Segment Routing Technology and Use Cases

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INTRODUCTION

Why Segment Routing

Network Resiliency
TI-LFA and automated 50ms protection

Network Simplification
Eliminate LDP, RSVP and other protocols

E2E Application Control – SDN ready
Assign the packet path as it exits the application

Simplified Service Creation
Easily configure L2VPN and L3VPN services

Service Velocity
Faster service creation, easier troubleshooting

Enhanced User Experience
Faster response time, automated service creation

Simplified Operations
Easy to operate the network

Standards Based
No vendor lock-in

Segment Routing Leading Use Cases

Disjoint Path
Ability to offer new services that provides location/power redundancy for their customers.

Efficient Traffic Engineering
Advanced Traffic Engineering is possible in a simplified manner with application defined paths

Flexible Algorithm (Flex -Algo)
TE-path from anywhere to anywhere computed by IGP. Define own custom algorithm i.e. latency

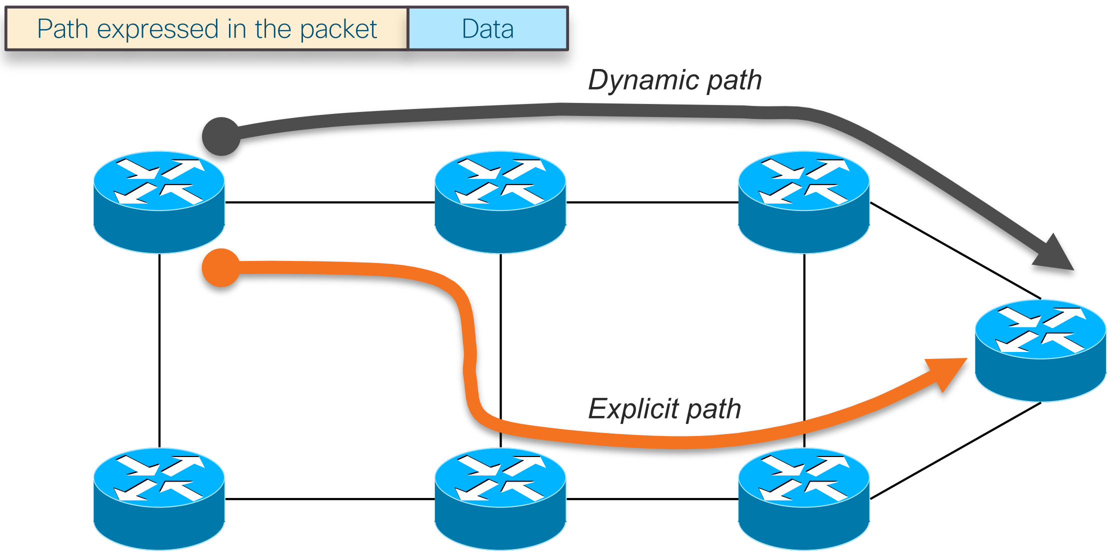
Low Latency Path
Ability to provide a deterministic low latency path for Latency sensitive services

Unified Forwarding Plane
Single data plane for packet transport in the network for operational simplicity

Network slicing/Service Chaining
Architecture optimised for service chaining of network functions and scalable soft slicing capabilities

Segment Routing

Segment Routing – Overall principle



Paths options

Dynamic (SPF computation)	Explicit (expressed in the packet)

Control Plane

Routing protocols with extensions (IS-IS,OSPF, BGP)	SDN controller (BGP , PCEP, NETCONF/YANG)

Data Plane

MPLS (segment labels)	IPv6 (+ SR extension header)

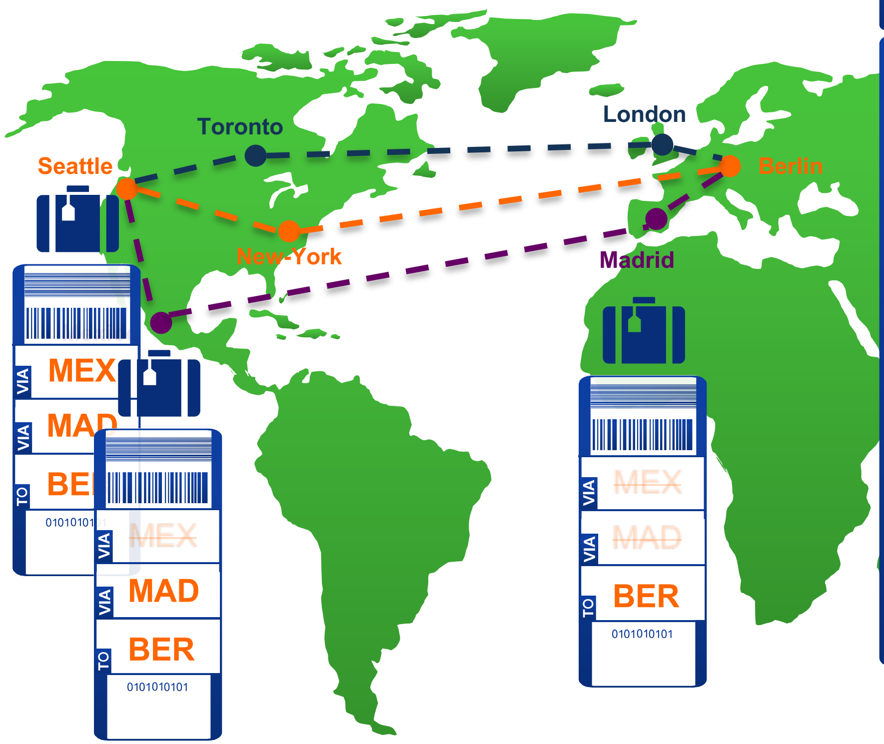
End to end forwarding behavior defined in the packet

Segment Routing Traffic Engineering

Segment Routing

RSVP-TE

IP/LDP



Mission – Route the luggage to Berlin via Mexico and Madrid

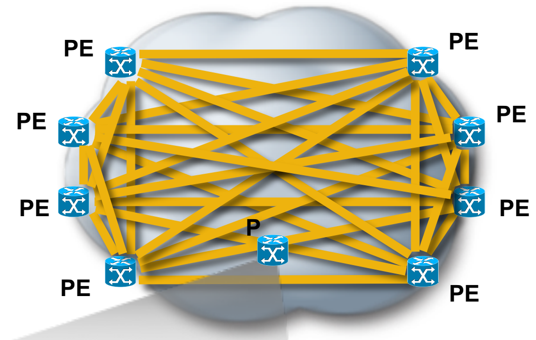
1. A unique and global luggage tag is attached to the luggage with the list of stops to the final destination

2. At each stop, the luggage is simply routed to the next hop listed on the luggage tag

RESULT: **Path can be controlled**
Simple and scalable

SCALING: No state and limited label utilization MPLS LFIB with Segment Routing

- LFIB populated by IGP (ISIS / OSPF/BGP)
- Forwarding table remains constant (Nodes + Adjacencies) regardless of number of paths

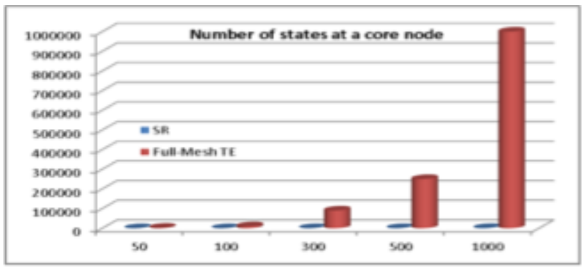


In Label	Out Label	Out Interface
L1	L1	Intf1
L2	L2	Intf1
…	…	…
L8	L8	Intf4
L9	L9	Intf2
L10	Pop	Intf2
…	…	…
Ln	Pop	Intf5

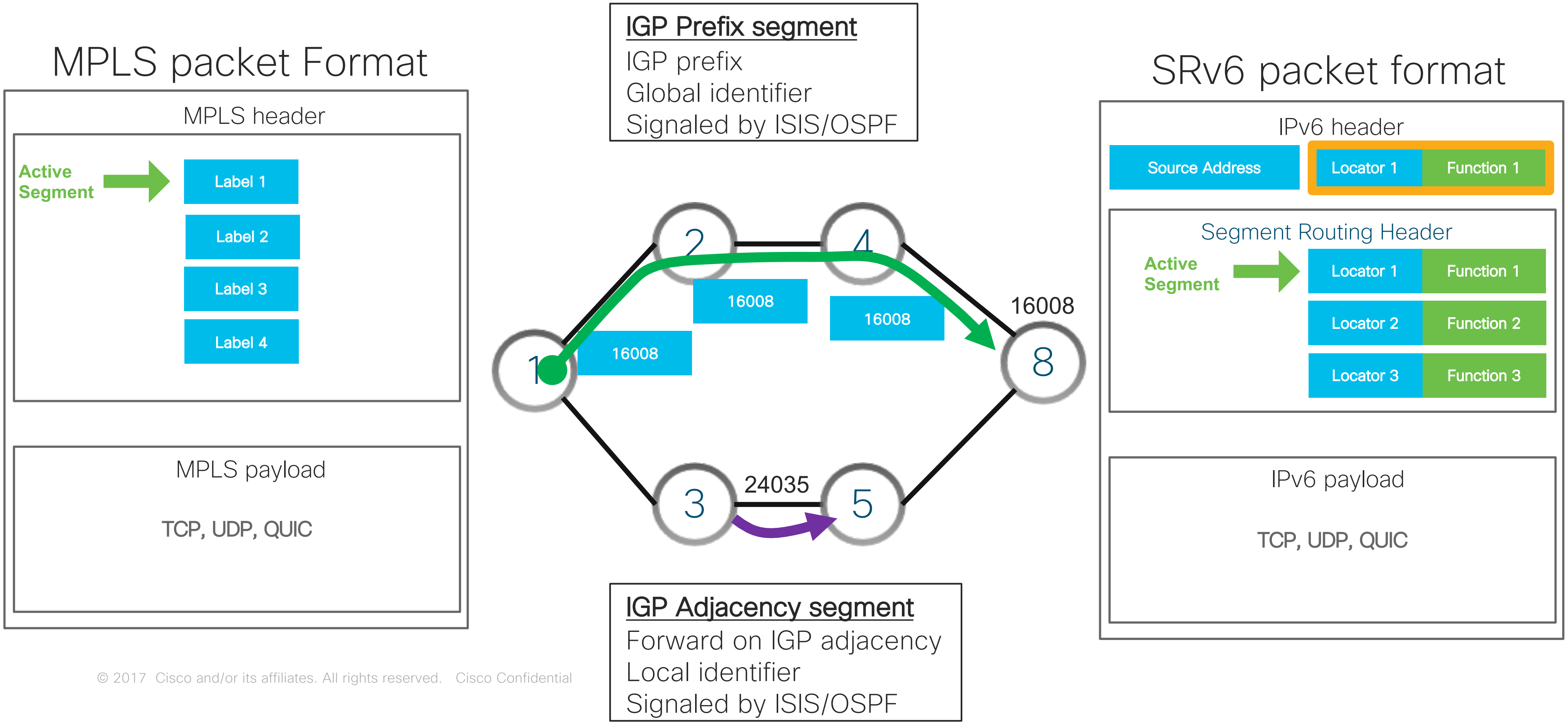
Network Node Segment Ids (L1 … L9)

Node Adjacency Segment Ids (L10 … Ln)

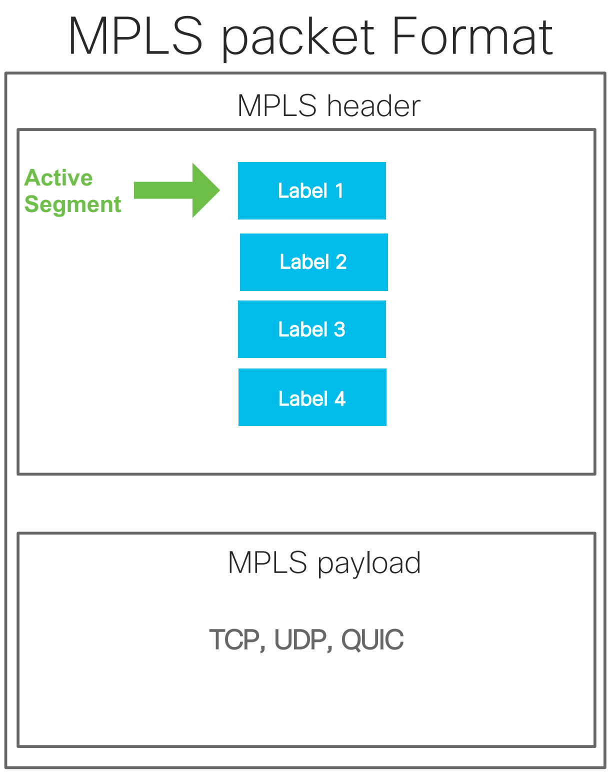
Forwarding table remains constant



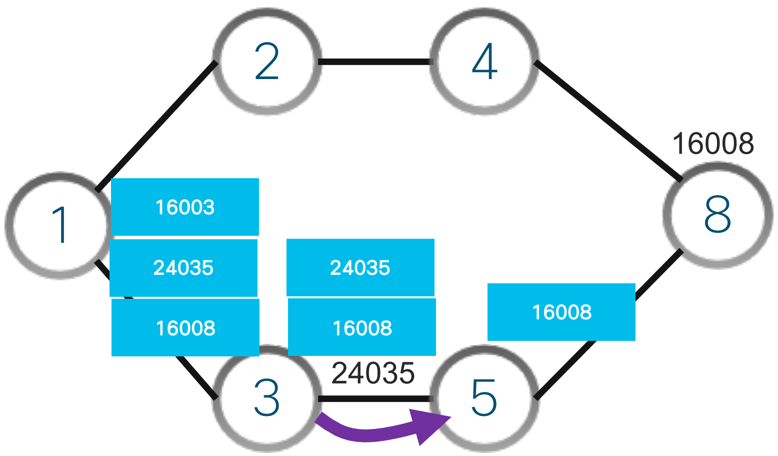
Segment Routing – packet structure + segments



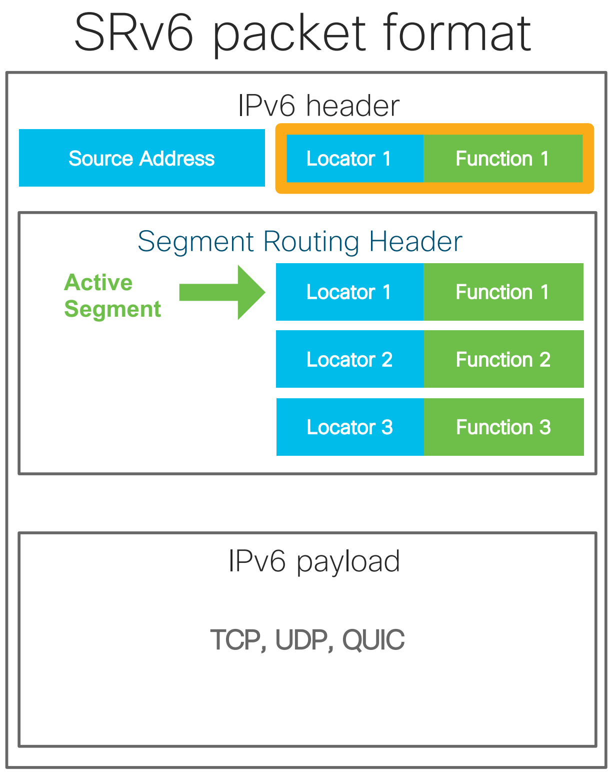
Segment Routing – packet structure + segments



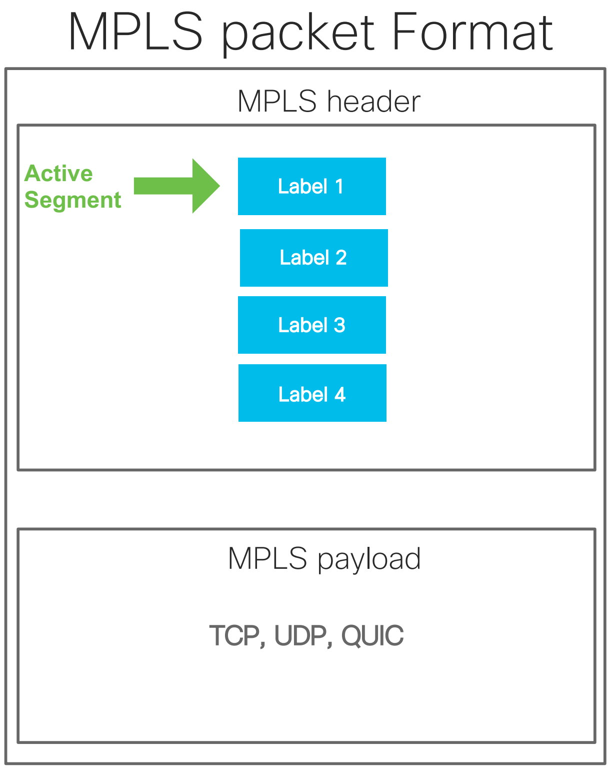
IGP Prefix segment
IGP prefix
Global identifier
Signaled by ISIS/OSPF

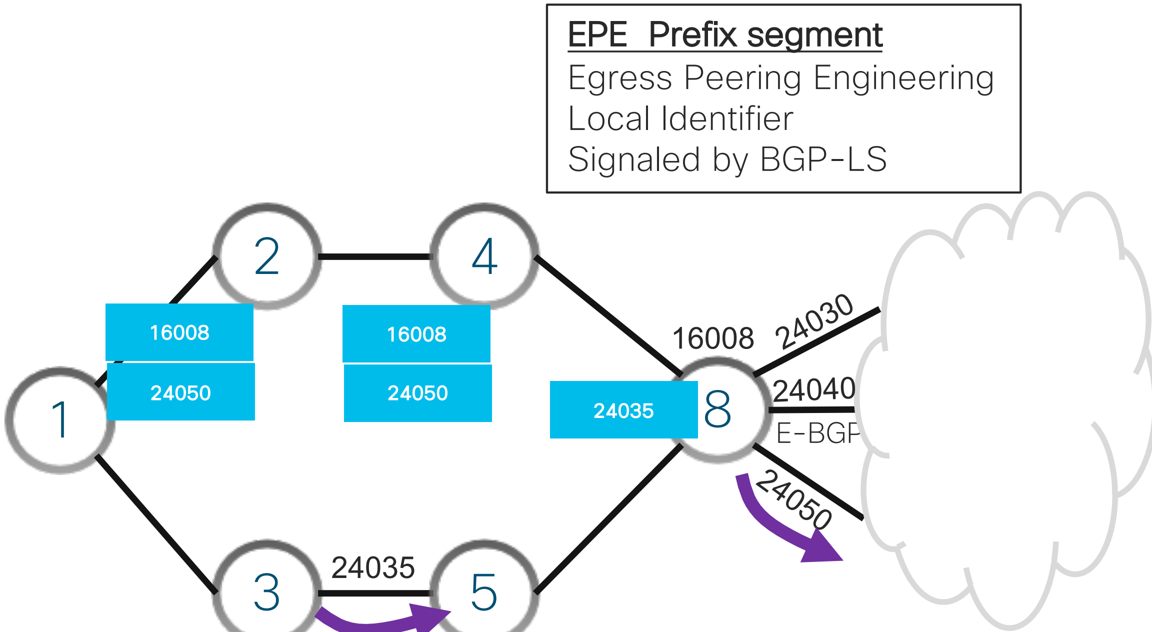


IGP Adjacency segment
Forward on IGP adjacency
Local identifier
Signaled by ISIS/OSPF



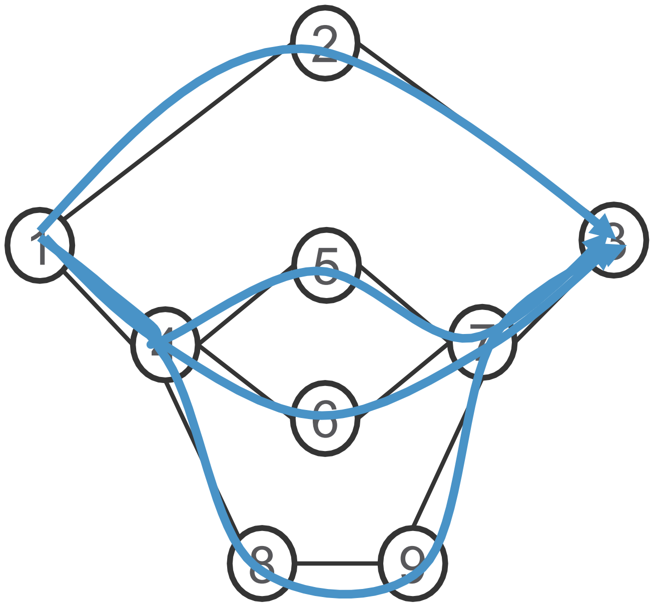
Segment Routing – packet structure + segments

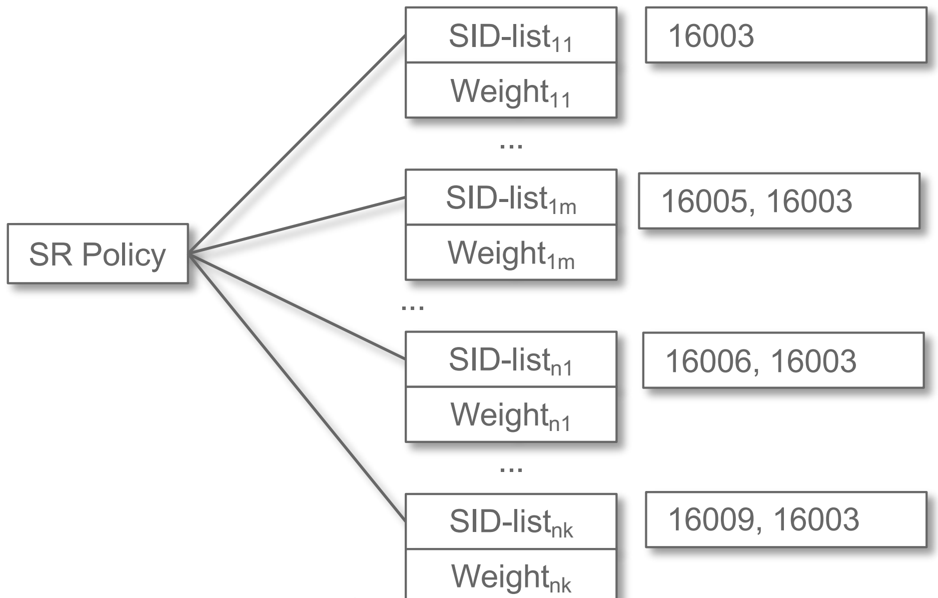




Multiple SID lists Unequal load balancing

- A policy can have multiple SID list
- Each SID list has his own weight for unequal load balancing





Interoperability

http://www.eantc.de/fileadmin/eantc/downloads/events/2017-2020/MPLS2018/EANTC-MPLSSDNNFV2018-WhitePaper-final.pdf

MPLS+SDN
+NFVWORLD
@PARIS2018

White Paper 2018

INTEROPERABILITY SHOWCASE

Use Cases

Rapid Protection: automatic TI LFA FRR

Problem

Incomplete coverage, topology **dependent** coverage of classical LFA

Solution

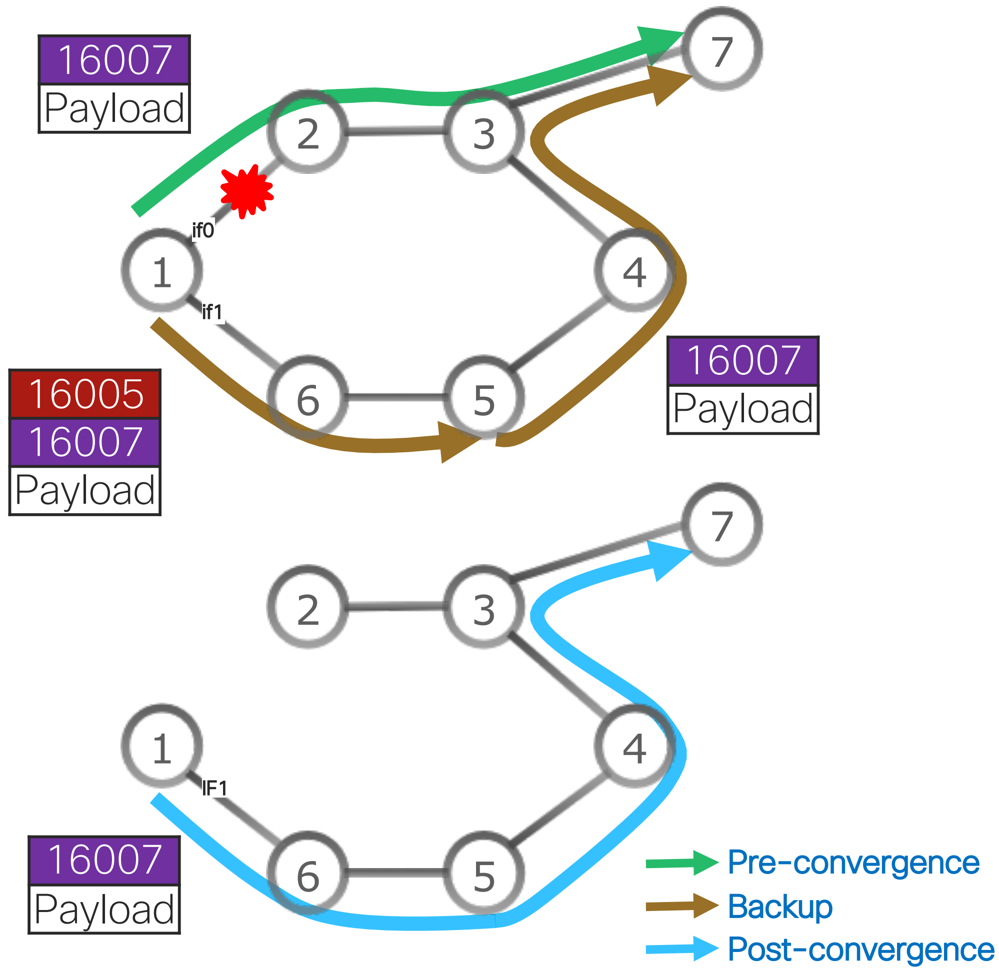
Automated Topology **Independent** with guaranteed sub-50ms per-prefix protection

Benefits

Simple and Automated
IGP computed / No midpoint backup state

Optimal
Backup path following post-convergence path

Scalable
Cisco's TI-FLA algorithm – **optimized for scalability**
Post-convergence path computation and SID-list encoding



Low Latency Path
Real time Delay Measurement

Applicability Examples

Extreme Real-time Communications

Tactile Internet

Voice Communications

Fixed / mobile

Solution

Compute Low Latency path based on measured link delay with MPLS Performance Monitoring (PM)

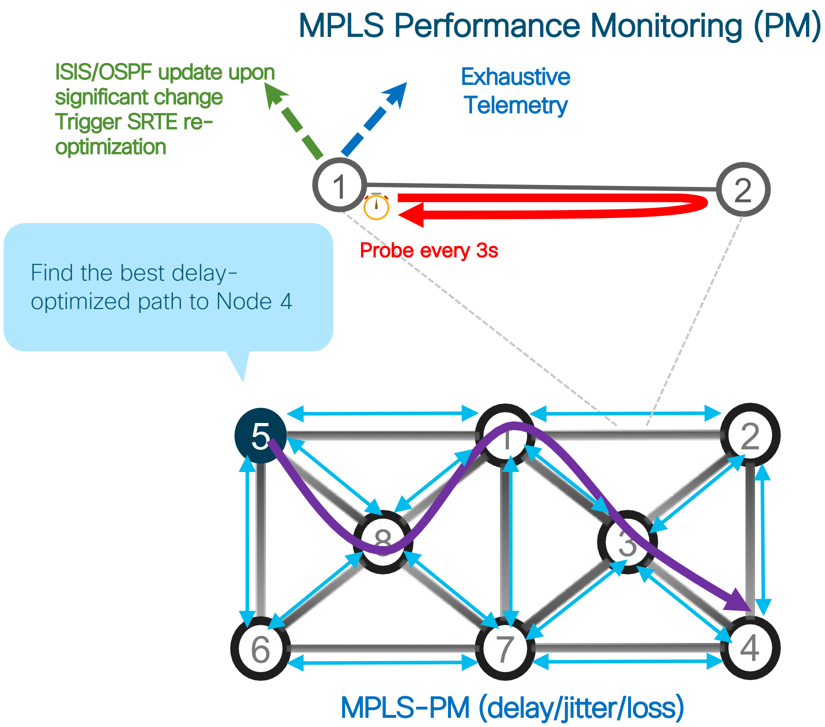
Benefits

Standard Based

MPLS Performance Management to measure real time link delay, jitter and loss

detect optical path reroute, by measuring delay/jitter/loss variations in real-time

Meet, Maintain and Monitor SLAs at all times



Operate with Advanced Monitoring

Problem

Traffic blackholes

Very difficult to detect, troubleshoot

Ex: CEF looks OK, IGP looks OK, etc. but half the data plane traffic is dropped

Solution

Data plane Monitoring; a blackhole detection mechanism

SR router auto-tests its dataplane **exactly as experienced by customer transit** traffic

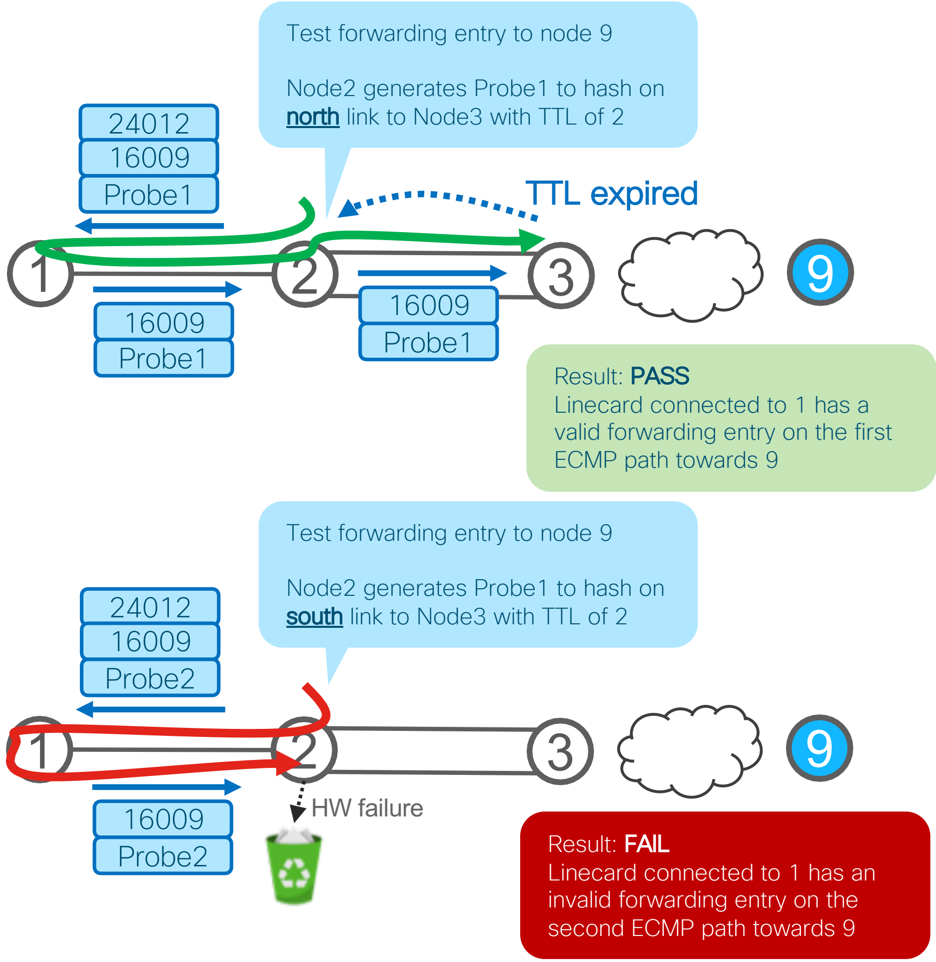
Real packets are injected through each combination of neighbors and destinations.

All the ECMP **possibilities** are tested one by one

Benefits

Proactive detection to enable fast reaction time to failures

Scalability when comparing with end-to-end probing techniques



Interested? SR Operations and Monitoring on segment-routing.net

Simplified planning: SR Traffic Matrix

Applicability Examples

Capacity Planning

Traffic Patterns

Network Optimization

IP or Optical

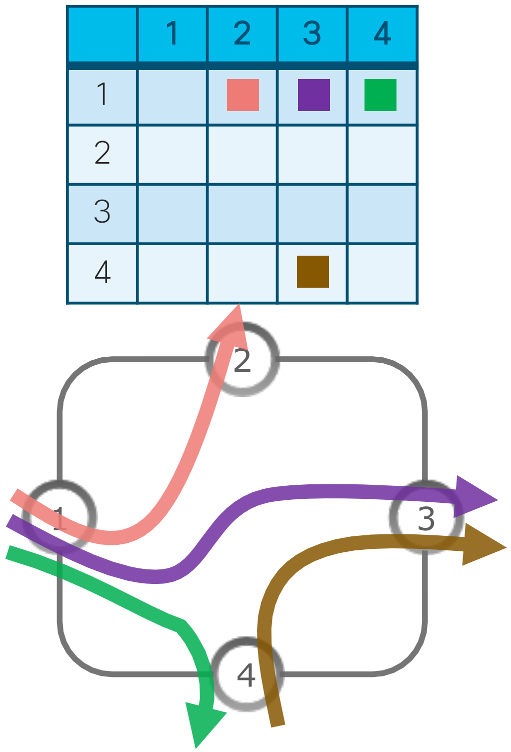
Solution

With Cisco Segment Routing, the traffic/demand matrix collection is automated

No extra off-box tooling required

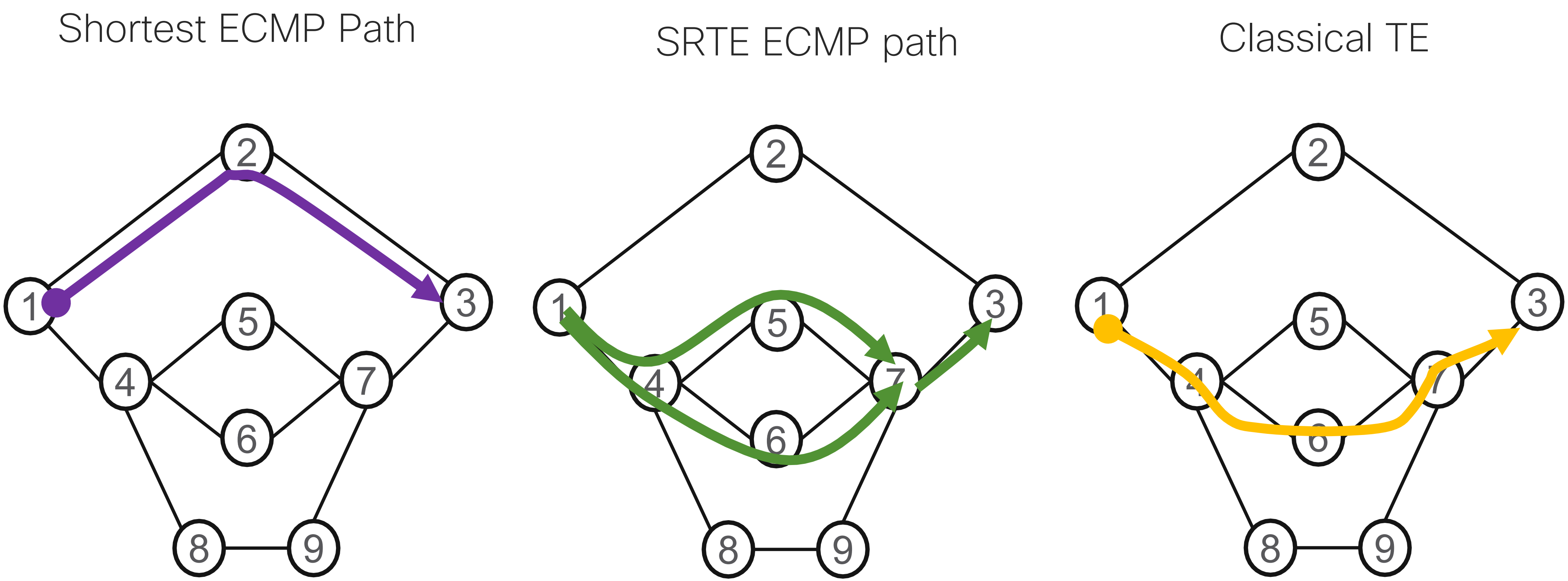
Benefits

Capacity planning
Bandwidth Optimization
IP/Optical Optimization



SRTE SR Policy

SRTE with Segment Routing



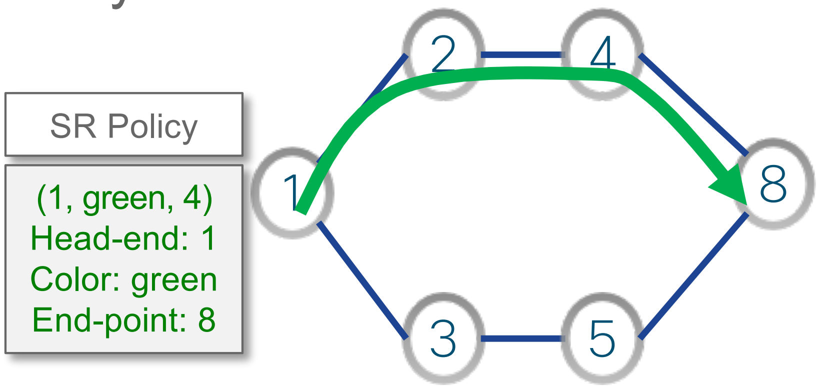
SR Native computation
SID List = {16003}

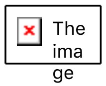
SR Native computation
SID List = {16007, 16003}

RSVP TE computation
SID List = {24014, 24048, 24059, 24017,24073}

SR Policy Identification

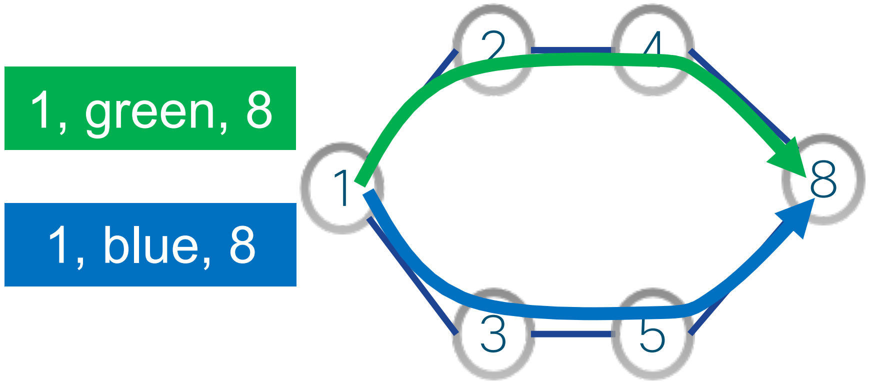
- An SR Policy is uniquely identified by a tuple
  (head-end, color, end-point)
  Head-end: where the SR Policy is instantiated (*implemented*)
  Color: a numerical value to differentiate multiple SRTE Policies between the same pair of nodes
  End-point: the destination of the SR Policy
- At a given head-end, an SR Policy is uniquely identified by a tuple (color, end-point)

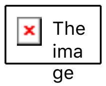




SR Policy Identification

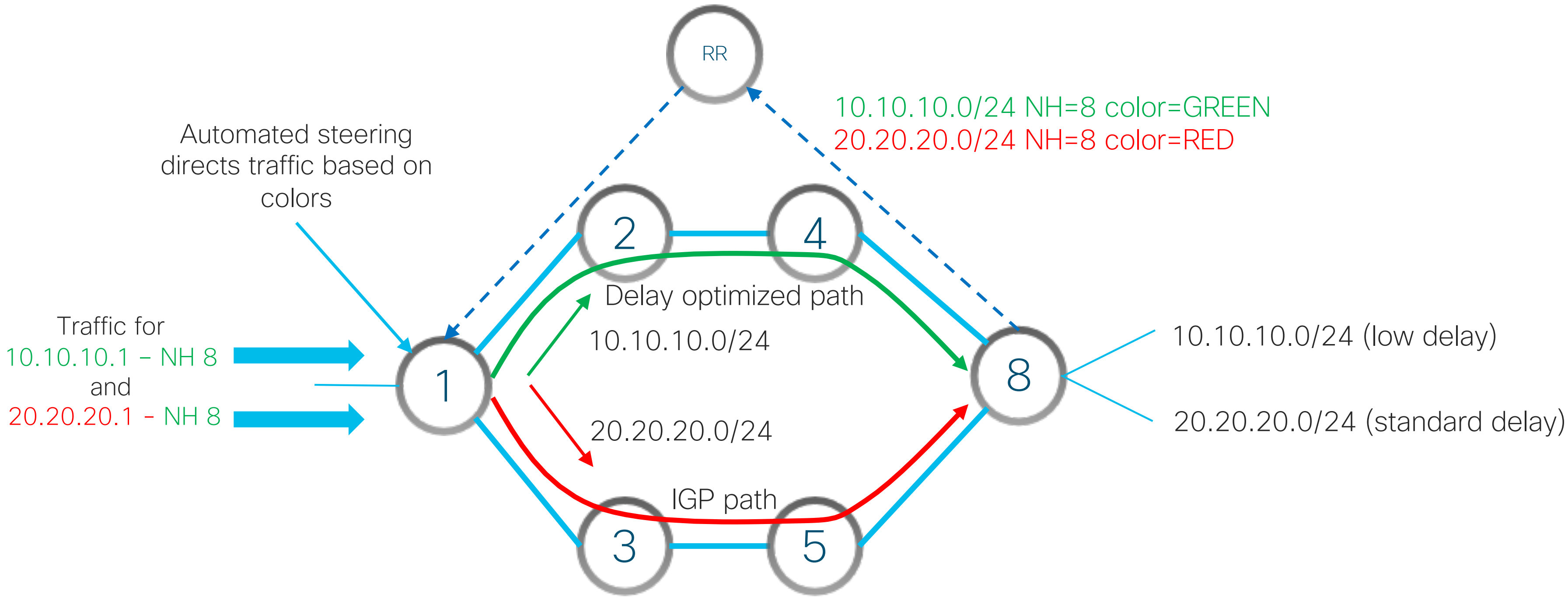
- For the same destination different colors (*) for different SLA
- Green = Low Latency
- Blue = High Bandwidth





(*) color extended community is specified in RFC 5512

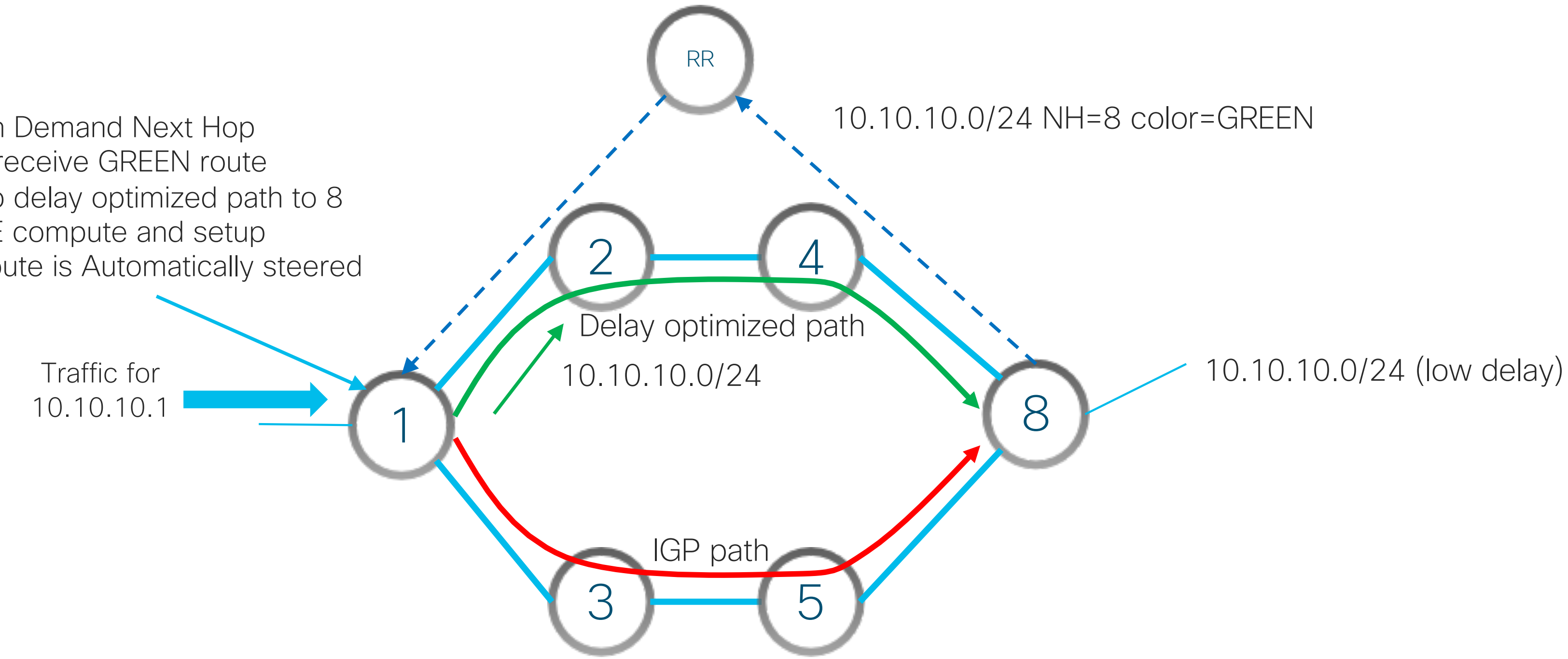
Segment Routing - Automated Steering (AS) based on destination



Steer traffic into SR Policy based on destination

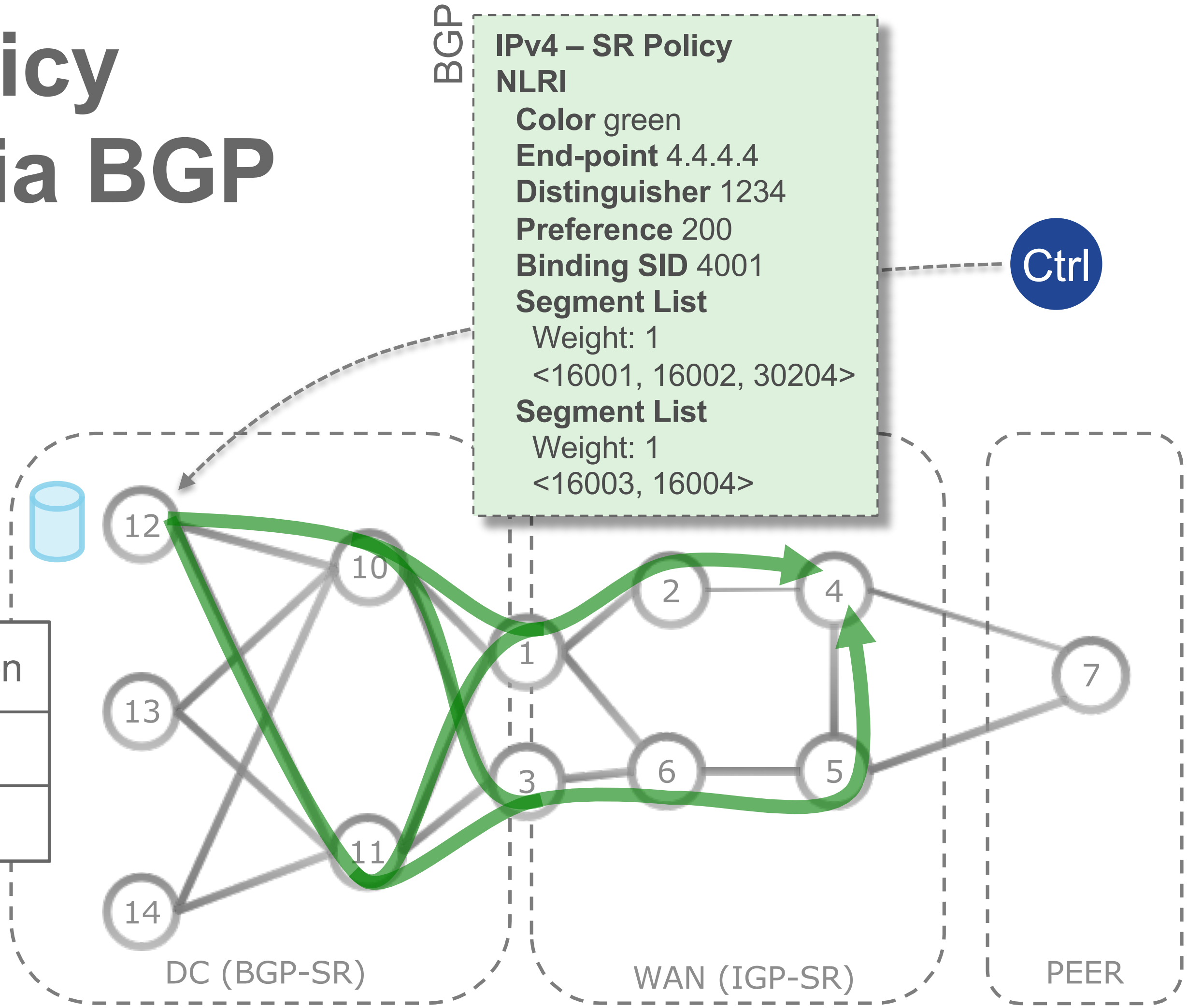
Segment Routing - On Demand Next Hop

- On Demand Next Hop
- 1 receive GREEN route
- No delay optimized path to 8
- HE compute and setup
- Route is Automatically steered



Steer traffic into SR Policy based on destination

Signaling SR Policy candidate path via BGP



FIB on Node12:

In	Out	Fraction
4001	<16001, 16002, 30204>	50%
	<16003, 16004>	50%

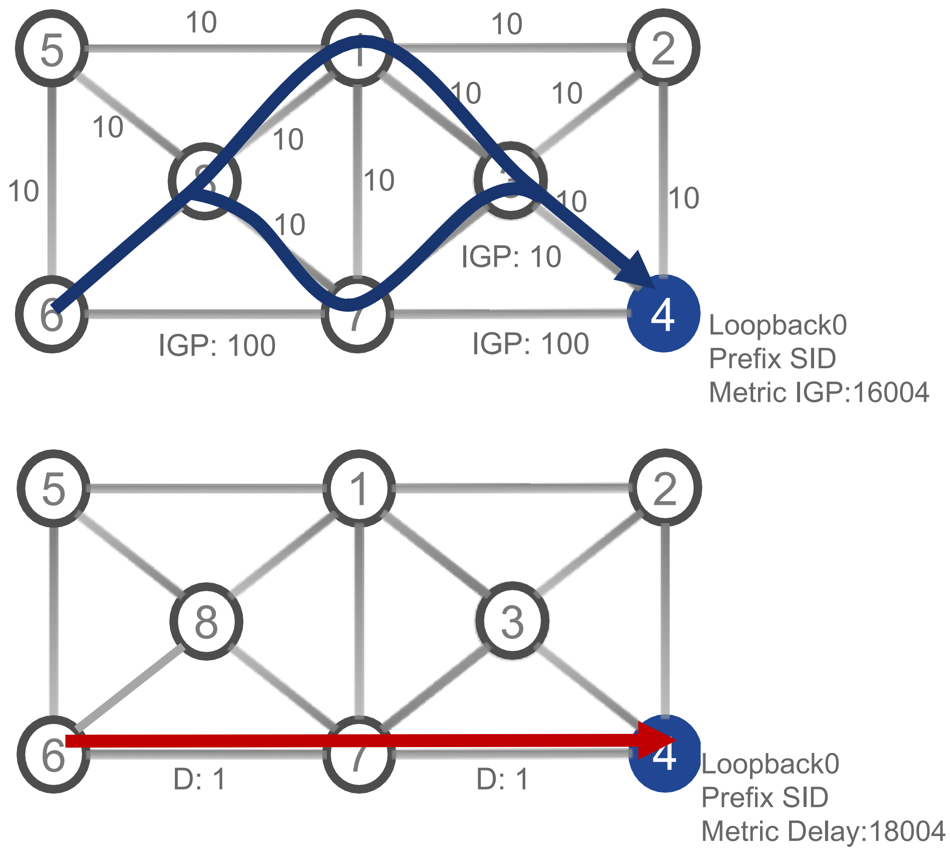
Flex Algo

SR IGP Flex Algo

- Complements the SRTE solution by adding new Prefix-Segments with specific optimization objective and constraints
  - minimize igp-metric or delay or te-metric
  - avoid SRLG or affinity
  - Plane A/B
  - Only encrypted links

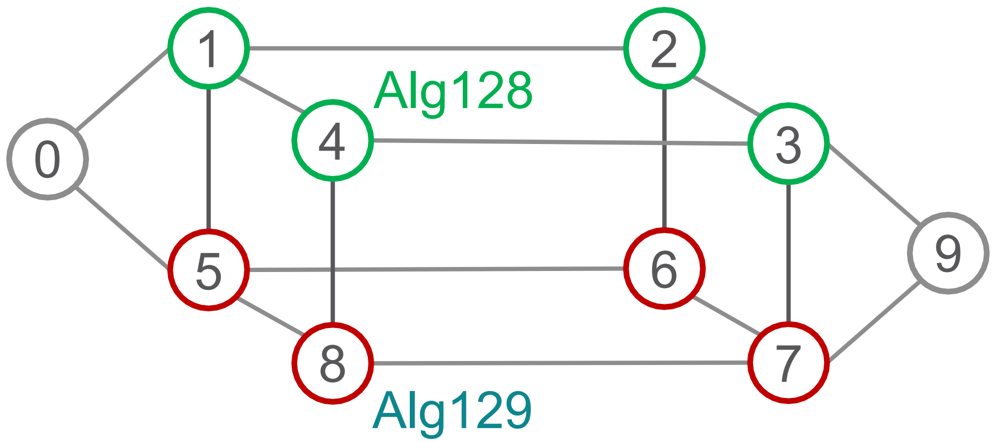
Multiple Prefix SIDs for the same destination Different paths!!

- What is SR IGP Flexible Algorithm?
- An operator-defined custom IGP algorithm leveraging dedicated Prefix-SID
- Example – operator configure the normal IGP and associate Pref-SID 16004 to Lo0
- operator defines Flex-Algo 129 as “minimize delay metric” with Prefix SID 18004 associated to Lo0
- For each destination two different SID are installed in routers FIB



Example Use-Case – Dual Plane

- Grey nodes support Algo 0/128/129
- Green nodes support 0/128
- Red nodes support 0/129
- Algo 128: minimize IGP metric
- Algo 129: minimize IGP metric
- Nodes advertise a Prefix SID for each Algo they support
  – For example, for node N: 16000 + N
    > + 0 for Algo 0
    > + 800 for Algo 128
    > + 900 for Algo 129



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