SDN-based Automated Peering Engineering Challenges and Solutions

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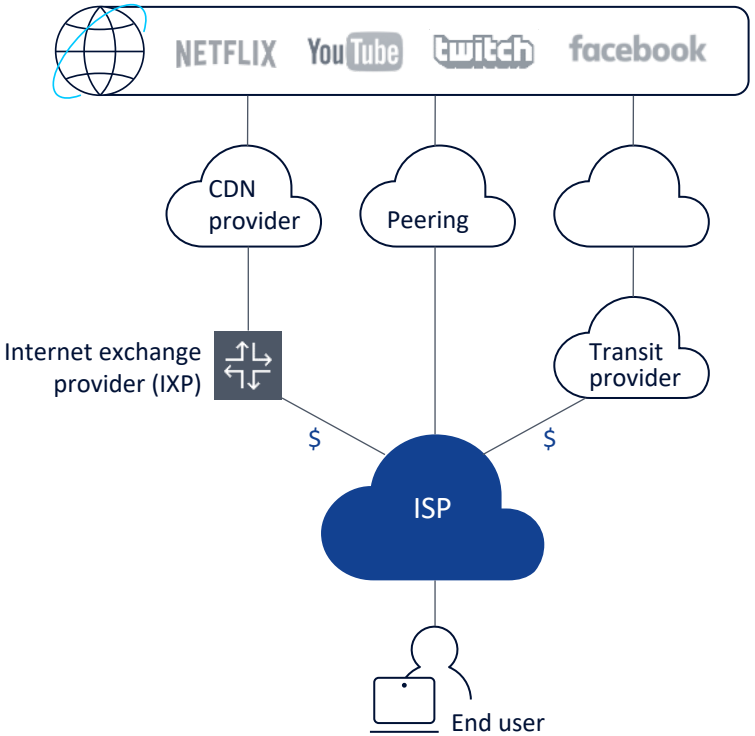
Peering Automation/Optimization with analytics and SDN Control

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?

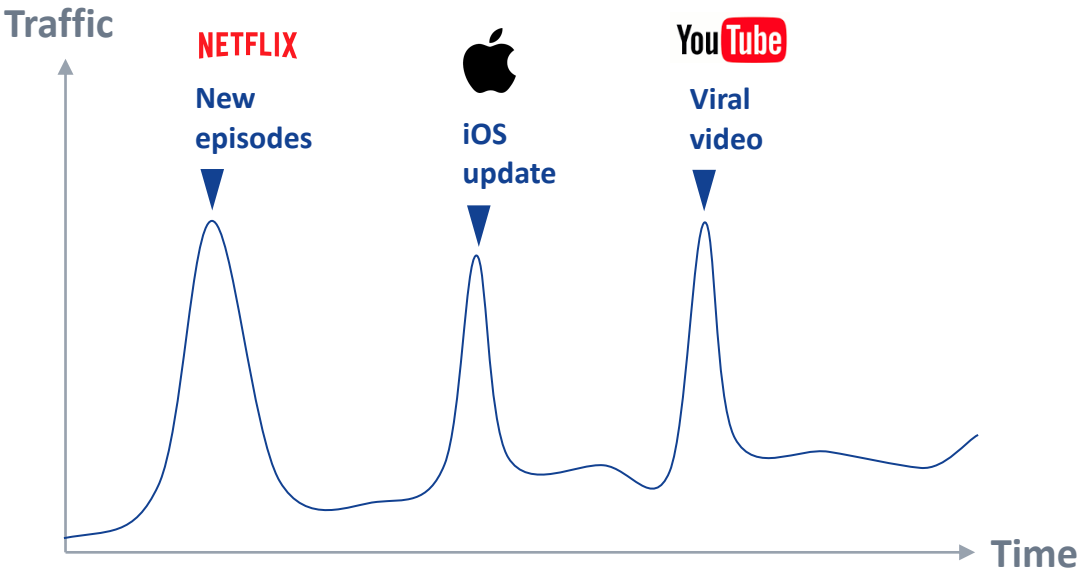


Internet traffic reality

2000 → 2018

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

NETFLIX YouTube Google Spotify twitch hulu amazon pandora facebook



Internet traffic became much more versatile, dynamic and unpredictable

Internet Peering: Changes

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

ISP LEADERBOARD - JANUARY 2019 SHOW SMALLER ISPS

RANK	ISP	SPEED Mbps	PREVIOUS Mbps	RANK CHANGE	TYPE (Fiber / Cable / DSL / Satellite / Wireless)
1	Comcast	4.46	4.51	+1	
2	Verizon - FiOS	4.46	4.51	-1	
3	Cox	4.46	4.51		
4	Spectrum	4.43	4.48		
5	Optimum	4.39	4.45		
6	Mediacom	4.31	4.35		
7	Suddenlink	4.26	4.30		
8	AT&T - U-verse	4.15	4.30		

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

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

Latency matters for both service providers, webscale and enterprises

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...

Routing mechanism - Border Gateway Protocol (BGP)

- ✗ Unaware of link capacity & real-time utilization
  - ↳ Packet loss and congestion
- ✗ No real-time path performance indication
  - ↳ High latency
- ✗ No end-to-end performance indication
  - ↳ Sub-optimum overall performance

Visibility

- ✗ Lack or limited visibility
  - ↳ Limited traffic engineering and steering

- ✗ Multiple teams involved
  (network operations, peer engineers, OAM probing, EMS alarms…)
  - ↳ Slow communication
- ✗ Complex, manual processes
  - ↳ Error-prone configurations
- ✗ Reactive model
  - ↳ Inadequate for sudden real-time event changes

Organization and tools

Problem Space

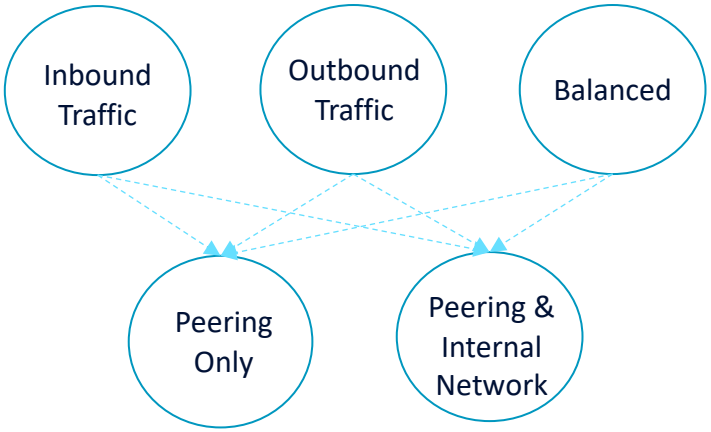
Objectives & applicability...

What do we want to address?

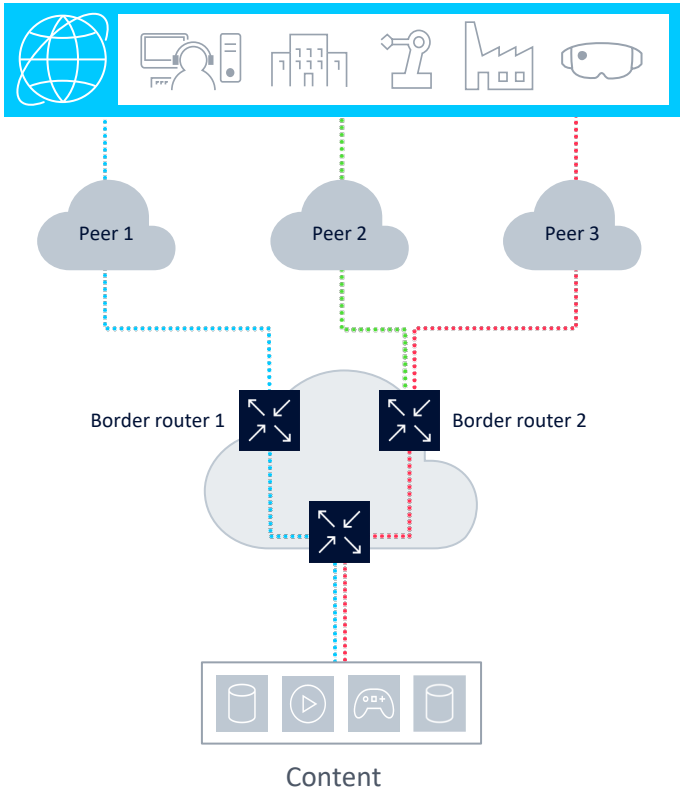
- Better bandwidth management, automatic congestion resolution, better traffic symmetry
- Better SLAs, & application Performance (Latency, Packet Loss)
- Reducing transit peering cost, addressing OPEX & CAPEX

What traffic are we interested in?

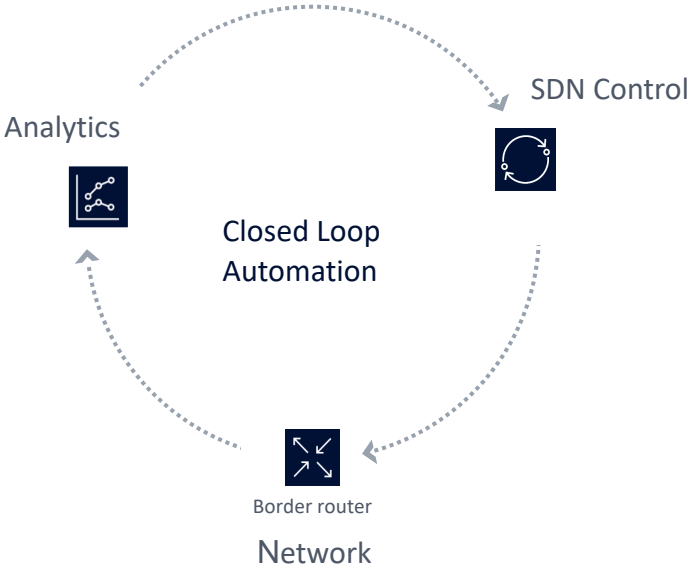
What part of the network?



Automated peering engineering



Insight-driven automation



Complexity of the "automation" problem?

Challenge:

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

- Stats, BGP routes, flow stats, protocol, destination AS, prefixes, application-based?
- Rates of sampling & collection

- Ping, TWAMP, TCP/UDP, HTTP, in-band?
- Internal lsp-ping
- Bi-directionality
- Return-path

Approach?

Peering Analytics & Telemetry

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

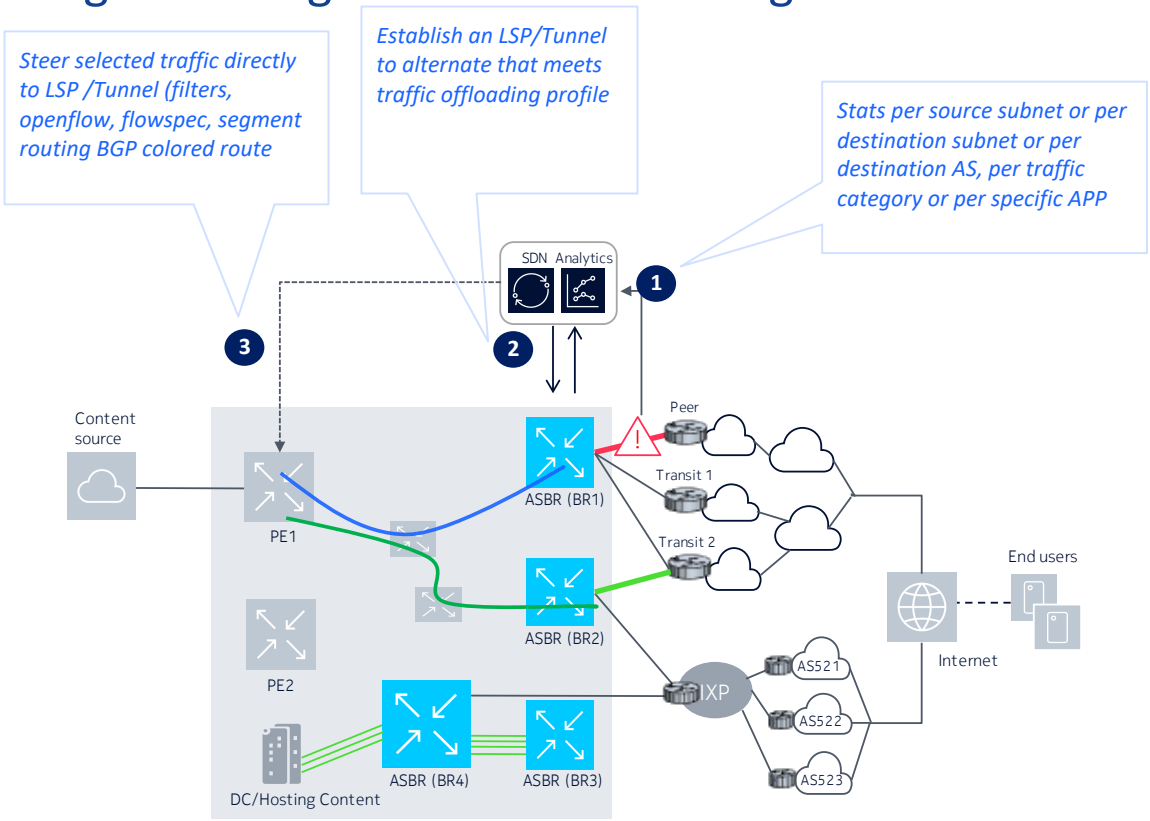
   Real-time stat/data collection and correlation (gRPC, Netconf/SNMP)
   Interface & Flow Stats (IPFix)

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



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.

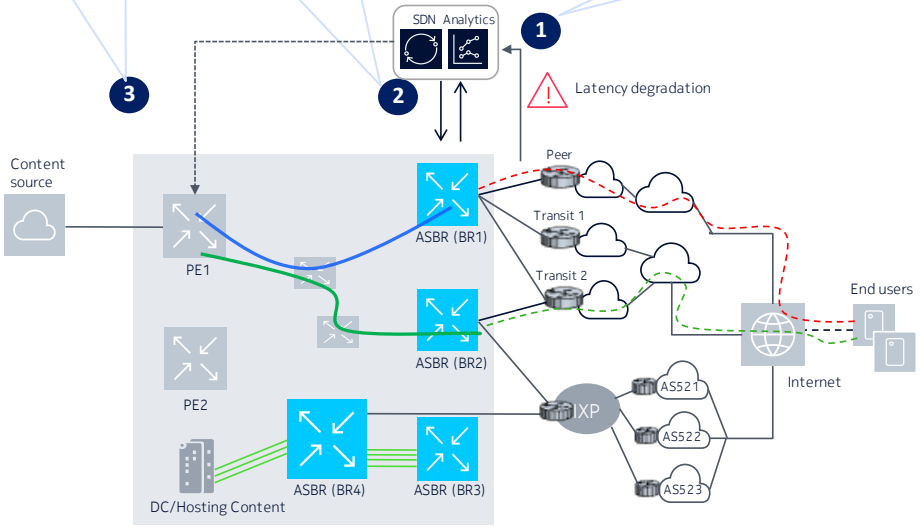
Approach:

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)

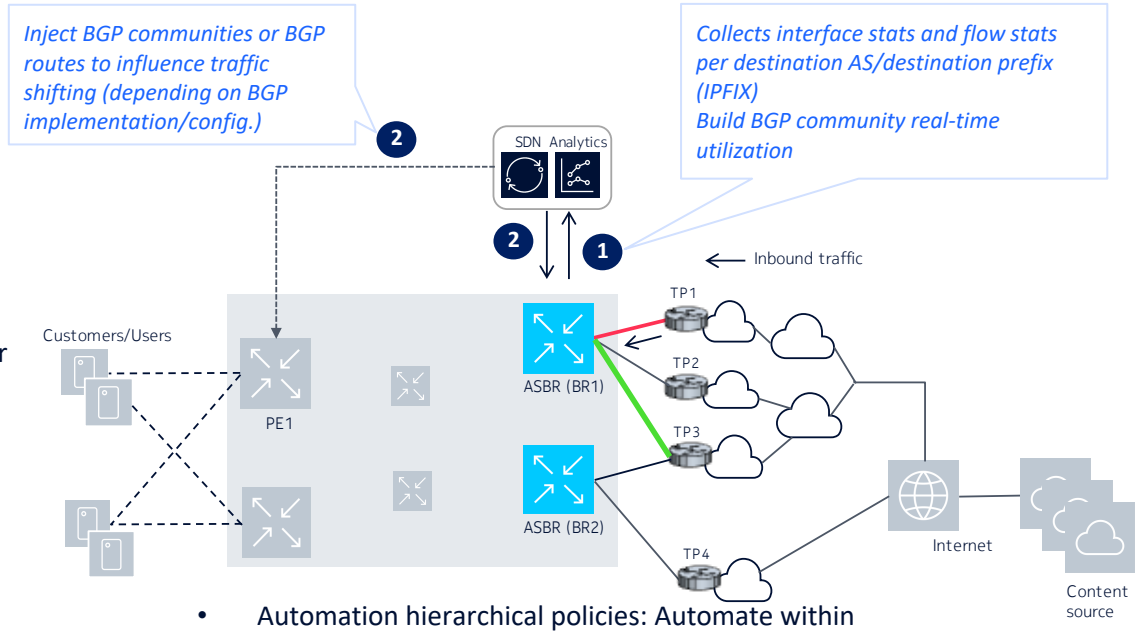
- *Compute end-to-end based on Total latency information*
- *Establish an LSP/Tunnel to alternate that meets traffic offloading profile*

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



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



- Automation hierarchical policies: Automate within the same router, other routers same site, completely different region (slice)
- Need to factor in the BGP convergence time

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

Summary

- 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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