Lecture 6 Overview

- Software Defined Networking overview
- Onix discussion
Evolution of Computing

Specialized Applications
Specialized Operating System
Specialized Hardware

Open Interface
Windows (OS) or Linux or Mac OS

Open Interface

Microprocessor

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Evolution of Networking?

Specialized Features

Specialized Control Plane

Specialized Hardware

App

Open Interface

Control Plane

or

Control Plane

or

Control Plane

Open Interface

Merchant Switching Chips

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Software Defined Networking

Abstract Network View

Network Virtualization

Global Network View

Network OS

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OpenFlow

“If header = x, send to port 4”
“If header = y, overwrite header with z, send to ports 5,6”
“If header = ?, send to me”
Basic OF Operations

- Match arbitrary bits in headers:
  - Match on any header, or new header
  - Allows any flow granularity

- Action
  - Forward to port(s), drop, send to controller
  - Overwrite header with mask, push or pop
  - Forward at specific bit-rate

Match: 1000x01xx0101001x

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What is a Network OS?

- ONIX provides abstractions for network management

- Basic functionalities:
  - State distribution primitives between controllers and network elements.
  - Virtualized network elements

- A global view & control of the network
  - Very different from Active Networking vision (node local)
Onix Architecture

Server 1
Network Control Logic

NIB
Switch Import / Export
Distribution I / E

Management Connectivity Network Infrastructure
Managed Physical Network Infrastructure

Server N
Network Control Logic

NIB
Switch Import / Export
Distribution I / E
Design Requirements

- **Generality**: Support a wide range of network management applications
- **Scalability**: No inherent limitations due to the platform
- **Reliability**: Graceful failure handling
- **Performance**: Sufficient performance
Onix API

- Developers program against a network graph
- Nodes represent physical network entities
Network Information Base

- The NIB is the focal point of the system
  - State for applications to access
  - External state changes imported into it
  - Local state changes exported from it
Scalability

- Physical controller becomes a bottleneck:
  - Memory: to keep NIB
  - CPU and bandwidth: to process events

- This is a classic distributed systems problem
  - Partitioning
  - Aggregation
Partitioning For Scale

- Multiple dimensions are available to applications:
  - Onix instances with different computations tasks
  - Onix instances have only subsets of the NIB
  - Switches connect to a subset of Onix instances
Aggregating for Scale

- Reduce fidelity of information before disseminating within the cluster
Aggregating for Scale

- Reduce fidelity of information before disseminating within the cluster
Consistency

- Onix provides two storage options
  - Replicated transactions (SQL) storage
  - One-hop memory-based DHT

- Do we need strong consistency for forwarding state between the controller and routers?

- Do we need strong consistency for NIB stored in controllers?

- Is it reasonable to ask applications for consistency preference and resolving conflicts?
Reliability

- **Network Element & Link Failures**: Applications' responsibility

- **Connectivity Infrastructure Failures**: Assumed reliable

- **Onix Failures**: Onix provides distributed coordination facilities provided for app failover
Discussion

- What are the security implications of Onix?
- Is Onix flexible and general enough for networking management?
- Are there applications you can run on a centralized network but not on a distributed one?
For Next Class…

- Read and review the P4 paper, and look at the P4 tutorial slides (will be going over them in class too)