



Virtualisation For Network Testing & Staff Training

SANOG 27

Kathmandu

25th January 2016

Philip Smith <philip@nsrc.org>

This document is a result of work by the Network Startup Resource Center (NSRC at <http://www.nsrc.org>). This document may be freely copied, modified, and otherwise re-used on the condition that any re-use acknowledge the NSRC as the original source.



UNIVERSITY OF OREGON



Virtualisation Technologies

- They are everywhere...
- By abstracting functionality away from hardware we gain:
 - Improved capacity usage
 - Lower power consumption
 - Better reliability (uptime, data loss)
 - Reduced costs for creating testbeds to verify new configurations or new code
 - More flexibility in designing architectures



Two kinds of virtualisation

- **Consolidation**

- Run many services and servers onto fewer physical machines: increases *efficiency*

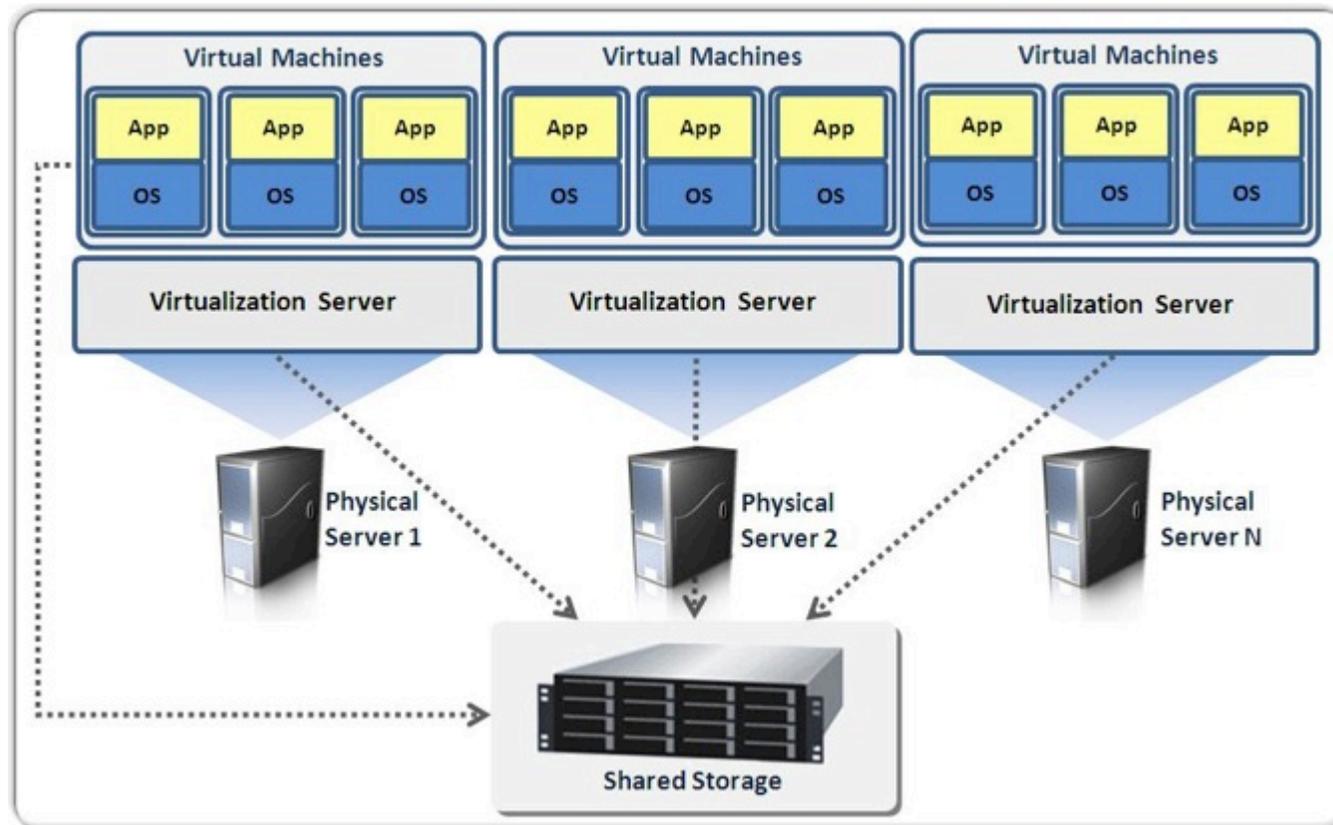
- **Aggregation**

- Distribute applications and resources across as many virtual servers as required, turning resources on or off as need: increases *scalability*



Some virtualisation benefits

- **Reduced power use** and better use of resources through **consolidation**



More benefits

- **Standardised** platform for people running services
 - Heterogeneous hardware platform hidden away behind virtualisation
 - Makes it easy to move hosts between platforms
 - Not tied to a particular vendor – migrations are easy
- **Open Source** offerings on par with commercial solutions and preferred by the “big boys”



Technical capacity training

- NSRC has actively participated for many years in Technical Capacity training around the world:
 - Africa – AfNOG and country NOGs
 - Asia Pacific – APRICOT, SANOG, PacNOG
 - Middle East – MENOG
 - Many national and regional R&E networks around the globe
 - etc
- Instructors, staff, students and the institutions have clearly benefited...



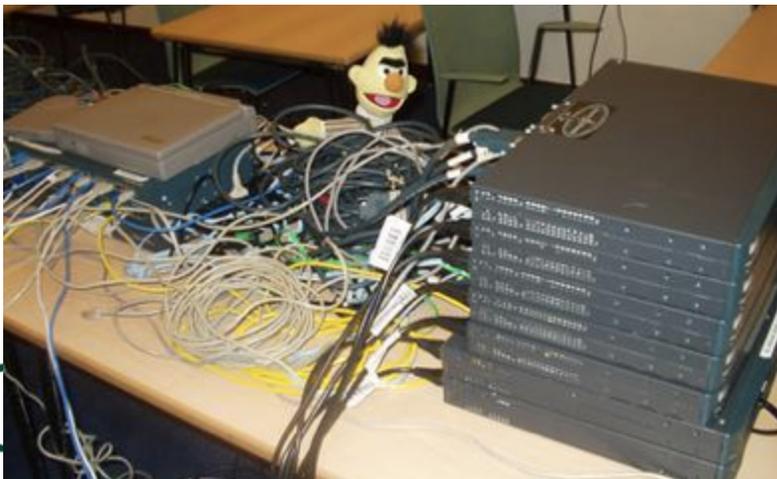
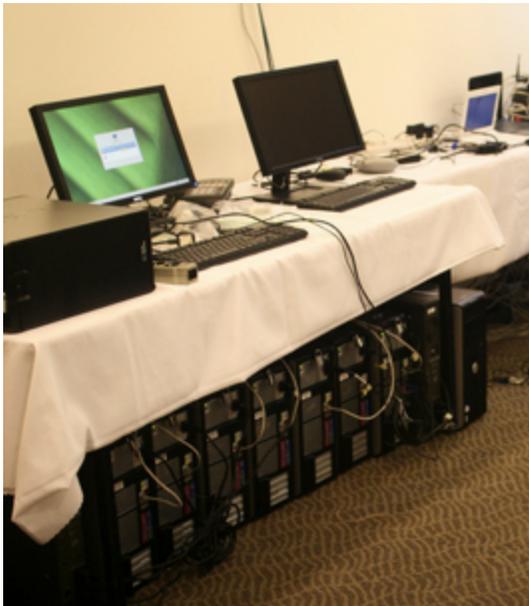
UNIVERSITY OF OREGON



AfNOG Training 2000-2010...



...lots of setup



Logistical benefits are obvious

- In the context of regional and local training:
 - “Virtualising” = less hardware (better use)
 - Reduced shipping costs
 - Reduced Logistics
 - Customs / import
 - Network equipment is often considered to be “telecommunications” – taxation issues, licensing
 - Small footprint – fits in a backpack or carry-on
 - Peripheral infrastructure (access points, desktop switches) are very small



For AfNOG 2013 we virtualised

- After successful pilot experiences at APRICOT, SANOG, etc...
- Typical AfNOG Workshops have
 - 140 PCs
 - 40 routers
 - 30 switches
 - 3-5 full-sized tower PCs
 - Keyboards, monitors, mice and network
- This became...



UNIVERSITY OF OREGON



Virtual AfNOG 2013

- This represents significant overkill (2x or more).
- Much more could be virtualised...
- Students must bring their own laptop
 - Most did already
 - (Previously AfNOG provided desktop PCs)



Motivations and benefits

- Other benefits than logistics are well aligned with the needs of regional / decentralised training:
 - Adaptability
 - Educational
- We will cover these in the next slides

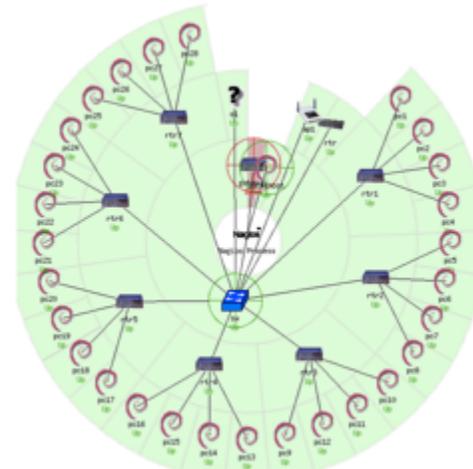


Benefits: Adaptability

- Single architecture supporting multiple workshops
- Architecture and platform uncoupled
 - A **Mac** running **Linux** running **FreeBSD**
 - A **PC** running **Linux** running **Windows**
- Fast reconfiguration!
 - Can be done in minutes with templates.
- Let's see this now!

(Next slide for images)

Network Management and Monitoring Workshop: Live in the room



Three items of equipment



Many workshop labs contained here-in!



UNIVERSITY OF OREGON



A smorgasbord of choices!

- Full virtualization
 - KVM (Linux and Solaris only)
 - Parallels (Mac OS X only)
 - QEmu
 - VirtualBox (Windows, Linux, Mac, FreeBSD)
 - Virtual PC (Windows only)
 - VMware (Workstation / Fusion, ESX)
 - Windows Hyper-V
 - Xen
- Lightweight/pseudo
 - FreeBSD / Linux Jails / LXC / OpenVZ
- Network Simulation
 - Marionnet
 - Navy CORE
- Network Emulation
 - Dynamips / Dynagen / GNS3
 - Olive (Juniper)
 - IOU & VIRL (Cisco)



Some virtualisation frameworks

- Manage/deploy virtualisation in a controlled fashion
 - VMWare vCenter (commercial – enterprise)
 - Libvirt (for managing KVM, Xen, VirtualBox)
 - Ganeti, Synnefo – clustering, small to med. size
 - OpenStack, Eucalyptus – large scale (cloud provider)
 - Kubernetes, Flannel – container support



What does NSRC use?

- **Hardware**

- MacMini Server (6,2), 16GB RAM, 2x256 SSD, i7 quad core
- Netgear GS108T fanless, Gigabit, managed 8-port switch
- Ubiquiti UniFi AP AC Lite (2.4GHz/5GHz)

- **Software**

- Ubuntu Linux 14.04 LTS 64-bit
- KVM (Kernel based Virtual Machine)
- Dynamips/Dynagen
- Ansible

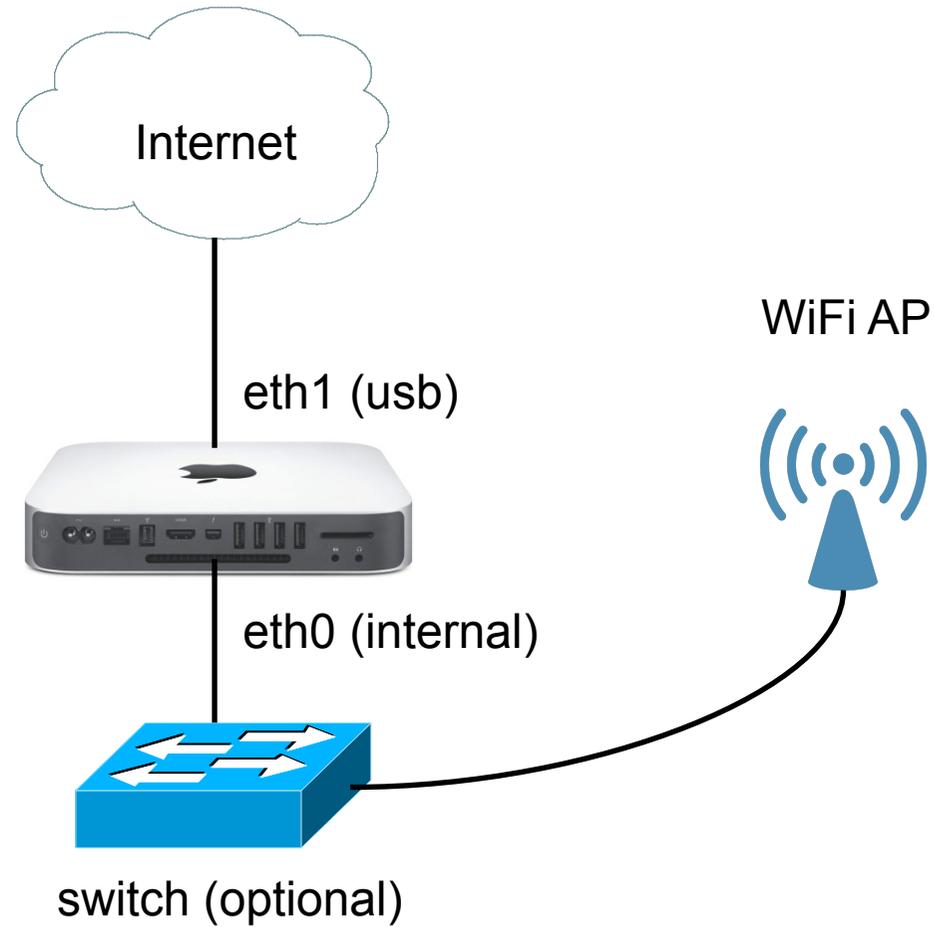


What does NSRC use?

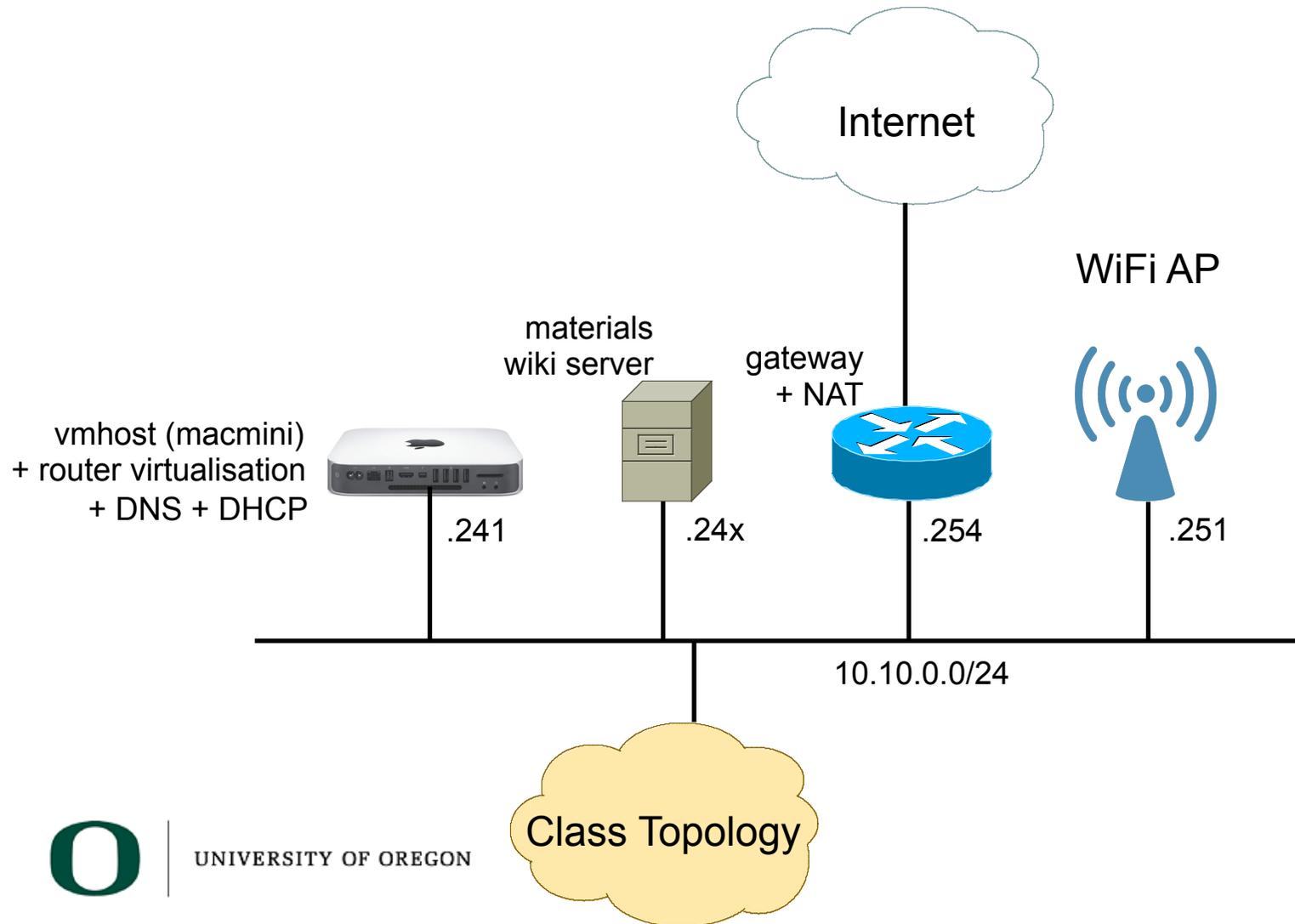
- Hardware
 - We use the MacMini for convenience
 - power / size ratio = very good
 - Can use any reasonably modern machine with virtualization extensions (VT-x/VT-d) in the CPU
 - Tower PC with Core i7, 7200 RPM disks
 - Rackmount server, Xeon/Opteron, faster disks
 - SSD disks are very nice, but not critical
 - RAM is a big factor
 - Number of CPU cores important (MacMini6,2 has 8)



Classroom layout (physical)



Classroom layout (logical)



UNIVERSITY OF OREGON



Workshop materials

- The class materials need to be hosted somewhere so students can access them
- The best place is the website describing what the training event is
- NSRC has been using wikis
 - We have used **trac** for this up to now
 - **dokuwiki** becoming a likely replacement
- A local copy of materials is very useful too:
 - To save bandwidth
 - In cases of sporadic Internet access

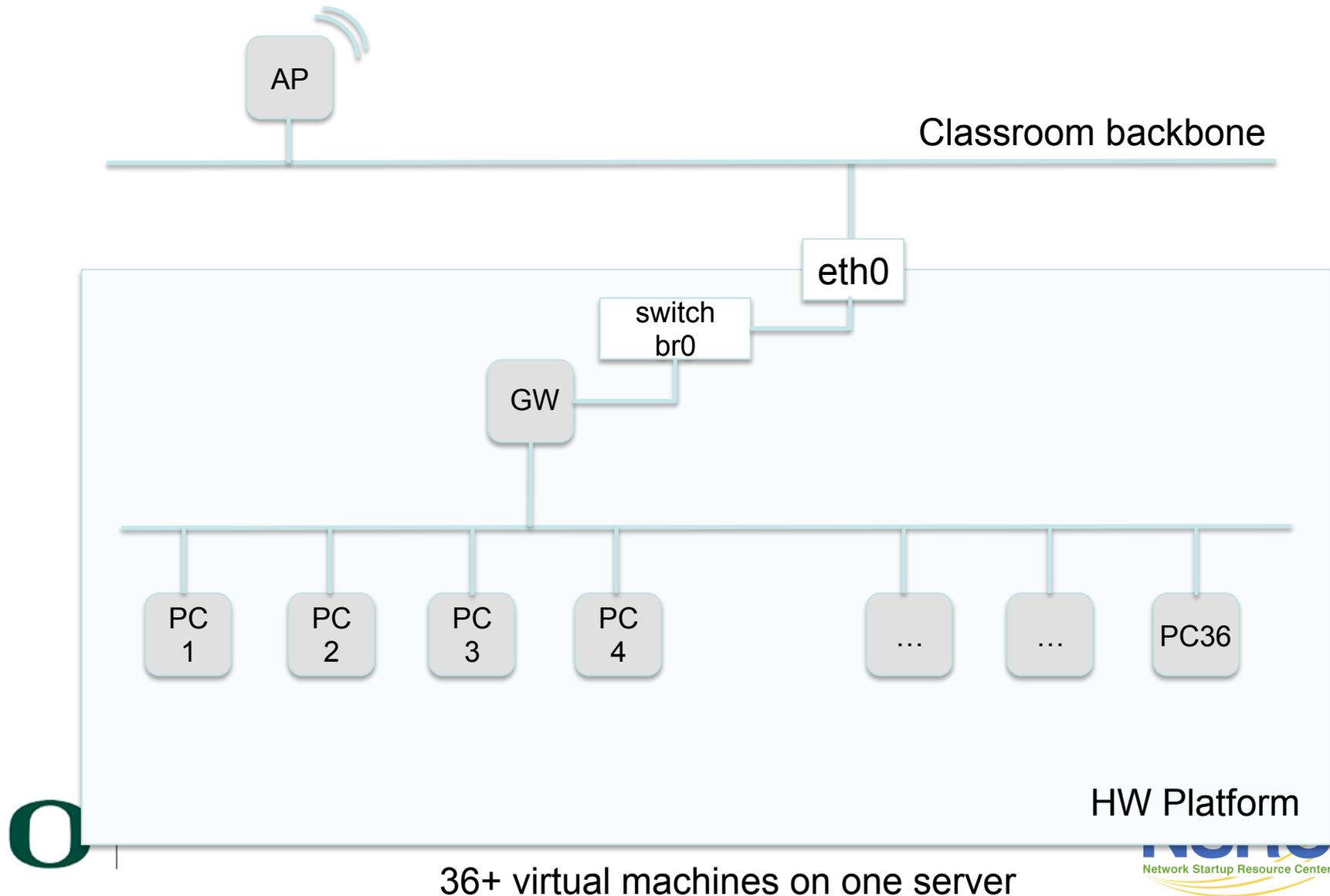


Some NSRC classroom virtual environments

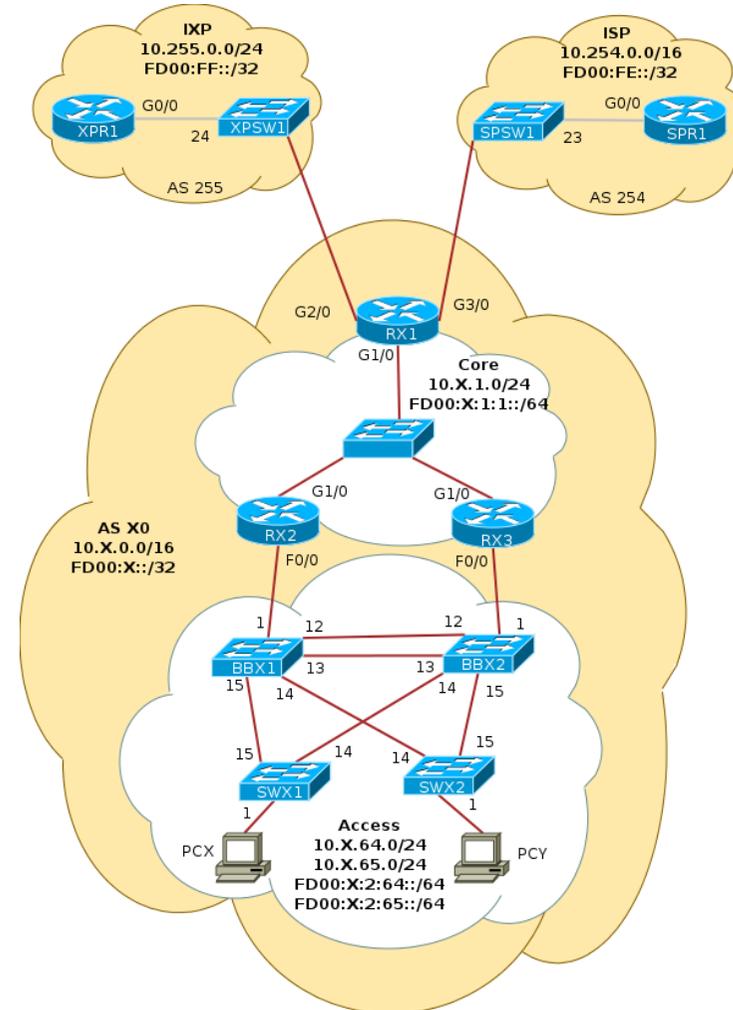
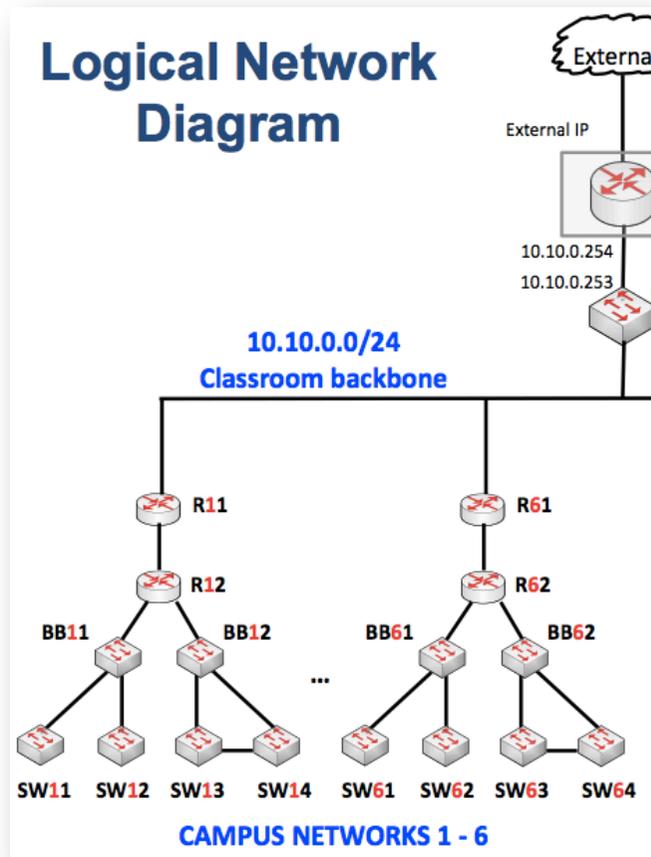
- UNIX / Linux introduction
 - Flat, simple network
- Campus Network Design (L2 and L3) Workshop
 - Based on lots of routers and switches
- NREN BGP Workshop
- Network Monitoring and Management Workshop
- Virtualisation Workshop (of course!)
- DNS/DNSSEC Workshop



UNIX / Linux Introduction

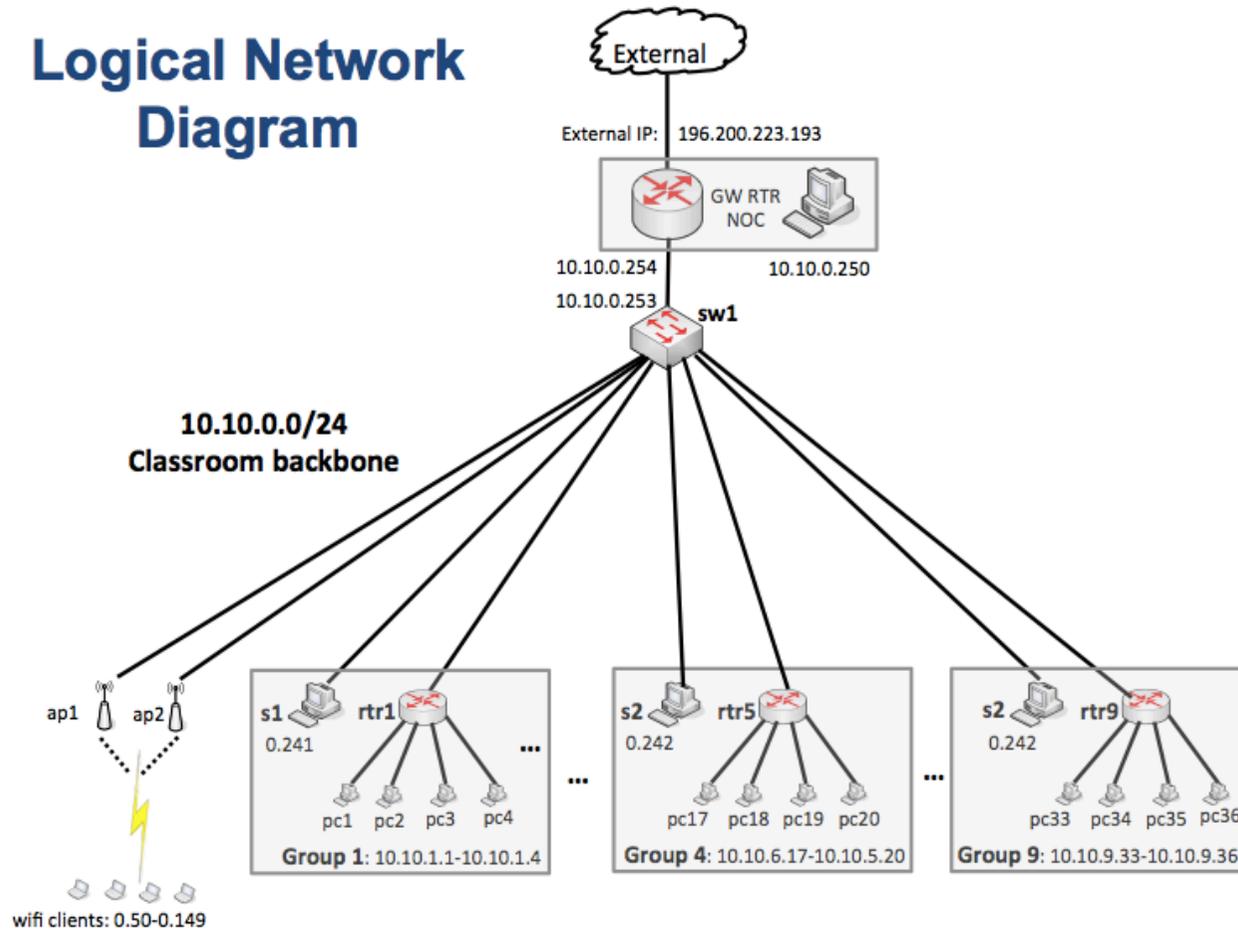


Campus Network Design (CND)



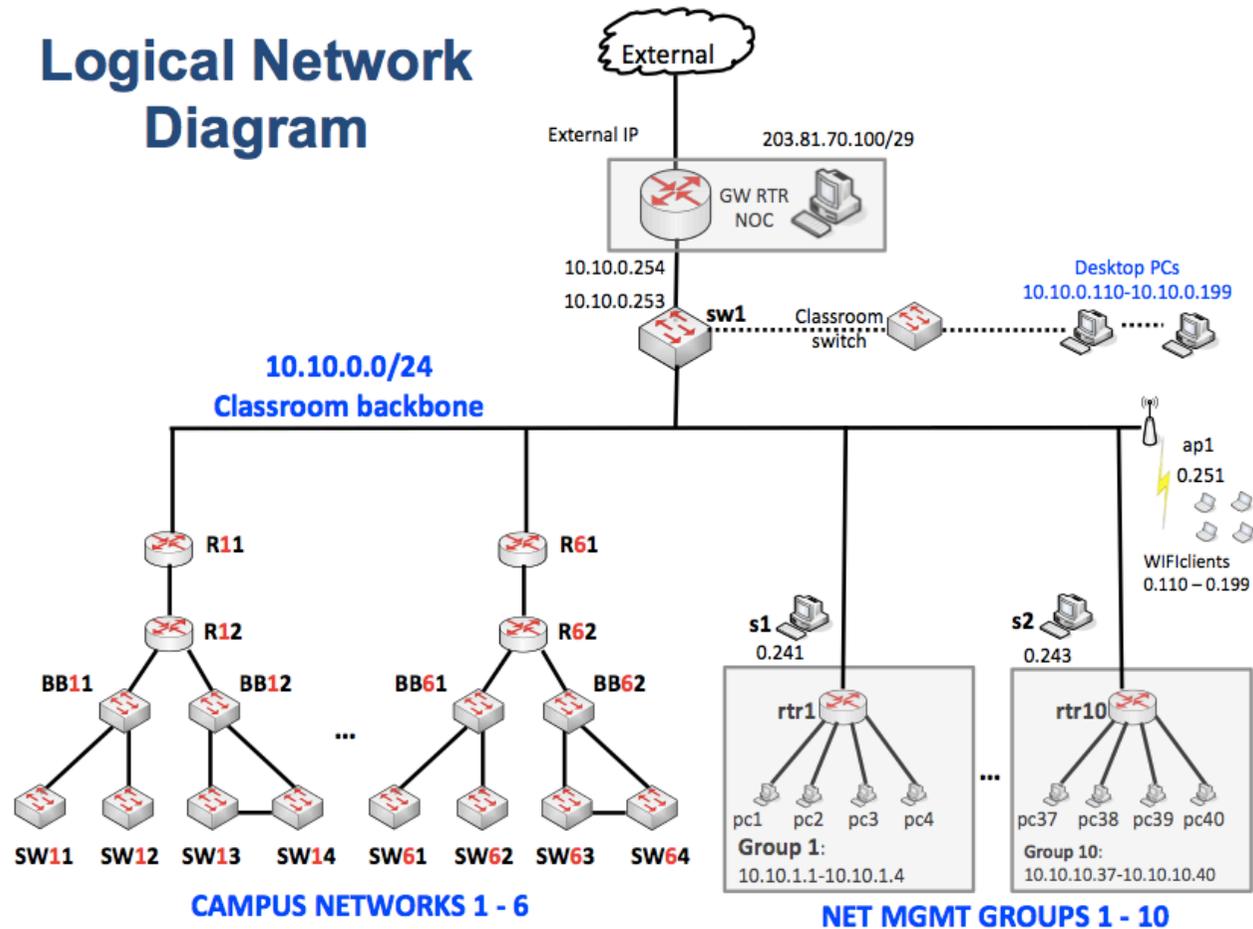
Network Management (NMM)

Logical Network Diagram

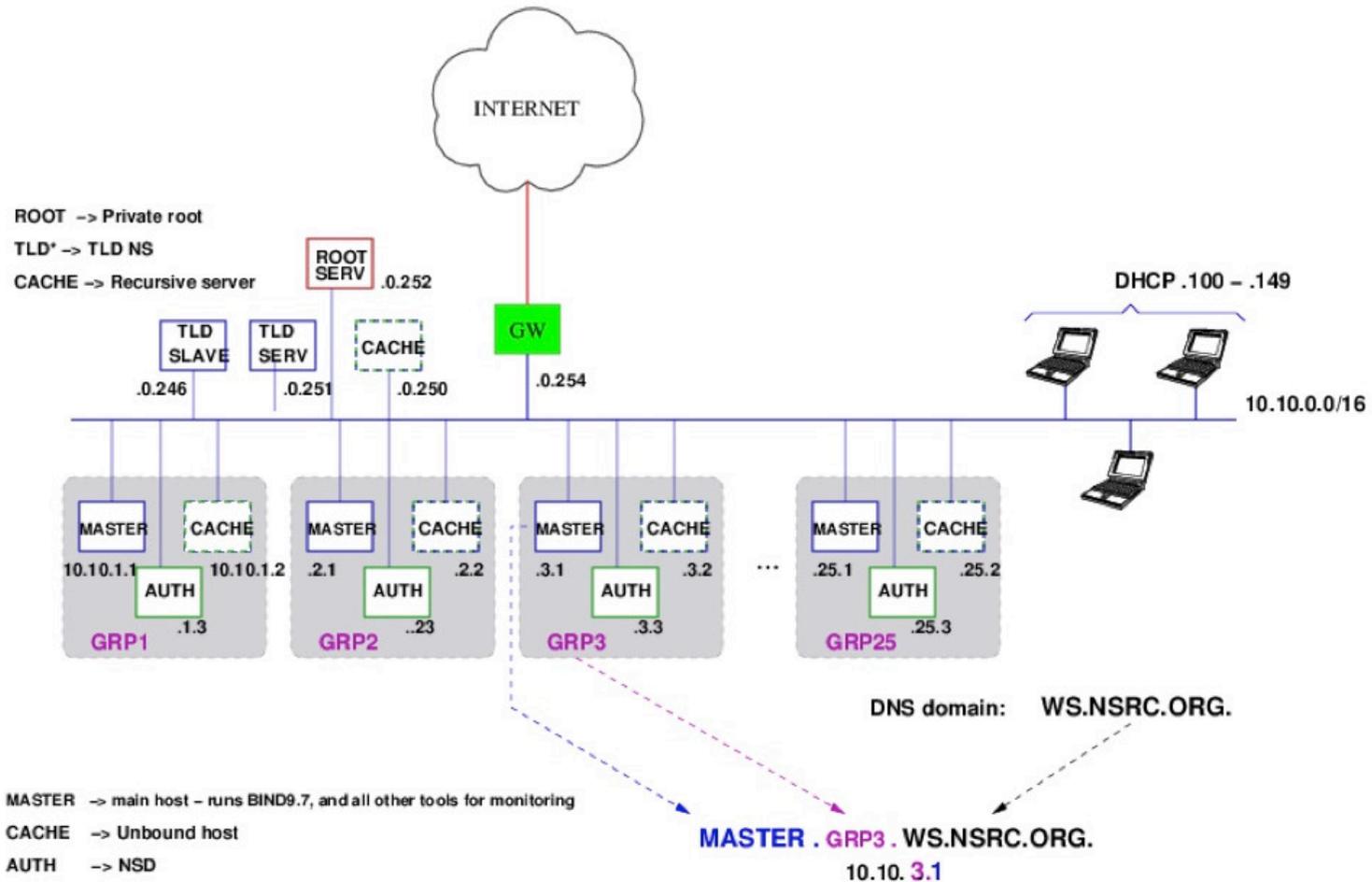


CND and NMM over 2-3 Machines

Logical Network Diagram



DNS/DNSSEC workshop



Benefits:

- Creating labs with actual hardware that duplicates what is in the field is very costly just for training and testing.
- Adapting the environment to mimic a different topology is relatively easy.
- Virtualisation technologies are part of modern IT infrastructure
 - Not just for training
 - Virtualised OS (“hypervisors”)
 - Virtualised network (VLANs, virtual switches, virtual routers, SDN)
 - Virtualised storage (iSCSI, disk images)



Benefits: (cont')

- Clear benefits for organisations that use virtualisation for provision of services already.
- Professionally relevant for students and instructors in the case of Education institutions
- Employees or trainee participants can easily re-create lab environments on laptops
- Much simpler to provide network and systems training.



Limitations...

- Hands-on is limited
 - No manipulation of “real hardware”
 - Some people grasp concepts better
 - Cables vs VLANs
 - Reality for present-day networks and systems
 - Not always possible to virtualise all hardware
 - With some vendors virtualisation of the actual OS running on the gear is not possible or available. (e.g TimOS for ALU) and with others not exactly free
- Keeping trainers current on the technology
 - Virtualisation technology moving faster than traditional metal solutions



Limitations...

- What tool(s) to use?
 - GNS/dynamips easily virtualises the Cisco MIPS architecture but what happens when the architecture is EOL?
 - Some vendors offer virtualisation for their architecture (e.g JUNOScope) but as a cloud solution so multivendor environments are challenging to build sometimes.
 - Internal vendor training tools (e.g Cisco's IOU) are not available for use by non-staff of the vendor except in rare cases
- Provisioning for different layouts is sometimes cumbersome requiring some effort to plumb packets between tools
 - NSRC currently uses ansible to help.



Approaches

- Where close-to-live equipment virtualisation is available that is a plus.
- Some larger companies have persuaded the vendors to have local installations of their virtualisation offerings (e.g. JUNOScope)
- In some cases the training will be limited to concepts and the virtualised labs will similarly test ideas rather than verify final configuration.
 - In either case something that virtualises the next-best gear is still better than something that simulates would be packet flows.



Questions?



UNIVERSITY OF OREGON

