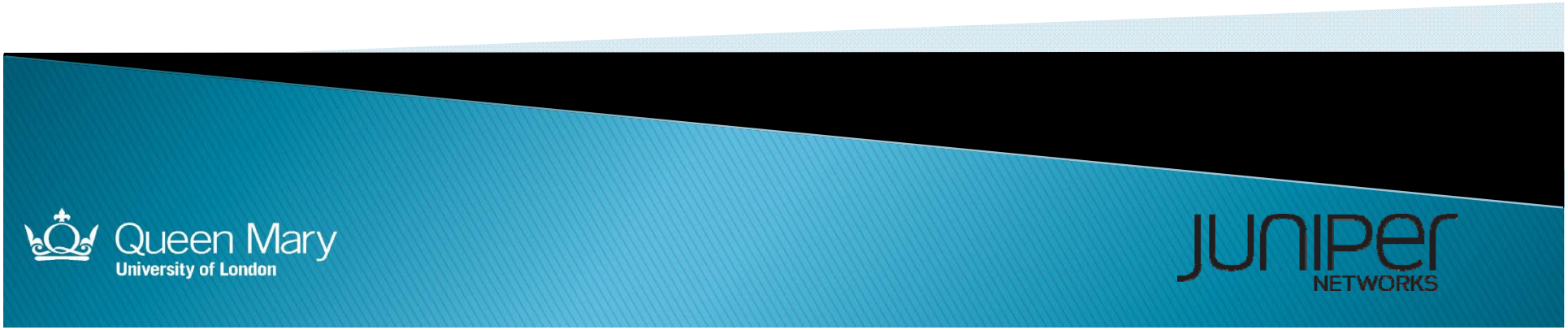
Flexible Cloud Environment for Network Studies

Vindya Wijeratne, Joel Obstfeld, Chris Phillips, Serpil Bayraktar

ACM SIGCOMM Education Workshop 2011, Toronto, Canada.



Outline

- Project Overview
- Previous setup
- Alternative Virtual Environments
- Junosphere
- Experiments
- Benefits and drawbacks
- Conclusions and Further Work

Project overview

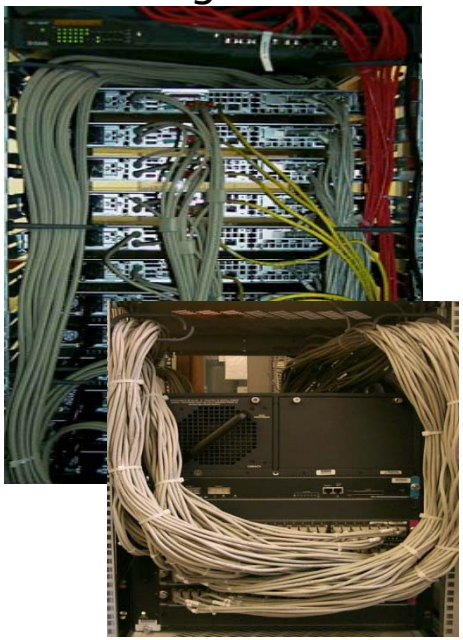
- Unique cloud-based virtualization platform
  - Hosted at Juniper Networks, Sunnyvale, California
- Scalable lab environment for the study of link-state and distance-vector routing protocol operation
- Over 200 students including distance-learning

Previous setup

The Complete Rack System

PCs + KVM Switches

Cabling + Switch



- Physical testbed located at QMUL with Linux-based PCs running Zebra/Quagga
  - Clusters of 8 machines plus packet-sniffing PCs
- Breakout patch panel for further flexibility

Previous setup - problems

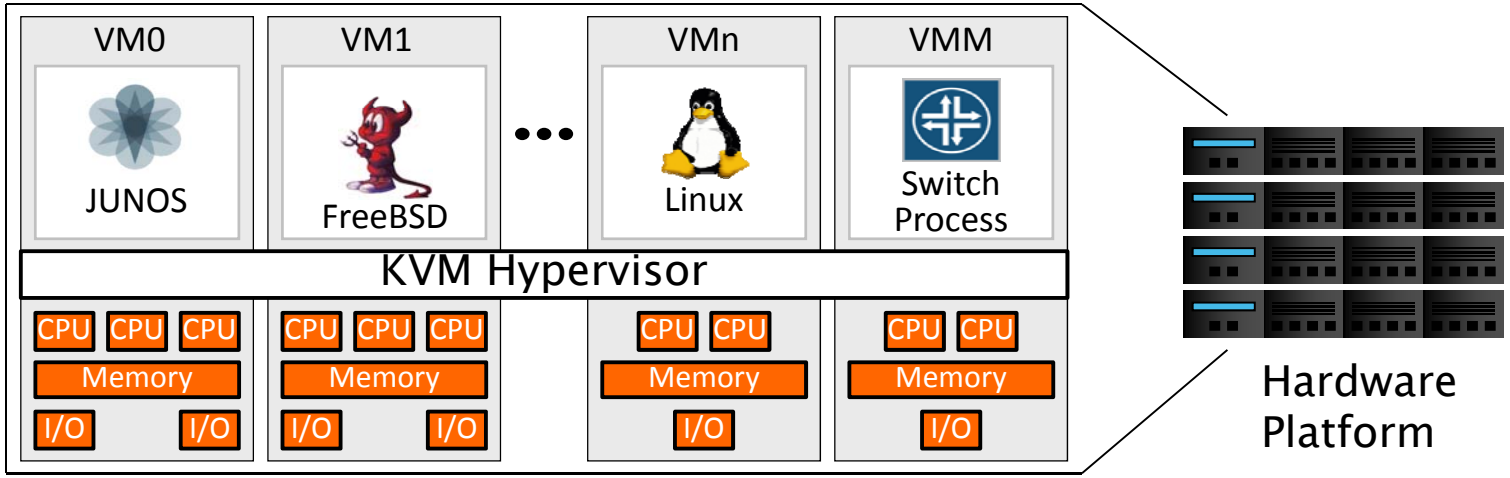
- Timetabling
  - High student-to-equipment ratios, less opportunity for extra experiments
- Need for dedicated laboratory
- Maintenance
- Lack of availability to distance-learning students

Alternative Virtual Environments

- Local or remotely located distributed virtual machines.
  - E.g. Emulab, Planetlab, Netkit
- De-centralised management
- Most solutions employ open-source routing daemons, e.g. Zebra, Quagga and XORP
  - Limited features compared to commercial router implementations

Junosphere

- Commercially available x86 based servers running a Linux Host OS and KVM hypervisor
- VMs are managed by VMM (Virtual Machine Manager) software developed by Juniper
- VDE (Virtual Distributed Ethernet) software provides emulated Ethernet network to VMs
- Number of VMs limited by the amount of memory present in the server & CPU horsepower



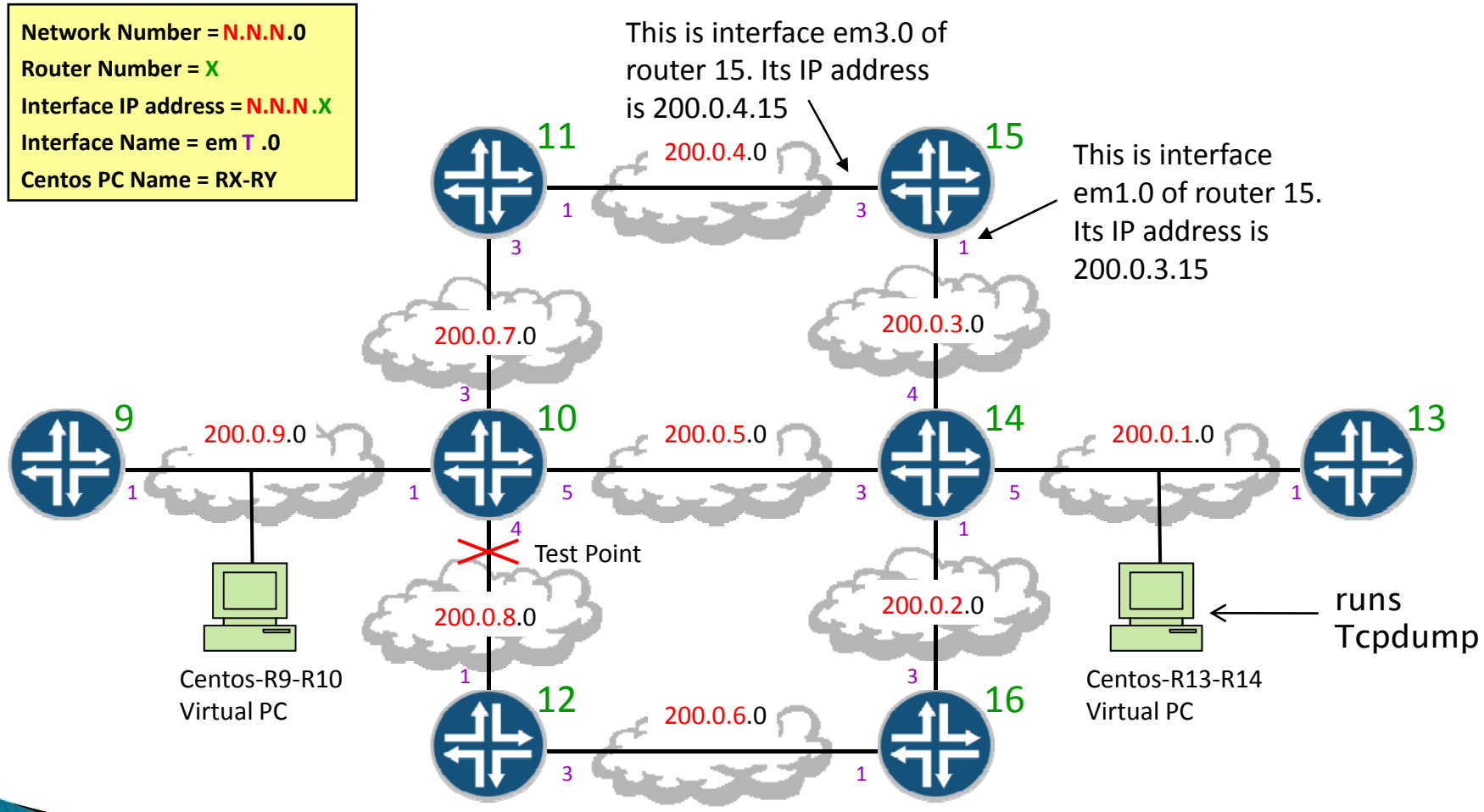
Junosphere ctd..

- A cloud based system
  - Stack of x86 servers running virtualization software
  - Hosted in a co-lo facility supported 24x7
- Allows academic institutions to create labs
- Supports the following lab elements:
  - Virtual Juniper routers running commercially available JUNOS
  - Various Unix systems: Freebsd, Centos, Ubuntu
  - Virtualized packet generators (e.g. Spirent vCenter)
  - Routing analytics tools (e.g. Route Insight Manager)
  - Virtualized CPE (e.g. OpenWrt)
  - Anything that can be virtualized using KVM hypervisor running on an x86 system

Junosphere ctd..

- Easy to stop and start the lab
  - If students make a mistake and crash a component of the lab, just tear down and restart
- Easy to create topologies
  - All lab elements are connected using VDE (Virtual Distributed Ethernet switch)

Experiments - topology



Experiments - details

- Each group had access to their own set of VMs, i.e. 8 virtual routers and 2 virtual CentOS PCs
- 240 VMs, i.e. 24 groups could access the platform simultaneously
- Tasks:
  - RIP/OSPF Basics
  - Examining failure and reconvergence with RIP/OSPF
  - OSPF Parameter negotiation and cost setting
  - RIP/OSPF Route redistribution
- Individual lab report:
  - Analysis of observed results
  - Essay on improving the reconvergence time

Benefits

- Reinforce concepts learnt in class by gaining hands-on experience, i.e. a complete learning cycle
- No special laboratory required
  - Accessible from any standard computer via Telnet/SSH
- Distance-learning students achieve the same learning experience as campus-based students

Benefits ctd..

- Improved scalability, i.e. less timetabling issues and more opportunity for extra experiments
- Ease of flexibility in varying experiments
- Scenario can be easily replicated
  - Promotes reusability (e.g. University of Vienna)
- The virtual routers are identical to their real-world counterparts
  - Exposure to commercial equipment within university

Drawbacks

- 'Time' in the virtualised environment is not the same as in the real world.

- Data-plane behaviour does not accurately emulate that of physical routers
  - Packet-scheduling characteristics and virtual link speeds are not a fair reflection of their physical counterparts

Conclusions and Further Work

- Valuable opportunity for students in experimenting with commercial equipment
  - Excellent feedback received
- Currently in discussions with other academic institutions on new lab designs and experiments
- Extended use of the platform for MSc projects
- Supports IS-IS and BGP in addition to RIP and OSPF
  - Scope for further teaching and research projects