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

Module 7.1: SDN In the Wild

- Three Lessons
  - **Data Centers**
  - Wide-Area Backbone Networks
    - SDX: A Software-Defined Internet Exchange
    - B4: Google's Wide-Area Backbone Network
  - Home Networks
- Programming Assignment
- Quiz

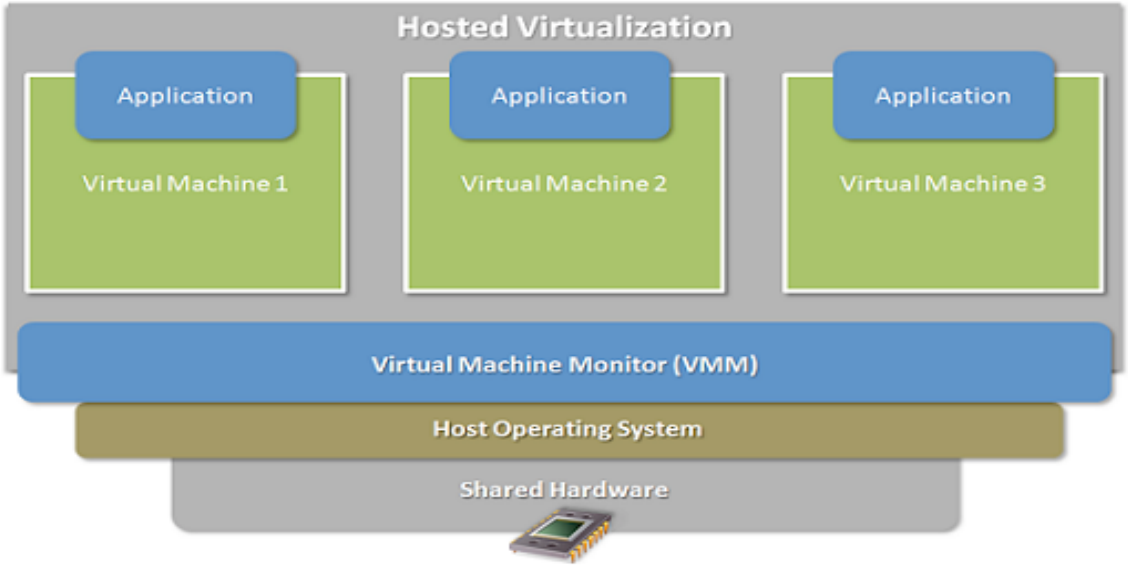
Cloud Computing

- Elastic resources
  - Pay-per-use
  - Infrastructure on demand
- Multi-tenancy
  - Multiple independent users
  - Amortize the cost of the (shared) infrastructure

Cloud Service Models

- Software as a Service
  - Provider licenses applications to users as a service
  - Avoid costs of installation, maintenance, patches, …
- Platform as a Service
  - Provider offers software platform for building applications
  - Avoid worrying about scalability of platform
- Infrastructure as a Service
  - Provider offers raw computing, storage, and network
  - Avoid buying servers and estimating resource needs

Enabling Technology: Virtualization

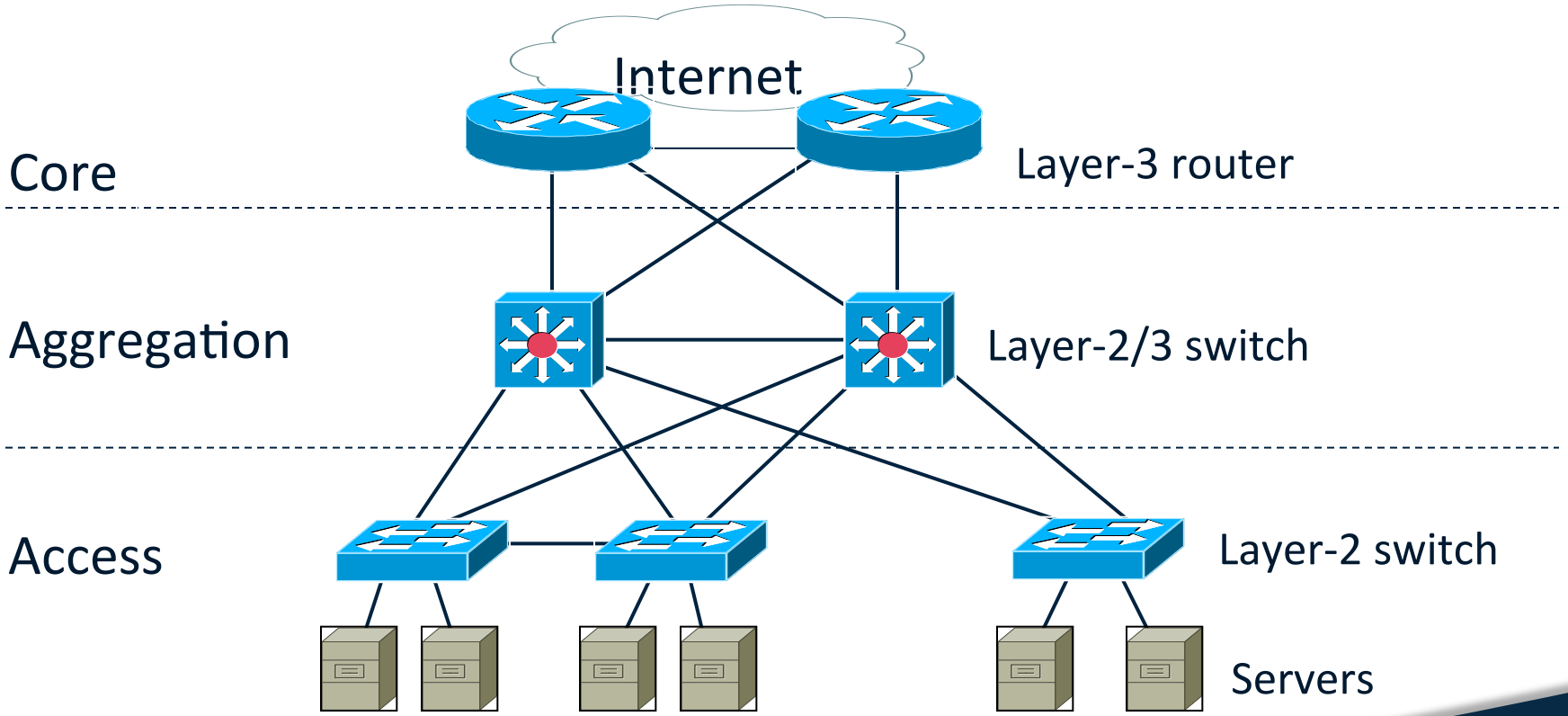


- Multiple virtual machines on one physical machine
- Applications run unmodified as on real machine
- VM can migrate from one computer to another

Design Requirements for Data Centers

- Easy migration of virtual machines
- Minimal switch configuration
- Efficient communication along forwarding paths
- No forwarding loops
- Fast, effective failure detection

Common Data Center Topology

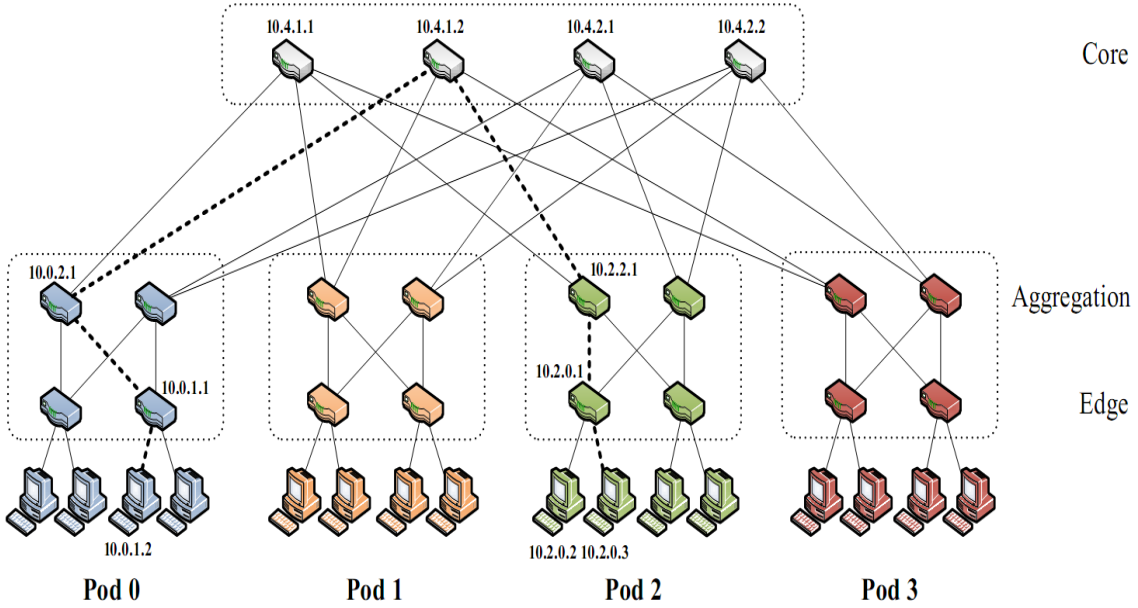


Problems with Common Topologies

- Single point of failure
- Over subscription of links higher up in the topology
- Tradeoff between cost and provisioning

Fat-Tree (Clos) Topology

- Multi-rooted tree topology
- Capacity increases towards the root(s) of the tree
- Inherent fault tolerance



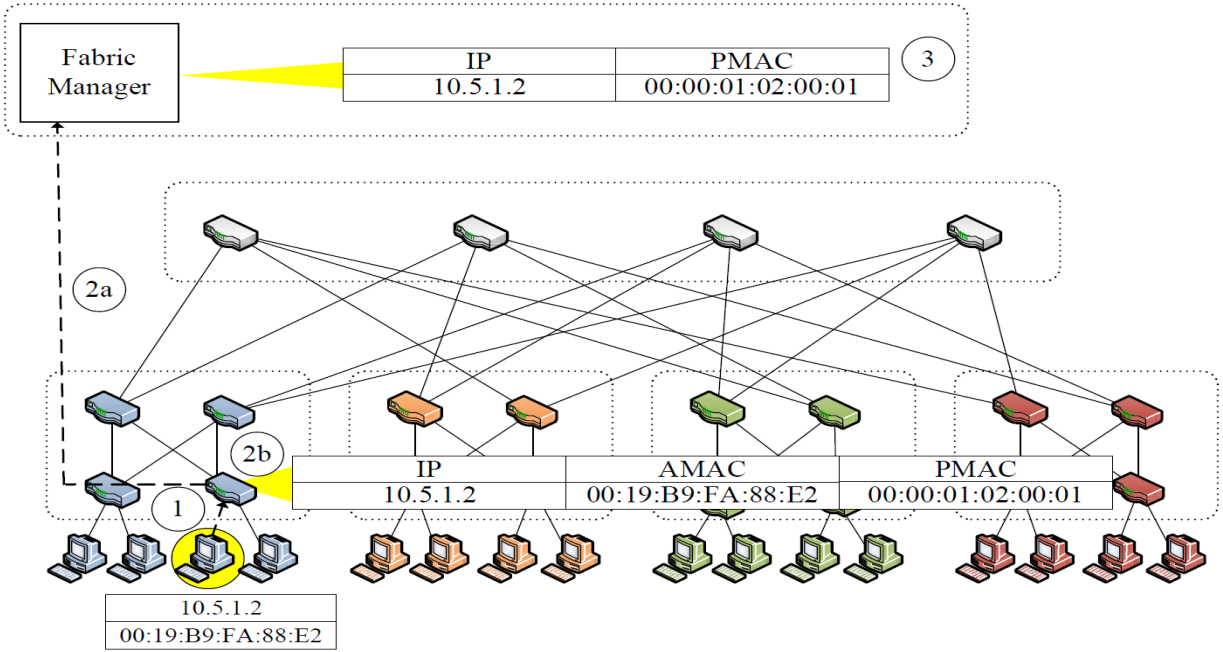
Charles E. Leiserson Fat-trees: universal networks for hardware-efficient supercomputing, IEEE Transactions on Computers, Vol. 34 , no. 10, Oct. 1985, pp. 892-901.

Satisfying the Design Requirements

- Need for a large, layer two topology
  - Plug-and-play, minimal configuration
- Many scaling problems to solve
  - State required for layer-2 forwarding
  - Avoiding flooding (e.g., ARP requests)
  - Fast updates to addressing upon VM migration

PortLand: SDN for Data Center Networks

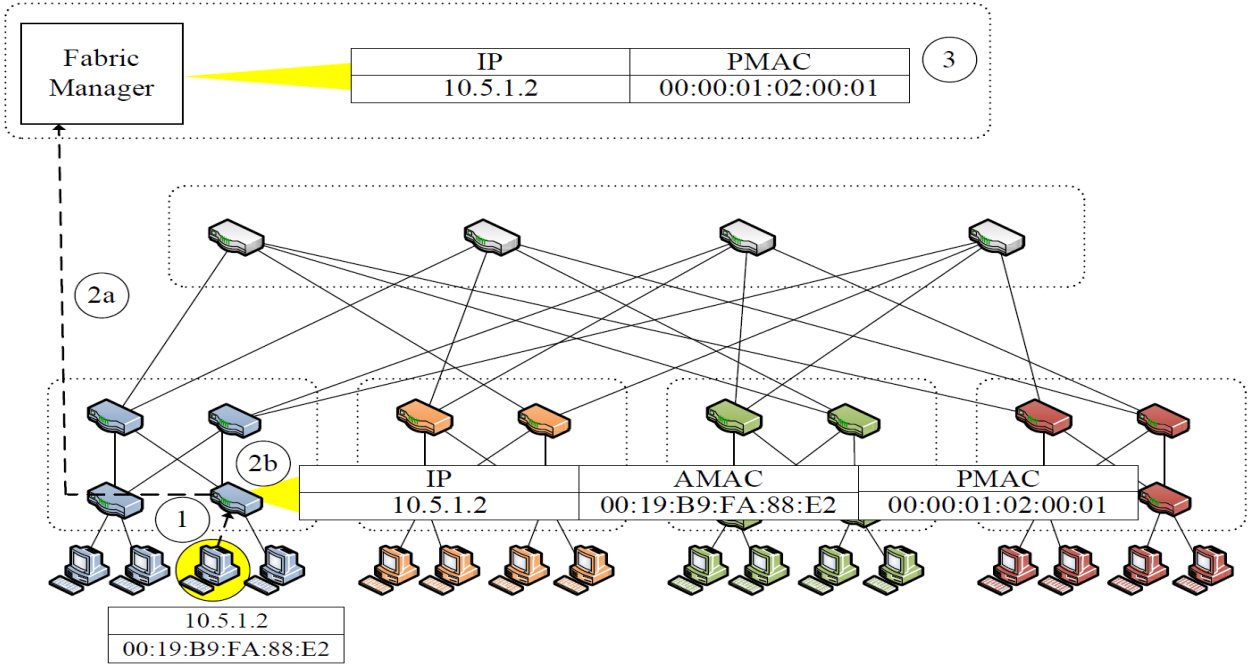
- Logically centralized **fabric manager**
- Positional **pseudo MAC addresses**
  - Address resolution: Proxy ARP
  - Forwarding based on pseudo MAC
  - Efficient forwarding



Niranjan Mysore, Radhika, et al. "PortLand: a scalable fault-tolerant layer 2 data center network fabric." ACM SIGCOMM Computer Communication Review. Vol. 39. No. 4. ACM, 2009.

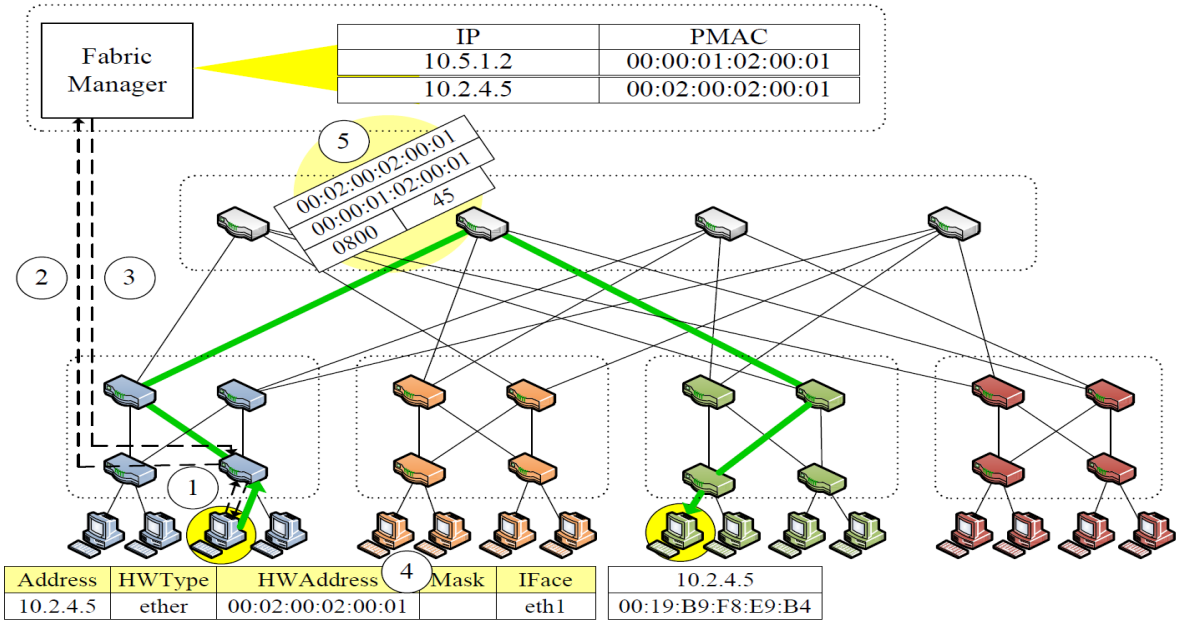
Fabric Manager: MAC Learning

1. New source MAC
2. Frame vectored to fabric manager.
3. FM constructs mapping to PMAC.



Fabric Manager: Proxy ARP

1. Edge switch intercepts ARP query.
2. Forwards to FM.
3. Return PMAC to edge switch.
4. Edge switch creates ARP reply.
5. Host sends to PMAC.



Summary

- Data center networks have unique requirements for scaling and flexibility
  - Tens of thousands of hosts
  - Need for minimal configuration and state
  - Ability to quickly migrate virtual machines
- PortLand Fabric Manager: An early SDN controller for data centers
  - PMACs, Proxy ARP