Software Defined Networks in SP Environments
Architecture, Elements and Use Cases

Stefano Previdi (sprevidi@cisco.com)
Distinguished Engineer
Cisco Systems

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Use Case: iOverlay Architecture

- Overlay client uses service from Server layer
- The two layers are independent and decoupled
- I for Information: all the required information is flowing between the two layers

“Client” or “Overlay”

“Server”

“i” for Information flowing between layers at the UNI boundaries
Use Case: Content Delivery Network
CDS-IS Service Router with NPS
Mobile: Backhaul Congestion Notification

- IGP Metric Extensions for BW and Delay information
- PCEP for LSP state information
- BGP-LS for topology (including IGP Metric Extensions)
Information Acquisition Example: SPs and CDNs

- How to signal to the CDN a change in the link resources availability?
  - Without re-advertising all affected SP prefixes!
- If CDN is able to understand some form of topology, the SP could advertise the change and instruct the CDN to use alternate peering point.
On the question of Centralized vs Distributed …

<table>
<thead>
<tr>
<th>Feature</th>
<th>Fully Distributed</th>
<th>Logically Centralized</th>
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<tbody>
<tr>
<td>Rapid prototyping (TTM vs. performance)</td>
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<td>Algorithms which require coordination between instances, benefit from “a global view”</td>
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<td>Large scale tables with relatively infrequent updates (ARP…)</td>
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<td>Software/Algorithm for tightly coupled homogeneous environments</td>
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<td>Controlled/tightly-managed Environments</td>
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<td>Rapid response to Topology Changes: Efficient “plain vanilla” Layer-3-style forwarding</td>
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<td>Rapid response to data-plane events / packet forwarding</td>
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<td>Simplicity of Control- and Data-Plane Integration**</td>
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</table>

** Past experience (e.g. PSTN, AIN, Softswitches/IMS, SBC): CP/DP split requires complex protocols between CP and DP.

Network Information Acquisition
Topology Information

• Why? What do we want to do?
  Traffic/Demand Engineering
  Application Traffic Optimization
  Service Chaining
  Virtualization of: paths, flows, topologies, infrastructures, …
  Segment Routing
  Others…

• What do we need
  A complete and exhaustive view of what’s in the reality underneath our apps.
Requirements

• Aggregation / Abstraction
  Aggregate topology elements: links and nodes
  Similar to prefix aggregation

• Extendibility
  Allow extension of topology
  Enhance LSDB information with policy originated info
  E.g.: inter layer peering points
Requirements

• Multi-layer / Multi-domain
  The same mechanism must be re-usable between any pair of layers
Topology Acquisition

- Functions Definitions
  - Acquisition
  - Topology Server/System
  - Orchestration
  - APIs

Orchestration: PCE/NPS/CDNI/Cloud, ...

Topology DB

Topology System

Topology Acquisitio
Information Acquisition Example: BGP-LS for NPS/ALTO Servers

1. IGP Redistribution into BGP-LS
2. Advertisement of BGP-LS NLRIs to RR
3. Advertisement of BGP-LS NLRIs to NPS/PCE server

• Benefits:
  - Single API from network to ALTO Srv
  - Isolation of IGP from ALTO
  - Leverage BGP Policies
  - Allows virtualization/aggregation of topology information
  - Control is kept in network layer
Topology Servers/Systems and Network Programmability

PCE, NPS, ALTO
Requirements: Network Virtualization
Segment Routing

• Virtualization
  multiple overlays (application, vpn) share the network

• Flow engineering
  traffic is engineered on a per-flow basis, maximize utility

• High Frequency
  overlays may change their per-flow path at high frequency

• Simplicity
Multi-Domain / Multi-Layer PCE

- DWDM
- IP/MPLS
- Services
- Backhaul
- Fiber
- Link
- Tunnel
- Inter-layer PCE APIs
- IP/MPLS PCE
- Optical PCE
- Inter PCE
Cisco Approach: Multilayer/Multidomain NPS/PCE

**Northbound APIs**
- Path Request APIs (PCEP)
- Network Guidance APIs (ALTO, NPS)

**East/West APIs**
- Inter-PCE APIs: Redundancy, Load Share, ...

**Orchestration layer**
- Topology Management: Multilayer, Multidomain, Aggregation, Virtualization, Stitching, Active/Passive...
- Information Databases: topologies, analytics, traffic matrix, inventory, locations, ...
- Algorithms and Service computations: PCALC, ALTO, NPS, SPF/RSPF, CDNI, ...

**Southbound APIs**
- Topology/State/Resources Information Acquisition APIs (BGP-LS/BGP/IGPs/...)
- State Signaling APIs (PCEP, OF, ...)

**Infrastructure**
- Optical
- IP/MPLS
- L2 Switching
- Video
- Mobile
- DC Network
- DC Compute
- DC Storage
- ...
Summary: Cisco Perspective on SDN

- **Cisco continues to pursue software defined networking**
  - SDN includes (1) network overlay virtualization (2) programmatic device APIs (3) network functional abstractions
  - Cisco’s portfolio already includes several key components of an SDN solution
    - PCE/PCEP, ALTO, OpenFlow, …

- **OpenFlow is a protocol, not an architecture**
  - OpenFlow primarily define a protocol for packet forwarding

- **Migration to SDN will be evolutionary**
  - Cisco will take a use-case driven approach
  - Cisco will in the near term engage with specific customers on SDN and OpenFlow as a prototype technology

- **Emerging upper level requirements**
  - Network Virtualization, Slicing
  - Service Chaining
Thank you.