Lock Testbed Setup Guide

Version 1.0 - 15 August, 2019

1. Overview

The operation of this testbed requires one host computer running Matlab Simulink and one installation of Oracle VM VirtualBox Manager (hereafter referred to simply as VirtualBox) running two different virtual machines (VMs) concurrently. A similar virtual machine software manager may be used instead, but these instructions will cover VirtualBox specifically.

2. Matlab Simulink Setup

The Simulink file contains the code to model the physical portions of the system. The IP addresses on the UDP Send and UDP Receive blocks are set to '192.168.56.2', as this is the address of the VM running the programmable logic controller (PLC). If the user is connecting to a different PLC, these addresses will need to be changed by double clicking each block and editing its Block Parameters, as shown in Figure 1.

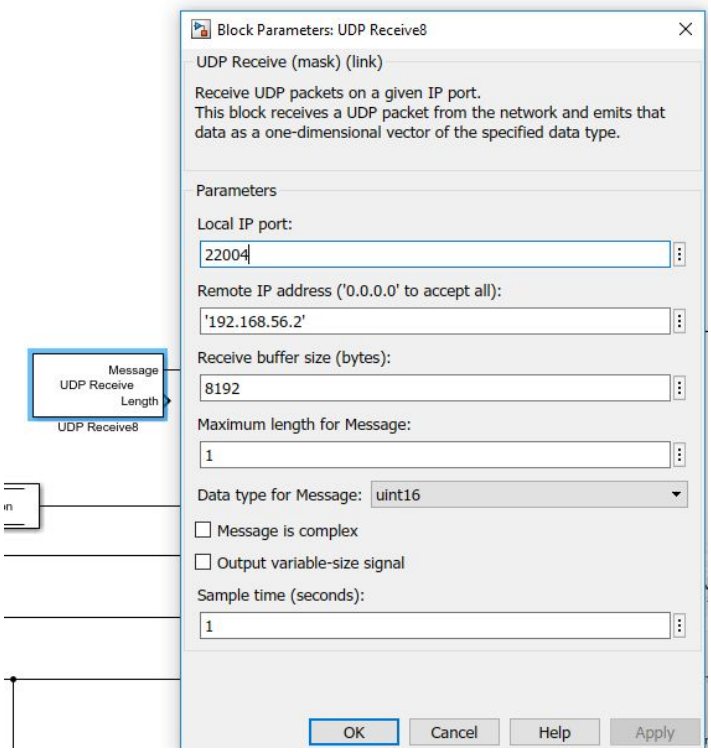

Figure 1: Block Parameter editing window for a UDP Receive block

3. VirtualBox Setup

Within VirtualBox, go to File -> Host Network Manager (or press Ctrl+H). Create a new Host-Only Network. Under the Adapter tab, select the "Configure Adapter Manually" radio button, then type 192.168.56.1 for the IPv4 address and 255.255.255.0 for the IPv4 network

mask. This is the IP address the VMs will use to reach the host computer where the Simulink program will run.

Under the DHCP Server tab, uncheck the box next to “Enable Server”. When completed, the window should look like Figure 2.

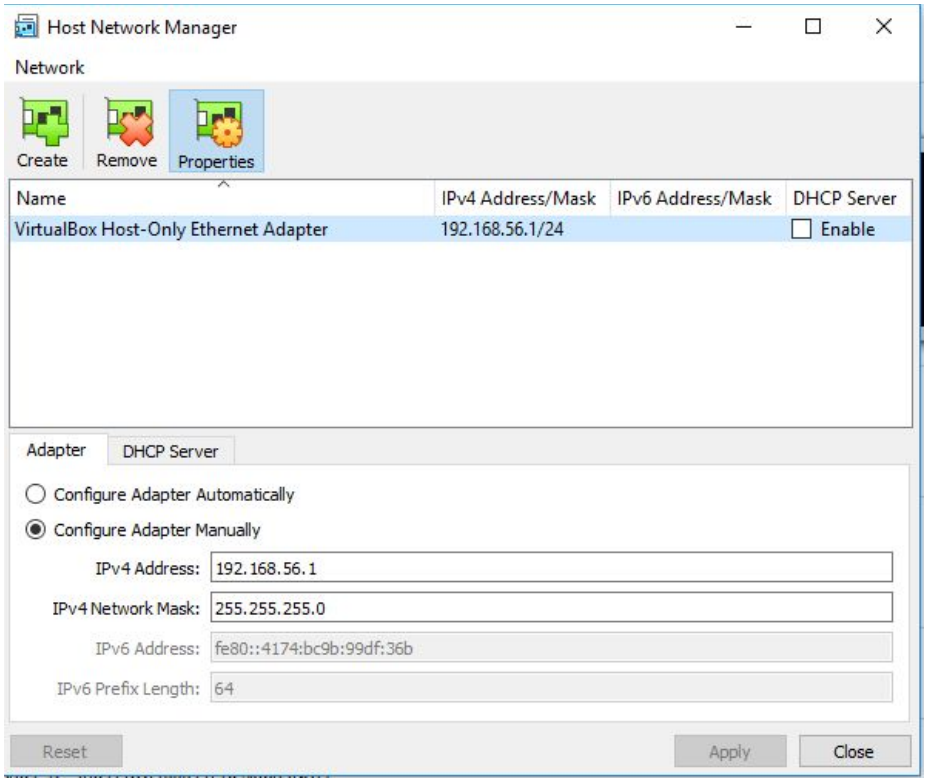

Figure 2: Host Network Manager Settings

Next, go to File -> Import Appliance (or press Ctrl+I). Navigate to the OpenPLC.ova file downloaded from <PLACE> to import that VM. Repeat this step with the ScadaBR.ova file.

4. OpenPLC VM Setup

On the VirtualBox main screen, click on the OpenPLC VM, then select Settings. Under the Network side tab, enable Adapter 1 by checking the Enable Network Adapter box, then choose “NAT” from the “Attached to:” dropdown menu. Switch to the Adapter 2 tab and enable it, as well. Choose “Host-only Adapter” from the “Attached to:” dropdown menu, then “VirtualBox Host-Only Ethernet Adapter” from the “Name:” dropdown directly below. This should be the adapter edited/created in Section 3. The configuration page for Adapter 2 is shown in Figure 3. Click “OK” to close the Settings window.

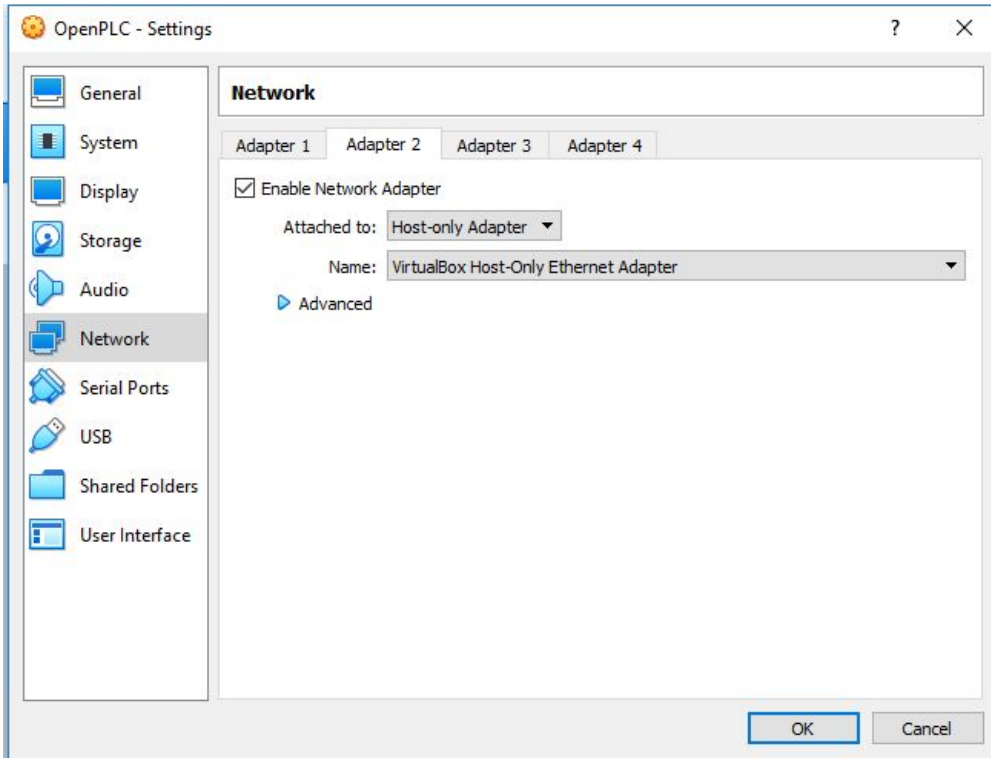

Figure 3: Configuration for Adapter 2 on the OpenPLC VM

Next, start the OpenPLC VM. Both the username and password are openplc.

Open the Wired Settings by clicking the arrow in the top right of the window (next to the power button) and selecting the wrench and gear icon in the resulting dropdown menu. Create a new host only network using the plus sign to the top right. A window with network options will appear on screen.

Under the Details tab, check the box beside “Connect automatically”. Under the IPv4 tab, select “Manual” as the IPv4 Method. Under “Addresses”, type 192.168.56.2 for Address, 255.255.255.0 for Netmask, and 192.168.56.1 for Gateway. The window should look like the screenshot in Figure 4.

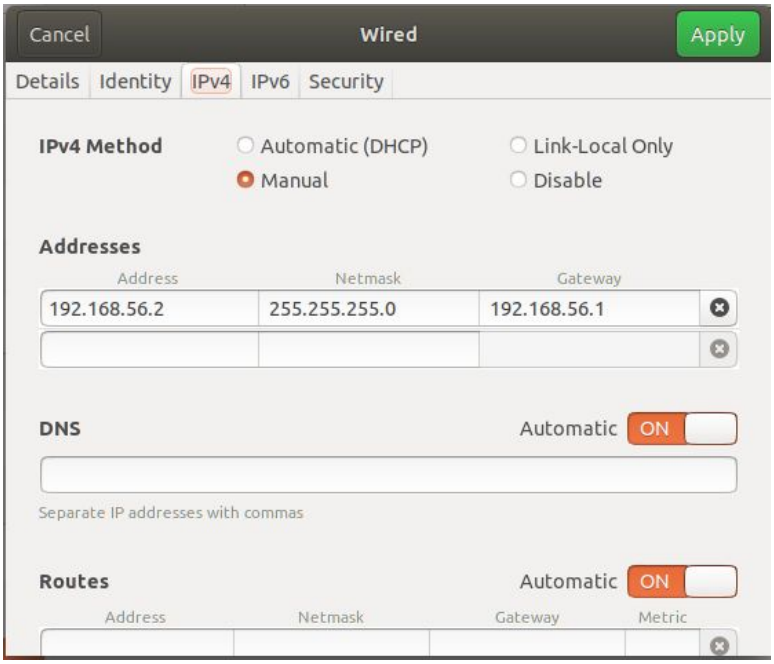

Figure 4: Wired network settings for the OpenPLC host-only network

Click the green Apply button in the top right, then restart the VM for the changes to take effect. Two Ethernet connections should not show up in the Network Settings window: the one you just created and the one that was there initially. Do not modify the original network.

5. HMI VM Setup

On the VirtualBox main screen, click on the ScadaBR VM, then select Settings. Under the Network side tab, enable Adapter 1 by checking the Enable Network Adapter box, then choose "Bridged" from the "Attached to:" dropdown menu. Switch to the Adapter 2 tab and enable it, as well. Choose "Host-only Adapter" from the "Attached to:" dropdown menu, then "VirtualBox Host-Only Ethernet Adapter" from the "Name:" dropdown directly below. This should be the adapter edited/created in Section 3. The configuration page for Adapter 2 should be the same as that shown previously in Figure 3.

Next, start the ScadaBR VM. Both the username and password are scadabr. Yes, the passwords used in the testbed are all that easy.

Use the following command to open the configuration file and add a host-only network and set a static IP address:

```
sudo sudoedit /etc/network/interfaces
```

Within this file, use the arrow keys to go to the very bottom. Add the following to the bottom of the file so that it will look like Figure 5:

```
# Static IP
```

```
allow-hotplug enp0s8
iface enp0s8 inet static
address 192.168.56.3
netmask 255.255.255.0
gateway 192.168.56.1
```

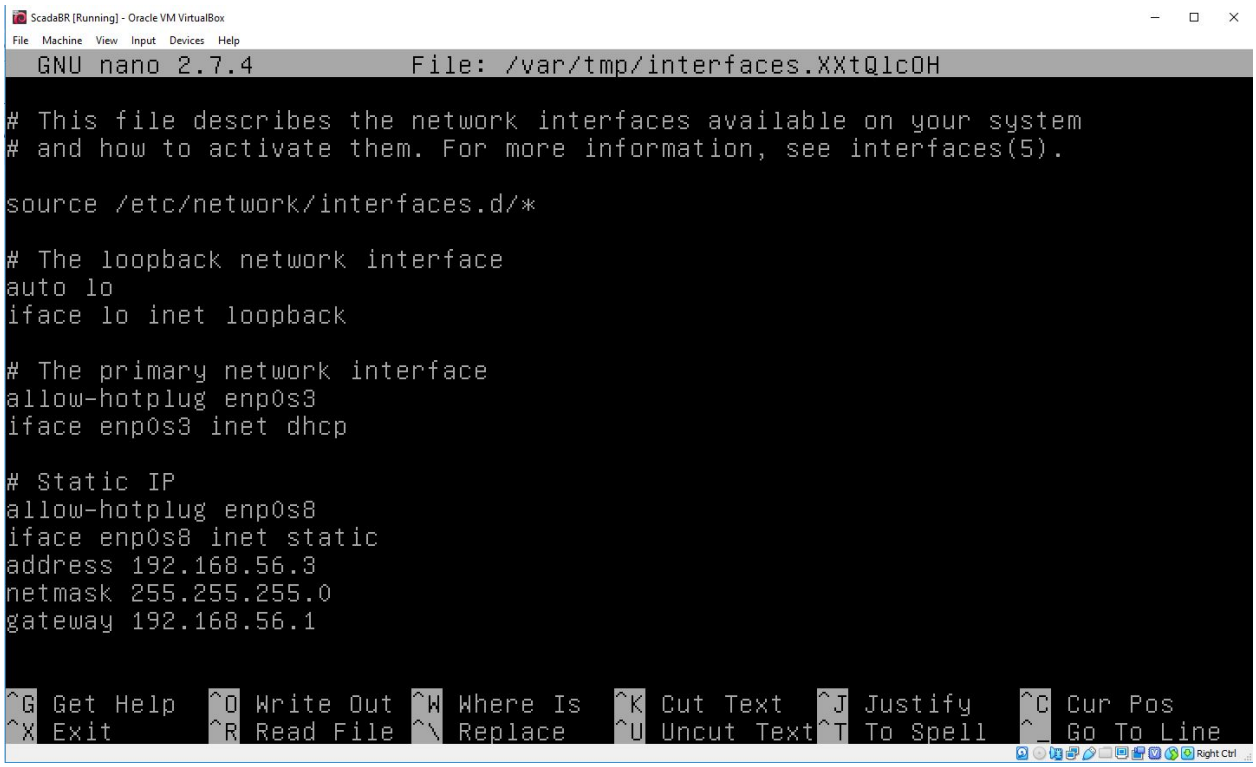

Figure 5: The edited interface file for the ScadaBR VM

Save the file by pressing Ctrl+O, changing the file name to /etc/network/interfaces, then typing "y" as prompted to overwrite. Press Ctrl+X to close the editor, then restart the VM for changes to take effect.

Once the VM has restarted, type `ip address` to confirm that the static IP is working. The resulting info should look similar to Figure 6, particularly the bottom portion bracketed in red in the screenshot.

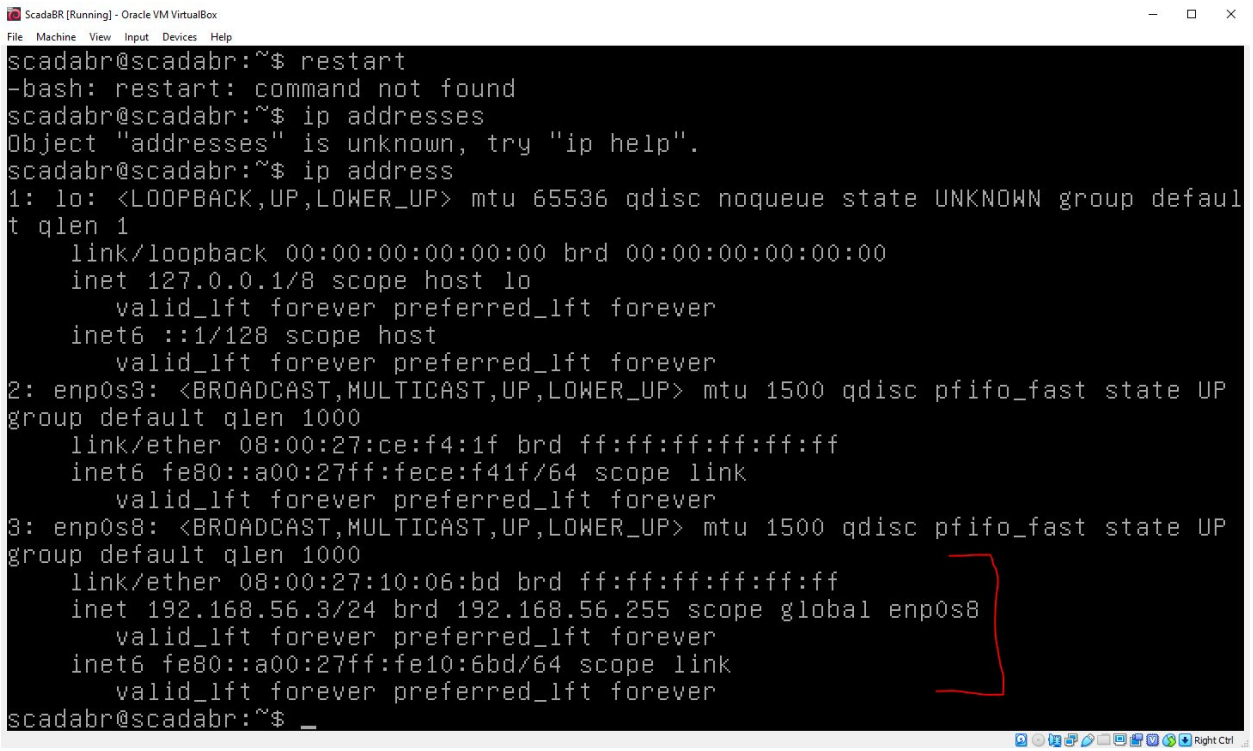

Figure 6: IP address information for the HMI VM

6. Starting the Testbed

Order is important when starting the testbed, as some files are dependent on others at startup.

Start the OpenPLC VM and open a terminal. Type `cd OpenPLC_v3` to navigate to the correct folder, then `sudo ./start_openplc.sh` to start the OpenPLC server. Ignore any socket.error messages.

Now open Firefox within the VM and go to localhost:8080/login to sign into the OpenPLC webserver. The username and password for this are both openplc. See? Super easy passwords. Once inside, go to the Programs tab on the left side and click on your *.st file, then select the Load Program button at the bottom of the resulting window. Once loaded, you can now start the PLC using the Start PLC button on the left. If the Dashboard tab does not show the PLC status as "Running", refresh the page manually.

If you wish to have the PLC run automatically as soon as the webserver starts, that option may be checked in the Settings tab. Either way, once OpenPLC is running, the dashboard should look like Figure 7.

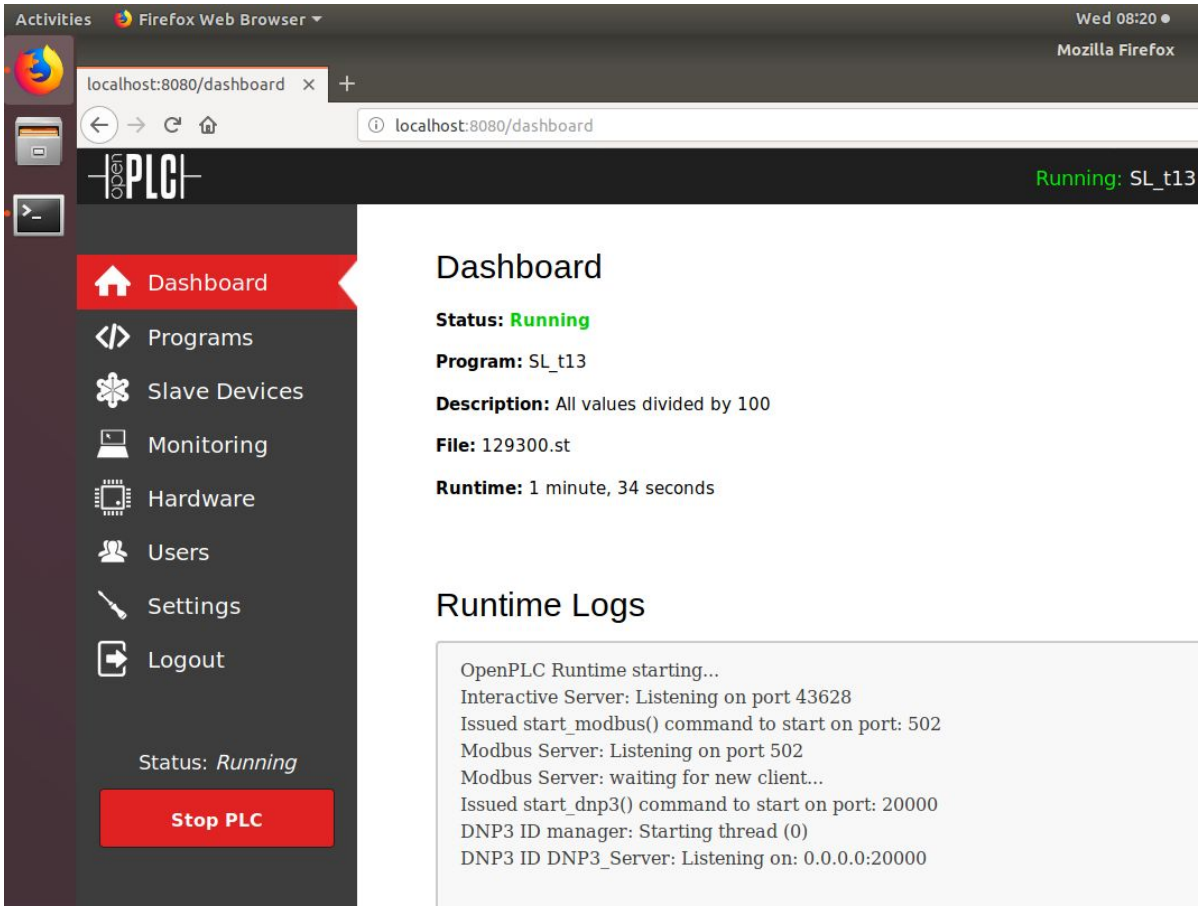

Figure 7: OpenPLC dashboard when running

Lastly, on the host computer, run the start_model.m script in Matlab. Be sure that the address listed on the first line points to the most recent version of the Simulink file. Alternatively, you may open the model manually in Simulink and run the model by selecting Simulation -> Run in the menu or pressing the green play button.

All portions of the testbed should now be open, running, and communicating among themselves.