EINE

Easy Internet vpN Extender

Large-scale plug&play x86 network appliance deployment over Internet

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Agenda

- Orange in one slide
- Our needs
  - Automation tools
  - Less expensive solution for our small offices
- Our Solution
  - D.I.Y
  - Deployment steps
  - Hardware selection
  - Project current status
- Build an EINE infrastructure from scratch

Orange in one slide

- Worldwide Telco: 244M customers, 156 000 employees
  - Residential: ISP, phone, TV, etc…
  - Personal: Mobile
  - Professional (Orange Business Services): ISP, VPN, VoIP, Cloud, etc…
    - International & Backbone Networks Factory (1 700 employees)
      - 40 submarine cables (6 cable ships)
      - 2.5 TB/s worldwide IP network
      - 700 000 managed devices
      - 220 countries
        - Internal network
          - Experimental features allowed: Let's put FreeBSD everywhere!
- Open Source Orange
  - Nov 2009: Orange started to provide source code of their triple play DSL box
  - http://opensource.orange.com

Our needs: Network automation tools

- *System admin*: “I’ve just deployed 200 servers this morning, now I’m waiting for your 20 firewalls and 4 load-balancers, can you do it this afternoon ?”

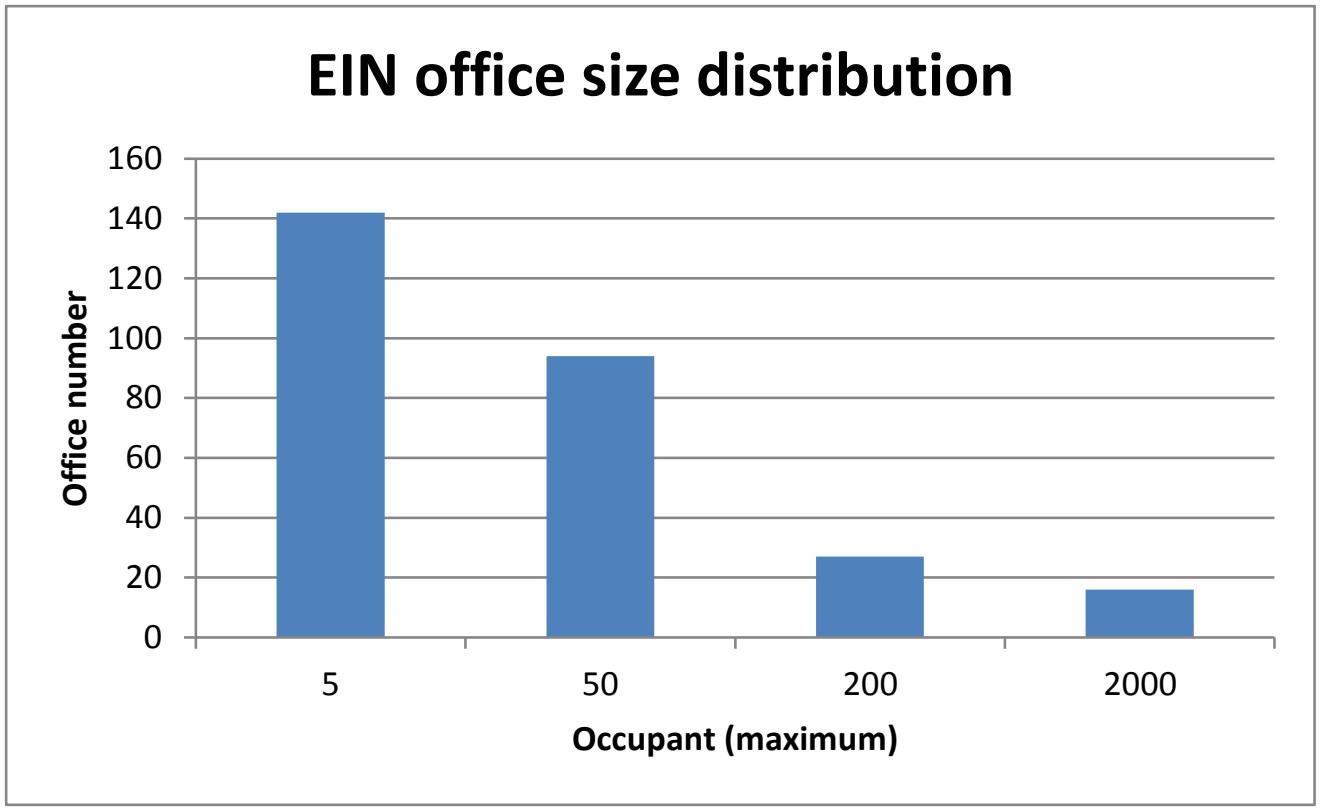
- *Network admin*: “OMG… can you wait a little month ?”

Our needs: Network automation tools

- We are waiting for automation tools from Network Vendors since too many years
  - In 2015 appliance vendors solution (like NETCONF) are still not production ready for large-scale and heterogeneous environment
- Why not re-using well-known IT tools for network ?
  - Because IT tools are for x86 servers
- Then, let's use x86 appliance for network too!
  - Thanks to the SDN trend for introducing x86 world into network engineers mind

Our needs: Less expensive solution for small offices

- We have 278 sites worldwide with the following size distribution:



Our solution

DO IT YOURSELF

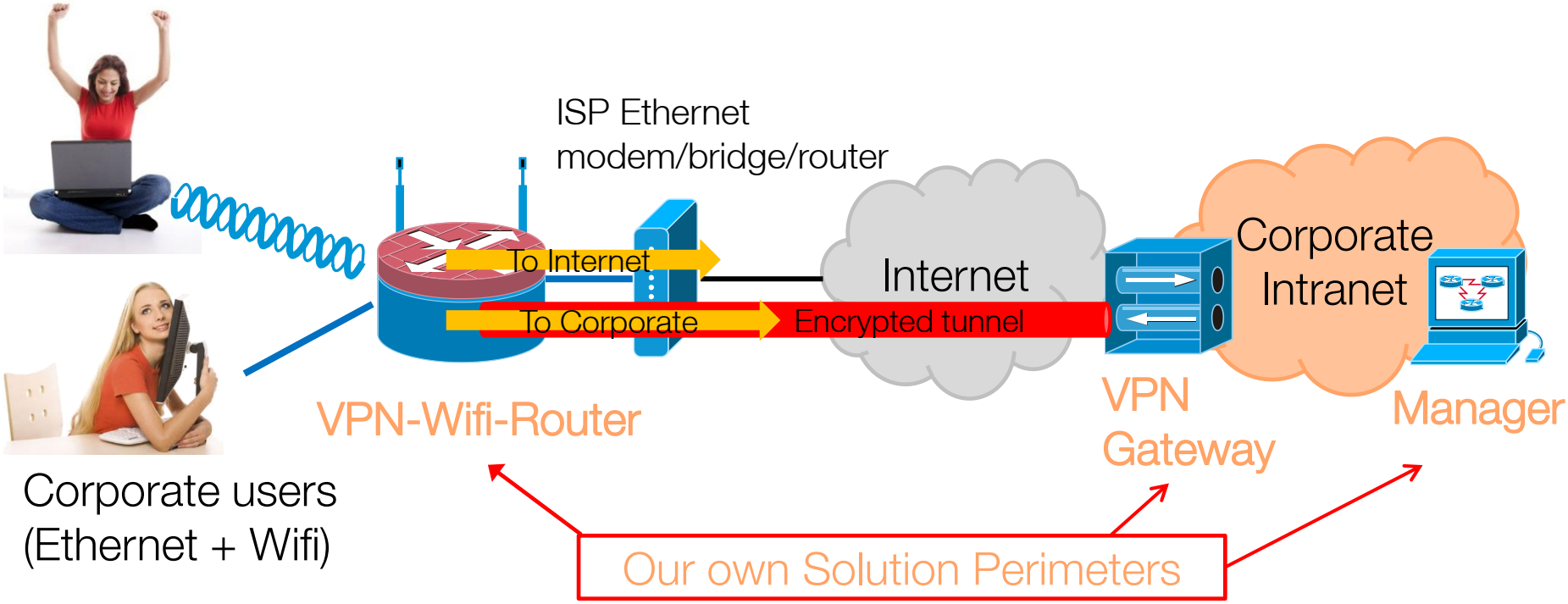
Our solution: Do It Yourself

- Build our own solution corresponding to OUR needs
  - ⇒ and not to some network manufacturer roadmap
  - ⇒ only OpenSource: No known backdoors
- **Simplify management** of the overall solution:
  - Plug & play appliance
  - Centralized management of all devices
  - WebGUI because next generation of engineers are too stupid for using command line

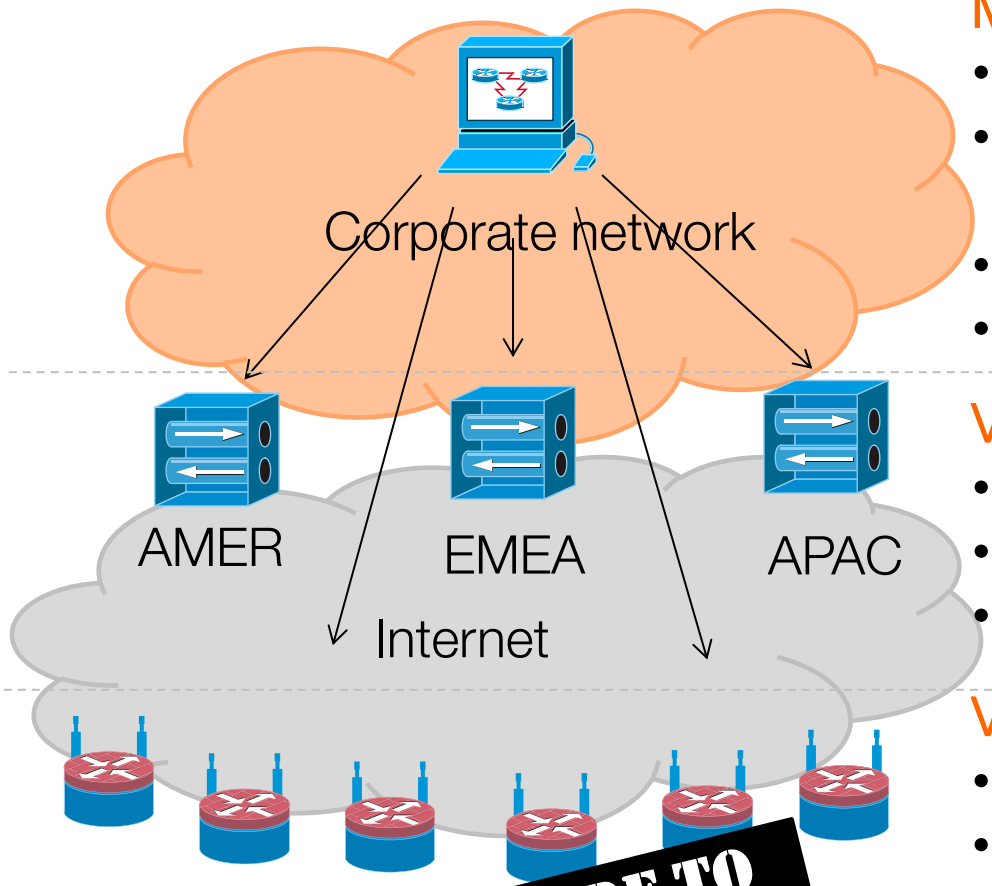
- Link cost reduction:
  - Replacing expensive dedicated link by cheaper local Internet Access

Our solution: Plug&Play Internet VPN

- Plug&Play VPN-Wifi-routers deployment for Office connectivity over low-cost local ISP



Our solution: Scalable and easy to manage



Manager

- *WebGUI*
- Centralized management of VPN gateways & VPN routers
- Certificate Authority
- *Configuration versioning*

VPN Gateway

- OpenVPN servers
- Radius proxy
- Dynamic routing (OSPF/RIP/ISIS)

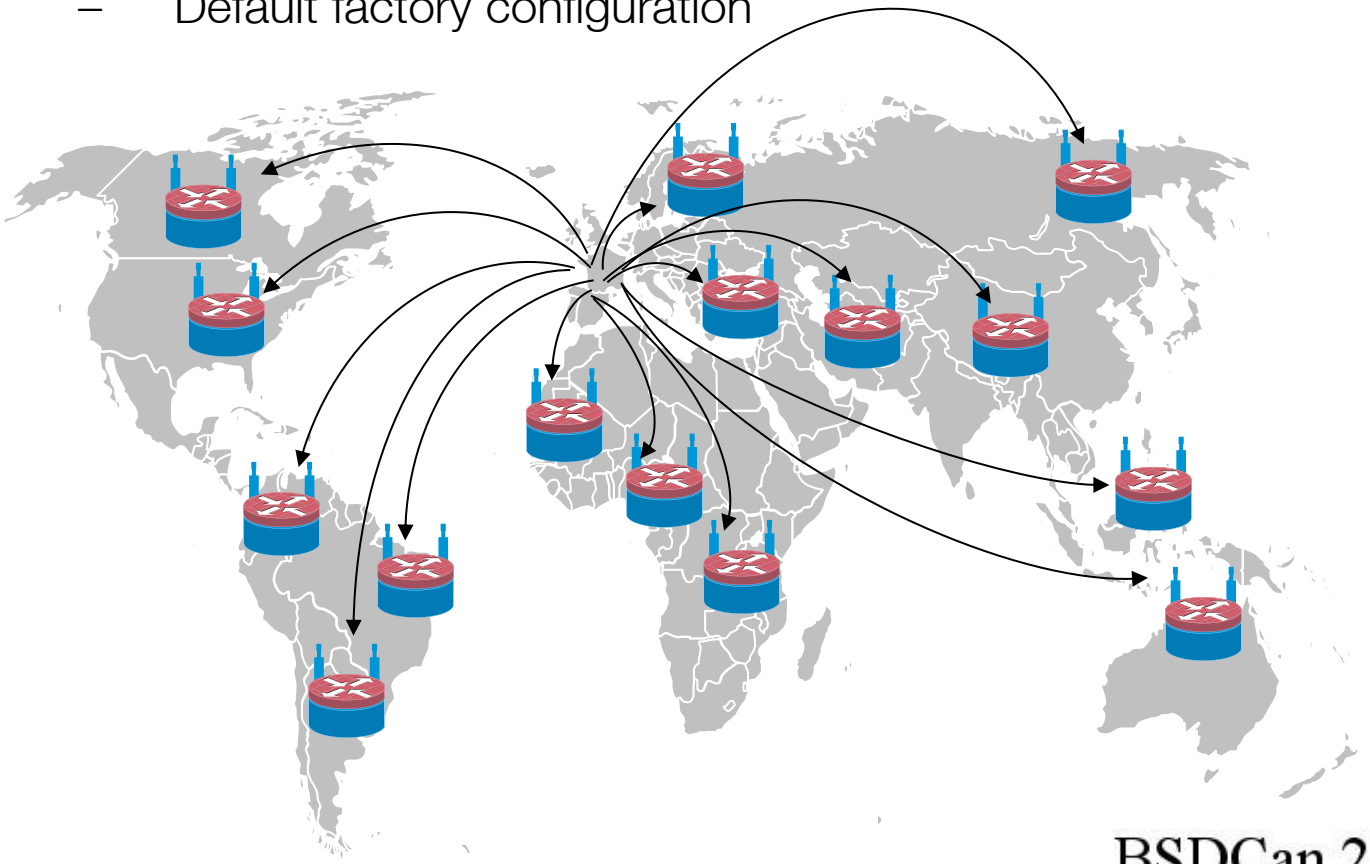
VPN-Wifi-Router

- OpenVPN client
- Firewall
- Wifi Access Point
- Dynamic routing (OSPF/RIP/ISIS)

ONE FIRMWARE TO RULE THEM ALL

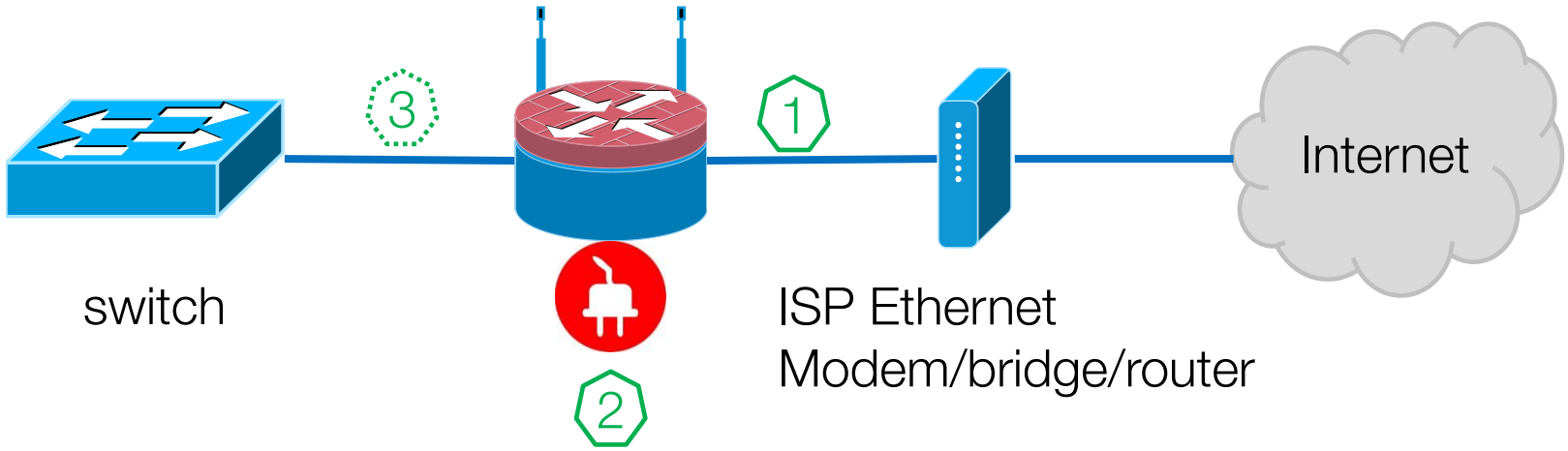
Our solution: Deployment steps

1. Boxes are sent to offices from the manufacturer
   - Default factory configuration



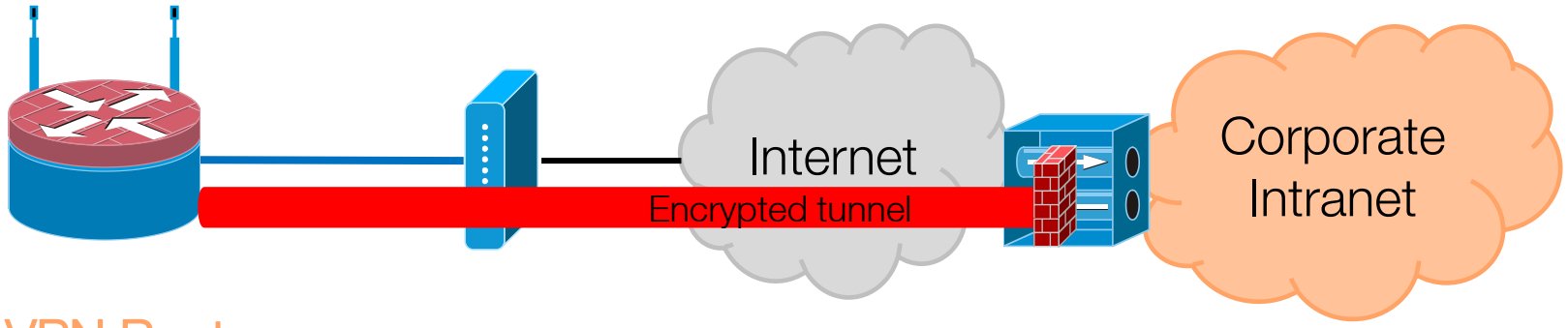
Our solution: Deployment steps

2. Local user (no FOIS needed) plugs & power the box
   - Still no box configuration needed



Our solution: Deployment steps

3. VPN-Wifi-router:
    1. Get IP address & gateway using DHCP
    2. Get date/time using NTP (certificates usage!)
    3. Open Tunnel to a VPN “enrollment” Gateway



VPN Router

ISP Ethernet
Modem/bridge

VPN Enrollment Gateway
(block ALL traffic coming from the tunnel)

Our solution: Deployment steps

4. Administrator logon to the manager WebGUI
   - They select new client to enroll

VPN-Routers	Gateways				
Name	geoIP	Tunnel uptime	Latency/Bandwidth Down/up 5min avg	Gateway	Version (upgrade all)
PNEP1	Nepal	3d, 04h21m12s	230ms/4M/512k	APAC	1.1
PUZB1	Uzbekistan	5d, 05h4m2s	350ms/8M/1M	EMA	1.1
PNIG1	Niger	0d, 09h34m1s	234ms/2M/256k	EMA	1.0 (upgrade)
NONE	Sydney	1d, 01h1m1s	230ms/4M/512k	Re[illegible]ter	1.0 (upgrade)
NONE	Singapore	1d, 01h1m1 s	340ms/2M/256k	Re[illegible]ter	1.0 (upgrade)

Our solution: Deployment steps

4. Administrator manually enroll device
   - Calling one-site personal for confirming router ID
   - This action pushes specific site configuration (certificates, hostname, addressing, etc…) to the device

Enrolling VPN-Router	
Role:	VPN router and Wifi Access Point
Hostname:	Sydney
Loopback address:	10.1.1.1
Wireless subnet:	10.10.1.0/25
LAN subnet:	10.10.1.128/25

Current roles:
- VPN gateway
- VPN Wifi Router

Other roles planned:
- Serial Terminal Server
- Captive portal

x86 appliances

SOFTWARE SELECTION

Software selection

- Operating system: FreeBSD (nanoBSD)
  1. We target network administrator and not system administrator
  2. It's the only OS I'm confident in
  3. Branch used: head
- Configuration management & deployment: Ansible
  - « just» python as dependency
  - I was able to use 2 days after discovering it (I'm not a sysadim)
- VPN: OpenVPN
  - IPSec is a filtering decision and not a routing decision
  - Need to use GRE/GIF tunnels for using routing protocol over it
- Routing software: Bird
  - Because… wow!

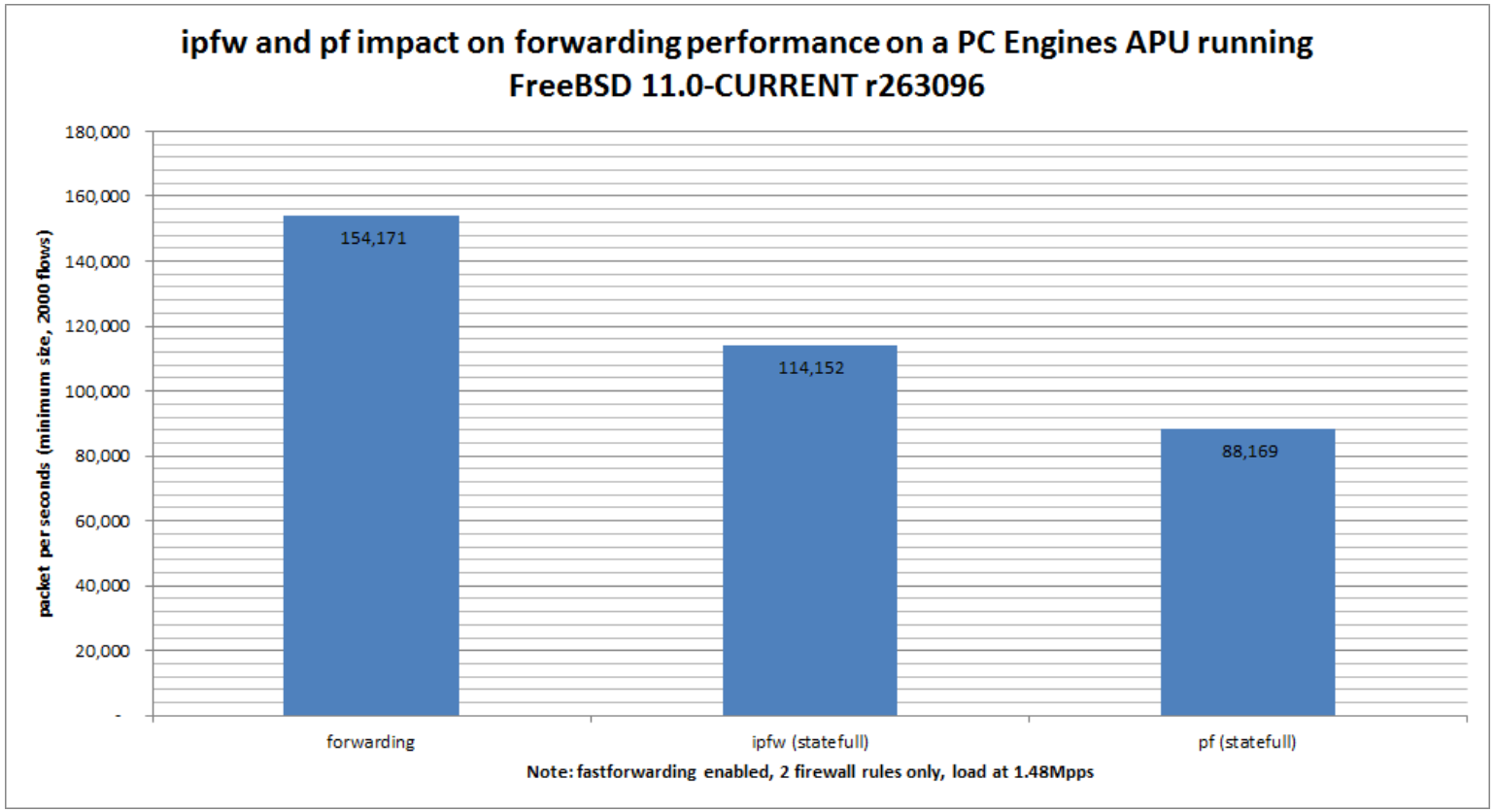
x86 appliances

HARDWARE SELECTION

VPN-Wifi-Router: PC Engines APU (1st generation)

- x86 64bits dual cores at 1Ghz
- 2 or 4GB of RAM
- 3 Gigabit NIC (RTL8111E)
- 16GB SSD
- Wireless 802.11a/b/g/n
- Total price: 150€ (2G) / 170€ (4G)

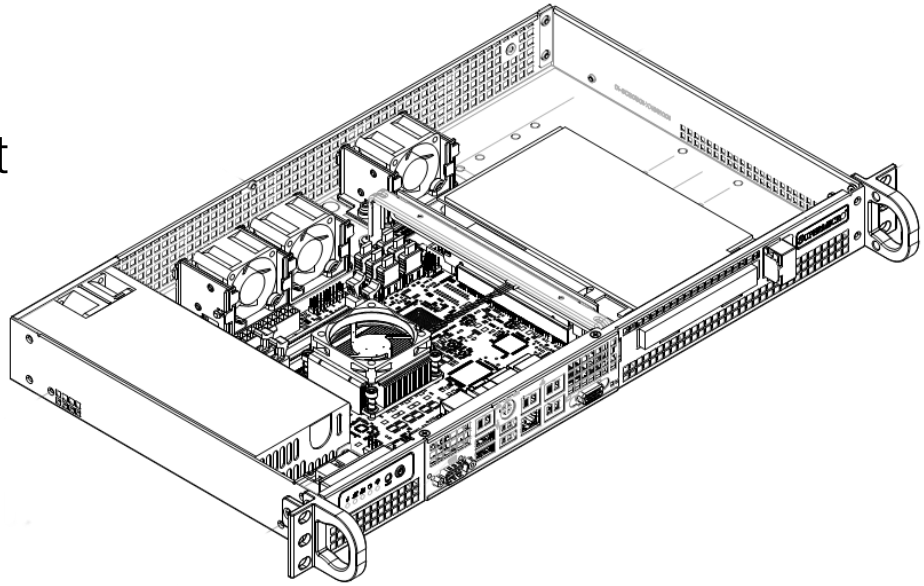
PC Engines APU (1st gen): Network performance



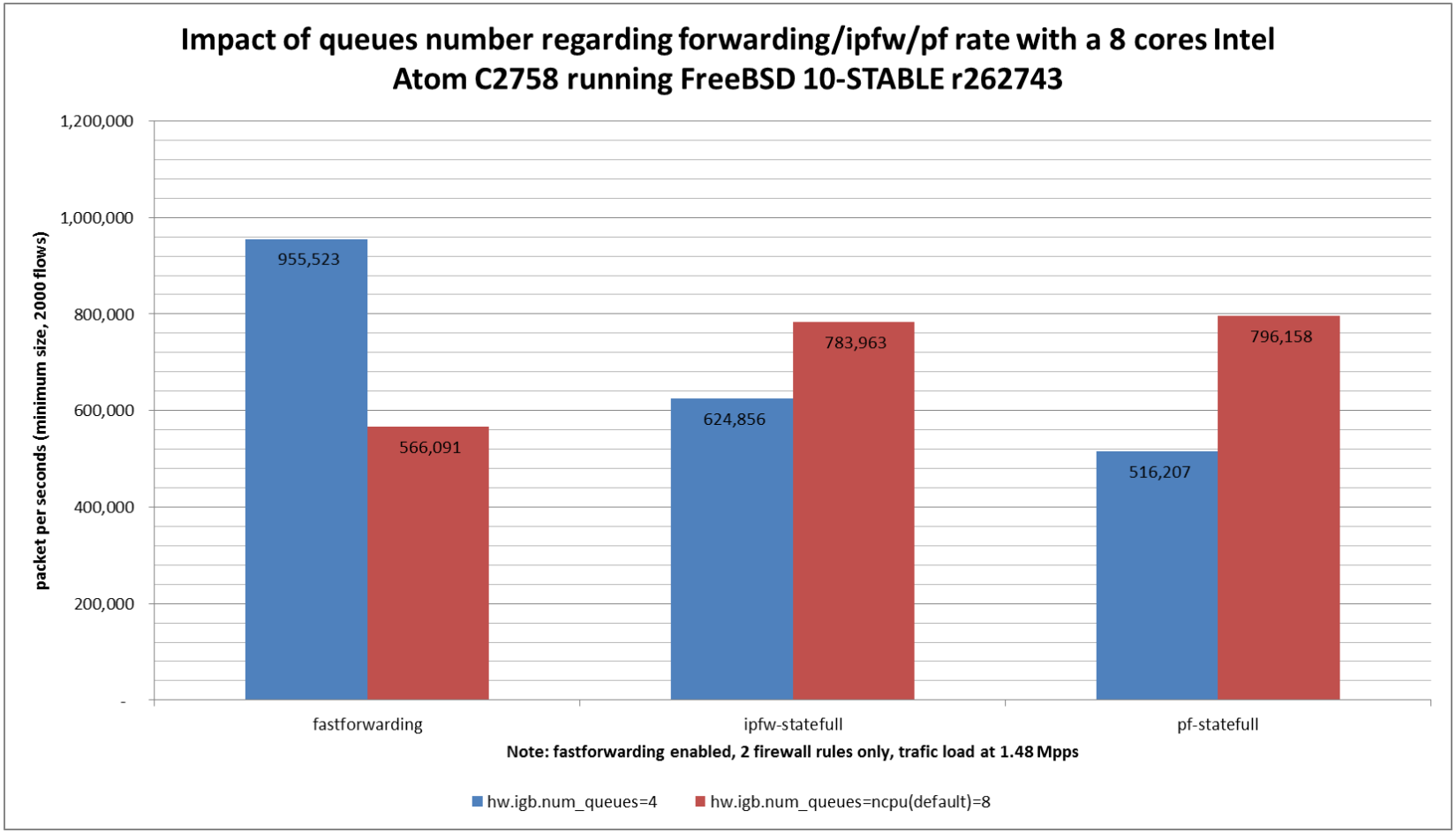
mode	pps	Estimated Ethernet IMIX throughput
routing	154 171	437 Mb/s
ipfw impact	114 152	324 Mb/s
pf impact	88 169	250 Mb/s

VPN gateway: Supermicro 5018A-FTN4

- 8 cores Intel Atom C2758 at 2.4GHz (support AES-NI)
- 4 Gigabits NIC
- 1U Network appliance size
- IPMI (serial over LAN) support
- Power consumption: Low
- + 8 GB RAM
- + Flash disk (4GB is enough)
- Total Price: 870€



8 cores or more: Tuning needed



Hardware Appliance for Manager

- Manager needs only to:
  - Will host small WebGUI
  - Store text file
  - Send SSH commands
- A simple VM or same hardware as VPN-Router is enough

Technical annex

PROJECT CURRENT STATUS

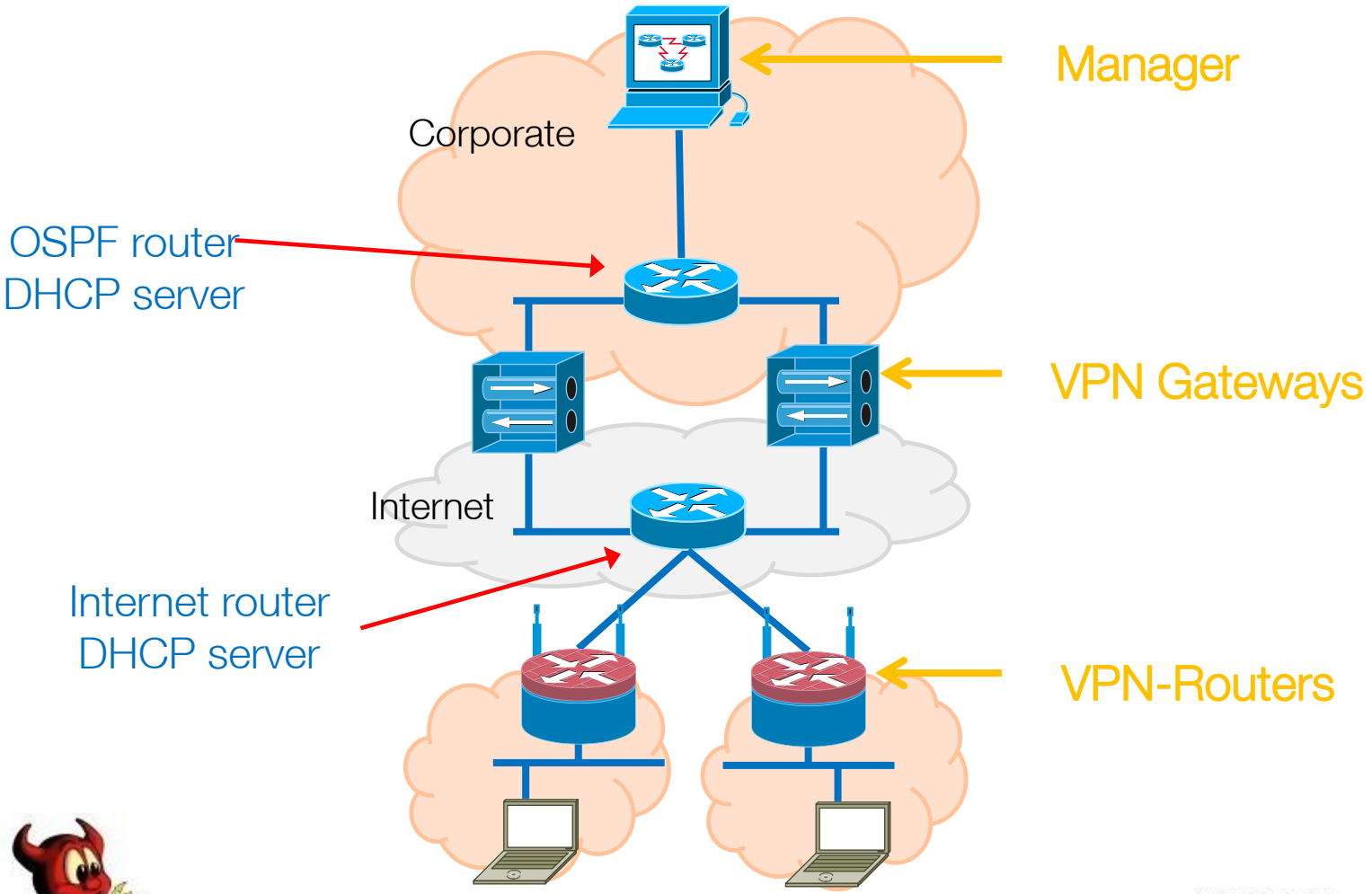
Project status

Tasks	advancement
Define Target & minimum features	Done
Selecting & buying PoC hardware	Done
Selecting & generating OS firmware	Done
Cisco “Easy VPN” like with GRE over IPSec + Certificate Management	Replaced by OpenVPN
Wifi EAP-TLS authentication including RADIUS proxy	Done
Writing helper scripts for configuration management & deployment tool	Done: Ansible, writing gateway and client management scripts
PoC Started	On going: 6 routers deployed
Manager WebGUI	On going
Writing “Best latency check” patch to OpenVPN	Not started
Approval for production deployment	On going

Virtual lab example

HOW TO BUILD AN EINE INFRASTRUCTURE FROM SCRATCH ?

Virtual Infrastructure to build



Running a full network virtual lab… in one command

- Download a Demo EINE firmware (RAW image disk) that already includes private keys archive

  https://sourceforge.net/projects/bsdrp/files/BSD_Router_Project/EINE/

- Or build an image from scratch:

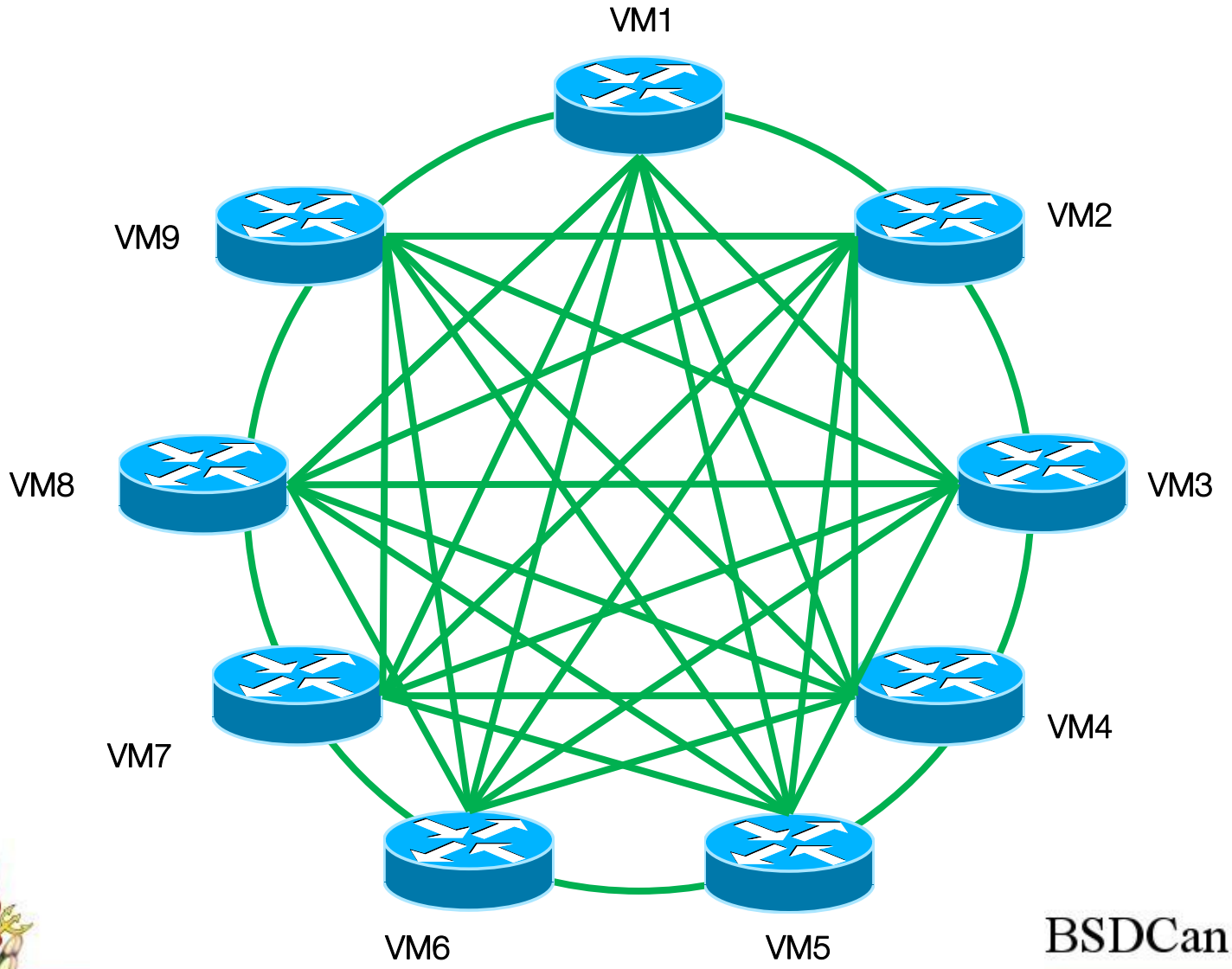
```
svnlite co https://github.com/ocochard/BSDRP/trunk BSDRP
cd BSDRP
./make -p EINE
```

- From a FreeBSD 10.1 with this shell script:
  - `BSDRP-lab-bhyve.sh -i EINE-0.9-full-amd64-vga.img.xz -n 9`
- From a MS Windows with VirtualBox with this PowerShell script:
  - `BSDRP-lab-vbox.ps1`
- Linux users have their VirtualBox lab-script shell too!

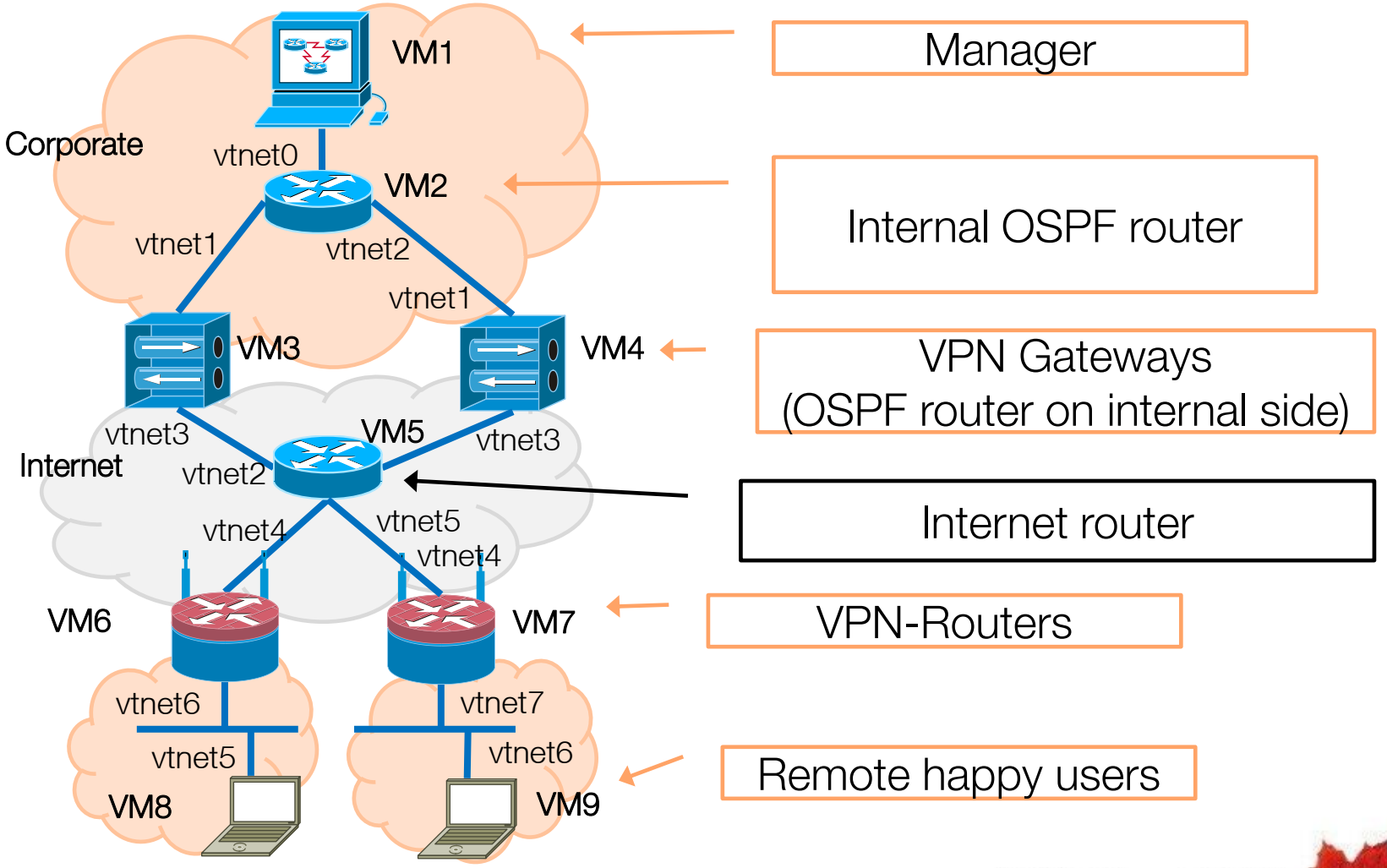
Running a full network virtual lab

```
> BSDRP-lab-bhyve.sh -i EINE-0.1-full-amd64-serial.img -n 9
BSD Router Project (http://bsdrp.net) - bhyve full-meshed lab script
Setting-up a virtual environment with 9 VM(s):
- Working directory: /tmp/BSDRP
- Each VM have 1 core(s) and 256M RAM
- 0 LAN(s) between all VM
- Full mesh Ethernet links between each VM
VM 1 have the following NIC:
- vtnet0 connected to VM 2.
- vtnet1 connected to VM 3.
- vtnet2 connected to VM 4.
- vtnet3 connected to VM 5.
- vtnet4 connected to VM 6.
- vtnet5 connected to VM 7.
- vtnet6 connected to VM 8.
- vtnet7 connected to VM 9.
VM 2 have the following NIC:
- vtnet0 connected to VM 1.
- vtnet1 connected to VM 3.
- vtnet2 connected to VM 4.
- vtnet3 connected to VM 5.
- vtnet4 connected to VM 6.
- vtnet5 connected to VM 7.
- vtnet6 connected to VM 8.
- vtnet7 connected to VM 9.
(...)
```

Virtual lab: Full mesh connected VMs



Virtual lab: Interfaces name and hostname



Network Interfaces naming

- FreeBSD use drivers name for network interface
  - PC Engines APU has re0, re1 and re2 network interfaces
  - Supermicro has igb0, igb1, igb2 and igb3 network interfaces
- For simplifying the management, interface on VPN gateways/routers are renamed:
  - Internet facing interface are named “net0”

    re0, igb0, vmx0, vtnet0, em0 => net0
  - Internal interface are named “net1”

    re1, igb1, vmx1, vtnet1, em1 => net1

Manager role set-up

On the VM to be configured as “manager”:

Usage: `role manager IP/SUBNET DEFAULT-GATEWAY INTERNAL-DNS-LIST INTERNAL-DOMAIN-LIST private-keys-archive`

```
role manager 10.0.12.1/24 10.0.12.2 "10.0.12.2 10.0.23.2"
eine.bsdrp.net /root/DEMO.private.keys.tgz
```

This command will:

1. Disable openVPN client
2. Generate a full ansible hierarchy in /usr/local/etc/ansible
3. Extract private keys from the archive

Gateways role set-up

On VPN gateways:

Usage: `role gateway IP/SUBNET DEFAULT-GATEWAY`

```
sudo ifconfig net0 name vtnet0
sudo ifconfig vtnet3 name net0
sudo sysrc -x ifconfig_vtnet0_name
sudo sysrc ifconfig_vtnet3_name="net0"
```

VM3: **`role gateway 10.0.23.3/24 10.0.23.2`**

VM4: **`role gateway 10.0.24.4/24 10.0.24.2`**

This command will:

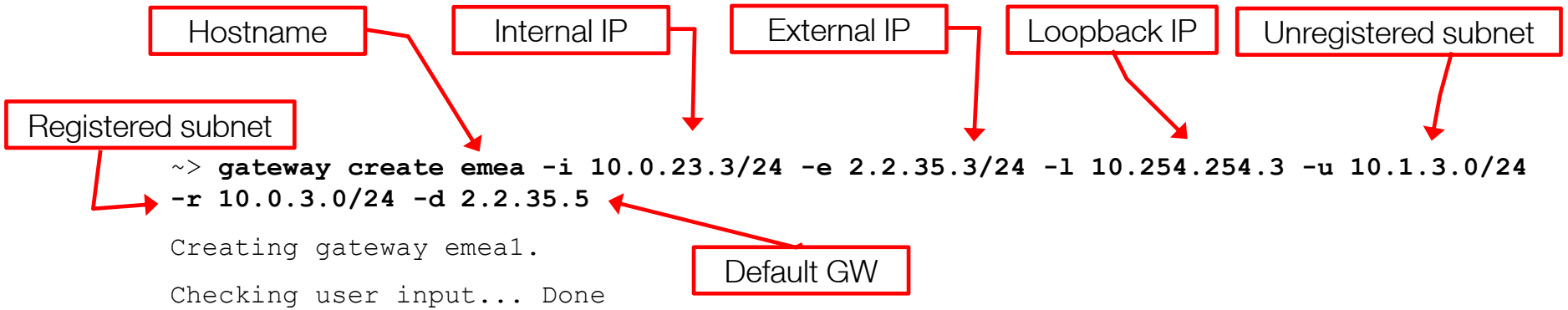
1. Disable openVPN client
2. Configure IP address on internal NIC
3. Start bird (routing protocol on internal NIC)

Others VMs set-up

Other lab specific VMs (routers, desktops, VPN routers) are configured with:

```
role vmX (with X the VM number)
```

Adding a VPN gateway



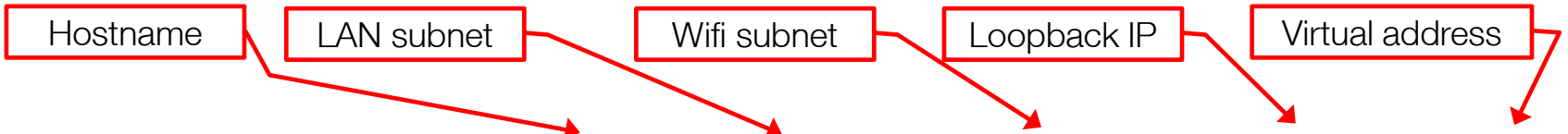

```
~> gateway create emea -i 10.0.23.3/24 -e 2.2.35.3/24 -l 10.254.254.3 -u 10.1.3.0/24
-r 10.0.3.0/24 -d 2.2.35.5
Creating gateway emea1.
Checking user input... Done
Testing if online... OK
Checking if not already existing in /etc/hosts... No
Updating /etc/hosts with volatile IP... Done
Adding VPN-Gateway to Ansible inventory... Done
Generating site certificate... Done
Generating Ansible host variable file... Done
Downloading gateway SSH keys... Done
Uploading configuration... Done
Deleting internal IP entry from /etc/hosts... Done
Adding loopback IP entry into /etc/hosts... Done
Gateway correctly added
Don't forget to save configuration
```

Listing unenrolled VPN-Wifi-Routers

```
~> vpn-wifi-router list -u
```

Common Name	Real IP	GeoIP	Virtual IP	Rcvd	Sent	Connected Since	Gateway
unregistered	203.57.57.8	Australia	**10.1.3.5**	11018	10376	Sun Sep 14 06:36:49 2014	emea1
Unregistered	202.56.56.6	Singapore	10.1.3.4	11156	10514	Sun Sep 14 06:36:32 2014	emea1

Enrolling a VPN-Wifi-router




```
~> vpn-wifi-router create sydney -e 10.7.1.0/24 -w 10.7.2.0/24 -l 3.3.3.7 -u 10.1.3.5
-i vtnet7 -x vtnet4
      Creating VPN-Wifi-router sydney.
      Checking user input... Done
      Testing if online... OK
      Checking if not already existing in /etc/hosts... No
      Updating /etc/hosts with volatile IP... Done
      Adding VPN-wifi-router to Ansible inventory... Done
      Generating site certificate... Done
      Generating Ansible host variable file... Done
      Generating OpenVPN CCD file... Done
      Downloading VPN-Wifi-router' SSH keys... Done
      Uploading OpenVPN CCD file to all gateways... Done
      Uploading registered configuration to VPN-Wifi-router... Done
      Asking VPN-Wifi-router to reboot in 5 seconds... Done
      Deleting unregistered VPN-Wifi-router s IP entry from /etc/hosts... Done
      Adding registered IP router entry into /etc/hosts... Done
      Client correctly registered, don't forget to save configuration
```

Deleting a client

```
~> vpn-wifi-router delete sydney
      Deleting VPN-Wifi-router sydney.
      Checking old entry in /etc/hosts... Yes
        Checking if it's online... yes
          factory-reset the VPN-Wifi-router... Done
          Asking VPN-Wifi-router to reboot in 5 seconds... Done
        Deleting old entry... Done
      Deleting entry in Ansible inventory... Done
      Revoking and deleting certificate... Done
        Uploading new CRL to all gateway... Done
      Checking if existing host variable file... Found
        Cleaning Ansible host variable file... Done
      Checking if existing CCD file... Found
        Removing CCD file... Done
          Cleaning CCD file on all gateways... OK
      Checking VPN-Wifi-router SSH key in know_hosts file... Found
        Delete VPN-Wifi-router SSH key... OK
      Client deleted, don't forget to save manager configuration
```

Administrative task: It's just Ansible !

- Displaying version of ALL ansible managed devices

```
ansible all -a "cat /etc/version"
```

- List host impacted by the proposed change

```
ansible-playbook vpn_wifi_routers.yml --list-hosts
```

- Synchronize to only one host:

```
ansible-playbook vpn_wifi_routers.yml -l sydney
```

- Synchronize only "interface" task changes to all VPN-gateways

```
ansible-playbook gateways.yml --tags interface
```

Questions ?