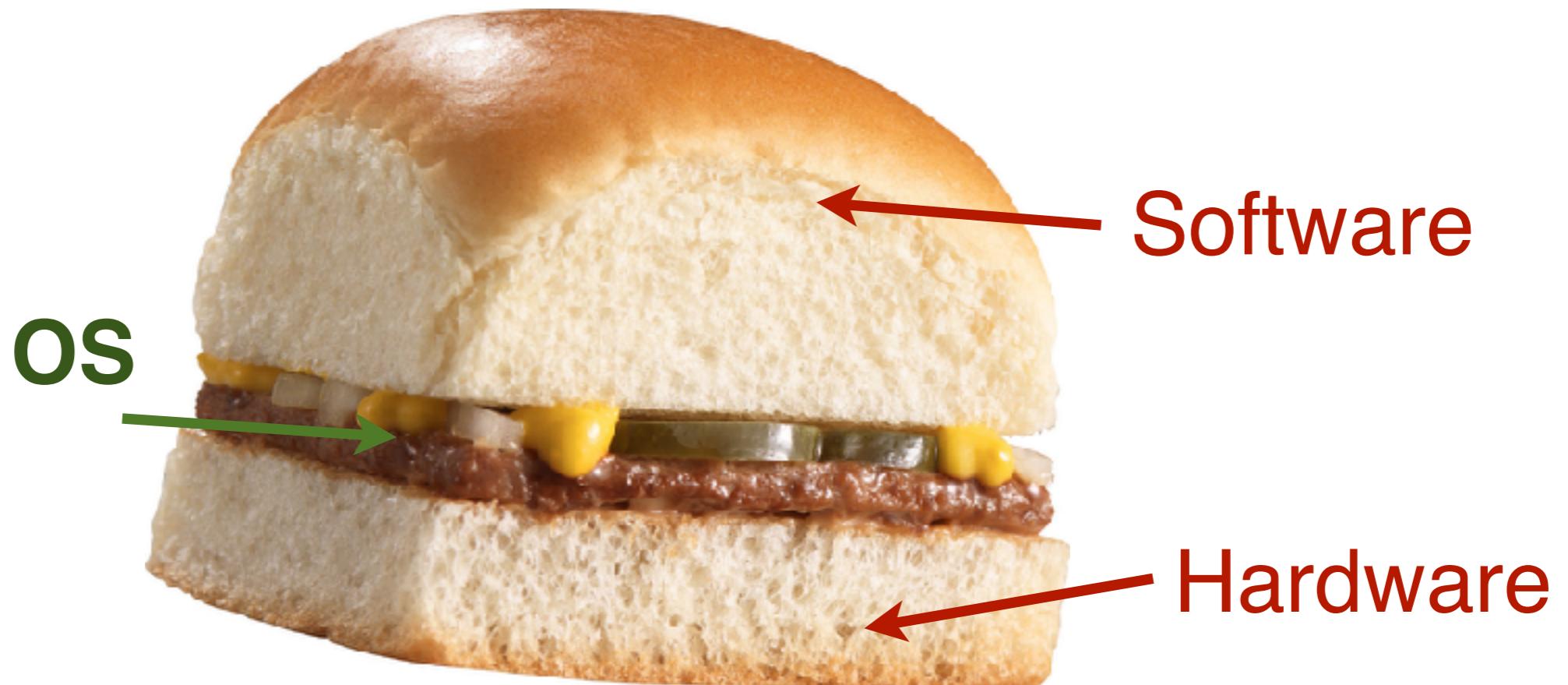


NFV Introduction

OS and Networks:
abstraction layers and trade-offs

The OS

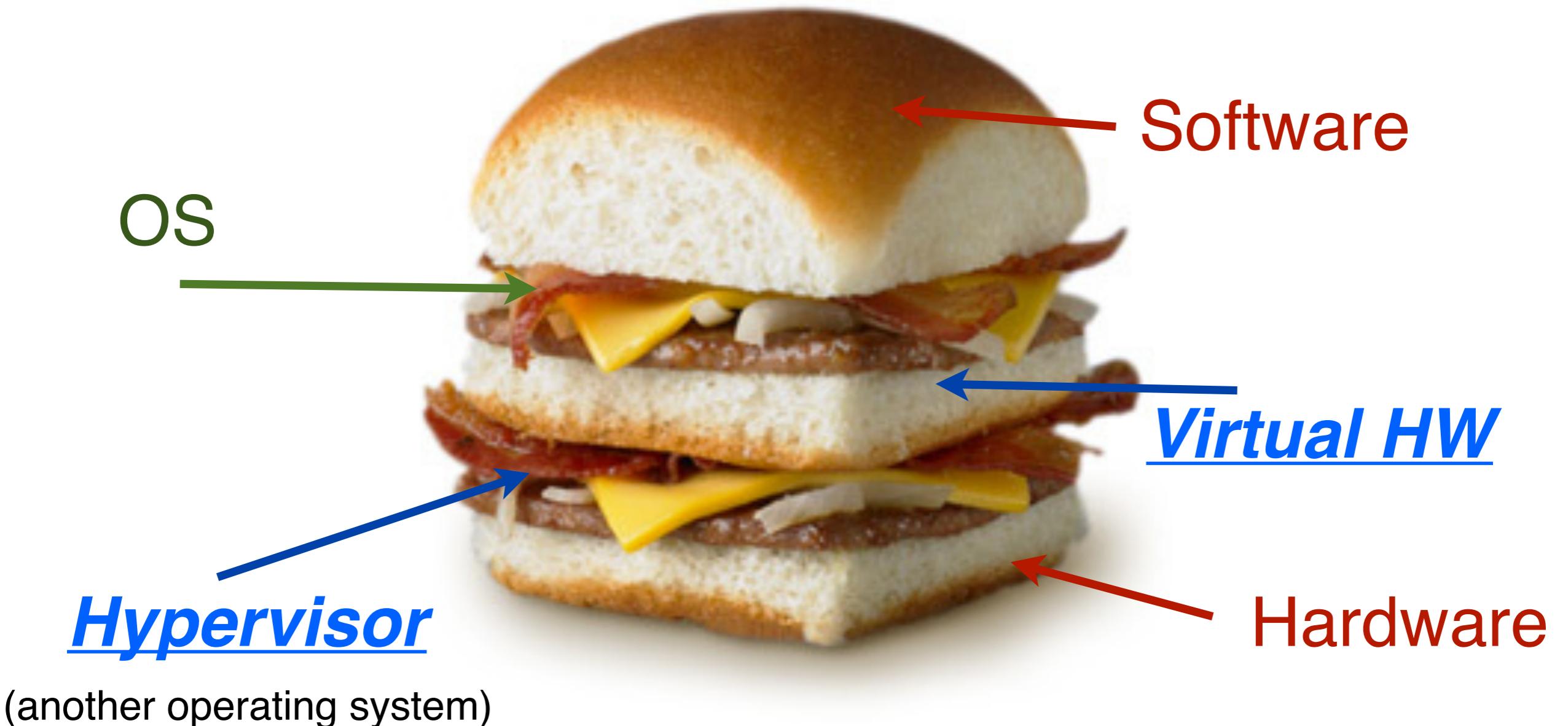
Delicious, with no fluff...



What could make this even better?

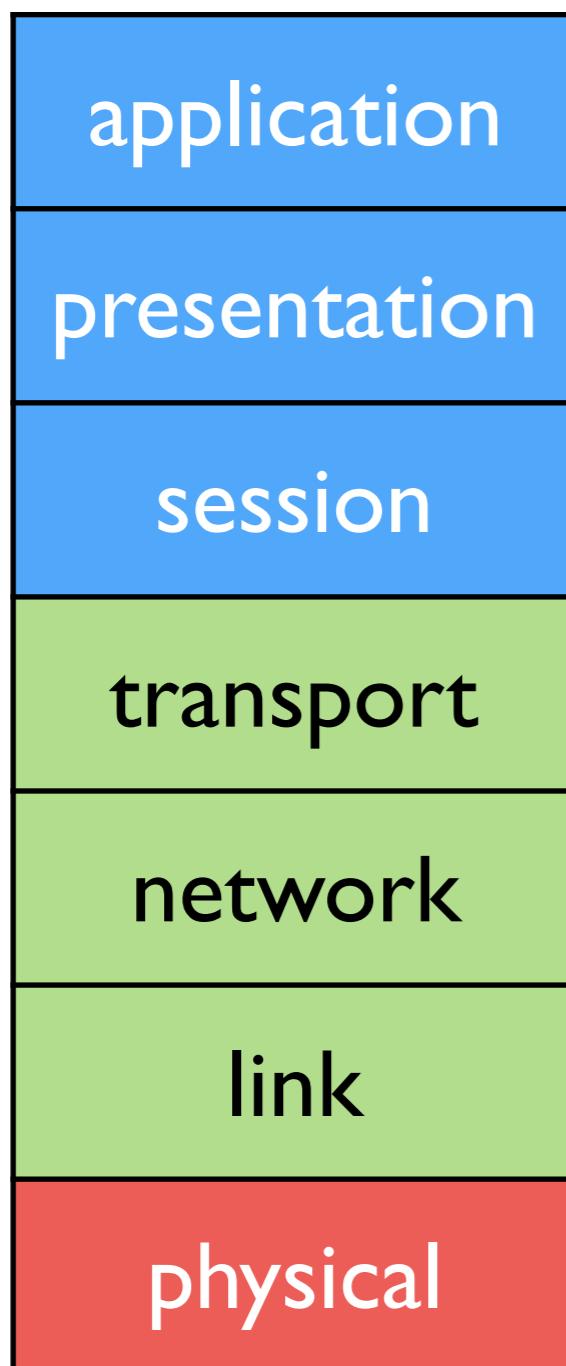
Virtualization Layers

Even more of all the good parts!

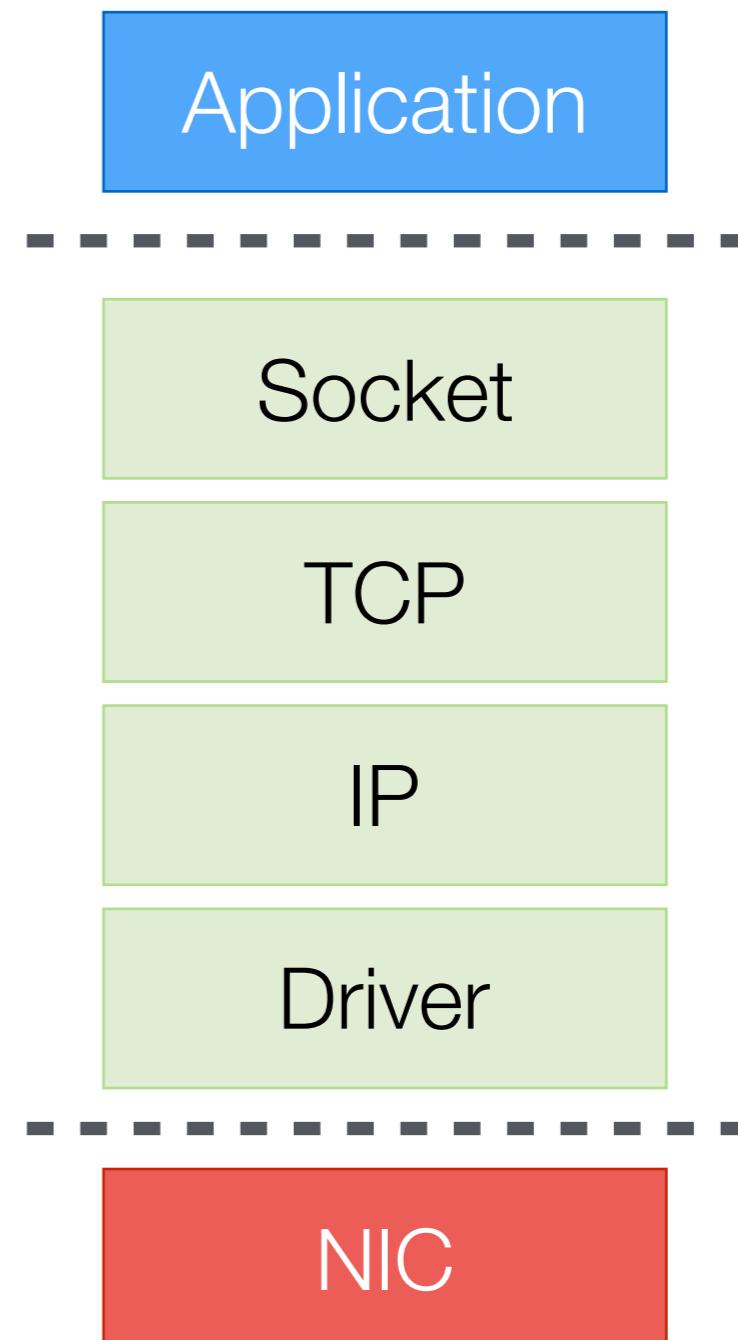


Networks rely on layers

OSI Model



System Structure



Networks for Systems Folk

Topics for today:

Overview of software-based network tech
Systems challenges related to networking

Middleboxes = middleware
Opportunities for network middleware

DPDK and OpenNetVM

Systems Details!

DPDK: low-level network I/O library

OpenNetVM: an NFV platform optimized for high performance service chains built on DPDK

- Open source project, collaboration between GW and UCR

Goals:

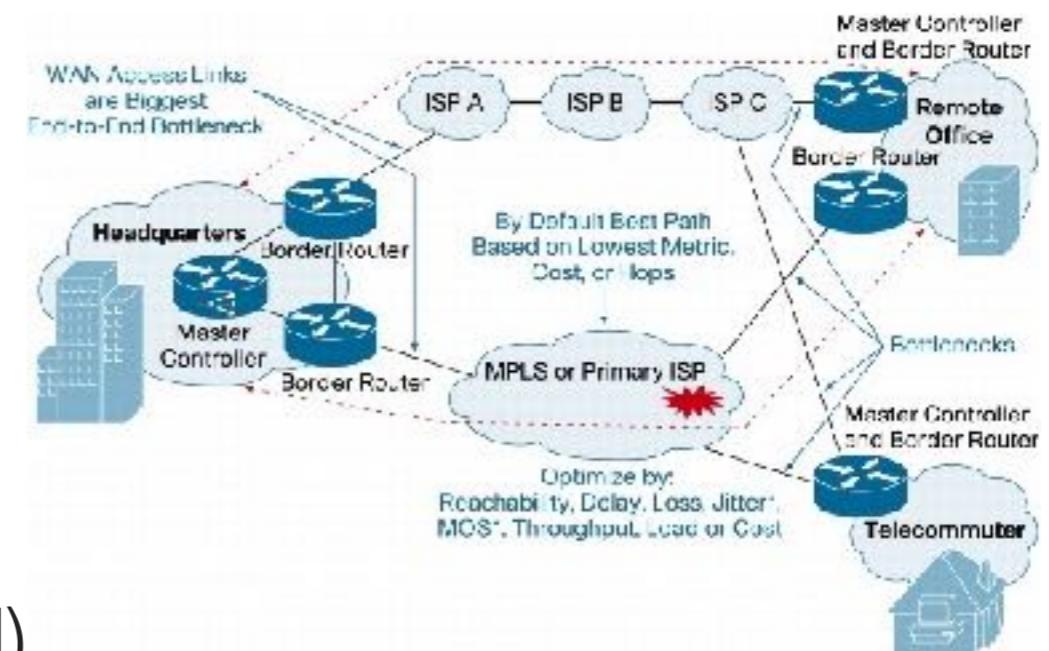
- Understand the design of DPDK and OpenNetVM
- Be able to run OpenNetVM's manager and network functions

Mix of presentation and tutorial

Networks are Changing

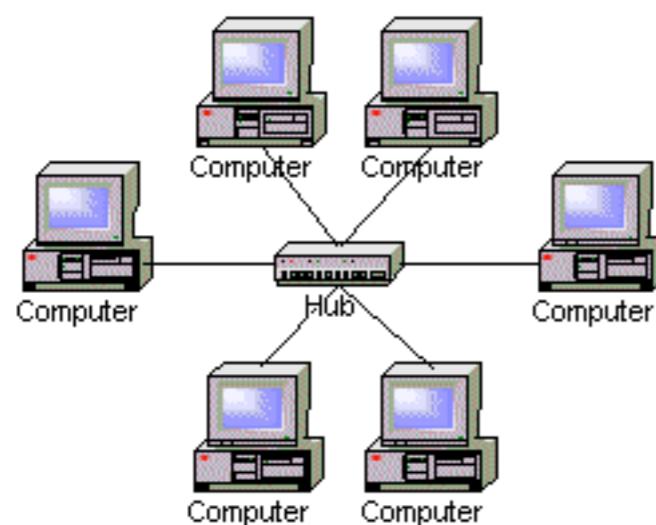
Scale and organization:

- Cloud data centers, mobile users
- Large-scale, highly dynamic

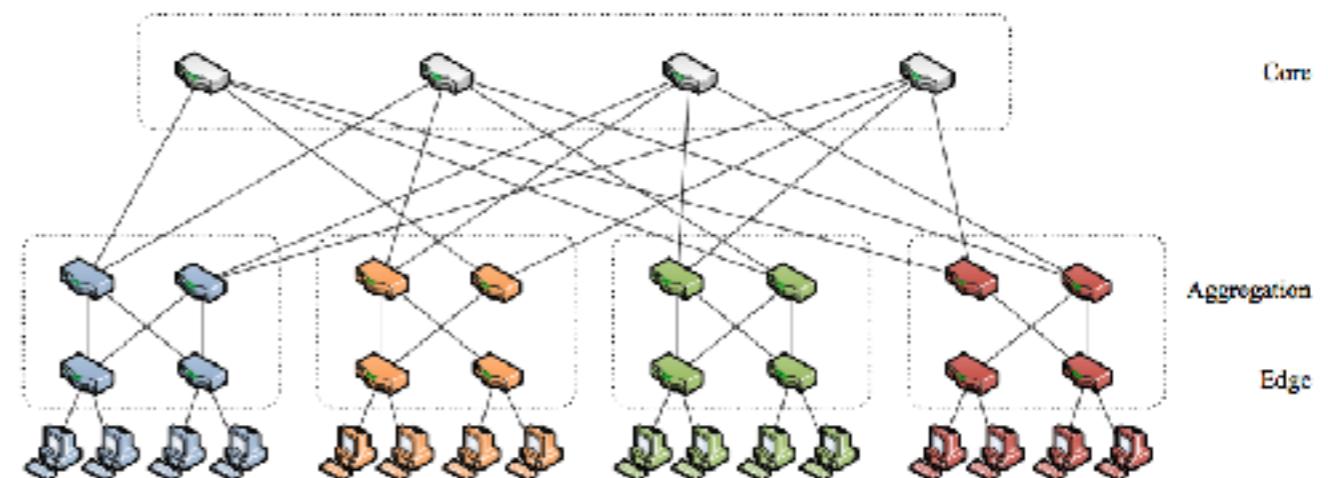


Hardware and control plane

- Software Defined Networking (SDN)
- Network Function Virtualization (NFV)



Then



Now...

Software Defined Networks

Create a centralized network **control plane**

- Routing rules for each flow

Simple, fast data plane

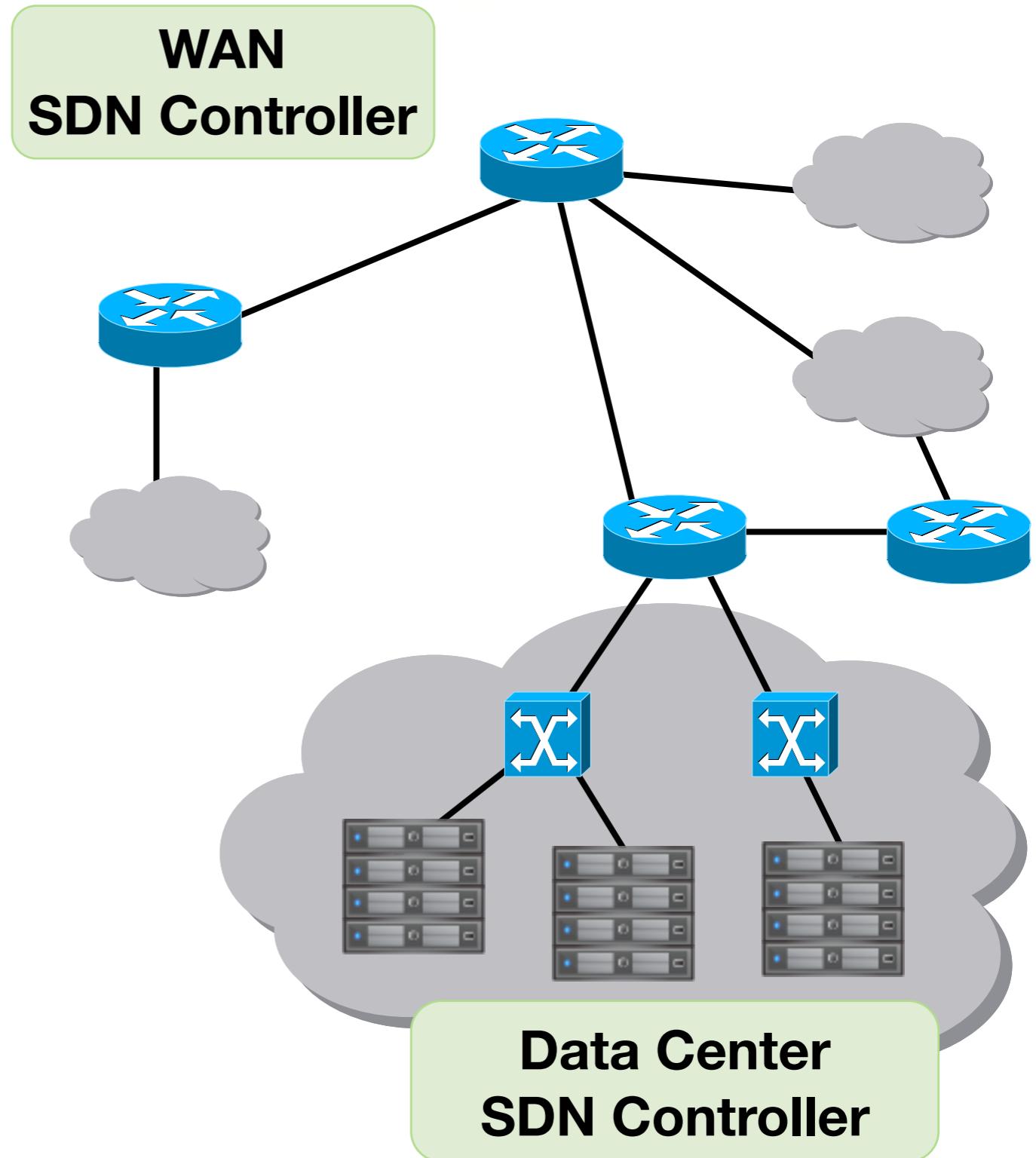
- Routers, switches, etc
- Ask SDN Controller for help

SDN lookup

- Send first packet of unknown flow to controller

Match/action rules

- in: n-tuple (header info)
- out: next hop destination



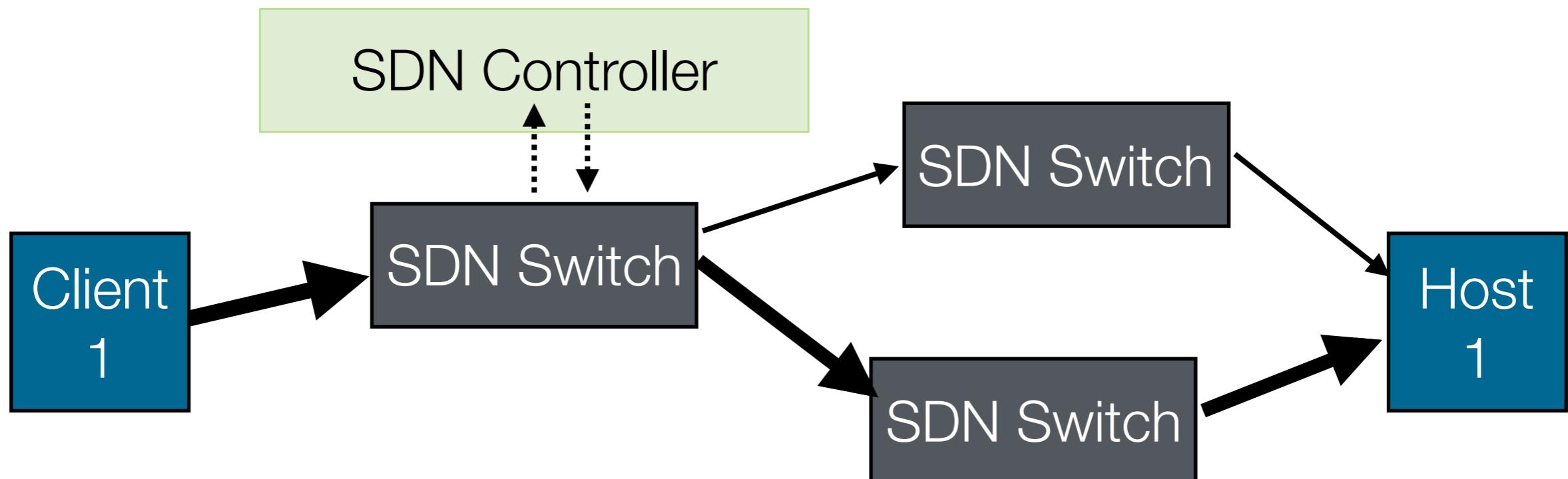
SDN Workflow

Data plane (switches): maintains a flow table

- Flow = one point-to-point connection (Src/Dest IP and Port)
- Action = how switch should process the packet

Control plane: populates flow table rules on switches

- Can be based on business logic
- Select next hop, drop, mirror, etc.



SDN Resources

SDN Controllers

- OpenDaylight
- Nox/Pox
- Project Floodlight
- Ryu

SDN controlled switches

- Your favorite HW vendor
- Open vSwitch (software)

Mininet

- Network emulator for experimenting with SDN control

Network Function Virtualization

Make an efficient,
customizable **data plane**

- routers, switches, firewalls,
proxies, IDS, DPI, etc

Run network functions
(NFs) in virtual machines

- More flexible than hardware
- Isolates functionality, easy to
deploy and manage
- Slower than hardware...

Router Firewall



Router

Switch

Virtualization Layer



Commodity Server

Software-based Networking

Network is more than just transport

- Security, QoS, accounting, caching, transcoding

Systems-level support for network software is lacking

- Needs careful resource management
- Maximizing parallelism and minimizing latency are crucial

Opportunity to redesign!

Convergence of research areas:

- | | |
|--|---|
| <ul style="list-style-type: none">- Operating Systems- Networking- Real Time Computing | <ul style="list-style-type: none">- Security- Modeling- Stream Processing |
|--|---|

Network Hardware

Perform network functionality on custom ASICs

Fast, expensive, inflexible



Compare

Cisco ASR 9001 Router

- **Dimensions:** Height:3.5" Width:17.4" Depth:18.5"
- **Weight:** 30.20 lb
- **Features:** Product Type:Router Chassis Number of Total Expansion Slots:7 Form Factor:Rack-mountable Compatible Rack Unit:2U VoIP Supported:No Expansion Slot Type:Port Adapter SFP+ Product Name:ASR 9001 Router Standard Memory:8 GB
- **Model #:** ASR 9001
- **Item #:** N82E16833420947
- **Return Policy:** Standard Return Policy

 \$33,650.99

\$5.99 Shipping

[ADD TO CART ▶](#)

Software-Based Networking

Hardware Routers and Switches

- Expensive, single purpose
- Controllable with SDNs, but not flexible



PacketShader [Han, SIGCOMM '10]

- Use commodity servers and GPUs
- 39 Gbps processing rates



Netmap [Rizzo, ATC '12] and DPDK

- Libraries to provide zero-copy network processing on commodity 10gbps NICs



ClickOS [Martins, NSDI '14] and NetVM [Hwang, NSDI '14]

- VM based network services
- Flexible deployment and composition



Network Functions (NFs)

Switches, routers, firewalls, NAT

AKA “middleboxes”

- Simple packet header analysis and forwarding

Intrusion Detection Systems (IDS)

- Deep packet inspection (DPI) beyond header to detect threats
- Must have high scalability to observe full packet flows

Intrusion Prevention Systems (IPS)

- Similar to IDS, but deployed in-line, so it can actively manipulate traffic flows
- Must be efficient to avoid adding delay

Cellular functions (Evolved Packet Core - EPC)

- Mobility management, accounting, security, etc.

Proxies, caches, load balancers, etc.