Promise and Potential Pitfalls
Transport SDN

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Outline

- Premise
- Transport Control Systems - Past Experiences
- Promise of SDN
- Potential Pitfalls
- SDN related work in OIF
- Summary
Premise

- **Carriers have long desired control for Transport**
  - Reduce time to deliver service
  - Reduce cost using mesh reroute not protection
  - Increase availability through 1:n protection
  - New Services

- **Different approaches have been taken**

- **Different technologies deployed**

*Much to be learned from the Past*
Networks deployed with control systems

- **AT&T ACCUNET Bandwidth manager (circa 1988)**
  - Management system integrated
  - Carrier specified behaviors
  - Dependent on Communications Infrastructure
  - Scaling limitations
Networks deployed with control systems

- **AT&T ACCUNET Bandwidth manager (circa 1988)**
- **VYVX T3 on-demand (circa 1994)**
  - **SDH based (1994-1998)**
  - Management-integrated
  - Carrier specified behaviors
  - 15 minute on-demand
  - Dependent on Communications Infrastructure
  - DS3 Circuit Emulation
  - NE-integrated - based on OSPF and Q.2931
  - “Seconds” on-demand
  - Dependent on Health of Control Protocols
Networks deployed with control systems

- **AT&T ACCUNET Bandwidth manager (circa 1988)**
- **VYVX T3 on-demand (circa 1994)**
- **Vodafone (circa 2000)**
  - SDH based
  - NE-integrated - based on GMPLS
  - Distributed
  - Behaviors specified by NE Vendor
Networks deployed with control systems

- AT&T ACCUNET Bandwidth manager (circa 1988)
- VYVX T3 on-demand (circa 1994)
- Vodafone (circa 2000)
- AT&T and Verizon Mesh Nets (circa 2003)
  - SDH based
  - NE-integrated - based on P-NNI
  - Distributed
  - Behaviors specified by NE Vendor
Carriers benefit from control systems

- **Traffic Recovery**
  - March ’11: Japan Earthquake
  - One Carrier’s experience
    - 21 cuts on 19 cables
    - High priority restored in 5 min

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Communications Day – March 14th, 2011

At Verizon Business, any impact to customer traffic was averted by its optical meshed infrastructure in Asia and across the Pacific, according to Linda Laughlin, director of media relations for Verizon Business’ Global Network Services Group.

“Verizon also participates in several submarine cables throughout the Asia-Pacific region, so if we need to move traffic to alternate network routes, we have the capability to reroute customer traffic using a technology called ‘meshing.’ Meshing creates additional paths to seamlessly reroute traffic in the event of multiple undersea cable breaks or network disruptions,” Laughlin said, adding that Verizon currently operates eight different paths across the Pacific.

Verizon also operates two local networks in Japan – Tokyo and Osaka, Laughlin added, both of which are still online. “All of our networks are operating normally.”
Carriers benefit from control systems

**Traffic Rebalancing**

- AT&T

The perfect storm of pop culture and new technology powers one of the busiest nights of the year on AT&T’s network: the finale of Fox television’s *American Idol*. Moser points to a graph showing what happens when viewers text and phone in their votes for the winner of the popular reality TV singing contest. What starts as a typical day instantly turns into a network-straining avalanche of traffic at 9 p.m. Eastern.

“You basically have one customer doubling the usage of the network, so it’s a significant event,” he said. “The fact that you can still use the network and never notice that this is happening is really a credit to the kind of thing we’re doing here.”

- Government Technology, Jan 31, 2012
Carriers benefit from control systems

- Multiple faults
  - Developing Countries - Significant amount of construction
    - Inadequate records, permitting
  - Require Multi-cut resiliency
    - Multiple cuts a day
    - Double failures weekly
Observations

- **Management-based control**
  - Dependent on Communications Infrastructure
    - Link failures limit ability to control NEs
  - Scaling Limitations
    - Overloaded Communications Infrastructure
    - Overloaded Connection rerouting
  - Carriers define network behaviors

- **NE-based control**
  - NE-vendors define network behaviors
    - Problems with carrier differentiation
  - Dependent on Health of Control Protocols
SDN improves transport control

- **Eliminate “One-size-fits-all” solutions**
  - NE-behaviors may not match carrier requirements
  - **Example**
    - Combined Reroute and Protection

- **Programmability enables carrier requirements to be met**
  - 400% Capacity use
    - 50ms protection all the time
  - 300% Capacity use
    - 50ms protection switch first fault
    - ~300ms switch second and subsequent
SDN improves transport control

- Eliminate “One-size-fits-all” solutions
- Multi-layer Control without omniscient NE
  - Mixed network: Router, ROADM and Packet-Optical Transport Platform (P-OTP)
  - Ships-in-the-night control plane operation
  - Ignores layer transition points
SDN improves transport control

- **Eliminate “One-size-fits-all” solutions**
- **Multi-layer Control without omniscient NE**
  - Without multi-layer graph, routing cannot choose optimal route
  - Requires Routers to understand, signal non-packet layers
SDN improves transport control

- Eliminate “One-size-fits-all” solutions
- Multi-layer Control without omniscient NE
- Homogeneous behaviors in Heterogeneous networks
  - Control Plane implementations not all the same
  - Multi-domain services: least-common denominator
  - One logical controller delivers consistent behaviors

Consistency reduces carrier operations costs
SDN improves transport control

- Eliminate “One-size-fits-all” solutions
- Multi-layer Control without omniscient NE
- Homogeneous behaviors in Heterogeneous networks
- Application awareness of network capabilities
  - Existing Control Planes are “write-only”
  - Request connections without any awareness of network
  - Business Applications need detail for services available

Match carrier services with application needs
Potential Pitfalls for Transport SDN

- **Management Interfaces as External Control**
  - ITU-T management interfaces $\neq$ OFWire
  - Management systems developed around human request paradigm
    - Slow to react - e.g. alarm integration
    - Designed for Configure and Forget operations
  - Not to be confused with Management Information Modeling
    - Use of same constructs in External Control interfaces
    - Macro operations required to improve speed
      - Collapse adaptation config and cross-connect creation

*Human Request paradigm not the same as control interface*
Potential Pitfalls for Transport SDN

- **Management Interfaces as External Control**
- **Centralized controller in Wide Area deployments**
  - **Data Centers** - simple control topology
    - Limited failure modes
  - **Wide Area** - complex control topology
    - Re-converge control paths on failure
    - Controller becomes unreachable?

Need distributed load-balanced controller
Potential Pitfalls for Transport SDN

- **Management Interfaces as External Control**
- **Centralized controller in Wide Area deployments**
- **Monolithic controller/application implementations**
  - Applications directly accessing NEs
    - No exposed interfaces
    - No reuse of common functions
  - Goal of SDN is re-programmability

Monolithic controller/applications repeat mistakes of today’s control systems
Potential Pitfalls for Transport SDN

- Management Interfaces as External Control
- Centralized controller in Wide Area deployments
- Monolithic controller/application implementations

**1+1 vs 1:n controller deployment**

- 1+1 requires both controller instances to scale for load
- 1:n uses additional controllers to scale for load
- 1:n enables better fault survivability
- 1:n can be distributed

Need interfaces that enable 1:n controller deployment
OIF activities to guide Transport SDN

- Carrier requirements document

- SDN Framework document
  - Goal to avoid monolithic systems
  - Better define components inside controller, interfaces to applications

- Demonstration/testing of SDN
  - Discussions underway for upcoming event
Emerging Service and Network Framework

- **Overall Application**
  - Many
    - Cloud computing
    - Re-optimization

- **Network-Specific Application**
  - Service setup
    - Variants (Unprotected, protected, re-routeable)
  - Service maintenance
  - Resource functions
Controller Decomposition & Interfaces
Overlaying ASON Architecture

- Business Application
- Network Applications
- Service Level
- ASON Call Control
- SNC
- SNC w/ Reroute
- Conn. Control*
- Path Computation*
- LRA
- TAP
- TNA Directory
- Topology
- OSPF
- Dataplane
- Exposed APIs

Network Service Requests

TMF

ONF

OIF

IETF
On-demand services are provisioned using ASON control functions

- Multi-domain
- Multi-layer
- Multi-technology

Domains can use Network Management, SDN or distributed control plane internally

Domains can use different technologies internally
Summary

- **SDN has great promise to improve transport control**
  - Programmability
  - Simplified multi-layer control
  - Common behaviors in Heterogeneous NE deployments
  - Application Awareness

- **Many pitfalls exist that can derail Transport SDN**
  - Reuse of Management interfaces for external control
  - Centralized control in Wide Area environments
  - Monolithic application/controllers
  - Use of 1+1 & Hard State instead of 1:n & Soft State

- **OIF is providing guidance to avoid pitfalls**
  - Carrier Requirements
  - Framework Document
  - Demonstrations
Thank you!

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