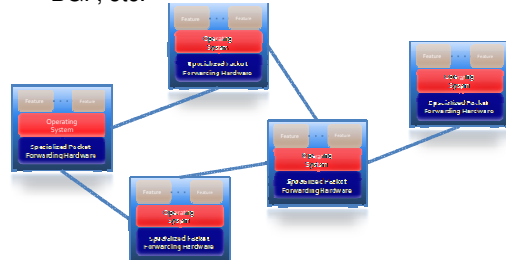# CS 490.31:
Software Defined Networks

2nd Lecture
20/3/2013
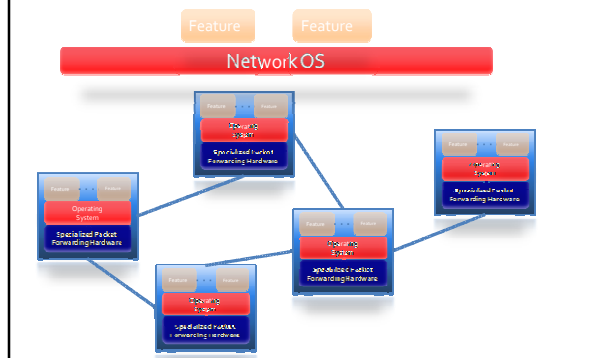
Xenofontas Dimitropoulos
ETH Zurich

Classical network architecture
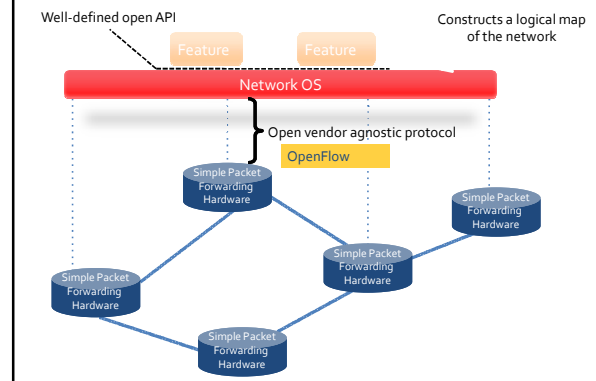
- Distributed control plane
- Distributed routing protocols: OSPF, IS-IS, BGP, etc.

From Vertically Integrated to …

Software Defined Network

Network OS

Network OS: distributed system that creates a consistent, up-to-date network view
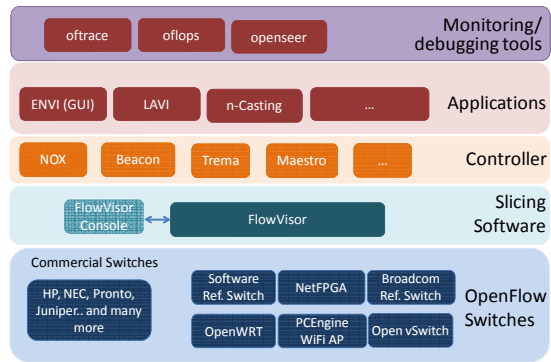- Runs on servers (controllers) in the network

Uses an open protocol to:
- Get state information **from** forwarding elements
- Give control directives **to** forwarding elements

OpenFlow

- OpenFlow
  - is a protocol for remotely controlling the forwarding table of a switch or router
  - is one element of SDN

The SDN Stack

oftrace	oflops	openseer	Monitoring/debugging tools

ENVI (GUI) | LAVI | n-Casting | ... | Applications

NOX | Beacon | Trema | Maestro | ... | Controller

FlowVisor Console ↔ FlowVisor — Slicing Software

Commercial Switches

HP, NEC, Pronto, Juniper.. and many more | Software Ref. Switch | NetFPGA | Broadcom Ref. Switch — OpenFlow Switches

OpenWRT | PCEngine WiFi AP | Open vSwitch

Switches
(all OpenFlow 1.0
for now)

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Current SDN hardware (as of ~2010)

Juniper MX-series

NEC IP8800

WiMax (NEC)

HP Procurve S400

Netgear 7324

PC Engines

Pronto 3240/3290

Ciena Coredirector

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Commercial Switches

Vendor	Models	Virtualize?	Notes	Pic
HP ProCurve	5400zl, 6600, +	1 OF instance per VLAN	-LACP, VLAN and STP processing before OpenFlow -Wildcard rules or non-IP pkts processed in s/w -Header rewriting in s/w -CPU protects mgmt during loop	
NEC	IP8800, +	1 OF instance per VLAN	-OpenFlow takes precedence -Most actions processed in hardware -MAC header rewriting in h/w	
Pronto/Pica8	3290, 3780, 3920, +	1 OF instance per switch	-No legacy protocols (like VLAN and STP) -Most actions processed in hardware -MAC header rewriting in h/w	

Controllers

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Open Controllers

Name	Lang	Platform(s)	License	Original Author	Notes
OpenFlow Reference	C	Linux	OpenFlow License	Stanford/Nicira	not designed for extensibility
NOX	Python, C++	Linux	GPL	Nicira	actively developed
Beacon	Java	Win, Mac, Linux, Android	GPL (core), FOSS Licenses for your code	David Erickson (Stanford)	runtime modular, web UI framework, regression test framework
Maestro	Java	Win, Mac, Linux	LGPL	Zheng Cai (Rice)	
Trema	Ruby, C	Linux	GPL	NEC	includes emulator, regression test framework
RouteFlow	?	Linux	Apache	CPqD (Brazil)	virtual IP routing as a service

Open Controllers (2)

Name	Lang	Platform(s)	License	Original Author	Notes
OpenFaucet	Python				Library
Mirage	OCaml				
POX	Python	Any			
Floodlight	Java	Any		BigSwitch, based on Beacon	

Too many to easily list of keep track of...

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[Hands-on Tutorial]
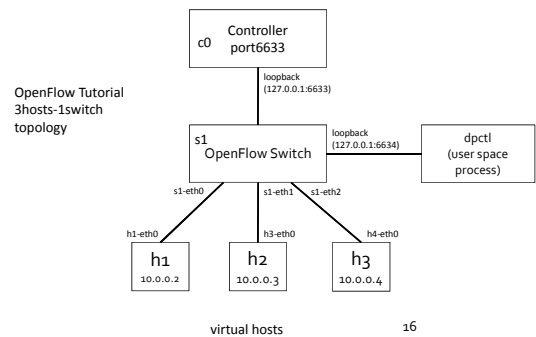
http://www.openflow.org/wk/index.php/OpenFlow_Tutorial

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TutorialFlow

Today's Hands-On Session

OpenFlow tutorial flow
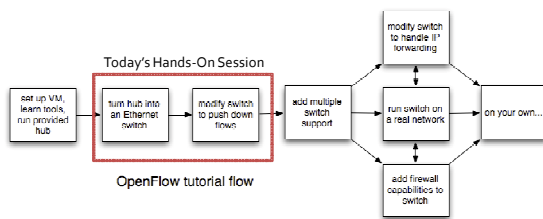
Part 5 of OpenFlow Tutorial:
http://www.openflow.org/wk/index.php/OpenFlow_Tutorial

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Tutorial Setup

OpenFlow Tutorial
3hosts-1switch
topology

c0 — Controller port6633
loopback (127.0.0.1:6633)

s1 OpenFlow Switch
loopback (127.0.0.1:6634)
dpctl (user space process)

s1-eth0   s1-eth1   s1-eth2

h1-eth0   h3-eth0   h4-eth0

h1 10.0.0.2   h2 10.0.0.3   h3 10.0.0.4

virtual hosts

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This talk wouldn't be possible without:

- Past slides from:
  - Brandon Heller
  - Nick McKeown