Is there a Role for GMPLS in Transport SDN?

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Agenda

- Defining Transport SDN
- The Open Transport Switch (OTS) Concept
- GMPLS Role in Transport SDN
- OTS Prototype Demonstration
- Summary
## Some Historical Context

<table>
<thead>
<tr>
<th>Packet World</th>
<th>Transport World</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Connectionless</td>
<td>• Connection (circuit) oriented</td>
</tr>
<tr>
<td>• Enterprise origins</td>
<td>• Service provider origins</td>
</tr>
<tr>
<td>• Dynamic flows</td>
<td>• Static pipes</td>
</tr>
<tr>
<td>• Innate control plane (EMS/NMS independent)</td>
<td>• EMS/NMS + Cross-connect paradigm</td>
</tr>
<tr>
<td>• Numerous distributed CP solutions</td>
<td>• Nascent CP (GMPLS)</td>
</tr>
<tr>
<td>• Monolithic, closed systems</td>
<td>• Open, programmable systems</td>
</tr>
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</table>

Historically, transport networks have been programmable.
Convergence of networking layers
• \{Packet + OTN + ROADM + WDM\} = Dynamic & Agile transport
• Necessity for economical scale & operational simplicity

Rise of the Data Center
• Cloud & content networking has an impact on network traffic
• Distributed computing & M2M traffic on the rise

Evolving cost/bit @ different layers
• Transport economics create opportunities for multi-layer optimization

Emergence of (packet) SDN
• Virtualization & Unification of whole network
Extending SDN to Transport

- Rapid & Flexible Bandwidth
  - Turn-up bandwidth quickly to support applications

- Simplify/Automate Operations
  - Multilayer, multivendor & multi-domain orchestration

- Improve Resource Utilization
  - Coordinate & optimize between layers, select optimal path

- Speed New Service Deployment
  - Services created faster w/direct API access to transport layer

SDN unlocks the value of dynamic transport bandwidth.
A Vision for Transport SDN
Multi-layer, Multi-Domain, Multi-Vendor Abstraction & Automation

This is what applications see
Open Transport Switch (OTS) Concept

- **Open Transport Switch** is a light weight virtual switch employed in SDN architectures for facilitating resource discovery, monitoring and provisioning of transport flows
- Extends OpenFlow for transport functions, adds other Web2.0 protocols
- Runs on top of programmable packet/optical transport platforms

What is the right network abstraction?
Multiple Abstractions Enable CP Compatibility

Indirect (Implicit) Path Set Up
(provision edge nodes only, leverage existing control plane)

Direct (Explicit) Path Set Up
(provision every node)
Use Case – Optimizing Inter-data Center Networking

- Dynamic, flexible QoS bandwidth for packet flows
- Layer 0/1/2/2.5/3 integration & abstraction
- Centralized TE for better performance & utilization
- Multi-layer resource optimization
Use Case – Multi-Layer Optimization

- Next-gen networks will drive need for multi-layer representation, topology computation & provisioning
- SDN approach facilitates orchestration across layers & domains

Optimize resource utilization & cost per bandwidth service (subject to QOS)
Transport SDN Demo Configuration

- SDN Controller communicating with OTS via OpenFlow extensions
- Bandwidth on Demand application for Big Data RDMA transport
- 3 physical transport path options (with varying latencies)
- Implicit & explicit provisioning of 10GbE/40GbE services demonstrated
## Potential OpenFlow Extensions for Transport Networks

<table>
<thead>
<tr>
<th>Function</th>
<th>Example</th>
<th>Issue</th>
<th>Potential Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connection setup</td>
<td><img src="" alt="Diagram" /></td>
<td>What if the flows are non-packet (e.g. circuits)?</td>
<td>Introduce the concept of flow-id into OpenFlow</td>
</tr>
<tr>
<td>Flow Aggregation (not demo’ed)</td>
<td><img src="" alt="Diagram" /></td>
<td>Flow modification messages add flows to an Ethernet port, not to another flow</td>
<td>Use of virtual port for non-packet flows</td>
</tr>
<tr>
<td>QoS and CAC (not demo’ed)</td>
<td><img src="" alt="Diagram" /></td>
<td>QoS is not in v1.0</td>
<td>Need to include latency requirements</td>
</tr>
<tr>
<td>Transport technique-agnosticism</td>
<td><img src="" alt="Diagram" /></td>
<td>How can we process “flows” over multi-protocol networks?</td>
<td>Extending service negotiation in OpenFlow</td>
</tr>
</tbody>
</table>
Summary

- SDN is changing the way people think about networking – focus has particularly been on packet flows

- Emerging converged packet/optical systems (P-OTS) & the economics between circuit & packet switching is driving interest in Transport SDN

- GMPLS can play an important role in supporting higher level abstractions of transport networks
  - Hybrid of Centralized + Distributed networking functions

- OTS demo is a 1st step towards realizing open, programmable transport networking
  - Multiple standards organization addressing
Thank You

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