Building Virtual Labs for Design Validation, Technical Training, & Operational Migrations

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NANOG89

INTRODUCTION

- Background

- Life in Higher Ed and Research & Education Networks

- Value-Adds

- Foot in the Door with the Technology

LAB ENVIRONMENTS

- Why have Sandbox and Lab environments?
  - New Design Validation
  - Method of Procedure Walk-Throughs and Testing
  - Training Initiatives

LAB ENVIRONMENTS – PROBLEM

- Hardware-based Sandboxes and labs are expensive to build and difficult to maintain their "good state"
- Even when you have hardware-based labs
- **Limited in scope** – one group at a time
- Takes **time to cable** them up for your use
- Once they are up – what's the lost time in teardown/rebuilt for each scenario
- Hardware Labs, plugged in, waste a lot of energy

LAB ENVIRONMENTS - SOLUTION

- **Emulation!**
- Simulate Network Environments vs. Building Them
- Use those environments for
  - Training your Staff
  - Working through Migrations and Maintenance Windows
  - Working out a new Design

EMULATION OPTIONS

- Variety of ways to emulate your network
- GNS3
- Virtual images on Virtual Appliances
- Cloud environments
- **EVE-NG**

EVE-NG EMULATION

WHAT IS EVE-NG?

- Next-Generation simulation software that allows us to mock up a variety of vendor infrastructures, with an easy to use tool as a footprint for our virtual environments

EVE-NG EMULATION OPTIONS

- **Bare Metal**

- **Virtual Machine**

- Cloud

- EVE-NG Partnered Paid Cloud

EVE-NG BARE METAL SERVER

- Isolated Resources = Better Performance

- Cloud Interfaces

Interface	IP Address
Host Name	Training.company.tech
Model	Dell PowerEdge R650
Serial #	2PPxxxx
CPU Cores	160
Memory	256 Gb
EVE-NG Version	5.0.1-106
Operating System	Ubuntu 20.04.6 LTS
Cabinet	POC02 RU35-34

EVE-NG RESOURCE CALCULATOR

- Found on EVE-NG Download Page

- Calculate the approximate CPU and RAM usage per lab

EVE Image folder	Vendor image name	CPU virtual cores Single node	RAM MB Single node	Number of Nodes Change value	RAM MB Total	CPU virtual cores total
Total RAM and CPU usage					**81920**	**44**
vcenter	VM Ware vCenter	2	10240	0	0	0
veloedge	VM Ware Velocloud Edge	2	4096	0	0	0
velogw	VM Ware Velocloud Gateway	4	8192	0	0	0
veloeorch	VM Ware Velocloud Orchestrator	4	16384	0	0	0
veos	Arista vEOS Switch	1	2048	0	0	0
versaana	Versa Networks Analytics	2	4096	0	0	0
versadir	Versa Networks Director	2	4096	0	0	0
versafvnf	Versa Networks FlexVNF	2	4096	0	0	0
vios	Cisco vIOS Router	1	1024	0	0	0
viosl2	Cisco vIOS Switch	1	1024	0	0	0
vmx	Juniper VMX 14	1	2048	0	0	0
vmxvcp	Juniper VMX VCP	1	2048	8	16384	8
vmxvfp	Juniper VMX VCE	3	4096	8	32768	24
vnam	Cisco Virtual Network Analysis Module	2	4096	0	0	0
vqfxpfe	Juniper vQFX PFE	2	4096	0	0	0
vqfxre	Juniper vQFX RE	2	2048	0	0	0
vsrx	Juniper vSRX 14	2	4096	0	0	0
vsrxng	Juniper vSRX 18, 19	2	4096	4	16384	8
vtbond	Cisco Viptela vBond	2	2048	0	0	0
vtedge	Cisco Viptela vEdge	2	2048	0	0	0
vtmgmt	Cisco Viptela vManager	4	16384	0	0	0
vtsmart	Cisco Viptela vSmart	2	2048	0	0	0
vwaas	Cisco WAAS	1	2048	0	0	0
vwlc	Cisco vWLC (Wireless Controller)	1	2048	0	0	0
vyos	VyOS router	1	512	0	0	0
win	Windows workstation	1	4096	4	16384	4
winserver	Windos Server	1	8192	0	0	0
xrv9k	Cisco XRv9000	4	16384	0	0	0
xrv	Cisco XRv	1	3072	0	0	0

EVE-NG LICENSE OPTIONS

Features/Edition	Community	Professional	Learning Center	Description
User's roles	admin only	admin only	admin, user, editor	Restrictions of the EVE usage, WEB UI, per user based
Lock user per folder	✘	✘	✔	User cannot see other EVE folders, only his own
Lock user edit rights	✘	✘	✔	User cannot edit labs, images etc
Shared Lab Folder	✘	✘	✔	Shared lab folder visible for all users
User's account validity (1/4 Hour accuracy)	✘	✘	✔	Ability to set calendar validity for account, Date and time (From -> To)
Lab Timer	✘	✔	✔	Timer for Lab training
Running labs folder	✘	✔	✔	User can run more than one lab. Running labs will appear in special running labs folder. Per user based
Node limit per lab	63	1024	1024	Limit of nodes to run per lab
TCP ports	fixed 128 per POD	Dynamic 1-65000	Dynamic 1-65000	Automatic TCP port choose for telnet session

EVE-NG INSTALLATION

INSTALLATION COOKBOOK

EVE-NG Professional
Cookbook

https://www.eve-ng.net/index.php/documentation/

Interfaces
EVE-NG MGMT Interface

- ## Map Eth0 to Cloud0

  - ### MGMT Connections
  - ### "User Gateway" to Virtual Nodes
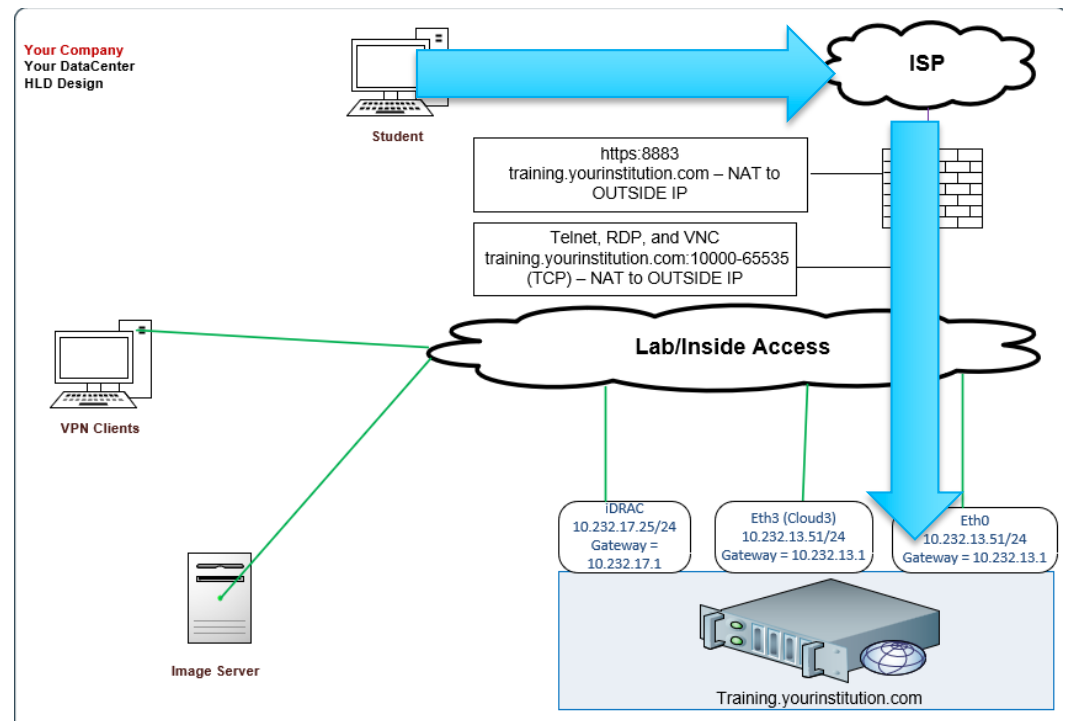
EVE-NG Interface Mapping

- The EVE-NG server requires the Physical Network Interfaces be mapped to Eth* interfaces

- There are scripts to run when there are multiple NICs to designate the proper one that stays persistent

```
root@training:~# more /etc/udev/rules.d/70-persistent-net.rules
SUBSYSTEM=="net", ACTION=="add", DRIVERS=="?*", ATTR{address}=="b4:96:91:c2:e1:4b", ATTR{dev_id}=="0x0", ATTR{type}=="1", KERNEL=="eth*", NAME="eth0"
SUBSYSTEM=="net", ACTION=="add", DRIVERS=="?*", ATTR{address}=="b4:96:91:c2:e1:4a", ATTR{dev_id}=="0x0", ATTR{type}=="1", KERNEL=="eth*", NAME="eth1"
SUBSYSTEM=="net", ACTION=="add", DRIVERS=="?*", ATTR{address}=="b0:7b:25:d4:4d:52", ATTR{dev_id}=="0x0", ATTR{type}=="1", KERNEL=="eth*", NAME="eth2"
SUBSYSTEM=="net", ACTION=="add", DRIVERS=="?*", ATTR{address}=="68:05:ca:cb:47:5e", ATTR{dev_id}=="0x0", ATTR{type}=="1", KERNEL=="eth*", NAME="eth3"
```

- NIC Order Script **opt/ovf/nicorder-wizard**

EVE-NG Cloud Interfaces

- Utilize **"other"** interfaces for Inside or Lab Access

- Example

  - Map "Eth*x*" to Cloud*x*

  - Image Transfer from Secure Location

  - Monitor your EVE-NG Server from Enterprise NMS
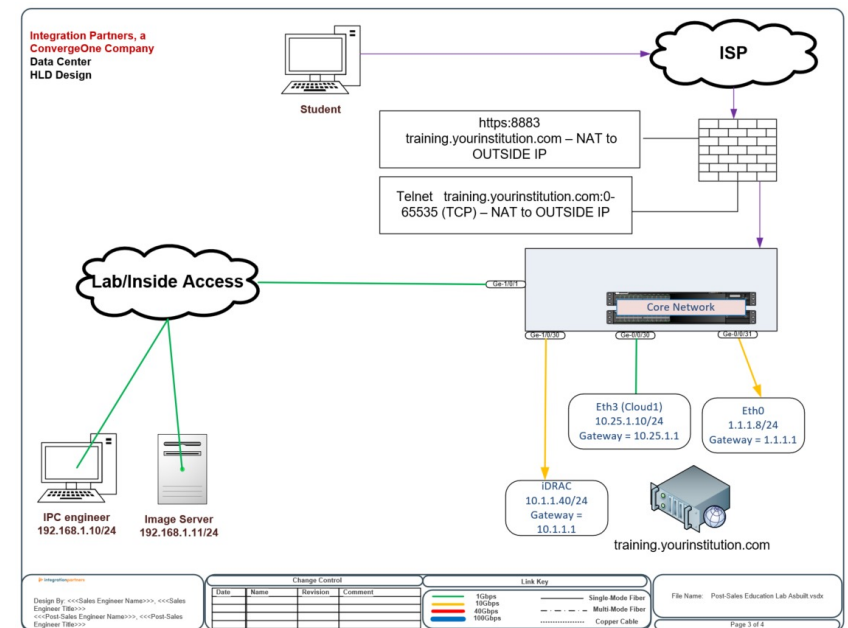
Interfaces
EVE-NG Server Monitoring

Category	Alert	Threshold	Action
CPU Overview	CPU Usage	85%	Email NOC
Disks	Filesystem Capacity	600 Gbps	Email NOC
Interfaces	iDRAC	Down	Email NOC
Interfaces	pnet0 (Outside)	Down	Email NOC
Interfaces	Pnet3 (Inside)	Down	Email NOC
Interfaces	pnet0 (Outside)	Bandwidth Exceeding 25%	Email NOC
Interfaces	Pnet3 (Inside)	Bandwidth Exceeding 25%	Email NOC
Memory Usage	Memory Usage	85%	Email NOC
Temperature Sensors	Loc1	75%	Email NOC

Interfaces
Other Interface Examples

- Ansible Server that needs Internet Access to pull ansible modules from internet

- Juniper MIST capable units for Cloud Administration

- Non-Cloud MGMT systems

Interfaces
Other Interface Examples

- Mix Non-Virtualized Devices into Virtualized Labs (Cradlepoint)
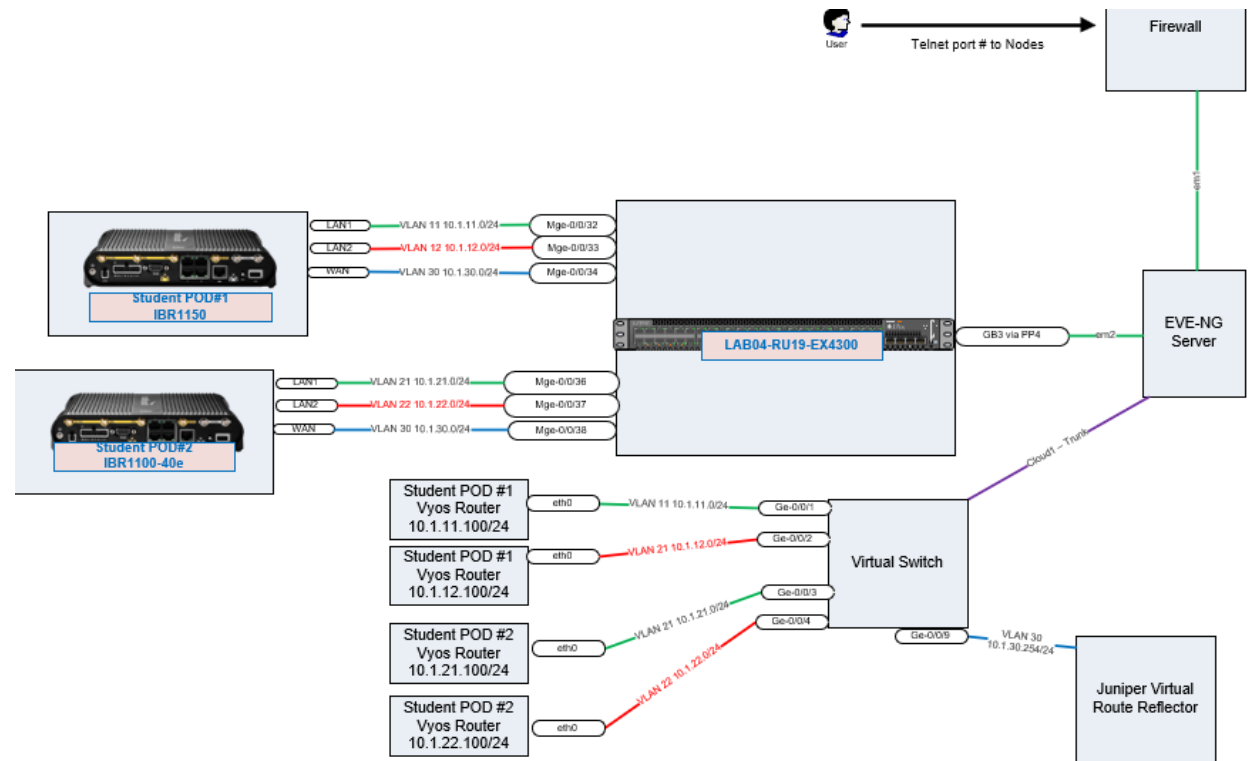
BEST PRACTICES - DOCUMENTATION

- **Design Guide**

- **As-built**

EVE-NG IMAGE REPOSITORY

Images
Adding Images

- Follow the How To Load Guide for Best Practice
- https://www.eve-ng.net/index.php/documentation/howtos/

Adding Images

- 4 Basic Steps
  - Create the folder in **/opt/unetlab/addons/qemu/**
  - Make sure to name the folder with the proper context pattern (Otherwise it won't link up properly in the WebUI)
  - Move the proper qcow2 file to the folder and rename it based on the instructions
  - Fix the permissions

Images
Adding Image Example – vSRX

- Create the folder for the vSRX Next-Generation Image running 22.1R1

```
mkdir /opt/unetlab/addons/qemu/vsrxng-22.1R1
```

- Navigate to the folder

```
cd /opt/unetlab/addons/qemu/vsrxng-22.1R1
```

Images

Adding Images

- Time Saver – Download the software directly from the vendor site onto the server

To download the image on your localhost, CLICK HERE
To download the image directly on your device, use the following URL:

https://cdn.juniper.net/software/vsrx3.0/22.1R1/junos-vsrx3-x86-64-22.1R1.10.qcow2?
SM_USER=mcarey@integrationpartners.com&__gda__=1651516973_71a1d867cab81d83921d9f4080bea0a3

copy

URL copied to clipboard !.

▸ Usage Instructions for Junos Products

Return to:
Software Downloads
Juniper Support

wget 'https://cdn.juniper.net/software..'

file save 'https://cdn.juniper.net/soft..'

Adding Images

- Qemu folder name = starts with the correct prefix in column 1

- qcow2 image is renamed to the correct name in Column 3

- Fix the permissions

veos-	Arista SW	hda, cdrom.iso
vios-	L3 vIOS Cisco Router	virtioa
viosl2-	L2 vIOS Cisco SW	virtioa
vtbond-	Viptela vBond	hda
vtedge-	Viptela vEdge	hda
vtsmart-	Viptela vSmart	hda
vtmanage-	Viptela vManage	hda, hdb
vmx-	Juniper vMX router	hda
vmxvcp-	Juniper vMX-VCP	hda, hdb, hdc
vmxvfp-	Juniper vMX-VFP	hda
vnam-	Cisco VNAM	hda
vqfxpfe-	Juniper vQFX-PFE	hda
vqfxre-	Juniper vQFX-RE	hda
vsrx-	vSRX 12.1 Juniper FW/router	virtioa
vsrxng-	vSRX v15.x Juniper FW/router	virtioa
vwaas-	Cisco WAAS	virtioa,virtiob,virtioc
vwlc-	vWLC Cisco WiFi controller	megasasa
vyos-	VYOS	virtioa
win-	Windows Hosts (Not Server Editions)	hda or virtioa(using driver)
winserver-	Windows Server Editions	hda or virtioa(using driver)
xrv-	XRv Cisco router	hda
xrv9k-	XRv 9000 Cisco router	virtioa

Rename the image file

- The chart told us to rename the file to "virtioa"

```
root@training:~# mv vsrxng-22.1R1.qcow2 virtioa
```

Images
Fix The Permissions

- After every new image upload – requirement to valid the files and structure

```
root@training:~# /opt/unetlab/wrappers/unl_wrapper -a fixpermissions
May 26 14:19:36 May 26 14:19:36 Online Check state: Valid

root@training:~#
```
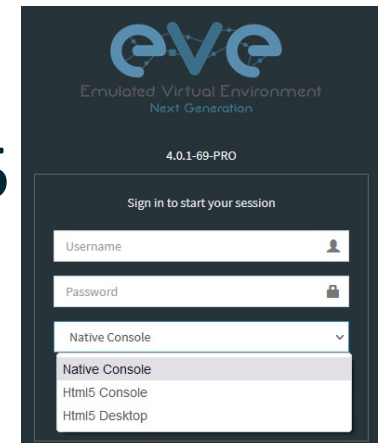
EVE-NG – UP AND RUNNING

Objectives
WebUI Modes

- Native Console
  - Utilize Native applications to reach your nodes
- HTML5 Console
  - Clientless solution using Guacamole HTML5 Engine
- HTML5 Desktop
  - Integrated Docker Desktop to manage nodes
  - **ThinClient File Transfers**

Labs

Lab Creation

Add a new object

- 🖴 Node
- ⇄ Network
- 🖼 Picture
- ⬛ Custom Shape
- A Text
- ➡ Line

- ⦙⦙⦙ Auto Align

ADD A NEW NODE

Template   ☐ Show unprovisioned templates

Nothing selected ▾

Nothing selected

Aruba ClearPass

Aruba OS-CX Virtual Switch

Cisco XRv

Docker.io

ExtremeVSP

ExtremeXOS

Juniper vMX VCP

Juniper vMX VFP

Juniper vQFX PFE

Juniper vQFX RE

Juniper vSRX

Juniper vSRX NextGen

Linux

LogZilla Log Management Platform

Virtual PC (VPCS)

VyOS

Labs
Lab Creation

Connectivity
Console TCP Ports

- EVE PRO

  - Dynamic TCP Ports 1-65000

  - Telnet

  - VNC

  - RDP

- New Port for every Node "Start" and/or "Wipe"
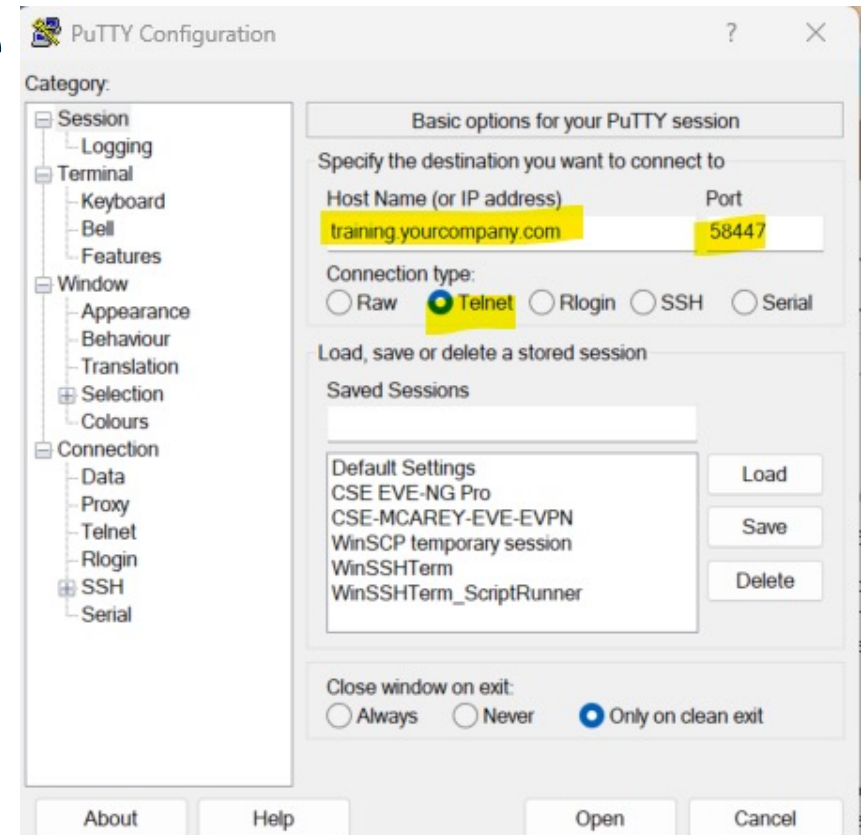
Connectivity
Console TCP Ports

- Link your Terminal Window application to WebUI

telnet://yourservername.com:34561
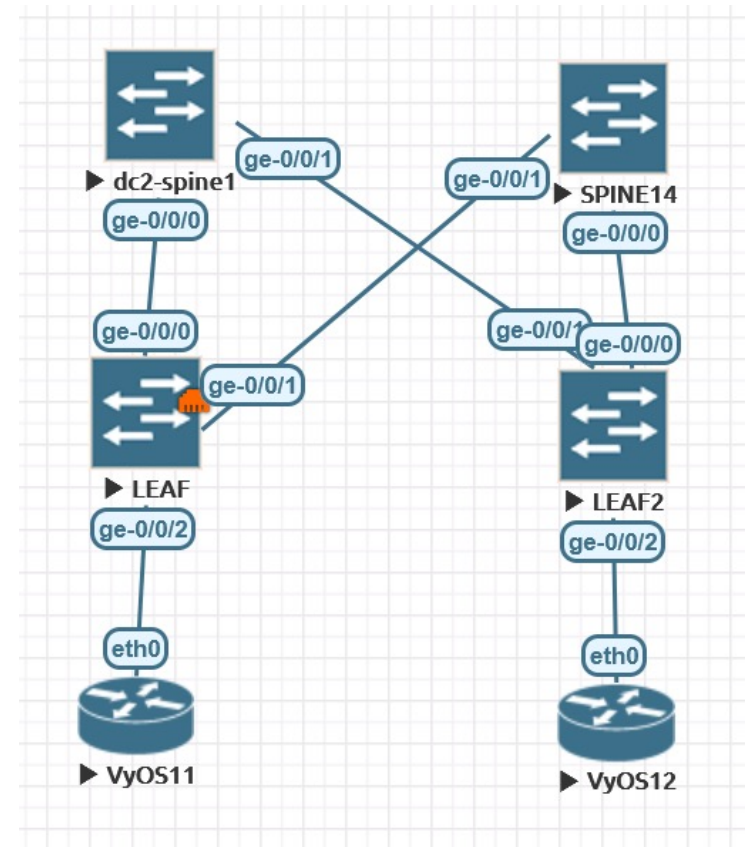
GET CONNECTED AND FOLLOW ALONG VIRTUAL LAB EQUIPMENT

- **Telnet** to your nodes with the address servername.com:**port#**
- Utilize Term Window for tab view (WinSSHTerm, SuperPutty, SecureCRT)

Lab Milestone
Lab Creation

- Create a New Lab

- Add Nodes to your lab and create a topology

- Start your nodes

- Apply configuration configs

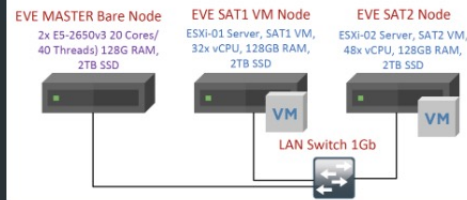# EVE-NG – ADVANCED CONFIGURATIONS

Advanced Features
Clustering

- Ability to add additional EVE-NG Servers and delegate which labs can run on each

EVE-NG Pro Cluster

EVE-NG Cluster is for everyone working in the Information Technology Sector. It is for very large enterprise companies, training facilities, service providers, consultants, people who want to train themselves; it is for everyone, it is for YOU!

- Scalability
- Multi servers system as one EVE
- Simple to complex labs across multi servers
- Training center users classrooms
- Various cluster designs and options
- Different HW specification cluster members
- Google Cloud Compute as cluster node

EVE Hybrid Bare HW and ESXi Cluster 120 vCPU, 384GB RAM, 6TB SSD. Cluster members can be different VM configuration and located on same or different ESXi servers

EVE MASTER Bare Node
2x E5-2650v3 20 Cores/ 40 Threads) 128G RAM, 2TB SSD

EVE SAT1 VM Node
ESXi-01 Server, SAT1 VM, 32x vCPU, 128GB RAM, 2TB SSD

EVE SAT2 Node
ESXi-02 Server, SAT2 VM, 48x vCPU, 128GB RAM, 2TB SSD

LAN Switch 1Gb

Path* /Advanced Juniper EVPN-VxLAN with MX Spine:

Name* per EVPN-VxLAN with MX Spines Class and RIFT
Use only [A-Za-z0-9_-]chars

Version* 1
Must be interger ([0-9]chars)

Author Michael Carey

Satellite any
- any
- master
- cse-eve-ng-satellite-02
- cse-eve-ng-satellite-01

Shared with ipc ✕

Config Script Timeout

Startup-Configs

Startup-Configs

- Create Baselines

- Establish Milestones

Startup-Configs
Commit Images to Default

- Not all images support Startup Configs

- Trace Node to Lab UUID

- Commit current state of node as new default
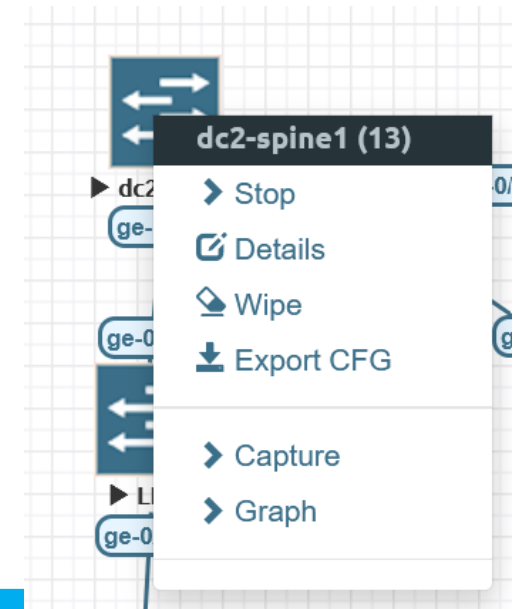

```
cd /opt/unetlab/tmp/0/3893e0b2-29y8-69e1-b46d-ccb4fc2001a2/13/


/opt/qemu/bin/qemu-img commit virtioa.qcow2
```

Import/Export

Import/Export Labs

- Difference between Community & Professional Edition

- Ability to share lab environments

- Also utilize for backing up labs

- Must have images already installed for imported labs to launch properly

Wireshark

Wireshark

- Professional Edition comes with Wireshark

- Can capture traffic within the WebUI on any link and analysis it

- Replicate a production problem in EVE-NG and troubleshoot it with Wireshark

- Teach students how to evaluate Wireshark output
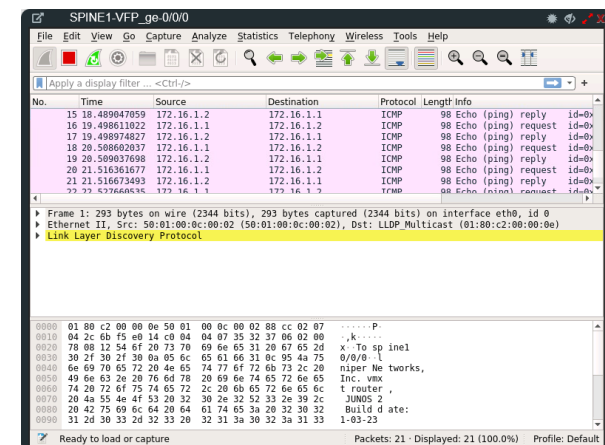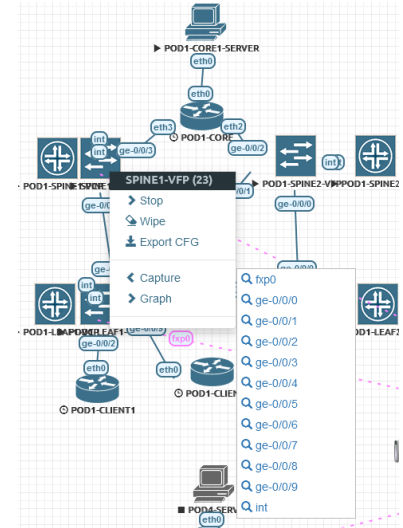
Vendor Tips and Tricks
Juniper Networks vQFX Knob

- vQFXs are perpetual beta – not sold, always available

- **vqfxpfe-10k-F-18.4R1**

- **vqfxre-10k-F-18.4R2-S2.3**

- EVE-NG recommends configuring the below knob
  due to the high CPU requirement of the QFX images:

```
echo "10000" > /sys/module/kvm/parameters/halt_poll_ns
```

Vendor Tips and Tricks

Juniper Networks

- vJunos-Switch and vJunosEvolved were introduced this year
- vMX is EOL
- Capable of MIST management

Extreme Networks

- Github EXOS updates
- VOSS is Control-Plane with limited Data-Plane

Vendor Tips and Tricks
Client Simulation

- VyOS Client Router
  - Cisco/Extreme like config
- vSRX in packet-mode
- Windows, Linux, Ubuntu
- Virtual PC (VPCS)

CASE STUDY – USE CASES

Topology
EVPN LAB

- Using vMX's for Spines & Leaf
- Using Docker image for Ansible

- ## Using VyOS for Client Simulations

- Single-Homed Client Simulation
- Multi-Homed Client Simulation
- External Type-5 routes
- 16-20 PODs for Students

- **"Always-On" POC Lab for Juniper EVPN**
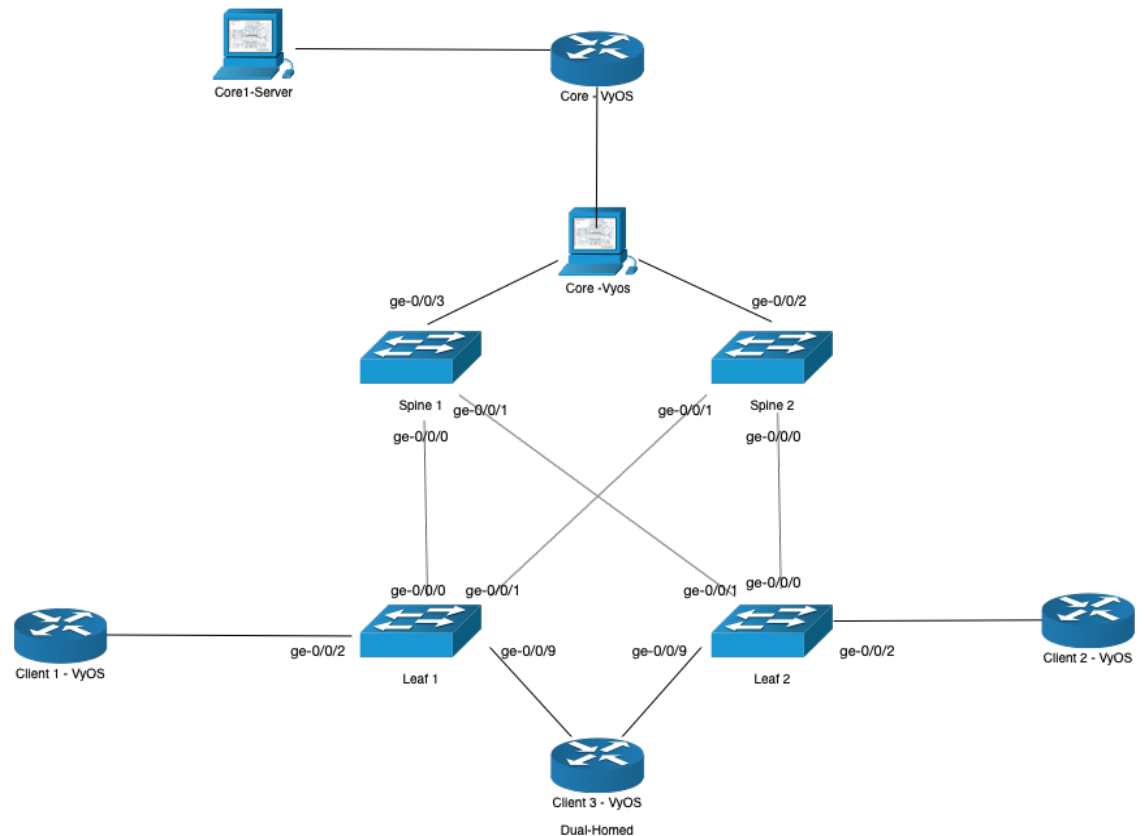
Training

Lab Guide

- BGP Underlay & Overlay
- Bridged-Overlay
  - Virtual Switch Route-Distinguishes & Route-Targets
- Edge-Routed Bridging
  - VRF Route-Distinguishers
  - Anycast Gateways
- Centrally-Routed Bridging
  - Virtual-Gateways on Spines
- Border Spine Routes
- Multi-homed client
- Protect Your Router – Best Practice Lab
- Ansible Playbooks

# METHOD OF PROCEDURE (MOP) EXECUTION

Juniper MX Project –Case Study

- BGP project to add a 2nd ISP Provider

- vMX code running 20.2R3.9 to simulate their current environment

- Forked the lab to a training package that was used internally for NOC personnel to train them on the new topology with hands-on exercises

Method of Procedure
Method of Procedure (MOP)

- **Model your Network**

- Execute the change

- Document the steps

- Document the expected results

- Create Milestones to reach
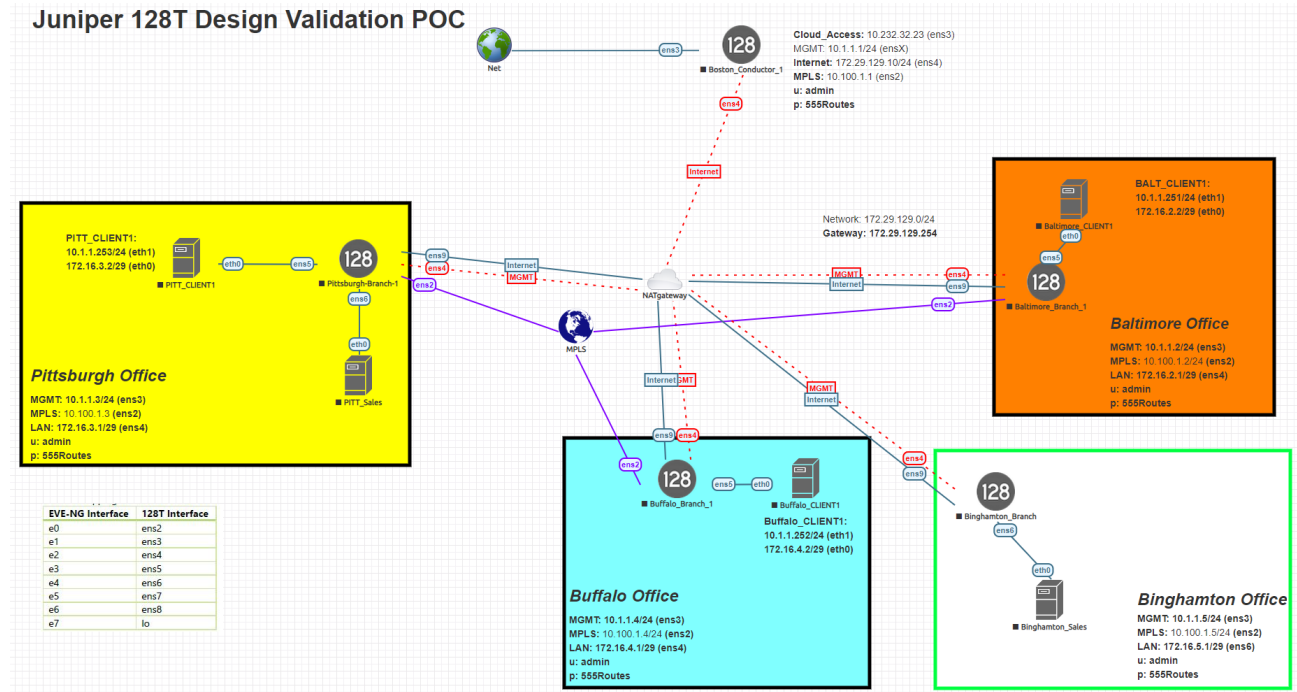

Method of Procedure Simulation – Step #8 DC Failure
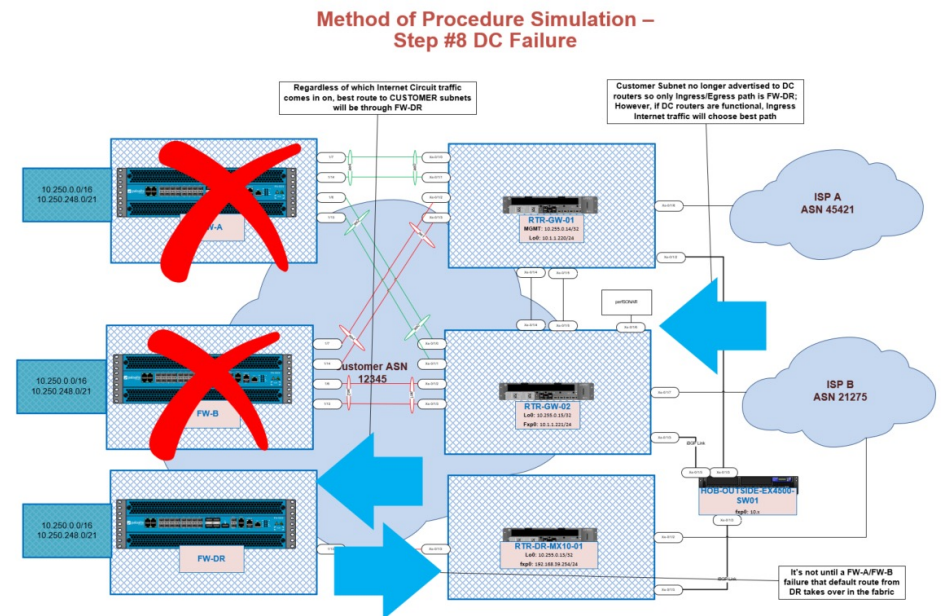
NEW TECHNOLOGY AND DESIGN VALIDATION

New Technology Validation

New Technology Validation

- Find out if you can run vendor firmware in EVE-NG
- Work with Vendors for support

New Technology and Design Validation

New Tech Validation

- Mock up designs using new technology that is now available
  - SD-WAN
  - Vendor-Agnostic Data Center Automation Tools
  - EVPN-VXLAN Deployments
  - Configuration Automation
  - Cloud Managed Designs

SUCCESS

Homework
Validation

- How do we know we are on the right path with "Simulated" Labs

- Vendor-based on-demand Labs

- EVE-NG Lab Distribution Files

- Youtube EVE-NG Videos

- Internal Organizational Successes

- Vendor focus on porting new technologies into the tool for easy POCs and quick hands-on experiences

Homework
Next Steps

- Download the free version of EVE-NG on a VM

- Create a familiar vendor topology and get some communication going in your lab

- Replicate an environment and Work through a design or problem that has been bugging you

- Document your successes

THANK YOU