

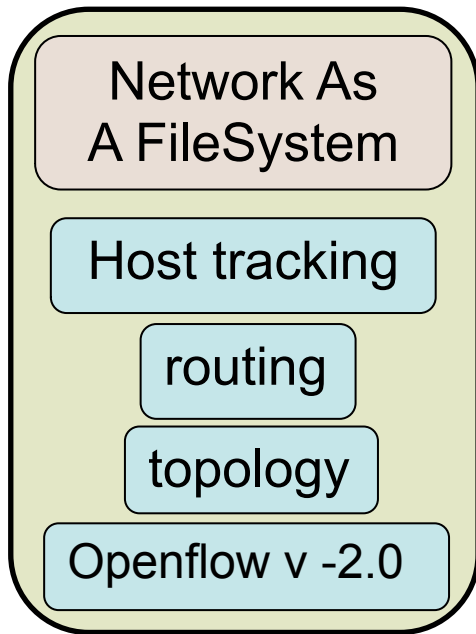
***NOX***

***A Network Operating System for OpenFlow***

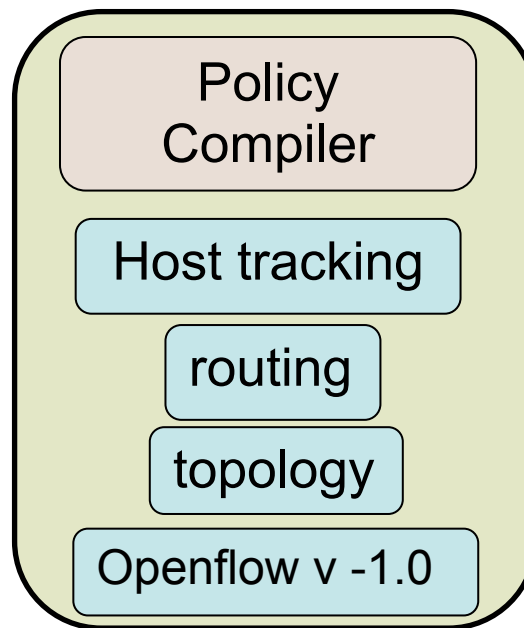
# *Background*

# The Genesis of Nox

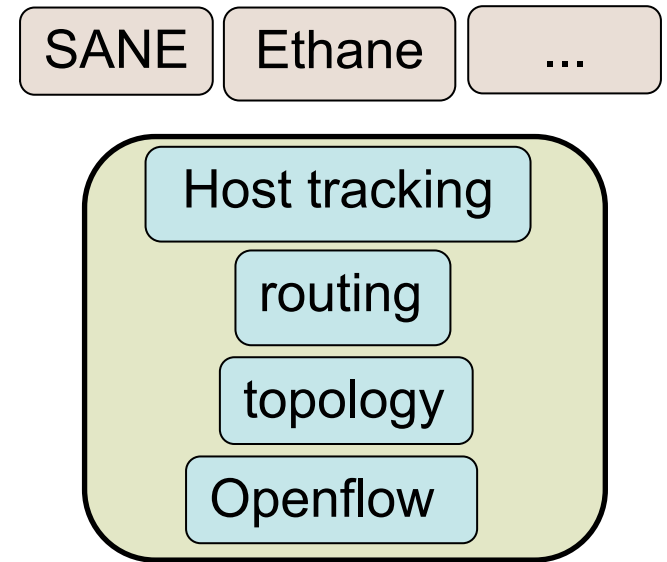
## SANE



## Ethane



## Nox



# The Rational for Nox

## External interfaces:

- CLI, SNMP, NetConf
- Protocols
- No real control of forwarding



## Control

### Minimal control:

- Per-box
- Config/Mgmt != fine-grained control

## Datapath

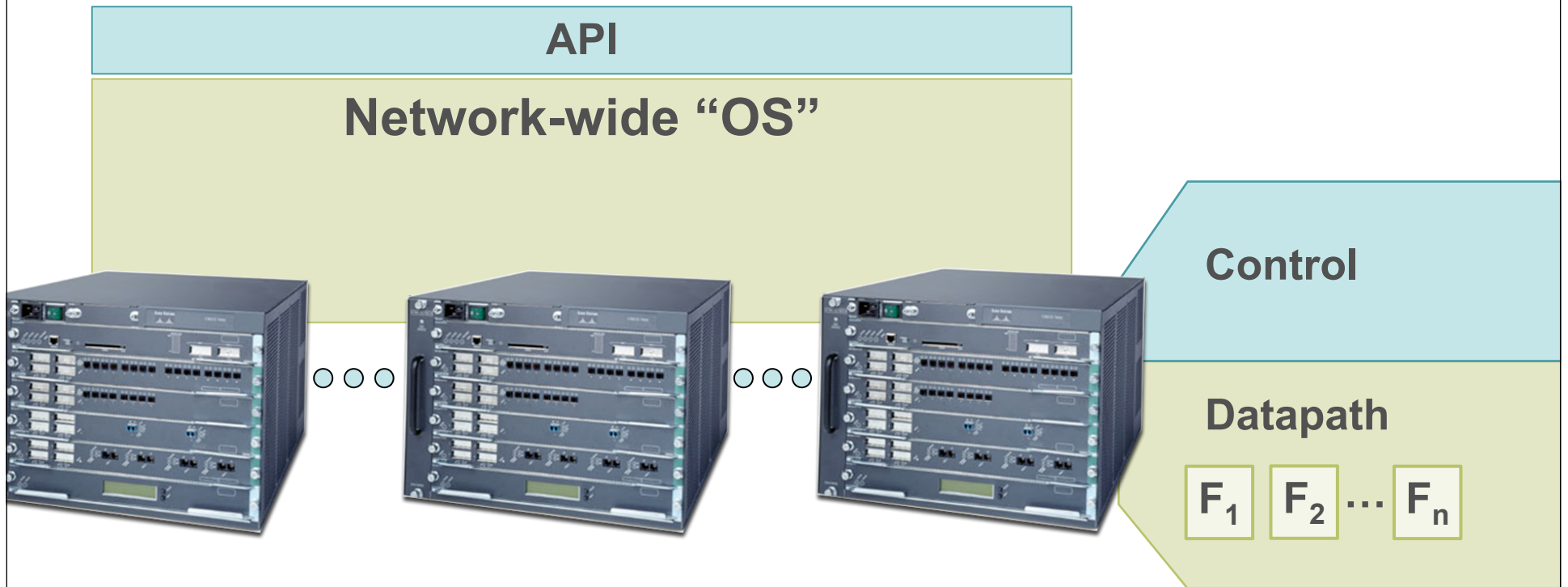
$F_1$   $F_2$  ...  $F_n$

### Hw Functions:

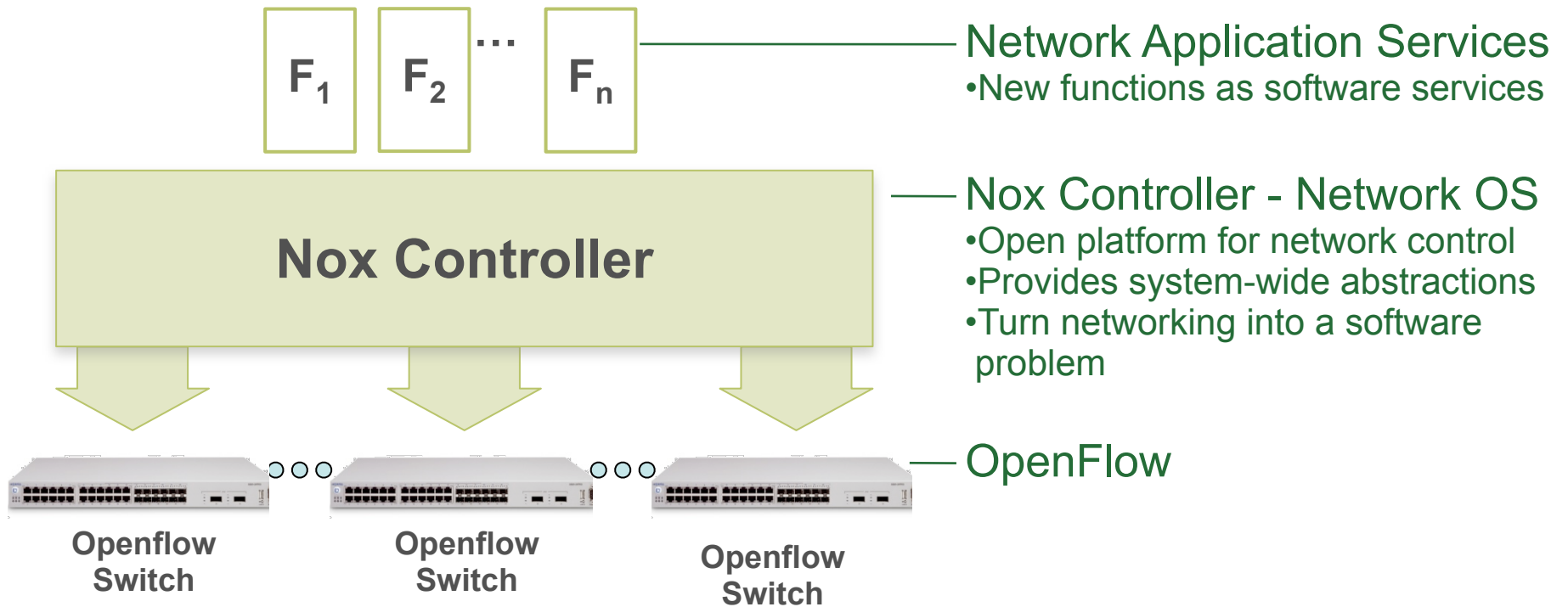
- Inflexible
- Proprietary
- Expensive

- New functions require new hardware (e.g. VNTag, TrustSec)
- Innovation happens at hardware design speeds
- No support for network-wide control or high-level abstractions

# The Goal of Nox



# Nox Components



# Objectives (with retrospective)

- Generality



- Performance



- Robustness



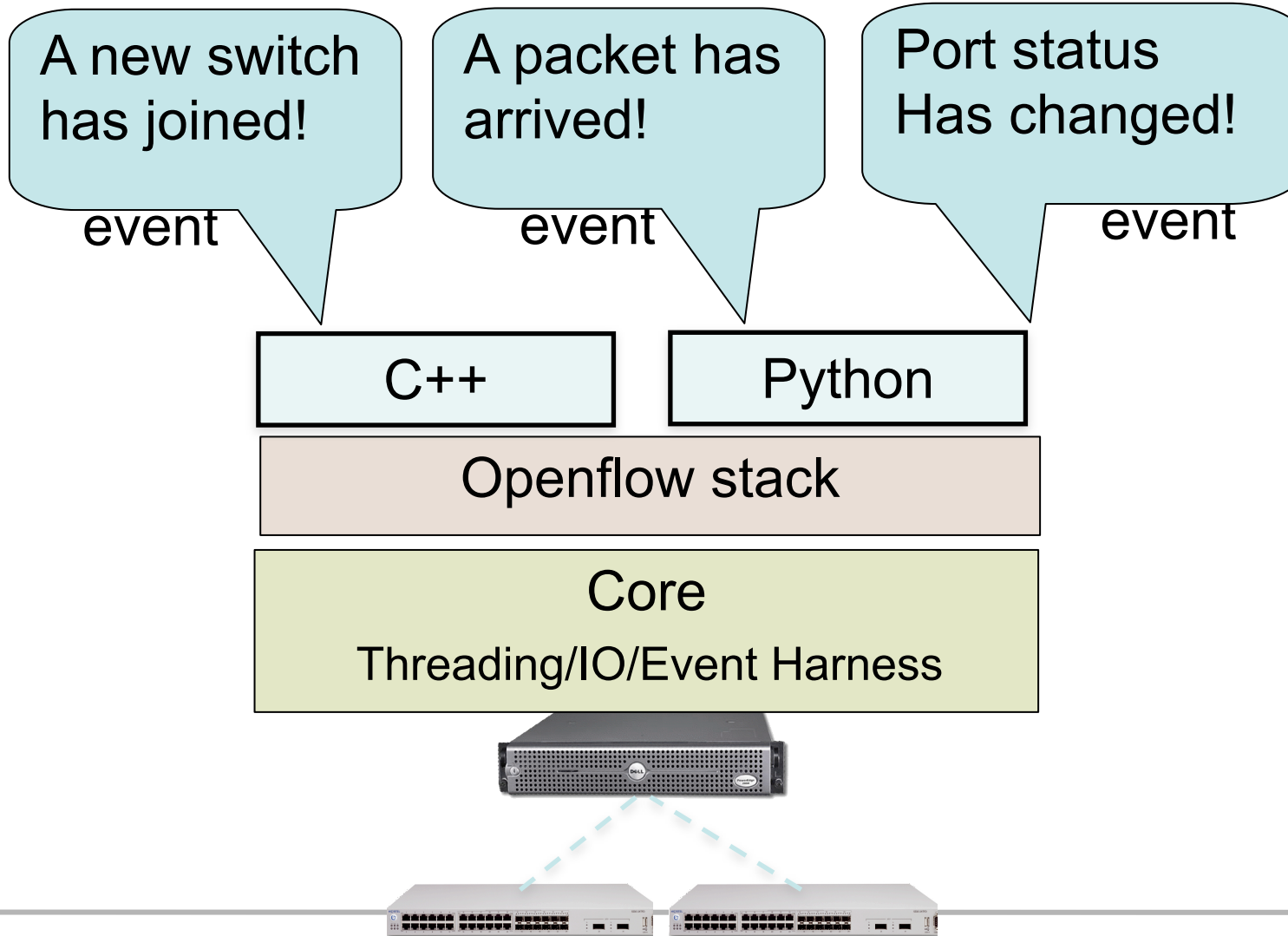
- Simplicity



# *Technical Overview*



# NOX Overview



# NOX Overview

A new link  
Was detected!

event

LLDP packet  
Received!

Topology  
Discovery

Send out LLDP  
Packet

C++

Python

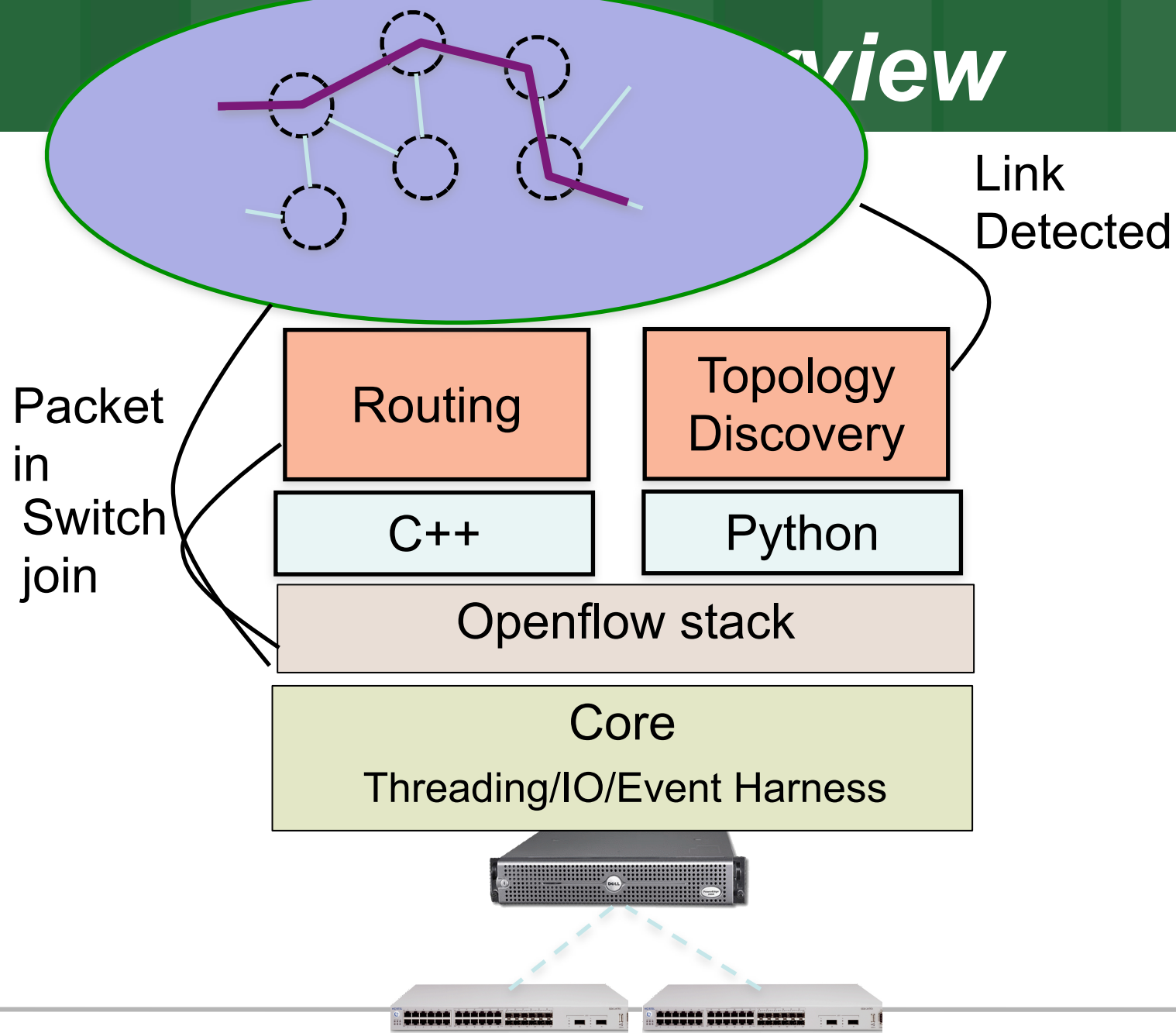
Openflow stack

Core

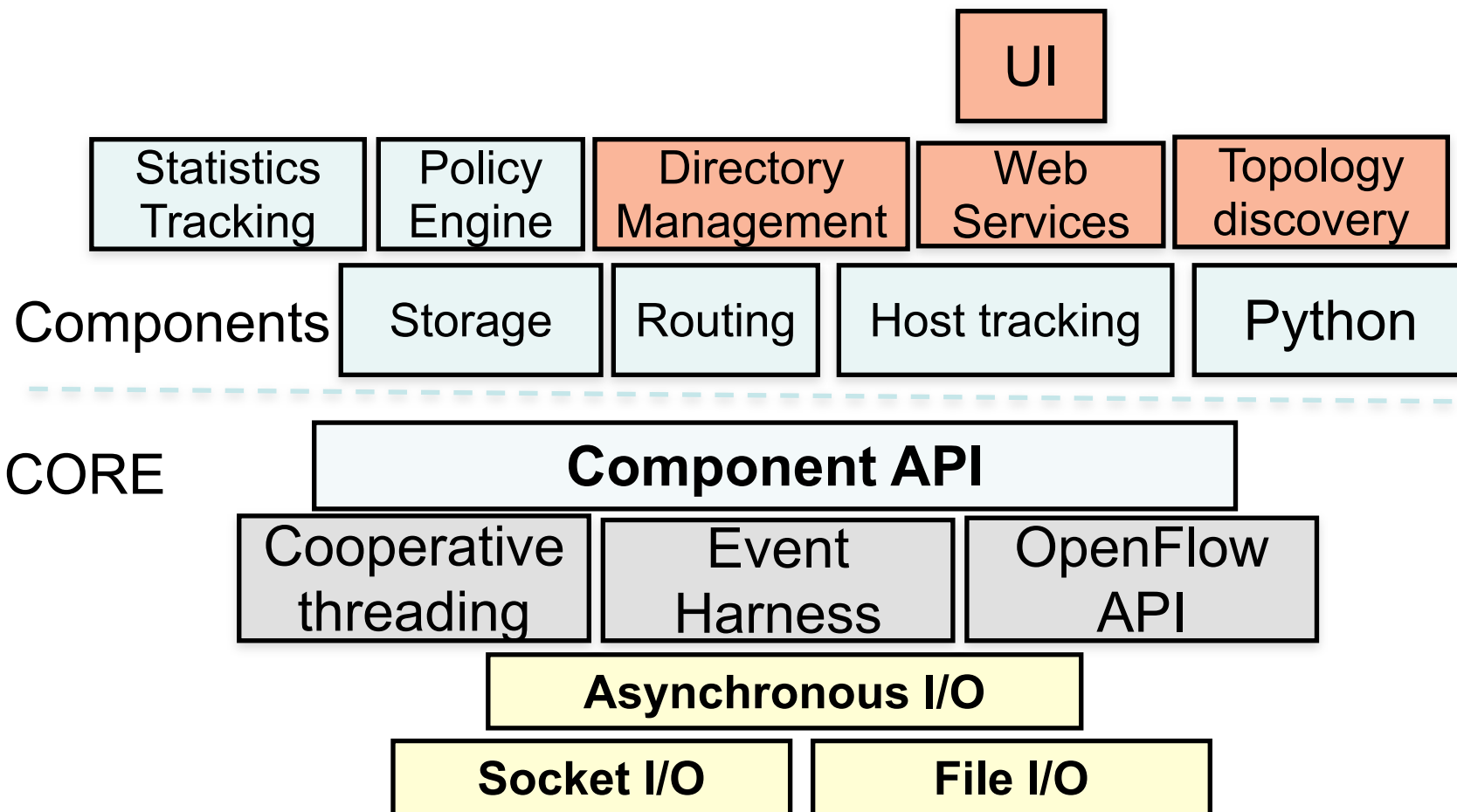
Threading/IO/Event Harness



# Overview



# Component Architecture



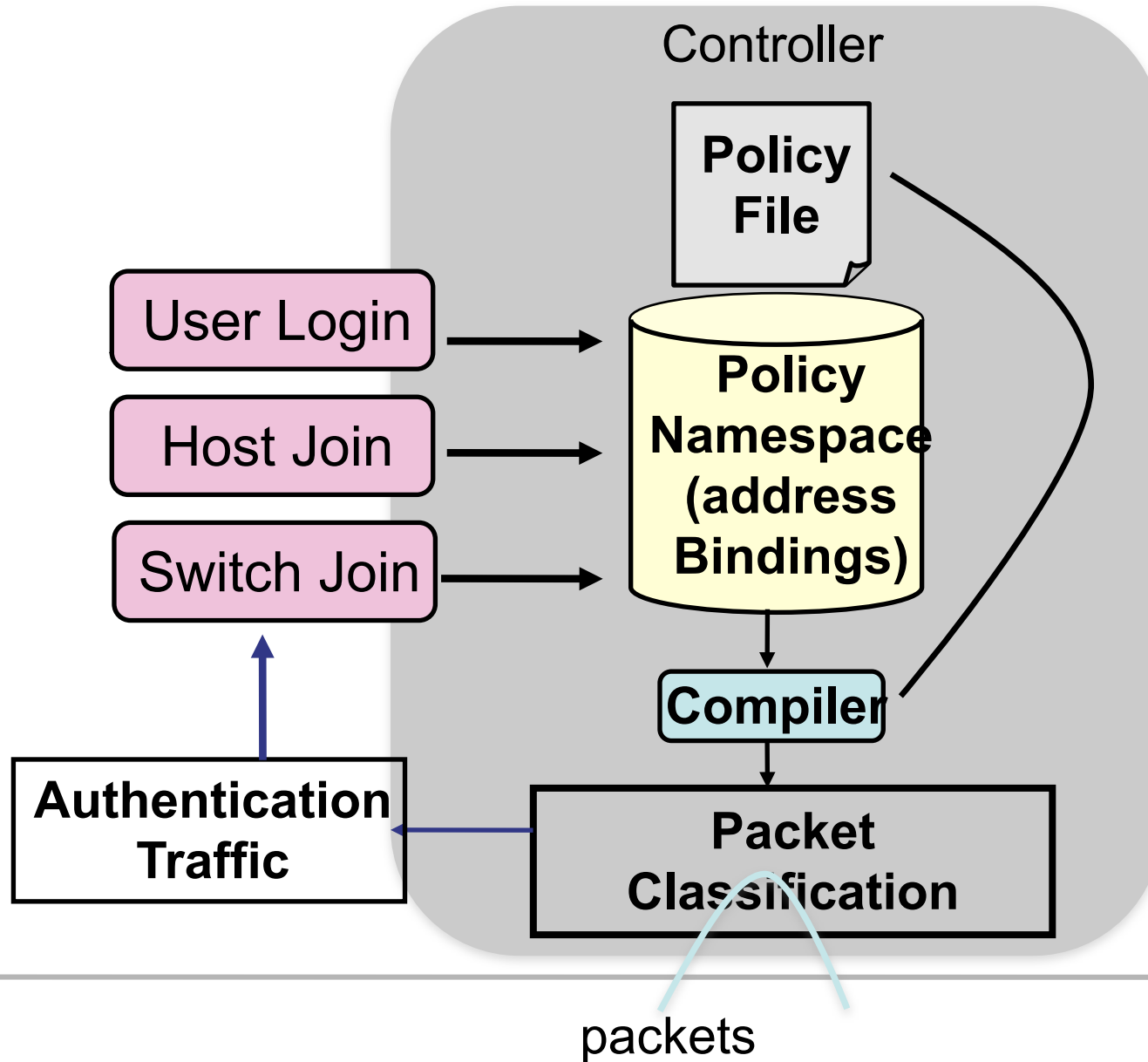
# *Example Uses*

---

- Declare security policy in high-level language
- Enforce policy network-wide (per-flow)
- Supports
  - Admission/Access control policy
  - Directory integration
  - Network monitoring and logging

Basic Idea: Use dynamic policy compiler to manage all connectivity on network

# Distributing Policy Lookup



# Network Access Control



Monitors



Policy



Settings



Help



CDBExplore



NDBExplore



WebServiceTest

Policy Manager

user: admin

Logout



Nicira  
NETWORKS

Quick Setup

Communication Rules

Host Authentication Rules

User Authentication Rules

## Communication Rules

▶ allow() <= protocol('arp')

▶ automatic authentication rule

▶ http\_redirect() <= usrc('discovered;unauthenticated') ^ tpdst(80) ^ hsrc('Built-in;gobi')

▶ http\_redirect() <= usrc('discovered;unauthenticated') ^ tpdst(80) ^ hsrc('Built-in;badwater')

▶ http\_redirect() <= usrc('discovered;unauthenticated') ^ tpdst(80) ^ in\_group('Built-in;laptops', 'HSRC')

▼ allow() <= True

Protected



### Protected Rule

This rule is vital to system integrity. To edit, you must first unselected the protected toggle below.

Metadata

Description:

Last Modified: Fri Oct 24 17:48:20 2008 by Built-in;admin

Comment:

Exception:

NOX Network | 3 Active Admins

Version: 0.3.0



# Network Visibility



Monitors



Policy



Settings



Help



CDBExplore



MDBExplore



WebServiceTest

Policy Manager



user: admin

Logout

## Overview

Network Overview

Switches

Hosts

Users

Locations

Groups

Network Events Log

### Server Information

Uptime: 3 minutes 26 seconds

CPU Load: 1%

Flows/sec: 19

### Entity Counts (Active/Total/Unregistered)

Switches: 3 / 3 / 0

Locations: 18 / 18 / 0

Hosts: 19 / 26 / 3

Users: 0 / 21 / 0

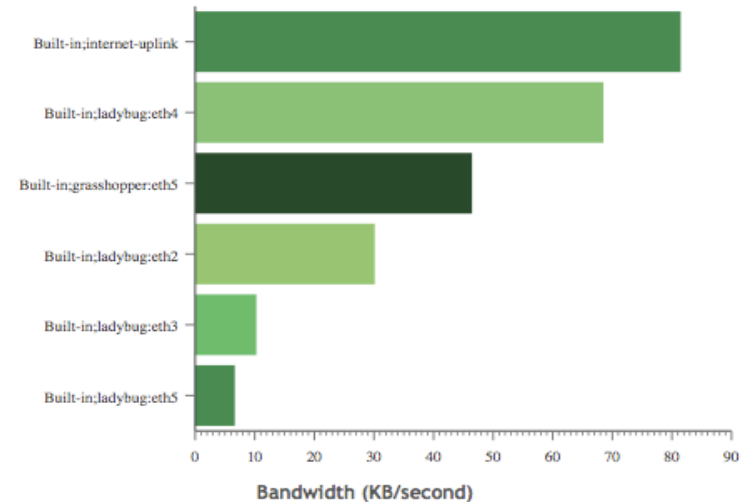
### Policy Statistics

Total Drops: 0

Total Rules: 6

Exception Rules: 0

### Top 5 Switch Ports by Bandwidth



### Recent Events

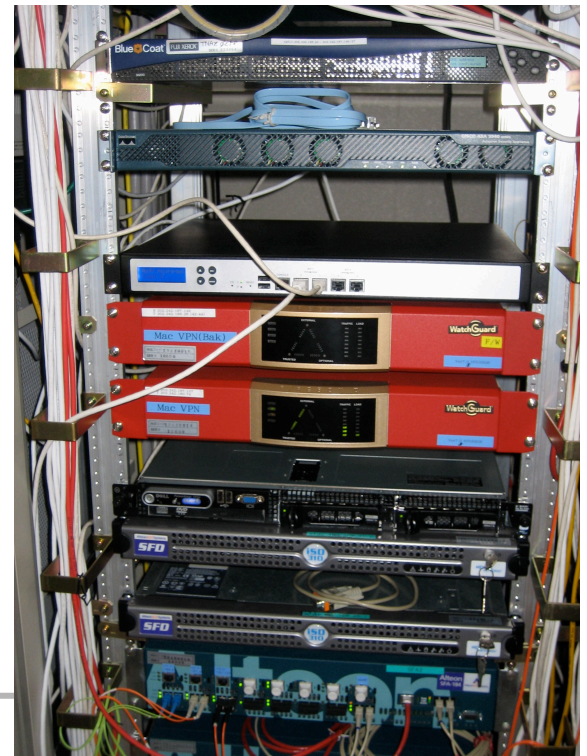
Priority	Timestamp	Message
2	Mon Oct 27 08:56:14 2008	Added network link between location Built-in;bumblebee-uplink and location Built-in;ladybug:eth5

NOX Network | 6 Active Admins

Version: 0.3.0

# *SNAC Deployments*

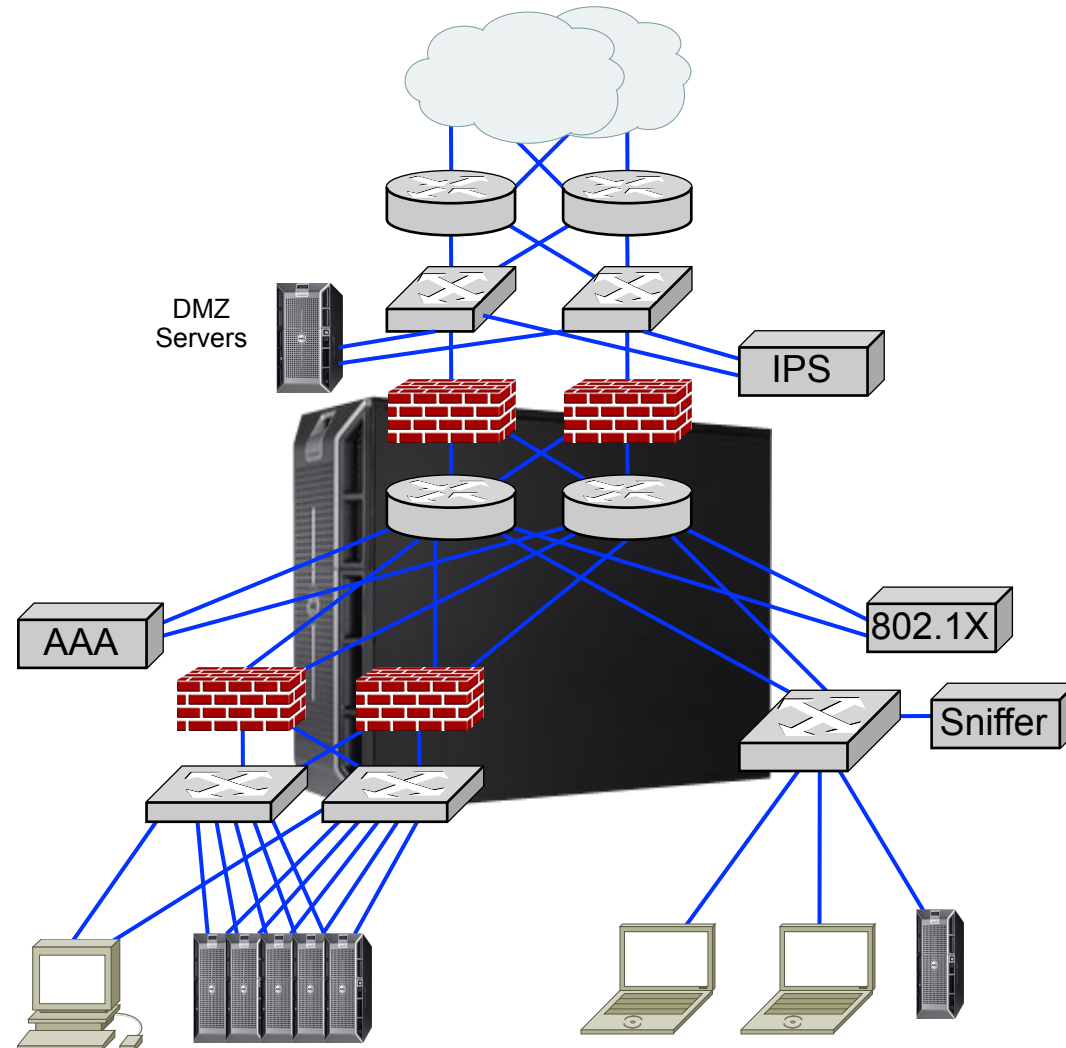
- Stanford CS (~400 devices)
- Government (multiple deployments)
- Medical University (~200 users)
- Small business (~50 devices)



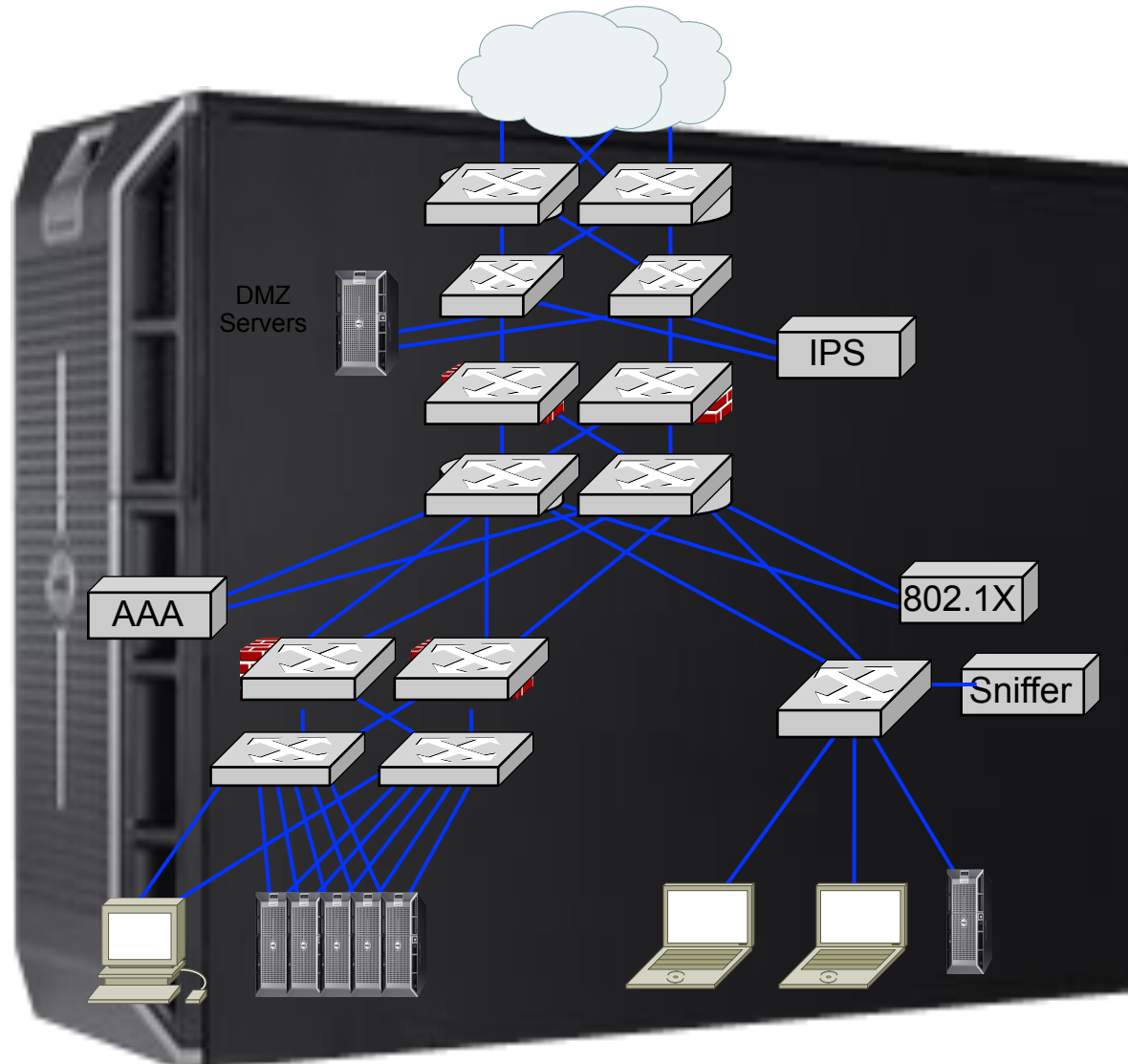




# Example: Network Virtualization



# Example: Network Virtualization





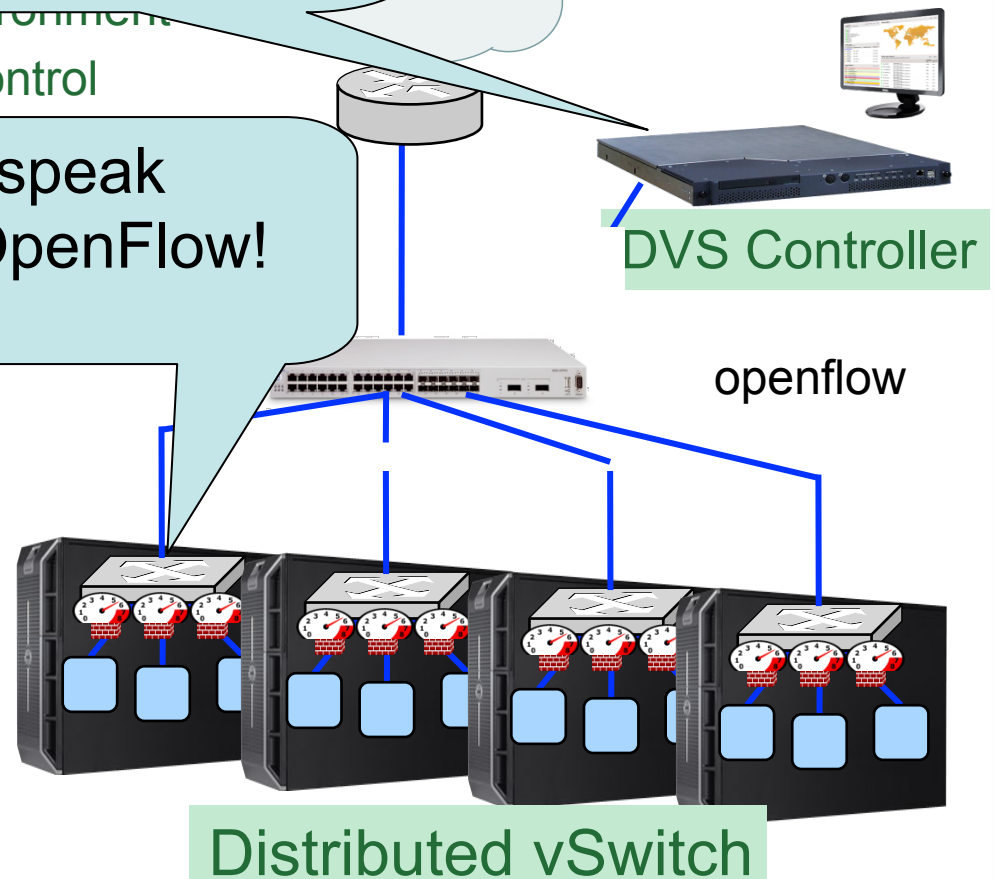
# Open vSwitch + DVS Controller

- Open vSwitch (<http://openvswitch.org/>)
  - Full featured virtual network switch
  - Handles dynamics of virtual environment
  - Exports standard visibility and control interfaces

I proactively push rules on host join!

I speak OpenFlow!

- DVS Controller
  - Central switch controller
  - Provides
    - *Distributed CLI*
    - *Policy declaration*
    - *Network visibility*
    - *QoS/RSPAN policy*
    - *Support VM Mobility*



# Virtual Network Console

vNetManager

https://vpn.nicira.com/vNetManager#dashboard

Version: 0.5.0-full-beta+build854-854 Last Update: Online Help Logout user: admin

Network Controller Dashboard Visibility & Control Settings

### Server Statistics

vNetManager

Up Time: 15 min

CPU Load: 0 %

### Network Statistics

Network	Active
Resource Pools	1
Xen Servers	2
Networks	7
VMs	6

### Recent Network Events

Pri	Date Time	Event
2	06/10/09 22:53:16	switch 'authenticated' joined the network.
2	06/10/09 22:53:16	switch 'authenticated' joined the network.
2	06/10/09 22:53:16	switch 'authenticated' joined the network.
2	06/10/09 22:53:16	switch 'authenticated' joined the network.
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2	06/10/09 22:53:16	switch 'authenticated' joined the network.
2	06/10/09 22:53:16	switch 'authenticated' joined the network.
2	06/10/09 22:53:16	switch 'authenticated' joined the network.
3	06/10/09 22:53:22	host 'Demo Etch 4.0 (1)' joined the network.
3	06/10/09 22:53:22	host 'Demo Etch 4.0 (1)' authenticated 46:fe:97:83:57:86 on location 'authenticated'.
3	06/10/09 22:53:22	host 'Demo Etch 4.0 (1)' authenticated 10.1.1.1 on 46:fe:97:83:57:86.
3	06/10/09 22:53:22	host 'Demo Controller' joined the network.
3	06/10/09 22:53:22	host 'Demo Controller' authenticated d2:44:a7:4d:a7:54 on location

### Bit Rate (bps) of the Top 5 VMs

### Packet Rate (packets/sec) of the Top 5 VMs

### Connection Rate (connections/sec) of the Top 5 VMs



## *Other Projects Using Nox*

- Home networking
  - Control virtualization
  - Datacenter policy
  - Network-wide monitoring
  - TE/WAN
  - Mobility
  - Many others ...
-

# *Concluding Notes*

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# Nicira's Role Going Forward

- Will continue to support Nox
  - Questions, bugfixes
- Will continue to develop tools useful for deployment
- Working on next-gen Nox (4<sup>th</sup> gen system)



***Thank You***

***<http://noxrepo.org>***