Georgia Institute of Technology

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Software Defined Networking

In this course, you will learn about software defined networking and how it is changing the way communications networks are managed, maintained, and secured.

School of Computer Science

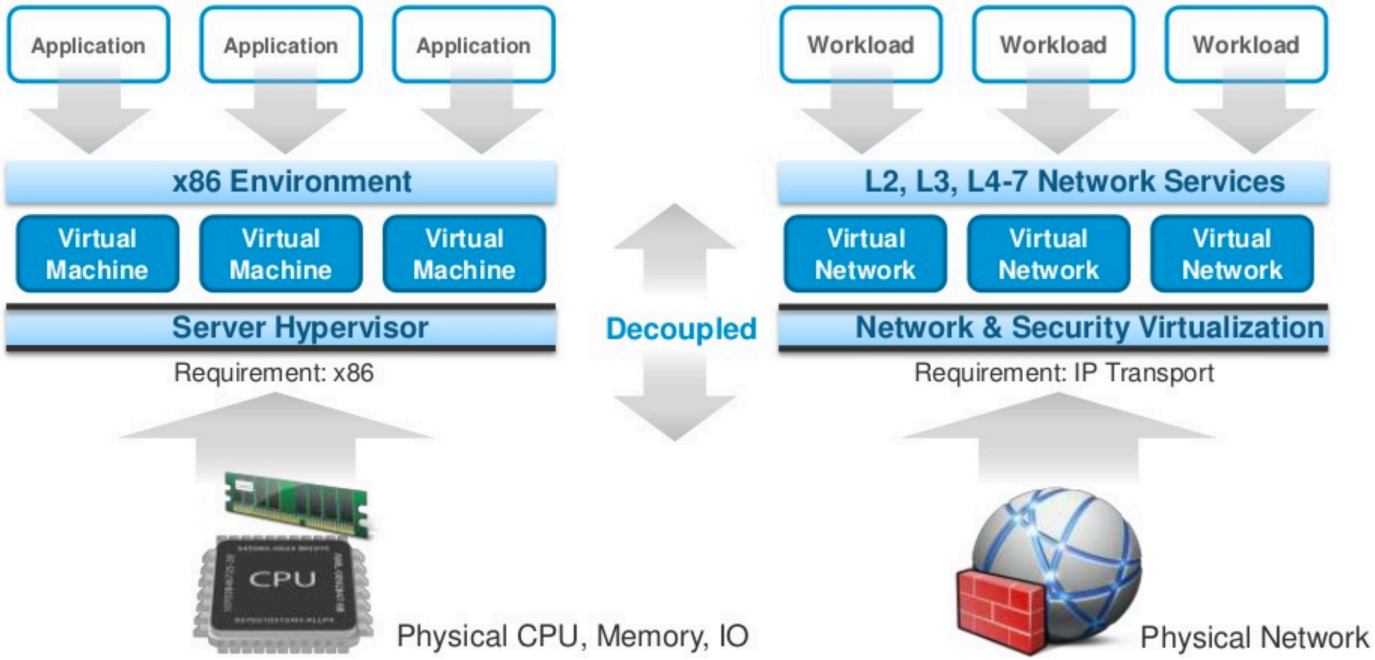
This Module: Network Virtualization

- Three Lessons
  - What is network virtualization and how is it implemented?
  - Examples of network virtualization and applications.
  - Virtual networking in Mininet
- Quiz
- Hands-on in Mininet

What is Network Virtualization?

- Abstraction of the physical network
  - Support for multiple logical networks running on a common shared physical substrate
  - A container of network services
- Aspects of the network that can be virtualized
  - **Nodes:** Virtual machines
  - **Links:** Tunnels (e.g., Ethernet GRE)
  - Storage

Network Virtualization



Source: Bruce Davie

Motivation for Network Virtualization

- "Ossification" of the Internet architecture
  - Lots of work on overlay networks in the 2000s
  - One-size-fits all architectures are difficult
  - Why not allow for easier evolution?

- Instead, why not create a substrate where "1,000 flowers can bloom"?

The Promise of Network Virtualization

- Rapid innovation: services delivered at software speeds (vswitch and controller)
- New forms of network control
- Vendor choice
- Simplified programming and operations

Distinction: SDN does not inherently abstract the details of the physical network

http://networkheresy.com/2013/04/29/netvirt-delivering/

Related: Virtual Private Networks

- Virtual network that connects distributed sites
  - Basically, secure tunneling
- Not designed to let multiple custom architectures run on the infrastructure

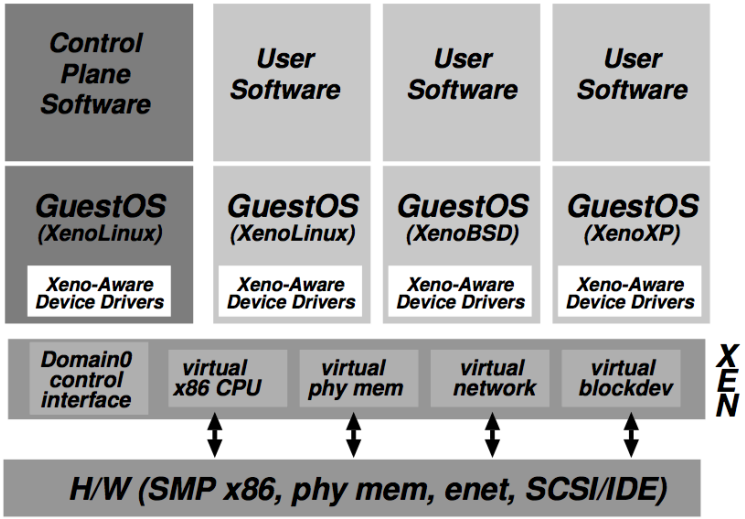
Design Goals

- **Flexibility:** topologies, routing and forwarding architecture; independent configuration
- **Manageability:** separate policy and mechanism
- **Scalability:** maximize number of co-existing virtual networks
- **Security and Isolation:** isolate both the logical networks and the resources
- **Programmability:** programmable routers, etc.
- **Heterogeneity:** support for different technologies

Virtual Nodes/Machines

- Xen Virtual Machine Monitor
- User-Mode Linux (with network namespaces, now part of Linux kernel)
- KVM (Linux kernel virtualization)
- Other virtual machine solutions
  - VMWare
  - Virtual Box

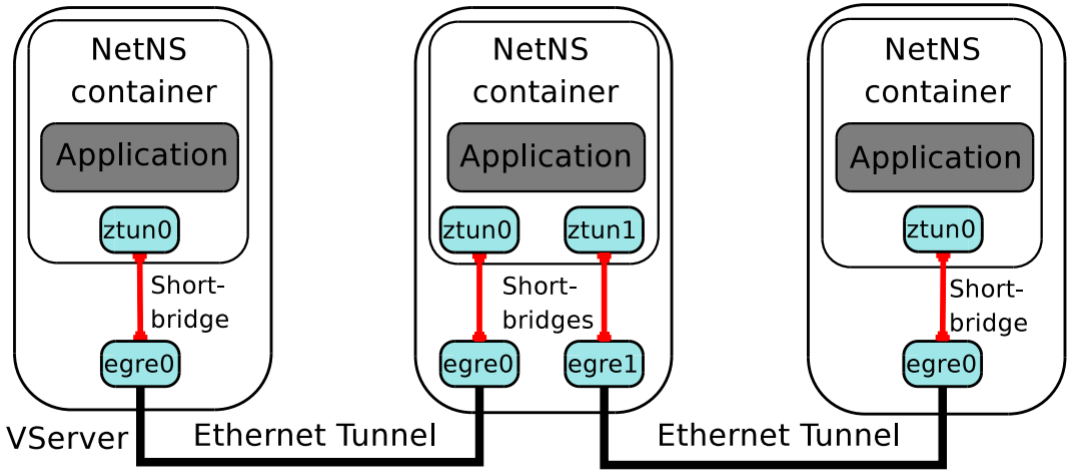
Example VM Environment: Xen



- Xen hosts multiple guest OSes.
- Domain0 runs control software in the XenoLinux environment.

Barham, Paul, et al. "Xen and the art of virtualization." *ACM SIGOPS Operating Systems Review* 37.5 (2003): 164-177.

Example Virtual Links: EGRE



- **Ethernet GRE (EGRE) Tunneling:** Ethernet frames from virtual hosts are encapsulated in IP packets
- Other approaches: VXLAN

Bhatia, Sapan, et al. "Trellis: A platform for building flexible, fast virtual networks on commodity hardware." *Proceedings of the 2008 ACM CoNEXT Conference*. ACM, 2008.

Switches: Open vSwitch

- **Problem:** Networking virtual machines together over a Layer 2 topology
  - (e.g., VINI used “shortbridge”, an extension of Linux bridging)

- Open vSwitch performs similar glue functions
  - Also can be configured remotely with OpenFlow, JSON

http://openvswitch.org/

Summary

- **Motivation:** Flexible, agile deployment
  - Rapid innovation, vendor independence, scale
- **Technologies:** Virtual nodes, links, switches
- SDN vs. Virtual Networks
  - SDN separates data plane and control plane
  - Virtual networks separate logical and physical networks
  - SDN can be a useful tool for implementing virtual networks