Computer Networks
COL 334/672

Data Center Networks

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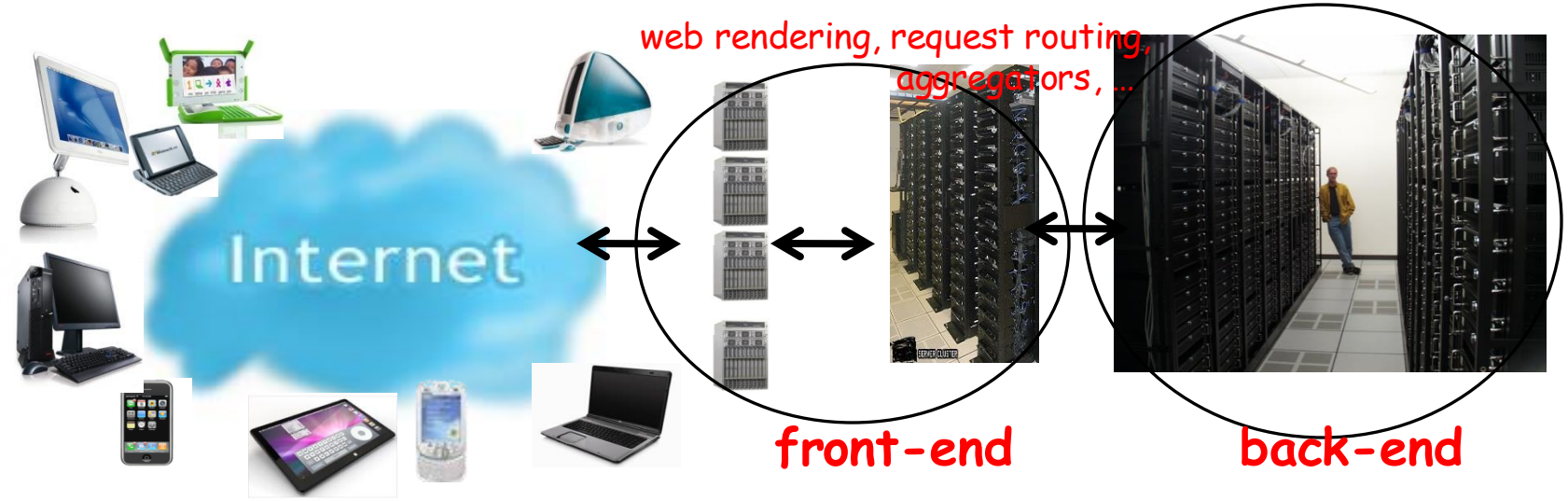
Datacenter Networks

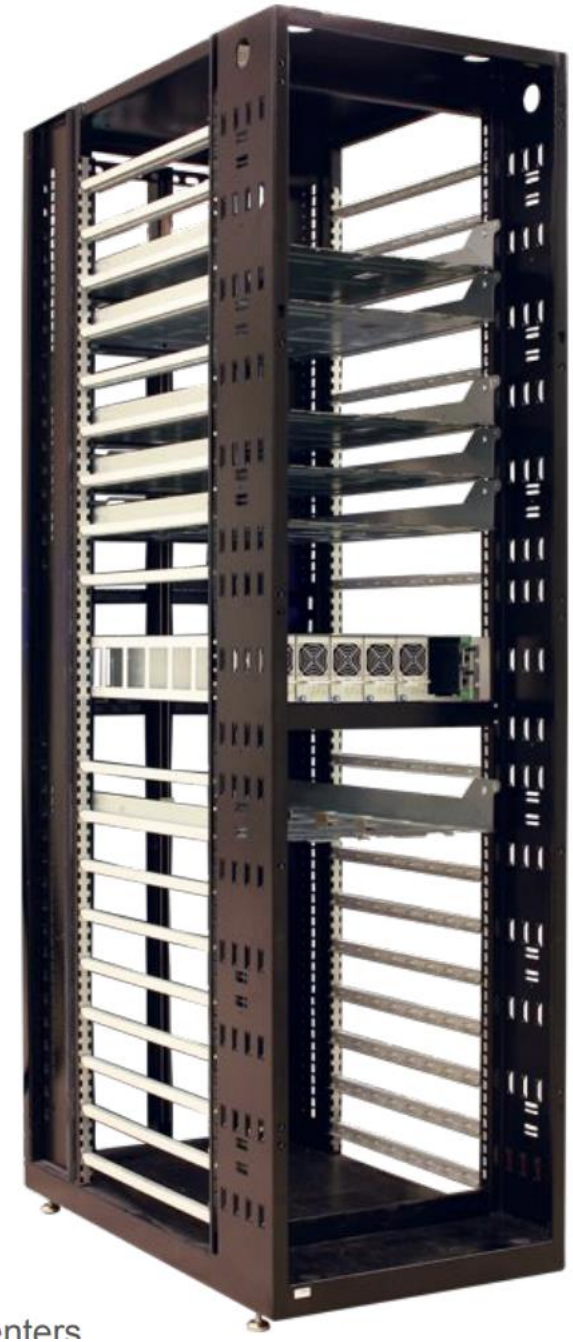
- Data centers: Backend of Internet, beyond storing content
- Provide *demand-elastic* resources including
  - Software (e.g., customer relationship management)
  - Platform (e.g., Google App Engine, Azure AI)
  - Infrastructure (e.g., Amazon EC2)



What does a data center consist of?

- Large number of nearly identical machines

- Silicon Valley



centers

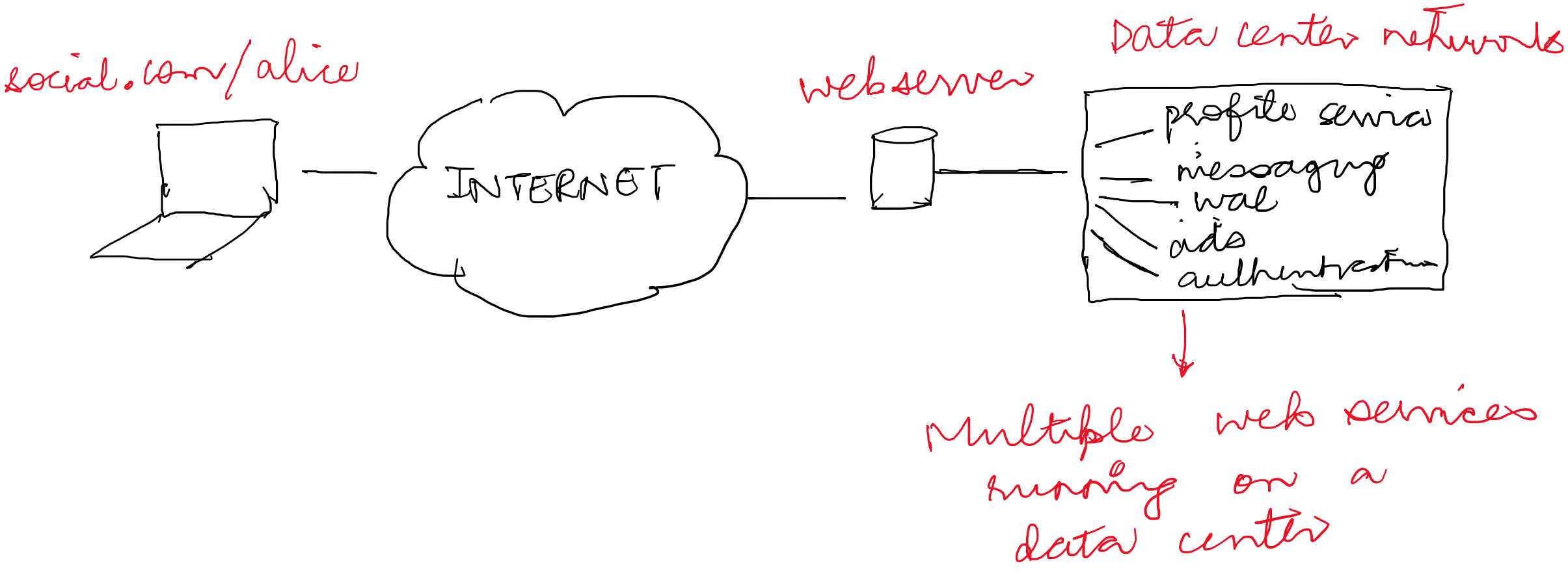
Characteristics of Datacenter Network

- Multi-tenancy
  - security, resource allocation
- Flexible service management
  - workload management, migration
  - elastic resources

Unique aspects from a networking standpoint:

- New set of challenges
- Completely owned by a single entity (enable innovation!)

Example use case



Keys Aspects of Datacenter Network Design

- Topology
- Routing
- Network virtualization
- Transport protocols

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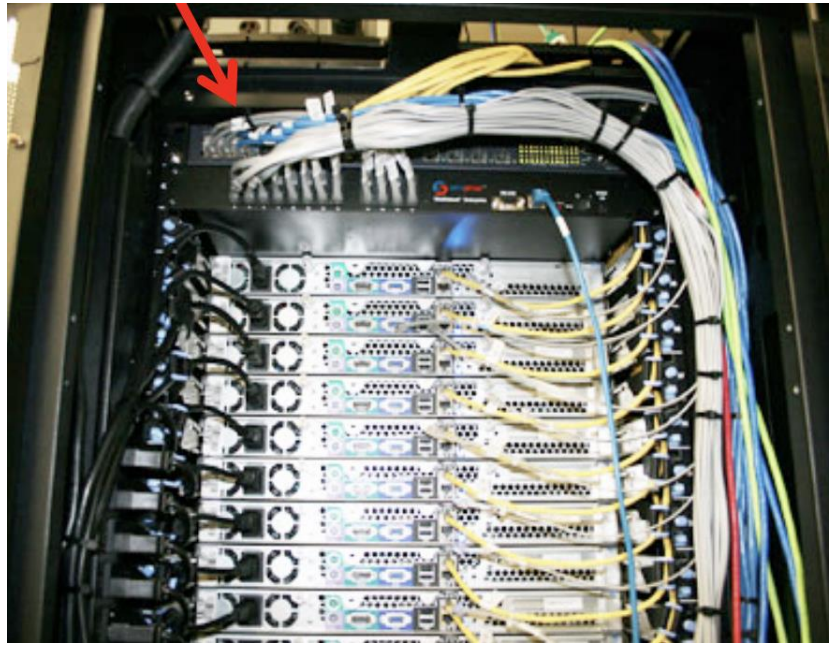
Topology Design

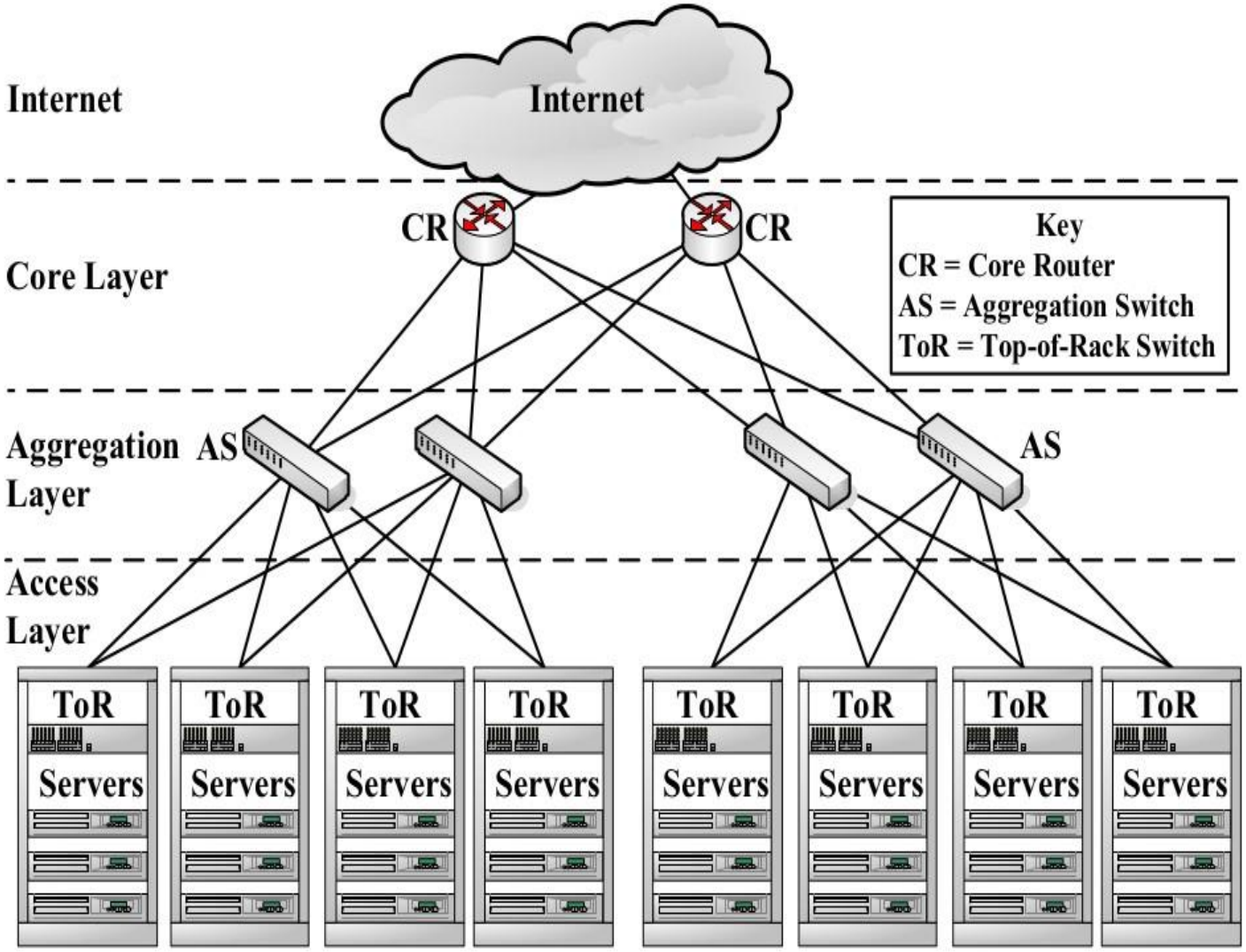
- Goal: Need to connect thousands of servers; each server is able to talk to other server
- Other concerns: performance, reliability, cost ..



Top of rack switch

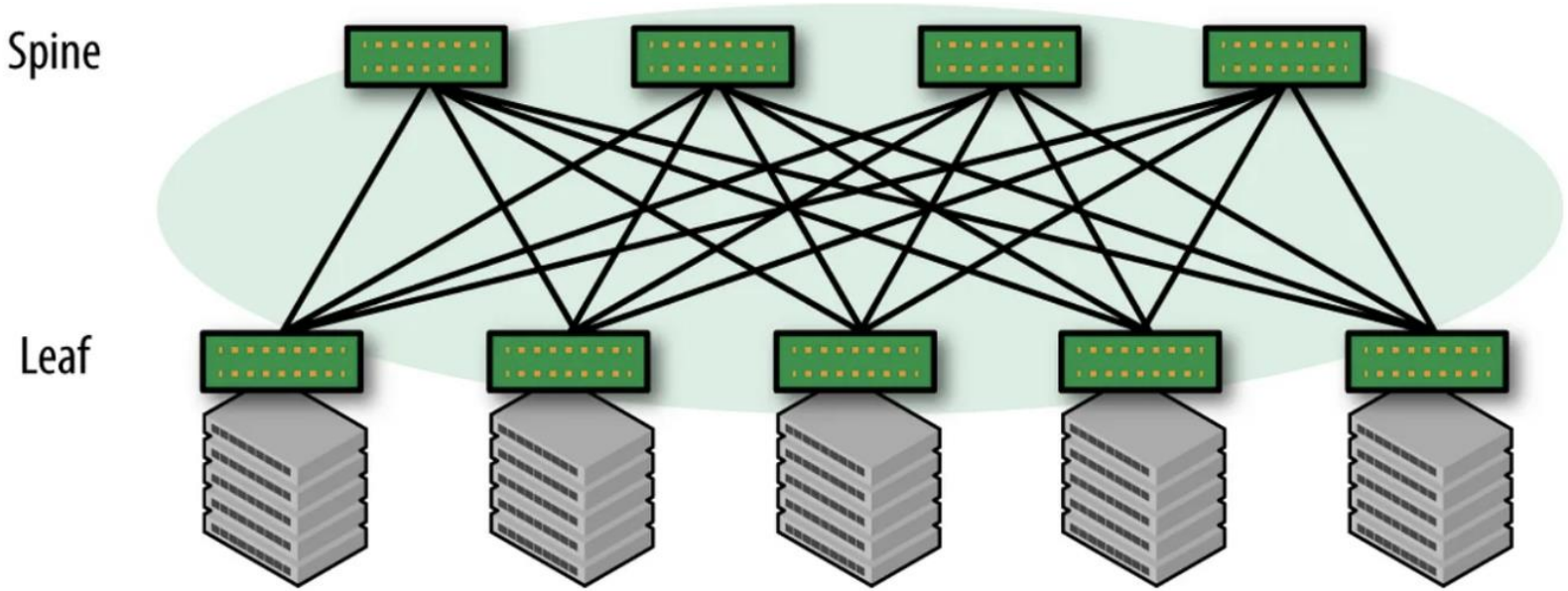
Design Options

- Conventional design



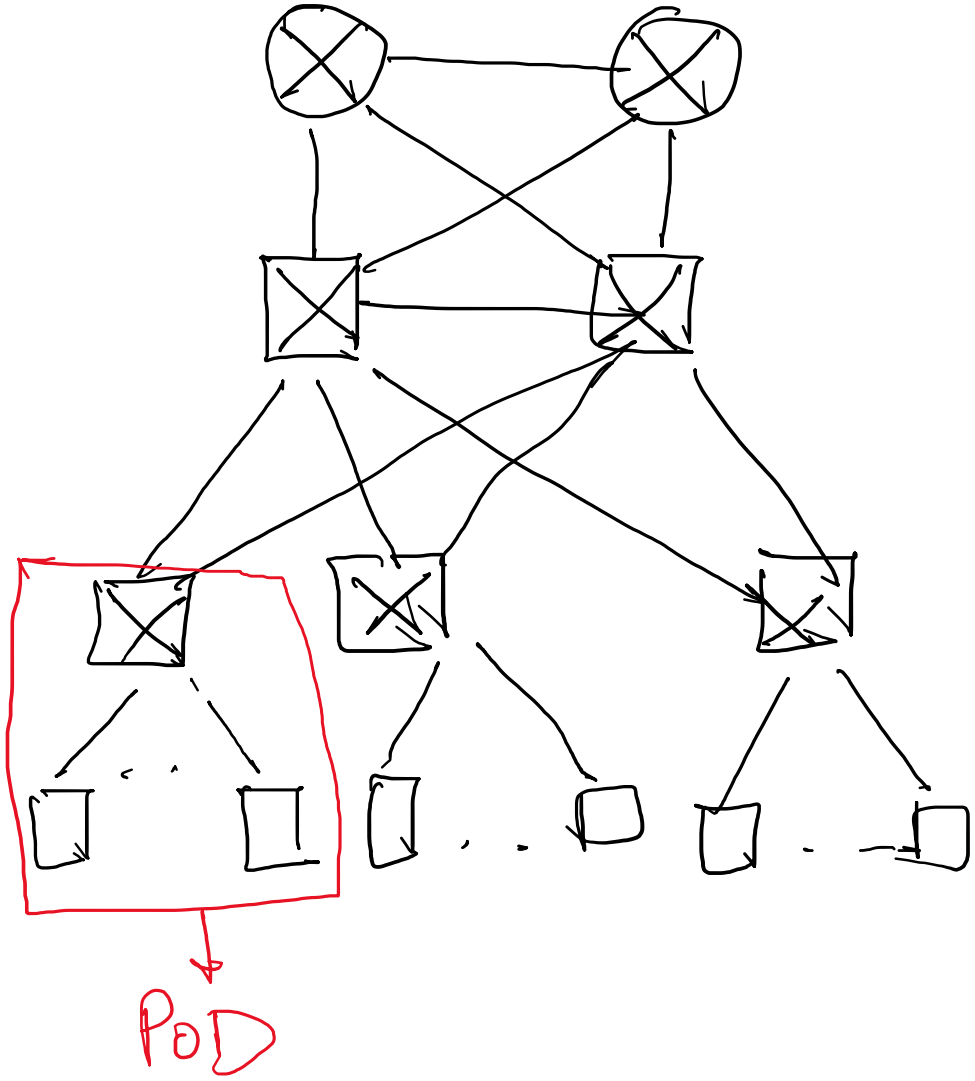
Design Options

- Other designs



Routing

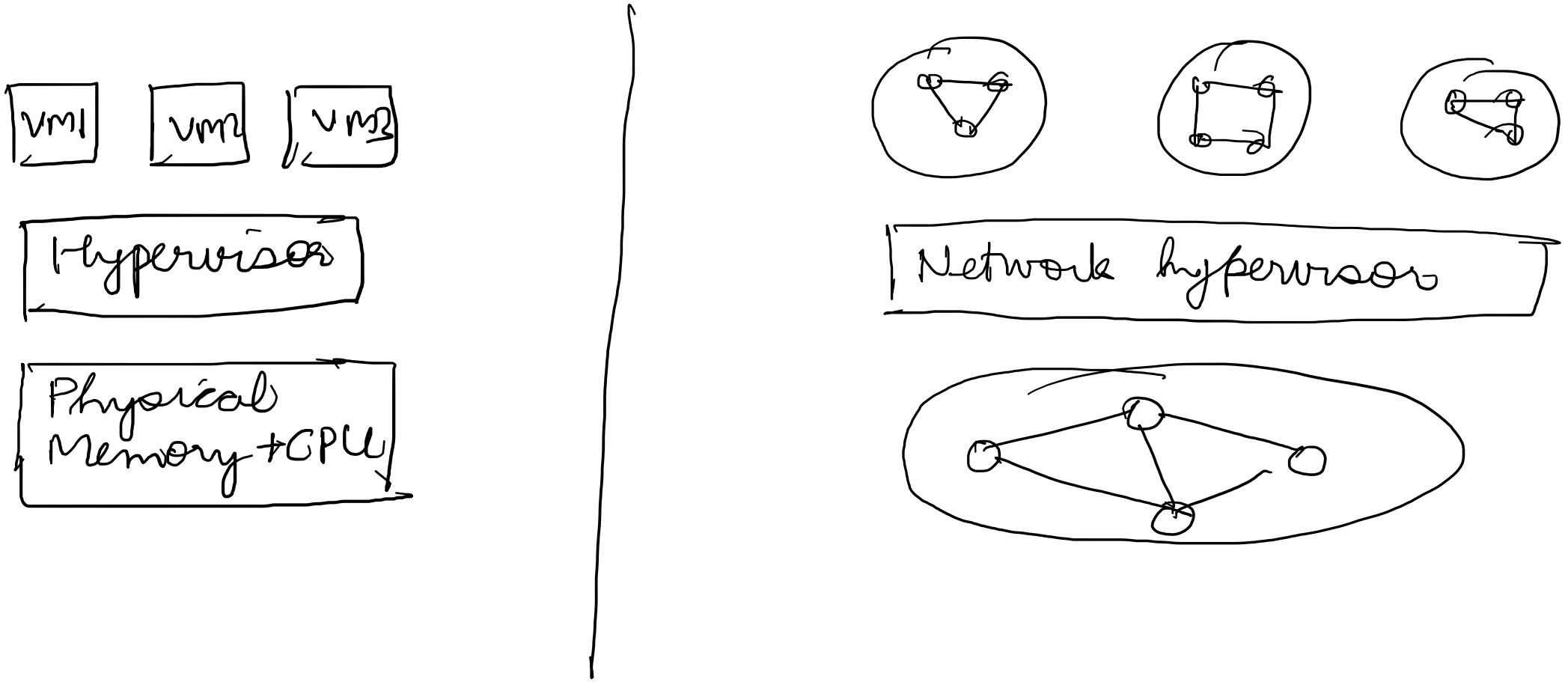
- L3 routing: VM migration can be tricky
- L2 routing: flooding and flat addressing!
- Solution: Enforce a special (IP) addressing scheme in DC
  - unused.PodNumber.switchnumber.Endhost
  - Allows host attached to same switch to route only through switch
  - Allows inter-pod traffic to stay within pod
- Mechanism?
  - Through a centralized control plane



What is Network Virtualization?

- Abstraction of physical network
  - Multiple logical networks on shared physical substrate
- Why is it needed in a datacenter? Multi-tenancy

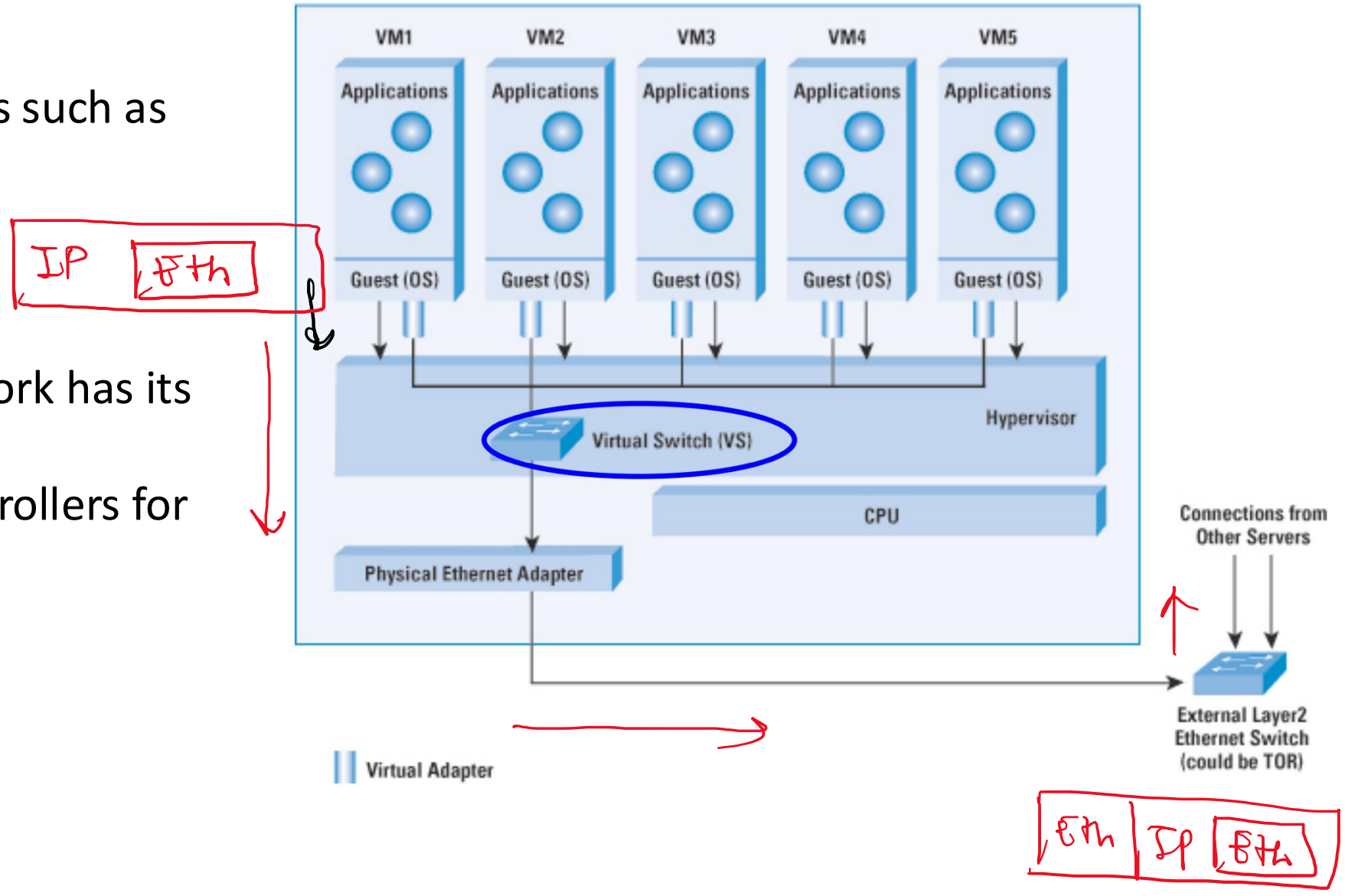
Analogy to Virtual Machines



How to implement network virtualization?

How are virtual networks implemented?

- Using tunneling
  - Multiple protocols such as VLAN, VXLAN
- Use SDN
  - Each virtual network has its own controller
  - Controller of controllers for virtualization

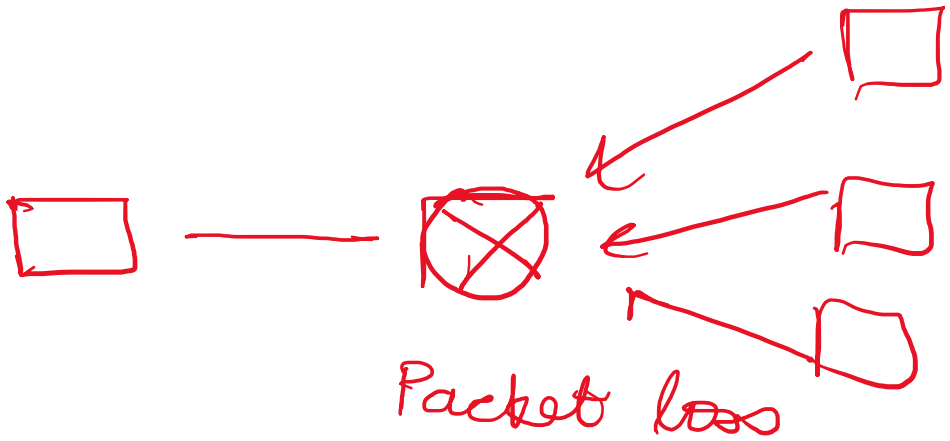


Modifying Transport

Why?

- Flow characteristics are different
  - Mostly short flows (or mice flows) whereas
- Network characteristics are different
  - Latency order of microseconds as opposed to milliseconds

- One example:
  - TCP Incast:



1. Randomize data transfer
2. Use a shorter RTO

Datacenter Networks

- Lots of interesting stuff happening
- Open questions:
  - Designing optimal transport
  - Improving efficiency
  - Optimizing networks for LLM workloads
- Research driven by industry

Attendance