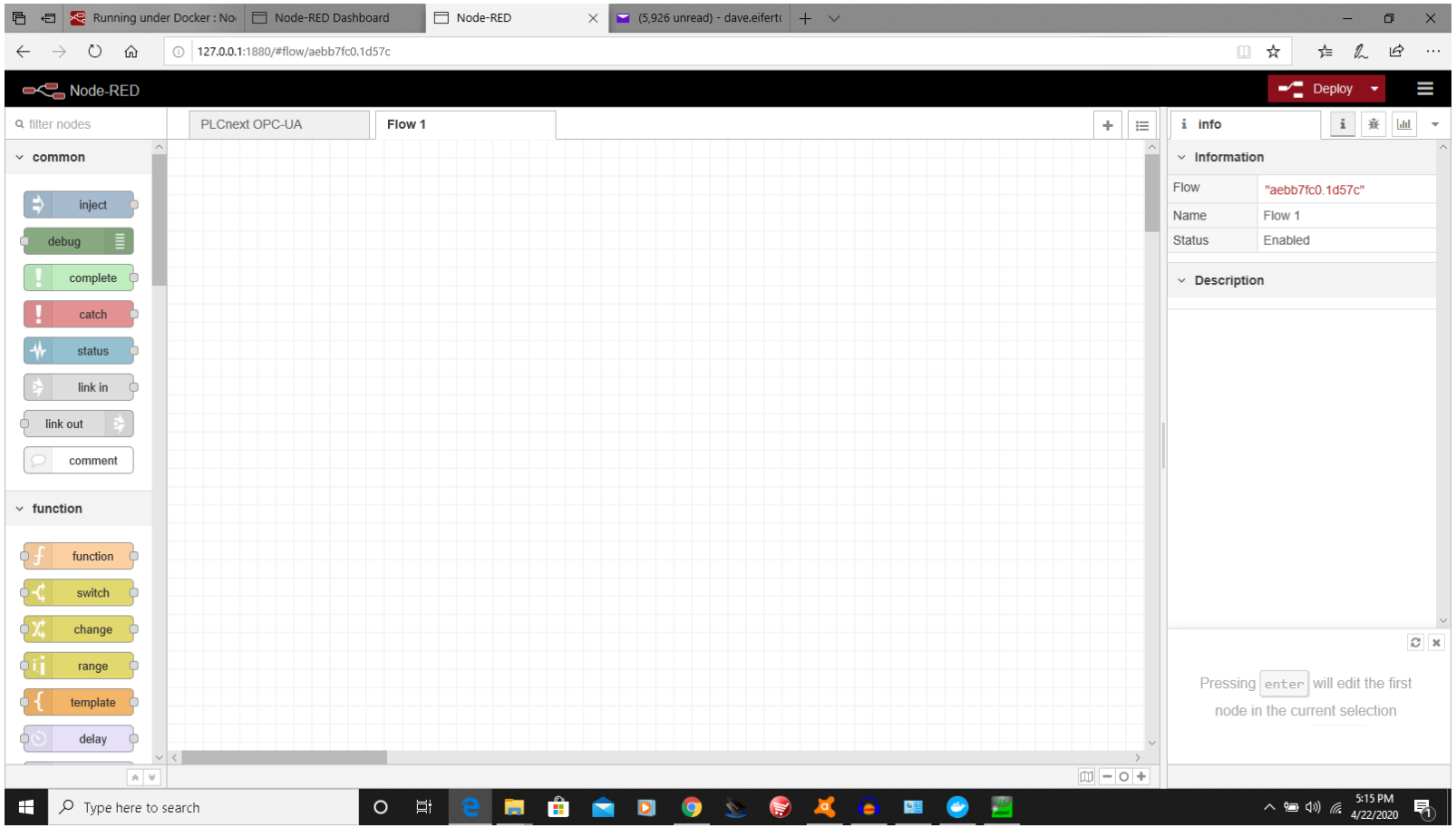
balena-engine start mynodered

“Opening” Node Red

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



Our experience leads to your success

Your partner in digitization

Experience in
machine building

Process expertise
in production

Products for
intelligent automation

With almost 100 years of experience, we are ideally placed to take the digitization of our world and turn it into the intelligent production of tomorrow.

PHOENIX CONTACT
INSPIRING INNOVATIONS

Let's shape the future together!

PHOENIX CONTACT
INSPIRING INNOVATIONS