ONRC
ON.Lab Overview
SDN: New Approach to Networking

Bill Snow
bill@onlab.us

http://onrc.net/  http://onlab.us
Stanford/Berkeley (with partners) SDN Activities

Led up to formation of ONRC and ON.Lab

2007

2008

2009

2010

2011

Ethane

Reference Switch

OpenFlow Spec

SDN Activities

Demo

SIGCOMM08

GEC3

SIGCOMM09

GEC6

GEC9

Interop 2011

VM Migration (Best Demo)

Trans-Pacific VM Migration

SDN Concept (Best Demo)

Baby GENI

Nation Wide GENI

“The OpenFlow Show” – IT World

Other countries

US R&E Community

Stanford University

~45 switch/APs ~25 user

In McKeown Group

GENI: 8 Universities + Internet2 + NLR Many other campuses

CIS/EE Building

Production Network

GENI software suite

Expediten/ Opt-in Manager/FOAM

FlowVisor

FlowVisor (Java)

NOX

SNAC

Beacon

Test Suite

oftrace

Measurement tools

Mininet

NetFPGA

Software

+Broadcom

OpenFlow Spec

v0.8.9

v1.0

v1.1

Stanford University

~45 switch/APs ~25 user

In McKeown Group

CIS/EE Building

Production Network

Over 68 countries

(Europe, Japan, China, Korea, Brazil, etc.)

VM Migration (Best Demo)

Trans-Pacific VM Migration

SDN Concept (Best Demo)

Baby GENI

Nation Wide GENI

“The OpenFlow Show” – IT World

GENI: 8 Universities + Internet2 + NLR Many other campuses

CIS/EE Building

Production Network

Over 68 countries

(Europe, Japan, China, Korea, Brazil, etc.)

SIGCOMM08

GEC3

SIGCOMM09

GEC6

GEC9

Interop 2011

VM Migration (Best Demo)

Trans-Pacific VM Migration

SDN Concept (Best Demo)

Baby GENI

Nation Wide GENI

“The OpenFlow Show” – IT World

GENI: 8 Universities + Internet2 + NLR Many other campuses

CIS/EE Building

Production Network

Over 68 countries

(Europe, Japan, China, Korea, Brazil, etc.)

VM Migration (Best Demo)

Trans-Pacific VM Migration

SDN Concept (Best Demo)

Baby GENI

Nation Wide GENI

“The OpenFlow Show” – IT World

GENI: 8 Universities + Internet2 + NLR Many other campuses

CIS/EE Building

Production Network

Over 68 countries

(Europe, Japan, China, Korea, Brazil, etc.)
Berkeley and Stanford establish Open Networking Research Center (onrc.net) with 12 founding members

**Mission:**
Comprehensive intellectual framework for SDN
Develop and deploy open source SDN tools & platforms
ONRC: Open Networking Research Center

Berkeley
Scott Shenker
PhD/Postdocs
Intellectual Framework: Research

Stanford
Nick McKeown
Guru Parulkar
Sachin Katti

ON.LAB

Open Network Lab
Exec Director: Guru
VP Eng: Bill Snow
12-15 Developers (ON.Lab and sponsor assignments), Interns, PhDs, Postdocs
Platforms/tools: Develop & Deploy
Foundations

Systems & Tools

Domains of Use

Tech Transfer

FlowVisor
FOAM
Mininet
NOX
POX
Beacon
...

Tools & Platforms

Open Source

Develop & Support

Deploy & Demonstrate

Mission: ++SDN Innovation
• Support R&E Communities
• Create an open source SDN stack
Scope of Activities

Domains:
- Enterprise
- Data Center
- Service Provider
- Cellular
- Home
ON.Lab Mission

Develop, deploy, and support open source SDN

— Tools and platforms for Research and Education

— Open source SDN stack (for cloud/WAN)
Support for Research and Education

Transitioned

Flowvisor, FOAM (Geni, Ofelia, Geant...)

Mininet

In Process

NOX/POX/BEACON
Open Source SDN Stack

Abstractions

Stack Architectures

Components

existing – NOX, POX, BEACON, Flowvisor...

new - BGP gateway

Evaluate/Develop/Test/Deploy/Iterate
SDN Control Plane Abstractions: One View

Application APIs (NB)

Abstract Network View

Global Network View

Openflow

Physical Network

Controller

Virtualization

Network OS (Dist. State Mgmt)
A Possible SDN Stack

Physical Network

Virtualization

Network OS

Provisioning APIs (Quantum)

Application to directly program physical network

Virtual Net Controller

Virtual Network

App 1

App 2

App 3

Virtualization

Programming, Automated Troubleshooting
Target Use Case: SDN Based Cloud

Operator

Orchestration Software

OpenStack

SDN Stack

Storage Mgmt

SDN Stack

VM Mgmt

Cloud

VMs

VMs

VMs

Storages

Storages

Storages

Core Network
Deployment Targets – Research Networks

OFELIA
OpenFlow in Europe – Linking Infrastructure and Applications

- EU FP7 project
- Started September 2010
- Duration: 3 years
- Total budget 6.3M€, funding 4.45M€

- 10 partners
  + 2 after the first Open Call
  + 6 after the second Open Call
  - Academic institutions
  - Industry partners:
    - Deutsche Telekom, NEC, ADVA Optical
    - Stanford university official partner
      - Nick McKeown, Guru Parulkar
      - Control framework, architecture, experience

- 10 OpenFlow-enabled islands at academic institutions

- Genoa (IBIT)
- Bristol (UBristol)
- Zurich (ETH)
- Barcelona (Spain)
- Berlin (TUB)
- Rome, Catania (CNIT)
- Trento (Create-Net)
- Pisa (CNIT, 2 instances)
- Brazil (UFU)

As well as others worldwide...
Target Deployments:
SDN based Private Cloud at Stanford

- SDN-enabled computer clusters connected by 10G backbone SDN
- New applications for IT mgmt, science community and network research
Target Deployments:
Internet2 100G Innovation Platform

Internet2 Planned 100 Gigabit Infrastructure Topology
Draft – Last updated 27 Mar 2012

Internet2 Network by the numbers
- 10 Juniper T1600 routers
- 7 Juniper MX960 nodes for TR-CPN
- 49 custom colocation facilities
- 250+ amplification racks
- 75,500 miles of newly acquired dark fiber
- 2,000 miles of partnered capacity with NTNC
- 8.8 Tbps of optical capacity
- 100 Gbps of IP capacity
- 300+ Ciena ActiveFiber 6500 network elements
Recall the 1990s?
Jurassic Park 1993

• “You never had control, that’s the illusion”
  – Dr. Ellie Sattler
• “Life Will Find a Way”
  – Dr. Ian Malcolm
• So...the next species is evolving...
Executive Summary

• SDN has emerged as the new paradigm of networking
  – Industry embracing it – faster than one would expect

• SDN research shows lot of promise
  – SDN abstractions and programming models
  – Automated trouble shooting

• Open source SDN to play an important role
  – The same as in other parts of the software industry

• ON.Lab is accelerating SDN adoption
  – Technology transfer
  – Development and innovation
  – Collaborations and partnerships