Software Defined Networks: A Carrier Perspective

Stuart Elby, PhD
VP, Network Architecture & Technology
Chief Technologist, Verizon Digital Media Services

19 October 2011
Why Does Verizon Care?

- Software defined network enables inexpensive feature insertion for new services and revenue uplift.
- Unacceptably high cost escalation results in a non-sustainable business case.
- The cost of transition must not be prohibitive.
- Using COTS hardware following mass market cost curves lowers equipment expenditures.
- The cost of PMO needs to be matched to the characteristics of revenue growth to support consistent margin.

© 2011 Verizon. All Rights Reserved.
Key Attributes for SDN Success

- Architecture for a Networked Operating System with a service/application oriented namespace
- Resource virtualization, elasticity and aggregation (pooling to achieve scaling)
- Appropriate abstractions to foster simplification
- Decouple topology, traffic and inter-layer dependencies: enable dynamic multi-layer networking
Critical Focus Areas

- **Network virtualization for multiple services**
  - A framework for multiple virtual networks to exist on top of one physical network
  - Use of application-aware routing software controlling inexpensive Ethernet switches or Packet Optical Transport nodes

- **Protocol specifications that can be standardized and implemented in all aspects of a software defined network ecosystem**
  - Operating systems, applications, infrastructure

- **A means to incrementally introduce the new architecture where new functions add most value and interwork with the large legacy**
  - Open Flow control interface and complimentary management protocols to enable new control paradigms on existing forwarding hardware
Deployment Scenarios for Carrier SDN & OpenFlow

- COTS
  - Blade Servers
  - Storage
  - Application Warehouse
- Software Defined Network
  - Forwarding
  - Steering
  - Traffic Management

- Edge Office
- Regional Office
- Hub Office

- Applications
- NGOLT
- PON
- Internet Routing
- Transport Element
- Optical
- Internet
- Origin Svr

Access | Metro | Core

© 2011 Verizon. All Rights Reserved.
Open Flow/SDN Use Cases

• General Strategy: Only build something in an external controller with OpenFlow when it has significant benefit, for example:
  – New feature set, new functions not implemented with existing protocol set
  – Existing feature/protocol set, but achieves better scaling, economics, and/or solves a problem not addressable by current vendors/standards

• Example Use Cases
  • Traffic Steering: service/application aware routing of traffic to the appropriate sequence of app servers
    • OpenFlow may complement Traffic Steering for long-lived flow detection and cut-through switching to reduce overall cost of services delivered
  • Hybrid Cloud Computing: integration of cloud computing bandwidth-on-demand features with public-private cloud services
    • Virtualization of the network and the enterprise and public data center resources via a common interface to the user
    • OpenFlow used to enable bandwidth-on-demand for data center interconnection.
  • OpenFlow switching operating in hybrid mode with on-board (native) control
  • OpenFlow switch partitioning and support for multiple controllers.
• Application stitching point in the TSA between overlay trails, which allows development of arbitrary feature graphs, which may vary over time
• Traffic Steering determines Application Trail through Service Features and Cache
• Although flexible and extensible, packets traverse a significant number of interfaces and processors, which may not be required for all flows, and for long-lived flows there is a strong motivation for optimization
For long-lived flows, desirable to avoid traversing TSA,
• Example shown for direct retrieval from cache after Features have confirmed security, content filtering
• Statistics for long-lived flow are collected via OpenFlow
• Optionally, OpenFlow snooping by controller for particular patterns could detect flow usage and determine when a long-lived flow completes
Bandwidth-on-Demand for Hybrid Cloud

Private Cloud Data Center 1

VM - Compute
LUN - Storage

1's Controller

Private Cloud Data Center 2

VM - Compute
LUN - Storage

2's Controller

Packet Switched Layer 2/3 Network

Legend:
- Physical Connection
- Hybrid Cloud API
- Control L2/L3 Bandwidth
- Control VPN Assignment
- Control VM Assignment
- Control LUN Assignment

Service Provider Public Cloud Data Center

SP Virtualization, Programmability and Monitoring

“Northbound API

Potential Use of Open Flow

© 2011 Verizon. All Rights Reserved.
Multiple (Virtual) Open Flow controllers control a subset of resources in the same physical Switch.

A network of Open-Flow enabled switches enables support of multiple networking experiments using less of your tax dollars as compared with separate physical networks.
Summary

• Software Defined Networking implemented on COTS infrastructure provides a means to align the network cost structure trend to that of the revenue
• Central Offices evolve to Data Centers, reaping the cost, scaling and service flexibility benefits provided by cloud computing technologies
• Some services / traffic types (e.g., video distribution) are best handled by a combination of SDN and OpenFlow-enabled cut-through switching
• Hybrid cloud computing may use a combination of SDN, OpenFlow and novel orchestration to provide seamless interworking with the enterprise environment
• OpenFlow requires several enhancements to work effectively in a virtualized cloud environment that includes legacy switching elements