# Software Defined Networks

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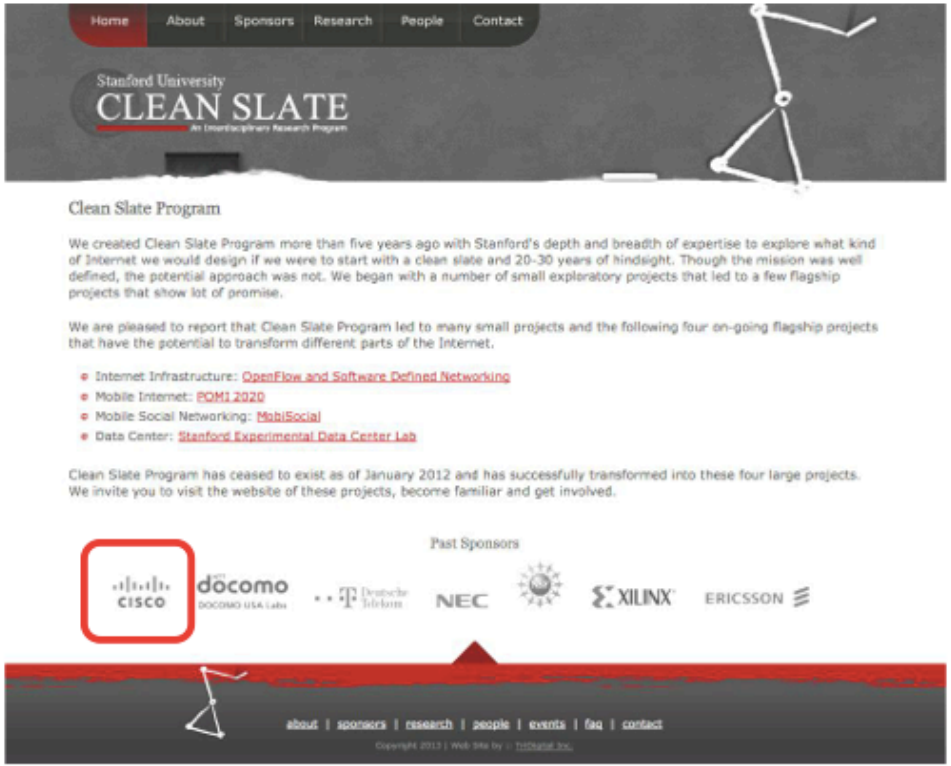
# INTRODUCTION TO SDN

# Where Did SDN Come From?

# Where Did SDN Come From?

2008



# What is Software Defined Network (SDN)?

- An approach and architecture in networking where control and data planes are DECOUPLED and intelligence and state are logically CENTRALIZED
- Enablement where underlying network infrastructure is abstracted from the applications [network VIRTUALIZATION](overlay)
- A concept that leverages programmatic interfaces (API) to enable external systems to influence network provisioning, control and operations

DECOUPLED

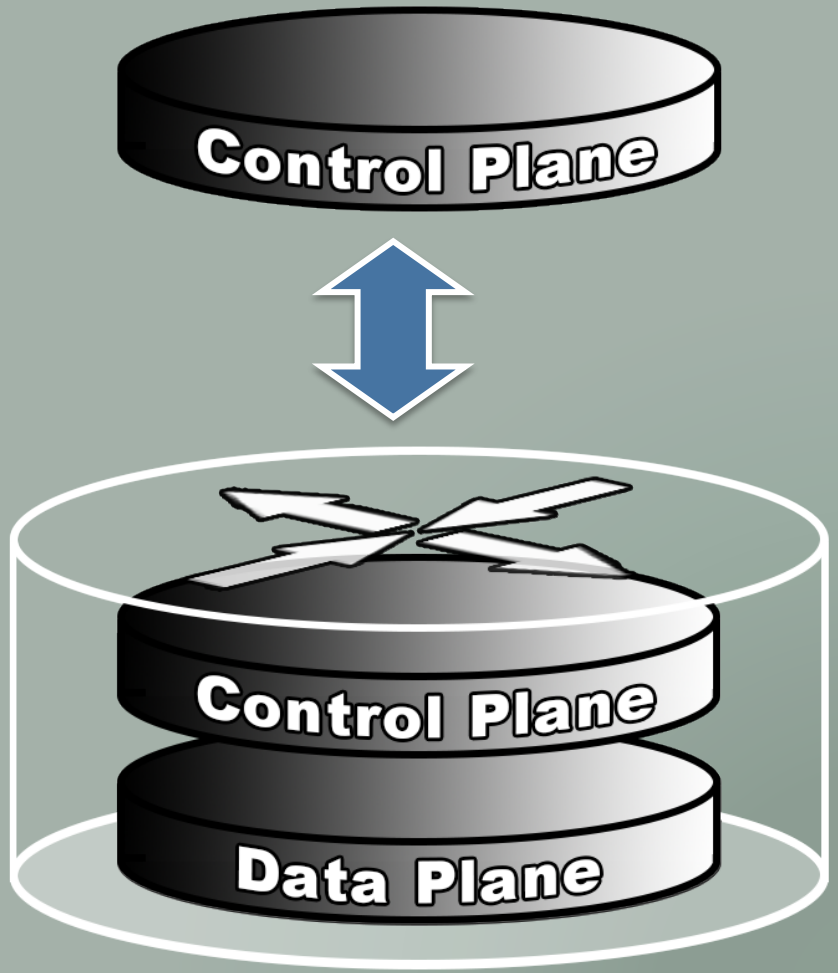
CENTRALIZED

VIRTUALIZATION

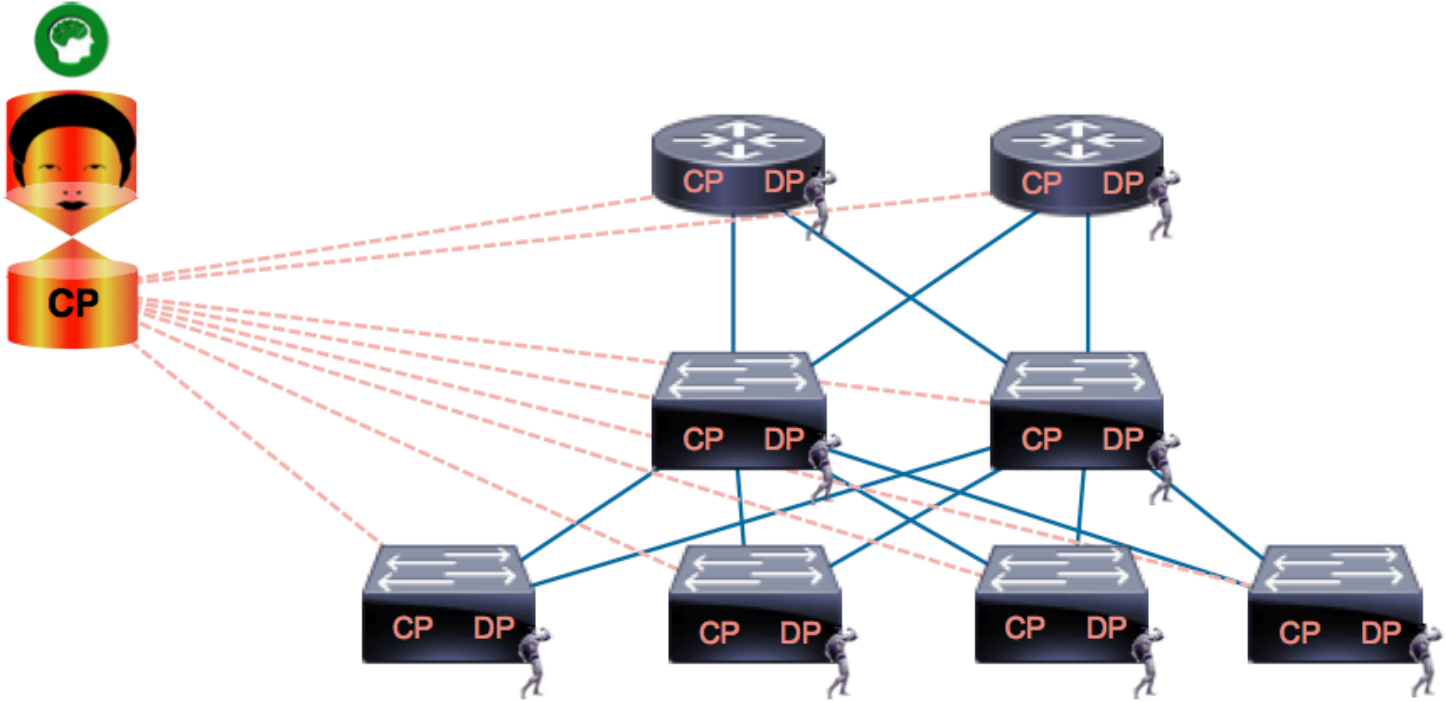
API

# Decoupled

- Determine best path, management
  - Control plane
  - Hop count, cost, bandwidth
- Switching Packets
  - Data plane
- Communication Protocols



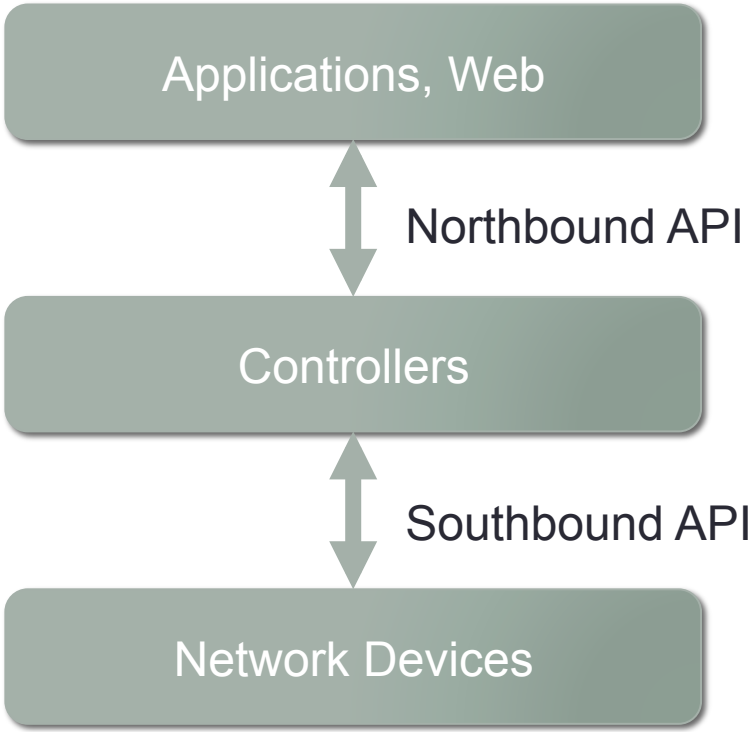
# Centralized




**Control plane becomes centralized**
**Physical device retains Data plane functions only**

# Virtualization (Overlay)

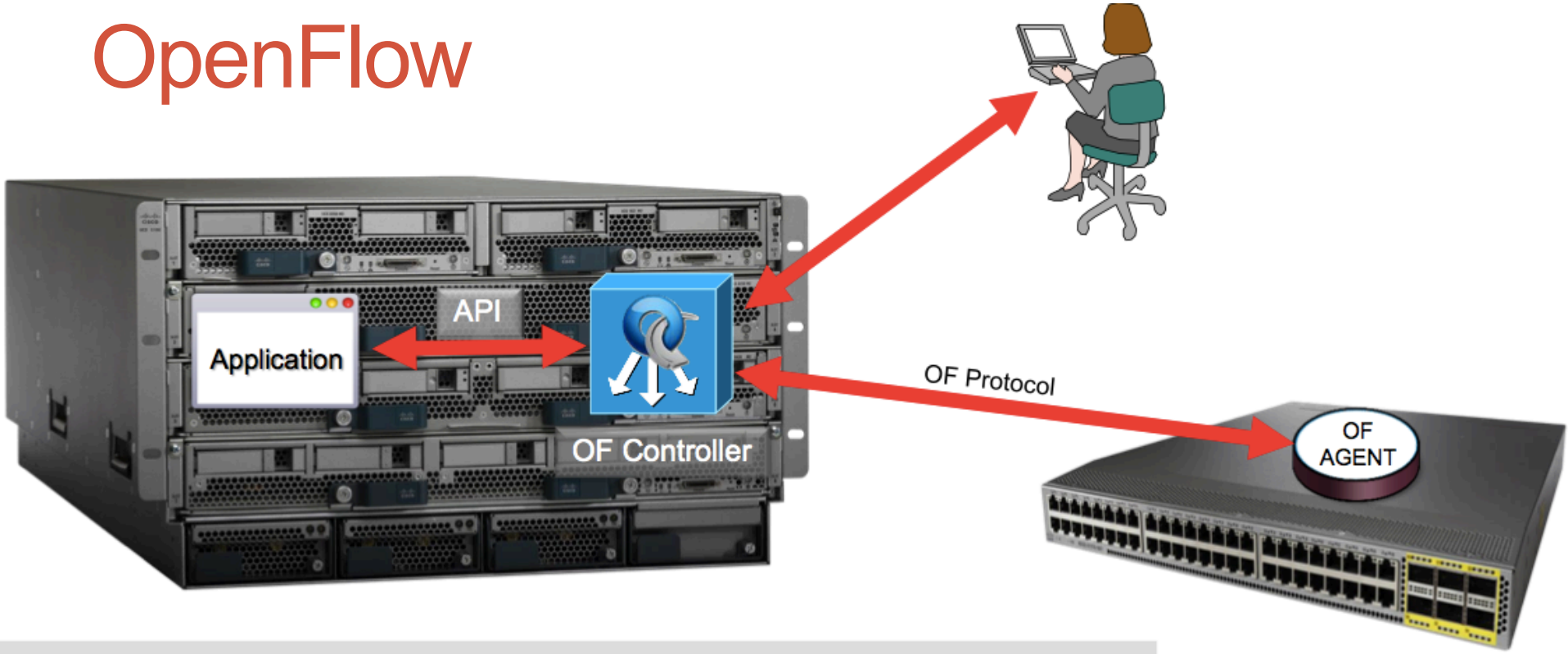
# API


Applications, Web
Northbound API
Controllers
Southbound API
Network Devices

# SDN Related Protocols/Standards

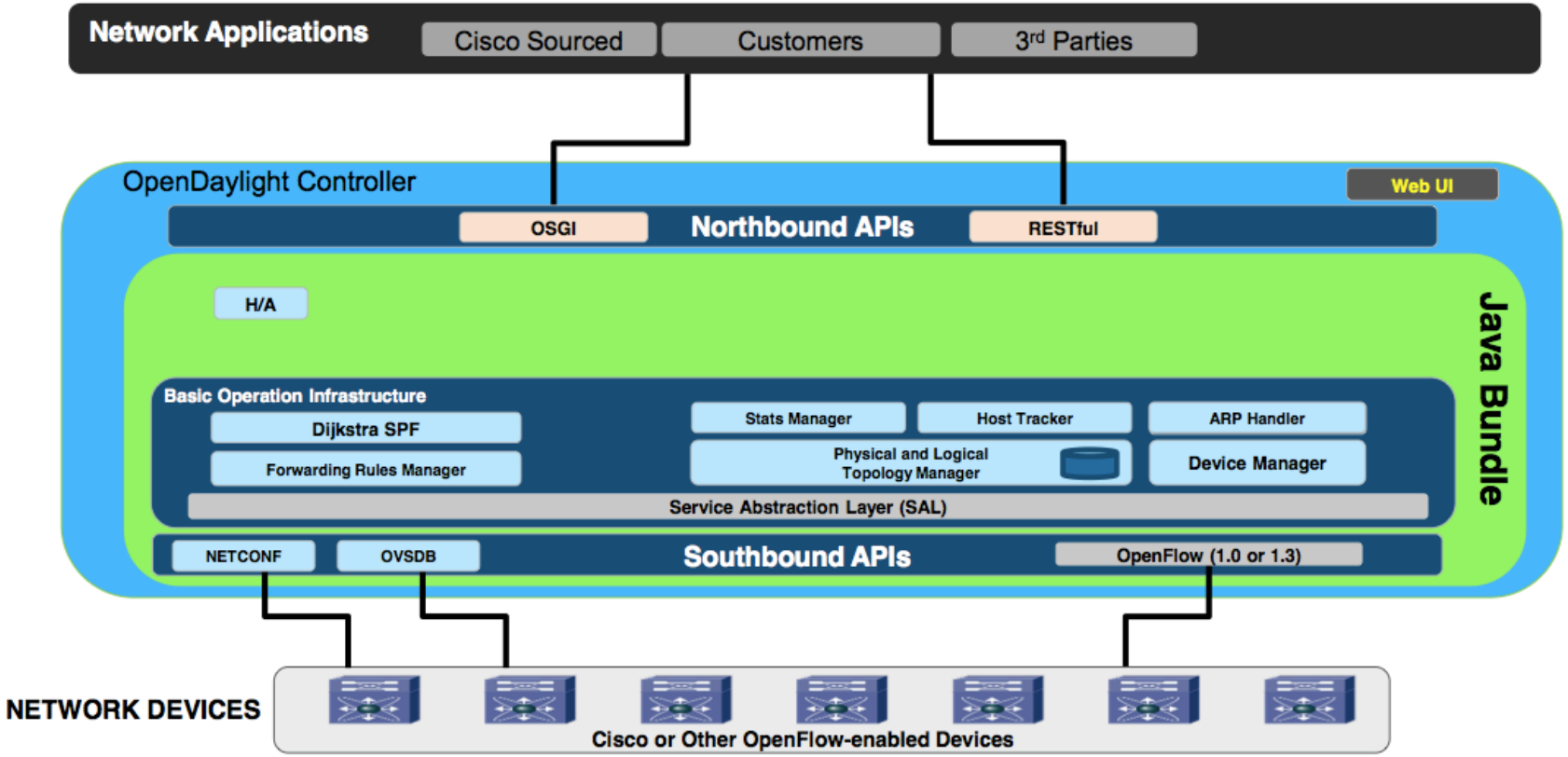
| | |
|---|---|
| Decoupled | OpenFlow, OpFlex |
| Centralized | OpenDayLight, APIC |
| Virtualization | VxLAN, LISP, OTV |
| API | REST, onePK |

# OpenFlow

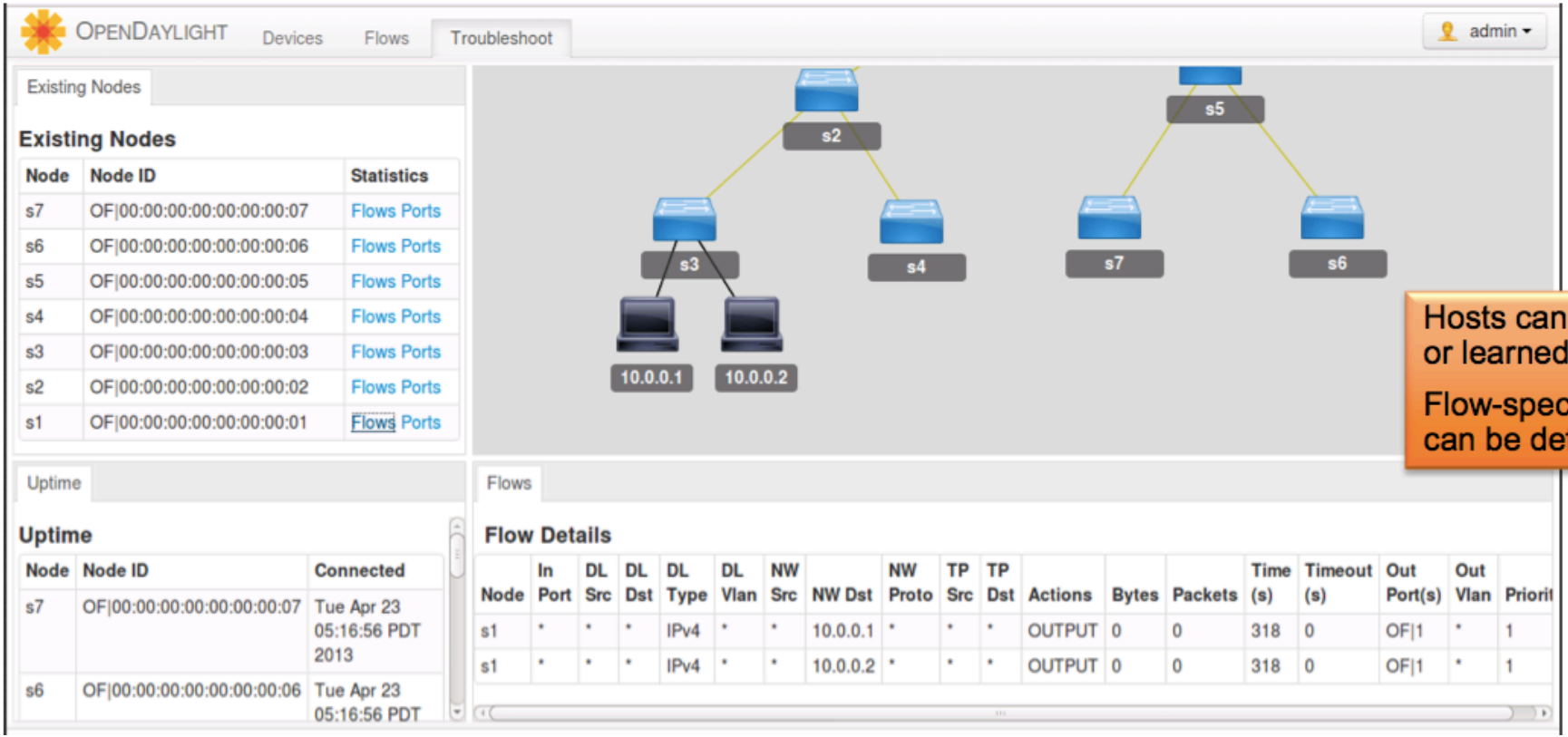



…a Layer 2 communications protocol that gives access to the forwarding plane of a network device,
…a specification for building switches conforming to the protocol

# OpenDayLight Project



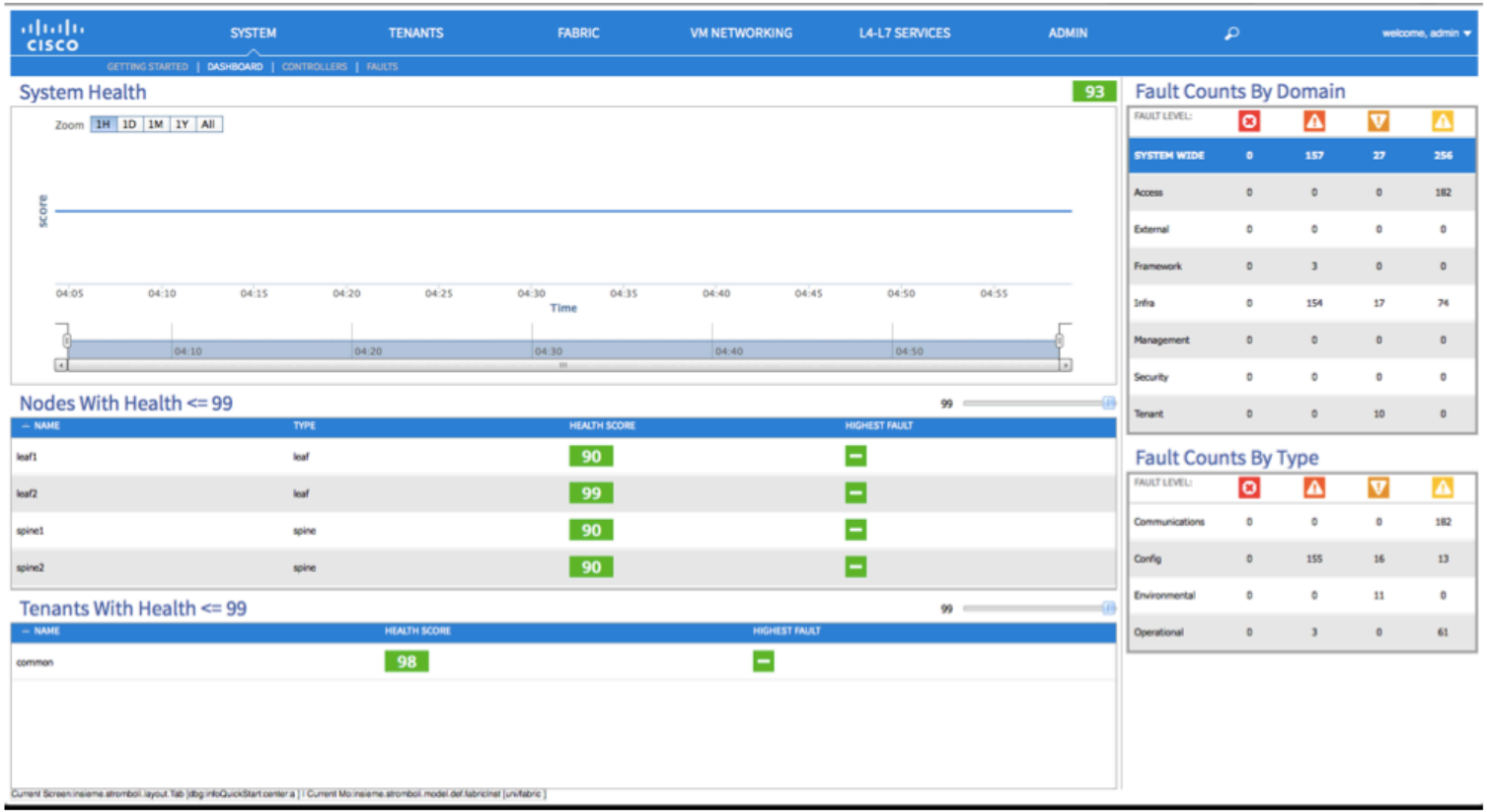
# OpenDayLight



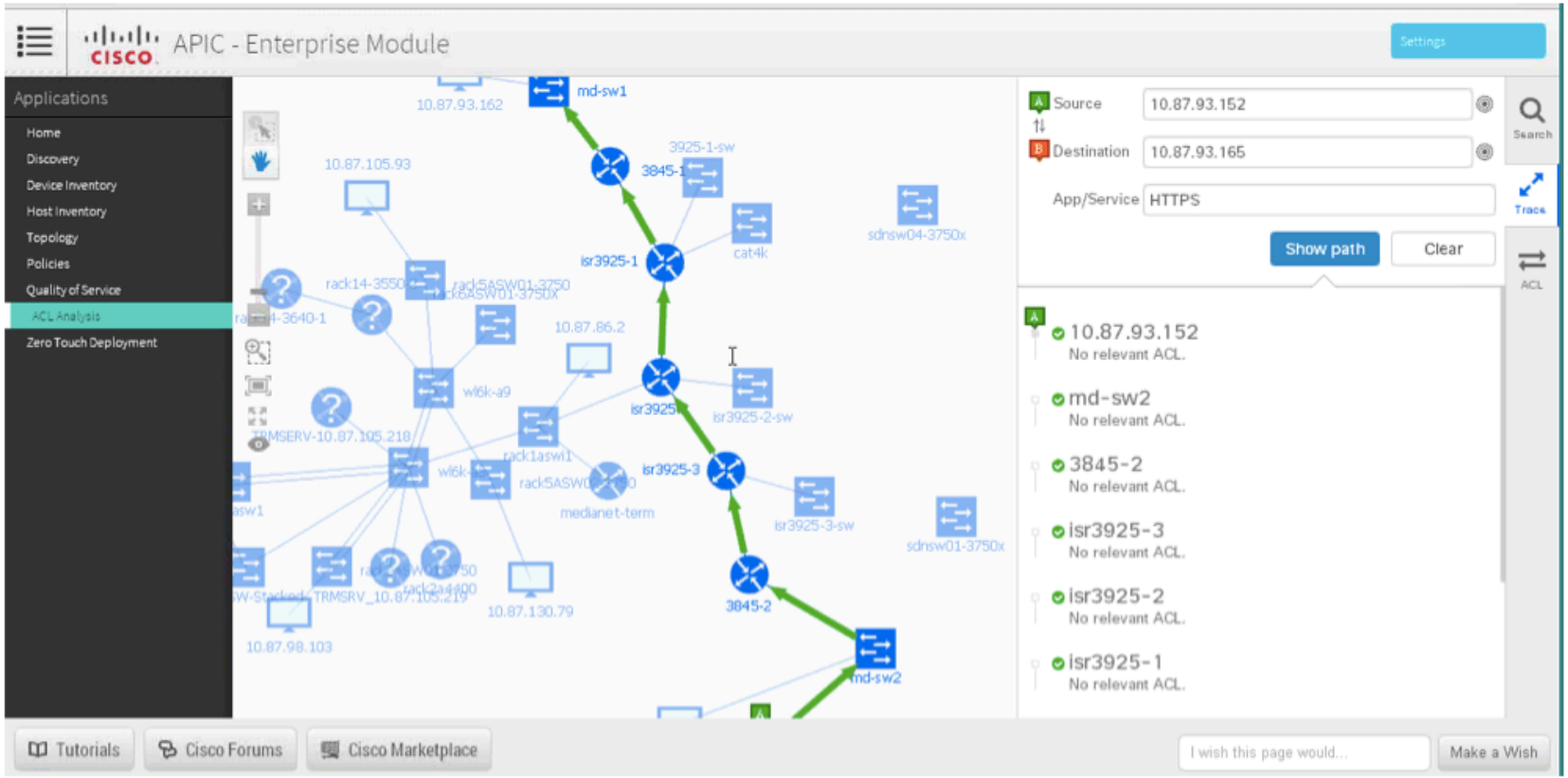

Hosts can be added or learned

Flow-specifications can be defined

# APIC-DC


CISCO
SYSTEM
TENANTS
FABRIC
VM NETWORKING
L4-L7 SERVICES
ADMIN
welcome, admin
GETTING STARTED | DASHBOARD | CONTROLLERS | FAULTS
System Health
93
Zoom 1H 1D 1M 1Y All
score
04:05 04:10 04:15 04:20 04:25 04:30 04:35 04:40 04:45 04:50 04:55
Time
Nodes With Health <= 99
99
NAME TYPE HEALTH SCORE HIGHEST FAULT
leaf1 leaf 90
leaf2 leaf 99
spine1 spine 90
spine2 spine 90
Tenants With Health <= 99
99
NAME HEALTH SCORE HIGHEST FAULT
common 98
Fault Counts By Domain
FAULT LEVEL:
SYSTEM WIDE 0 157 27 256
Access 0 0 0 182
External 0 0 0 0
Framework 0 3 0 0
Infra 0 154 17 74
Management 0 0 0 0
Security 0 0 0 0
Tenant 0 0 10 0
Fault Counts By Type
FAULT LEVEL:
Communications 0 0 0 182
Config 0 155 16 13
Environmental 0 0 11 0
Operational 0 3 0 61

# APIC-EM


APIC - Enterprise Module
Settings
Applications
Home
Discovery
Device Inventory
Host Inventory
Topology
Policies
Quality of Service
ACL Analysis
Zero Touch Deployment
md-sw1
10.87.93.162
3925-1-sw
3845-1
10.87.105.93
cat4k
sdnsw04-3750x
isr3925-1
rack14-3550
rack5ASW01-3750
10.87.86.2
wl6k-a9
isr3925-2-sw
isr3925-3
rack1aswi1
medianet-term
isr3925-3-sw
sdnsw01-3750x
10.87.130.79
3845-2
10.87.98.103
md-sw2
Source
10.87.93.152
Destination
10.87.93.165
App/Service
HTTPS
Show path
Clear
Search
Trace
ACL
10.87.93.152
No relevant ACL.
md-sw2
No relevant ACL.
3845-2
No relevant ACL.
isr3925-3
No relevant ACL.
isr3925-2
No relevant ACL.
isr3925-1
No relevant ACL.
Tutorials
Cisco Forums
Cisco Marketplace
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# Customer Needs: Network Programmability

## Research/ Academia

- Experimental OpenFlow/SDN components for production networks

**Network "Slicing"**

## Massively Scalable Data Center

- Customize with Programmatic APIs to provide deep insight into network traffic

**Network Flow Management**


## Cloud

- Automated provisioning and programmable overlay, OpenStack

**Scalable Multi-Tenancy**

## Service Providers

- Policy-based control and analytics to optimize and monetize service delivery

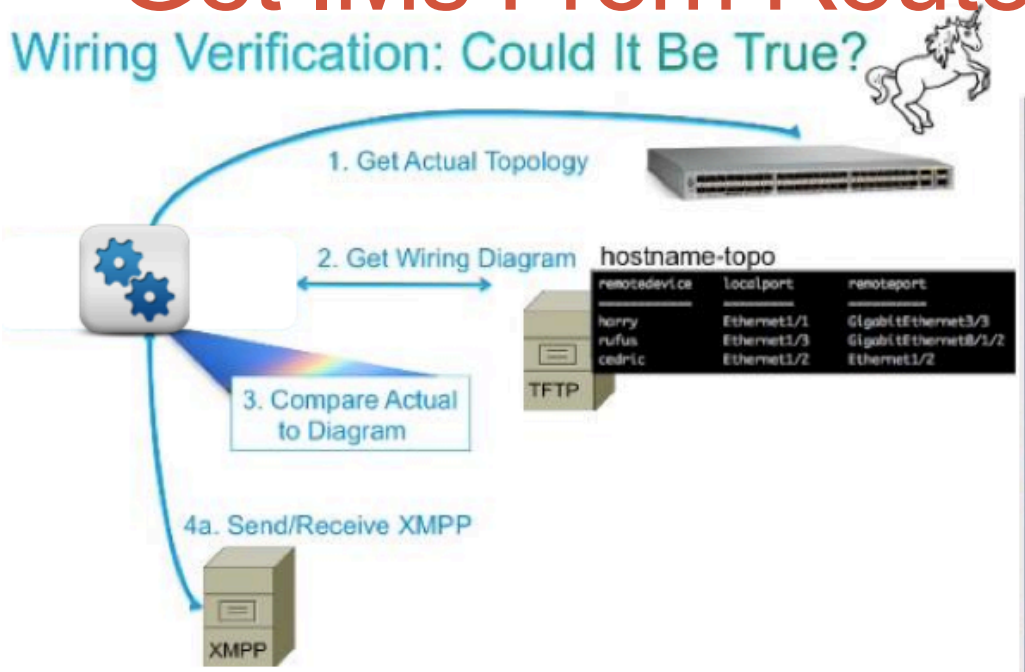
**Agile Service Delivery**

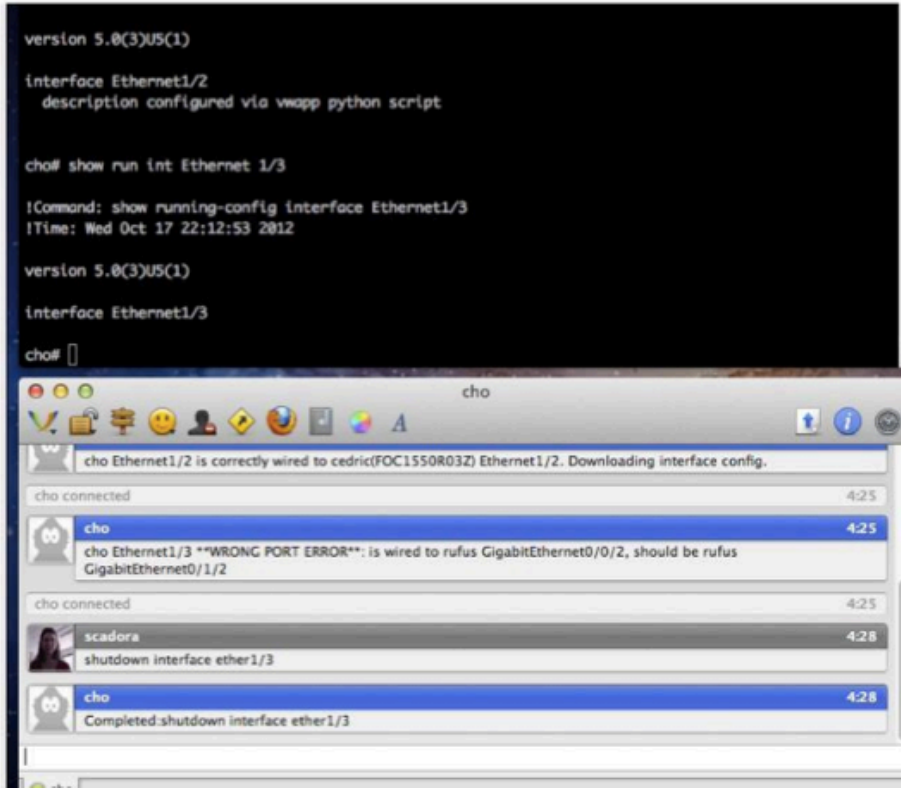
## Enterprise

- Virtual workloads, VDI, Orchestration of security profiles

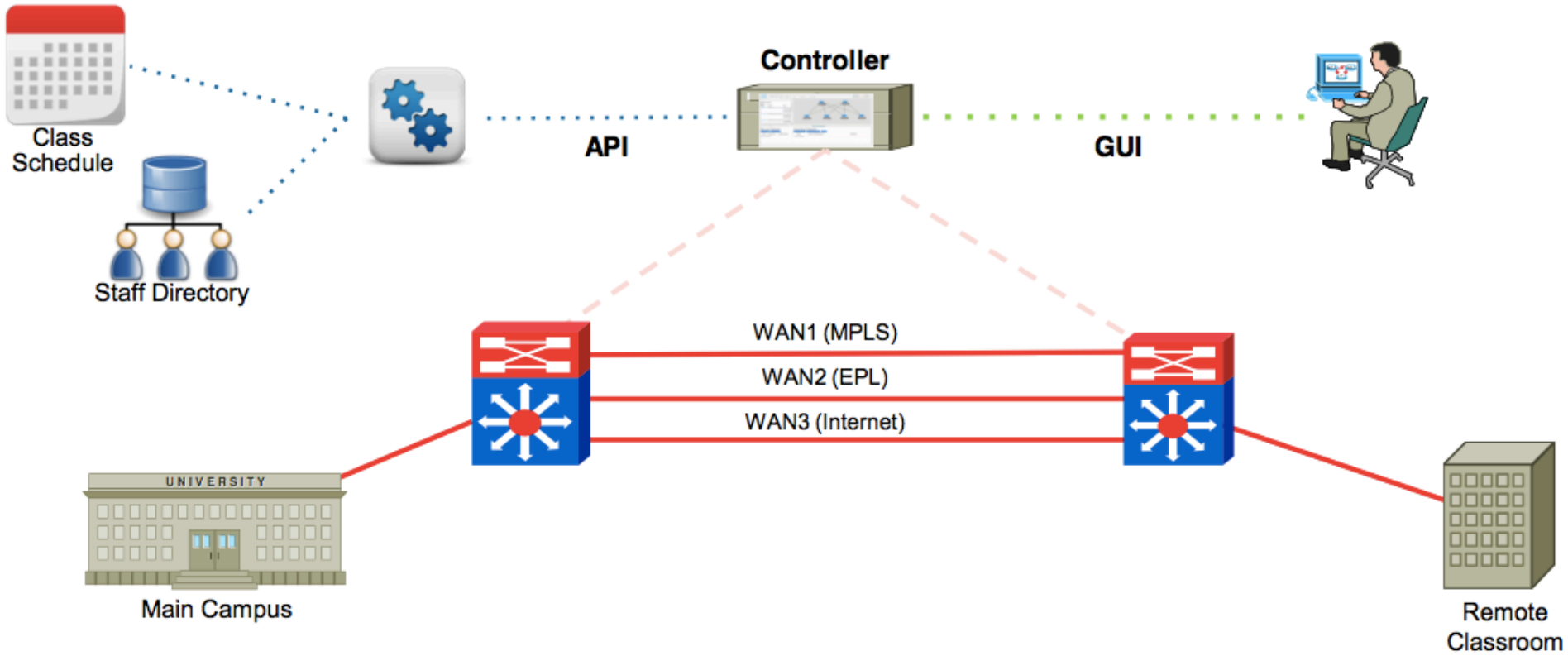
**Private Cloud Automation**

# Get IMs From Routers/Switches



# Business Metrics Influencing Routing



# OpenFlow Platform Support

| Function | Available Now | Q2 CY14 | Q3 CY14 | Q4 CY14 | 1H CY15 |
|---|---|---|---|---|---|
| OpenFlow Feature Level 1 | Nexus 3K<br>Nexus 5K<br>Nexus 6K<br>Nexus 7K (PoC)<br>Catalyst 6K (PoC)<br>Catalyst 3K (PoC)<br>Catalyst 4K (PoC)<br>ASR9K(CA) | | | | |
| OpenFlow Feature Level 2 | | Catalyst 3K (EFT)<br>Catalyst 4K (EFT)<br>ASR9K | Nexus 7K | Catalyst 6K<br>Catalyst 3K<br>Catalyst 4K<br>Nexus 3K (planning) | |
| OpenFlow Feature Level 3 | | | | Nexus 9K (planning) | Catalyst 3K (planning)<br>ASR9K (planning) |

Feature Level 1 – OF Line protocol v1.0; subset of OF1.0 features (Basic matches/Actions, IPv4)

Feature Level 2 – OF Line protocol v1.3; subset of OF1.0/1.3 features (IPv6, Multiple tables, Capabilities)

Feature Level 3 – OF Line protocol v1.3; subset of OF1.0/1.3 features (QoS, MPLS, Group Tables, Meters), Performance & Scale focus, Serviceability and Usability Improvements

# What is Software Defined Network (SDN)?

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# SDN vs. ACI

## IMPERATIVE CONTROL

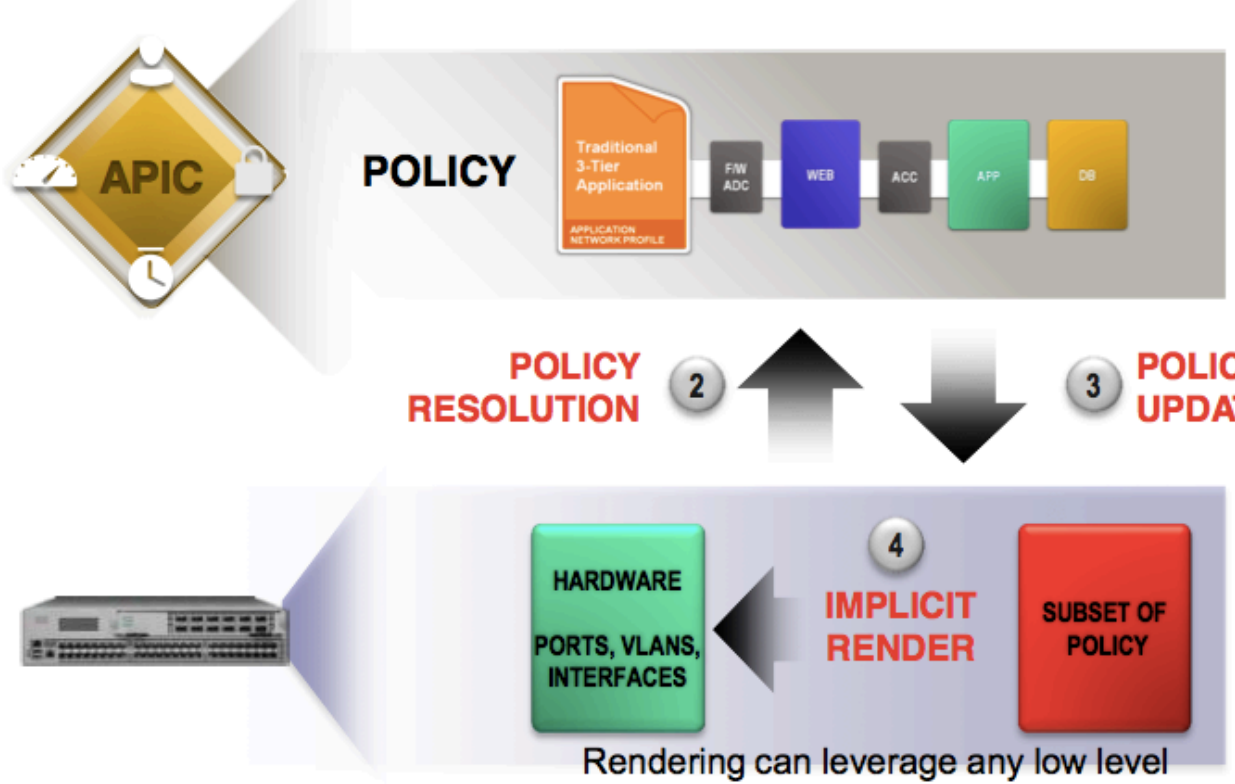
Baggage handlers follow sequences of simple, basic instructions

## DECLARATIVE CONTROL

Air traffic control tells where to take off from, but not *how* to fly the plane

# How OpFlex Works

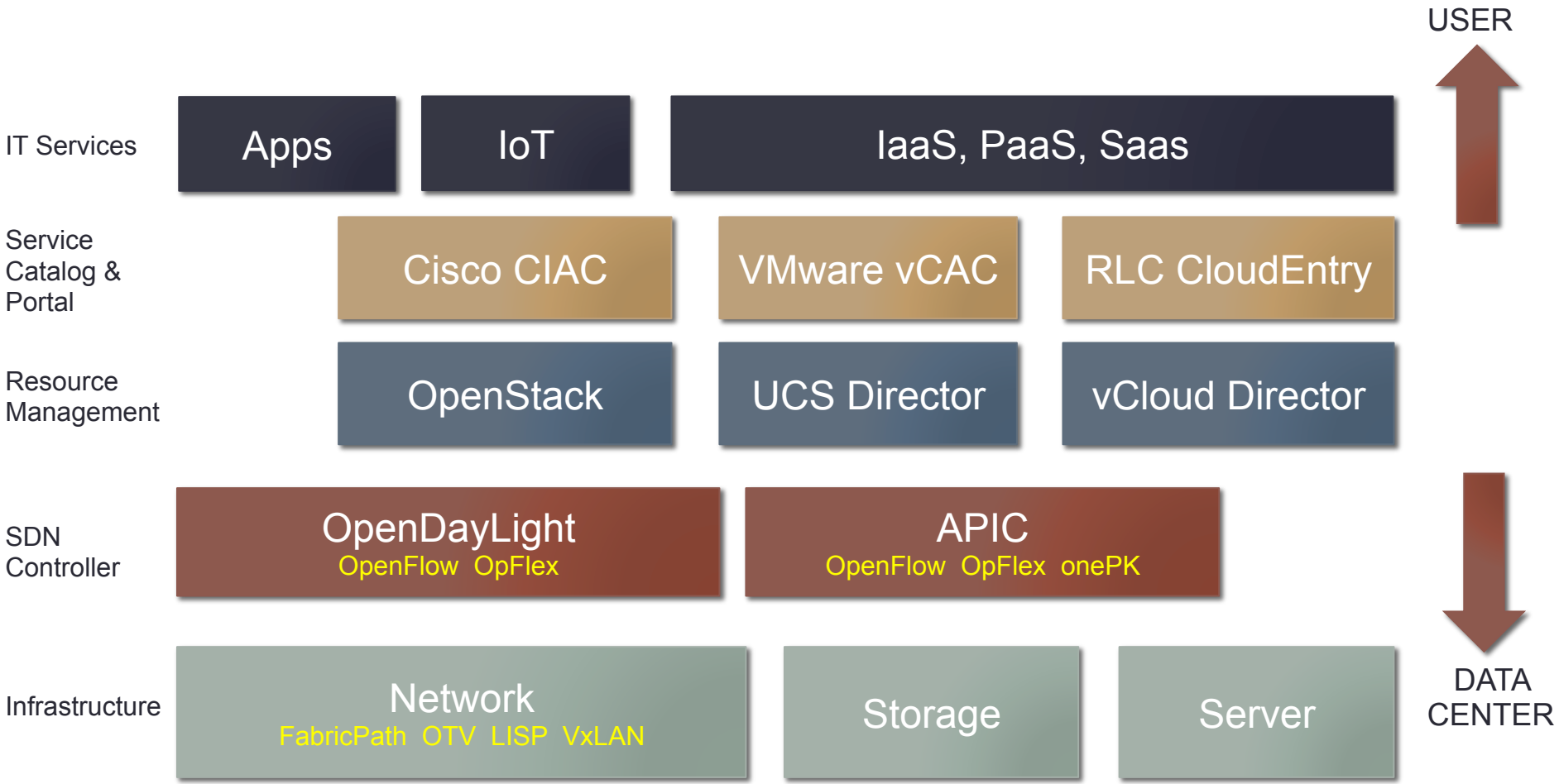
A policy authority such as the APIC manages a logical model of desired state




1

The policy endpoint interprets the policy and maps it to its hardware capabilities

Rendering can leverage any low level programming API including OVSDB, OpenFlow or device-specific API


USER
IT Services
Apps
IoT
IaaS, PaaS, Saas
Service Catalog & Portal
Cisco CIAC
VMware vCAC
RLC CloudEntry
Resource Management
OpenStack
UCS Director
vCloud Director
SDN Controller
OpenDayLight
OpenFlow OpFlex
APIC
OpenFlow OpFlex onePK
Infrastructure
Network
FabricPath OTV LISP VxLAN
Storage
Server
DATA CENTER

# Remember This?

**Telephony in 1998**

- IP Telephony struggled until we got ‘hybrid engineers’ to translate between the Circuit Switch ‘Tip & Ring’ and Packet Switch ‘Bits & Bytes’ camps
- Likewise, now, we need the next generation of ‘hybrid engineers’ to translate between traditional network domain engineers and software/application developers

# Thank you

# Acronym

- REST – Representational State Transfer
- OSGI – Open Service Gateway Initiative
- ACI – Application Centric Infrastructure
- APIC – Application Policy Infrastructure Controller