

ON.LAB

Accelerate SDN Adoption with  
Open Source SDN Control Plane

with a difference

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Thinking influenced by Nick McKeown, Scott Shenker, and Colleagues at ON.Lab, Stanford

I am responsible for any faults

Network operators love SDN

They want to adopt it

Still they are too slow to deploy it

Why?

# Why Network Operators Slow to Deploy SDN?

SDN needs to mature

Network operators increasingly dependent on leading incumbent vendors

# Critical SDN Components

- (Commodity) OF/SDN optimized forwarding devices (switches)

- Expect silicon and (white box) vendors to step up to deliver

Not focus of this talk

- Distributed SDN Control Plane

- Scale-out, HA, north bound API, performance

Open Source  
ONOS Project

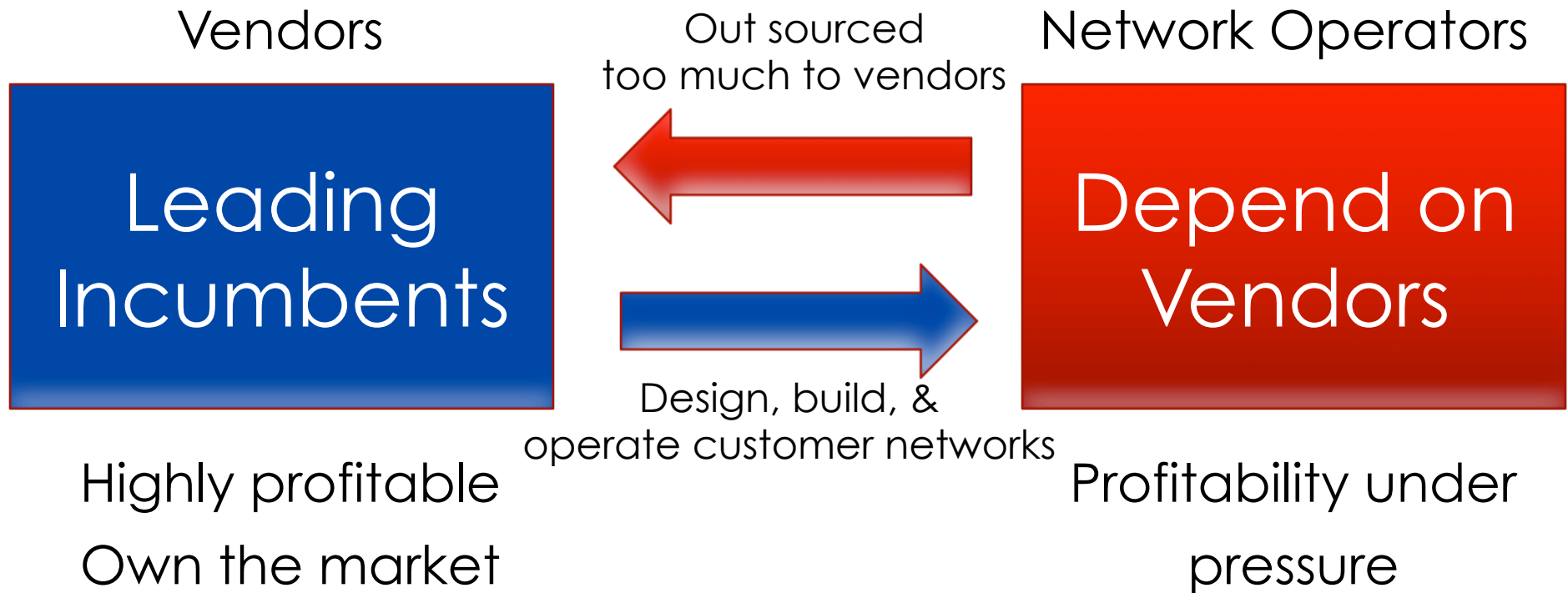
- Compelling use cases

with a difference

Every disruptive technology takes time to  
mature

But SDN has its own challenges due to how the  
network industry works

# Network Operators and Vendors



Leading incumbents not likely to deliver  
"real SDN" any time soon

Surprised?



# Incumbents' Approach to SDN

## ■ Phase 1

- Incumbents ignored SDN

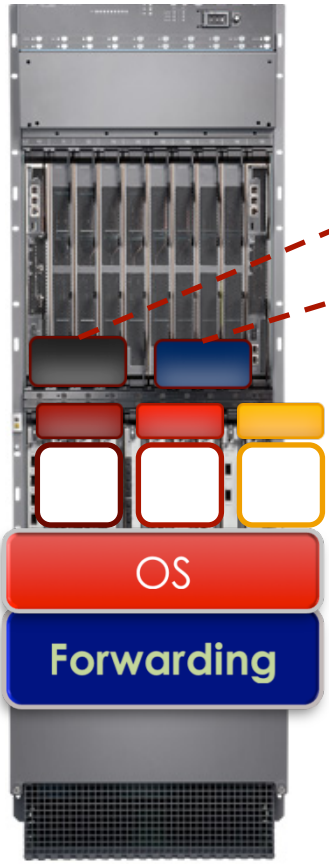
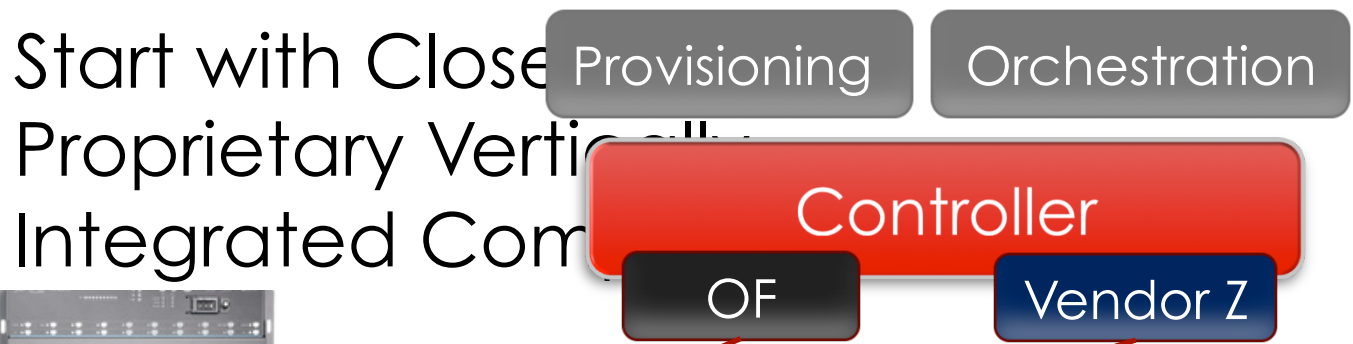
## ■ Phase 2

- Incumbents actively played SDN down and in denial

## ■ Phase 3

- Incumbents “embrace” SDN; claim to be SDN leaders
- Incumbents redefine SDN to preserve their legacy

# Incumbents' Approach to Preserving Legacy

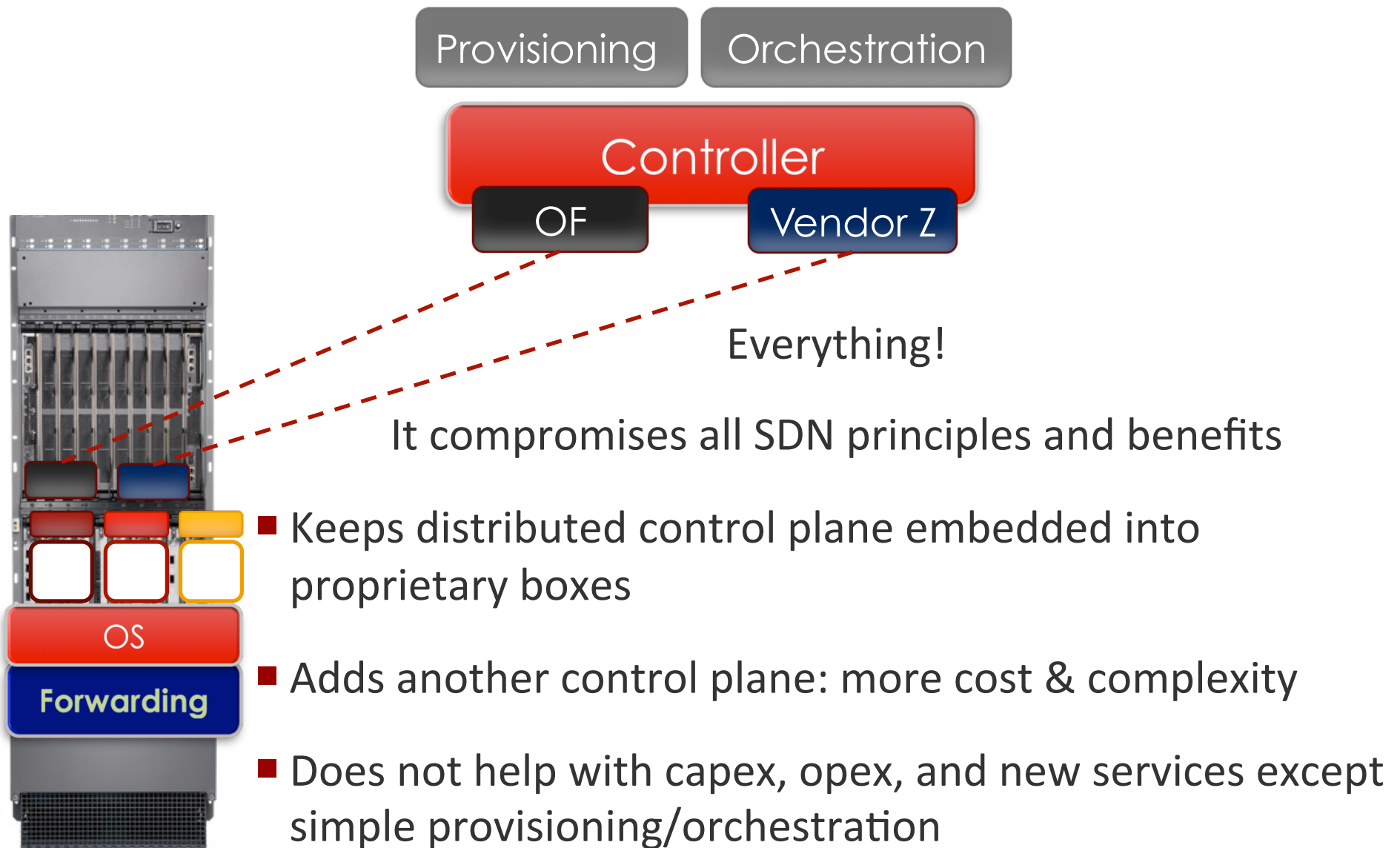


Claimed Advantages?

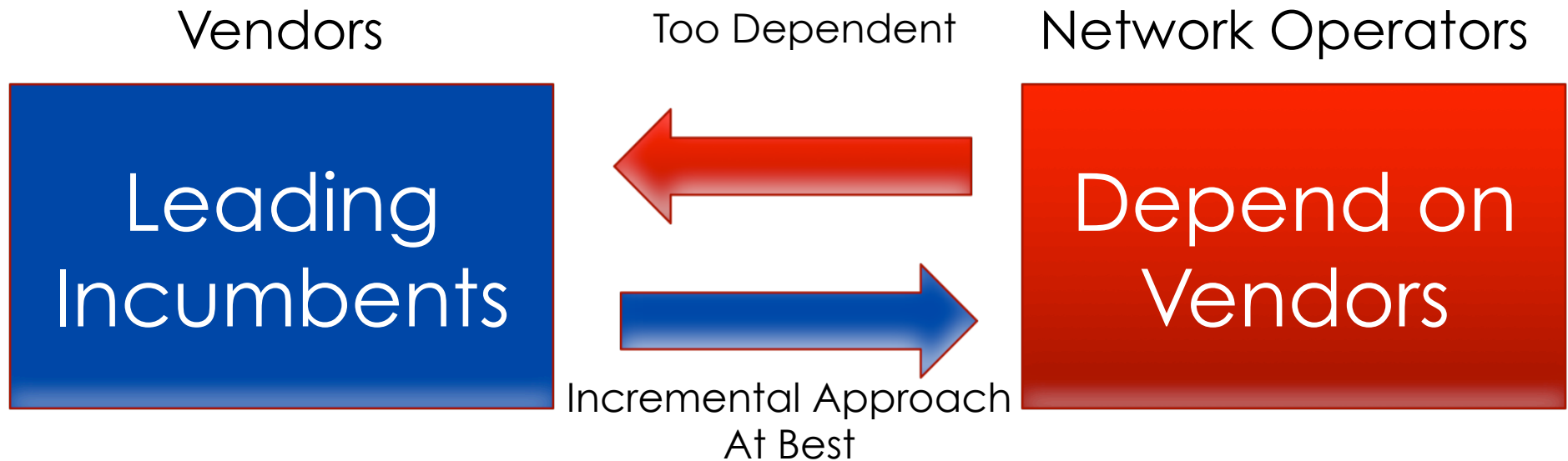
- Allows the customer to realize benefits of SDN on the same infrastructure
- Allows the vendor to build SDN on its existing products

**So what is wrong?**

# What is Wrong with Incumbents Approach?



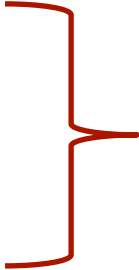
# Network Operators' Challenge



How can Network Operators realize SDN value?

# How to help network operators realize SDN?

## Technology Building Blocks

- Commodity OF/SDN optimized forwarding devices (switches)
  - Distributed SDN Control Plane
  - Compelling use cases
- Open Source  
ONOS Project
- 

**With Network Operators and Vendors\***

**Vendors\*: Ones that are willing to challenge the status quo**

**To break network operators dependence on a few vendors and create more choices for operators**

# Open Source ONOS Project

*with a difference*

Network Operators  
Carriers/Enterprises

Open Source  
SDN Control Plane  
Features, Functions, Performance

Vendors\*

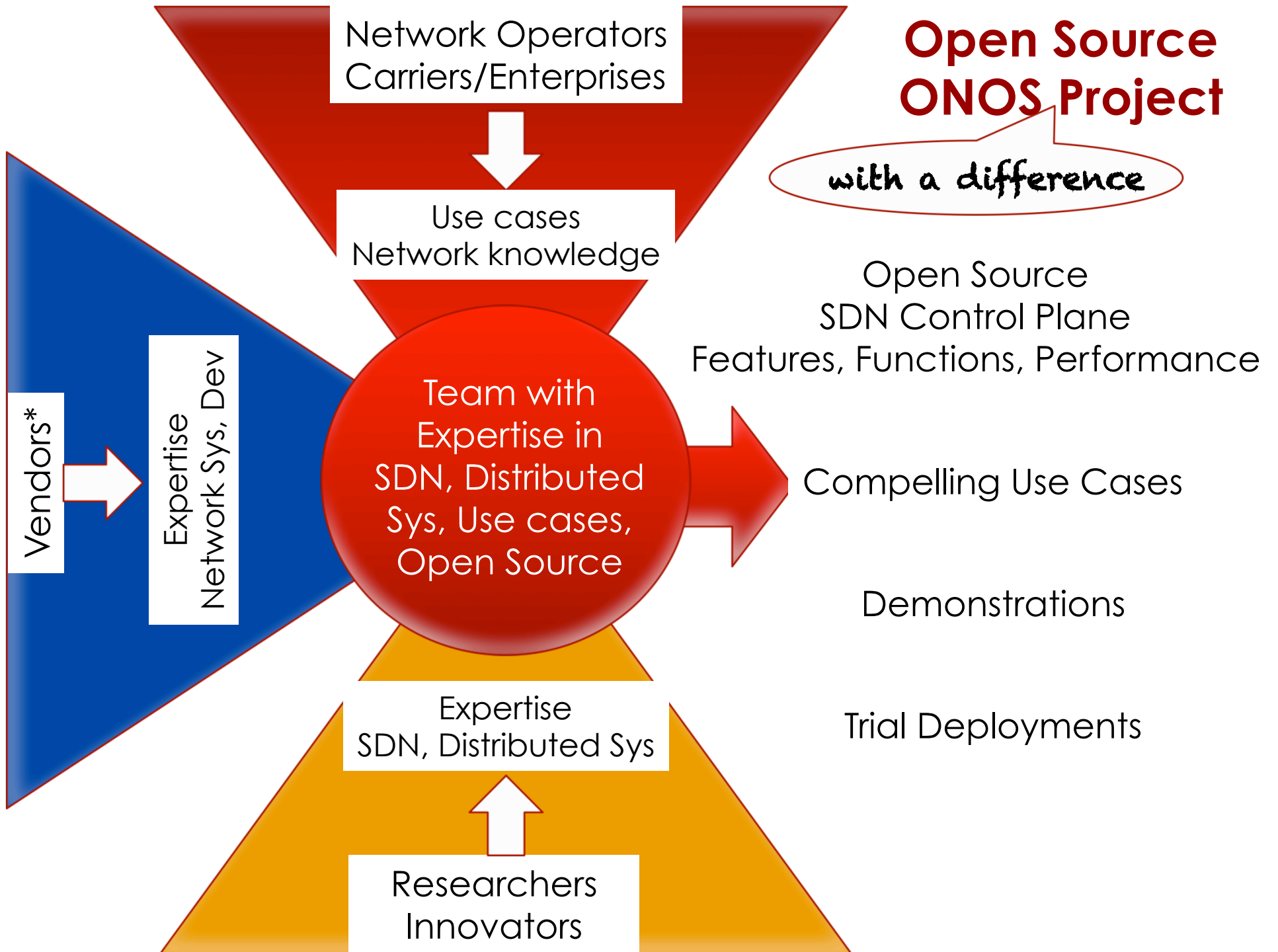
Team with  
Expertise in  
SDN, Distributed  
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Open Source

Compelling Use Cases

Demonstrations

Trial Deployments

SDN  
Researchers  
Innovators



The logo for ON.LAB, with 'ON' in blue and '.LAB' in red. A thick red vertical bar is on the left, and a red horizontal bar is on the right.

ON.LAB

ONOS:

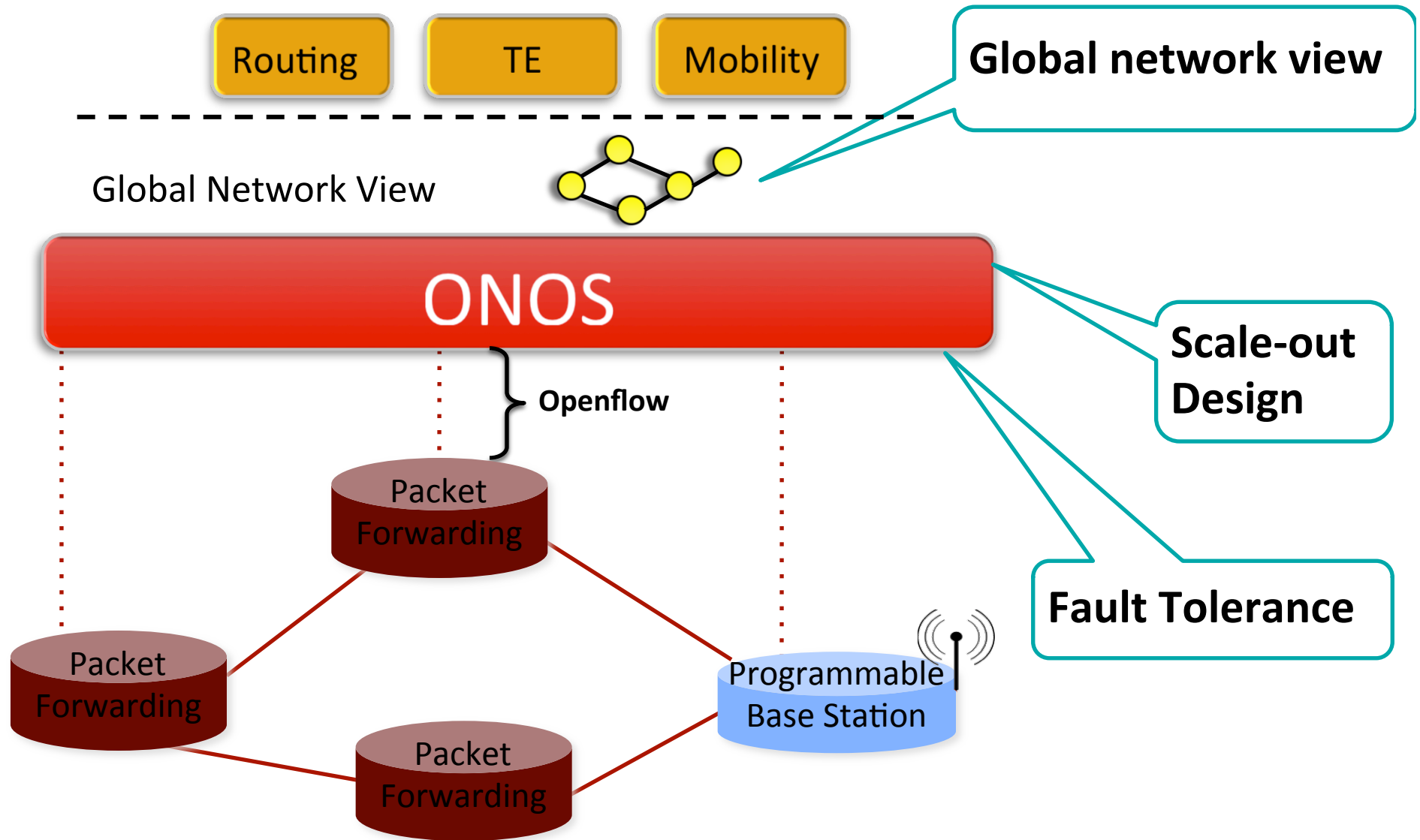
***An Open Source Distributed Network OS***

ON.Lab Team



# Open Network OS (ONOS): Focus

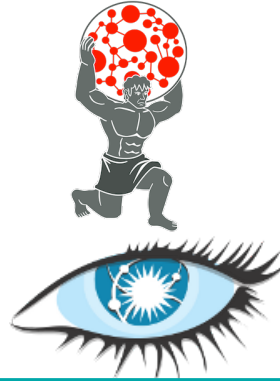
(Started in Summer 2012)



# ONOS High Level Architecture

**Distributed Network Graph/State**

**Network Graph**  
*Eventually consistent*



**Titan Graph DB**

**Cassandra In-Memory DHT**

**Coordination**

**Distributed Registry**  
*Strongly Consistent*



**Zookeeper**

**Scale-out**

Instance 1

Instance 2

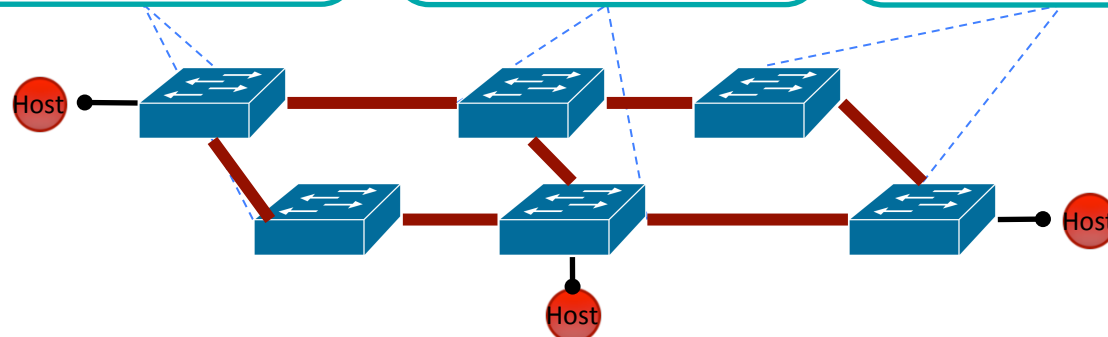
Instance 3

**OpenFlow Controller+**

**OpenFlow Controller+**

**OpenFlow Controller+**

**+Floodlight Drivers**



# Prior Work

## ONIX

Distributed control platform for large-scale networks

ONOS design influenced by ONIX

ONIX: closed source; datacenter + virtualization focus

## Other Work

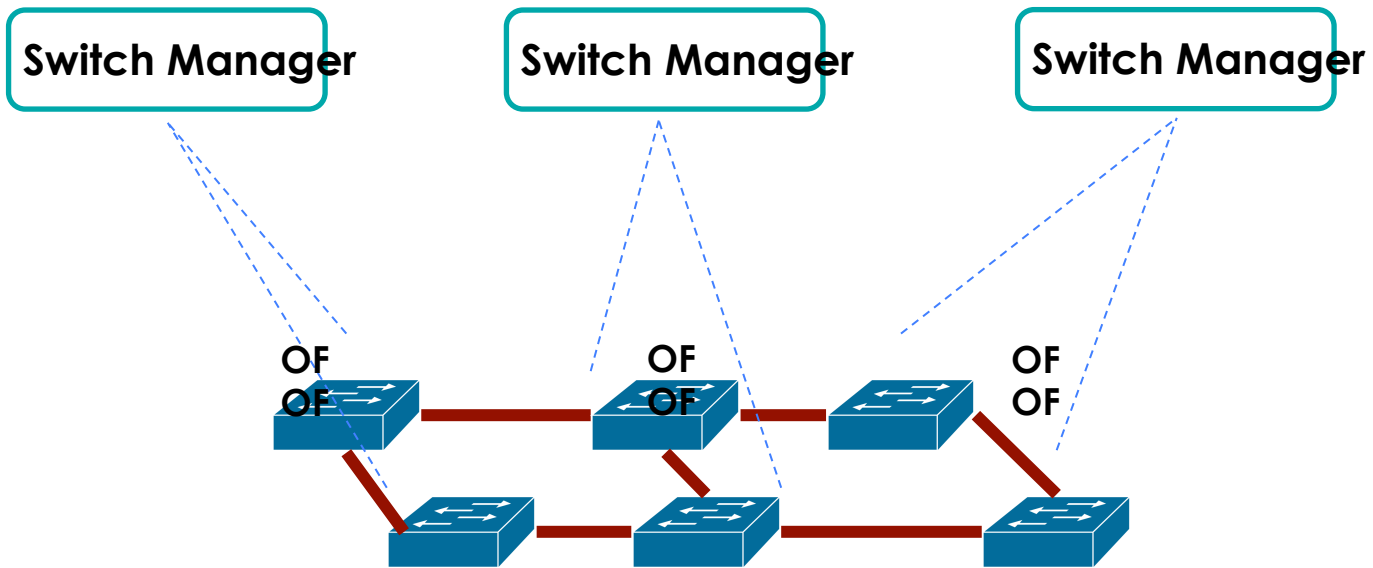
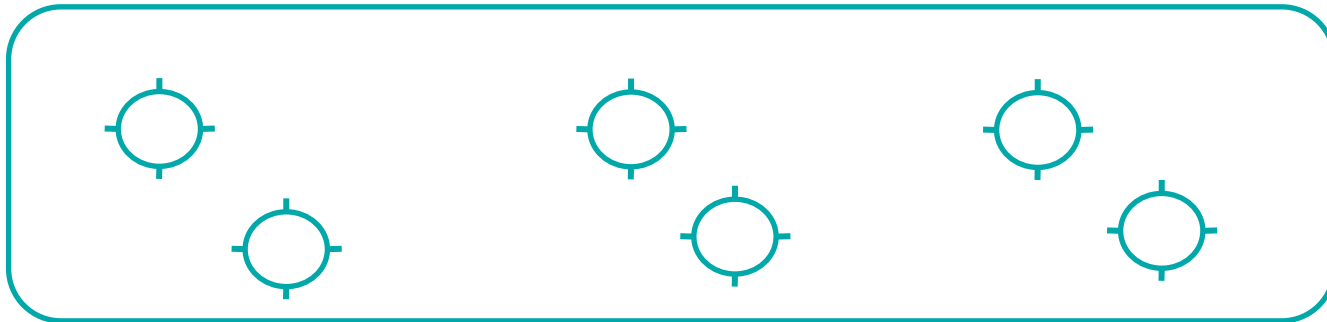
Helios (NEC), Midonet (Midokura), Hyperflow, Maestro, Kandoo, ...

NOX, POX, Beacon, Floodlight, Trema controllers

*Community needs an open source distributed SDN OS*

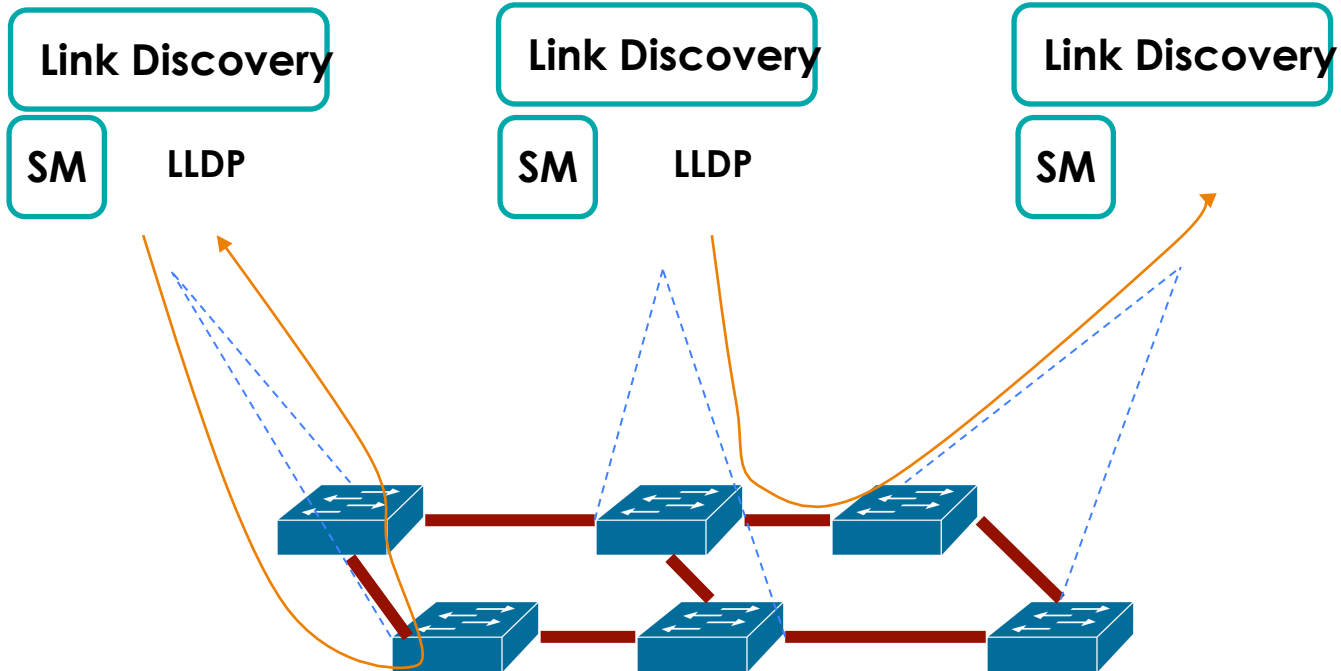
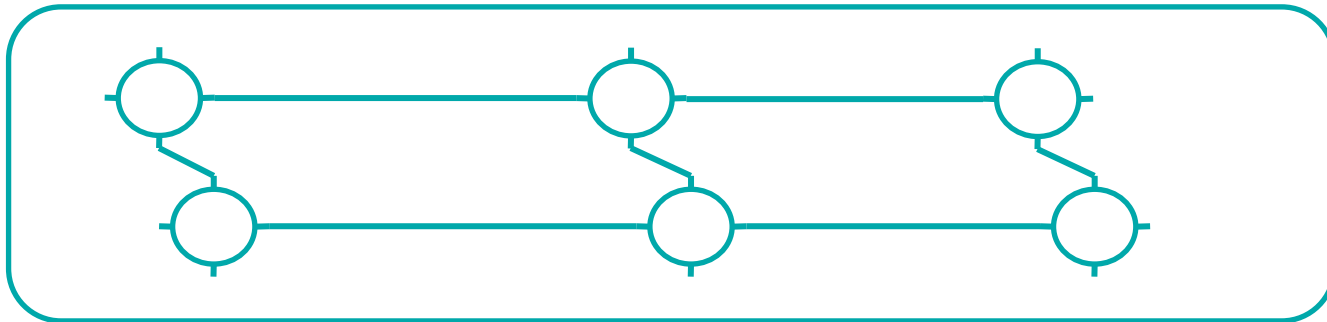
# Network Graph: Switches

Network Graph: Switches



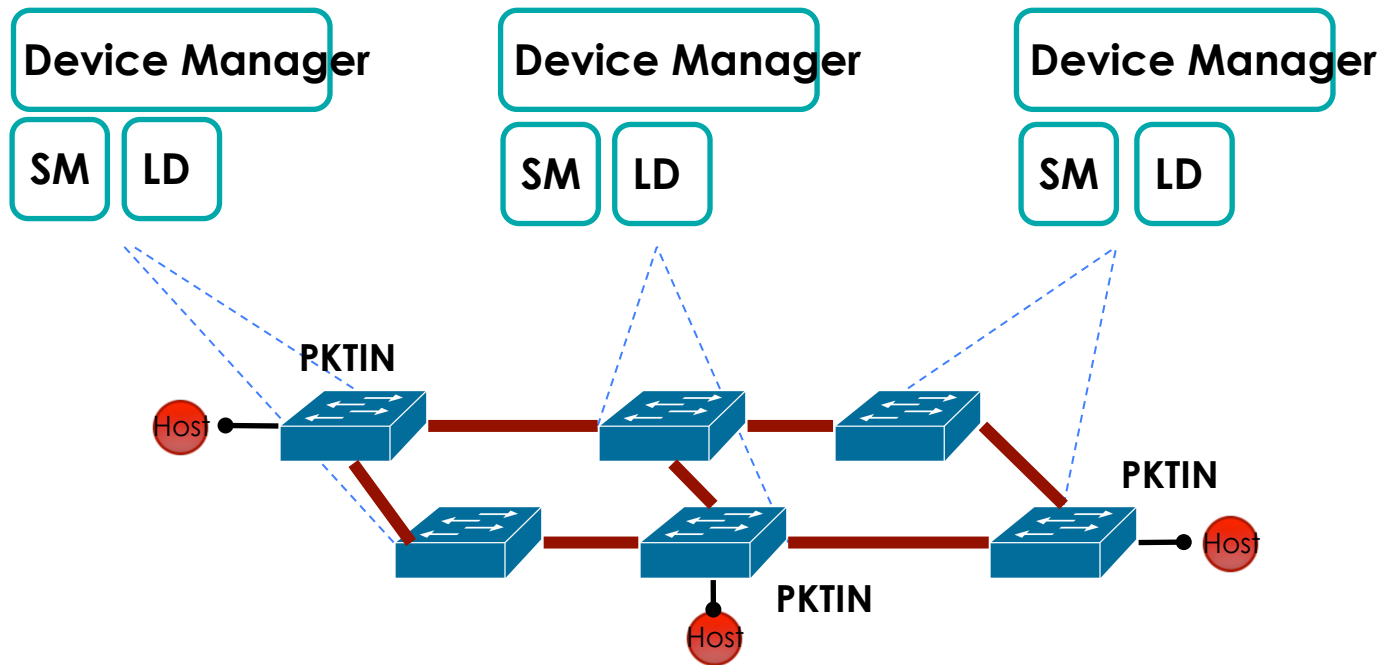
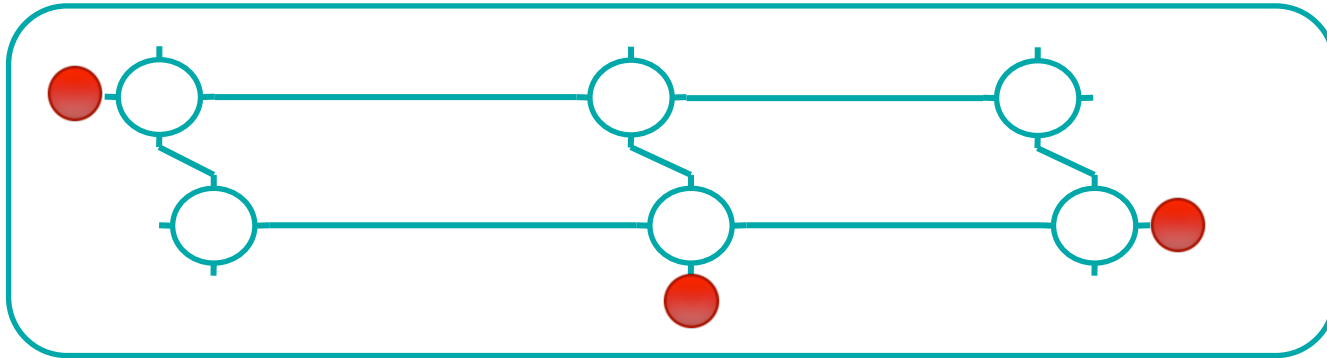
# Network Graph: Link Discovery

Network Graph: Links



# Network Graph: End Devices

Network Graph: Devices



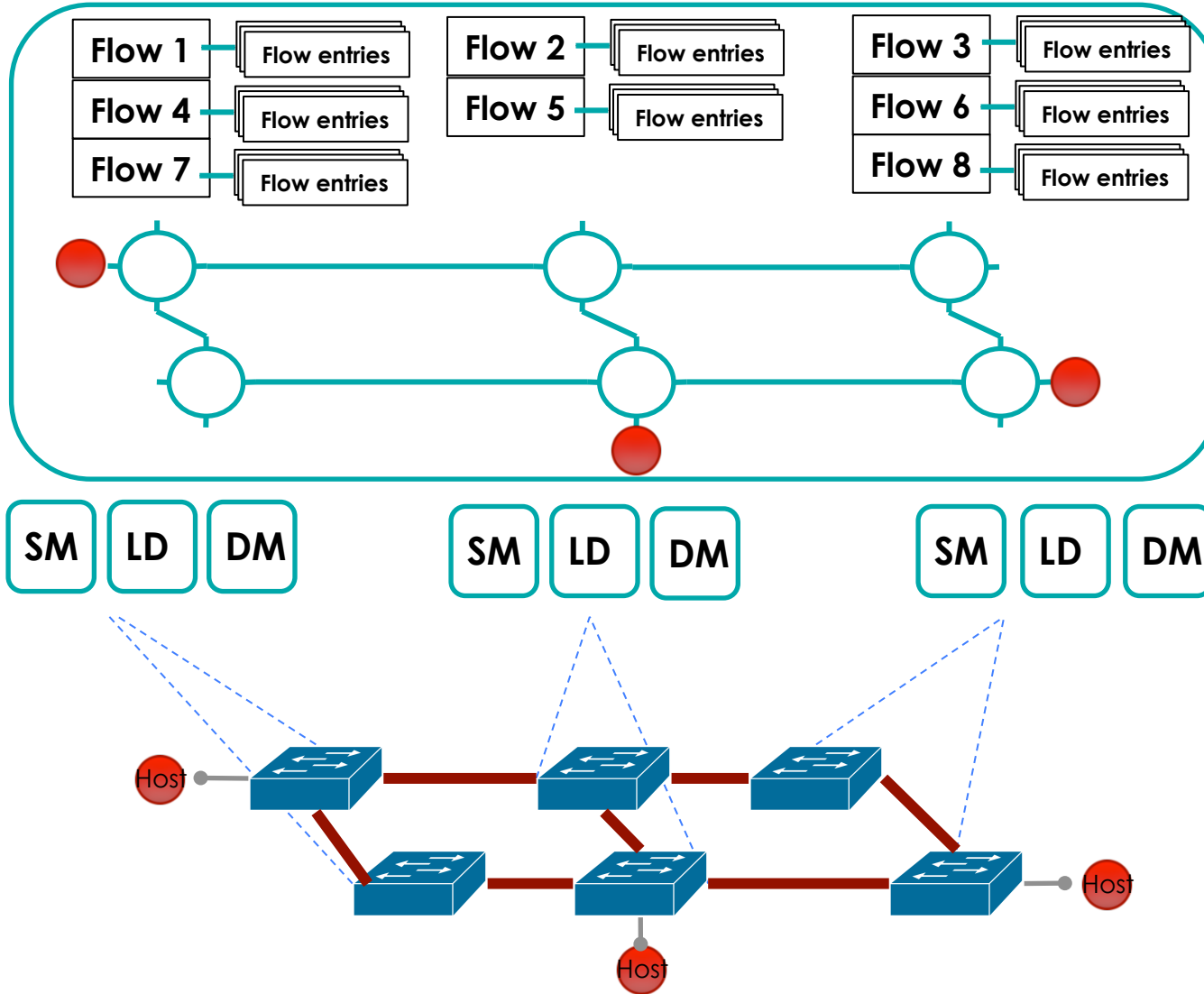
# Path Computation with Network Graph

Path Computation

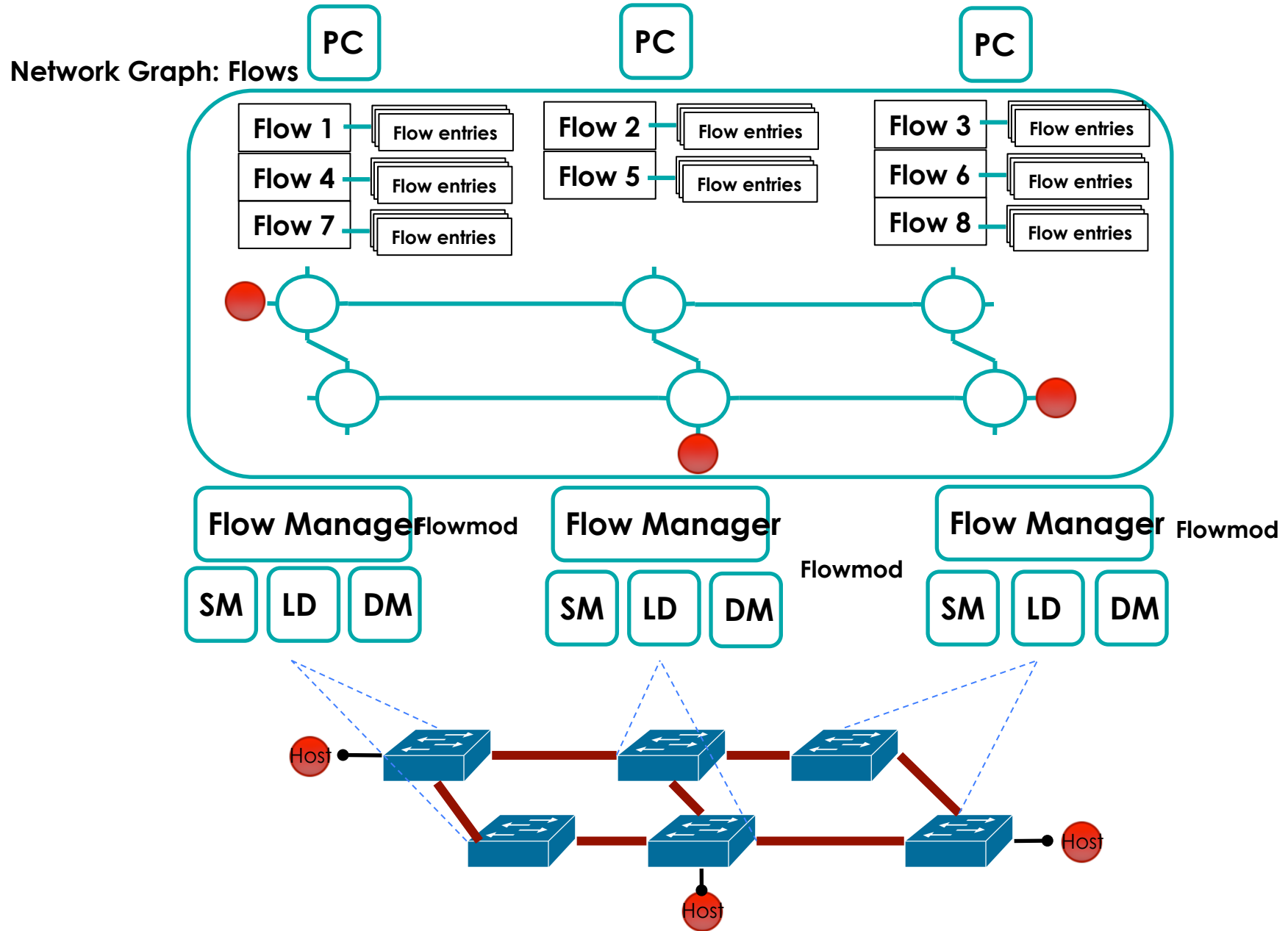
Path Computation

Path Computation

Network Graph: Flow Paths

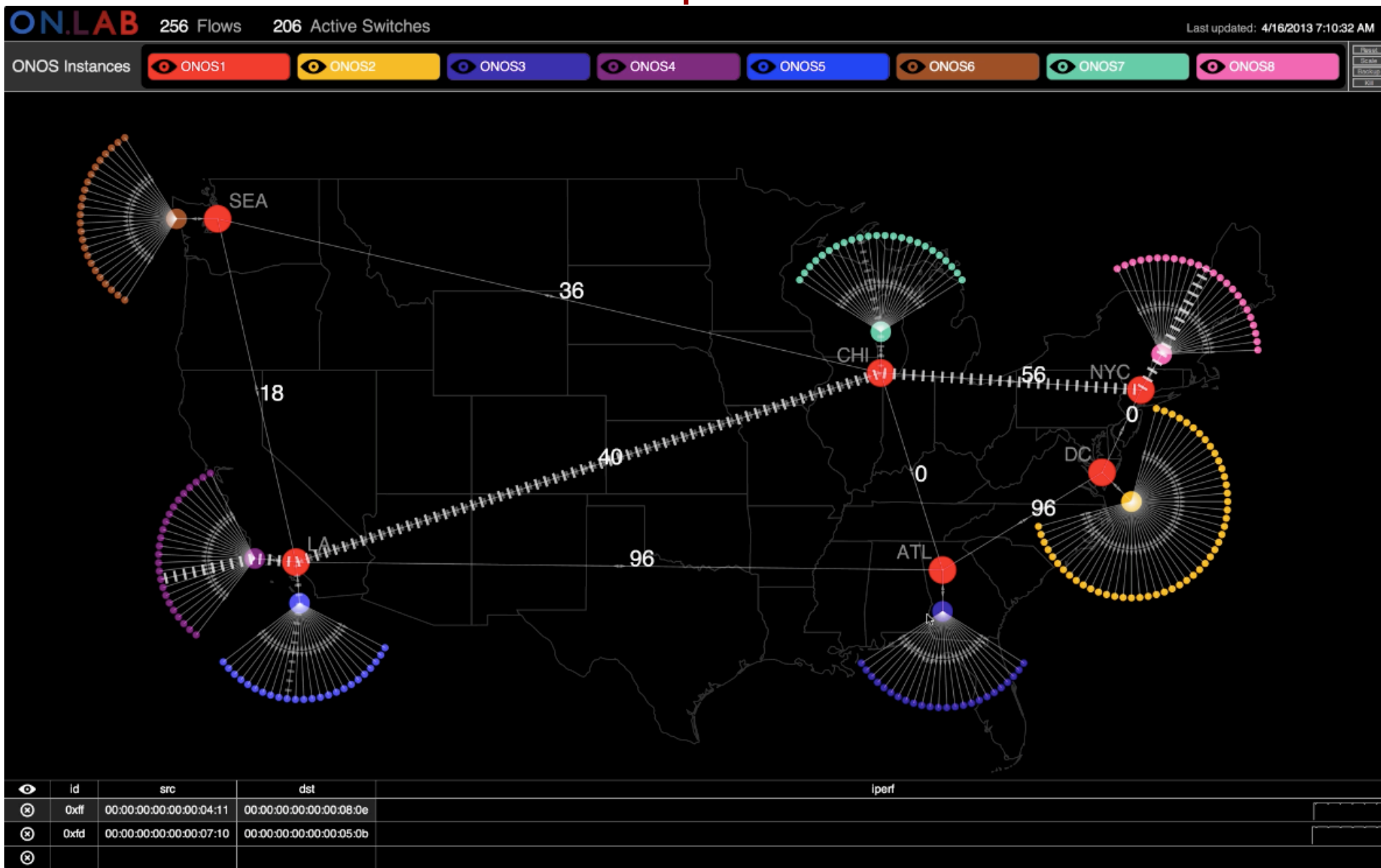


# Network Graph and Flow Manager





# Demo: ONOS for Service Provider WAN ONS, April 2013



# Lessons Learned

- Scale-out design with HA is important
- Network graph is a promising north-bound abstraction
- Achieving performance with off-the-shelf open source components difficult
- There are many systems challenges
  - Distributed data store and state synchronization
  - Choice of consistency models for different network state
  - CAP theorem implications
  - Efficient and low latency events/notifications functionality
  - Performance: targets and how to achieve them

# ONOS Work In Progress



## ONOS Core

**Low-latency distributed data store**

**Events, callbacks and publish/subscribe API**

**Expand graph abstraction for more types of network state**



## ONOS Apps

**Control functions: intra-domain & inter-domain routing**

**Example use cases: traffic engineering, dynamic virtual networks on demand, ...**



## Community

**Work with key partners: service providers, a few vendors**

**Support deployments in R&E networks and trial deployments with network operators**

Being deployed in R&E Networks

Learn more at <http://onlab.us/tools.html>

ONOS Next Phase

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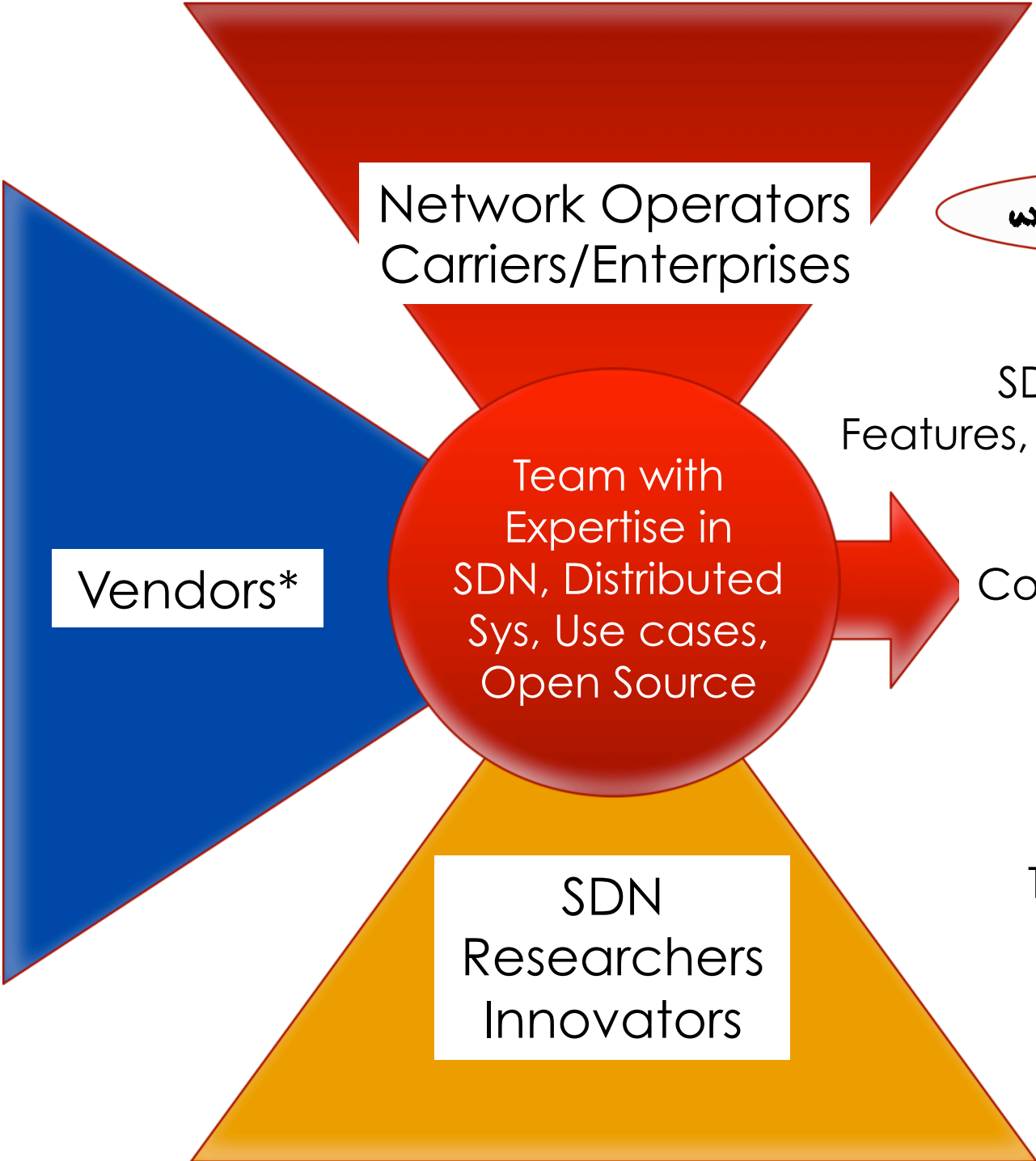
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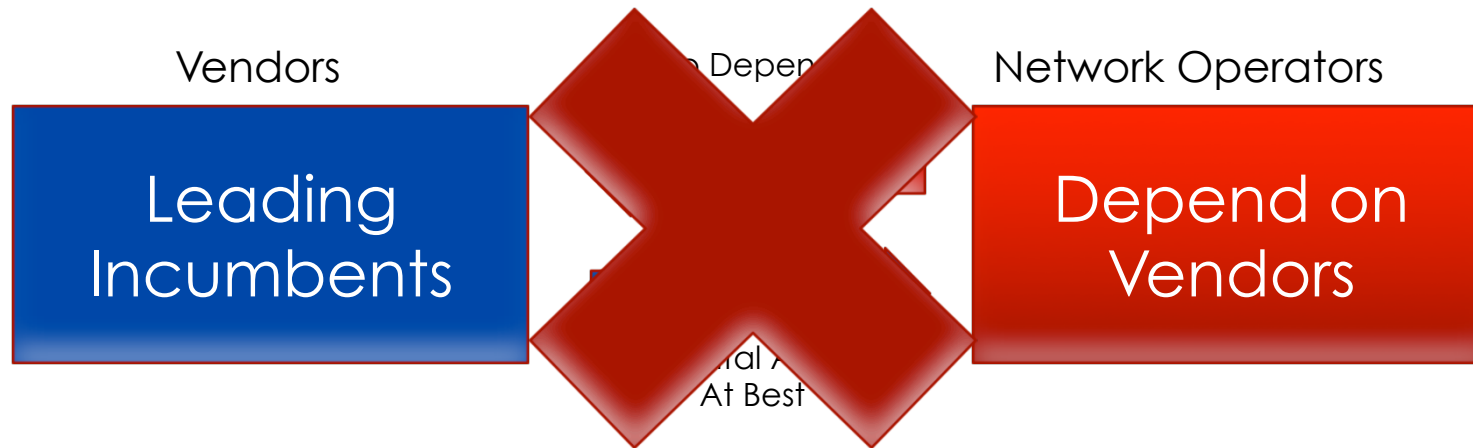
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SDN  
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Innovators



# Expected Results



## Network Operators

- Address hard technology problems
- Help create solutions that meet your requirements
- Create SDN expertise within your org

**Accelerate SDN adoption**

## Vendors\*

- Address hard technology problems
- Work closely with customers
- Create solutions that customers would deploy

**Reduced time to market; grow market share**

**THANK YOU!**

# How to Accelerate Adoption of SDN?

## Technology Building Blocks

- Commodity OF/SDN optimized forwarding devices (switches)
- Distributed SDN Control Plane
- Compelling use cases

**Open Source  
ONOS Project**

**With Network Operators and vendors that are willing to challenge the status quo**

**To break network operators dependence on a few vendors and create choices ...**