Lecture 23: Link Layer IV

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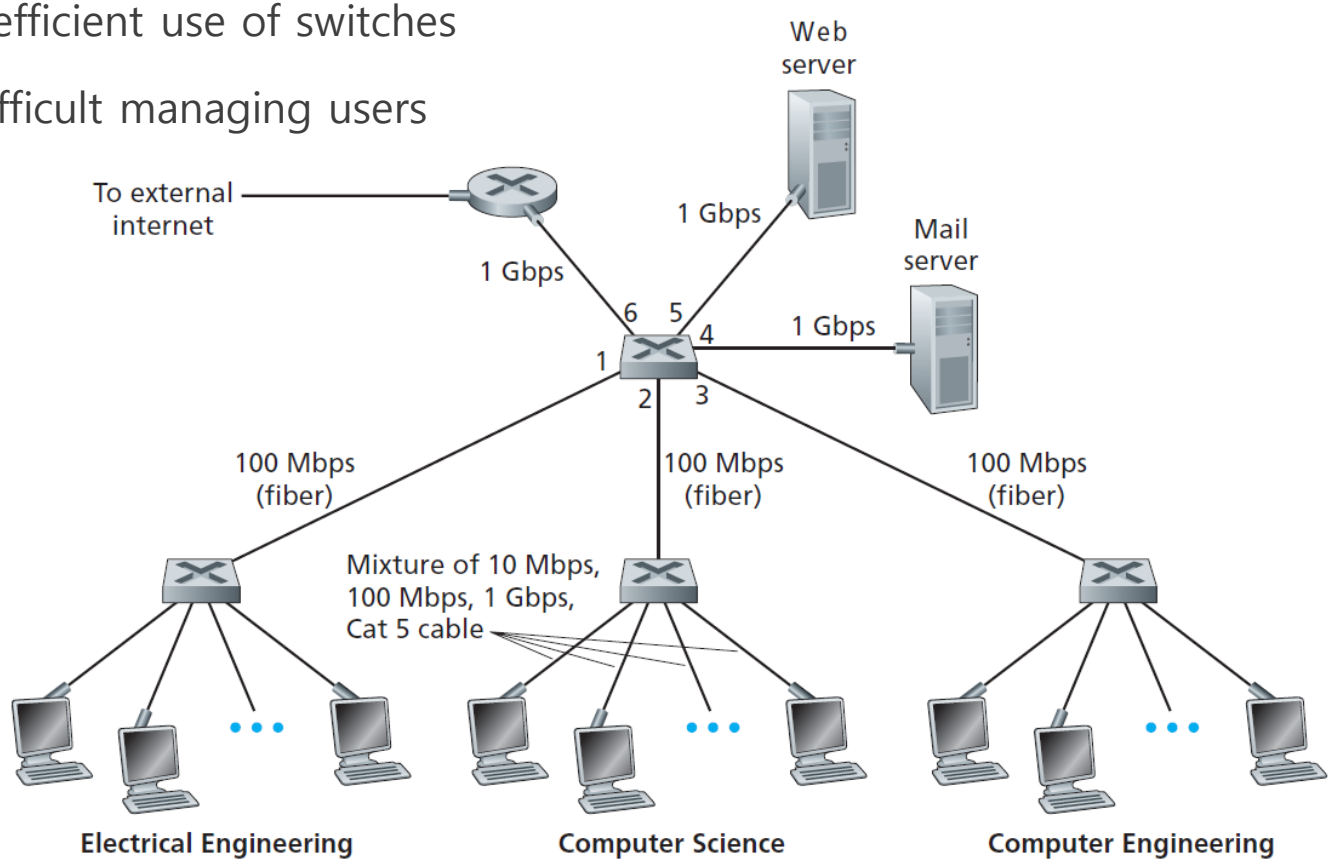
Contents of Chapter 6

- Introduction to the link layer
- Error-detection and –correction techniques
- Multiple access links and protocols
- **Switched local area networks**
  - Link-layer addressing and ARP
  - Ethernet
  - Link-layer switches
  - Virtual local area networks (VLANs)
- Link virtualization: A network as a link layer **(skipped)**
- **Data center networking**

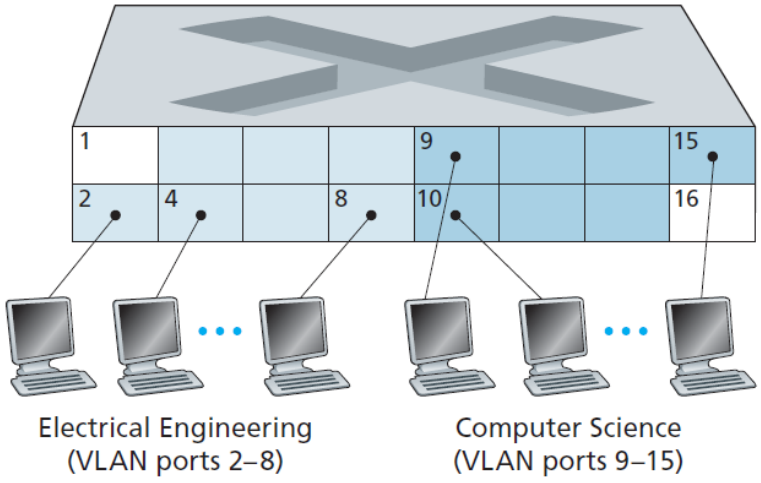
Virtual Local Area Networks (VLANs)

- **An institutional network connected together by four switches**
  - Lack of traffic isolation
  - Inefficient use of switches
  - Difficult managing users



Virtual Local Area Networks (VLANs)

- **Virtual local area networks (VLANs)**
  - Multiple virtual LANs are defined over a single physical LAN infrastructure.
  - The switch's ports are divided into groups and each group constitutes a VLAN.
  - The switch hardware only delivers frames between ports belonging to the same VLAN.
    - Broadcast traffic within a VLAN

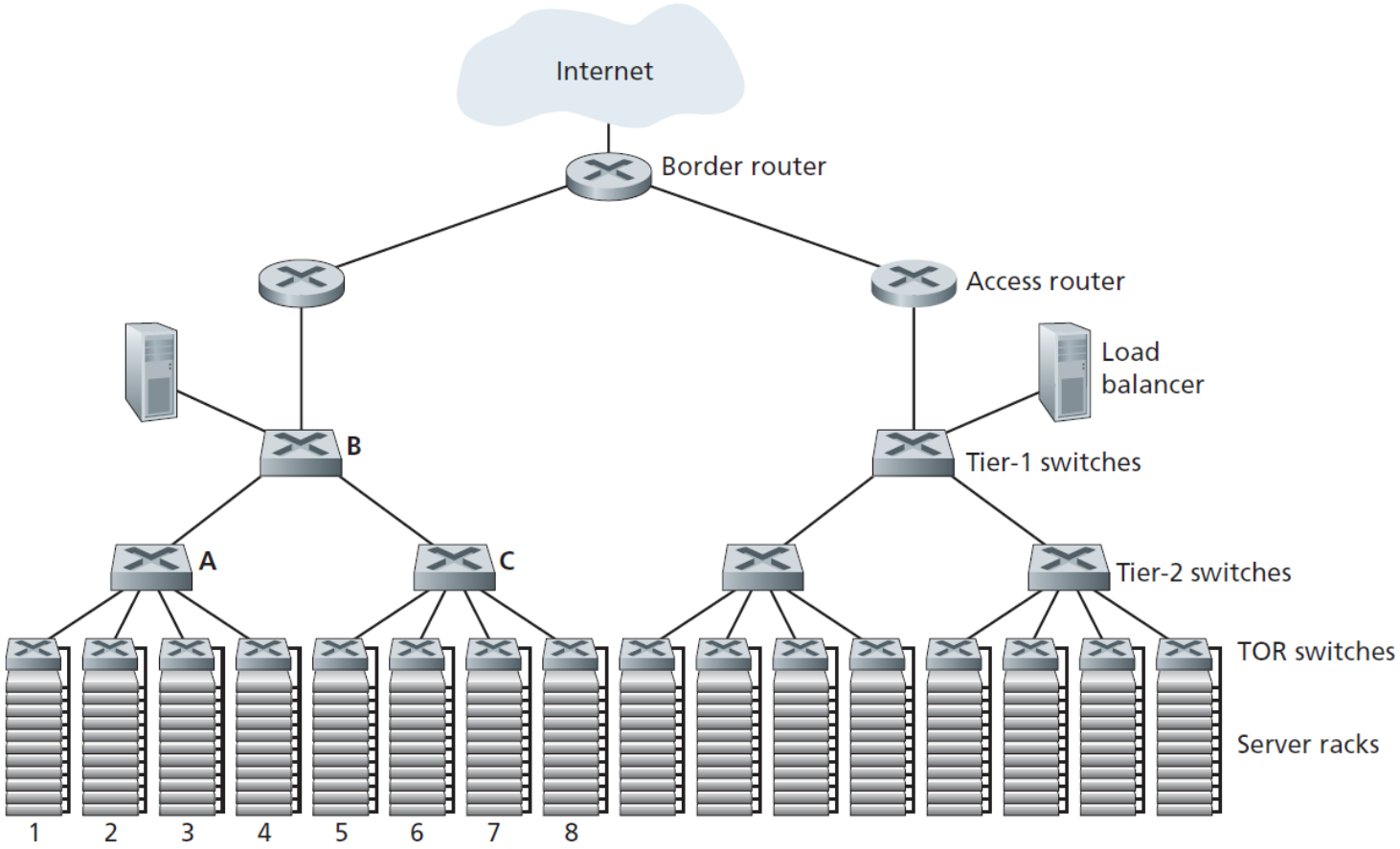


Data Center Networking

- **Massive data centers for cloud applications**
  - Google, Microsoft, Facebook, Amazon
- **The cost of a large data center**
  - The hosts (45%)
  - Infrastructure (25%)
    - Transformers, uninterruptable power supplies systems, generators, and cooling
  - Electric utility costs (15%)
  - Networking (15%)
    - Switches, routers, load balancers, external links, and transit traffic costs

Data Center Networking

- A data center network with a hierarchical topology

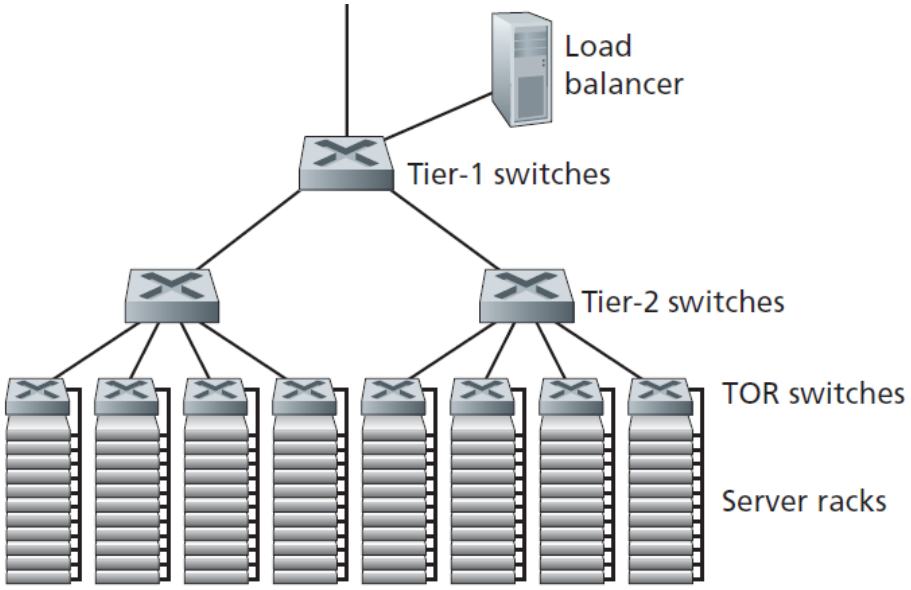


TOR: Top of rack

Data Center Networking

Load balancing

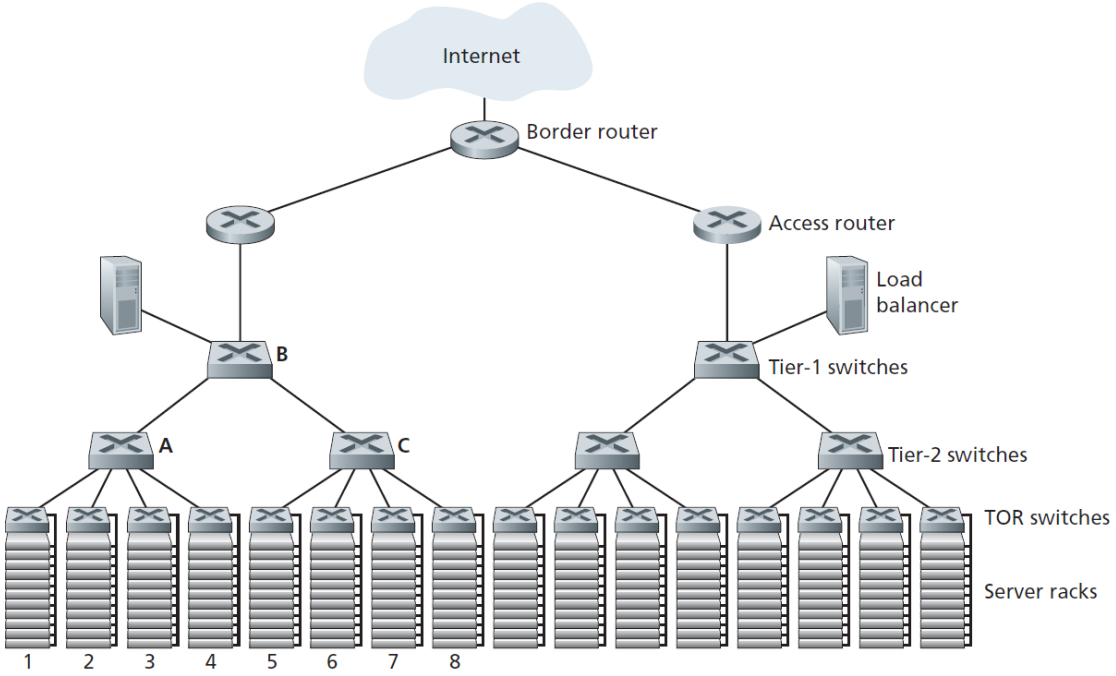
- The external requests are first directed to a load balancer whose job is to distribute requests to the hosts.
- The load balancer translate the public external IP address to the internal IP address of the appropriate host.
  - Preventing clients from directly interacting with the hosts



Data Center Networking

Hierarchical architecture

- Possible to scale a data center to hundreds of thousands of hosts
- However, the problem is the limited host-to-host capacity.
  - A large-scale Internet search engine or a cloud computing service may run on thousands of hosts spread across multiple racks



Data Center Networking

- **Trends in data center networking**
  - Fully connected topology
    - Improve the host-to-host capacity
  - Shipping container-based modular data centers (MDCs)
    - Google container data center (https://www.youtube.com/watch?v=zRwPSFpLX8I)