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OF@TEIN+ Playground: SmartX Box & Inter-connect Provisioning

OF@TEIN+ 1st

Annual Meeting 2018

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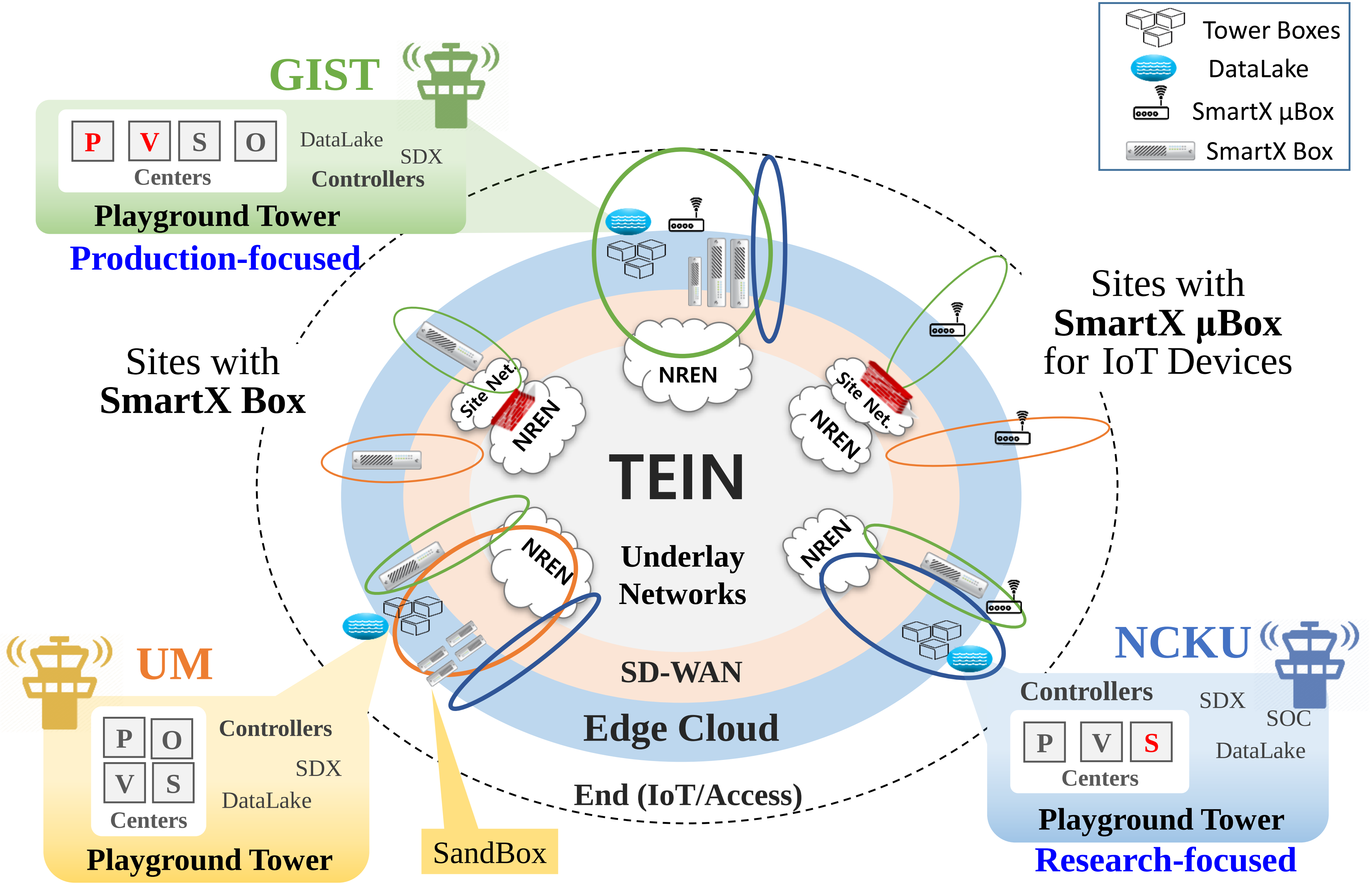
Gwangju, South Korea

Outline

- **OF@TEIN+ Playground: Overview**
  - Draft proposal for OF@TEIN+ Playground
  - SmartX Box concept
- **Step 0: Preparation for Provisioning the SmartX Box**
  - SmartX Box hardware & networking requirements
  - Existing hardware resource types
  - SmartX Box wiring & network connections
- **Step 1: Software Provisioning**
  - SmartX Box key software types
  - SmartX Box ‘Triple Star’ (***) software design
  - Basic requirements of Triple Star software
  - Software & hardware mapping
  - Triple Star software installation steps
- **Step 2: Inter-connect Provisioning for SmartX Box**
  - SmartX Box software configuration setup
  - SDN inter-connect provisioning
  - Cloud inter-connect provisioning
- **Demonstration**
  - SmartX Box software upgrading for an existing site
  - Video demonstration

Proposal for OF@TEIN+ Playground

2018.01.17



GIST

P V S O

Centers

DataLake

SDX

Controllers

Playground Tower

Production-focused

Sites with
SmartX Box

Sites with
SmartX µBox
for IoT Devices

UM

P O
V S

Centers

Controllers

SDX

DataLake

Playground Tower

Incubation-focused

SandBox

NCKU

Controllers

SDX

SOC

P V S

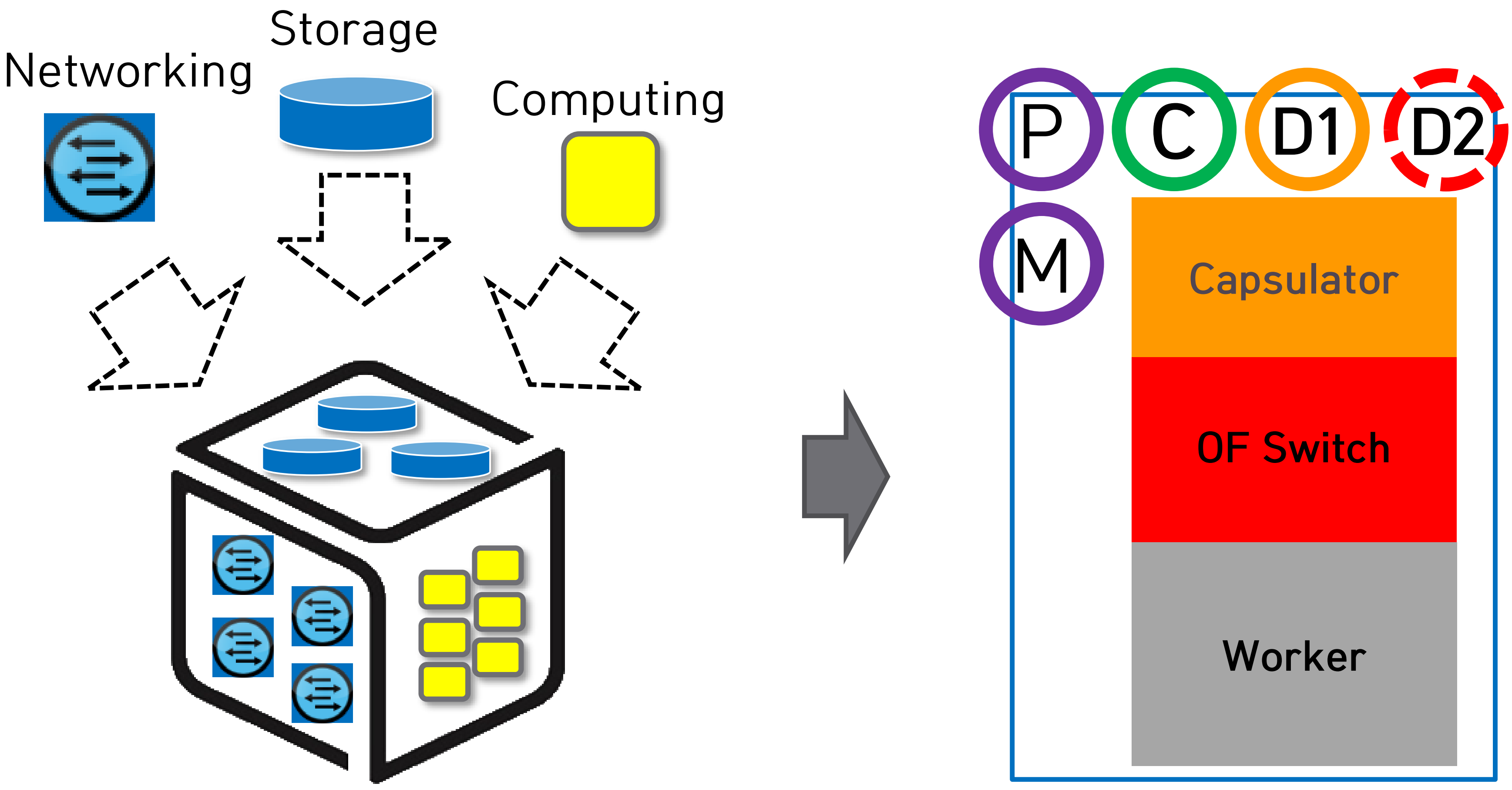
Centers

DataLake

Playground Tower

Research-focused

SmartX Box: Hyper-converged Resources



3 Tier Nodes: Capsulator and OF Switch (Networking), Worker (Computing + Storage)
3 Network Planes: Power + Management / Control / Data1 + Data2

Step 0: Preparation for Provisioning SmartX Box

- Hardware & Networking Requirements
- Existing Hardware Types
- Wiring & Network Connections

SmartX Box: Hardware & Networking Requirements

1. **SmartX Box Hardware (Recommended) Specification**
   - Processor (CPU) : 8 cores
   - Memory (RAM) : 32 GB
   - Storage (SSD/HDD) : 512 GB
   - Network interface : 5 Ethernet ports (Power + Management + Control + Data1 + Data2 [optional])

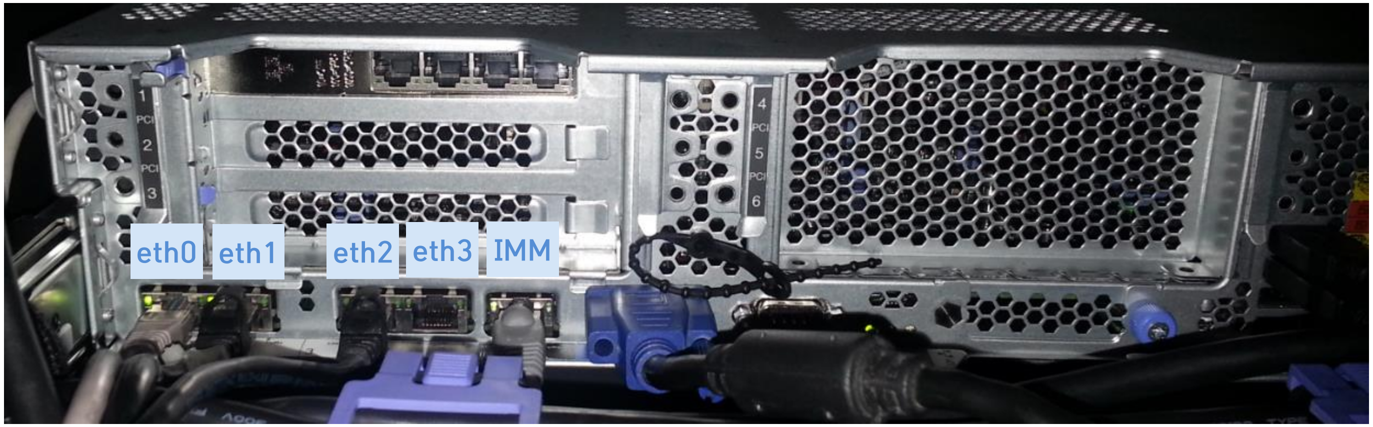
2. **L2 Switch with dedicated VLANs and subnet IP addresses**
   - VLAN/Subnet 1 : /28 block for Power + Management + Control
   - VLAN/Subnet 2 : /30 block for Data1
   - VLAN/Subnet 3 : /29 block for Data2 [optional]

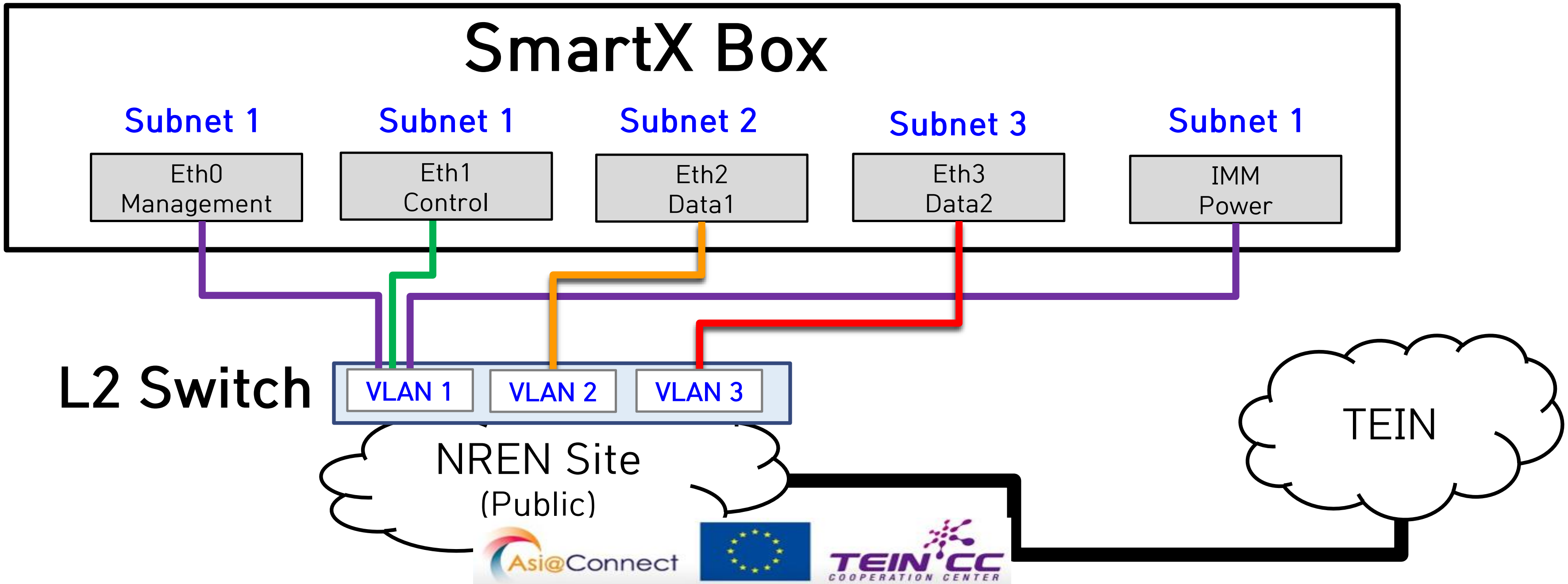
SmartX Box: Hardware Resource Types

Model	Type B (IBM System x3650 M4)	Type O (SuperServer E300-8D)
Size	17.5 in X 29.4in X 3.4in	10in X 8.9in X 8.9in
Processor	**Intel® Xeon® processor E5-2630**, 12 Cores, 12 Threads, 2.30GHz	**Intel® Xeon® processor D-1518**, 4 Cores, 8 Threads, 2.2GHz
Memory	24 x DDR3 DIMM sockets (32GB)	4x DDR4 DIMM sockets (32GB)
Graphics	Matrox G200eR2	Aspeed® AST2400
I/O	8 x USB 3.0 ports 2 x VGA port IBM ServerRAID, IBM SATA Device	2 USB 3.0 ports 1 VGA port 4 x SATA3 ports
Network Interfaces	4 x 1GbE LAN ports 2 x 10GbE Embedded Adapter (Optional) 1 x Integrated Management Module II (IMM2)	2 10G SFP+ LAN ports 6 1GbE LAN ports 1 Dedicated IPMI LAN port
Storage	600GB (HDD)	256GB (SSD)

SmartX Box: Wiring & Network Connections

(Example: Type B with IBM M4 Server)





SmartX Box

Subnet 1 — Eth0 Management

Subnet 1 — Eth1 Control

Subnet 2 — Eth2 Data1

Subnet 3 — Eth3 Data2

Subnet 1 — IMM Power

L2 Switch

VLAN 1

VLAN 2

VLAN 3

NREN Site
(Public)

TEIN

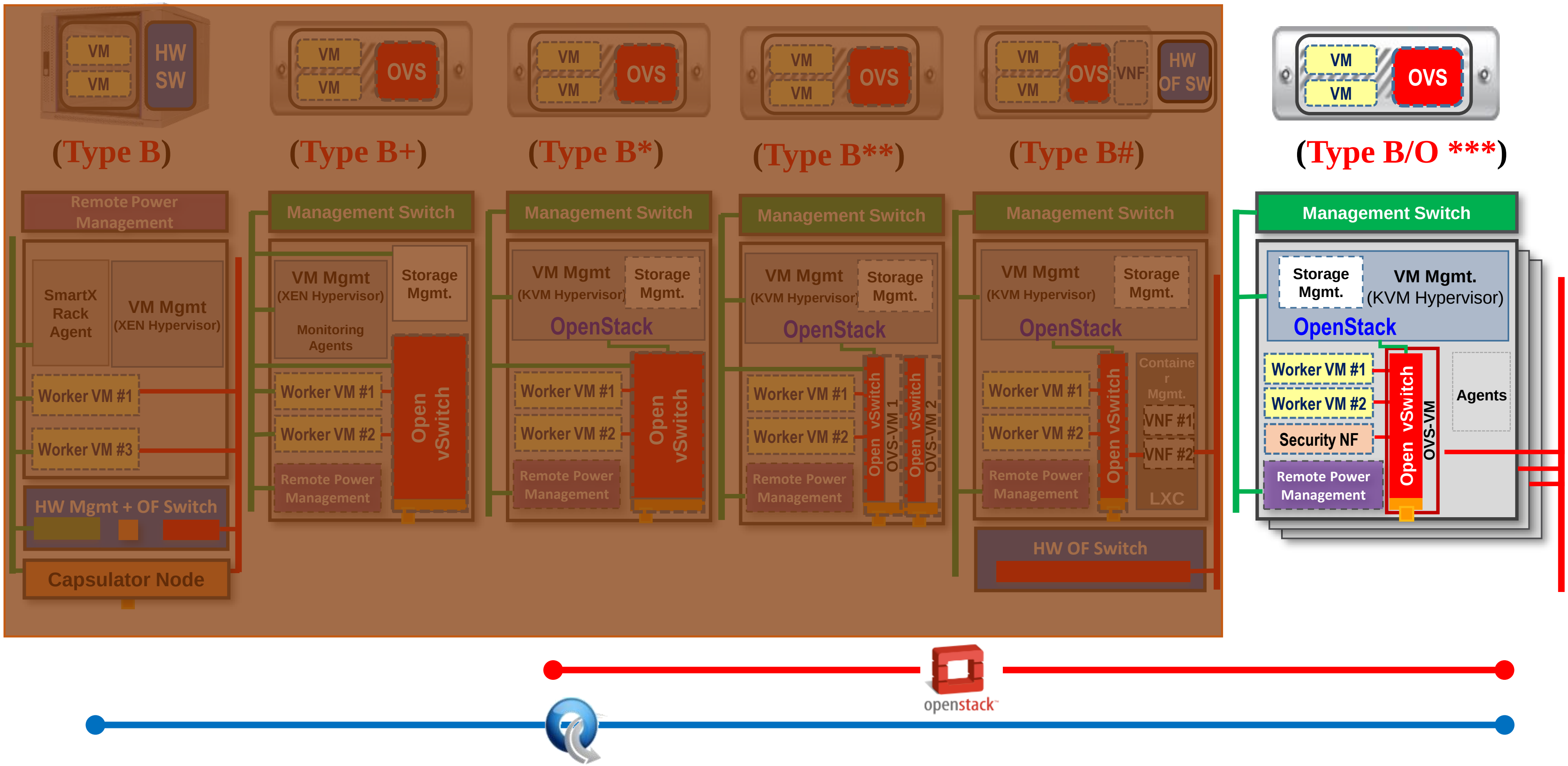
Asi@Connect

TEIN*CC
COOPERATION CENTER

Step 1: Software Provisioning

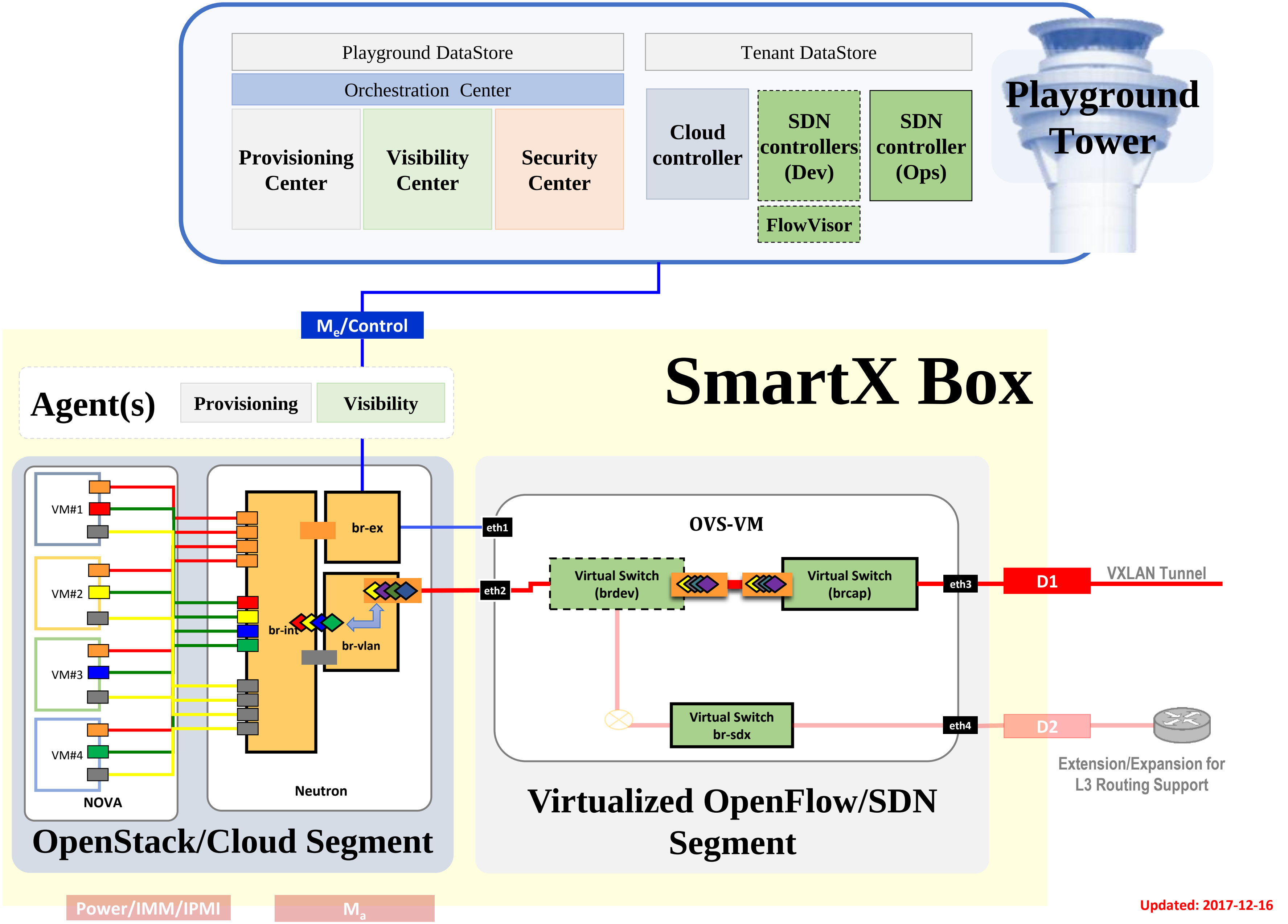
- Overview
- Software provisioning for Controller’s
- Cloud software provisioning for SmartX Box
- SDN software provisioning for SmartX Box

SmartX Box: Key Software Types Timeline



Asi@Connect TEIN*CC COOPERATION CENTER

SmartX Box: Triple Star (***) Software Design (v2)



Playground DataStore

Orchestration Center

Provisioning Center

Visibility Center

Security Center

Tenant DataStore

Cloud controller

SDN controllers (Dev)

SDN controller (Ops)

FlowVisor

Playground Tower

M_e/Control

SmartX Box

Agent(s)

Provisioning

Visibility

VM#1

VM#2

VM#3

VM#4

NOVA

br-ex

br-int

br-vlan

Neutron

OpenStack/Cloud Segment

OVS-VM

eth1

eth2

eth3

eth4

Virtual Switch (brdev)

Virtual Switch (brcap)

Virtual Switch br-sdx

D1

VXLAN Tunnel

D2

Extension/Expansion for L3 Routing Support

Virtualized OpenFlow/SDN Segment

Power/IMM/IPMI

M_a

Updated: 2017-12-16

SmartX Box: Basic Requirements of TripleStar (∗∗∗) Software

Software Component	Version
• Ubuntu version	16.04.03 (LTS)
• Kernel version	4.10.0-28-generic
• VM Management	KVM by OpenStack (Stable Ocata)
• OVS version	2.6.1 (Ubuntu Repository)

SmartX Box: Software & Hardware Mapping

SmartX Box Hardware

Type B

Type O

SmartX Box Software

Type B+ → Plus (+) Version

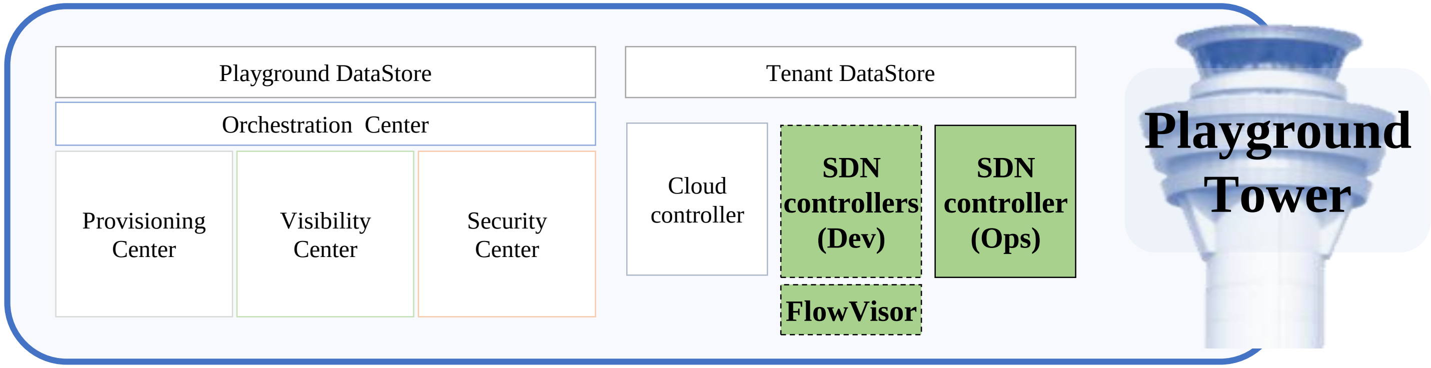
Type B* → Star (*) Version

Type B# → Sharp (#) Version

Type B** → Double Star (**) Version

Type O/B* → Triple Star (***) Version**

SDN Controllers Provisioning



Software	Version	Features	Function
FlowVisor		Flow Slicer	Slice or Divide the Flow Table in the Switches
OpenDaylight	Stable Hydrogen	Controller (Dev)	Centralized Policy/Rules Management
ONOS	Stable Loon	Controller (Ops)	Centralized Policy/Rules Management

Flowvisor Provisioning

https://github.com/OPENNETWORKINGLAB/flowvisor/wiki

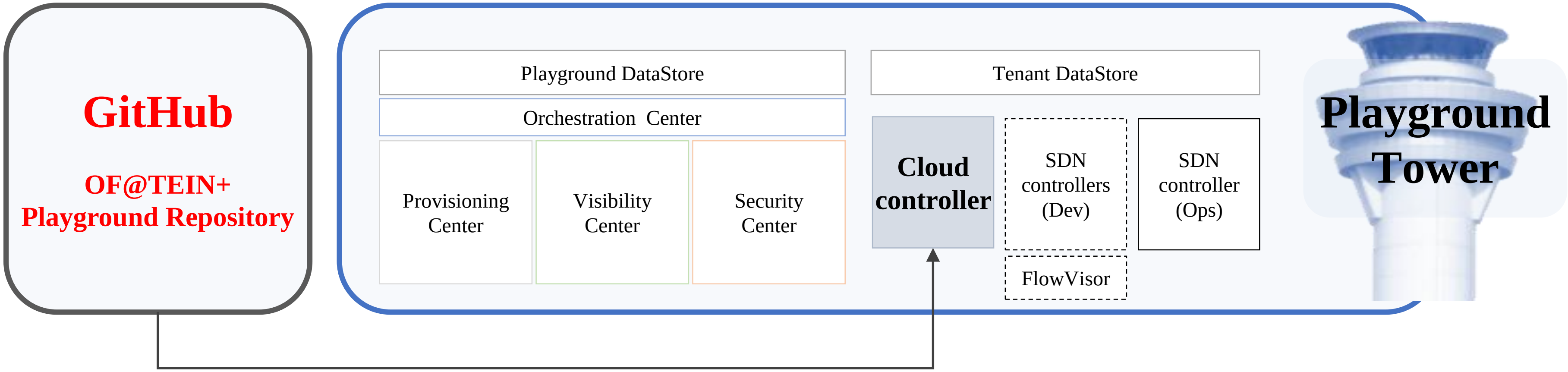
ONOS Controller (Ops) Provisioning

```
$wget http://repo1.maven.org/maven2/org/onosproject/onos-releases/onos-1.11.1/onos-1.11.1.tar.gz
$ tar –xvzf onos-1.11.1.tar.gz
$ cd onos-1.11.1/bin
$ ./onos-service start
```

ODL Controller (Dev) Provisic

https://wiki.opendaylight.org/view/Relea

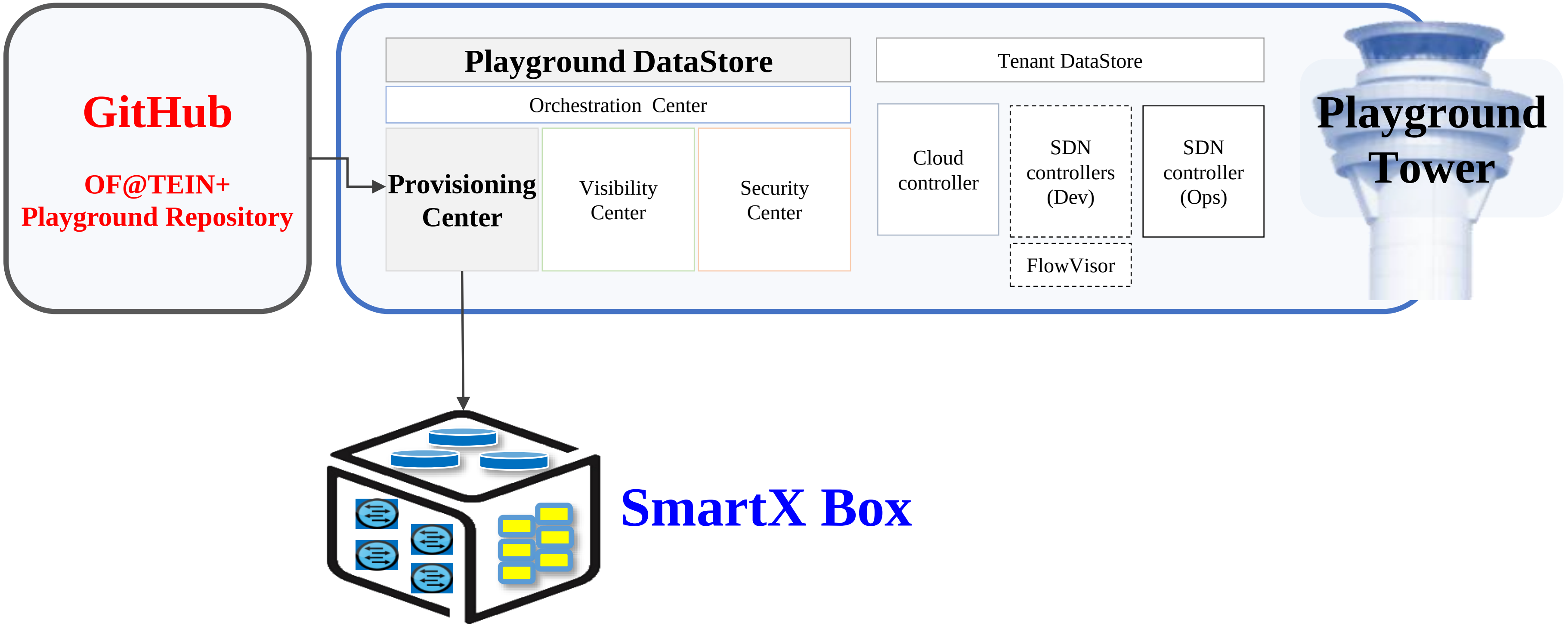
Cloud Controllers Provisioning



Software	Version	Features	Function
OpenStack	Stable Ocata	Keystone	Centralized Account Management
		Horizon	Centralized Dashboard (Web UI)

```
$ git clone https://github.com/OFTEIN-NET/Provisioning-SmartX-Box-TripleStar
$ cd Provisioning-SmartX-Box-TripleStar
$ sudo chmod +x install_controller.sh
$ ./install_controller.sh
```

SmartX Box Provisioning



GitHub

OF@TEIN+
Playground Repository

Playground DataStore

Orchestration Center

Provisioning Center

Visibility Center

Security Center

Tenant DataStore

Cloud controller

SDN controllers (Dev)

SDN controller (Ops)

FlowVisor

Playground Tower

SmartX Box

Software	Version	Features	Function
OpenStack	Stable Ocata	Nova	Instances (VMs) management
		Neutron	Instances Networking Configuration
		Glance	Image Storage
Open vSwitch	2.6.1 (Packages)	OVS Switch	Configuring Operator/Developers SDN Switches
		OVSDB	Centralized management/control SDN switches

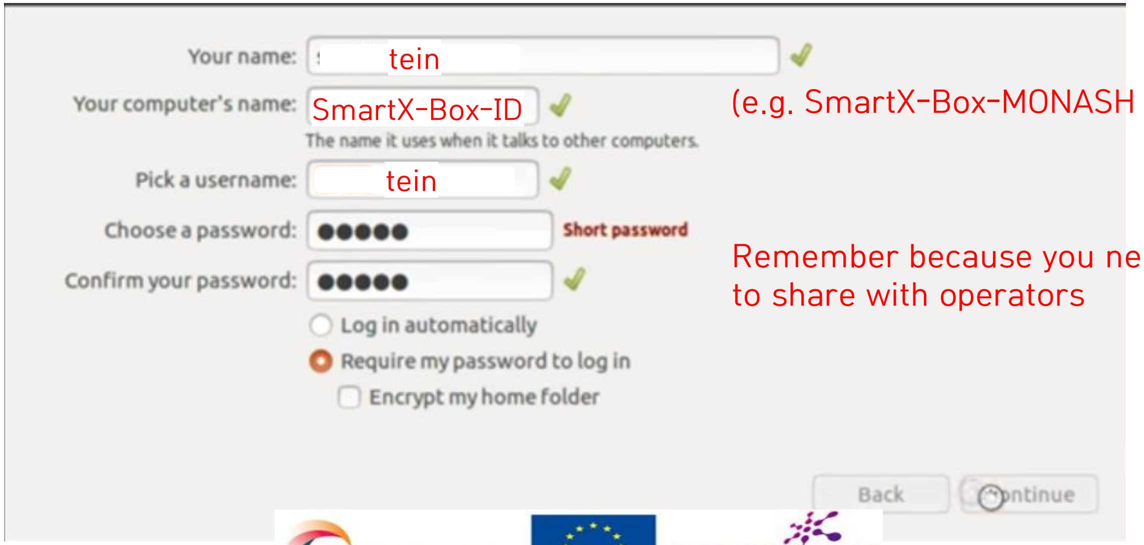
SmartX Box Provisioning: Triple Star (***)
Software Installation Steps

1. Install Ubuntu OS (16.04.3)
2. Check the connectivity to central sites (GIST, MYREN, and NCKU)
3. Submit network-related information to operator
4. Download 'Otriple Star' installation software
5. Execute OpenStack cloud installation script
6. Execute OVS-VM creation script for deploying SDN switches
7. Execute vSwitches creation and configuration script for integrating Cloud and SDN segments
8. Inform and request for an OpenStack account to operator for performing any experiments

(1) Install Ubuntu OS (16.04.3)

- In case you need assistance in installing Ubuntu 16.04.3. Just follow the given link as a reference and modify accordingly
  - https://www.youtube.com/watch?v=c_Ja2PRt0cc

- During Ubuntu installation specify following details



Your name: tein ✓

Your computer's name: SmartX-Box-ID ✓ (e.g. SmartX-Box-MONASH for Monash

The name it uses when it talks to other computers.

Pick a username: tein ✓

Choose a password: ●●●●● Short password

Confirm your password: ●●●●● ✓

Remember because you need to share with operators

○ Log in automatically

● Require my password to log in

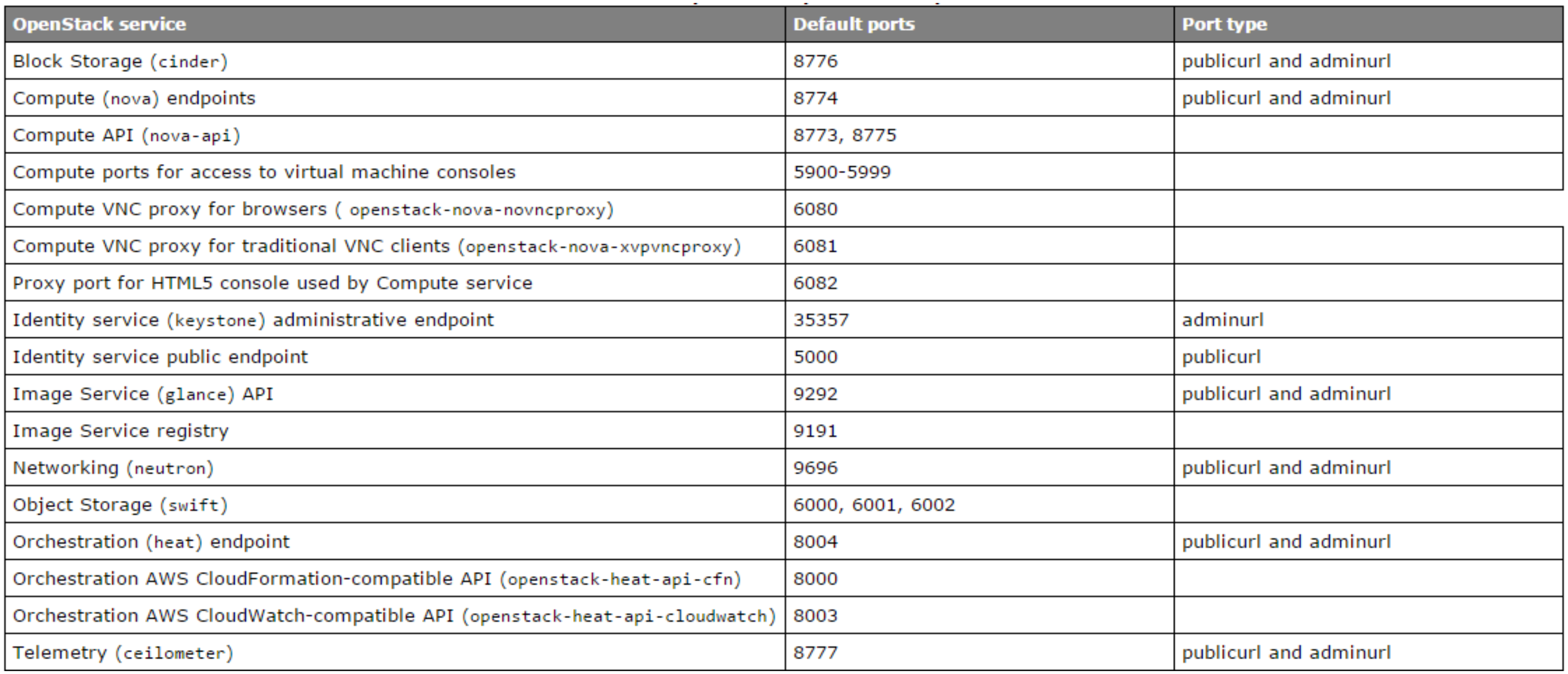
□ Encrypt my home folder

(2) Box Connectivity Verification

- Required before Starting installation (if failed, installation will be failed)
- Connectivity to these entities are required:
  - Cloud Controller for OpenStack Centralized Management (Keystone and Horizon) : 103.22.221.74
  - OpenFlow-SDN Network Slicer (FlowVisor) : 103.22.221.52
  - SmartX Configuration and Access Center : 103.22.221.53
  - One of the Testbed HUB nodes (MYREN, NCKU or GIST) : 103.26.47.229, 140.116.158.233 or 61.252.52.11
- If you are behind a Firewall, please add rules as shown in the next page

(2) Server Connectivity Verification

- **Firewall Rules for OpenStack Cloud**



OpenStack service	Default ports	Port type
Block Storage (cinder)	8776	publicurl and adminurl
Compute (nova) endpoints	8774	publicurl and adminurl
Compute API (nova-api)	8773, 8775	
Compute ports for access to virtual machine consoles	5900-5999	
Compute VNC proxy for browsers (openstack-nova-novncproxy)	6080	
Compute VNC proxy for traditional VNC clients (openstack-nova-xvpvncproxy)	6081	
Proxy port for HTML5 console used by Compute service	6082	
Identity service (keystone) administrative endpoint	35357	adminurl
Identity service public endpoint	5000	publicurl
Image Service (glance) API	9292	publicurl and adminurl
Image Service registry	9191	
Networking (neutron)	9696	publicurl and adminurl
Object Storage (swift)	6000, 6001, 6002	
Orchestration (heat) endpoint	8004	publicurl and adminurl
Orchestration AWS CloudFormation-compatible API (openstack-heat-api-cfn)	8000	
Orchestration AWS CloudWatch-compatible API (openstack-heat-api-cloudwatch)	8003	
Telemetry (ceilometer)	8777	publicurl and adminurl

- Compute (nova) placement 8778

- **Firewall Rules for OpenFlow SDN**
  - OpenvSwitch : VXLAN (UDP/4789), OVSDB (TCP/4455)
  - OpenFlow Controller : OF-Control (TCP/6633), REST API (TCP/8080)

(3) Submit Network Information

- Required for modifying the installation script for the site
- Submit these information to Operator via Email: ops@oftein.net
  - Site Name (Comsats, Monash, …)
  - Box IP Address (Management IP)
  - Free Public IP Address (for VMs Pool and one IP for OVS instances)
  - Gateway IP Address for Management Subnet
  - Data path subnet details (IP address, netmask, gateway)

Wait for the confirmation from OF@TEIN+ Operator(s) before proceeding to the next steps

(4) Download ‘Triple Star’ Software

- Download the Otriple Star software (e.g. when installing at COMSATS University)

  ```
  # scp -r netcs@103.22.221.74:/home/netcs/openstack/Box-Installations/OTripleStar-Install-COMSATS .
  ```

- Move inside the downloaded directory

  ```
  # cd OTripleStar-Install-COMSATS
  ```

- Change permissions on the scripts

  ```
  # sudo chmod +x *.sh
  ```

(5) Installing OpenStack Cloud Software

- Script Name: **install_smartx_box.sh**

- Execute Installation Script with this command in the Linux CLI

```
# ./install_smartx_box.sh
```

(6) Creating OVS-VM for SDN Switches Configurations

- Script Name: **create_ovs_vm.sh**

- Execute Installation Script with this command in the CLI

```
# ./create_ovs_vm.sh
```

(7) Creating SDN Switches and Integrating with OpenStack

- Script Name: **create_ovs_bridges.sh**
- Execute SDN switches configuration Script

```
# ./create_ovs_bridges.sh
```

(8) Inform + Request Account for Experiment

- Send the account request to operator

  Email : ops@oftein.net

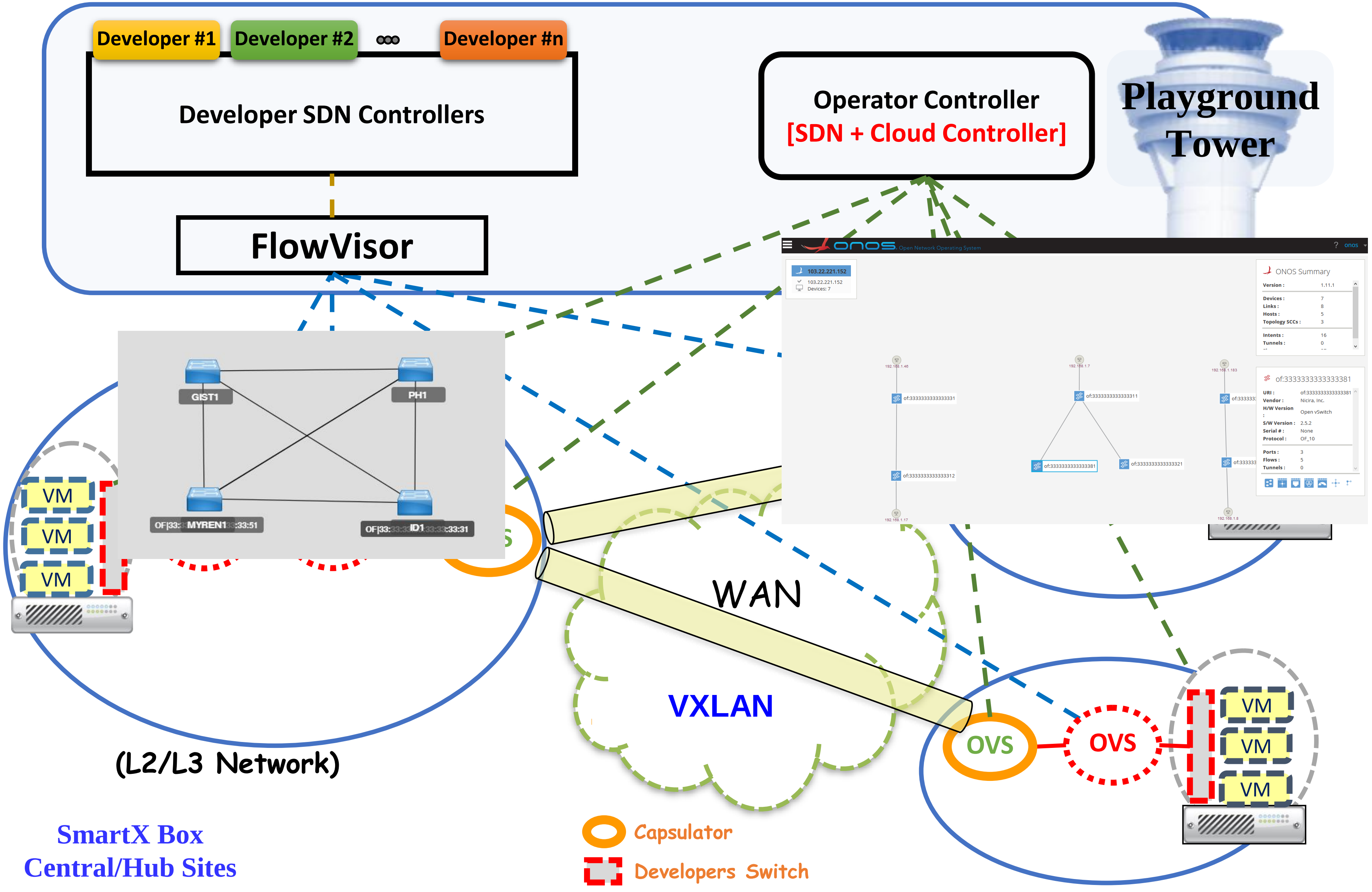
- Please check detailed information for testing VM-to-VM communication using SDN-Cloud Testbed

  https://www.youtube.com/watch?v=gdxpKvy-75E

Step 2: Inter-connect Provisioning

- Overview
- Software provisioning for Controller's
- Cloud software provisioning for SmartX Box
- SDN software provisioning for SmartX Box

Multi-islands SDN with Network Slicing



onos Open Network Operating System

103.22.221.152
103.22.221.152
Devices: 7

ONOS Summary

Version : 1.11.1
Devices : 7
Links : 8
Hosts : 5
Topology SCCs : 3
Intents : 16
Tunnels : 0

192.168.1.46
of:3333333333333331
of:3333333333333312
192.168.1.17
192.168.1.7
of:3333333333333311
of:3333333333333381
of:3333333333333321
192.168.1.183
192.168.1.8

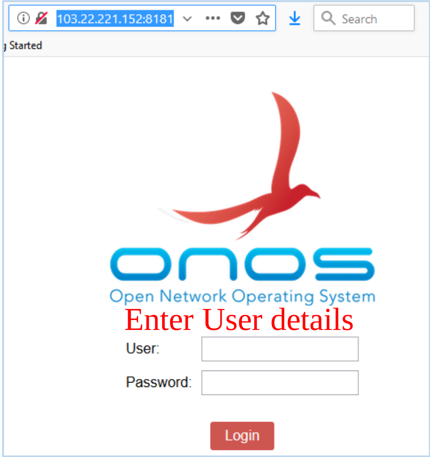
of:3333333333333381
URI : of:3333333333333381
Vendor : Nicira, Inc.
H/W Version : Open vSwitch
S/W Version : 2.5.2
Serial # : None
Protocol : OF_10
Ports : 3
Flows : 5
Tunnels : 0

SmartX Box
Central/Hub Sites

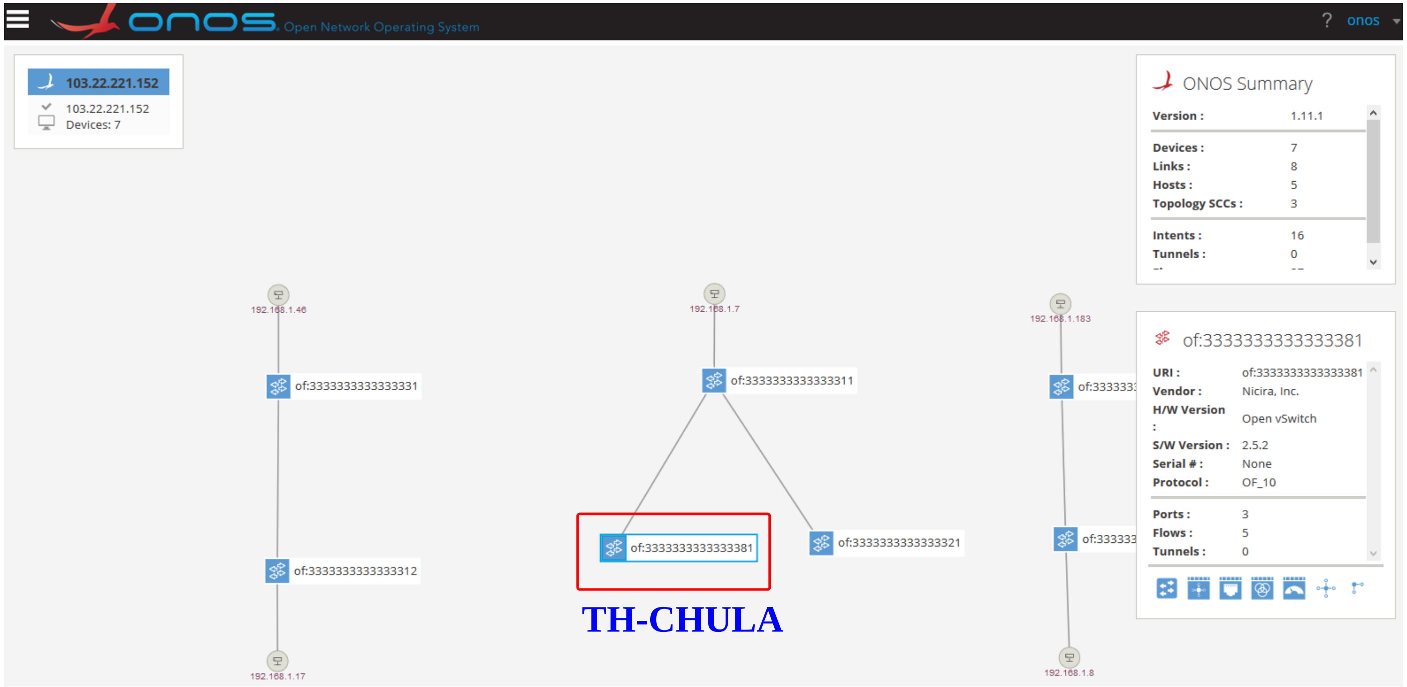
SmartX Box
Remote Sites

Asi@Connect TEIN*CC COOPERATION CENTER

Access Operator Controller & Add ONOS Intents



Enter User details



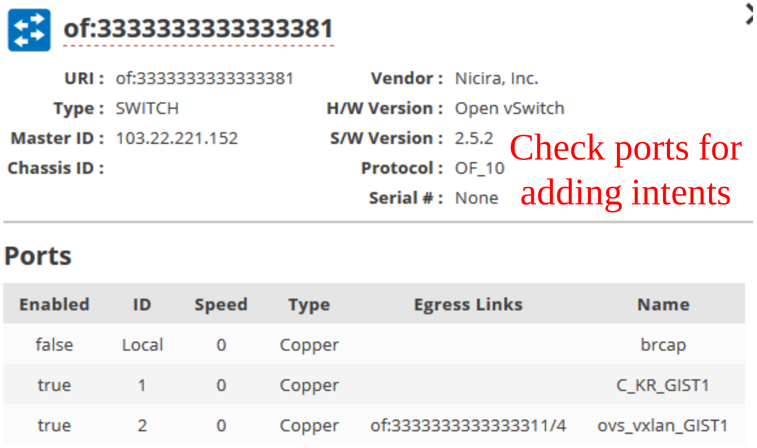
ONOS Summary

Version :	1.11.1
Devices :	7
Links :	8
Hosts :	5
Topology SCCs :	3
Intents :	16
Tunnels :	0

of:3333333333333381

URI :	of:3333333333333381
Vendor :	Nicira, Inc.
H/W Version :	Open vSwitch
S/W Version :	2.5.2
Serial # :	None
Protocol :	OF_10
Ports :	3
Flows :	5
Tunnels :	0

TH-CHULA



of:3333333333333381

URI :	of:3333333333333381	Vendor :	Nicira, Inc.
Type :	SWITCH	H/W Version :	Open vSwitch
Master ID :	103.22.221.152	S/W Version :	2.5.2
Chassis ID :		Protocol :	OF_10
		Serial # :	None

Ports

Enabled	ID	Speed	Type	Egress Links	Name
false	Local	0	Copper		brcap
true	1	0	Copper		C_KR_GIST1
true	2	0	Copper	of:3333333333333311/4	ovs_vxlan_GIST1

Check ports for adding intents

#KR-GIST1

add-point-intent of:3333333333333311/1 of:3333333333333311/2

add-point-intent of:3333333333333311/2 of:3333333333333311/1

add-point-intent of:3333333333333311/4 of:3333333333333311/3

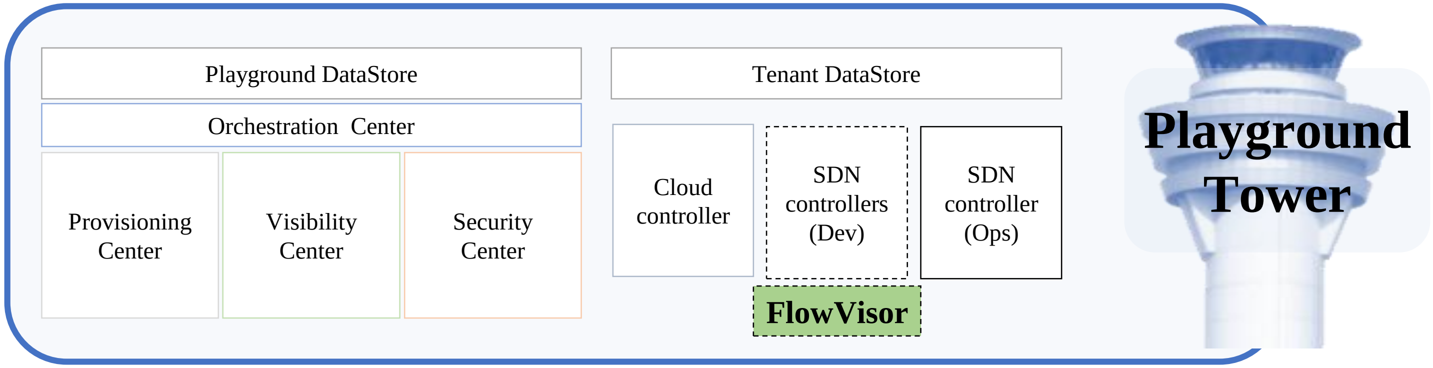
add-point-intent of:3333333333333311/3 of:3333333333333311/4

#TH-CHULA

add-point-intent of:3333333333333381/2 of:3333333333333381/1

add-point-intent of:3333333333333381/1 of:3333333333333381/2

Virtual Networking VLAN-based network Slicing (FlowVisor + OpenvSwitch)



Playground DataStore

Orchestration Center

Provisioning Center

Visibility Center

Security Center

Tenant DataStore

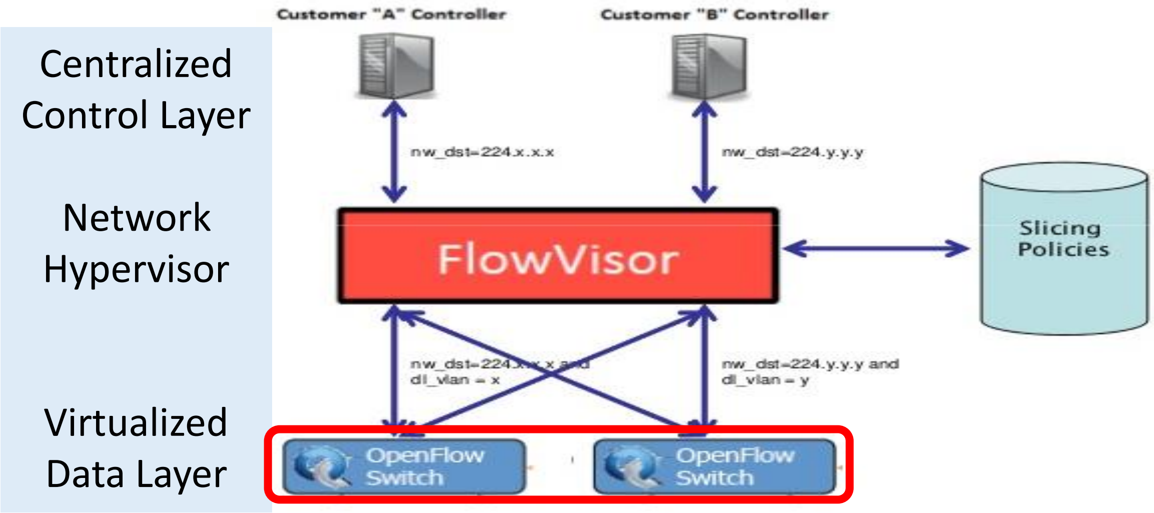
Cloud controller

SDN controllers (Dev)

SDN controller (Ops)

FlowVisor

Playground Tower



Centralized Control Layer

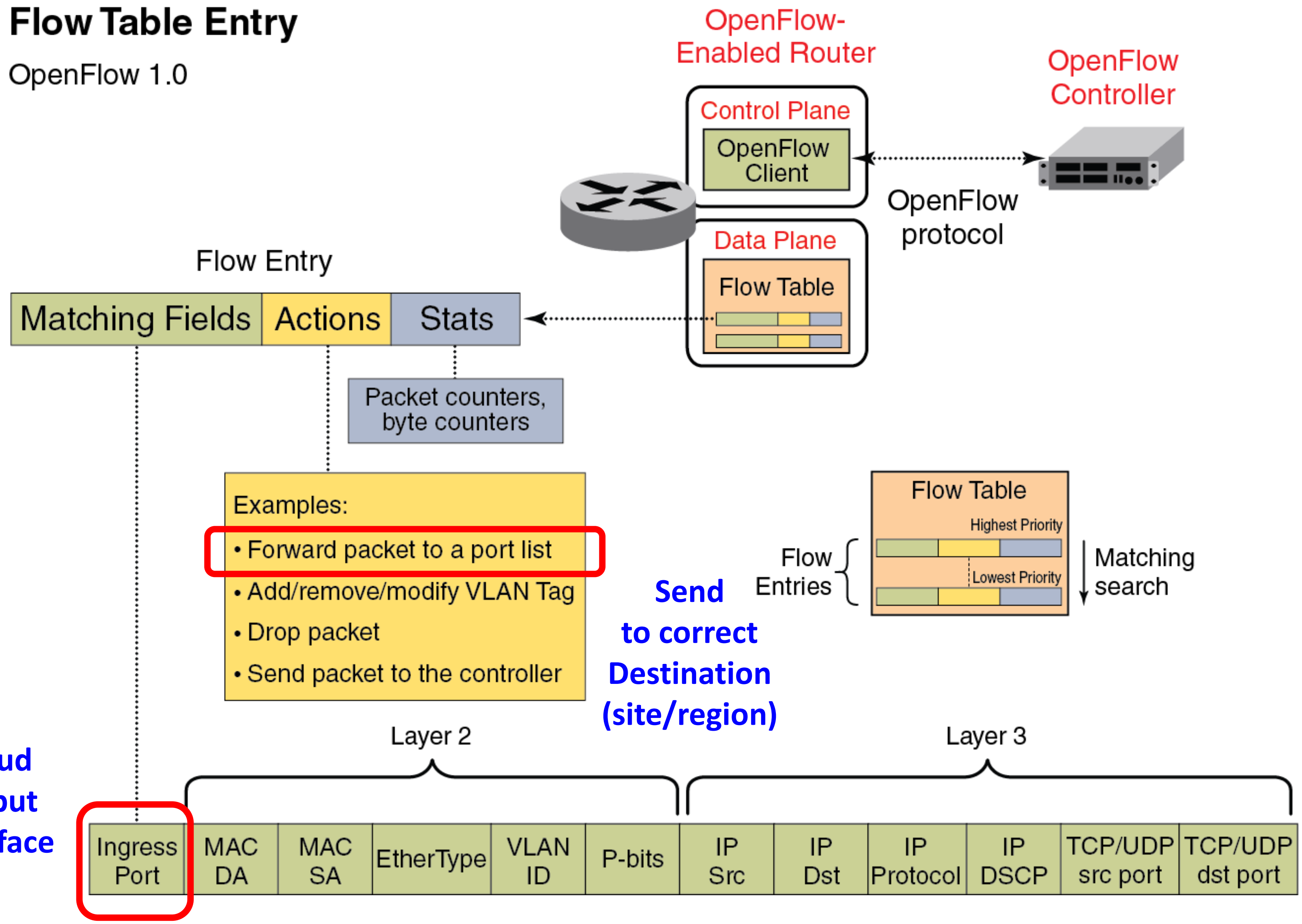
Network Hypervisor

Virtualized Data Layer

Adding new slice & flowspace

```
fvctl-json --passwd-file=passwd list-datapaths
fvctl-json --passwd-file=passwd list-slices
fvctl-json --passwd-file=passwd add-slice OPENSTACK-VLAN-101 tcp:103.22.221.150:6633 user@gmail.com
fvctl-json --passwd-file=passwd add-flowspace OPENSTACK-VLAN-101-FLOWSPACE 1111111111111181 10 dl_vlan=101 OPENSTACK-VLAN-101=4
```

Centralized Control for Developer using Port-based Flow Control (OpenDaylight)



Flow Table Entry

OpenFlow 1.0

OpenFlow-Enabled Router

OpenFlow Controller

Control Plane

OpenFlow Client

OpenFlow protocol

Data Plane

Flow Table

Flow Entry

Matching Fields | Actions | Stats

Packet counters, byte counters

Examples:

- Forward packet to a port list
- Add/remove/modify VLAN Tag
- Drop packet
- Send packet to the controller

Flow Table

Highest Priority

Lowest Priority

Flow Entries

Matching search

Send to correct Destination (site/region)

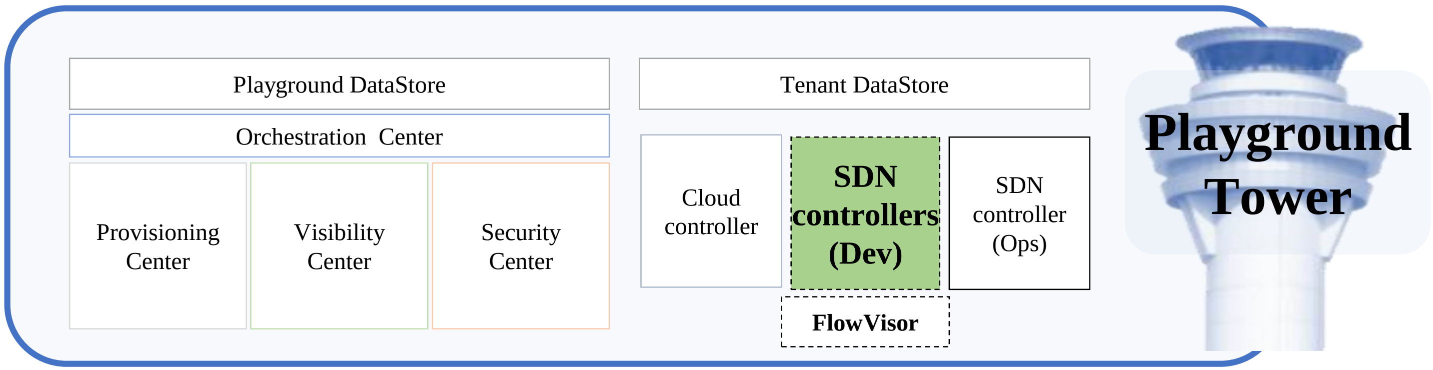
Layer 2

Layer 3

Ingress Port | MAC DA | MAC SA | EtherType | VLAN ID | P-bits | IP Src | IP Dst | IP Protocol | IP DSCP | TCP/UDP src port | TCP/UDP dst port

Cloud Output Interface

Adding Flow Entries using OpenDaylight REST API



Playground DataStore

Orchestration Center

Provisioning Center

Visibility Center

Security Center

Tenant DataStore

Cloud controller

SDN controllers (Dev)

SDN controller (Ops)

FlowVisor

Playground Tower

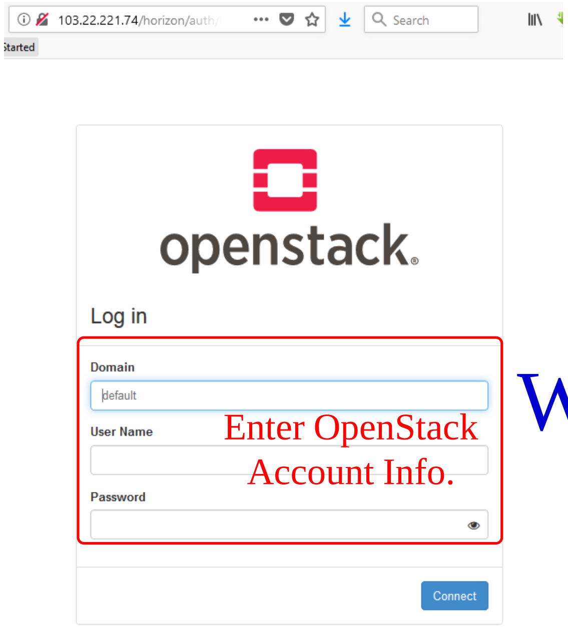
# GIST Box

```
curl -u admin:admin -H 'Content-type: application/json' -X PUT -d '{"installInHw":"true", "name":"GIST_OUT_ALL", "node": {"id":"11:11:11:11:11:11:11:11", "type":"OF"}, "ingressPort": '1', "priority":"65535","actions":["OUTPUT='2,3'"]}' http://$1:8080/controller/nb/v2/flowprogrammer/default/node/OF/11:11:11:11:11:11:11:11/staticFlow/GIST_OUT_ALL

curl -u admin:admin -H 'Content-type: application/json' -X PUT -d '{"installInHw":"true", "name":"GIST_MY_UM", "node": {"id":"11:11:11:11:11:11:11:11", "type":"OF"}, "ingressPort": '2', "priority":"65535","actions":["OUTPUT='1'"]}' http://$1:8080/controller/nb/v2/flowprogrammer/default/node/OF/11:11:11:11:11:11:11:11/staticFlow/GIST_MY_UM

curl -u admin:admin -H 'Content-type: application/json' -X PUT -d '{"installInHw":"true", "name":"GIST_TH_CHULA", "node": {"id":"11:11:11:11:11:11:11:11", "type":"OF"}, "ingressPort": '3', "priority":"65535","actions":["OUTPUT='1'"]}' http://$1:8080/controller/nb/v2/flowprogrammer/default/node/OF/11:11:11:11:11:11:11:11/staticFlow/GIST_TH_CHULA
```

# TH-CHULA Box

```
curl -u admin:admin -H 'Content-type: application/json' -X PUT -d '{"installInHw":"true", "name":"TH_OUT_ALL", "node": {"id":"11:11:11:11:11:11:11:81", "type":"OF"}, "ingressPort": '1', "priority":"65535","actions":["OUTPUT='2'"]}' http://$1:8080/controller/nb/v2/flowprogrammer/default/node/OF/11:11:11:11:11:11:11:81/staticFlow/TH_OUT_ALL

curl -u admin:admin -H 'Content-type: application/json' -X PUT -d '{"installInHw":"true", "name":"TH_GIST", "node": {"id":"11:11:11:11:11:11:11:81", "type":"OF"}, "ingressPort": '2', "priority":"65535","actions":["OUTPUT='1'"]}' http://$1:8080/controller/nb/v2/flowprogrammer/default/node/OF/11:11:11:11:11:11:11:81/staticFlow/TH_GIST
```

Verify OpenStack Installation



Log in

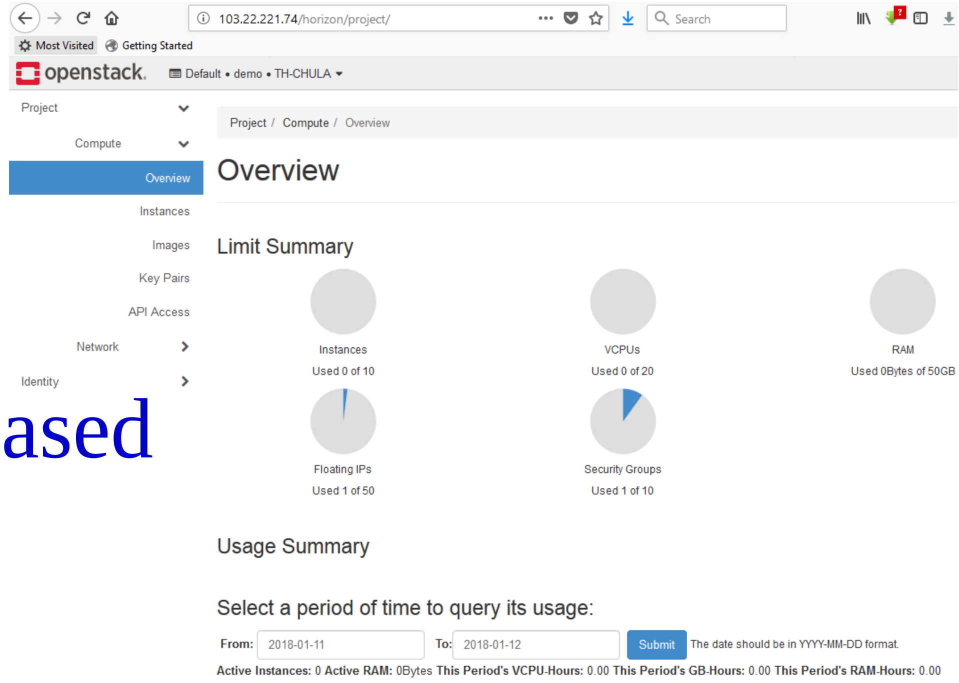
Domain: default

User Name:

Password:

Enter OpenStack Account Info.

Web-based



Overview

Limit Summary

Instances: Used 0 of 10

VCPUs: Used 0 of 20

RAM: Used 0Bytes of 50GB

Floating IPs: Used 1 of 50

Security Groups: Used 1 of 10

Usage Summary

Select a period of time to query its usage:

From: 2018-01-11 To: 2018-01-12 Submit The date should be in YYYY-MM-DD format.

Active Instances: 0 **Active RAM:** 0Bytes **This Period's VCPU-Hours:** 0.00 **This Period's GB-Hours:** 0.00 **This Period's RAM-Hours:** 0.00

[SSH Remote Access] Enter System Account

$ ssh <system_account>@103.22.221.74

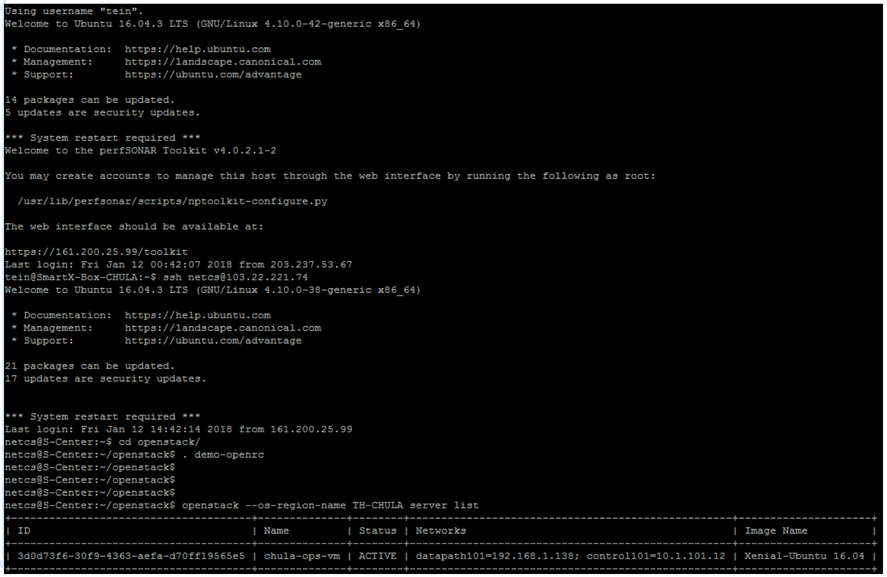
[After Login]

$ cd openstack

$. demo-openrc

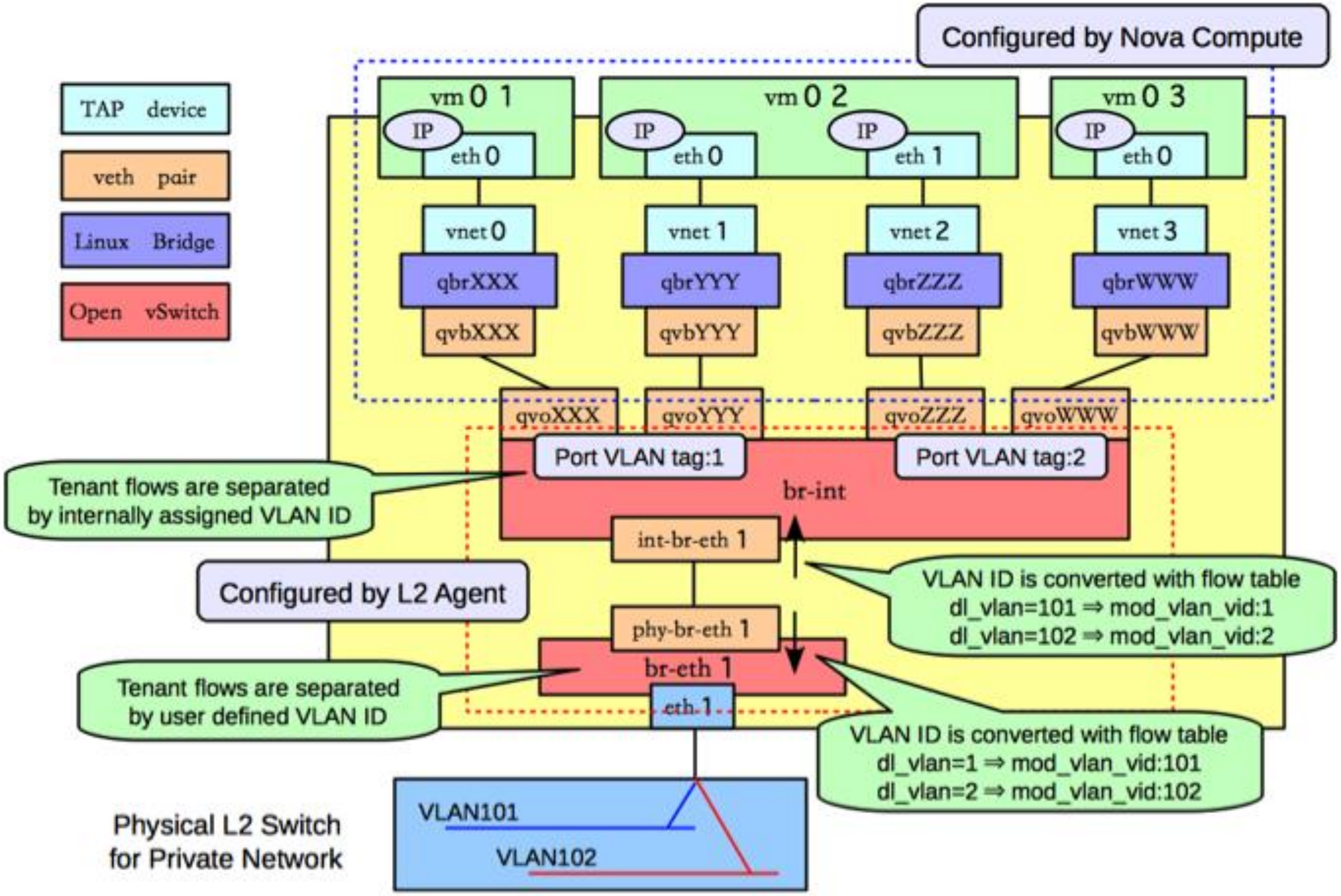
$ openstack –os-region-name TH-CHULA server list

API-based



```
Using username "tein".
Welcome to Ubuntu 16.04.3 LTS (GNU/Linux 4.10.0-42-generic x86_64)

 * Documentation:  https://help.ubuntu.com
 * Management:     https://landscape.canonical.com
 * Support:        https://ubuntu.com/advantage

14 packages can be updated.
5 updates are security updates.

*** System restart required ***
Welcome to the perfSONAR Toolkit v4.0.2.1-2

You may create accounts to manage this host through the web interface by running the following as root:

  /usr/lib/perfsonar/scripts/nptoolkit-configure.py

The web interface should be available at:

https://161.200.25.99/toolkit
Last login: Fri Jan 12 00:42:07 2018 from 203.237.53.67
tein@SmartX-Box-CHULA:~$ ssh netcs@103.22.221.74
Welcome to Ubuntu 16.04.3 LTS (GNU/Linux 4.10.0-38-generic x86_64)

 * Documentation:  https://help.ubuntu.com
 * Management:     https://landscape.canonical.com
 * Support:        https://ubuntu.com/advantage

21 packages can be updated.
17 updates are security updates.


*** System restart required ***
Last login: Fri Jan 12 14:42:14 2018 from 161.200.25.99
netcs@S-Center:~$ cd openstack/
netcs@S-Center:~/openstack$ . demo-openrc
netcs@S-Center:~/openstack$
netcs@S-Center:~/openstack$
netcs@S-Center:~/openstack$
netcs@S-Center:~/openstack$ openstack --os-region-name TH-CHULA server list
+--------------------------------------+--------------+--------+---------------------------------------------------+---------------------+
| ID                                   | Name         | Status | Networks                                          | Image Name          |
+--------------------------------------+--------------+--------+---------------------------------------------------+---------------------+
| 3d0d73f6-30f9-4363-aefa-d70ff19565e5 | chula-ops-vm | ACTIVE | datapath101=192.168.1.138; control101=10.1.101.12 | Xenial-Ubuntu 16.04 |
+--------------------------------------+--------------+--------+---------------------------------------------------+---------------------+
```

SDN-Cloud Tenant Networking VLAN-based Tenant Network (OpenStack Neutron)



Configured by Nova Compute

Tenant flows are separated by internally assigned VLAN ID

Configured by L2 Agent

VLAN ID is converted with flow table
dl_vlan=101 ⇒ mod_vlan_vid:1
dl_vlan=102 ⇒ mod_vlan_vid:2

Tenant flows are separated by user defined VLAN ID

VLAN ID is converted with flow table
dl_vlan=1 ⇒ mod_vlan_vid:101
dl_vlan=2 ⇒ mod_vlan_vid:102

Physical L2 Switch
for Private Network

Tag
(Nova)

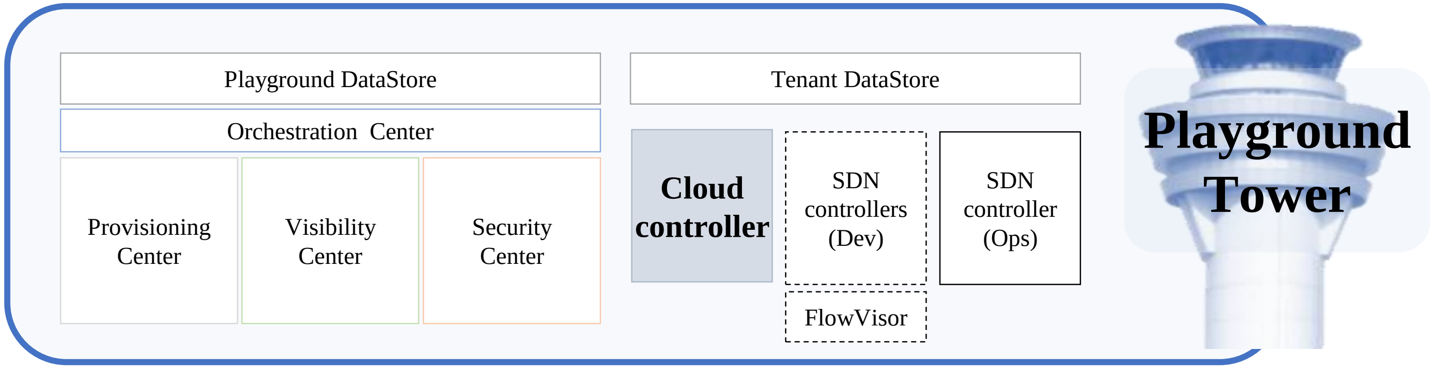
⬇

VLAN Map
(Neutron)

⬇

Physical Map
(Neutron)

Creating OpenStack Neutron Networks



Playground DataStore

Orchestration Center

Provisioning Center

Visibility Center

Security Center

Tenant DataStore

Cloud controller

SDN controllers (Dev)

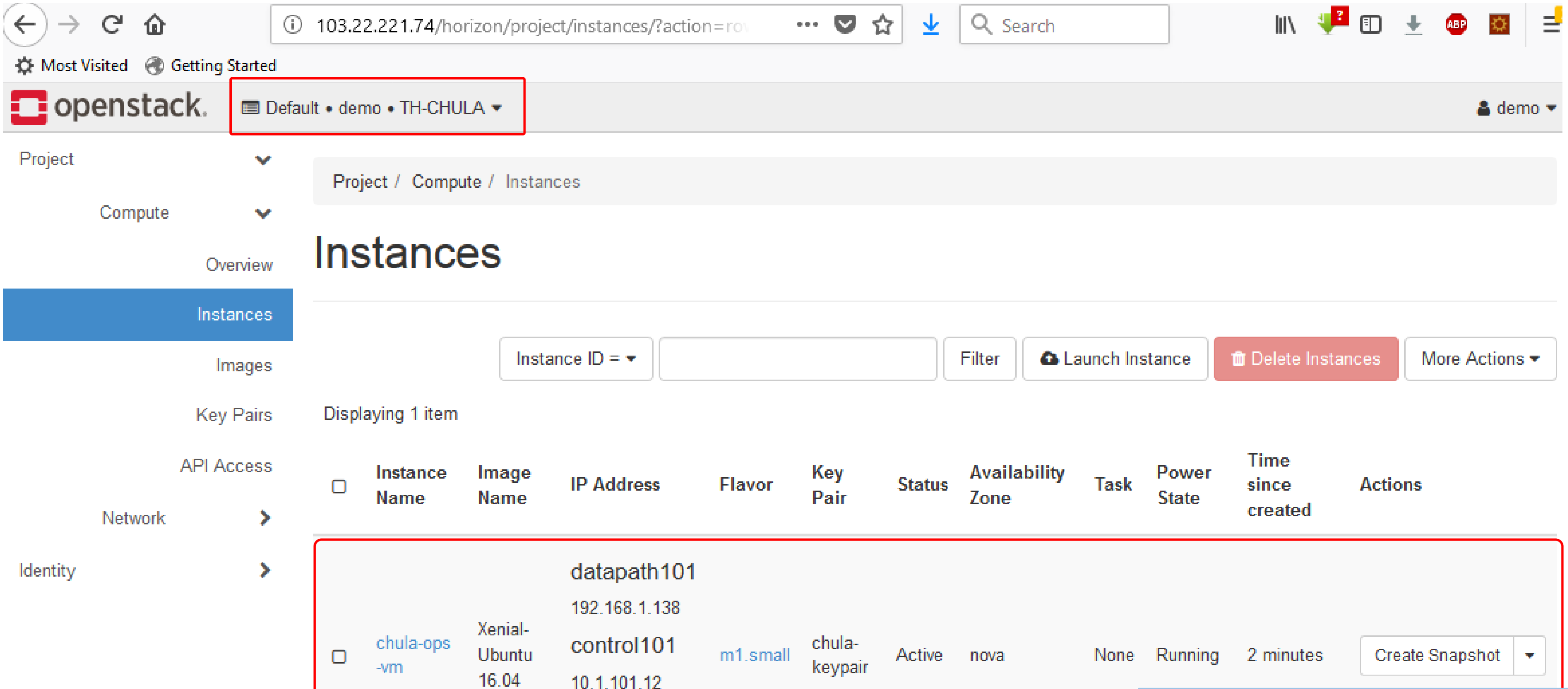
SDN controller (Ops)

FlowVisor

Playground Tower

```
USER="demo“
PROJECT="demo“
REGION1="TH-CHULA“
NET_ID=01

. admin-openrc

PROJECT_ID=`openstack project list | grep $PROJECT | awk '{print $2}'`
USER_ID=`openstack user list | grep $USER | awk '{print $2}'`

# Create Data Network
neutron net-create --os-region-name $REGION1 --tenant-id $PROJECT_ID --provider:network_type vlan --provider:physical_network provider --provider:segmentation_id 1$NET_ID datapath1$NET_ID

# Create Control Network
neutron net-create --os-region-name $REGION1 --tenant-id $PROJECT_ID --provider:network_type vxlan control1$NET_ID

# Create Subnets
. $USER-openrc
openstack --os-region-name $REGION1 subnet create --os-project-id $PROJECT_ID datapath1$NET_ID --network datapath1$NET_ID --subnet-range 192.168.1.0/24 --allocation-pool start=192.168.1.1,end=192.168.1.15 --no-dhcp --gateway noneopenstack --os-region-name $REGION1 subnet create --os-project-id $PROJECT_ID --network control1$NET_ID control1$NET_ID --subnet-range 10.1.1$NET_ID.0/24 --dhcp --gateway 10.1.1$NET_ID.1 --dns-nameserver 8.8.8.8

# Create Virtual Router
openstack --os-region-name $REGION1 router create --os-project-id $PROJECT_ID router1$NET_ID
openstack --os-region-name $REGION1 router add subnet router1$NET_ID `openstack --os-region-name $REGION1 network list | grep control1$NET_ID | awk '{print $6}'`
openstack --os-region-name $REGION1 router set router1$NET_ID --external-gateway public
```

Creating OpenStack Instance



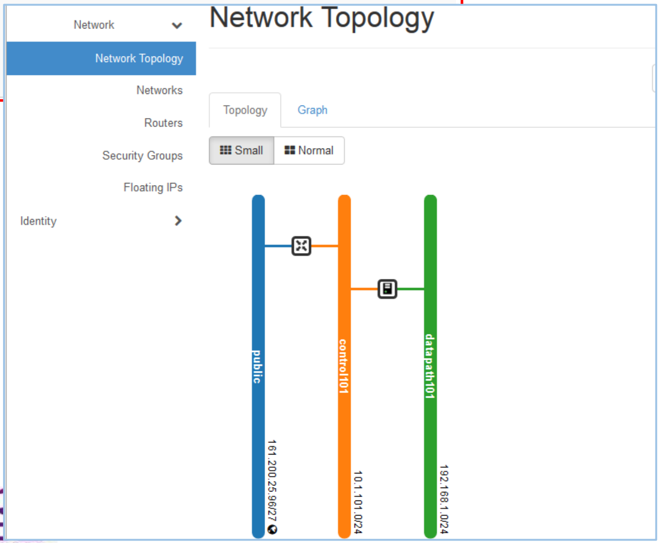
Instances

Instance ID = ▾ | Filter | Launch Instance | Delete Instances | More Actions ▾

Displaying 1 item

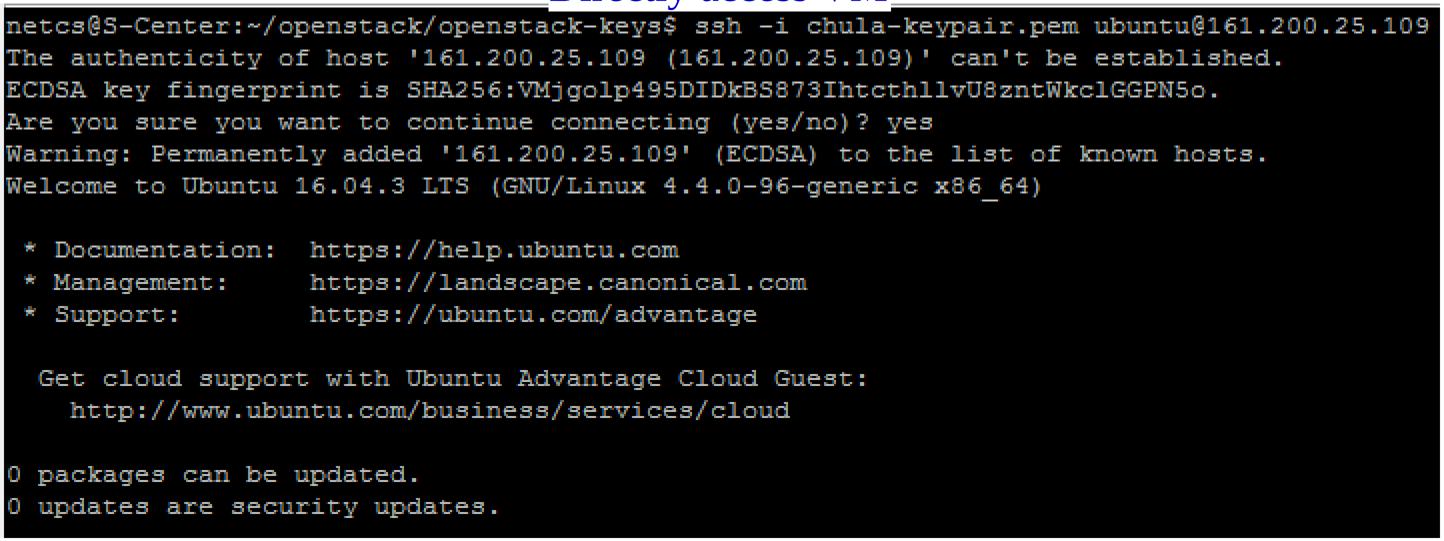
□	Instance Name	Image Name	IP Address	Flavor	Key Pair	Status	Availability Zone	Task	Power State	Time since created	Actions
□	chula-ops-vm	Xenial-Ubuntu 16.04	datapath101 192.168.1.138 control101 10.1.101.12 Floating IPs: 161.200.25.109	m1.small	chula-keypair	Active	nova	None	Running	2 minutes	Create Snapshot ▾

Displaying 1 item


Network Topology

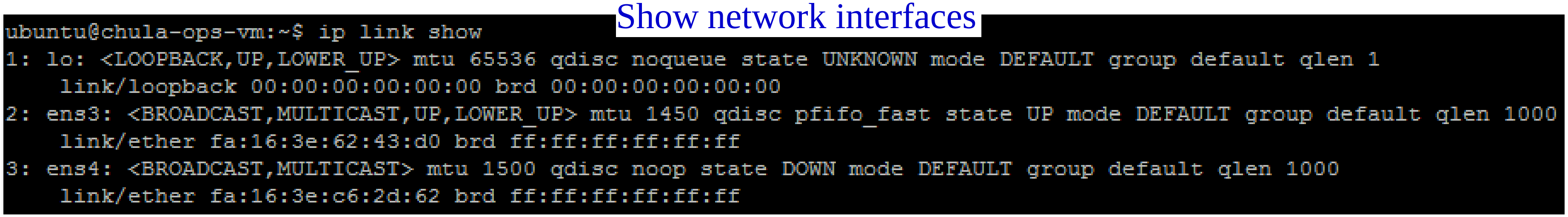
Access VM, Configure Datapath Interface & Verify end-to-end Connectivity

Directly access VM

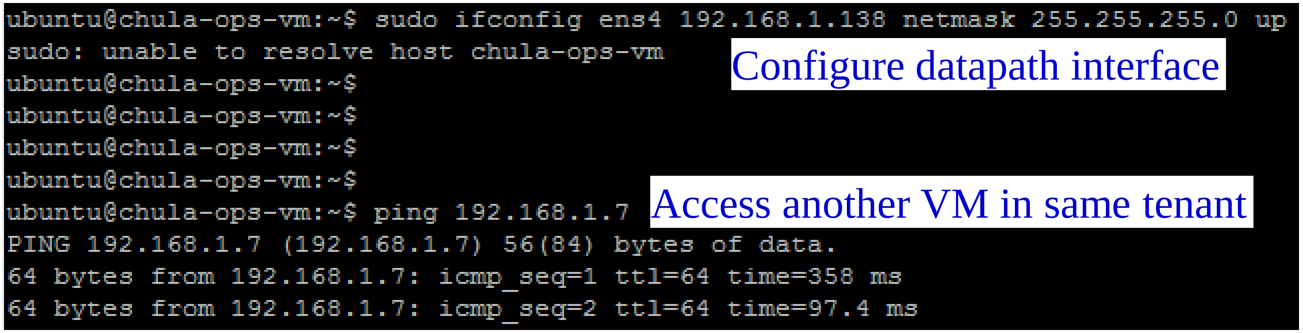


```
netcs@S-Center:~/openstack/openstack-keys$ ssh -i chula-keypair.pem ubuntu@161.200.25.109
The authenticity of host '161.200.25.109 (161.200.25.109)' can't be established.
ECDSA key fingerprint is SHA256:VMjgolp495DIDkBS873IhtcthllvU8zntWkclGGPN5o.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added '161.200.25.109' (ECDSA) to the list of known hosts.
Welcome to Ubuntu 16.04.3 LTS (GNU/Linux 4.4.0-96-generic x86_64)

 * Documentation:  https://help.ubuntu.com
 * Management:     https://landscape.canonical.com
 * Support:        https://ubuntu.com/advantage

  Get cloud support with Ubuntu Advantage Cloud Guest:
    http://www.ubuntu.com/business/services/cloud

0 packages can be updated.
0 updates are security updates.
```

Show network interfaces



```
ubuntu@chula-ops-vm:~$ ip link show
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN mode DEFAULT group default qlen 1
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
2: ens3: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1450 qdisc pfifo_fast state UP mode DEFAULT group default qlen 1000
    link/ether fa:16:3e:62:43:d0 brd ff:ff:ff:ff:ff:ff
3: ens4: <BROADCAST,MULTICAST> mtu 1500 qdisc noop state DOWN mode DEFAULT group default qlen 1000
    link/ether fa:16:3e:c6:2d:62 brd ff:ff:ff:ff:ff:ff
```



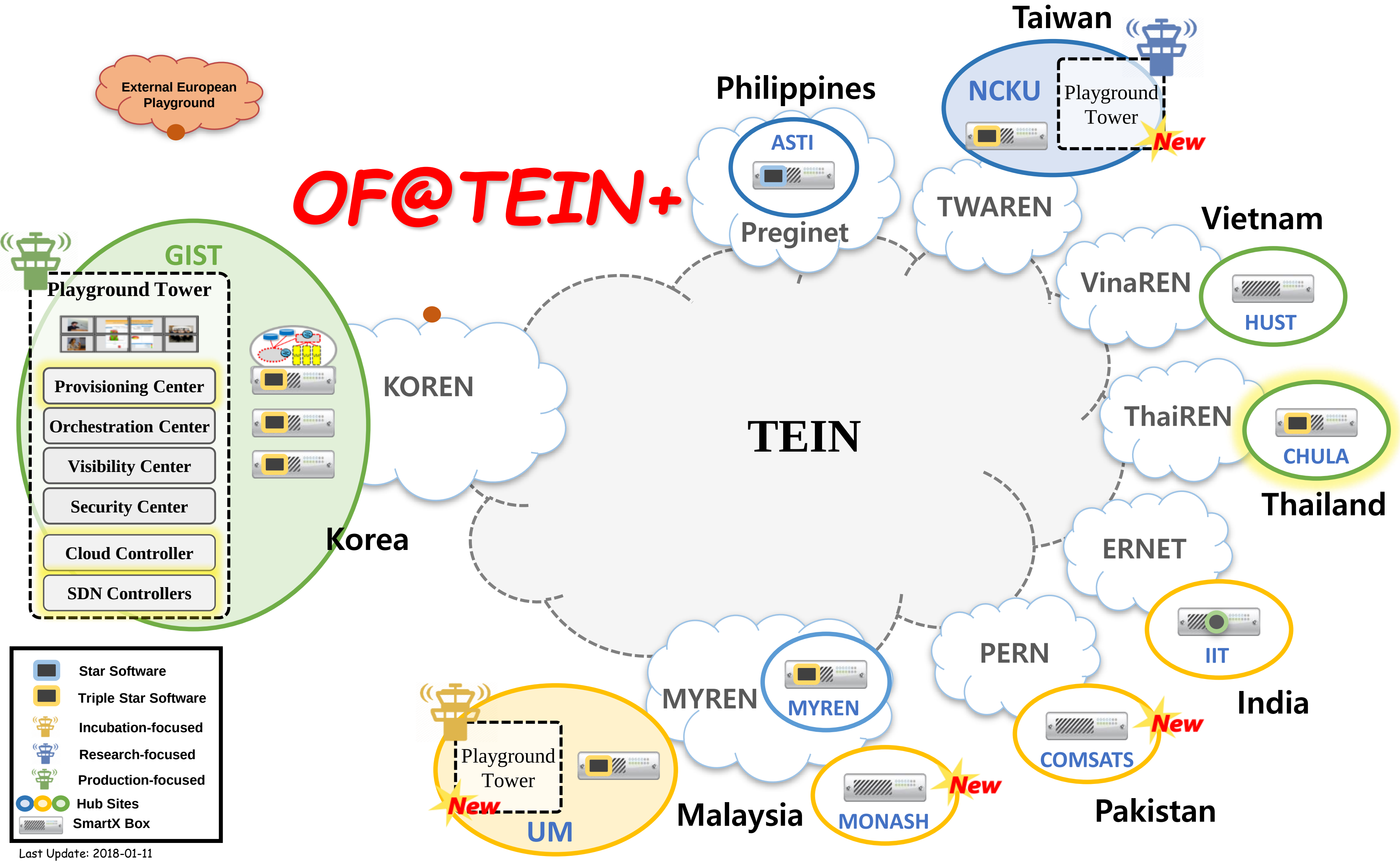
```
ubuntu@chula-ops-vm:~$ sudo ifconfig ens4 192.168.1.138 netmask 255.255.255.0 up
sudo: unable to resolve host chula-ops-vm
ubuntu@chula-ops-vm:~$
ubuntu@chula-ops-vm:~$
ubuntu@chula-ops-vm:~$
ubuntu@chula-ops-vm:~$
ubuntu@chula-ops-vm:~$ ping 192.168.1.7
PING 192.168.1.7 (192.168.1.7) 56(84) bytes of data.
64 bytes from 192.168.1.7: icmp_seq=1 ttl=64 time=358 ms
64 bytes from 192.168.1.7: icmp_seq=2 ttl=64 time=97.4 ms
```

Configure datapath interface

Access another VM in same tenant

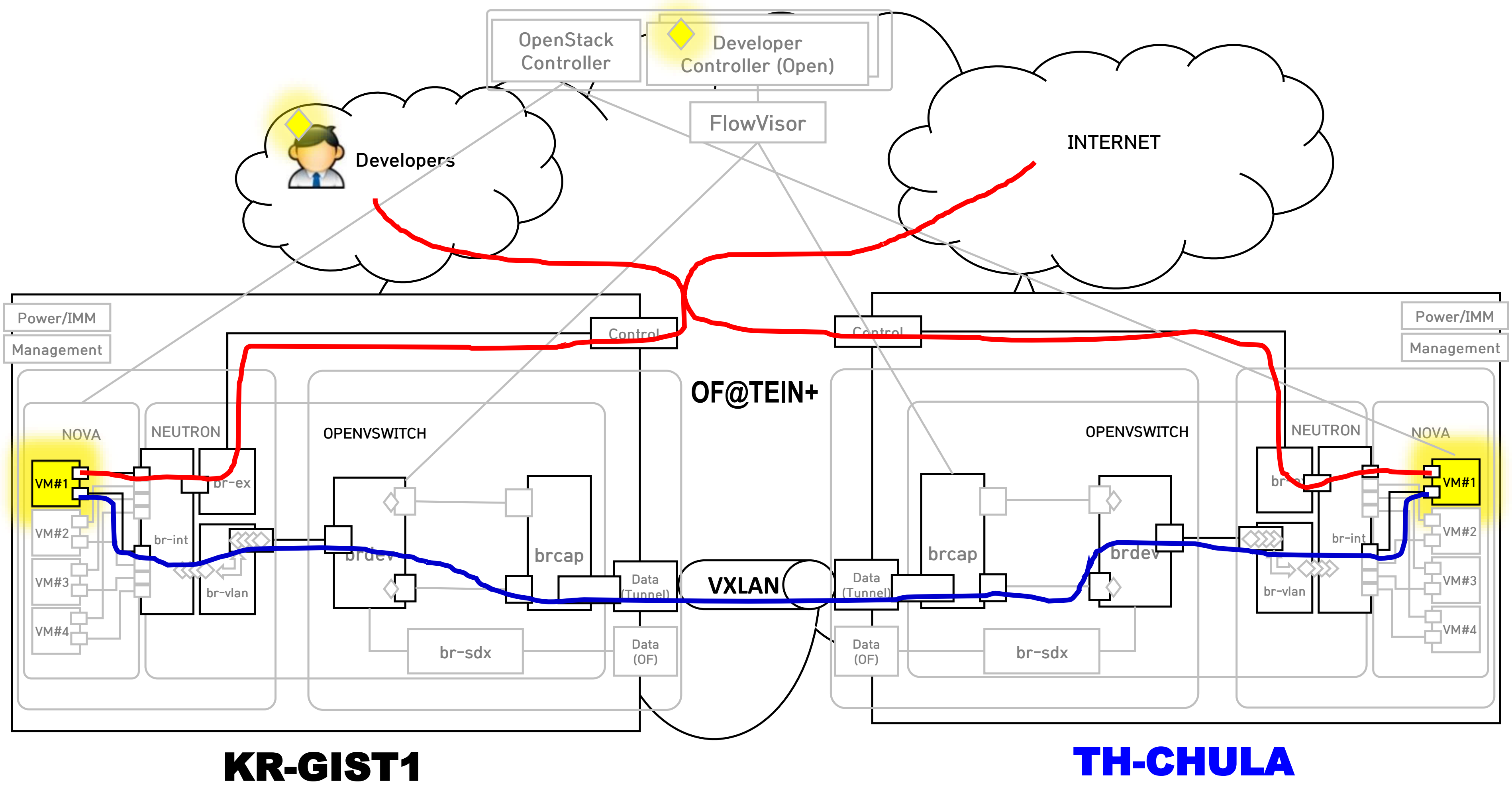
SmartX Box & Inter-connect: Provisioning Demonstration

OF@TEIN+ Playground: Upgrading (Existing) / Adding (New) Site into Multi-site Cloud



Last Update: 2018-01-11

SmartX Box & Inter-connect: Provisioning Verification Scenario



Thank You

ops@oftein.net

Asi@Connect

TEIN*CC
COOPERATION CENTER