SDN-based Automated Peering Engineering
Challenges and Solutions

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Peering Automation/Optimization with analytics and SDN Control

The five key questions...

1. What has changed/changing in the peering?
2. Is peering automation possible?
3. In what context and what value it brings?
4. What are the key use cases?
5. What are the challenges ahead?
Internet traffic reality

2000 → 2018
From web browsing to social media, video streaming and online gaming

Internet traffic became much more versatile, dynamic and unpredictable
Internet Peering: Changes

Speed and latency matter: Performance emerges as key driver over cost

<table>
<thead>
<tr>
<th>ISP LEADERBOARD - JANUARY 2019</th>
<th>SHOW SMALLER ISPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>RANK</td>
<td>ISP</td>
</tr>
<tr>
<td>1</td>
<td>Comcast</td>
</tr>
<tr>
<td>2</td>
<td>Verizon - FIOS</td>
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<tr>
<td>3</td>
<td>Cox</td>
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<tr>
<td>4</td>
<td>Spectrum</td>
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<tr>
<td>5</td>
<td>Optimum</td>
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<tr>
<td>6</td>
<td>Mediacom</td>
</tr>
<tr>
<td>7</td>
<td>Suddenlink</td>
</tr>
<tr>
<td>8</td>
<td>AT&amp;T - Universe</td>
</tr>
</tbody>
</table>

Source: https://ispspeedindex.netflix.com/country/us/

Latency matters for both service providers, webscale and enterprises

Source: https://www.reviews.org/internet-service/best-internet-gaming/
Internet Peering: Change

Peering Analytics much more richer than ever before

- **Cost**
  - Transit fees

- **Performance**
  - Link utilization, latency, jitter, packet loss

- **Geographical coverage**
  - Countries, regions, sites

- **Source and destination**
  - Transit providers, enterprises, partners, CDN, IXC ...

- **Application type**
  - Video, gaming, storage, VoIP, P2P ...

Meaningful Big Data attributes
Intuitive and related to the business intent

What can we do with all this massive data?
## Existing Limitations...

<table>
<thead>
<tr>
<th><strong>Routing mechanism</strong> - Border Gateway Protocol (BGP)</th>
<th><strong>Organization and tools</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>✗ Unaware of link capacity &amp; real-time utilization</td>
<td>✗ Multiple teams involved</td>
</tr>
<tr>
<td>➫ Packet loss and congestion</td>
<td>(network operations, peer engineers, OAM probing, EMS alarms...)</td>
</tr>
<tr>
<td>✗ No real-time path performance indication</td>
<td>✗ Complex, manual processes</td>
</tr>
<tr>
<td>➫ High latency</td>
<td>➫ Error-prone configurations</td>
</tr>
<tr>
<td>✗ No end-to-end performance indication</td>
<td>✗ Reactive model</td>
</tr>
<tr>
<td>➫ Sub-optimum overall performance</td>
<td>➫ Inadequate for sudden real-time event changes</td>
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**Visibility**

| ✗ Lack or limited visibility | ➫ Limited traffic engineering and steering |

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Reda Laichi LACNOG 2019
Problem Space

Objectives & applicability...

What do we want to address?

Better bandwidth management, automatic congestion resolution, better traffic symmetry

Better SLAs, & application Performance (Latency, Packet Loss)

Reducing transit peering cost, addressing OPEX & CAPEX

What traffic are we interested in?

Inbound Traffic

Outbound Traffic

Balanced

Peering Only

Peering & Internal Network

What part of the network?

Automated peering engineering

Insight-driven automation

Peer 1
Peer 2
Peer 3
Border router 1
Border router 2
Content

Analytics
Closed Loop Automation
SDN Control

Network
Complexity of the “automation” problem?

**Challenge:**
Existing operational environment and its complexity, and taking into account the human dimension

**Approach?**

- **Peering Analytics & Telemetry**
  - Ping, TWAMP, TCP/UDP, HTTP, in-band?
  - Internal lsp-ping
  - Bi-directionality
  - Return-path

- **OAM - Probing**

**Automatic Real-time Events Detection**

**Software Control**
Steering, flows, Routes, Policies

**Network Data & Monitoring**
- Topology, path, router/interface discovery

Leveraging recent technology developments

- Filters, BGP Policies, Route Injection, BGP FlowSpec, Openflow, BGP SR TE Policies & route coloring, RIB/FIB API, RSVP-TE/SR, PCEP, Netconf

- BGP-LS, EPE extensions, OSPF, ISIS, BMP, netconf

**The other challenge is in system integration, open interfaces and multi-vendor...at scale**
Use Case 2: Egress peer engineering with congestion based steering

Problem:
100s of peering partners, which peer and egress link is best and is least congested?

Approach:

1. Automatic link congestion detection
   - Real-time stat/data collection and correlation (gRPC, Netconf/SNMP)
   - Interface & Flow Stats (IPFix)

2. Determine optimal alternate ASBR & alternate peer based on topology and bandwidth availability.
   - Auto-create/use existing tunnel/path to alternate ASBR (can be PCE initiated)

3. Steer selected IP flows at the edge of the network across the newly/existing tunnel and encode the egress peer link label/segment ID.

   Note: Colored BGP route to BGP-SR TE Policy tunnel can be used for steering

   Stats per source subnet or per destination subnet or per destination AS, per traffic category or per specific APP

   Steer selected traffic directly to LSP/Tunnel (filters, openflow, flowspec, segment routing BGP colored route

   Establish an LSP/Tunnel to alternate that meets traffic offloading profile
Use Case 3: Local and EPE with Latency-based Steering
Performance-based Optimization End-to-End

Problem:
100s of peering partners, BGP best path on default peer causing high latency for top traffic or selected application/branch destination traffic.

Approach:
1. Real-time probing from each source PE and each alternate ASBRs of discovered top/VIP destinations
2. Determine optimal alternate ASBR based on end-to-end latency/performance data using path computation based on abstract topology Auto-create the LSP/tunnel to alternate ASBR
3. Auto-steer selected traffic to the LSP/tunnel to alternate ASBR/ASBR+Egress peer link

Steer selected traffic directly to LSP /Tunnel (filters, openflow, flowspec, segment routing BGP colored route)

• Compute end-to-end based on Total latency information
• Establish an LSP/Tunnel to alternate that meets traffic offloading profile

In addition to stats, collect latency measurement from PE-ASBR (in-band using LSP ping) and ASBR-Destination point per selected prefix using Ping, TWAMP, TCP/UDP, HTTP

Approach:
1. Real-time probing from each source PE and each alternate ASBRs of discovered top/VIP destinations
2. Determine optimal alternate ASBR based on end-to-end latency/performance data using path computation based on abstract topology Auto-create the LSP/tunnel to alternate ASBR
3. Auto-steer selected traffic to the LSP/tunnel to alternate ASBR/ASBR+Egress peer link

Latency degradation
Use Case 4: Controlling Inbound Traffic

- **Problem:** The links from transit providers are congested due to high incoming traffic. Automate traffic shifting per BGP communities to alternate TP.

- **Solution/Approach:** Integrates and automate analytics data showing top BGP community traffic.

- Monitors bandwidth availability down to Customer devices and performs BGP route extraction and analysis (using BMP) – Extract topology information, LSPs, telemetry

- Using BGP Policies or route injection, selectively shift customer incoming traffic to alternate peer links or to even to an alternate transit provider

- Optionally steer selected customer prefixes to specific LSPs

Two approaches **full automation** or **semi automation** (manual mode with abstraction)

- Automation hierarchical policies: Automate within the same router, other routers same site, completely different region (slice)
- Need to factor in the BGP convergence time
• Automation and optimization using analytics and SDN control bring a lot of value to peering in terms of simplified operations, better traffic engineering and operations, and improving QoE.

• However any effective automation needs to consider:
  • Culture and operational change considerations
  • Existing BGP operational models in place and the high level of customization
  • Leverage predictive analytics with control
  • Automation & optimization algorithms need to consider redundancy, recovery and ECMP.
Questions?

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