THE APPLICATIONS OF SDN
Benefits from SDN

- Network Virtualization
- Switch based Firewall
- Multipath Forwarding
- Congestion Control
- Identify bugs
Network Virtualization in SDN

- The process of combining hardware and software network resources to be some virtual networks.
SDN-based Network Virtualization

- Each tenant can run his virtual network with controller in SDN.
- OpenFlow network removes limitations, allowing administrators to create a flow-based virtual network abstraction.
SDN-based Network Virtualization
Switch based Firewall in SDN

- OpenFlow switches can emulate Firewall by assigning rules to switches.
Multipath Forwarding in SDN

- Forwarding by rule and central controller’s decision.

Controller can install multipath roles in SDN switches.
Congestion Control by SDN

- Controller can get SDN switches information to know if congestion happened.

Controller gets switches status to decide flow rate
Identify Bugs by SDN

- Identify bugs with systematically tracking down their root cause
  - When an operational network misbehaves, it is very hard to find the root cause
  - Allows users to define a Network Breakpoint
  - Capture and reconstruct the sequence of events leading to the breakpoint
CHALLENGES
Challenges

- Complex designing solutions
- Limited TCAM size
- Controller delay and overhead
- Multi-controller working together
- Migrating from legacy to SDN
SDN - Data-Plane Challenges

- State of Specification
  - Maturity Concerns
  - OF 1.0 single flow table, ... OF 1.1 leverages multiple tables

- Silicon Concerns
  - Spec is much ahead of silicon development... OF Spec is a moving target for merchant silicon
  - Merchant silicon is not optimized for OF... supports of current networking features is a higher priority

- Specific issues
  - Scalability of Flow-Matches (limited by TCAM size)
  - Cost concerns
SDN – Control-Plane Challenges

- Control Plane scalability
  - Centralized vs. distributed controllers...
  - Single view of the state of the network, forwarding tables,... is this a distributed database problem?

- Interoperability
  - SDN/NON-SDN
  - Inter-Controller
  - Between different controllers
  - Orchestrating SDNs managed by different controllers
  - With Hypervisor virtual networking
SDN - Application-Environments Challenges

- Network Resource Abstraction & Conflict Resolution
  - Resource abstraction
  - Conflict resolution among different application actions

- Development tools and New Application Paradigm
  - Computing system style application...
  - New class of Network Programming
  - Languages... New tools
  - New development skills... New talents... New education curriculum...
RESEARCH RESOURCES
Research Platform for SDN

- **Mininet**
  - Network emulator
  - Designed for emulating SDN networks
  - Easy to use
  - High performance (100 nodes on a laptop)

- **Network OS for Research**
  - NOX (C++/Python)  [http://noxrepo.org](http://noxrepo.org)
  - Maestro (Rice University)
  - Helios (NEC)
  - Beacon (Java)  coming soon, ...

- **Network OS Commerce**
  - ONIX [OSDI 2010, Google, Nicira, NEC]
  - Expect others
OpenFlow Testbed

- **Candidate controllers:**
  - Nicira’s Nox: C++ and python ← prototyping
  - NTT’s Ryu: python ← more production level

- **Candidate switches:**
  - **Standalone switches**
    - Pica8 (3290): OpenFlow v1.1, a spin-off of Quanta
    - HP (5400zl): either OpenFlow mode or legacy mode.
    - NEC(IP8800): either OpenFlow mode or legacy mode.
    - Pronto: legacy routing stack and OpenFlow enabled features can not be support in the same VLAN
    - Brocade (CES/CER/MLX/XMR/MLXe): fully support hybrid mode
  - **PC-based switches (decreasing programmability)**
    - OVS (OpenVSwitch): pure software based OpenFlow enabled data path
    - Netronome: network processor PCI card
    - NetFPGA (Stanford): research oriented cards