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

<table>
<thead>
<tr>
<th>Interface</th>
<th>IP Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Host Name</td>
<td>Training.company.tech</td>
</tr>
<tr>
<td>Model</td>
<td>Dell PowerEdge R650</td>
</tr>
<tr>
<td>Serial #</td>
<td>2PPxxxxx</td>
</tr>
<tr>
<td>CPU Cores</td>
<td>160</td>
</tr>
<tr>
<td>Memory</td>
<td>256 Gb</td>
</tr>
<tr>
<td>EVE-NG Version</td>
<td>5.0.1-106</td>
</tr>
<tr>
<td>Operating System</td>
<td>Ubuntu 20.04.6 LTS</td>
</tr>
<tr>
<td>Cabinet</td>
<td>POC02 RU35-34</td>
</tr>
</tbody>
</table>
EVE-NG RESOURCE CALCULATOR

- Found on EVE-NG Download Page
- Calculate the approximate CPU and RAM usage per lab
# EVE-NG License Options

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

```bash
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 “Ethx” to Cloudx
  - Image Transfer from Secure Location
  - Monitor your EVE-NG Server from Enterprise NMS
## EVE-NG Server Monitoring

<table>
<thead>
<tr>
<th>Category</th>
<th>Alert</th>
<th>Threshold</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPU Overview</td>
<td>CPU Usage</td>
<td>85%</td>
<td>Email NOC</td>
</tr>
<tr>
<td>Disks</td>
<td>Filesystem Capacity</td>
<td>600 Gbps</td>
<td>Email NOC</td>
</tr>
<tr>
<td>Interfaces</td>
<td>iDRAC</td>
<td>Down</td>
<td>Email NOC</td>
</tr>
<tr>
<td>Interfaces</td>
<td>pnet0 (Outside)</td>
<td>Down</td>
<td>Email NOC</td>
</tr>
<tr>
<td>Interfaces</td>
<td>Pnet3 (Inside)</td>
<td>Down</td>
<td>Email NOC</td>
</tr>
<tr>
<td>Interfaces</td>
<td>pnet0 (Outside)</td>
<td>Bandwidth Exceeding 25%</td>
<td>Email NOC</td>
</tr>
<tr>
<td>Interfaces</td>
<td>Pnet3 (Inside)</td>
<td>Bandwidth Exceeding 25%</td>
<td>Email NOC</td>
</tr>
<tr>
<td>Memory Usage</td>
<td>Memory Usage</td>
<td>85%</td>
<td>Email NOC</td>
</tr>
<tr>
<td>Temperature Sensors</td>
<td>Loc1</td>
<td>75%</td>
<td>Email NOC</td>
</tr>
</tbody>
</table>
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/
Images

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
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

wget ‘https://cdn.juniper.net/software..’

file save ‘https://cdn.juniper.net/soft..’
Images

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

<table>
<thead>
<tr>
<th>Image Type</th>
<th>Description</th>
<th>Drive</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>vEOS-</td>
<td>Arista SW</td>
<td>hda,</td>
<td>cdrom.iso</td>
</tr>
<tr>
<td>vIOS-</td>
<td>L3 vIOS Cisco Router</td>
<td>virtio</td>
<td></td>
</tr>
<tr>
<td>vIOS2-</td>
<td>L2 vIOS Cisco SW</td>
<td>virtio</td>
<td></td>
</tr>
<tr>
<td>vBond-</td>
<td>Viptela vBond</td>
<td>hda</td>
<td></td>
</tr>
<tr>
<td>vEdge-</td>
<td>Viptela vEdge</td>
<td>hda</td>
<td></td>
</tr>
<tr>
<td>vSmart-</td>
<td>Viptela vSmart</td>
<td>hda</td>
<td></td>
</tr>
<tr>
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<td>Viptela vManage</td>
<td>hda,</td>
<td>hdb</td>
</tr>
<tr>
<td>vMx-</td>
<td>Juniper vMx router</td>
<td>hda</td>
<td></td>
</tr>
<tr>
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<td>Juniper vMx-VCP</td>
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<td>hdb,</td>
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<tr>
<td>vMxVFP-</td>
<td>Juniper vMx-VFP</td>
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</tr>
<tr>
<td>VNAM-</td>
<td>Cisco VNAM</td>
<td>hda</td>
<td></td>
</tr>
<tr>
<td>vQFX-PFE-</td>
<td>Juniper vQFX-PFE</td>
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<td>vSRX-</td>
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<td>virtio</td>
<td></td>
</tr>
<tr>
<td>vSRX-v15.</td>
<td>X5 Juniper FW/router</td>
<td>virtio</td>
<td></td>
</tr>
<tr>
<td>vWAAS-</td>
<td>Cisco WAAS</td>
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<tr>
<td>vWLC-</td>
<td>WLCL Cisco WIFI controller</td>
<td>megasasa</td>
<td></td>
</tr>
<tr>
<td>vYOS-</td>
<td>VYOS</td>
<td>virtio</td>
<td></td>
</tr>
<tr>
<td>wHSE-</td>
<td>Windows Hosts (Not Server Editions)</td>
<td>hda or virtio(using driver)</td>
<td></td>
</tr>
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</tr>
<tr>
<td>xRV-</td>
<td>XRV Cisco router</td>
<td>hda</td>
<td></td>
</tr>
<tr>
<td>xRV9000-</td>
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</table>
Rename the image file

- The chart told us to rename the file to “virtioa”

```bash
root@training:~# mv vsrxng-22.1R1.qcow2 virtioa
```
Fix The Permissions

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

```bash
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
- Text
- Line

Auto Align

ADD A NEW NODE

Template
- Nothing selected
- Aruba ClearPass
- Aruba OS-CX Virtual Switch
- Cisco XRv
- Docker.io
- ExtremeVSP
- ExtremeXOS
- Juniper vMX VCP
- Juniper vMX VPP
- Juniper vQFX PFE
- Juniper vQFX RE
- Juniper vSRX
- Juniper vSRX NextGen
- Linux
- Log2Ile Log Management Platform
- Virtual PC (VPCS)
- VyOS
Lab Creation

ADD CONNECTION BETWEEN EXTREMEOS1 AND EXTREMEOS2

Source ID: 1
Source Name: ExtremeOs1

Choose Interface for ExtremeOs1
- port1

Choose Interface for ExtremeOs2
- Mgmt
- port1
- port2

Save  Cancel
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://yourservename.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
Startup-Configs

- Create Baselines
- Establish Milestones
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:

```bash
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
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
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
Case Study

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 (MOP)

- Model your Network
- Execute the change
- Document the steps
- Document the expected results
- Create Milestones to reach
NEW TECHNOLOGY AND DESIGN 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
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
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