Segment Routing

Clarence Filsfils – cf@cisco.com
Agenda

• Objective
• Abstract Routing Model
• Use-cases
• Conclusion
• Q&A
SR Objectives

• Tackling issues reported by operators for years
  – IGP-based FRR for any topology
  – Simpler to operate, more scalable explicit routing

• Supporting “SDN”-based services
  – Provide a more responsive and scalable interaction between WAN orchestration, the applications and the network

• Evolution, no revolution
  – Must be simple to operate
  – Must support incremental deployment
Objective for this Nanog talk

• Informative
• Trigger your interest
  – A wealth of details in the upcoming drafts
• Seek your involvement
• Brief
  – We could speak for a full-day as we have much research and use-cases to share and discuss
Details

- draft-filsfils-rtgwg-segment-routing-00
- draft-filsfils-rtgwg-segment-routing-use-cases-00
- draft-previdi-isis-segment-routing-routing-extensions-00
- draft-psenak-ospf-segment-routing-routing-extensions-00
- draft-msiva-pce-pcep-segment-routing-routing-extensions-00
Real

• Excellent endorsement and leadership from SP and Entreprise community
• Multi-vendor consensus and collaboration
• By mid June, we will submit detailed IETF drafts
  – Architecture
  – Use-cases
  – ISIS extensions
  – OSPF extensions
  – PCEP extensions
  – FRR
• SR EFT is available since Feb 28
  – 12k, ASR9k, CRS1, CRS3
Abstract Routing Model

draft-filsfils-rtgwg-segment-routing-00
Segment Routing

• A 32-bit segment can represent any instruction
  – Service
  – Context
  – IGP-based forwarding construct
  – Locator

• Ordered list of segments
  – An ordered chain of topological and service instructions

• Per-flow state only at ingress SR edge node
  – Ingress edge node pushes the segment list on the packet
IGP Segments

• Prefix Segment
  – Steers traffic along ECMP-aware shortest-path to the related IGP Prefix
  – Global segment within the SR IGP domain
  – Node Segment: a prefix segment allocated to a prefix that identifies a specific node (e.g. the prefix is its loopback)

• Adjacency Segment
  – Steers traffic onto an adjacency or a set of adjacencies
  – Local segment related to a specific SR node

• SR Global Block
  – A subset of the Segment space
  – All the global segments must be allocated from SRGB
  – Operator manages SRGB like an IP address block: it ensures unique allocation of a global segment within the SR domain
IGP Prefix Segment

- Z advertises its global prefix segment 65 with his loopback address Z/32
  - simple ISIS sub-TLV extension
  - simple OSPF Opaque sub-TLV extension
- All remote nodes install the prefix segment to Z in the SR dataplane along the shortest path to Z/32
- IPv4 and IPv6

A packet injected anywhere with active segment 65 will reach Z via ecmp-aware shortest-path

draft-previdi-isis-segment-routing-extensions-00
draft-psenak-ospf-segment-routing-extensions-00
IGP Adjacency Segment

- C allocates a local segment 9003 for its adjacency CO
- C advertises the adjacency segment in the IGP
  - Simple ISIS sub-TLV extension
  - Simple OSPF Opaque sub-TLV extension
- C is the only node to install the adjacency segment in SR dataplane
- IPv4 and IPv6

A packet injected at node C with active segment 9003 is forced through datalink CO

draft-previdi-isis-segment-routing-extensions-00
draft-psenak-ospf-segment-routing-extensions-00
Combining Segments

- Source Routing
- ABCOPZ is expressed as \(\{72, 9003, 65\}\)
• Prefix Segment is at the heart of the proposal
  – ecmp multi-hop shortest-path
  – in most topologies, any path can be expressed as list of prefix segments
Combining Segments

- Service Segments can be part of the source route

\{72, 78, 9450, 65\}
SR Control-Plane

• Lightweight extension to ISIS/OSPF
• IPv4 and IPv6
• Agnostic to the dataplane
  – works with any dataplane that supports the encoding of a list of segments on the packet
MPLS dataplane

- The 20 right-most bits of the segment are encoded as a label
- A list of segments is represented as a stack of labels
- The active segment is the top label
- The IGP Prefix segment stays on the top of the stack thanks to a SWAP operation where the ingress and egress label values are the same
- Transports IPv4 and IPv6
- No changes in the operations of the MPLS dataplane
- SR can co-exist and interwork with other MPLS control-plane protocols (LDP, RSVP)
IPv6 dataplane
(without any MPLS dataplane)

• All the SR ISIS/OSPF Control Plane is dataplane agnostic and hence applies directly to IPv6
• Remaining work: detailing the IPv6 tunneling and new Routing Extension type header
  – High-level description provided at March IPv6 Conference
  – Detailed Draft should be available soon
    • We are working on this in close collaboration with Comcast and other SP/Entreprise operators and academia
    • Any contribution is welcome
Use-Cases

draft-filsfils-rtgwg-segment-routing-use-cases-00
Automated & Guaranteed FRR

- Directed LFA FRR is guaranteed in any symmetric topology
  - 2002, LFA FRR project at Cisco
  - draft-bryant-ipfrr-tunnels
- No extra computation (RLFA)
- Simple repair stack
  - node segment to P node
  - adjacency segment from P to Q

![Diagram of directed LFA FRR]

Default metric: 10
Disjointess in Dual-Plane
Anycast SID illustration

A sends traffic with [65]
Classic ecmp “a la IP”

A sends traffic with [111, 65]
Packet gets attracted in blue plane and then uses classic ecmp “a la IP”
CoS-based TE

Anycast SID illustration

• Tokyo to Brussels
  – data: via US: cheap capacity
  – voip: via russia: low latency

• CoS-based TE with SR
  – IGP metric set such as
    • Tokyo to Russia: via Russia
    • Tokyo to Brussels: via US
    • Russia to Brussels: via Europe
  – Anycast segment “Russia” advertised by Russia core routers

• Tokyo CoS-based policy
  – Data and Brussels: push the node segment to Brussels
    ➔ ECMP-aware shortest-path to Brussels
  – VoIP and Brussels: push the anycast node to Russia, push Brussels
    ➔ ECMP-aware shortest-path to Russia, followed by
      ECMP-aware shortest-path to Brussels
Engineer traffic towards egress peers

- Ingress border routers control how their traffic is balanced between peers
  - Overriding BGP decision at egress border
Full control and OAM

- For Traffic Engineering
- or for OAM
The network is simple, highly programmable and responsive to changes instructed by stateful PCE.
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Conclusion

• Technology is simple
  – Lightweight ISIS/OSPF extensions
  – Immediate applicability to MPLS dataplane
    • IPv4 and IPv6
  – A new type of Routing Extension header for IPv6 pure dataplane

• Numerous use cases
• Significant industry interest
• Multi-vendor/operator constructive collaboration
• Your feedback and contribution is welcome!