Network Virtualization

COS 597E: Software Defined Networking

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MW 11:00am-12:20pm

Course Project

- Timeline
  - Mon Oct 21: Short proposal due
  - Tue Jan 14: Written report due
  - Later that week: short oral presentation
- Project
  - Work alone, or in teams of 2-3
  - Your own topic, or from a suggestion
  - Can overlap with independent work, thesis, or graduate research topic
  - Optionally use or extend Pyretic

2

Controller Applications

- Distributed server load balancer
- Denial of service attack detection/mitigation
- Traffic engineering
- Latency-equalized routing
- Routing in intermittingly-connected networks
- Countermeasures against wiretapping
- Inter-domain control (e.g., for DoS detection, flexible routing, monitoring, …)

3

SDN Platform

- Efficient compilation
  - Hardware switches with multi-stage tables
  - Software switches with configurable tables
  - Network virtualization
- Better tools
  - Network debugging
- Partial deployment
  - Interact with legacy routing protocols
  - Support programmability in partial deployment

4

SDN Platform

- Incorporating end hosts
  - Ship low-level packet processing to VMs
  - Steer traffic through middleboxes
  - Integrate Pyretic with OpenStack
- Network measurement
  - Better measurement support on switches
  - Integration with existing measurement (sFlow)
  - Collecting measurements at end hosts
- Preventing DoS attacks on the controller

5

SDN Platform

- Distributed controllers
  - Multi-threaded controller
  - Hierarchical controllers
  - Fault tolerance through backup controllers
  - Scalability by sub-dividing the network
  - Inter-domain controllers
- Quality of service
  - Extend Pyretic to support QoS mechanisms
  - Support specification of higher-level policies

6

Other Ways to Find Projects

- Talk with graduate students and postdocs working on SDN
- Follow up on one of the papers we've read
- Combine SDN with one of your other interests
- Look at workshop papers
  - HotSDN workshop (August 2012 and 2013)
  - Open Networking Summit Research Track (April 2013)

7

Network Virtualization

FlowVisor and Nicira's NVP

8

Network Virtualization History

- Dedicated overlays for incremental deployment
  - Mbone (multicast) and 6bone (IPv6)
- Multi-service networks
  - Tempest project for ATM networks
- Overlays for improving the network
  - Resilient Overlay Networks (RON)
- Shared experimental testbeds
  - PlanetLab, Emulab, Orbit, …
- Virtualizing the network infrastructure
  - Overcoming Internet impasse through virtualization
  - Later testbeds like GENI, VINI, …
- Virtualization in SDN
  - Open vSwitch, MiniNet, FlowVisor, Nicira NVP, …

http://www.cs.princeton.edu/courses/archive/fall13/cos597E/papers/sdnhistory.pdf 9

Network Virtualization

- Decoupling the services provided by a network from the physical infrastructure
- Virtual network is a "container" of network services, provisioned by software
- Faithful reproduction of services provided by a physical network

http://www.opennetsummit.org/pdf/2013/presentations/bruce_davie.pdf 10

Two Main Ideas

- Sharing the network
  - Different controllers for different users/traffic
  - Isolation (bandwidth, table space, flow space)
- Abstracting the topology
  - One big virtual switch
  - Many virtual switches to one physical switch
  - Arbitrary network topologies
- While presenting a familiar abstraction
  - A network

11

Why Slice the Network?

- Multiple administrative groups
  - Different departments on a campus
- Multiple customers
  - Tenants in a shared data center
  - Researchers on a shared infrastructure
- Experiments vs. operational network
  - Support research without breaking real services
- Expanding a network's footprint
  - Lease components in another carrier's network

12

Why Abstract the Topology?

- Partial deployment
  - Tunnel through components you don't control
- Simplicity
  - Hide inessential details, churn, migration, …
- Privacy
  - Hide internal details of the network
- Scalability
  - Present a smaller topology and fewer events
- Experimentation
  - Try topologies that don't really exist

13

Network Virtualization and SDN

- Network virtualization != SDN
  - Predates SDN
  - Doesn't require SDN
- Easier to virtualize an SDN switch
  - Run separate controller per virtual network
  - Partition the space of all flows
  - Leverage open interface to the hardware

14

Discussion

- Where to support virtualization?
  - Controller platform
  - Hypervisor
  - Switch
- Is a virtual network a good abstraction?
  - Familiar abstraction
  - But, is it the right one?

15