Developing a Software Defined Networking (SDN) Curriculum for Undergraduate Computer Engineering Students

C.J. Sher DeCusatis and A. Carranza
Computer Engineering Technology Dept., N.Y. City College of Technology, Brooklyn, NY
Outline

• What is SDN?
• How is SDN approached now?
• Computer Engineering Technology at Citytech
• Creating a SDN Curriculum for Undergraduate Computer Engineering Students
Figure 7-12 Campus LAN with Design Terminology Listed
How to train a network administrator

- Statically provisioned
- Box level scale
- PhD in vendor hardware
- Under utilized
SDN: Centralized Management & Control

• Ethernet topologies were built distributed
  Scalable but hard to monitor

• Openflow topologies (today) are centralized
  Control-data separation forces this model

Strengths of one approach are weaknesses of the other
Centralized is better suited to modern cloud applications
Approaches to Networking Education

Traditional Approach
• Train IT staff & network admins on use of conventional switches (CCNA)
• Install cloud middleware (OpenStack)
• Approximately translate user requirements into static, single tenant network configurations

SDN Approach
• Understand network programming interface; write or download network provisioning apps
• Design, program, & configure SDN controllers, switches (physical & virtual), and virtualization overlays
• Contribute to open source efforts (Project Open Daylight)
• Innovate – new ways to create workload aware, dynamic, multi-tenant enterprise networks with end to end QoS
Computer Engineering Technology at Citytech
Fact Sheet

Enrollment 16,208 students, 65% full time, 35% part time

By School 43.8% School of Technology & Design

Background 38.1% born outside of US
61% report language other than English spoken at home
33% list their parents as college grads

Finances 61% report household income less than $30,000
80% incoming freshmen receive need-based aid
19% work more than 20 hours per week

• The total enrollment of the Computer Engineering Department is around 1000 students, around 250 of them in the BS program after completing the AAS degree
• Our students go into their senior year knowing how to design in HDL, with some background in C++, Python, Java & other languages
• Their background with fiber optic labs & data communications prepares them to take the CCNA exam
• They are ready to learn how to design & administer SDN OpenFlow switches
Computer Engineering Technology Programs

• Electromechanical Engineering Technology/AAS
  – Required courses in major that relate to SDN include Digital Control, Electromechanical Systems, Data Communications

• Computer Engineering Technology/BTech
  – Require an AAS in either EMT, EET/TCET or MECH
  – Additional classes in topics in computer control systems and Microcomputer Interfacing
  – Technical Electives to create specialties in various tracks, such a robotics or networking
  – Accredited by ABET
Associates Degree Networking Classes

• Logic and Problem Solving - Includes intro to Python
• Digital Electronics - how to design in HDL
• Data Communications - prepares them to take the CCENT exam
• Intro C++ Programming Language
Networking related upper division electives

• Electro-Optical Technology and Applications-themed this year- Fiber Optics
• Microcomputer Interfacing-Networking Examples
• Applied Digital Technology-themed this year- Cloud Computing
• Special Project-Technology (Capstone Project)
Creating a SDN Curriculum for Undergraduate Computer Engineering Students
SDN goals

Our plan is to add a class on Software Defined Networking using NetFPGA

- Understanding how to configure and manage SDN networks
- Understanding how to design SDN routers
- Understanding how to program FPGAs to become other OpenFlow devices, such as firewalls
- Connect to the Cloud Computing Center at Marist
What is NetFPGA?

- Originally designed as a tool for education, the 1G platform consisted of a PCI board with a Xilinx Virtex-II pro FPGA and 4 x 1GigE interfaces feeding into it, along with a downloadable code repository containing an IP library and a few example designs.
- A board with 10GigE is also available.
- It costs about $1000 per 1GigE unit and $3000 per 10GigE unit.
- Sample software code for Ethernet and OpenFlow Switches is available.
NetFPGA

• A line-rate, flexible, and open platform for research and classroom experimentation.
• More than 2,000 NetFPGA systems have been deployed at over 150 institutions in over 40 countries
• Sample projects available at http://netfpga.org/project_table.html
Summary & Next Steps

• Education plans will leverage NetFPGA for classwork that helps students understand Ethernet Switch Technology & OpenFlow
  – Program some FPGA examples related to low latency environments, such as stock market transactions
  – Program a sample Firewall for an OpenFlow System
• Research agenda in collaboration with the New York State Center for Cloud Computing & Analytics
  – CUNY labs have WAN equipment compatible with Marist College SDN lab (Adva Optical Networking WDM platform)
  – Connect to Marist using Internet 2(NYSERNET)
• SDN can be incorporated very naturally into our Computer Engineering Curriculum
• NetFPGA building on strengths in HDL design and networking
Websites of Interest

- http://netfpga.org/videos.html
- http://netfpga.org/project_table.html
- http://groups.geni.net/geni/wiki/GeniNewcomers
Any Questions?