Software Defined Networking

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

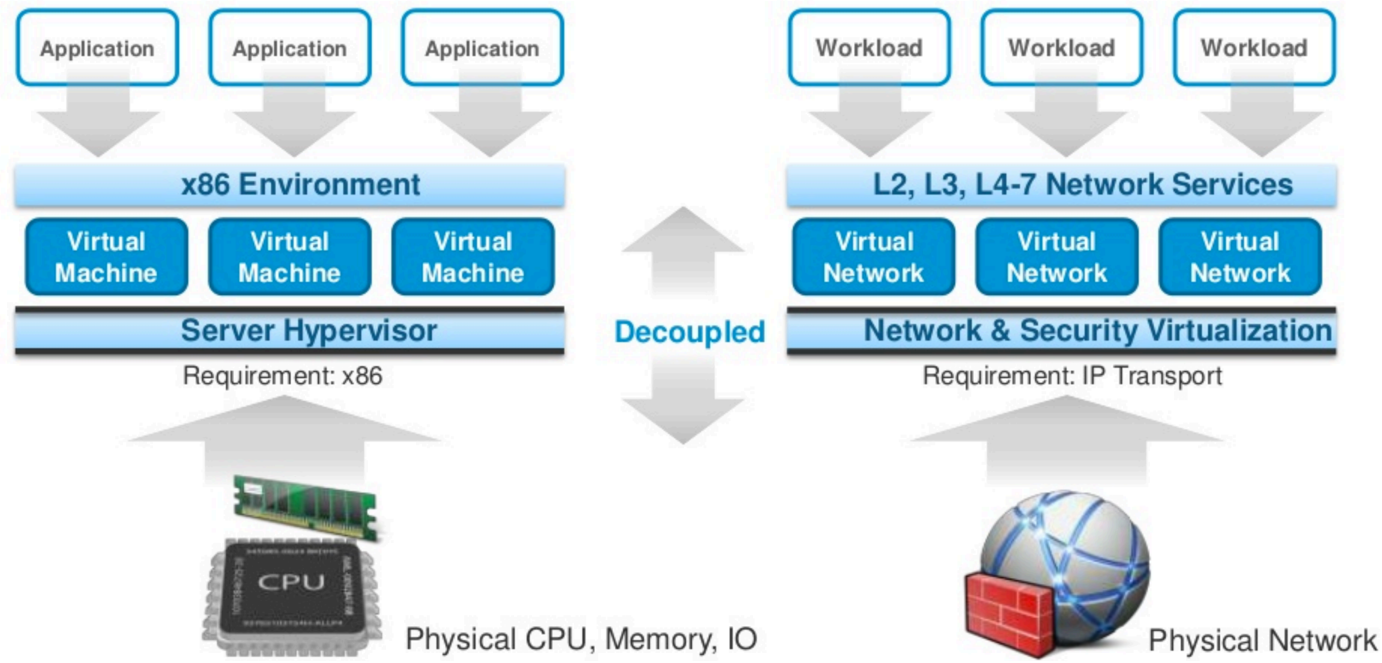
This Module: Network Virtualization

- Lessons
  - What is network virtualization and how is it implemented?
  - Examples of network virtualization and applications.
  - Network virtualization in Mininet
  - Slicing network control
  - Virtualization in data centers
  - Docker, OpenStack

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

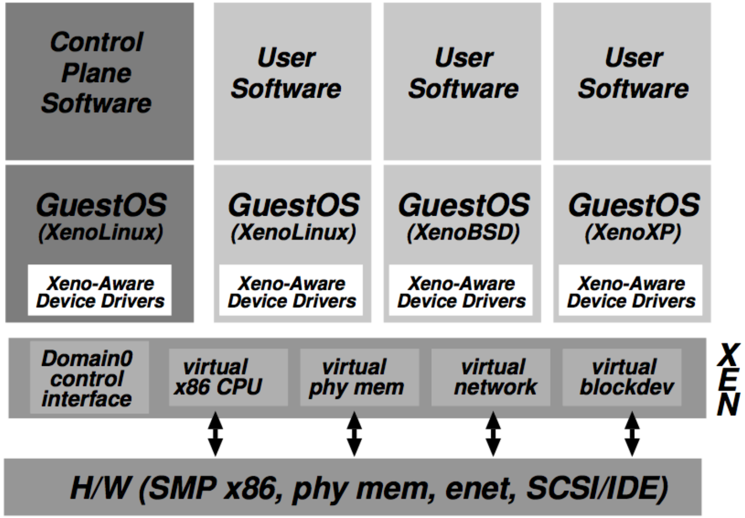
Design Goals

- **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

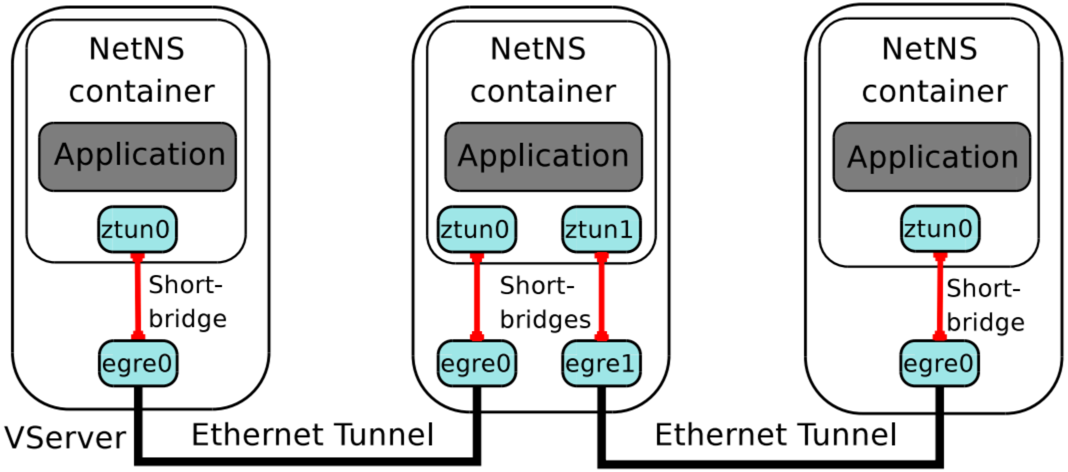
Example VM Environment: Xen



- 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