SDN Software Stack
COS 597E: Software Defined Networking

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MW 11:00am-12:20pm

Simple Enterprise Design

- Single layer-two subnet
  - Hubs and switches
  - Gateway to the Internet
  - Single IP address block

- Local services
  - DHCP
  - DNS

Limitations of Simple Design

- Performance
  - Spanning tree
- Security
  - No access control
  - No isolation

Hybrid of Switches and Routers

- Ethernet Bridging
  - Flat addressing
  - Self-learning
  - Flooding
  - Forwarding along a tree

- IP Routing
  - Hierarchical addressing
  - Static configuration
  - Host configuration
  - Forwarding along shortest paths

Virtual Local Area Networks

- Group related hosts
  - Same company
  - Same role (e.g., faculty vs. students)
  - All WiFi users
- Treat them as a single LAN
  - Single IP address block
  - Single broadcast domain
  - No access control
- Independent of their location

Rewire the network in software!
Example: Two VLANs

- **Red VLAN**
- **Orange VLAN**

Switches forward traffic as needed

Making VLANs Work

- Changing the Ethernet header
  - Adding a field for a VLAN tag
  - Implemented on the bridges/switches
  - ... but can interoperate with old Ethernet cards

- Bridges/switches trunk links
  - Say which VLANs are accessible via which interfaces

- Approaches to mapping access links to VLANs
  - Each interface has a VLAN "color"
  - Each MAC address has a VLAN "color"

VLANs in SDN

- Hybrid deployment
  - VLAN for SDN adopters
  - Remaining traffic using legacy protocols

- Switch-controller communication
  - Separate VLAN
  - Using legacy protocols

- Tagging of packets
  - VLAN header as a virtual "tag" on packets

Server Virtualization and Virtual Switches

Virtual Machines (VMs)

- **Virtual machine**
  - Software implementation of a computer
  - With interface identical to bare hardware
  - Devices, interrupts, memory, page tables, etc.

- **Hypervisor (virtual machine monitor)**
  - Creates and runs virtual machines
  - Manages execution of the guest OSes
  - Subdivides the hardware resources
  - Executes privileged instructions

Virtual Machine (VM)
Motivations for VMs

- Diverse operating systems
  - Running software for obsolete platforms
  - Research, experimentation, and testing
- Sharing a single host
  - Server consolidation (lower cost, energy)
  - Isolation of applications or customers/tenants
- Fast provisioning of new servers
- Snapshotting system state
  - Backup and redeployment
  - Migrating a VM to a different host machine
- VM introspection
  - Track configuration settings
  - Identify configuration mistakes or compromises

Virtual Switches

SDN Software Stack

Discussion

- What is a good “division of labor”?
- Good design for the protocol?
- Good abstractions for the NOS?
- How apt is the “operating system” analogy?
- What parts of the system need standards?
- What are interesting SDN applications?