

Using Raspberry Pi For Network Commissioning

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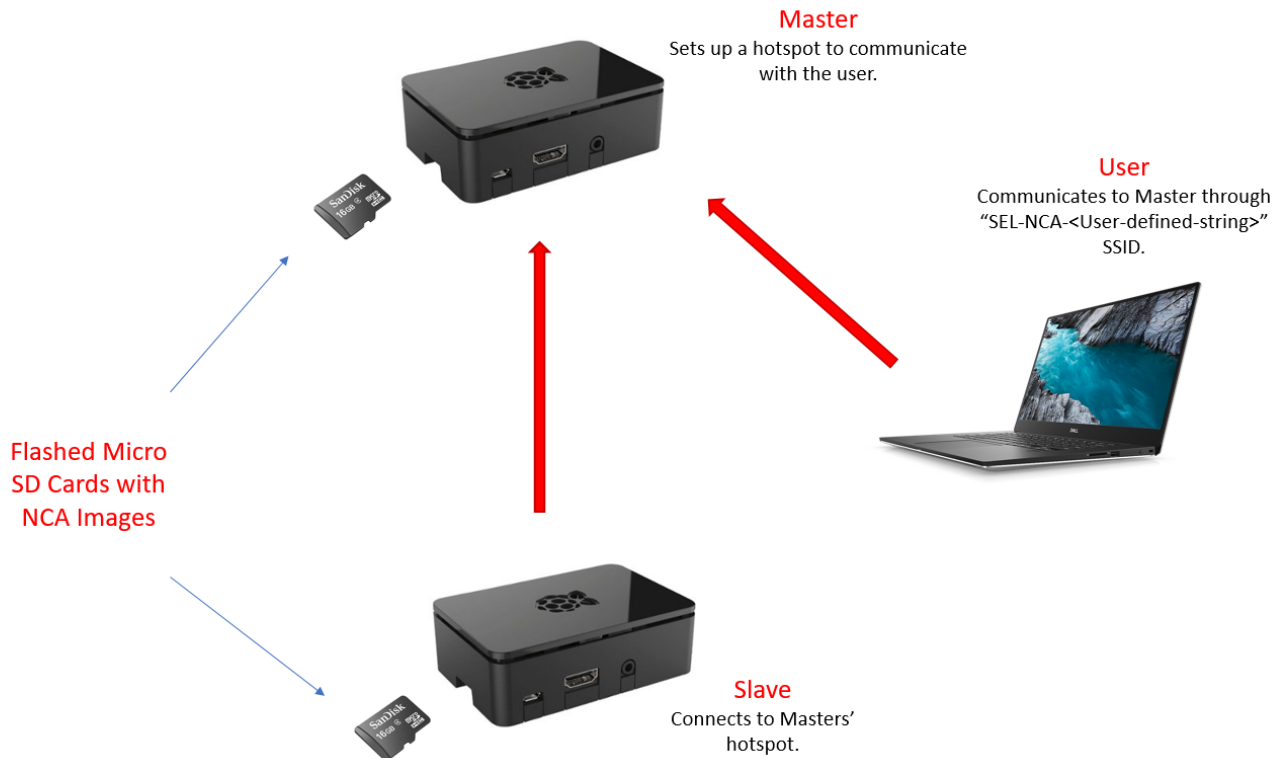
Overview

The Network Commissioning Assistant (NCA) is a tool suite for testing, monitoring and debugging Software Defined Networks (SDN). It is an inexpensive solution consisting of two Raspberry Pi's running a pre-existing Rasbian Lite version. The tool's setup is documented as follows:

- For a list of materials you will need, see [Raspberry Pi Tester BOM](#).
- To set up the NCA tool, you must have the appropriate images flashed onto SD cards. See [Image Flashing Guide](#) for instructions on flashing pre-existing images onto SD cards.
- For building up images from scratch, do development and/or make a release, see [Development and Release Procedure \(NCA\) OLD](#).

Quickstart

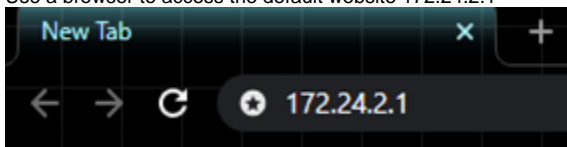
The only difference between the "Master" and "Slave" NCA's is that the slave connects to the other's wireless hot spot. That's how they, and you, communicate with the network. Make sure to configure both pi's in an order that allows you to connect to that hot spot. Essentially, always ensure you have a "Master" pi.



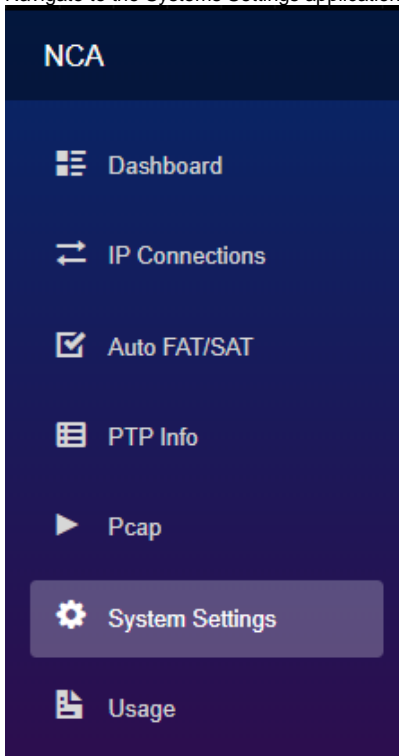
To setup the pi's for the first time:

1. Flash two of the NCA images (latest version) onto the micro-SD cards, and insert them in both pi's.
2. Power on the first pi which will be configured as **Slave**.
3. Connect to the default SSID ("SEL-NCA-CHANGE-ME"). The network will not have internet access necessarily. If asked whether you want your PC to be discoverable on that network, either option will work.

4. Use a browser to access the default website 172.24.2.1



5. Navigate to the Systems Settings application in the sidebar.



6. Change the following settings and click on "Configure."

Settings

Time	17:16:22 PM
Date	2020-04-17
SSID	SEL-NCA-ODH

IP Address:

192.168.12.2 **a. Change to 192.168.12.2**

Wireless IP:

172.24.2.2 **b. Change to 172.24.2.2**

SSID:

SEL-NCA-ODH **c. Change to SEL-NCA-<Your-Initials>**

Unique SSID easily recognizable when using this Pi. Add owner's initials. Example: SEL-NCA-ODH

☐ Master Mode: **d. Uncheck box to configure as Slave**
Is this Raspberry Pi access point?

☒ Security mode: **e. Check box to enable security mode.**
Highly recommended

Password

f. Use whatever password.

Configure **Sync Time** **g. Click on "Configure"**

7. A confirmation modal will pop up. After confirming the changes and clicking on "Configure," the pi should restart.

Confirmation

New SSID: **SEL-NCA-ODH**

Security mode: **Enabled**

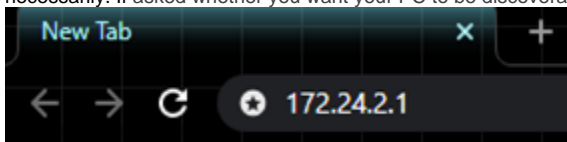
NOTE: The following configuration values should be different than the other Pi's:

- New Pi Mode: **Slave**
- New IP Address: **192.168.12.2**
- New Wireless IP Address: **172.24.2.2**

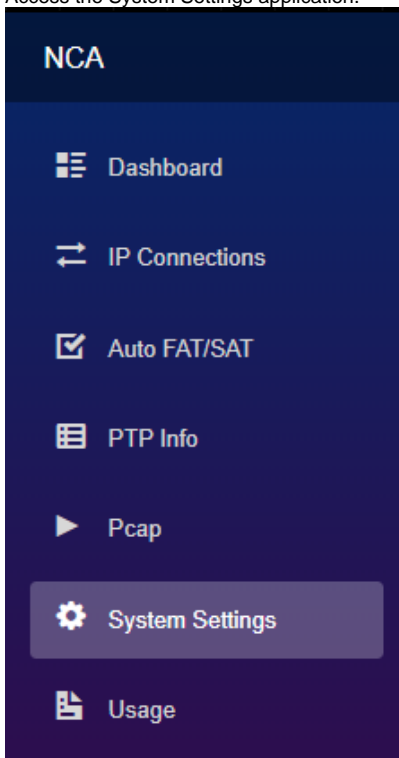
a. Click on "Configure" **Configure** **Close**

8. Power on the other pi which will be configured as **Master**.

9. Connect to the default SSID ("SEL-NCA-CHANGE-ME"), and navigate to the 172.24.2.1 page. The network will not have internet access necessarily. If asked whether you want your PC to be discoverable on that network, either option will work.



10. Access the System Settings application.



11. Change the following settings and click on "Configure."

SSID: SEL-NCA-ODH **Mode:** Master

Settings

Time	17:08:36 PM
Date	2020-04-17
SSID	SEL-NCA-ODH

IP Address:

192.168.12.1

Wireless IP:

172.24.2.1

SSID:

SEL-NCA-ODH **a. Change to SEL-NCA-<Same-as-Slave>**

Unique SSID easily recognizable when using this Pi. Add owner's initials. Example: SEL-NCA-ODH

☒ **Master Mode:**
Is this Raspberry Pi access point?

b. Check box to configure as Master

☒ **Security mode:**
Highly recommended

c. Check box to enable security mode.

Password

.....

d. Use same password as Slave.

Configure **Sync Time**

g. Click on "Configure"

12. A confirmation modal will pop up. After confirming the changes, the pi should restart.

Confirmation ×

New SSID: **SEL-NCA-ODH**

Security mode: **Enabled**

NOTE: The following configuration values should be different than the other Pi's:

- New Pi Mode: **Master**
- New IP Address: **192.168.12.1**
- New Wireless IP Address: **172.24.2.1**

a. Click on "Configure" **Configure** **Close**

13. Make sure both pi's are powered on and connect to the new SSID that you specified earlier.

14. Open internet browser and access 172.24.2.1 (Master) to go to the NCA dashboard and make sure you can see the Remote Pi's info. NOTE: The top bar of the interface will display the network you are currently connected to and the current configuration of the pi (Master or Slave).

SSID: SEL-NCA-ODH Mode: Master		
Dashboard		
Pi	LocalPi (Master)	RemotePi (Slave)
Configured IP	192.168.12.1	192.168.12.2
Current IP	172.18.228.235	172.18.228.231
Wireless IP	172.24.2.1	172.24.2.2
Version	v3.0.0.echo	v3.0.0.echo
Time		
Local Browser	6/2/2020 10:13:11 PM	
Raspberry Pi	4/17/2020 7:22:43 PM	
Please Sync Pi's time with Local time		

Dashboard

Gives small amount of information about local and remote pi.

NOTE: "Local Pi" refers to the interface of the current pi's server, while "Remote Pi" simply refers to the "other" pi, regardless of which pi is configured as Master or Slave.

Local Pi Status			Remote Pi Status		
Dashboard					
Pi	LocalPi (Master)		RemotePi (Slave)		
Configured IP	192.168.12.1		192.168.12.2		
Current IP	192.168.12.1		192.168.12.2		
Wireless IP	172.24.2.1		172.24.2.2		
Version	v3.0.0		v3.0.0		
Time					
Local Browser		6/2/2020 10:42:50 PM			
Raspberry Pi		4/17/2020 4:38:09 PM			
Sync Time					

The Pi might stop updating for up to 10 seconds when syncing large time differences.

If you need help or have questions/comments please contact Jason Dearien: jason_dearien@selinc.com.

Sync Time

There is a table that displays information about local time and the time on the Pi, and if these differ by more than 15 seconds, a button will pop up to sync the time. This is relevant for the Pcap application, so that the timestamps on any of files created by the pi will have a roughly correct time, but it is not required for the proper function of the application.

After pressing this button, if the time change between the pi and browser is significant, it may cause a slight interruption in the web-interface but it should recover.

IP Connections

The IP Connections is an application that simulates end-to-end protocols between the two devices. The possible test configurations are the following:

- Client/Server Mode
- UDP (It is good to try the Bi-directional setting on Unidirectional protocols, for negative testing).
 - Unidirectional
 - Bidirectional
- TCP/UDP Port Number.
- IP Address
- Remote IP Address
- Subnetwork Mask
- Default Gateway

If configuration details are sent while running an active test, the test will be restarted with the new configuration.

NOTE: It is recommended that all the configuration changes be made from the Master pi. However, if you want to configure the Slave Pi, you will have to navigate to his page, whose link is located in the header of the Slave pi column, and configure its information locally. The differences between the Master and Slave IP Connections interface are as follows:

- IP and Remote IP address will be reversed.
- Client Mode will be inverted

Results

There are several different pieces of information that appear in the App Status table. Most of these are simply reflections of the way that the pi was configured at the time of starting the current running test. Other reflect information about the status of the communication between the two pi's.

	Local Pi Status	Remote Pi Status
App Status	Local Pi Running	Remote Pi Running
Pi	192.168.12.1	192.168.12.2
IP	192.168.12.1	192.168.12.2
Netmask	255.0.0.0	255.0.0.0
Gateway		
Remote_IP	192.168.12.2	192.168.12.1
Port	161	161
Mode	Client-UDP Bi-Directional	Server-UDP Bi-Directional
App Control	Stop Local	Stop Remote
Message #	TX: 123 RX: 38	RX: 37 TX: 38
ARP Entry	Absent	Present
Status	Error	Error
Error Messages	No response from server	Haven't received message in a while

Will say "Local Pi" (or "Remote Pi") "Running"/"Config" depending on the running state of the test.

Switches between "Client"/"Server", and followed by one of the three:

- "TCP" - Standard TCP handshake with response from server
- "UDP Bi-directional" - Two way UDP messaging.
 - If testing on Unidirectional protocol, the server's status will show no errors, but the client will have a "did not receive expected response" error.
- "UDP Uni-directional" - One way messaging.

Can independently start/stop the local/remote apps.

TX represents the message # attempted to transmit last, while RX is the last known message number that was received. For Uni-directional protocols, the server does not transmit data, so it is irrelevant.

This represents whether the pi currently has the remote IP address in its ARP table.

If there is an error, "Error" will be shown. If the Mode is in Unidirectional UDP, then the client will show successful, unless it failed to properly send the message.

Displays error messages found. Sometimes they are unknown errors, and in that case, the complete error string encountered will be displayed.

Configuration Values

Application Controls

Client Mode ☒ UDP ☒ Unidirectional ☐

TCP/UDP Port: 161

IP Address: 192.168.12.1 Remote IP Address: 192.168.12.2

Subnetwork mask: 255.0.0.0 Default Gateway:

Start Both Stop Both Configure Both Configure Local Configure Default

Auto FAT/SAT

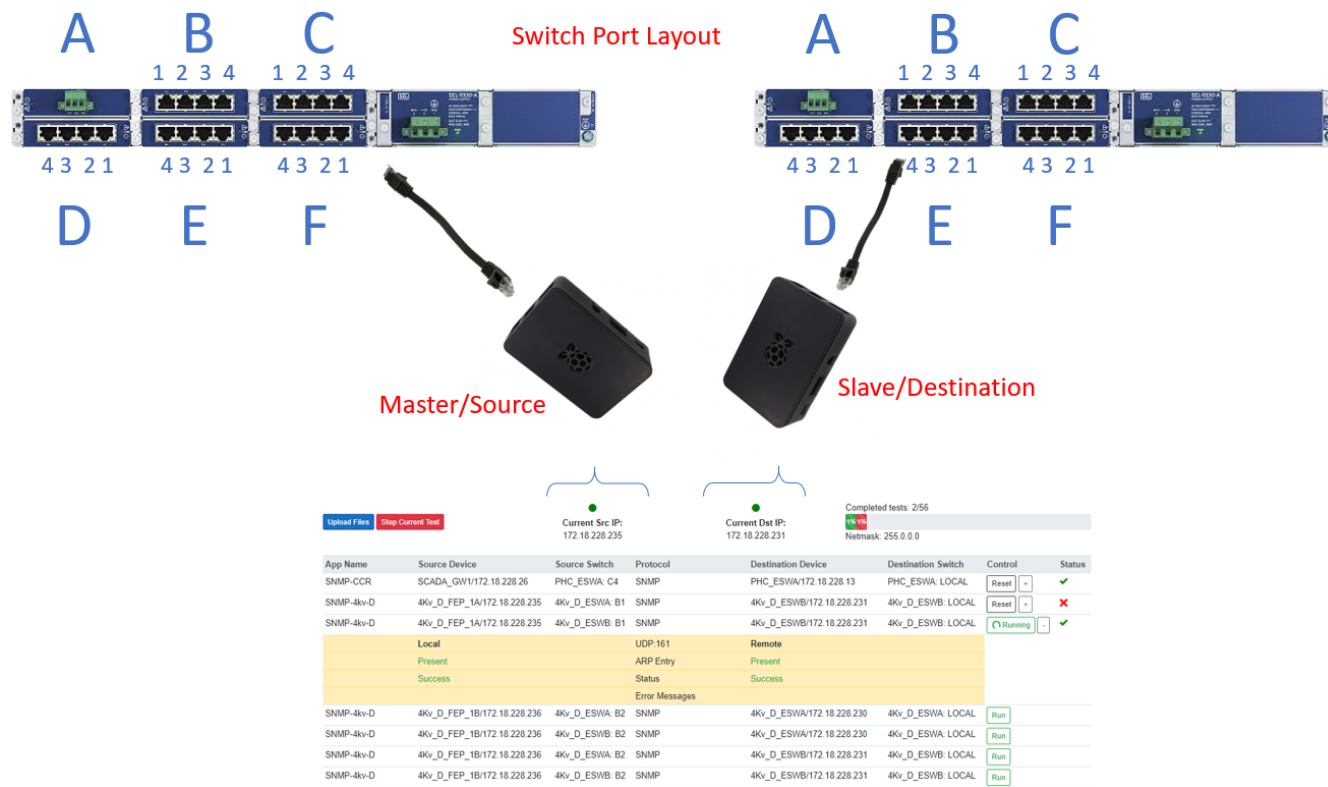
This is the automated version of the IP Connections application, which simulates end-to-end protocols between the two devices. On this application, instead of manually typing the port number, source and destination IP addresses, the user needs to upload two different files:

- **SAT file.** This file must contain at least the following headers:
 - AppName
 - SrcName
 - SrcPort
 - SrcIP
 - SrcSwitch
 - SrcSwitchPort
 - Protocol
 - DstName
 - DstPort
 - DstIP
 - DstSwitch

- DstSwitchPort
- **Protocols file.** This file must contain at least the following headers:
 - Name
 - Unicast
 - Bidirectional
 - EthType
 - IpProto
 - TcpDst
 - UdpDst

The application will left-join the SAT with Protocol files on "AppName" and "Name" fields, and a list of all the available tests will be displayed. The user can run individual tests by clicking on the "Run" button. When a test is run, the application will configure both Pi's and start the test accordingly. When a test is running, then stopped or a different test is started, the current running test will save the last state it was on. This allows the user to keep track of previous passed and/or failed tests.

Recommended steps



1. Run desired test.
2. Plug Source pi into Source Switch and Remote pi into Destination Switch.
3. Wait for a pass or fail state.
4. Stop current test or run a different one. NOTE: The application will save the last state the test was on; hence, do not unplug any of the pi's before stopping or starting a new test.
5. Repeat until all desired tests have been run.

Application Overview

Stops the current running test

Upload Files Stop Current Test

Pi's Status
Green: Running
Red: Stopped

Configured IP address

Current Src IP: 172.18.228.235 Current Dst IP: 172.18.228.231

Progress Bar
Green: Passed tests
Red: Failed tests

Completed tests: 2/56
1% 1%
Netmask: 255.0.0.0

App Name	Source Device	Source Switch	Protocol	Destination Device	Destination Switch	Control	Status		
SNMP-CCR	SCADA_GW1/172.18.228.26	PHC_ESWA: C4	SNMP	PHC_ESWA/172.18.228.13	PHC_ESWA: LOCAL	Reset +	✓ Passed Test		
SNMP-4kv-D	4Kv_D_FEP_1A/172.18.228.235	4Kv_D_ESWA: B1	SNMP	4Kv_D_ESWB/172.18.228.231	4Kv_D_ESWB: LOCAL	Reset +	✗ Failed Test		
SNMP-4kv-D	4Kv_D_FEP_1A/172.18.228.235	4Kv_D_ESWB: B1	SNMP	4Kv_D_ESWB/172.18.228.231	4Kv_D_ESWB: LOCAL	Running -	✓ Failed Test		
Local			UDP:161	Remote		Current Test Status			
Present			ARP Entry	Present					
Success			Status	Success					
			Error Messages						
SNMP-4kv-D	4Kv_D_FEP_1B/172.18.228.236	4Kv_D_ESWA: B2	SNMP	4Kv_D_ESWA/172.18.228.230	4Kv_D_ESWA: LOCAL	Run			
SNMP-4kv-D	4Kv_D_FEP_1B/172.18.228.236	4Kv_D_ESWB: B2	SNMP	4Kv_D_ESWA/172.18.228.230	4Kv_D_ESWA: LOCAL	Run			
SNMP-4kv-D	4Kv_D_FEP_1B/172.18.228.236	4Kv_D_ESWA: B2	SNMP	4Kv_D_ESWB/172.18.228.231	4Kv_D_ESWB: LOCAL	Run			
SNMP-4kv-D	4Kv_D_FEP_1B/172.18.228.236	4Kv_D_ESWB: B2	SNMP	4Kv_D_ESWB/172.18.228.231	4Kv_D_ESWB: LOCAL	Run			

PTP Info

Straight forward Application. It just listens on physical address for any PTP packets. It grabs the correction, clock identity, and time since last PTP packet.

It only grabs correction values from the Sync message. This means that the application is accurate only for 1-step PTP. If you are using 2-step, the correction will be inaccurate. This is because we do not add together the correction values of the Sync and Follow-up messages.

Application Overview

PTP Info

Correction	Haven't seen a packet yet
ClockIdentity	Error
Time Since Last Message	0 seconds

Pcap

The Pcap application is used to create .pcap files for viewing in wireshark. The configuration settings are based on the time/max size of the file, whichever comes first. The user is allowed to start the application without a configuration. In which case, the maximum size will be used, and there won't be a limit to the time frame.

App Status

Capture Download

Nothing captured

File Size

Run Size

App Configuration

Size Limit

Time Limit

Time

Size

Start

Limits

Time*: 5 seconds < time < 24 hours

Size: 1KB < size < 2 GB

*If no time value is given, the application will not stop until the size limit is reached.

Results

The result file can be downloaded at any time using the hyperlink "Capture Download" row. Files are deleted when a new test is run, or the raspberry pi turns off.