



ONOS Northbound Interfaces

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POSTECH**

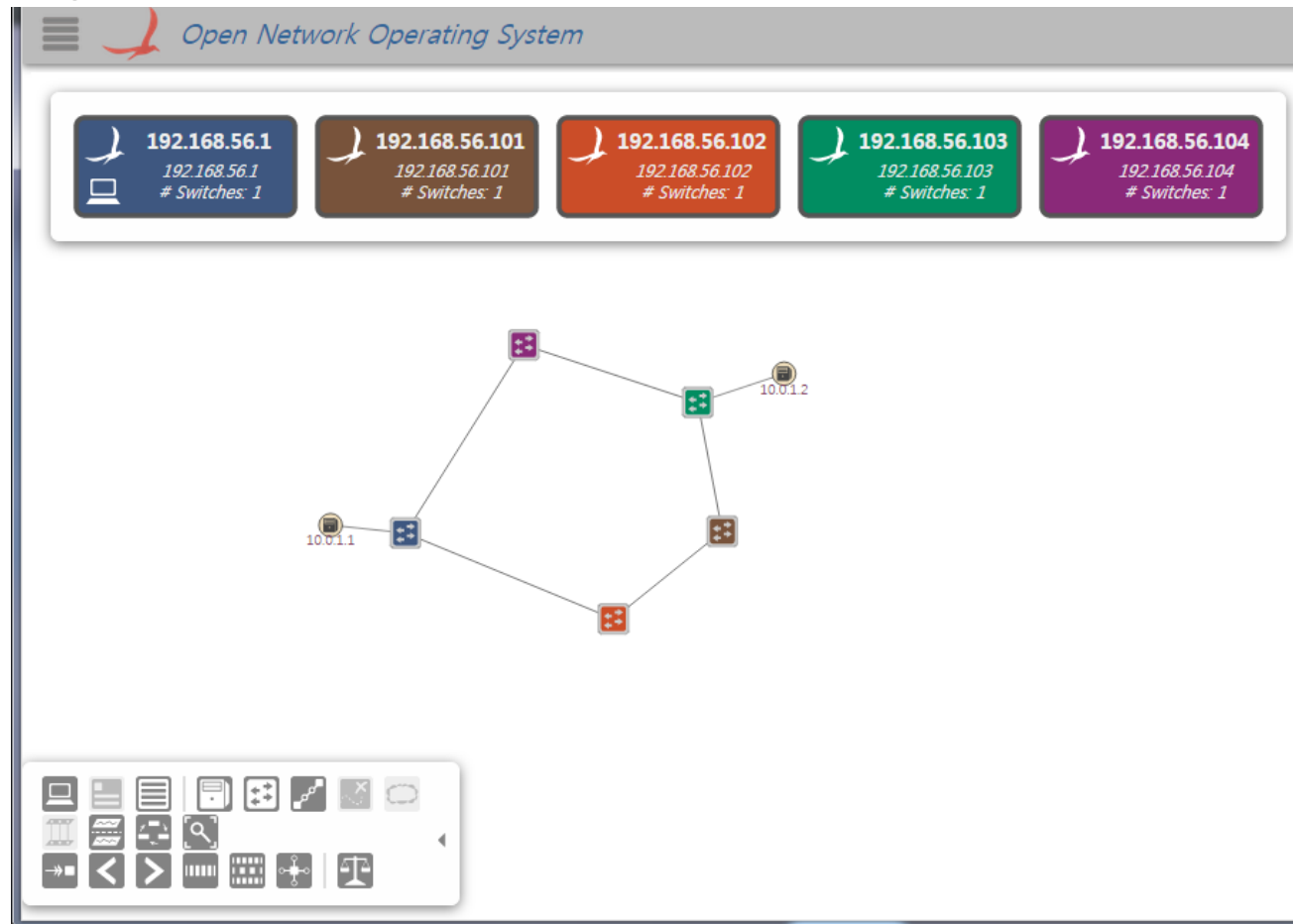
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❖ ONOS Interface

- Web GUI
- CLI
- REST API

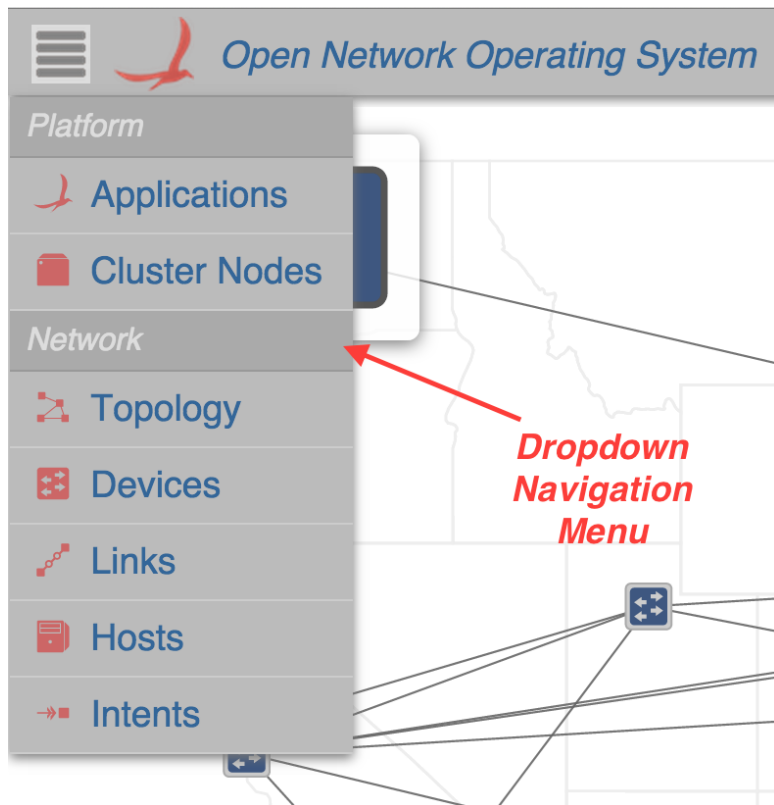
❖ ONOS (Web) GUI Overview

- A single-page web application
- Accessible through the URL `http://onos_ip:8181/onos/ui`



❖ GUI Navigation

- Platform
 - Bundle installation, instance mgmt.
- Network
 - Network related resource mgmt.



View	Description
Applications	A listing of applications installed
Cluster Nodes	A top level listing of all the cluster nodes, or instances in the network
Topology	An interactive visualization of the network topology (indication of which devices are mastered by each ONOS instance)
Devices	A top level listing of the devices
Links	A top level listing of all links
Hosts	A top level listing of all the hosts
Intents	A top level listing of all intents
Flows	A top level listing of all flows for a selected device
Ports	A top level listing of all ports for a selected device
Groups	A top level listing of all the groups for a selected device





❖ Application View

- Active vs. Installed
 - Active: applications are installed and running
 - Installed: applications are installed but not running

Applications (25 total)

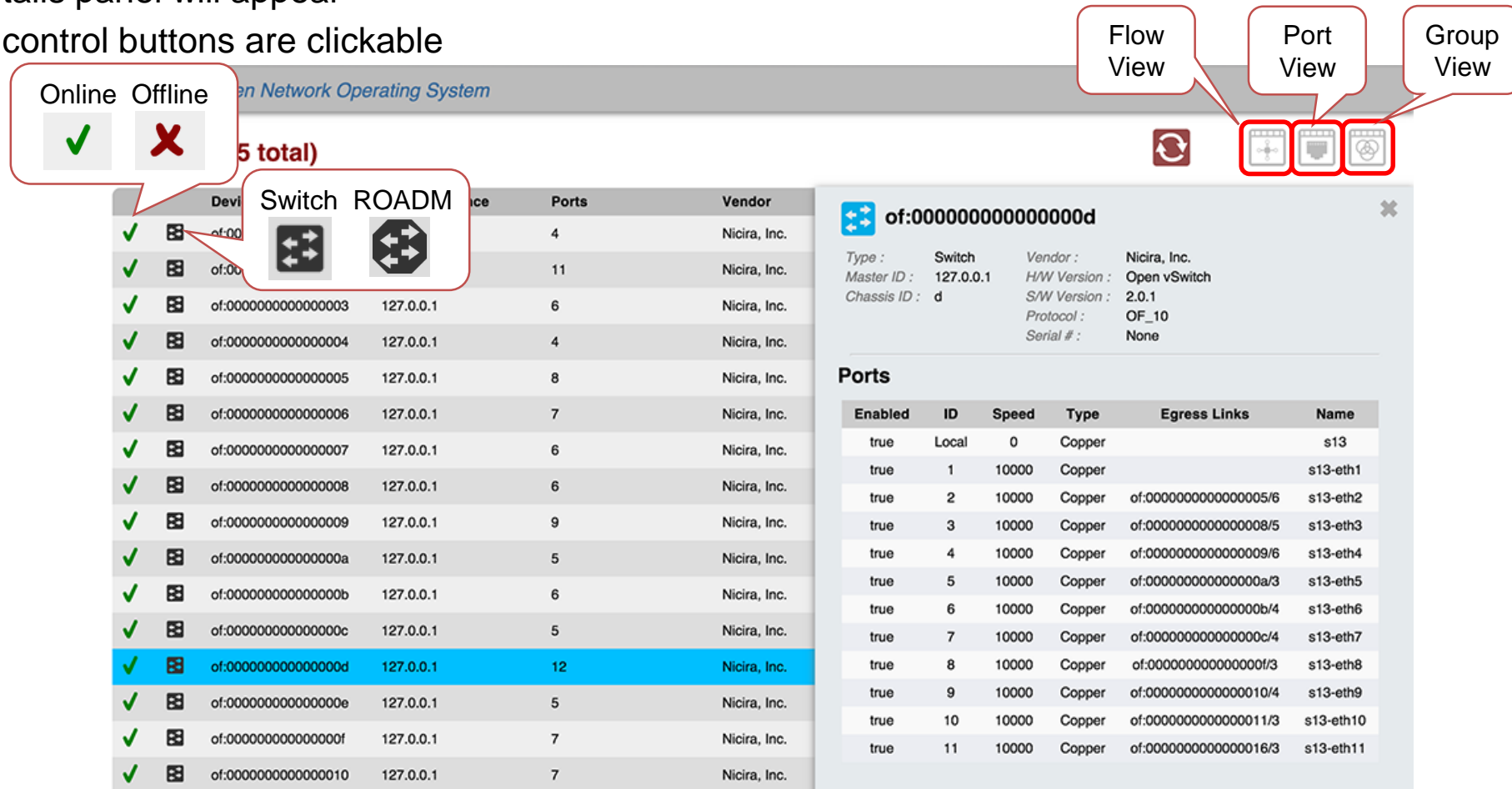


App ID	Version	Origin	Description
org.onosproject.aaa	1.3.0.SNAPSHOT	ATT	ONOS authentication application
org.onosproject.bgprouter	1.3.0.SNAPSHOT	ON.Lab	BGP router application
org.onosproject.config	1.3.0.SNAPSHOT	ON.Lab	Network configuration application
org.onosproject.cordfabric	1.3.0.SNAPSHOT	ON.Lab	Simple fabric application for CORD
org.onosproject.demo	1.3.0.SNAPSHOT	ON.Lab	Flow throughput test application
org.onosproject.distributedprimitives	1.3.0.SNAPSHOT	ON.Lab	ONOS app to test distributed primitives
✓ org.onosproject.drivers	1.3.0.SNAPSHOT	ON.Lab	Builtin device drivers

Icon	Action	Description
	Install	Bring up a file explorer so that you can upload an .oar file with your ONOS application directly
	Activate	Change the state of the current application from INSTALLED to ACTIVE
	Deactivate	Change the state of the current application from ACTIVE to INSTALLED
	Uninstall	Uninstall the current application

❖ Device View

- When a row is selected
 - A details panel will appear
 - The control buttons are clickable



The screenshot displays the ONOS Web GUI interface. At the top, there are three view buttons: "Flow View", "Port View", and "Group View". Below these, a table lists network devices. A callout box highlights the "Online" and "Offline" status indicators, showing a green checkmark for "Online" and a red X for "Offline". Another callout box highlights the "Switch" and "ROADM" icons. The table has columns for "Dev", "Switch", "ROADM", "Ports", and "Vendor". The row for "of:000000000000000d" is selected and highlighted in blue. To the right of the table, a detailed view of the selected switch is shown, including its type, master ID, chassis ID, vendor, and a list of ports.

Online Offline
✓ ✗

5 total)

Dev	Switch	ROADM	Ports	Vendor
✓ of:0000000000000000	✗	✗	4	Nicira, Inc.
✓ of:0000000000000001	✗	✗	11	Nicira, Inc.
✓ of:0000000000000003	✗	✗	6	Nicira, Inc.
✓ of:0000000000000004	✗	✗	4	Nicira, Inc.
✓ of:0000000000000005	✗	✗	8	Nicira, Inc.
✓ of:0000000000000006	✗	✗	7	Nicira, Inc.
✓ of:0000000000000007	✗	✗	6	Nicira, Inc.
✓ of:0000000000000008	✗	✗	6	Nicira, Inc.
✓ of:0000000000000009	✗	✗	9	Nicira, Inc.
✓ of:000000000000000a	✗	✗	5	Nicira, Inc.
✓ of:000000000000000b	✗	✗	6	Nicira, Inc.
✓ of:000000000000000c	✗	✗	5	Nicira, Inc.
✓ of:000000000000000d	✗	✗	12	Nicira, Inc.
✓ of:000000000000000e	✗	✗	5	Nicira, Inc.
✓ of:000000000000000f	✗	✗	7	Nicira, Inc.
✓ of:0000000000000010	✗	✗	7	Nicira, Inc.

of:000000000000000d

Type : Switch Vendor : Nicira, Inc.
Master ID : 127.0.0.1 H/W Version : Open vSwitch
Chassis ID : d S/W Version : 2.0.1
Protocol : OF_10
Serial # : None

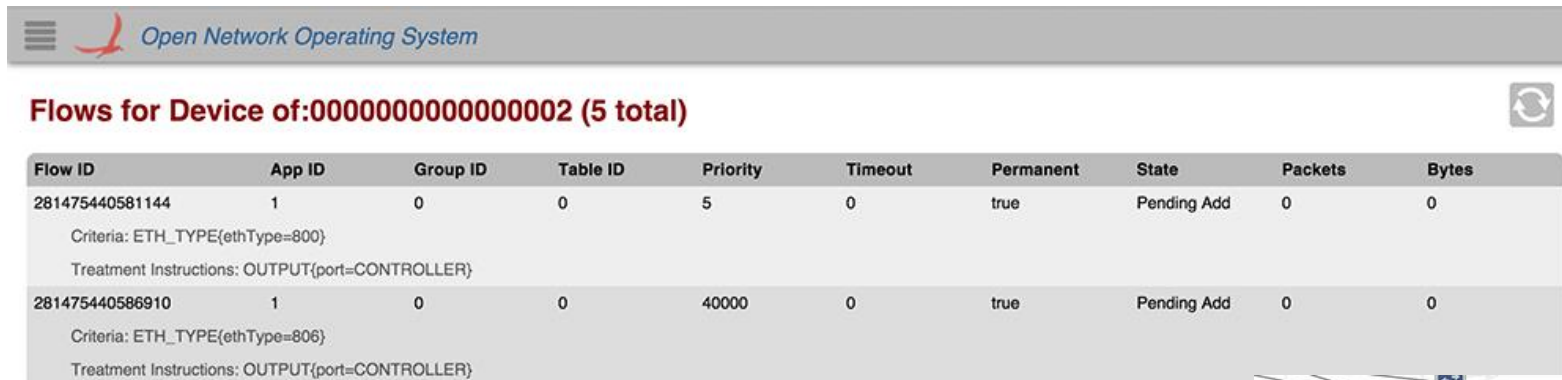
Ports

Enabled	ID	Speed	Type	Egress Links	Name
true	Local	0	Copper		s13
true	1	10000	Copper		s13-eth1
true	2	10000	Copper	of:0000000000000005/6	s13-eth2
true	3	10000	Copper	of:0000000000000008/5	s13-eth3
true	4	10000	Copper	of:0000000000000009/6	s13-eth4
true	5	10000	Copper	of:000000000000000a/3	s13-eth5
true	6	10000	Copper	of:000000000000000b/4	s13-eth6
true	7	10000	Copper	of:000000000000000c/4	s13-eth7
true	8	10000	Copper	of:000000000000000f/3	s13-eth8
true	9	10000	Copper	of:0000000000000010/4	s13-eth9
true	10	10000	Copper	of:0000000000000011/3	s13-eth10
true	11	10000	Copper	of:0000000000000016/3	s13-eth11



❖ Flow View

- List up the flows which are scrollable inside the table body
 - Criteria: matching fields
 - Treatment instruction: actions to take for matched packets



The screenshot shows the ONOS Web GUI interface. At the top, there's a header with the ONOS logo and the text "Open Network Operating System". Below the header, a title bar reads "Flows for Device of:0000000000000002 (5 total)". A table displays the flow information. The table has columns: Flow ID, App ID, Group ID, Table ID, Priority, Timeout, Permanent, State, Packets, and Bytes. Two flow entries are visible. Each entry has a 'Criteria' and 'Treatment Instructions' section below it.

Flow ID	App ID	Group ID	Table ID	Priority	Timeout	Permanent	State	Packets	Bytes
281475440581144	1	0	0	5	0	true	Pending Add	0	0
Criteria: ETH_TYPE{ethType=800} Treatment Instructions: OUTPUT{port=CONTROLLER}									
281475440586910	1	0	0	40000	0	true	Pending Add	0	0
Criteria: ETH_TYPE{ethType=806} Treatment Instructions: OUTPUT{port=CONTROLLER}									

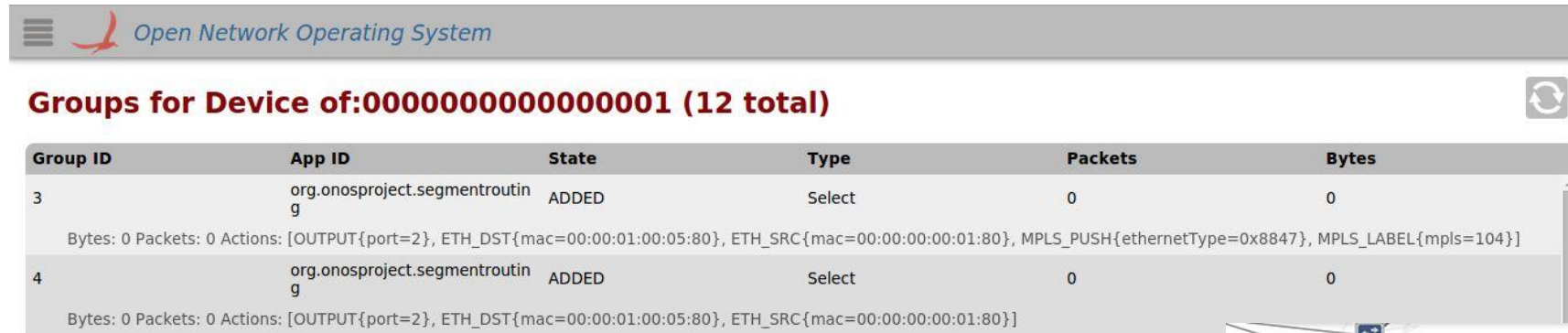
- Two ways of navigating to the Flow View
 - Topology view → select a device → click flow view icon
 - Device view → select a device → click flow view icon
- Query string via URL
 - List up the flows which are belonging to a device
 - E.g., <http://localhost:8181/onos/ui/index.html#/flow?devId=of:0000000000000002>





❖ Group View

- List up all groups of a selected device
 - Group: consists of a set of flow rules
 - Similar to the group entries that stored in group table in OpenFlow protocol



Open Network Operating System



Groups for Device of:0000000000000001 (12 total)

Group ID	App ID	State	Type	Packets	Bytes
3	org.onosproject.segmentrouting	ADDED	Select	0	0
Bytes: 0 Packets: 0 Actions: [OUTPUT{port=2}, ETH_DST{mac=00:00:01:00:05:80}, ETH_SRC{mac=00:00:00:00:01:80}, MPLS_PUSH{ethernetType=0x8847}, MPLS_LABEL{mpls=104}]					
4	org.onosproject.segmentrouting	ADDED	Select	0	0
Bytes: 0 Packets: 0 Actions: [OUTPUT{port=2}, ETH_DST{mac=00:00:01:00:05:80}, ETH_SRC{mac=00:00:00:00:01:80}]					

- Two ways of navigating to the Group View
 - Topology view → select a device → click group view icon
 - Device view → select a device → click group view icon
- Query string via URL
 - List up the flows which are belonging to a device
 - E.g., <http://localhost:8181/onos/ui/index.html#/group?devId=of:0000000000000002>



❖ Host View

Host ID	MAC Address	VLAN ID	IP Addresses	Location
 00:00:00:00:00:01/-1	00:00:00:00:00:01	-1	10.0.0.1	of:0000000000000001/1
 00:00:00:00:00:02/-1	00:00:00:00:00:02	-1	10.0.0.2	of:0000000000000002/1
 00:00:00:00:00:03/-1	00:00:00:00:00:03	-1	10.0.0.3	of:0000000000000003/1
 00:00:00:00:00:04/-1	00:00:00:00:00:04	-1	10.0.0.4	of:0000000000000004/1
 00:00:00:00:00:05/-1	00:00:00:00:00:05	-1	10.0.0.5	of:0000000000000005/1

❖ Intent View

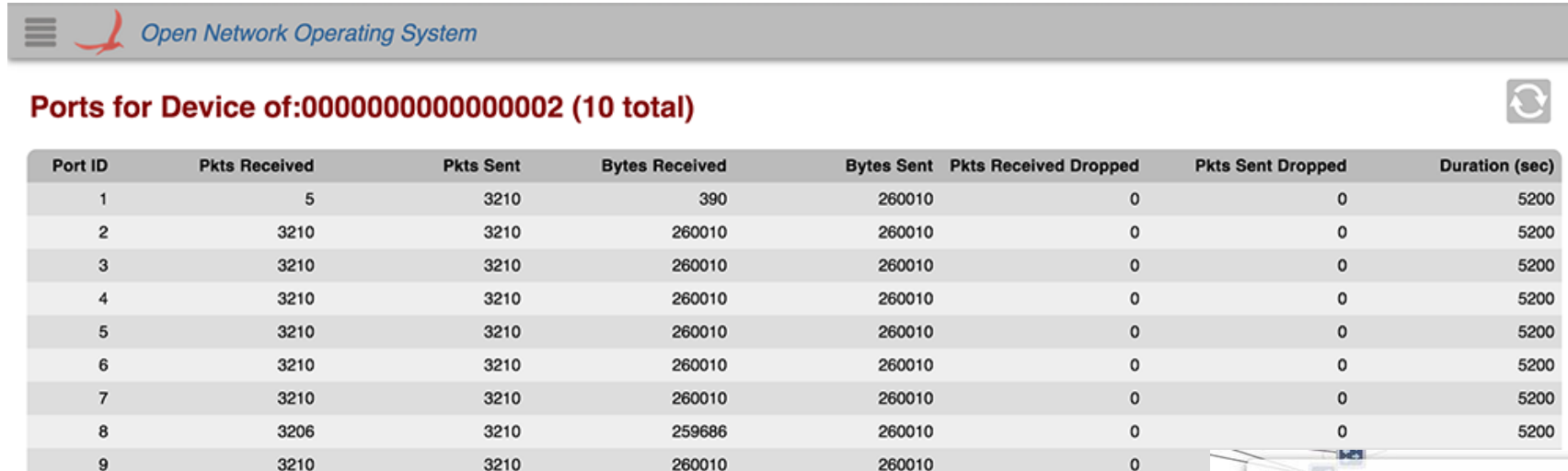
Port 1	Port 2	Type	Direction	Durable
✓ of:0000000000000001/2	of:0000000000000019/2	Direct	A <--> B	false
✓ of:0000000000000001/3	of:0000000000000006/3	Direct	A <--> B	false
✓ of:0000000000000002/4	of:0000000000000006/4	Direct	A <--> B	false
✓ of:0000000000000002/6	of:000000000000000f/2	Direct	A <--> B	false
✓ of:0000000000000003/2	of:0000000000000002/3	Direct	A <--> B	false

❖ Link View

Application ID	Key	Type	Priority
29 : org.onosproject.cli-random	0x57	HostToHostIntent	100
Resources: 00:00:00:00:00:04/-1, 00:00:00:00:00:17/-1			
Details: Host 1: 00:00:00:00:00:04/-1, Host 2: 00:00:00:00:00:17/-1			
29 : org.onosproject.cli-random	0x20	HostToHostIntent	100
Resources: 00:00:00:00:00:02/-1, 00:00:00:00:00:0B/-1			
Details: Host 1: 00:00:00:00:00:02/-1, Host 2: 00:00:00:00:00:0B/-1			

❖ Port View

- List up all ports of a selected device



The screenshot shows the ONOS Web GUI interface. At the top, there is a header bar with the ONOS logo and the text "Open Network Operating System". Below the header, there is a section titled "Ports for Device of:0000000000000002 (10 total)" with a refresh icon. Below this title is a table with 8 columns: Port ID, Pkts Received, Pkts Sent, Bytes Received, Bytes Sent, Pkts Received Dropped, Pkts Sent Dropped, and Duration (sec). The table contains 10 rows of data for Port IDs 1 through 10.

Port ID	Pkts Received	Pkts Sent	Bytes Received	Bytes Sent	Pkts Received Dropped	Pkts Sent Dropped	Duration (sec)
1	5	3210	390	260010	0	0	5200
2	3210	3210	260010	260010	0	0	5200
3	3210	3210	260010	260010	0	0	5200
4	3210	3210	260010	260010	0	0	5200
5	3210	3210	260010	260010	0	0	5200
6	3210	3210	260010	260010	0	0	5200
7	3210	3210	260010	260010	0	0	5200
8	3206	3210	259686	260010	0	0	5200
9	3210	3210	260010	260010	0	0	5200

- Two ways of navigating to the Port View
 - Topology view → select a device → click port view icon
 - Device view → select a device → click port view icon
- Query string via URL
 - List up the flows which are belonging to a device
 - E.g., <http://localhost:8181/onos/ui/index.html#/port?devId=of:0000000000000002>



The screenshot shows the CHCG device details page in the ONOS Web GUI. It displays various metadata for the device, including URI, Vendor, H/W Version, S/W Version, Serial Number, Protocol, Master IP, Latitude, Longitude, Ports, and Flows. A "Show port view for this device" button is visible at the bottom.

CHCG

URI : of:0000000000000002
Vendor : Nicira, Inc.
H/W Version : Open vSwitch
S/W Version : 2.0.1
Serial Number : None
Protocol : OF_13

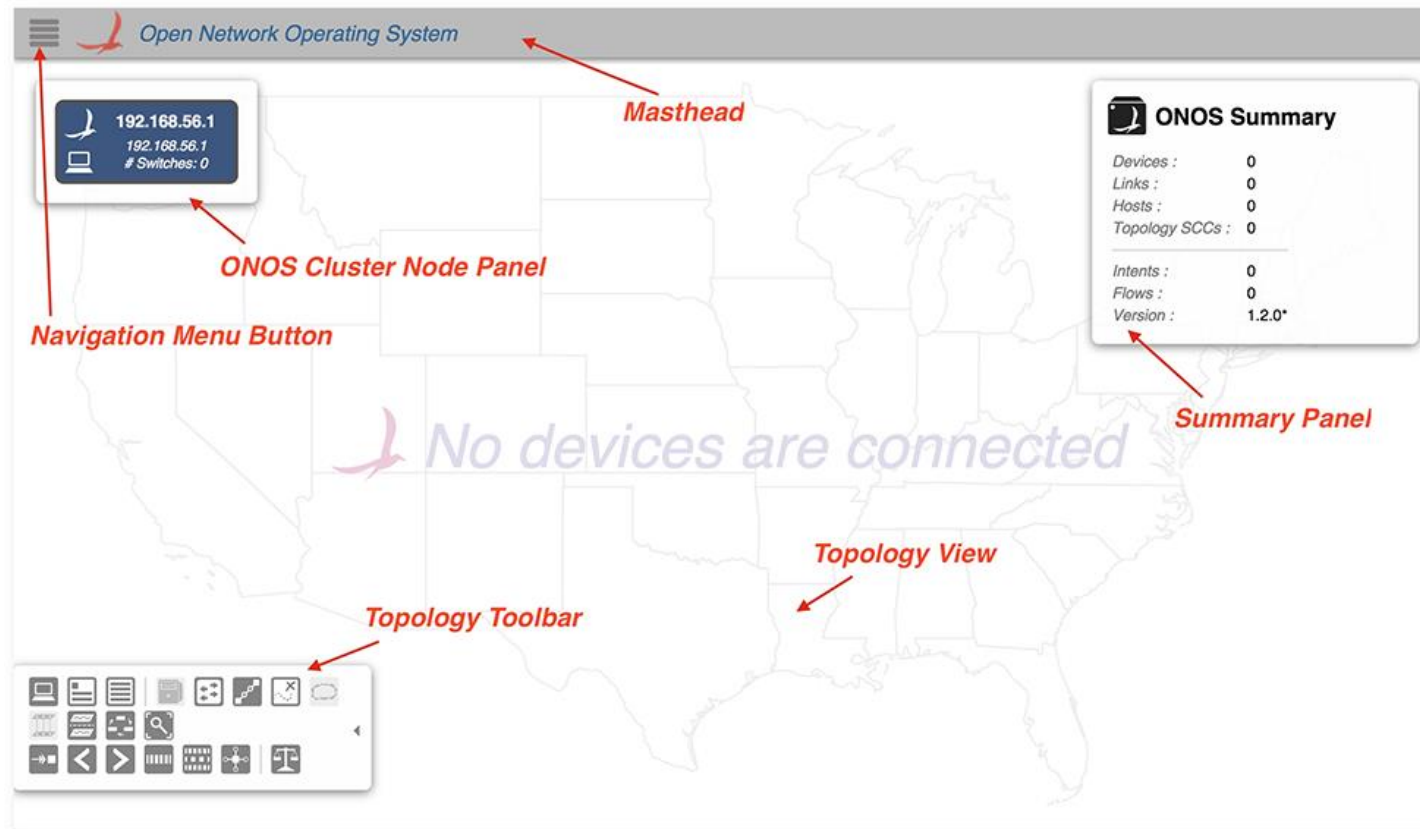
Master : 192.168.56.1
Latitude : 41.877461
Longitude : -87.642892

Ports : 11
Flows : 5

Show port view for this device









❖ Topology View









- A visual overview of the network topology
- Establish a web socket connection with ONOS instance
 - Exchange the event message to determine the topology state



❖ Topology View

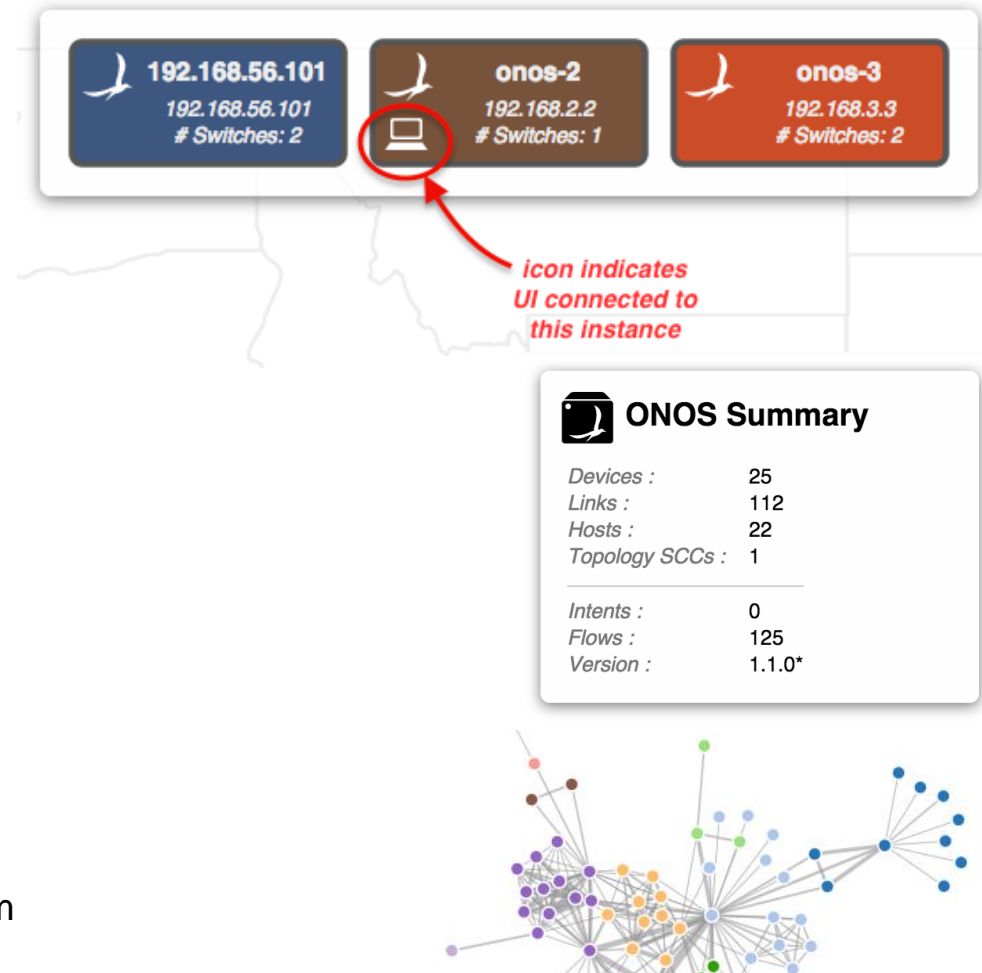
▪ Toolbar

Icon	Key	Description
	I	Toggle ONOS instances panel
	O	Toggle ONOS summary panel
	D	Disable / enable details panel
	H	Toggle host visibility
	M	Toggle offline visibility
	P	Toggle port highlighting
	B	Toggle background map
	S	Toggle sprite layer

Icon	Key	Description
	N	Cycle node layers
	L	Cycle device labels
	R	Reset pan / zoom
	V	Show all related intents
	W	Monitor traffic of selected intent
	A	Monitor all traffic
	F	Show device link flows
	E	Equalize mastership roles

❖ Topology View

- Instance panel
 - Show the instance ID, IP, # of switches
 - Color coding shows controller mastership
- Summary panel
 - Show a brief summary of network properties
 - Devices, links, hosts, intents, flows, versions, etc.
- Nodes and links
 - Undirected graph of nodes and links
 - Nodes → devices (switches) and hosts
 - Links → network links
 - Initial layout of the nodes and links
 - Provided by the use of **D3 Force Layout** algorithm
 - Layout customization
 - **onos-topo-cfg** command can be used to upload topology meta-data to the server
 - Include longitude/latitude information for each of the nodes



❖ Topology View

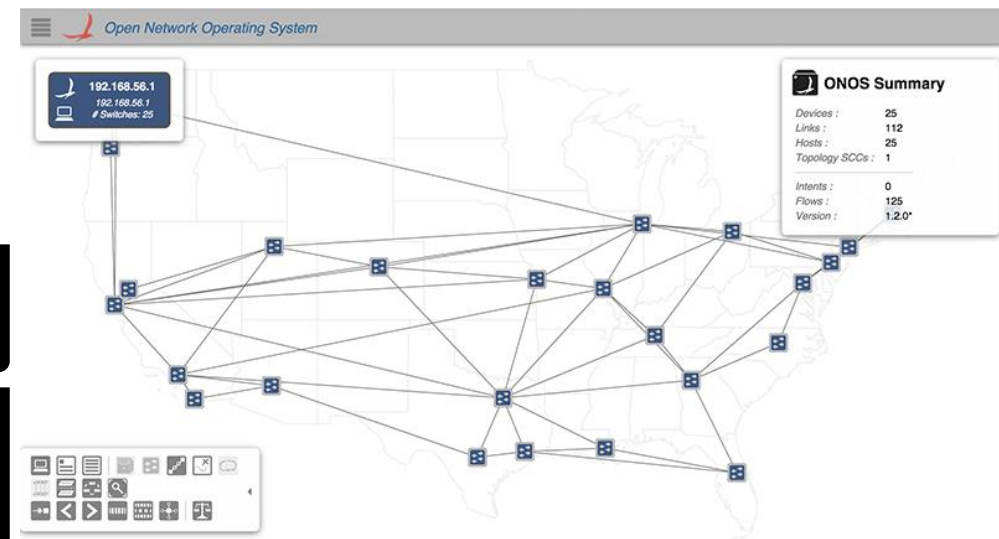
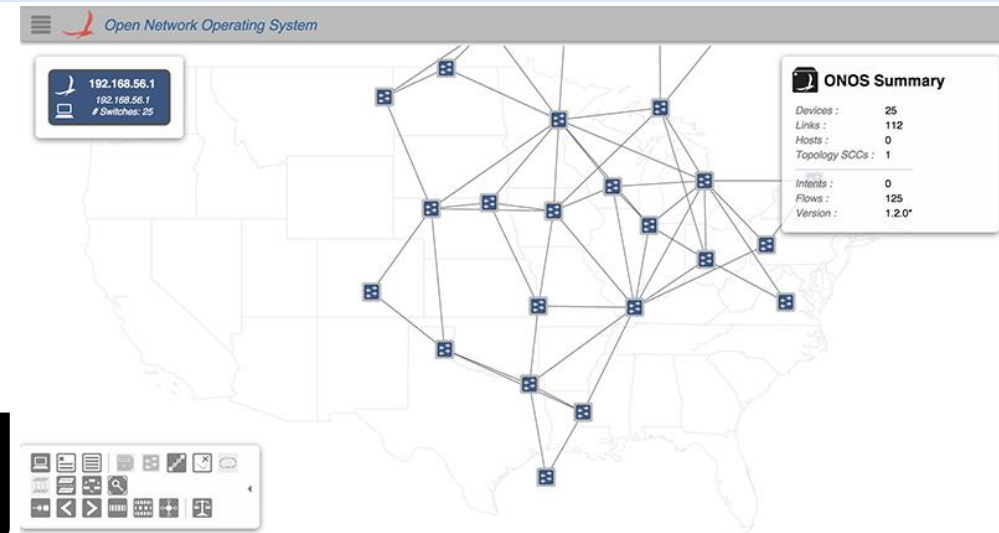
- Layout rearrangement
 - Topology generation
 - ONOS uses free-floating topology by default

```
$ cd ~/onos/tools/test/topos  
$ sudo python ./att-onos.py $OC1
```

- Topology rearrangement
 - On receipt of the data, the server sends node updates to the GUI
 - Longitude/latitude data is used to calibrate node positions

```
$ cd ~/onos/tools/test/topos  
$ onos-topo-cfg 127.0.0.1 attmpls.json
```

```
{ "alias": "s1", "uri": "of:000000000000  
00001", "mac": "000000000001", "annotations":  
{ "name": "CMBR", "latitude": 42.373730,  
"longitude": -71.109734 }, "type": "SWITCH" }
```

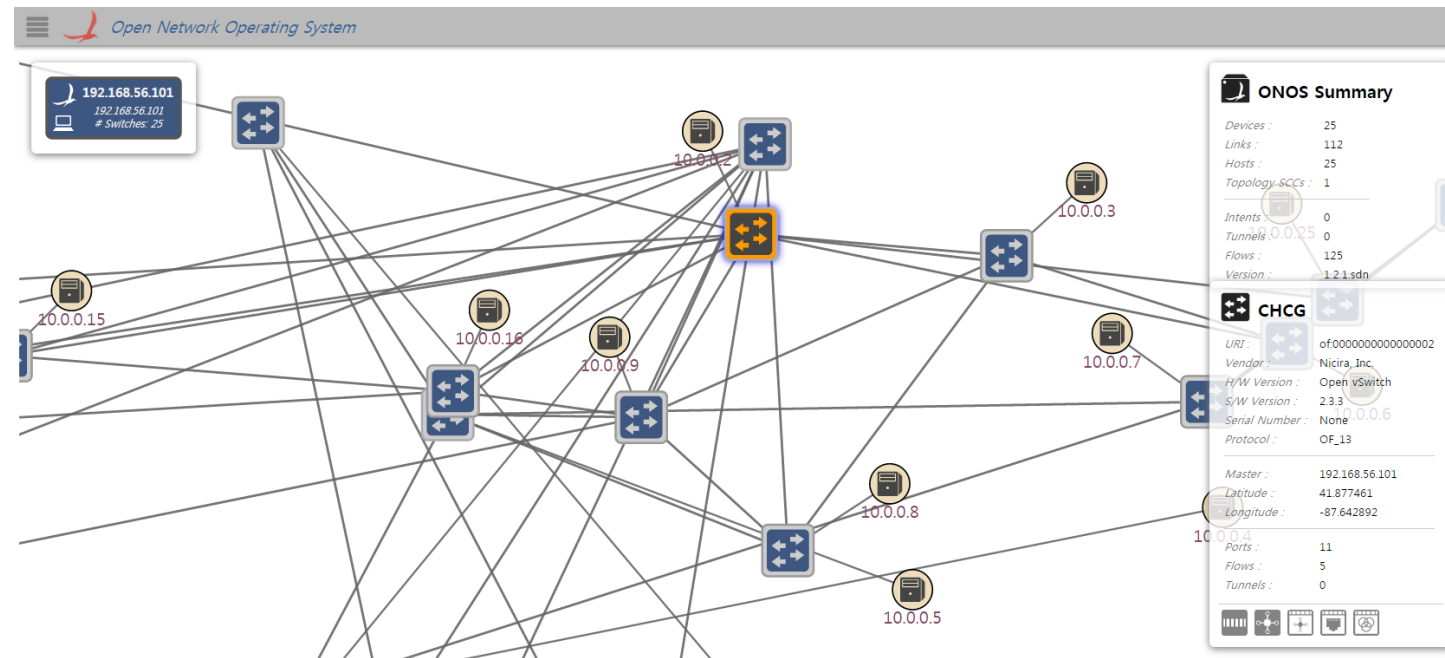


❖ Topology View

■ Mouse gestures

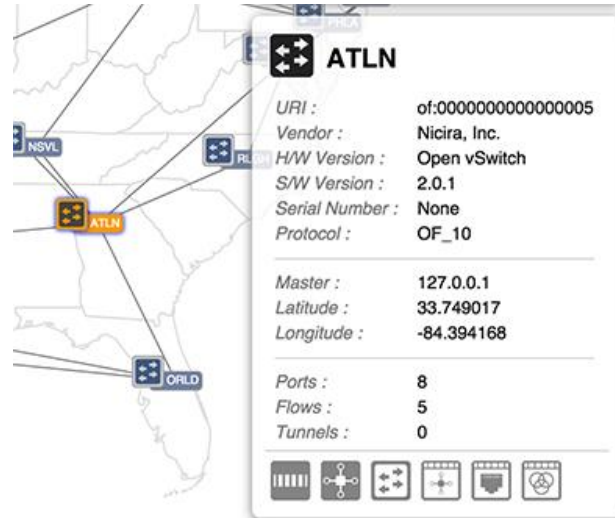
- Node reposition
 - Click & drag to a new location
- Multiple selection
 - Hold shift key + click on node
- Release selection
 - Escape key

- Panning
 - cmd-drag (MAC)
 - alt-drag (Win)
- Zooming
 - cmd-scroll (MAC)
 - alt-scroll (Win)
- Reset panning & zooming
 - 'R' key



❖ Topology View

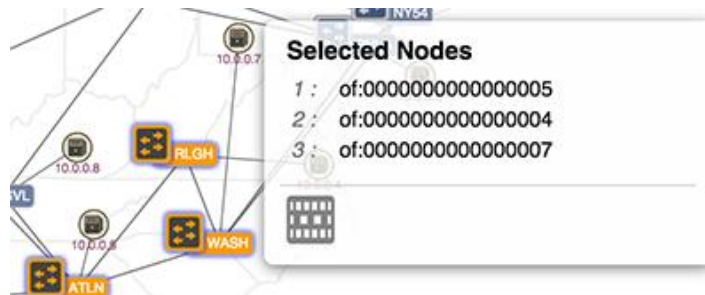
- Details panel (4 cases)
 - A single device is selected



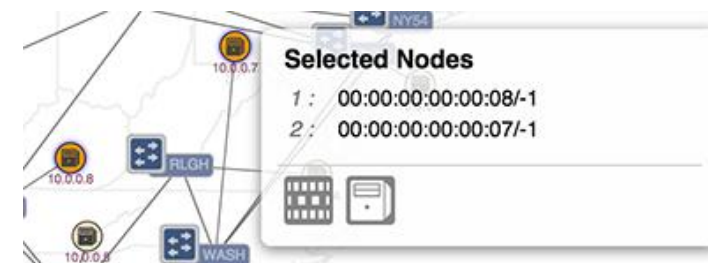
- A single host is selected



- Multiple devices are selected

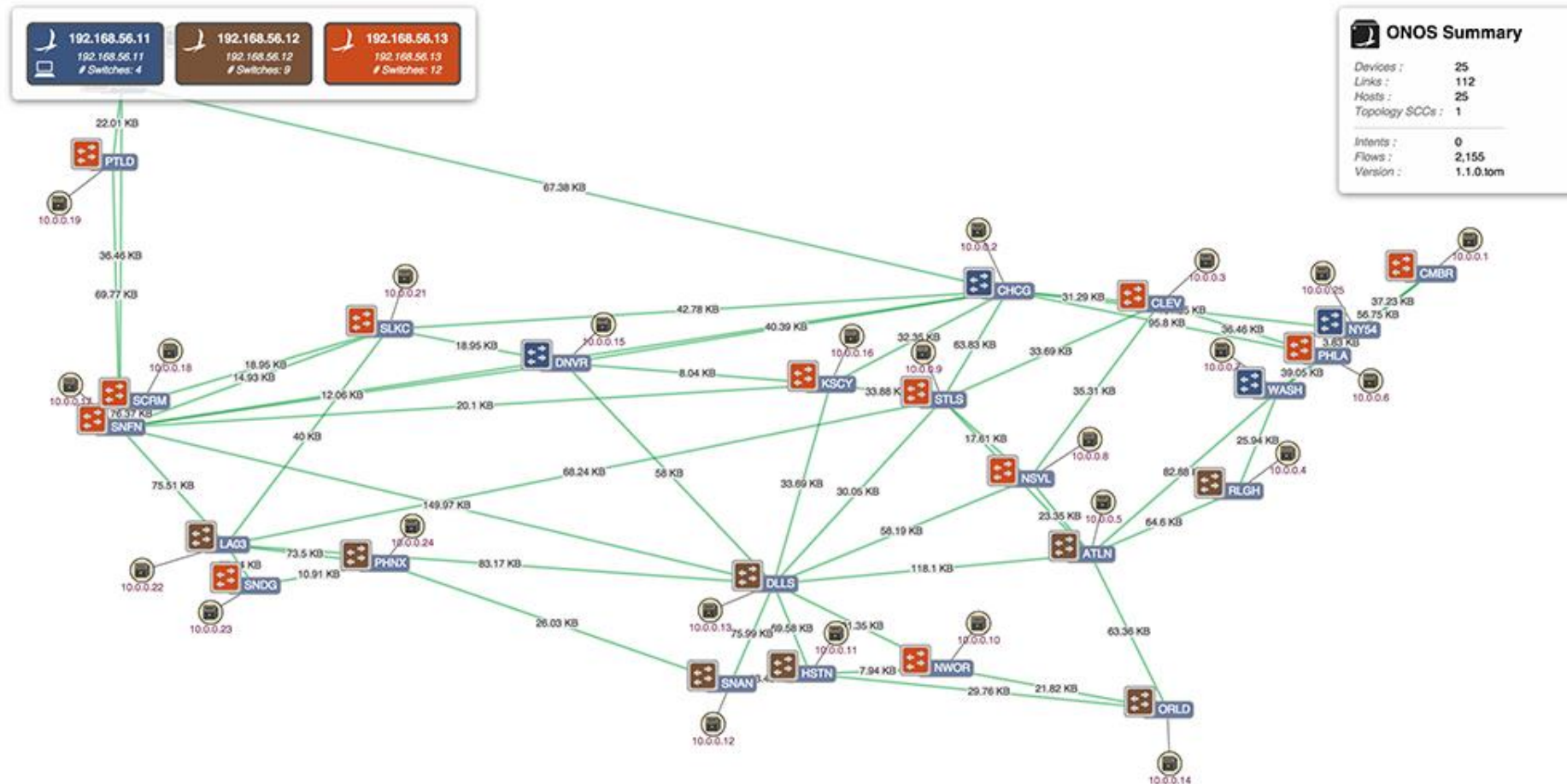


- Exactly two hosts are selected



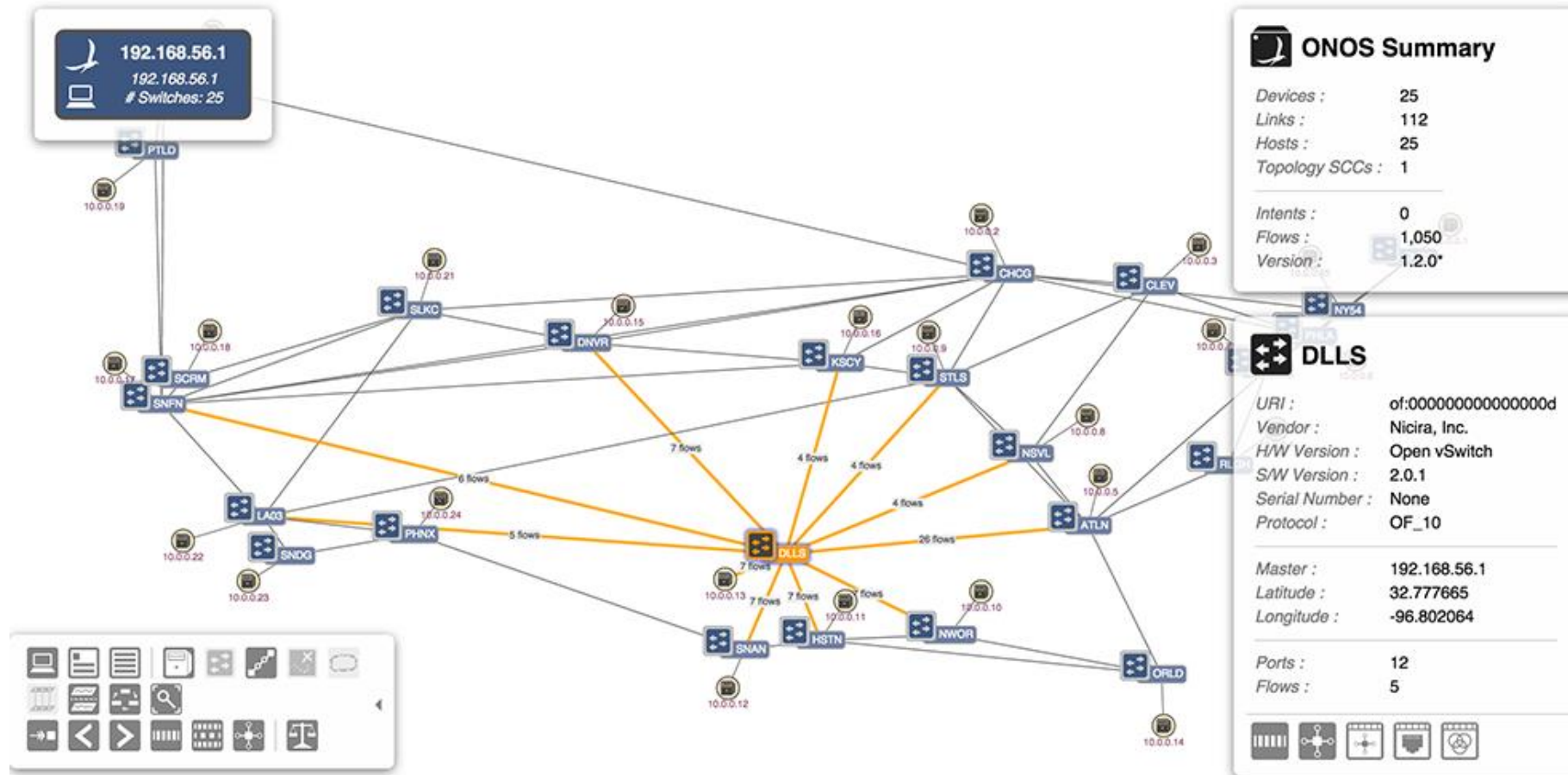
❖ Topology View

- Visualizing traffic
 - Press the 'A' key will display the traffic in green color



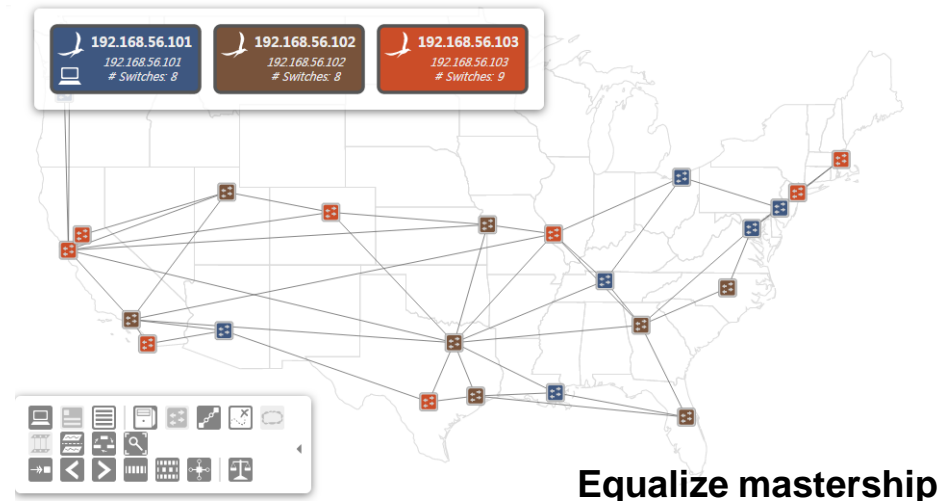
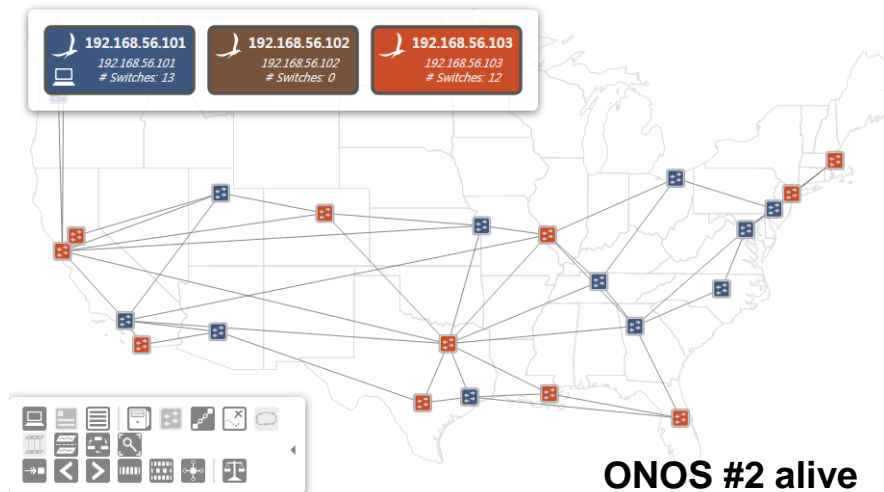
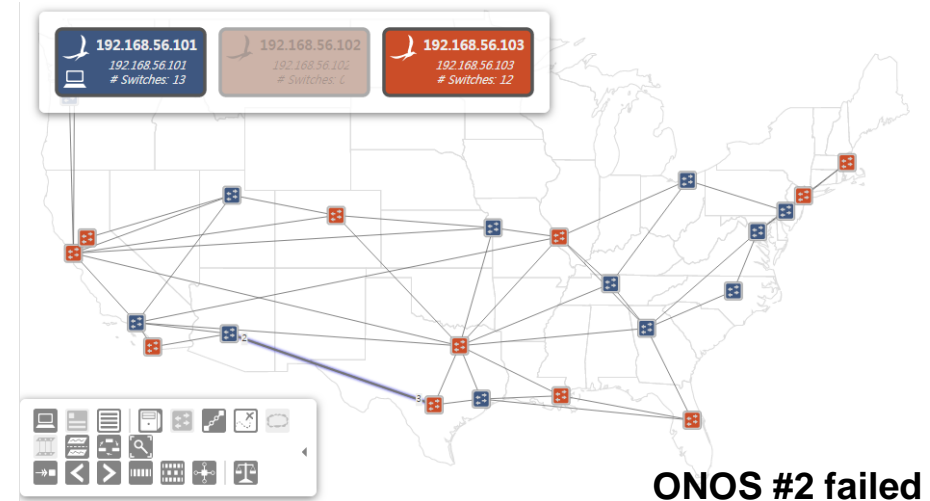
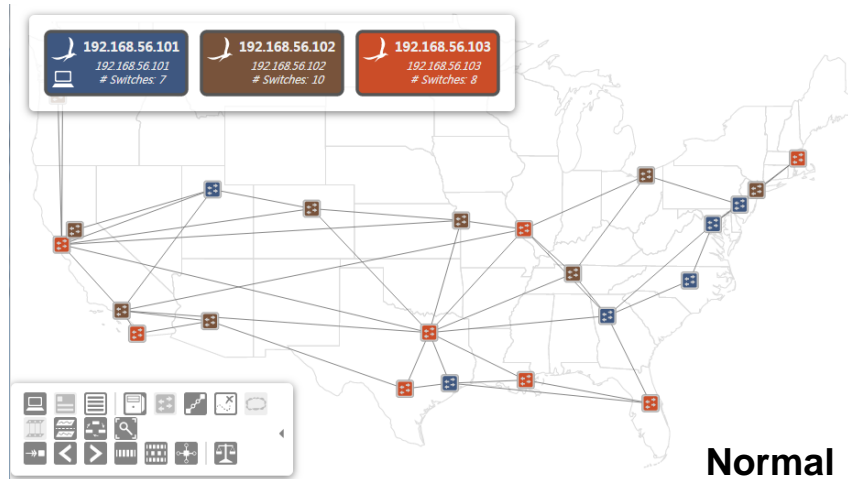
❖ Topology View

- Visualizing device link flows
 - Select a device, and press the 'F' key will display the # of flows egressing from it



❖ Topology View

▪ Failover & mastership



❖ ONOS CLI Overview

- An extension of Karaf's CLI
- Leverage features such programmatic extensibility
- Able to load and unload bundles and SSH access



❖ Access CLI

- Local installation
 - Access with the command ***karaf clean***
- Remote installation
 - Deploy with ***onos-package*** and ***onos-install*** command
 - Access with ***onos*** command

```
$ onos {$ip_address}  
Logging in as karaf  
Welcome to Open Network Operating System (ONOS)!
```



```
...  
onos>
```

❖ ONOS Commands

- ONOS Supplies a set of its own commands
 - **help onos** lists the available commands

```
onos> help onos
COMMANDS
...
onos:add-host-intent      Installs host-to-host connectivity intent
onos:add-mpis-intent      Installs mpis connectivity intent
...
onos:app                  Manages application inventory
onos:app-ids              Lists application ID information
onos:apps                 Lists application information
--More--
```

- **help onos:<command>** shows the descriptions about the command

```
onos> help onos:apps
DESCRIPTION
    onos:apps
    Lists application information
SYNTAX
    onos:apps [options]
OPTIONS
    -a, --active      Show active only
    -j, --json        Output JSON
    --help            Display this help message
    -s, --short       Show short output only
```


❖ ONOS REST API Overview

- Provide REST API using Jersey
- All endpoints need to be prefixed with
 - `http://onos_ip:8181/onos/v1`
- Available REST APIs
 - Device, Link, Host, Topology, Path, Flow, Intent, Application, Component Configuration

▶ `http://192.168.56.101:8181/onos/v1/topology/clusters`

☒ GET ☐ POST ☐ PUT ☐ PATCH ☐ DELETE ☐ HEAD

- Later version will provide graphical interface for REST API
 - E.g., swagger



Raw	JSON	Response
Copy to clipboard Save as file		
<pre>{ -clusters: [1] -0: { id: 0 deviceCount: 25 linkCount: 112 root: "of:0000000000000000a" } }</pre>		

❖ Example REST API

Type	API	Method	Description
Device	/devices	GET	Lists all infrastructure devices.
	/devices/{deviceId}	GET	Lists details of a specific infrastructure device.
	/devices/{deviceId}/ports	GET	Lists ports of a specific infrastructure device.
Link	/links	GET	Lists all infrastructure links.
	/links? {device=deviceId}{port=portNumber}{direction=[ALL,INGRESS,EGRESS]}	GET	Lists details of a link.
Host	/hosts	GET	Lists all end-stations hosts.
	/hosts/{hostId}	GET	Lists details of a specific end-station host specified by the host ID.
	/hosts/{mac}/{vlan}	GET	Lists details of a specific end-station host specified by the host MAC address and Vlan Id.
Flow	/flows/{deviceId}	GET	Gets list of flow rules applied to the specified infrastructure device.
	/flows/{deviceId}{flowId}	GET	Gets details of a specified flow rule.
	/flows	GET	Gets details of all flow rules in the system.



References

1. ONOS: <http://onosproject.org/>
2. ONOS CLI: <https://wiki.onosproject.org/display/ONOS/Appendix+A+%3A+CLI+commands>
3. ONOS REST: <https://wiki.onosproject.org/display/ONOS/Appendix+B%3A+REST+API>
4. ONOS GUI: <https://wiki.onosproject.org/display/ONOS/The+ONOS+Web+GUI>