

Computer Networks

COL 334/672

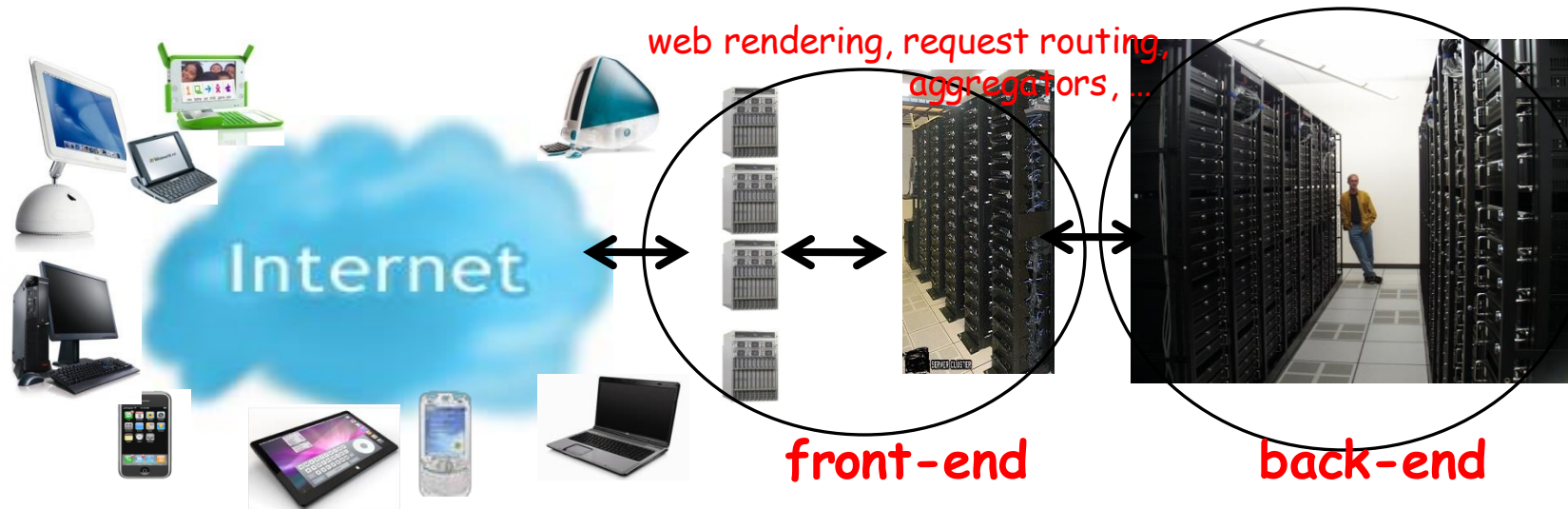
Data Center Networks

Tarun Mangla

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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

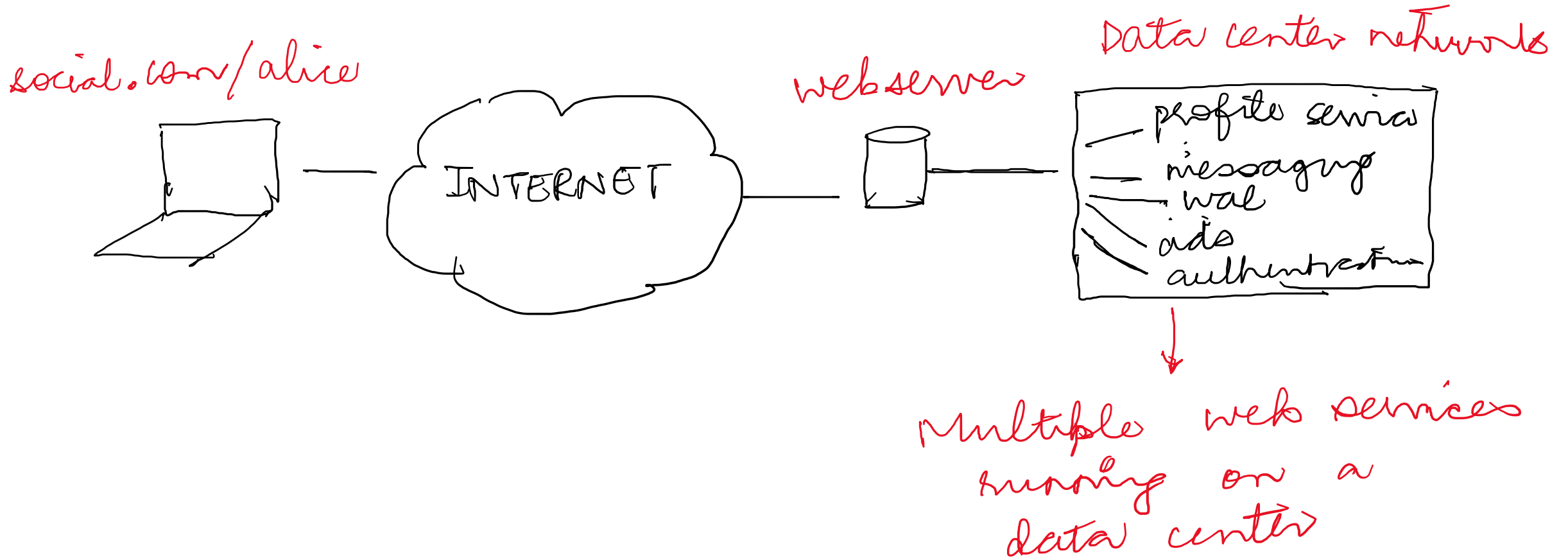
Characteristics of Datacenter Network

- 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



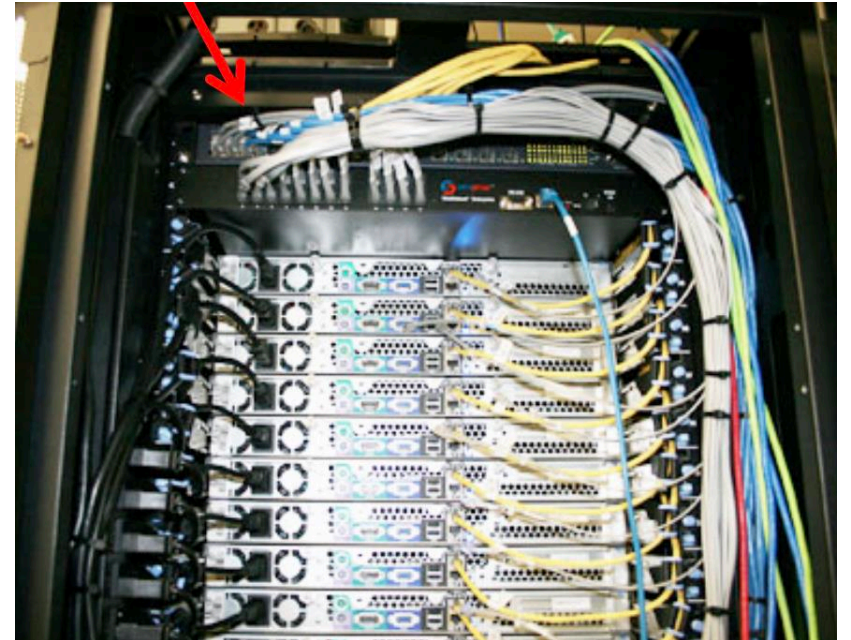
Keys Aspects of Datacenter Network Design

- Topology
- Routing
- Network virtualization
- Transport protocols

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Topology Design

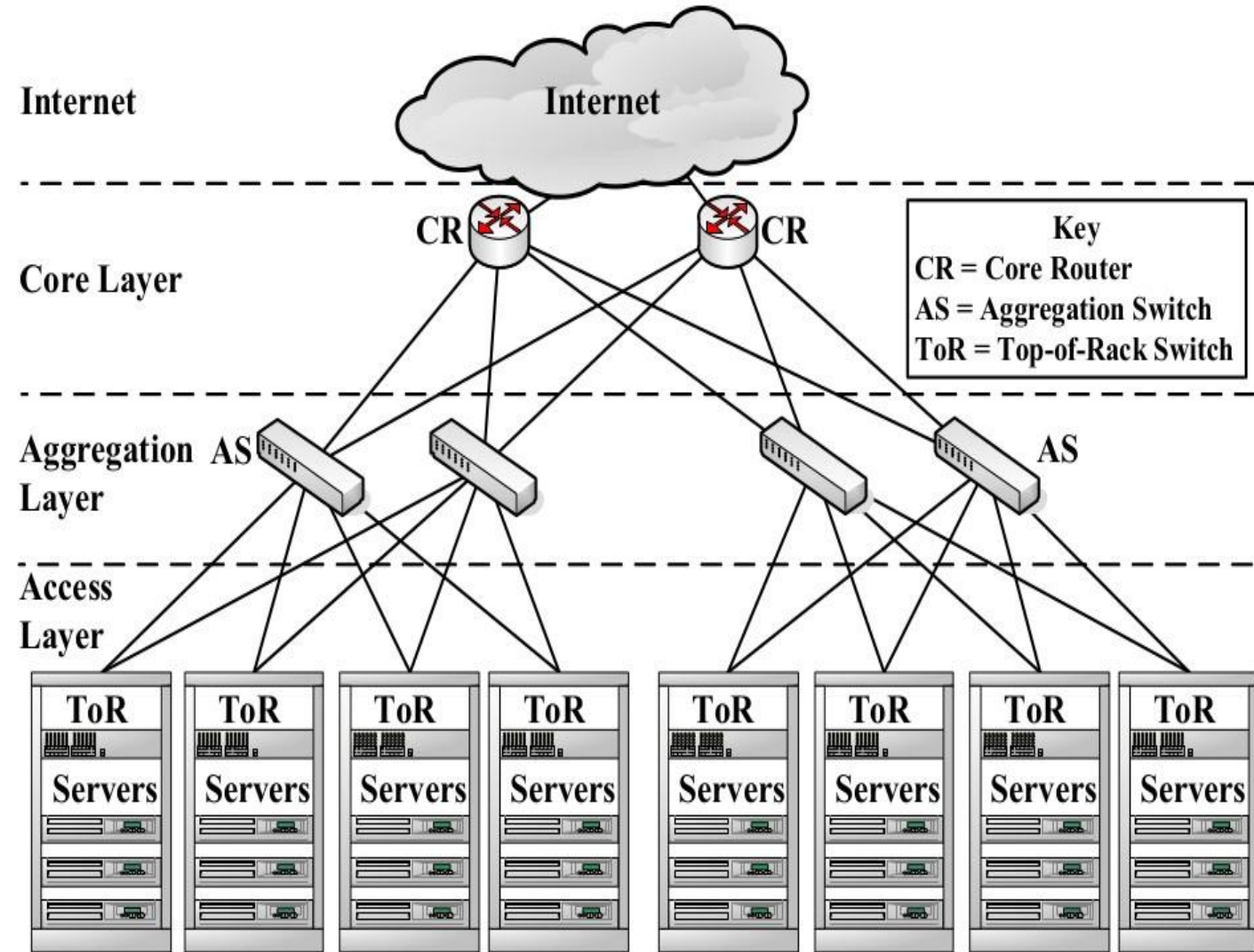
- Goal: Need to connect thousands of servers; each server is able to talk to other server
- Other concerns: performance, reliability, cost ..



Top of rack switch

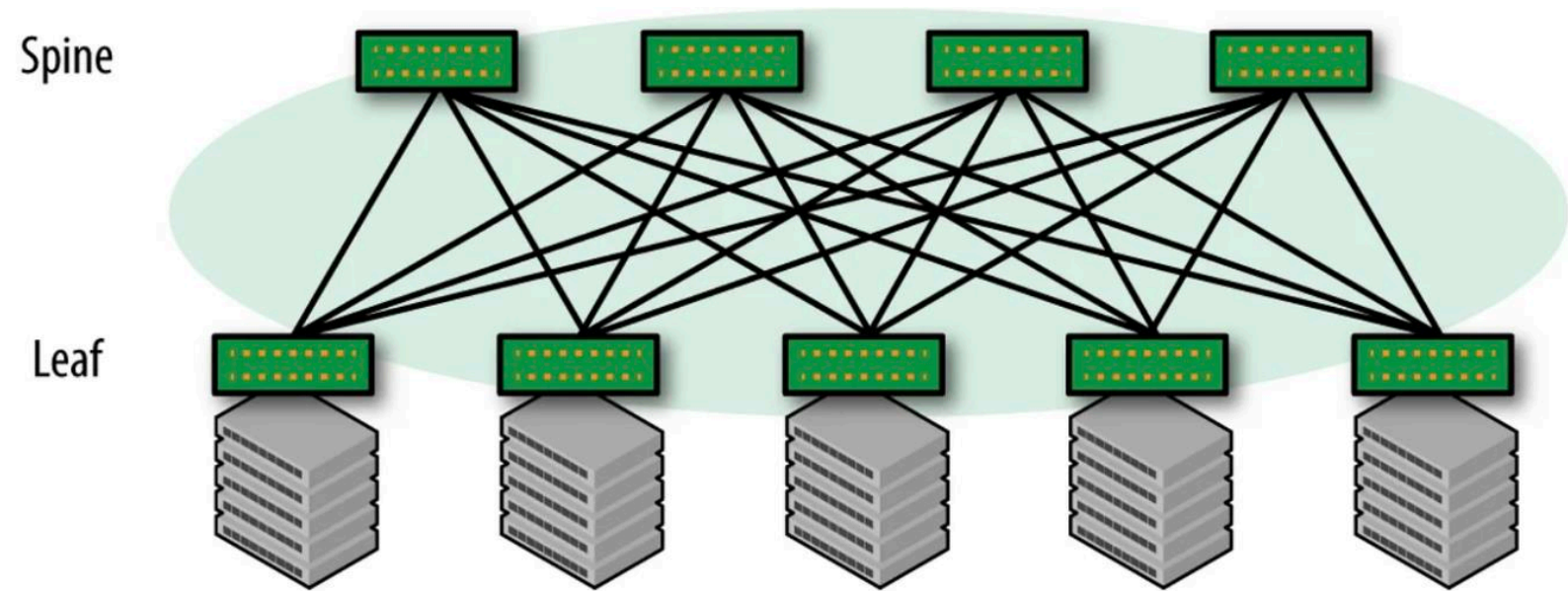
Design Options

- Conventional design



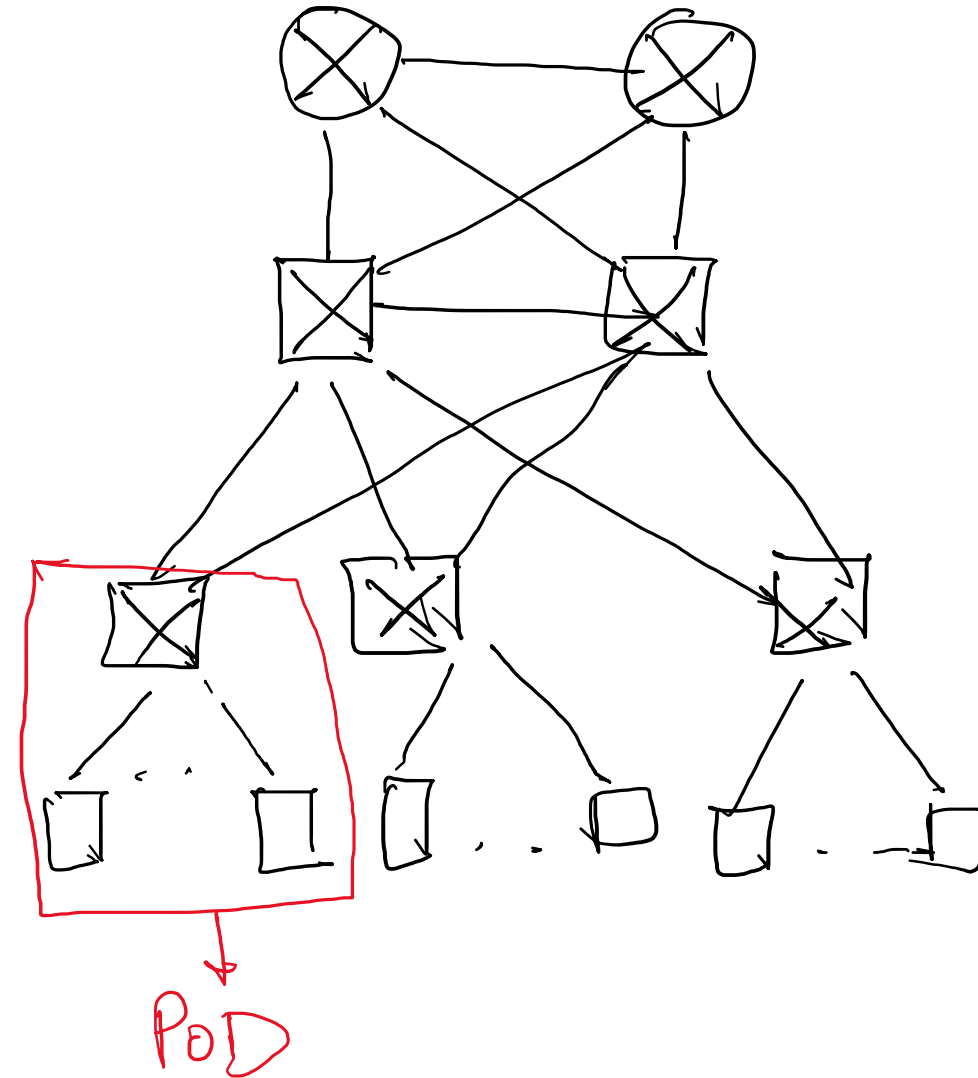
Design Options

- 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**

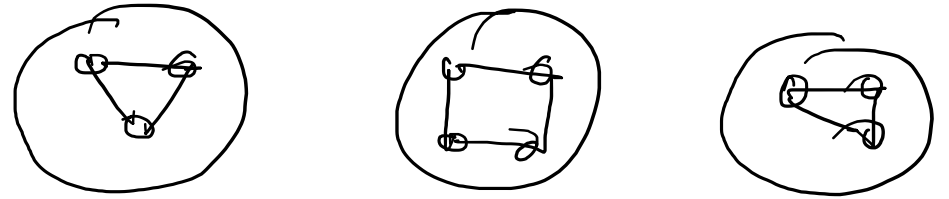
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Analogy to Virtual Machines

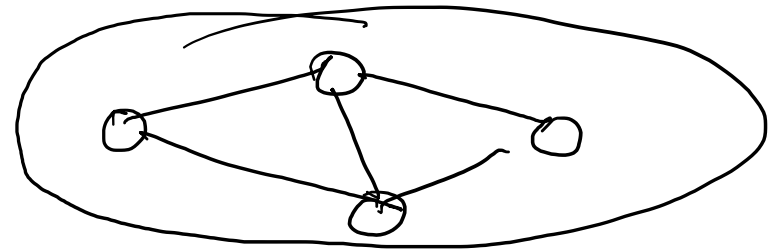
vm1 vm2 vm3

Hypervisor

Physical
Memory + CPU



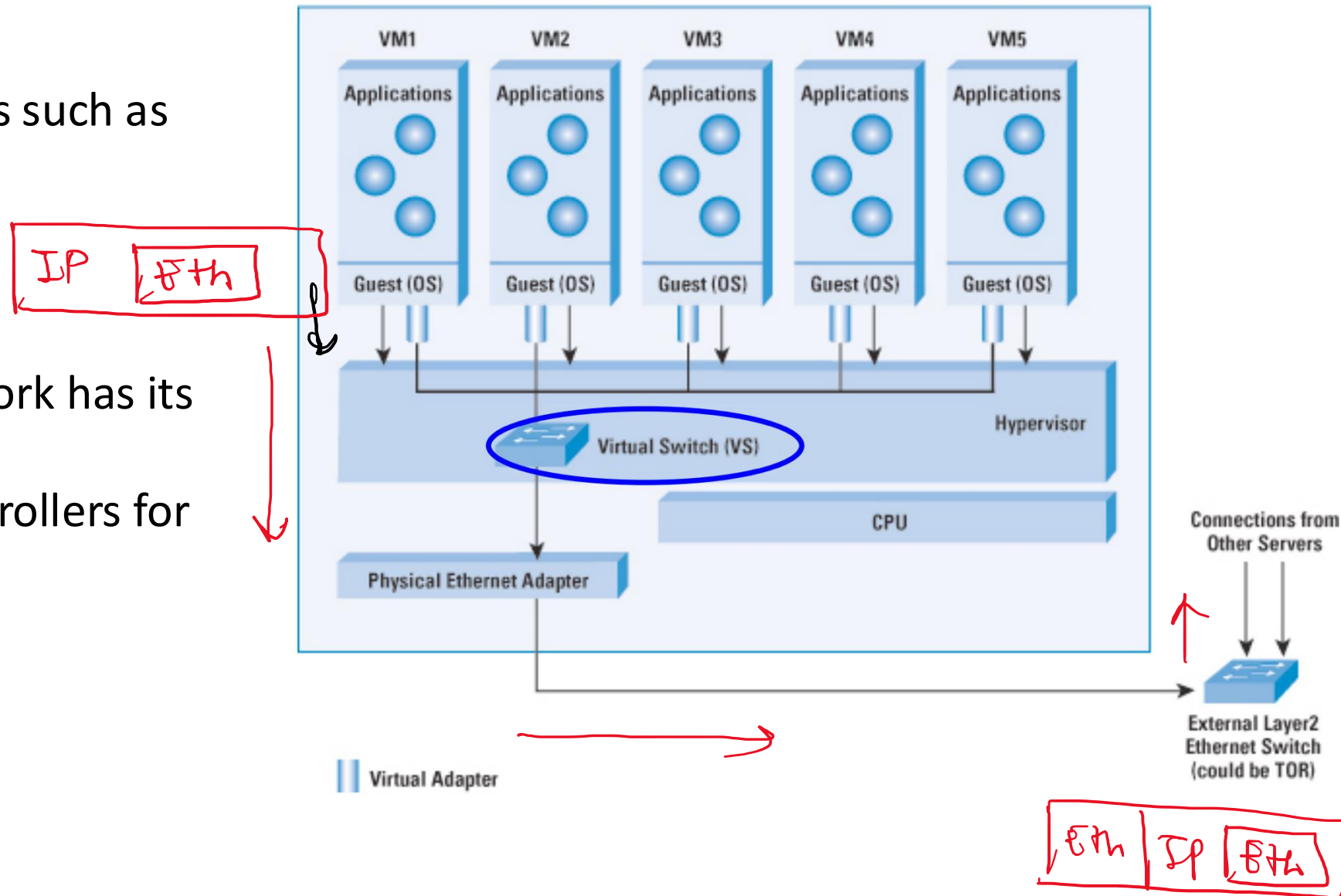
Network hypervisor



How to implement network virtualization?

How are virtual networks implemented?

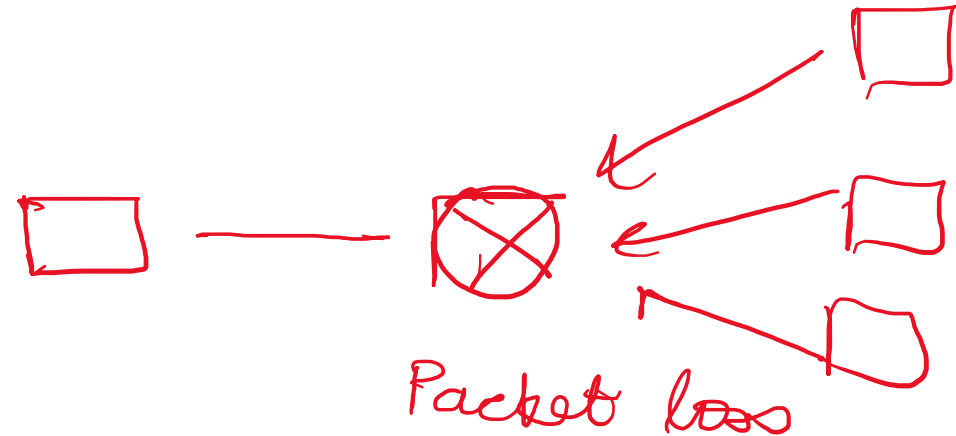
- Using tunneling
 - Multiple protocols such as VLAN, VXLAN
- Use SDN
 - Each virtual network has its own controller
 - Controller of controllers for virtualization



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

