neutron-lan

SDN study environement @ home

github.com/alexanderplatz1999

Last update: April 17th, 2014

Background and Motivation

- My belief
  - SDN = software defines network
- Too many SDN definitions
  - I have been confused a lot.
  - OpenFlow, OVSDB, Netconf, BGP extensions such as FlowSpec...
  - The latest one: OpFlex (DevOps-like)
- What’s the real SDN?
  - Let’s develop SDN by myself and examine every definition.
- But, wait! I need a SDN study environment at home.
  - I am a poor guy, so I cannot buy expensive SDN-capable switches from Cisco, Juniper...

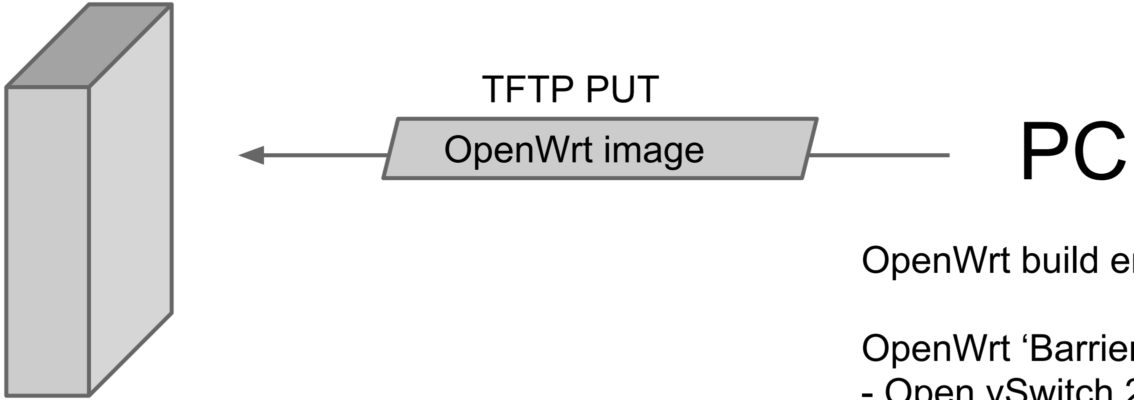
Strategy

- My budget is less than $200.
- Switches/routers I purchased in Akihabara, Tokyo
    - Three $40 broadband routers and one $40 Raspberry Pi
- And I develop all the SDN software from scratch
    - But reuse existing networking software as much as possible, such as Open vSwitch
- Base knowledge/skills
    - SDN in the past: SIP and IP-PBX
    - OpenFlow, OpenStack neutron and SaltStack
    - Java and Python
    - HTML5 and CSS (a little)
- Let’s develop neutron-like SDN for my home network ⇒ let’s call it ‘neutron-lan’

Project ‘neutron-lan’ characteristics

- Cheap routers as ‘Baremetal Switch’
  - OpenWrt, Raspberry Pi
  - u-boot for installing new firmware
- Home-made DevOps tool ‘NLAN’ from scratch
  - 100% Python implementation
  - YAML-based state rendering
  - Model-driven service abstraction
- VXLAN-based edge-overlay for network virtualization
- LXC for Network Functions Virtualization
- Open vSwitch as a programmable switch
- OVSDB as a general-purpose config database

Cheap routers as ‘Baremetal Switch’



Broadband Router
w/ u-boot boot loader

OpenWrt build environment

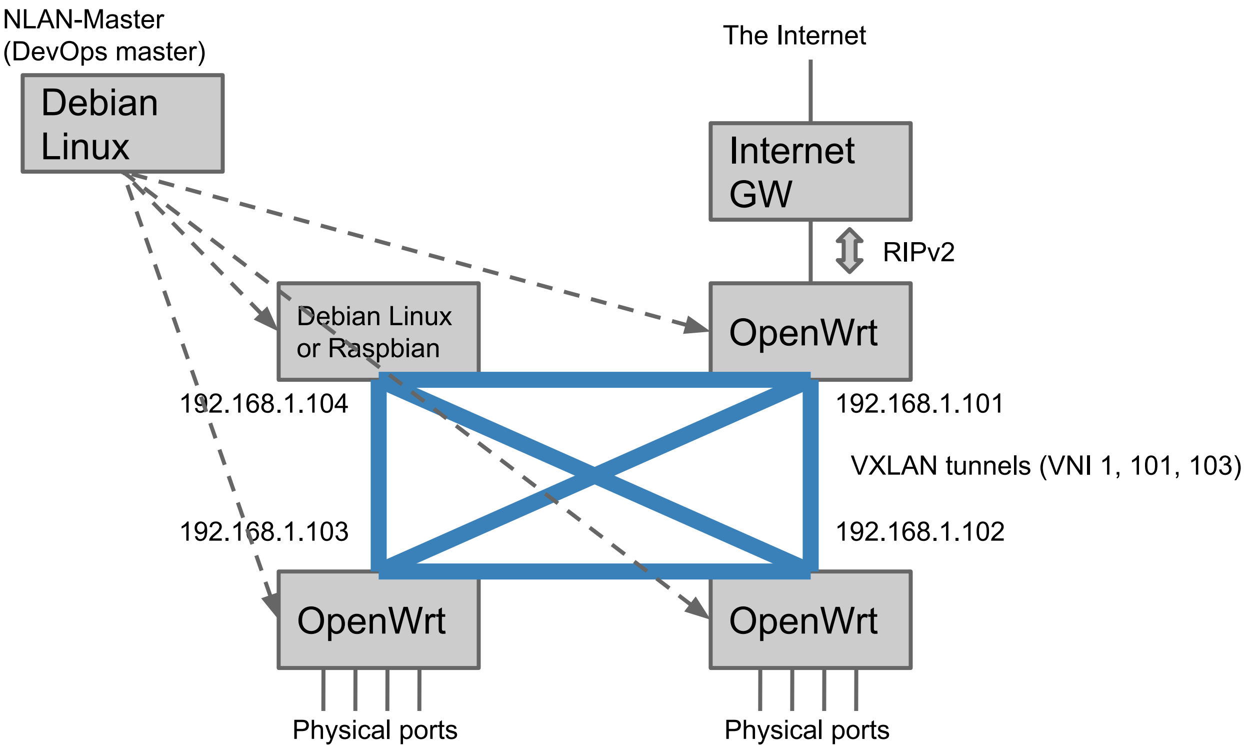
OpenWrt ‘BarrierBreaker’ image w/
- Open vSwitch 2.0.0
- Network namespaces
- Veth

Test bed (cont'd)

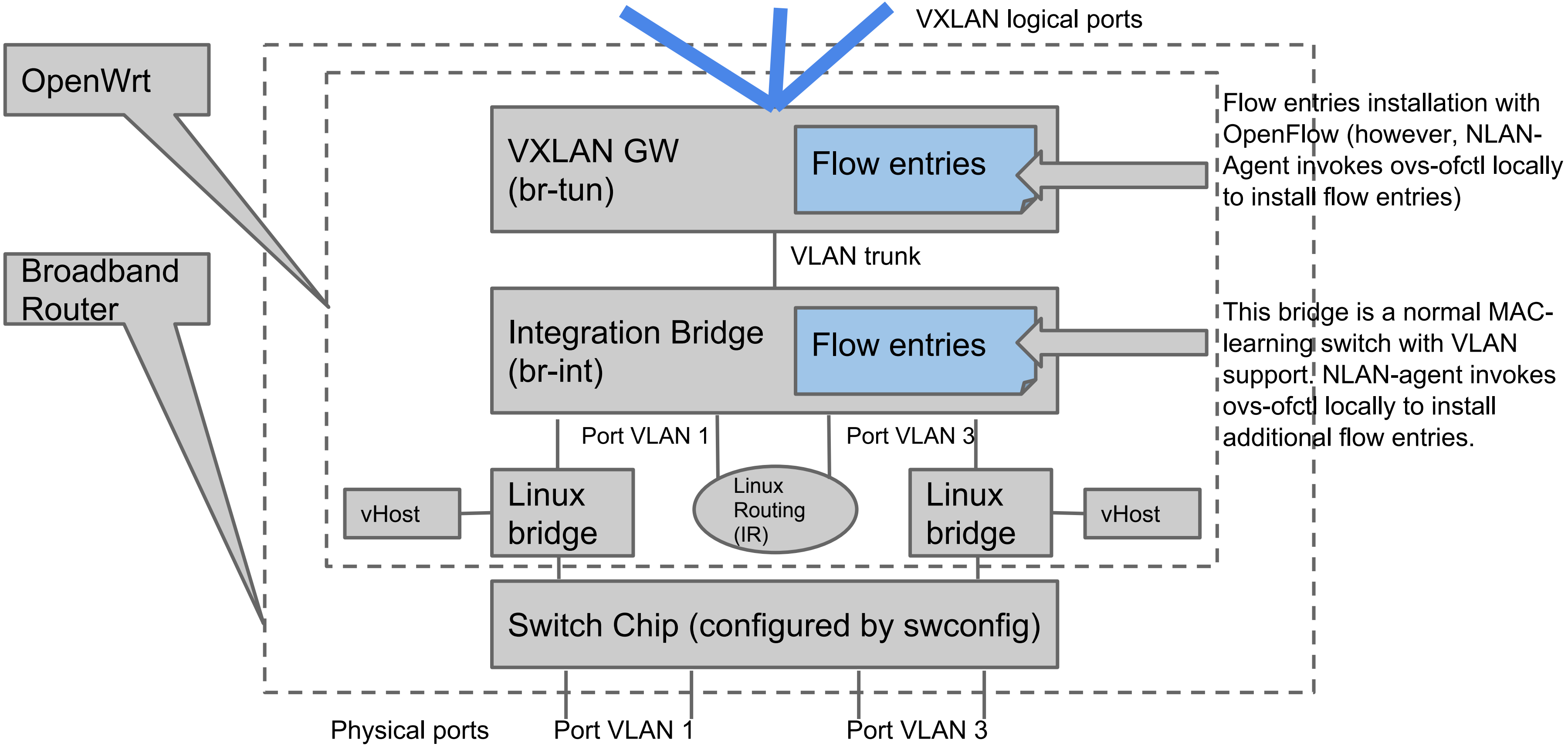
OpenWrt routers
(and Home Gateway)

Raspberry Pi

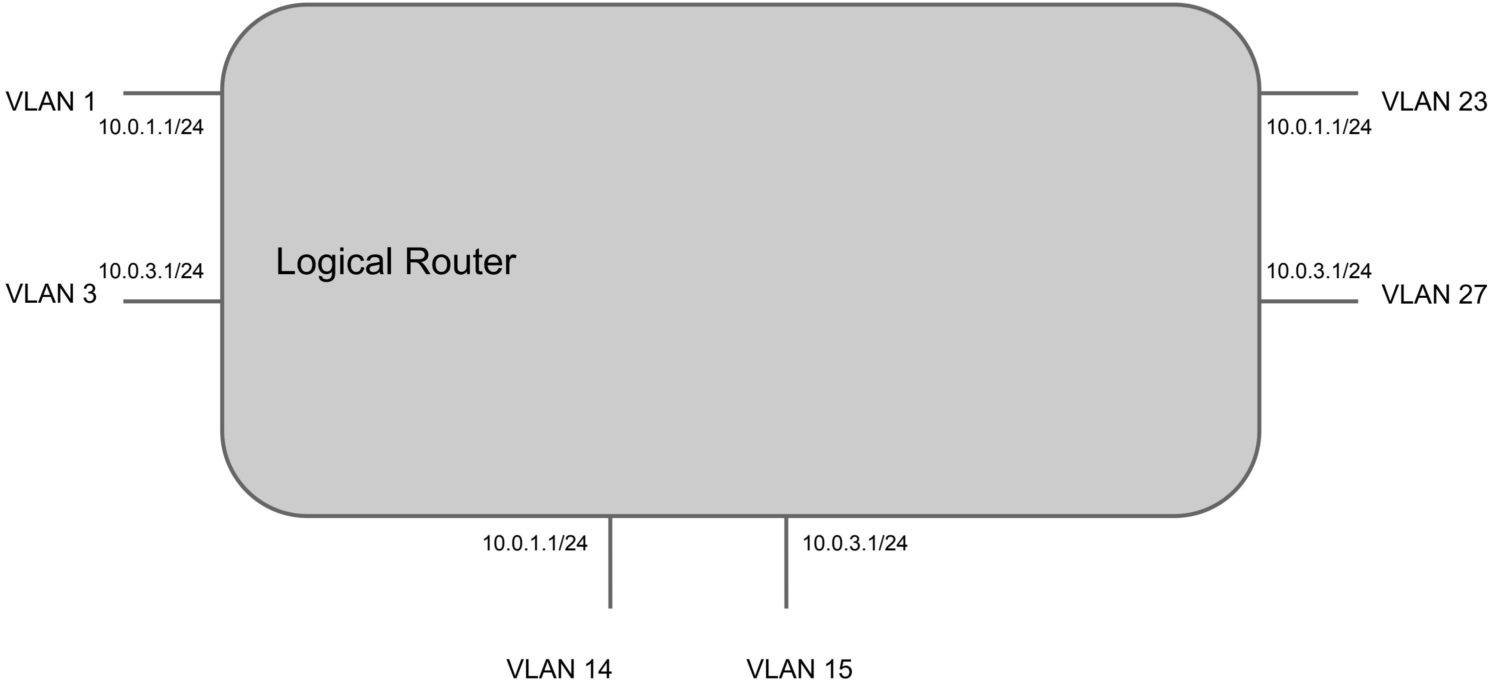
Test bed


NLAN-Master
(DevOps master)
Debian Linux
The Internet
Internet GW
RIPv2
Debian Linux or Raspbian
OpenWrt
192.168.1.104
192.168.1.101
VXLAN tunnels (VNI 1, 101, 103)
192.168.1.103
192.168.1.102
OpenWrt
OpenWrt
Physical ports
Physical ports

OpenStack-neutron-like bridge configuration



Distributed Virtual Router (Logical view)



Virtual network topologies

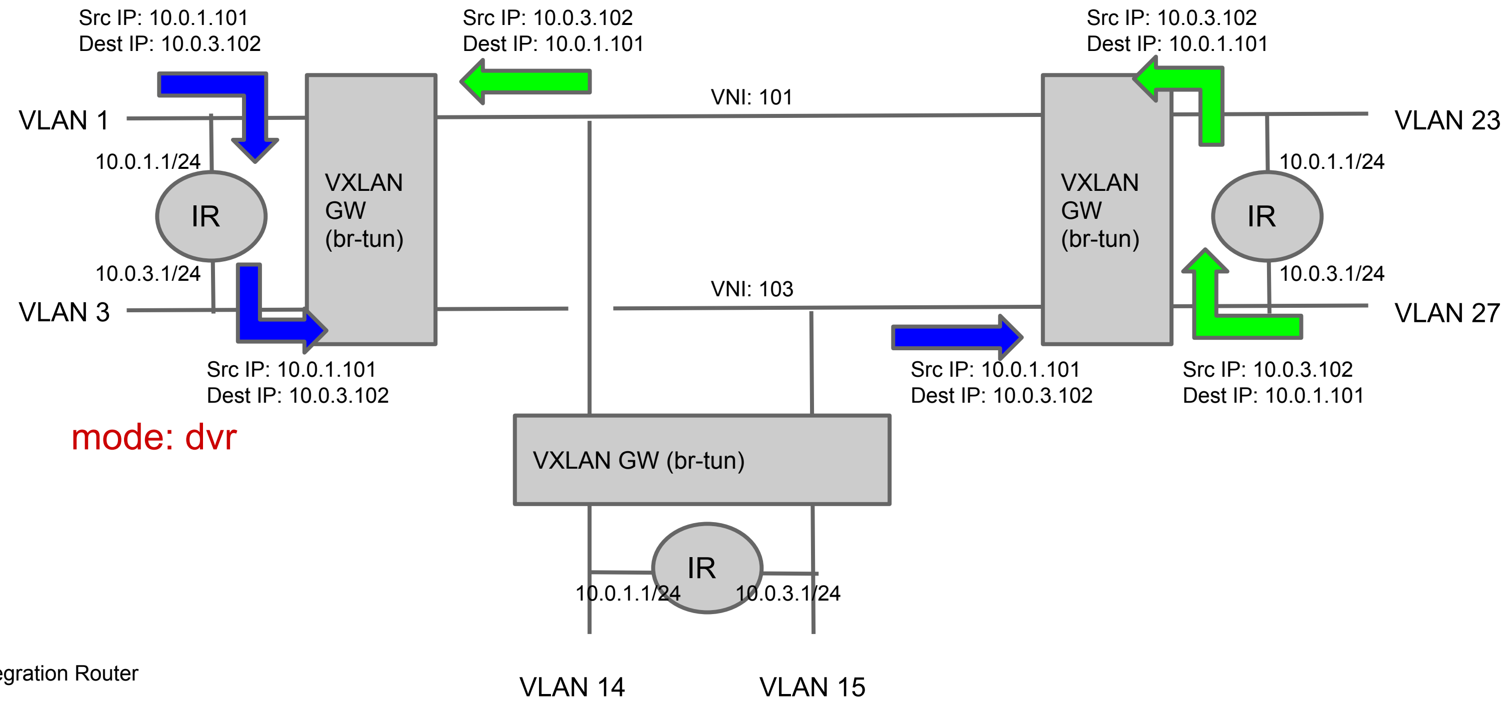
NLAN node operation mode	Virtual Network Topology
dvr	Distributed Virtual Router
hub	Hub & Spoke
spoke	Hub & Spoke
spoke_dvr	Mixtuare of DVR and Hub & Spoke

NLAN state in YAML

```
subnets:
  - vid: 1
  vni: 1001
  ip_dvr: '10.0.1.1/24'
  mode: hub
  ip_vhost: '10.0.1.101/24'
  ports:
          - eth0.1
  peers: <peers>
```

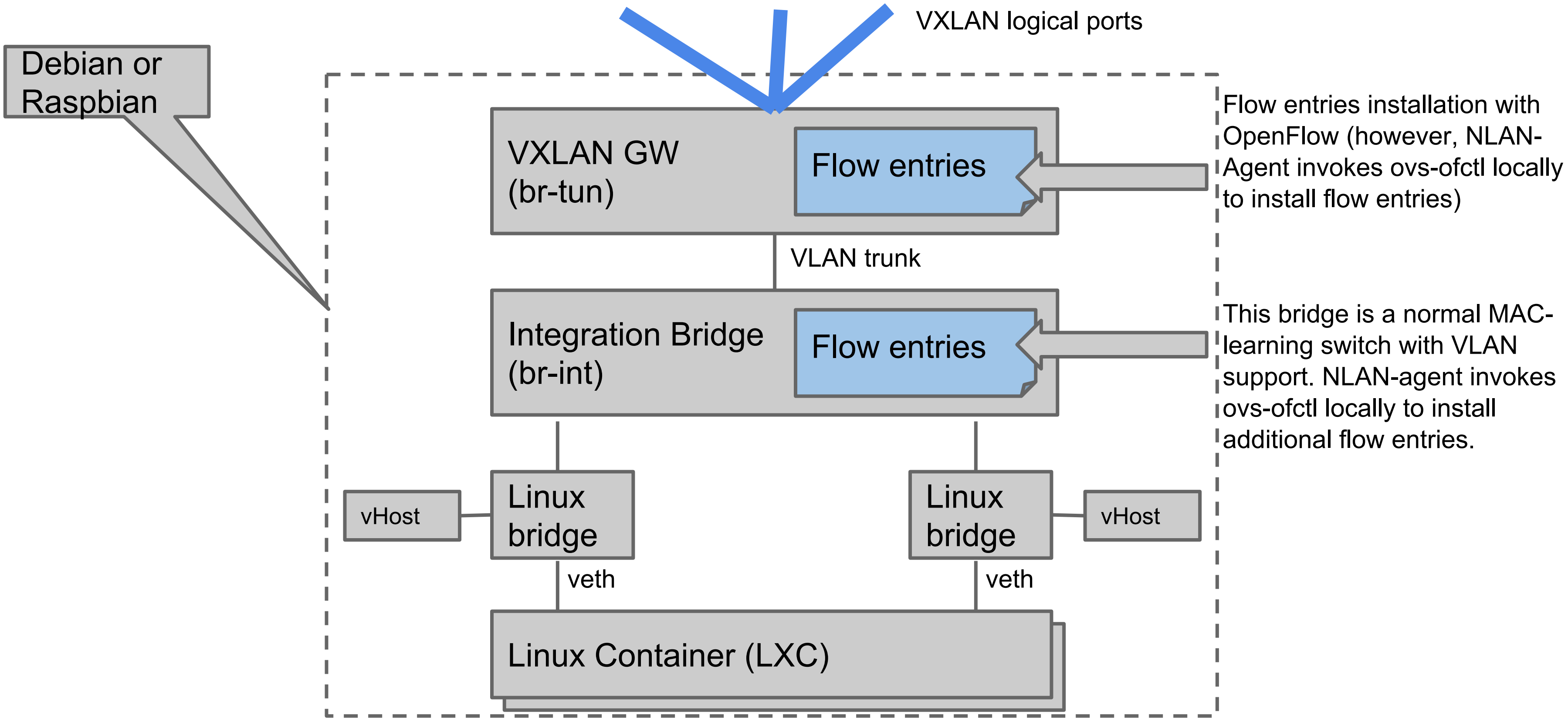
mode can be ‘dvr’, ‘hub’, ‘spoke’ or ‘spoke_dvr’

Distributed Virtual Switch and Distributed Virtual Router

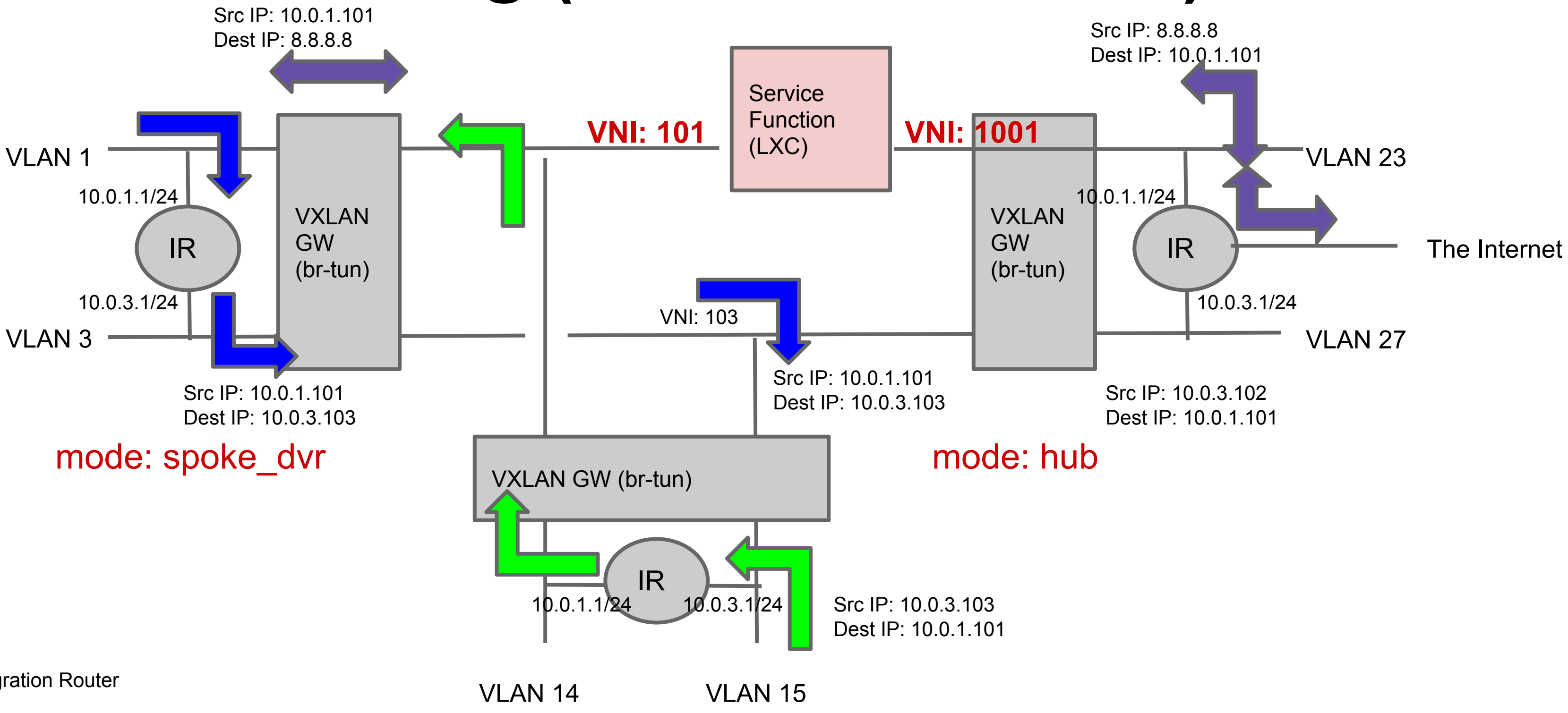


IR: Integration Router

Service Function in Linux Container

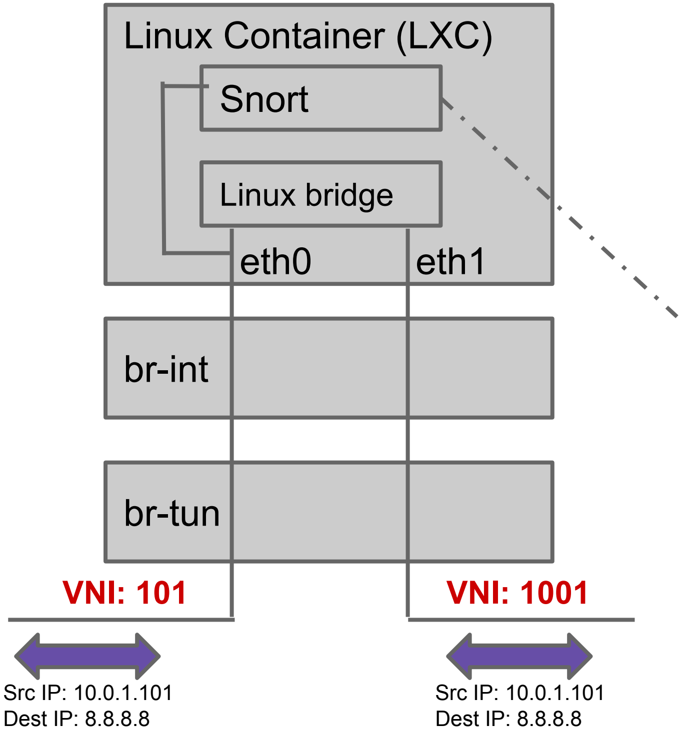


Service Chaining (Service Insertion)



IR: Integration Router

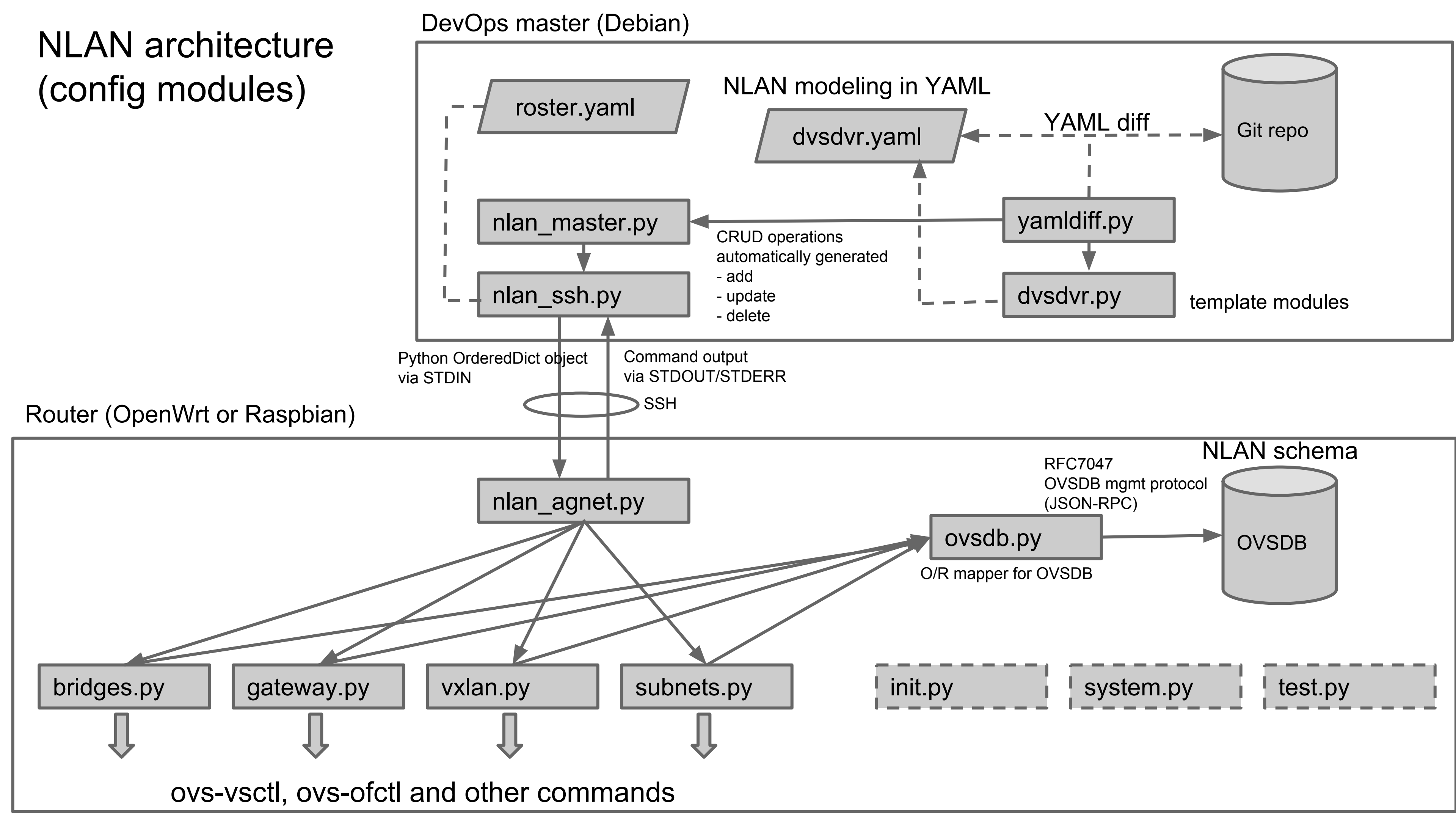
Example: Snort (in IPS mode) as Service Function



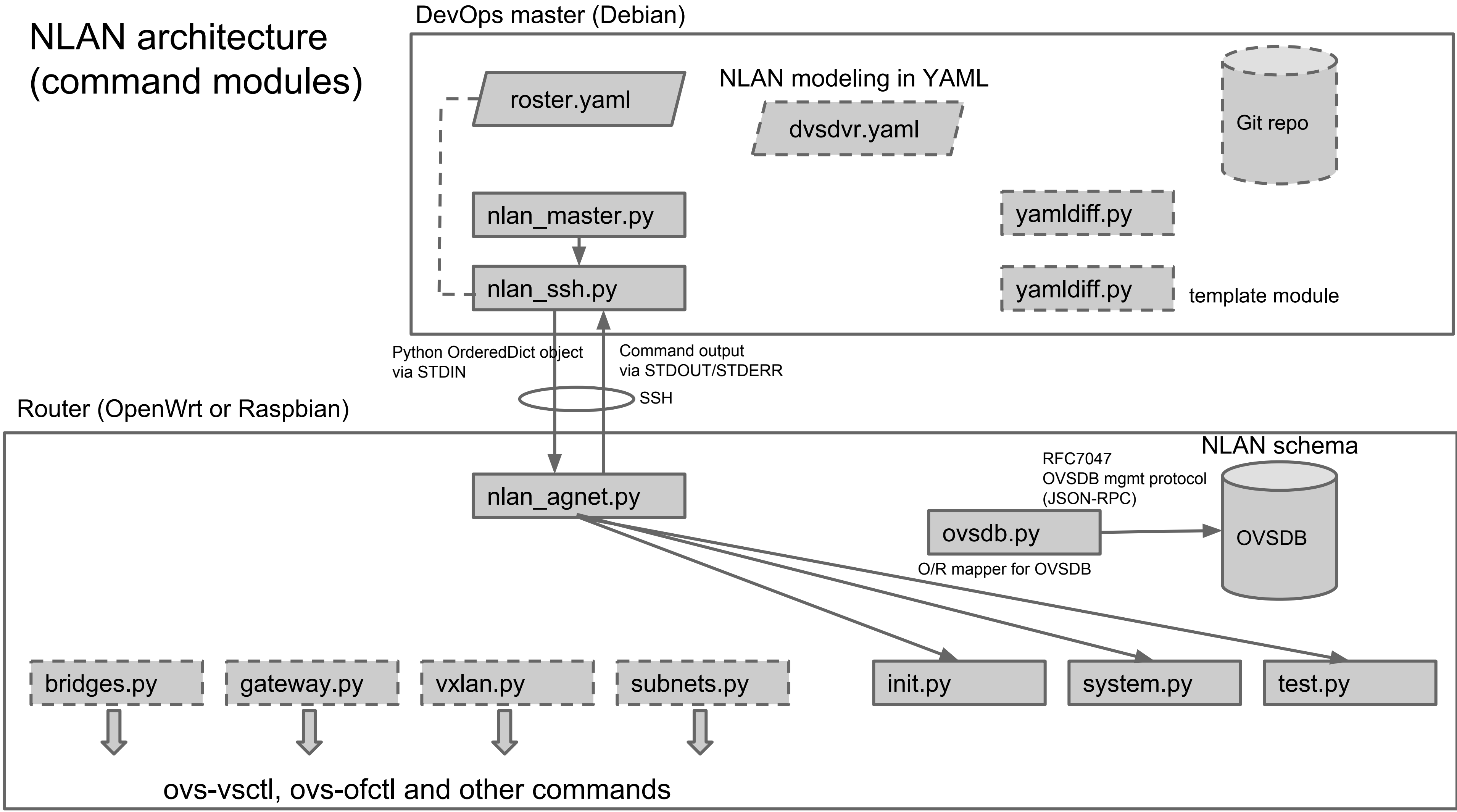

```
04/13-23:16:32.859385 10.0.1.102 -> 8.8.8.8
ICMP TTL:64 TOS:0x0 ID:11745 IpLen:20 DgmLen:84 DF
Type:8  Code:0  ID:49496   Seq:25  ECHO
=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+

04/13-23:16:32.861970 8.8.8.8 -> 10.0.1.102
ICMP TTL:63 TOS:0x0 ID:38077 IpLen:20 DgmLen:84
Type:0  Code:0  ID:49496  Seq:25  ECHO REPLY
=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+

04/13-23:16:33.861151 10.0.1.102 -> 8.8.8.8
ICMP TTL:64 TOS:0x0 ID:11746 IpLen:20 DgmLen:84 DF
Type:8  Code:0  ID:49496   Seq:26  ECHO
=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+

04/13-23:16:33.862906 8.8.8.8 -> 10.0.1.102
ICMP TTL:63 TOS:0x0 ID:38078 IpLen:20 DgmLen:84
Type:0  Code:0  ID:49496  Seq:26  ECHO REPLY
=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+
```

Home-made DevOps tool ‘NLAN’

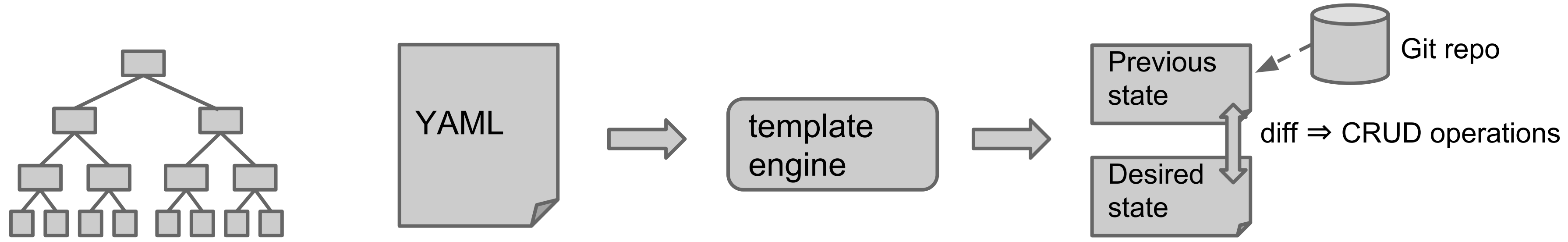
- 100% Python implementation
- Borrwed a lot of ideas from SaltStack
  - Model-driven procedure
  - YAML-based states w/ a simple template engine
- Works with OpenWrt with minimal Python
  - opkg install python-mini
  - opkg install python-json
- OVSDB as a local config mgmt database


NLAN architecture
(config modules)
DevOps master (Debian)
NLAN modeling in YAML
roster.yaml
dvsdvr.yaml
YAML diff
Git repo
nlan_master.py
yamldiff.py
nlan_ssh.py
dvsdvr.py
template modules
CRUD operations
automatically generated
- add
- update
- delete
Python OrderedDict object
via STDIN
Command output
via STDOUT/STDERR
SSH
Router (OpenWrt or Raspbian)
NLAN schema
RFC7047
OVSDB mgmt protocol
(JSON-RPC)
nlan_agnet.py
ovsdb.py
OVSDB
O/R mapper for OVSDB
bridges.py
gateway.py
vxlan.py
subnets.py
init.py
system.py
test.py
ovs-vsctl, ovs-ofctl and other commands

NLAN architecture (command modules)



Model-driven service abstraction (cont'd)



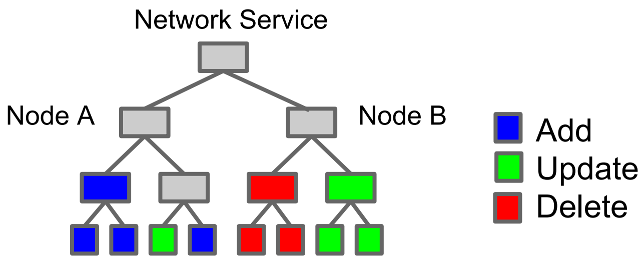
Step1: define network service model

Step2: write the mode as "desired state" in YAML format w/ some placeholders for a template engine

Step3: write a template engine to fill out the placeholders.

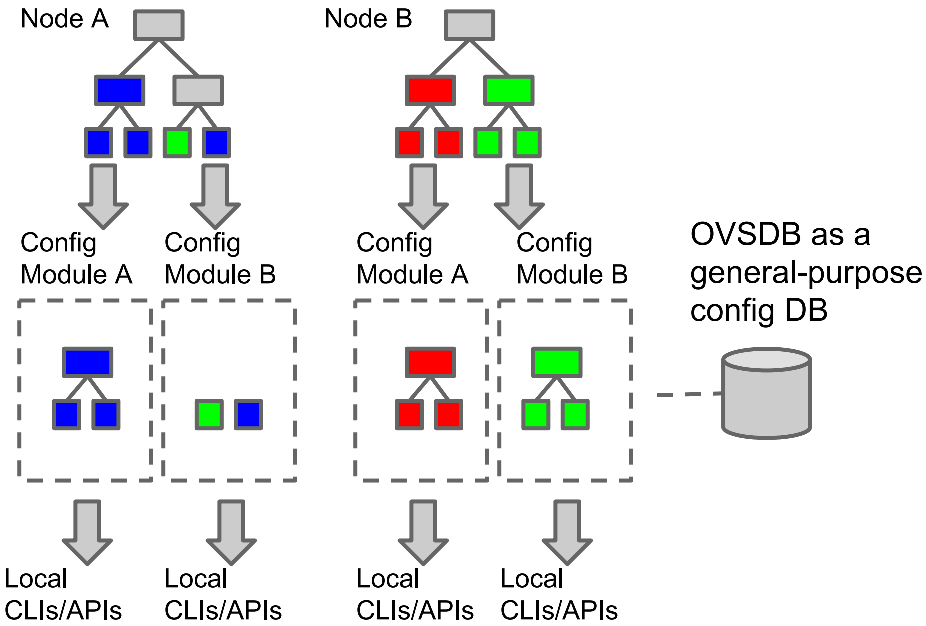
Step4: NLAN-Master generates CRUD operations comparing the desired state with the previous state

Model-driven service abstraction



Step5: Now CRUD-operations (= difff of the previous and the desired states) are in the form of Python OrderedDict object

Step6: NLAN-Agent routes the CRUD operations to corresponding nodes/modules



Template and placeholders example

```
#!template.dvsdvr
openwrt1:
        :
  vxlan:
        local_ip: <local_ip>
        remote_ips: <remote_ips>
  subnets:
        - vid: 1
        vni: 101
        ip_dvr: '10.0.1.1/24'
        ip_vhost: '10.0.1.101/24'
        ports:
        - eth0.1
        peers: <peers>
        :
```

template engine “template.dvsdvr”

- generates a local ip address
- generates VXLAN remote ip addresses
- generates broadcast tree per VNI

```
#!template.dvsdvr
openwrt1:
        :
  vxlan:
        local_ip: '192.168.1.101'
        remote_ips: [‘192.168.1.102’, ‘192.168.1.103’, ‘192.168.1.104’]]
  subnets:
        - vid: 1
        vni: 101
        ip_dvr: '10.0.1.1/24'
        ip_vhost: '10.0.1.101/24'
        ports:
        - eth0.1
        peers: [‘192.168.1.102’, ‘192.168.1.104’]
        :
```

Python OrderedDict

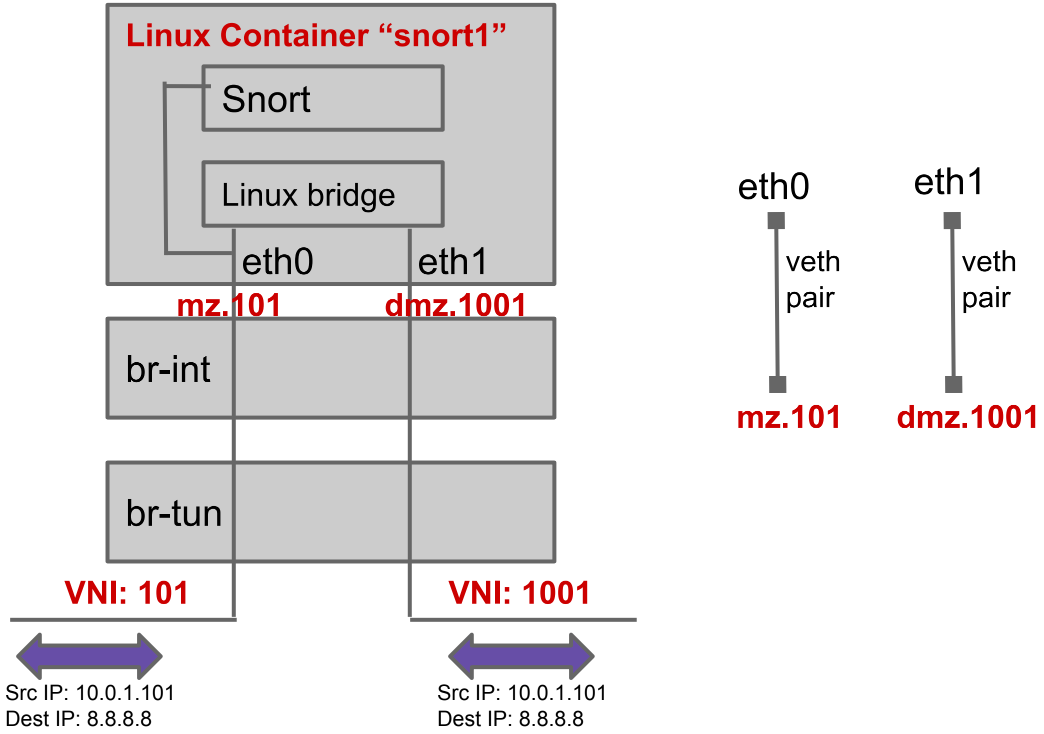
- NLAN-Master sends Python OrderedDict to NLAN-Agent via ssh STDIN.
- To be exact, string form of an OrderedDict object

"OrderedDict([('bridges', {'ovs_bridges': 'enabled'}), ('gateway', {'network': 'eth0.2', 'rip': 'enabled'}), ('vxlan', {'remote_ips': ['192.168.1.103', '192.168.1.102', '192.168.1.104'], 'local_ip': '192.168.1.101'}), ('subnets', {('vni', 1): {'ip_vhost': '192.168.100.101/24', 'ip_dvr': '192.168.100.1/24', 'peers': ['192.168.1.102', '192.168.1.103'], 'vid': 2, 'vni': 1}, ('vni', 103): {'peers': ['192.168.1.102', '192.168.1.103', '192.168.1.104'], 'vid': 3, 'ip_vhost': '10.0.3.101/24', 'vni': 103, 'ip_dvr': '10.0.3.1/24', 'ports': ['eth0.3']}, ('vni', 101): {'peers': ['192.168.1.102', '192.168.1.103', '192.168.1.104'], 'vid': 1, 'ip_vhost': '10.0.1.101/24', 'vni': 101, 'ip_dvr': '10.0.1.1/24', 'ports': ['eth0.1']}})])"

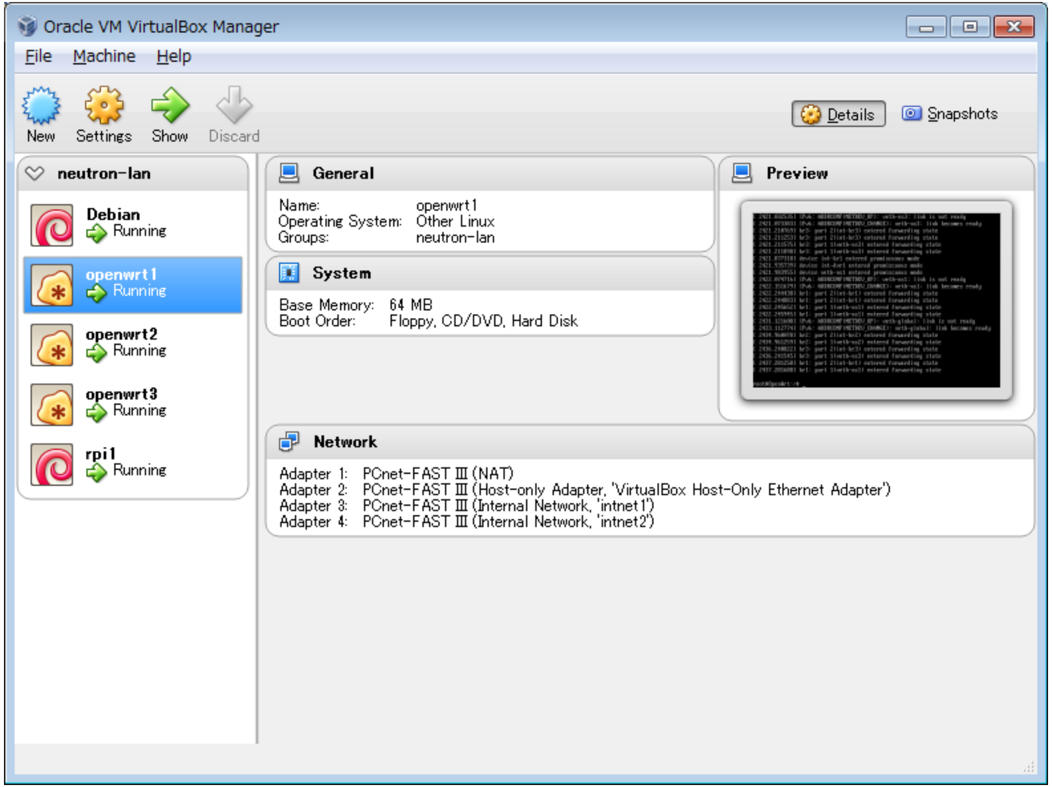
- I don’t use JSON, since NLAN is 100% Python implementation.

Service Function Chaining in YAML

```yaml
rpi1:
  bridges:
    ovs_bridges: enabled
  services: # Service Functions
    - name: snort1
    chain: [mz.101, dmz.1001]
  vxlan:
    local_ip: <local_ip>
    remote_ips: <remote_ips>
  subnets:
    - vid: 111
    vni: 1001
    peers: <peers>
    ports: <sfports>
    - vid: 1
    vni: 101
    peers: <peers>

    ports: <sfports>
```



NLAN Software Development on VirtualBox



- OpenWrt image for x86
  - Very light-weight Linux supporting Open vSwitch 2.0.0
- Network adapters
  - Internet access: “NAT”
  - Management: “Host-Only”
  - NLAN underlay: “Internal”