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The bridge to possible

Design your Next-Gen MPLS Network with Automation & Orchestration in mind

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BRKMPL-2113

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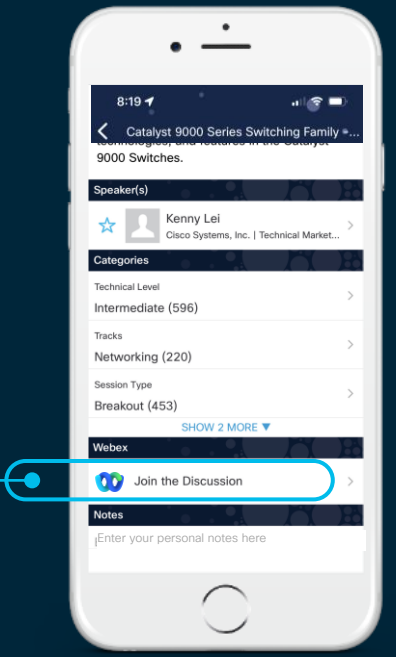

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Webex spaces will be moderated by the speaker until June 17, 2022.

Agenda

- Introduction
- Legacy MPLS Architectures in the past
- NG-MPLS Architectures - Transport
  - SR, TE, FRR, HA, etc..
- NG-MPLS Architectures - Services
  - L3VPN, EVPN
- Automation & Orchestration
- Conclusion

What this session is (not) about

MPLS (SR) Design Best Practices

Cisco Technologies that help with Automation & Orchestration

Not a deep dive of every technical feature mentioned

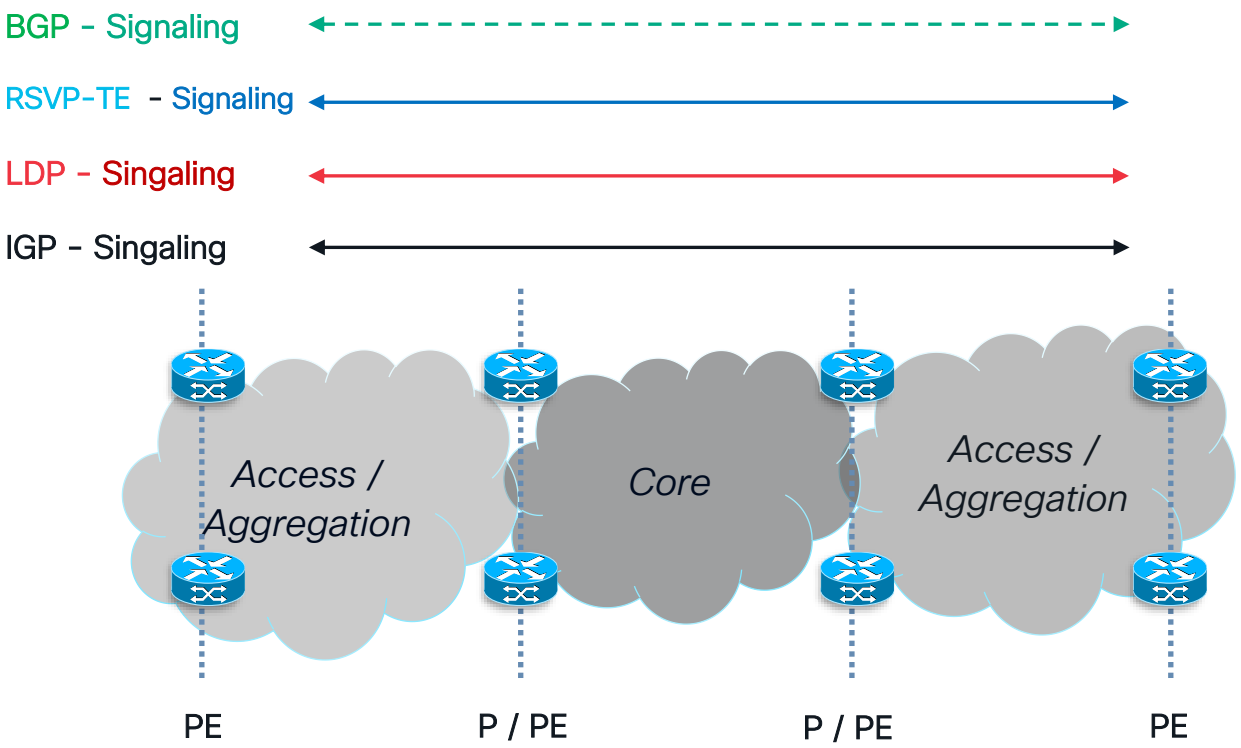
Not a Configuration Guide

Network demands are increasing

- The number of devices requiring communications will continue to grow:
  - IoT devices will account for 50% (14.7 billion) of all global networked devices by 2023
  - Mobile subscribers will grow from 66% of the global population to 71% of the global population by 2023

MPLS Architecture in the past

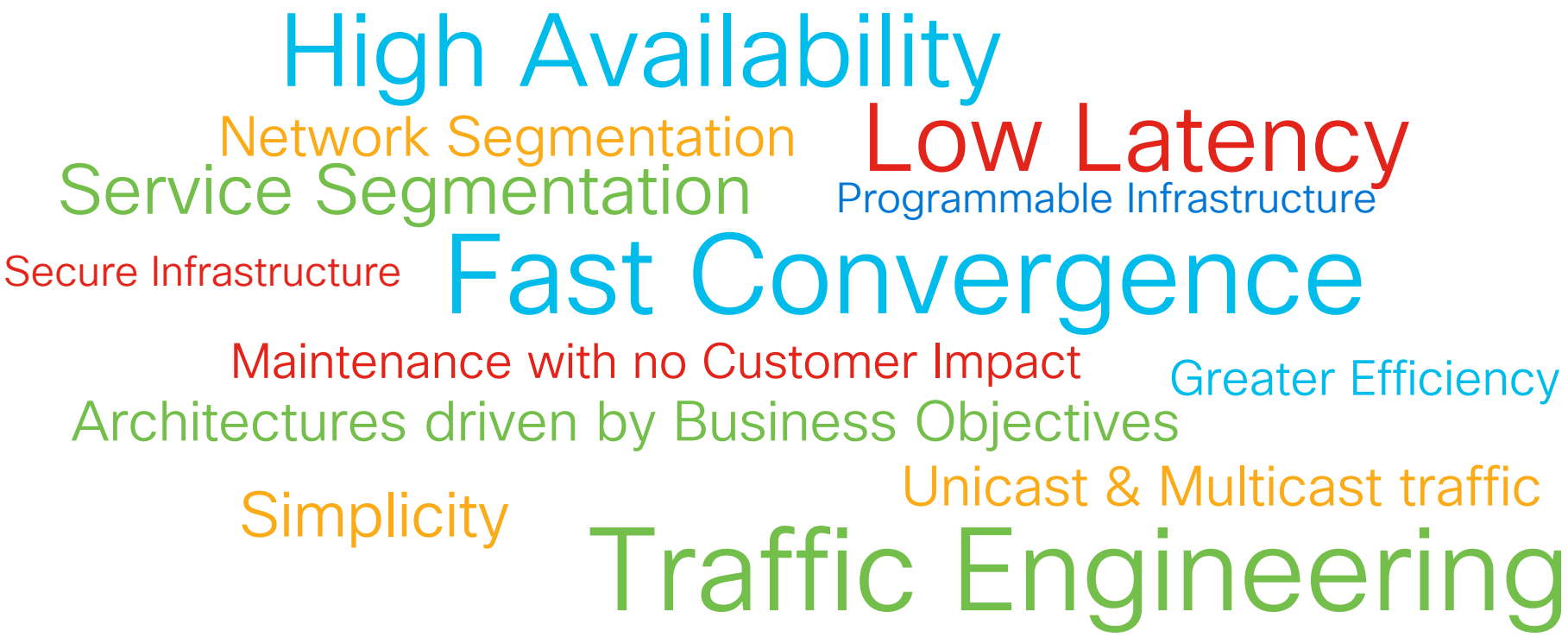
MPLS in the past ...



- IGP: **OSPF** or **ISIS**
  - For IPv4/IPv6 Prefix Reachability
  - Interfaces and Loopbacks
- **LDP**
  - Label Switching
  - LSP Signaling
- **RSVP**
  - Traffic Engineering
  - FRR (Fast Re-Route)
- **BGP**
  - VPNs (L2/L3)
  - Peering
  - BGP-LU (RFC-3107)
  - Internet

NG-MPLS Requirements

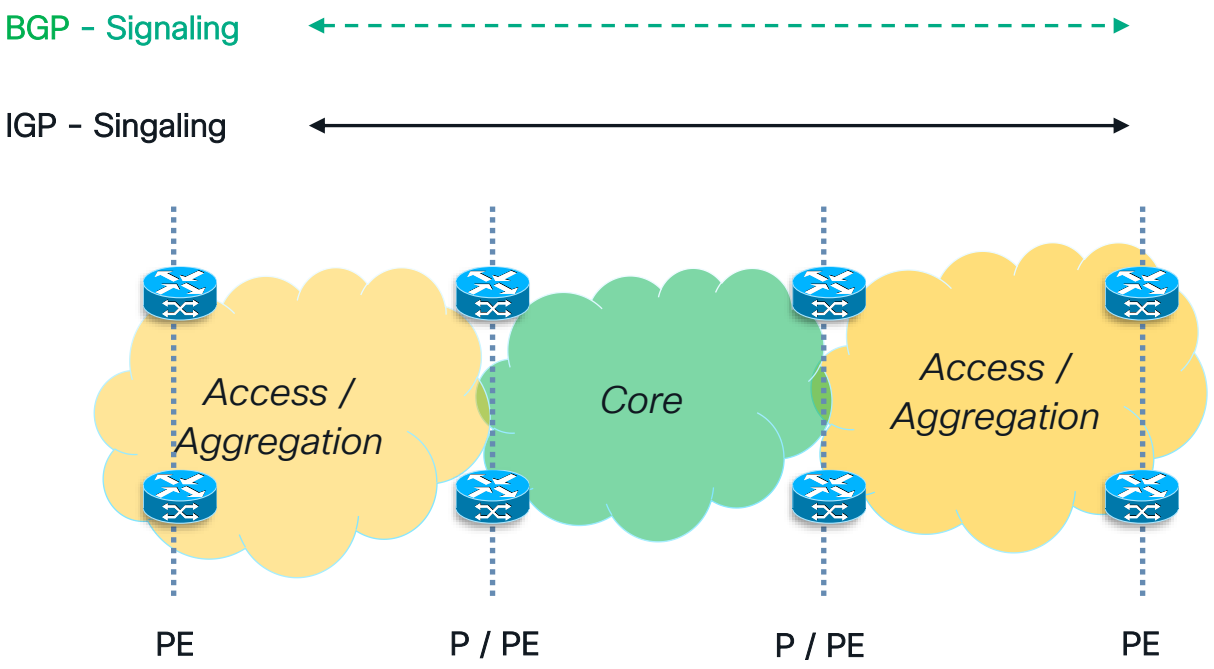
Next Gen MPLS Network requirements



NG-MPLS Architectures - Transport

SR, TE, FRR, HA, etc..

Simplification & Protocol reduction



- IGP: **OSPF** or **ISIS**
  - For IPv4/IPv6 Prefix Reachability
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- ~~LDP~~
  - ~~Label Switching~~
  - ~~LSP Signaling~~
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  - ~~Traffic Engineering~~
  - ~~FRR (Fast Re-Route)~~
- BGP
  - VPNs (L2/L3)
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Segment Routing: Value Proposition

Create New Revenue Streams
- Differentiate Services with SR Policies
- Intent-Based Value-Add Services

Deploy with Ease
- Seamless Brownfield Integration
- Single Control for Inter Domain Implementations

Monitor Health
- Data Path Validation Including ECMP
- Real Time Per-Link Performance Monitoring with Telemetry

Increase Availability
- Automated 50ms Protection
- Assured Loop-free Convergence upon Recovery

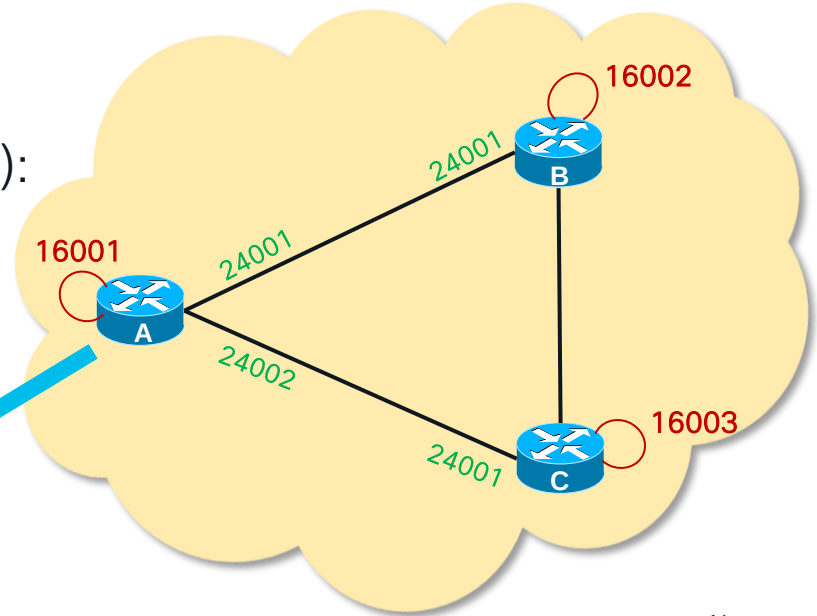
Multi-vendor consensus – Designed and built with network operators

What is Segment Routing (RFC 8402)

- MPLS: an ordered list of segments represented as a stack of labels
- IPv6: an ordered list of segments encoded in a routing extension header (SRH)

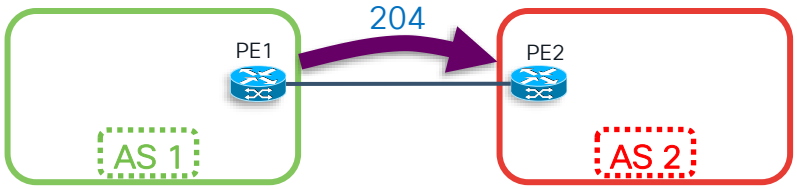
- IGP Distributes following **Segment IDs (SID)**:
  - Prefix Segment (Node SID or Anycast SID)
  - Adjacency Segment (Adj SID)

	Lo0	G0/0	G0/1
Node SID	16001		
Adj SID		24001	24002

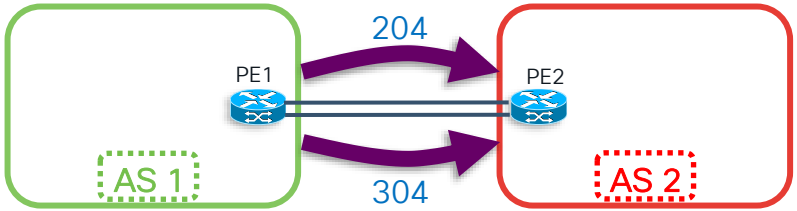


BGP Peering SID for Inter-AS

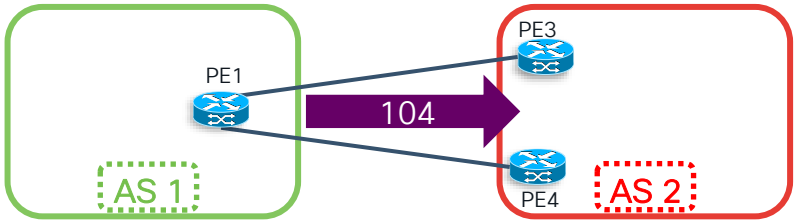
- Peer Node SID – to eBGP Peer



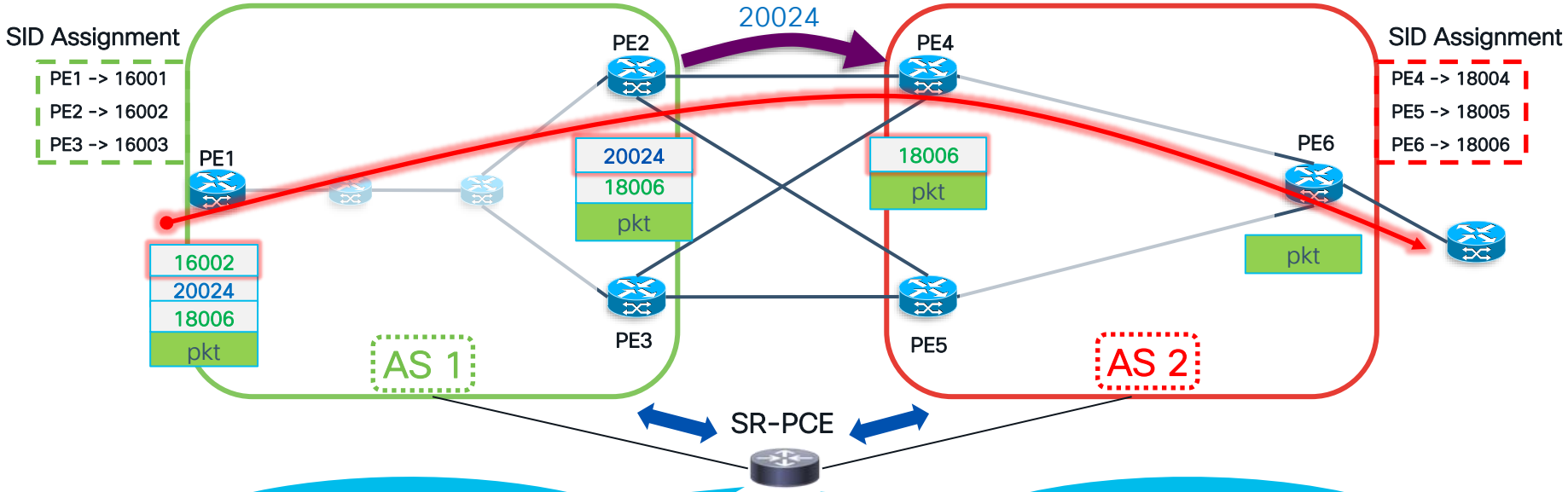
- Peer Adjacency SID – to eBGP Peer via interface



- PeerSet SID – to set of eBGP peers – (Loadbalance between eBGP peers)



Inter-AS with SR-PCE & BGP Peering SID

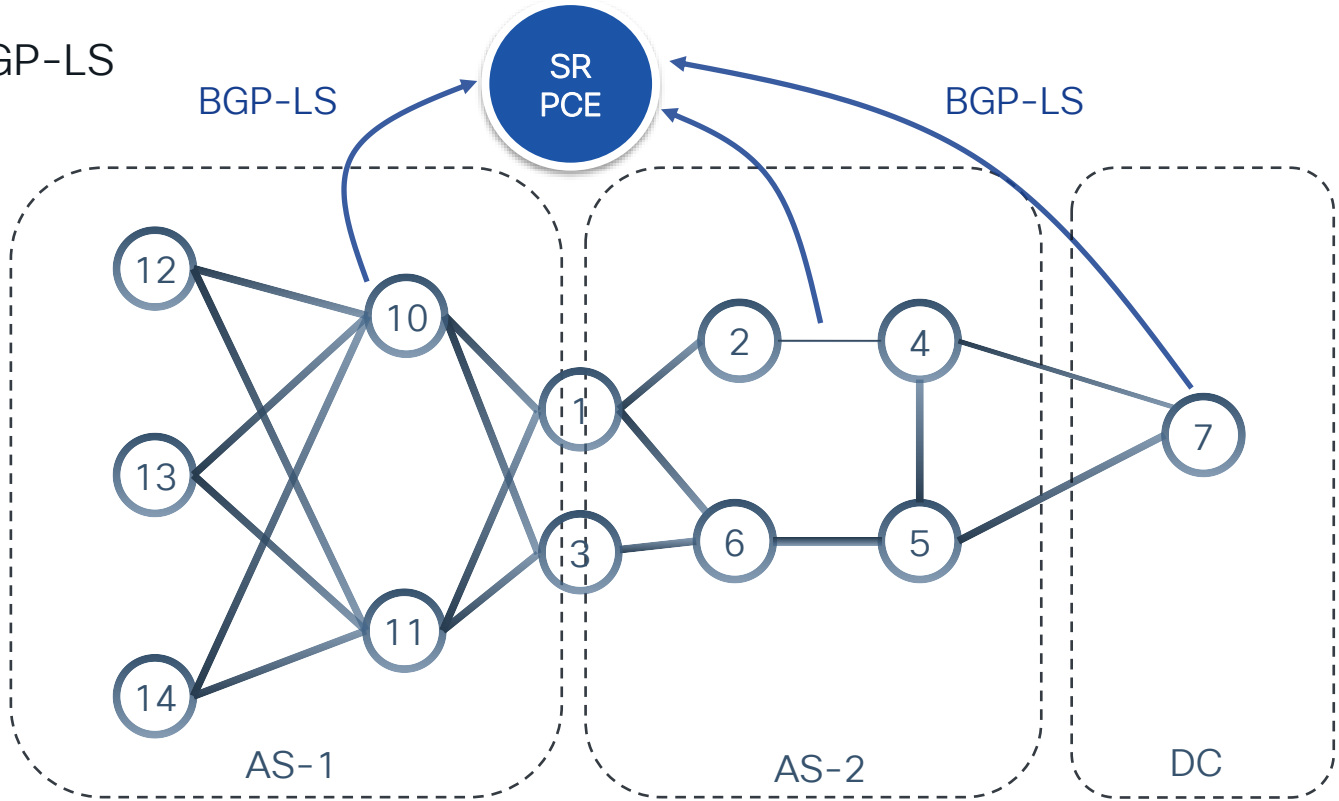


I have a complete view of all domains

I can also provide end-to-end Paths with different constraints

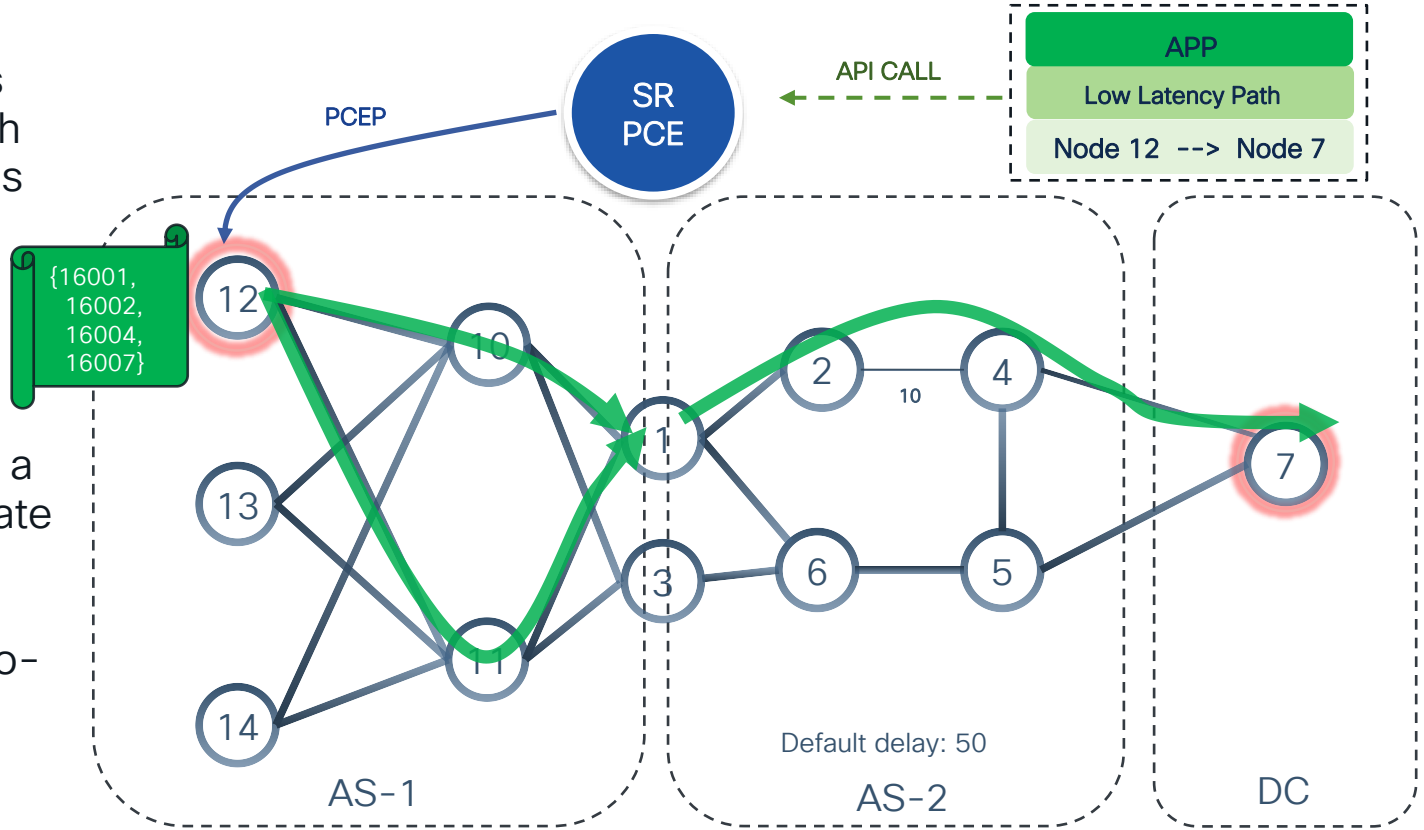
What about inter-domain path calculation?

- SR PCE collects via BGP-LS
  - IGP segments
  - BGP segments
  - Topology
- North-Bound API
- Multi-Domain Topology
- Computation
  - Deployment via PCEP



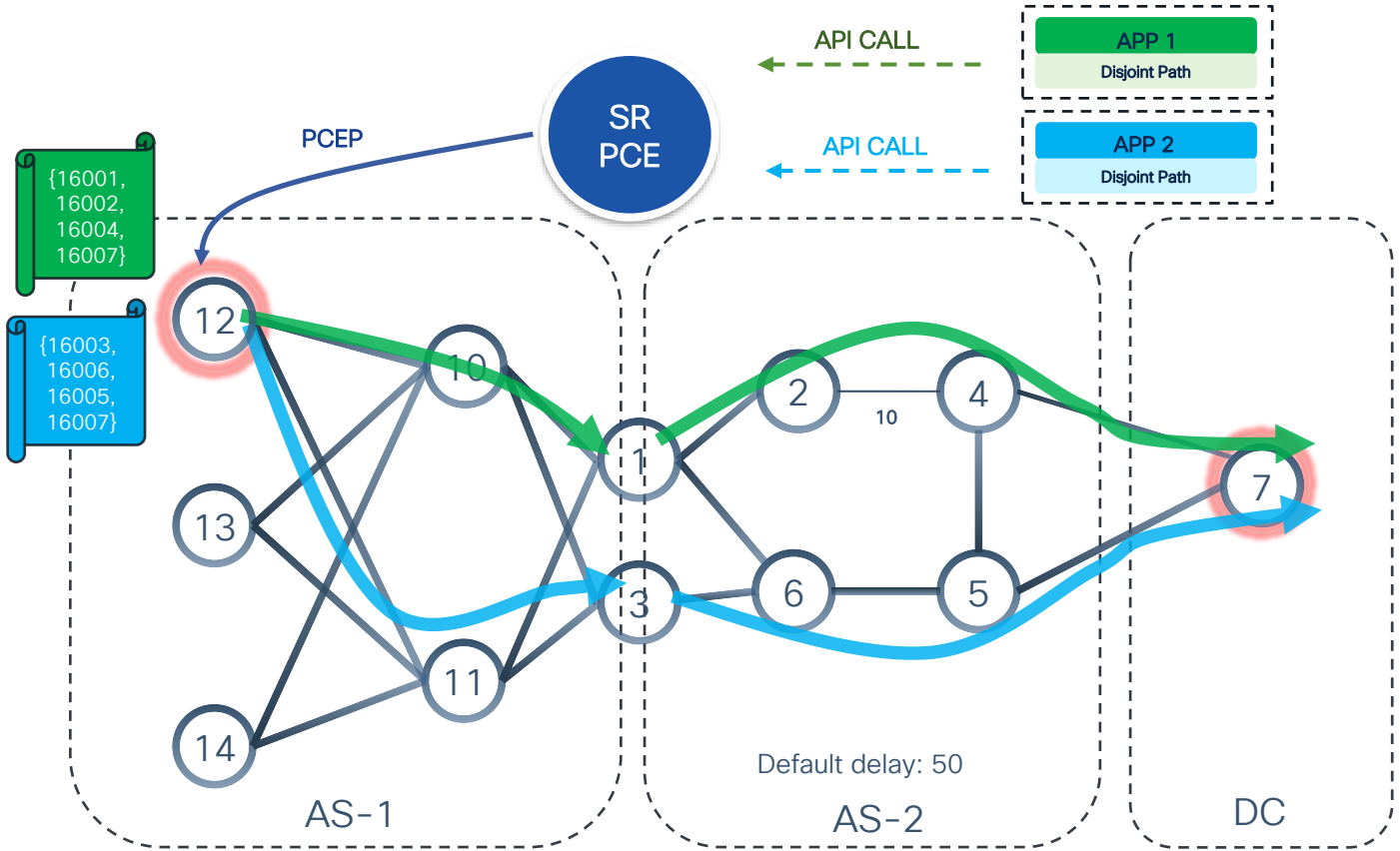
An End-to-end Path as a List of Segments (1)

- SR PCE computes that the green path can be encoded as
  - 16001
  - 16002
  - 16004
  - 16007
- SR PCE programs a single per-flow state to create an application-engineered end-to-end policy

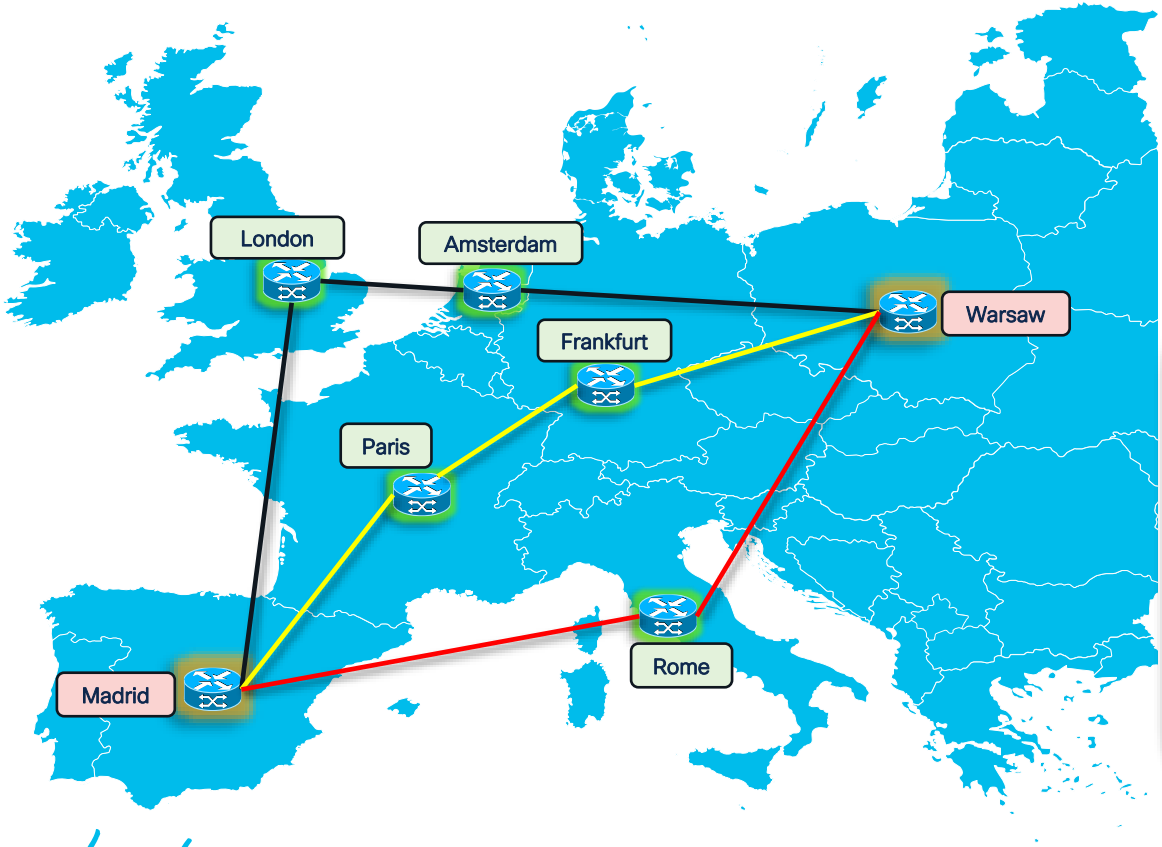


An End-to-end Path as a List of Segments (2)

- SR PCE computes that the green path can be encoded as
  - 16001
  - 16002
  - 16004
  - 16007
- SR PCE computes that the blue path can be encoded as
  - 16003
  - 16006
  - 16005
  - 16007



Practical Use-Cases (Optimization Based SR-TE Path)



- TE Affinity-bit (coloring)
- SRLG
- Delay
- Disjoint Path

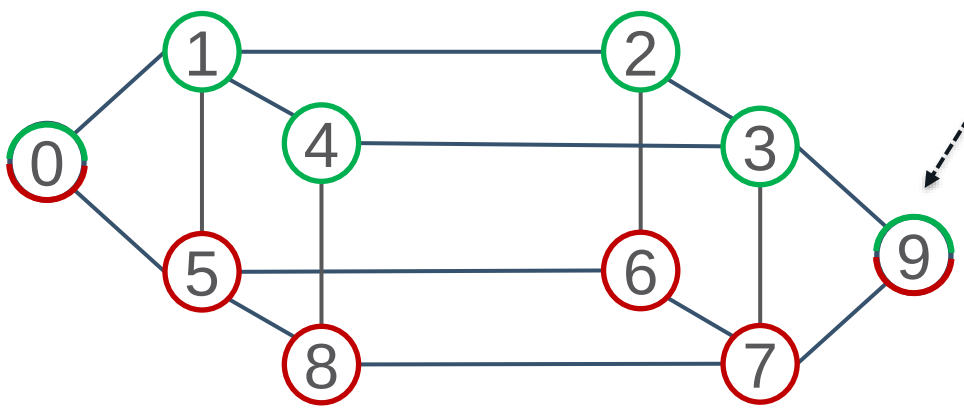
High Bandwidth Path:
Madrid – London – Amsterdam – Warsaw

Secure / Encrypted Path (MacSec enabled):
Madrid – Paris – Frankfurt – Warsaw

Low Delay Path:
Madrid – Rome – Warsaw

Disjoint Path:
1. MAD – PAR – FFM – WAW
2. MAD – RME – WAW
3. MAD – LON – AMS – WAW

Multi-Plane Network with Flex-Algo
Network Slicing

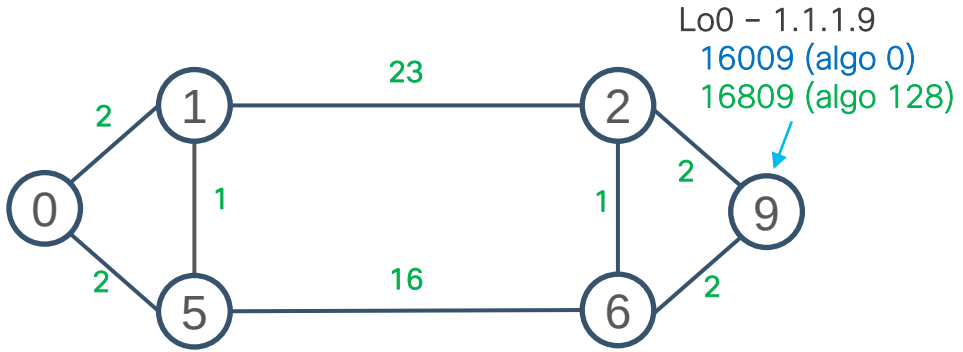


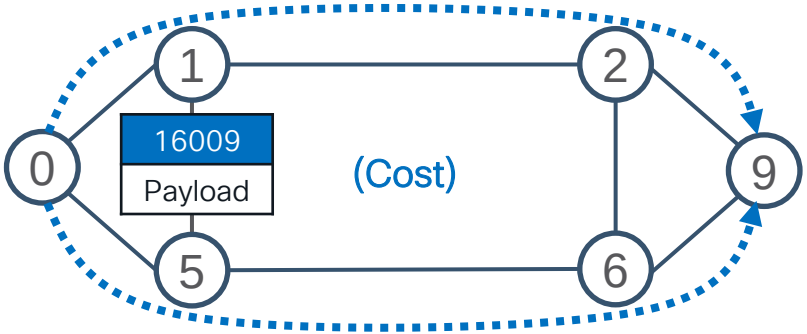
- All the nodes support Algo 0: minimize IGP metric
- Green nodes also support 128: Secure links (MACSec)
- Red nodes also support 129: Minimize Delay

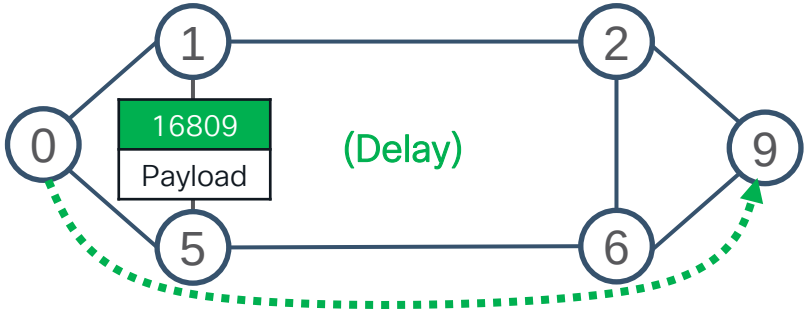
- A Prefix-SID determines which Slice the Node belongs to.
- More than 1 Prefix-SID can be assigned to a Node, each belonging to different Slice (Algo)

Use Case: Delay vs Cost of Transport

- All nodes support Algo 0 & 128
- ISIS link metric 10
- Algo 128: minimize delay metric
- Per-link measurement of delay and advertisement as delay metric via ISIS
- Delay metric at that time shown in green

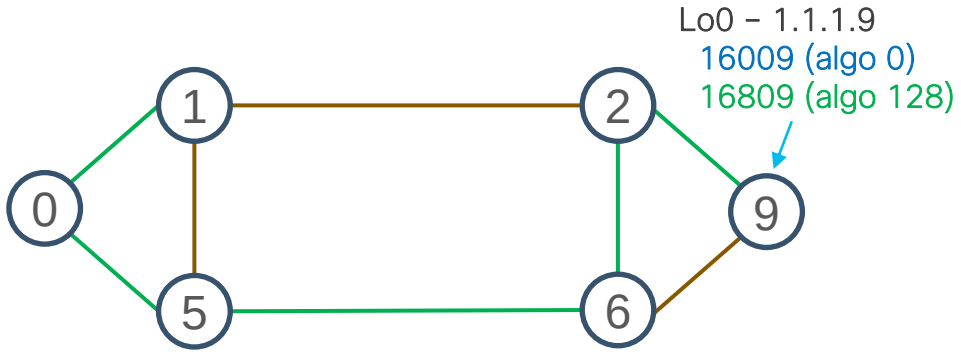


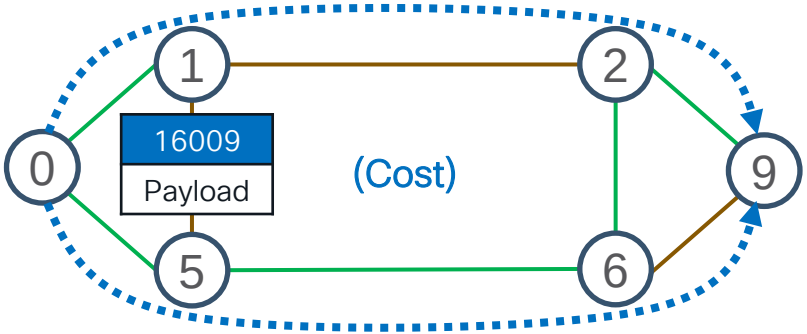


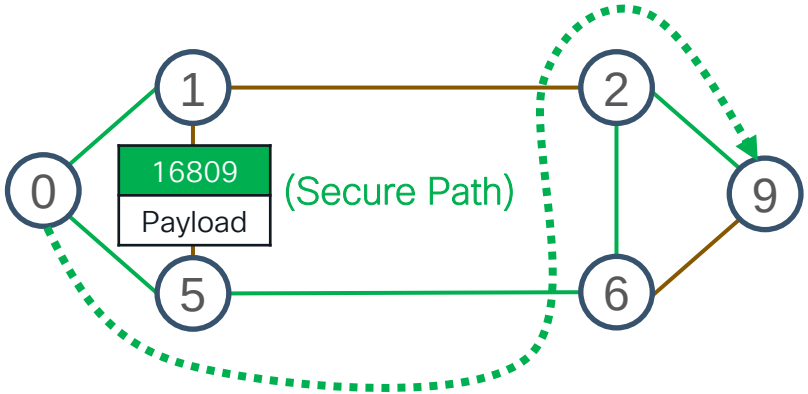


Use Case: SRTE for Secure Paths

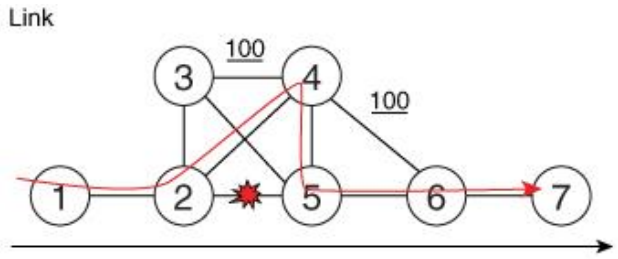
- ISIS link metric 10
- Link colors shown Unencrypted / Encrypted
- All nodes support Algo 0 & 128
- Algo 128: minimize IGP while traversing links with encryption enabled (exclude brown)
- Per-link colors flooded in IGP

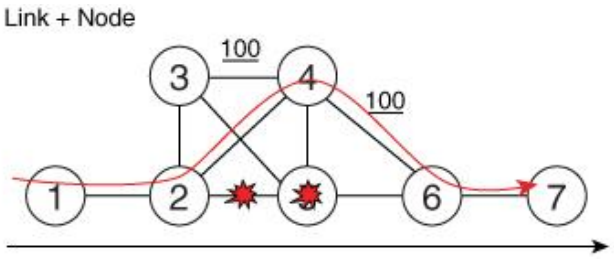


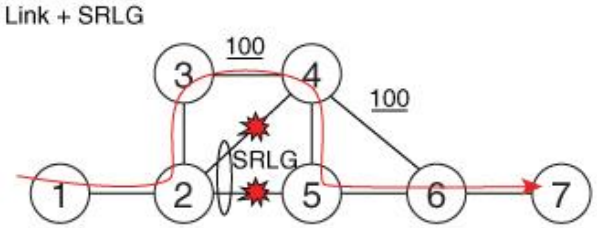


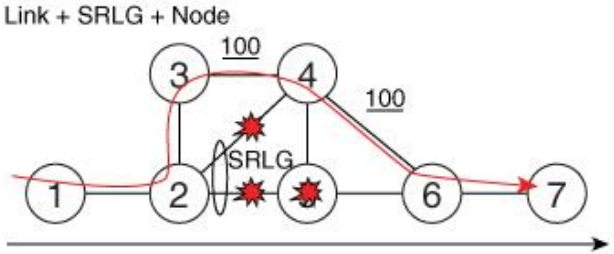


How does SR handle Traffic Protection?
Welcome… Ti-LFA







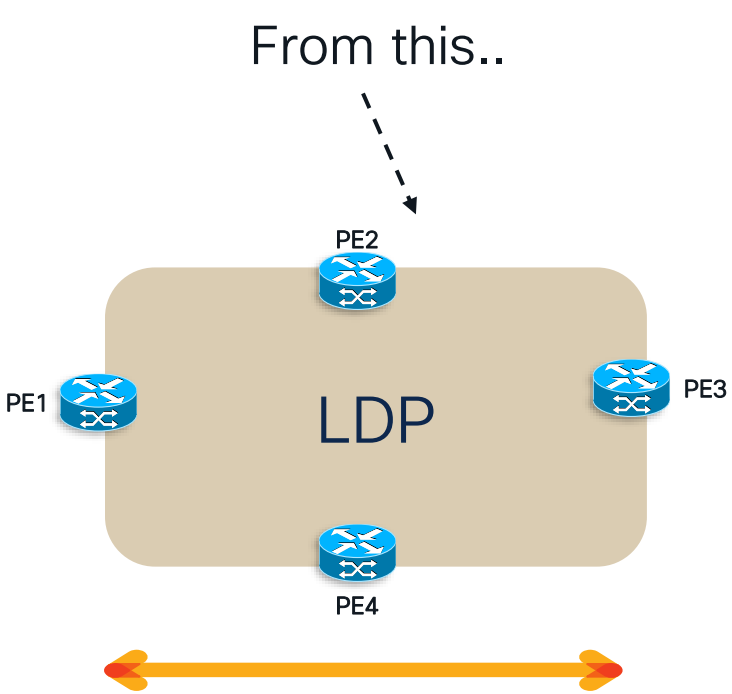


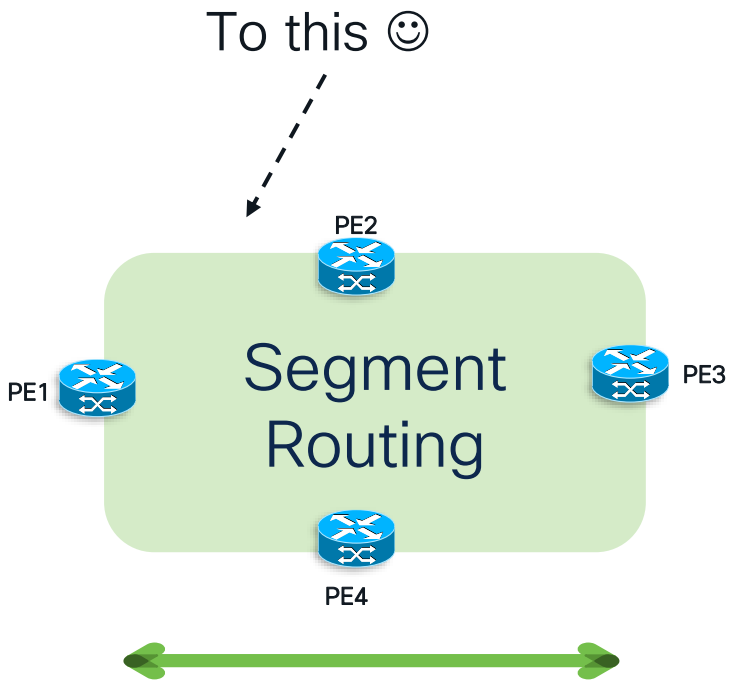
Default metric: 10

Pre-convergence

Post-convergence

So how do I move...

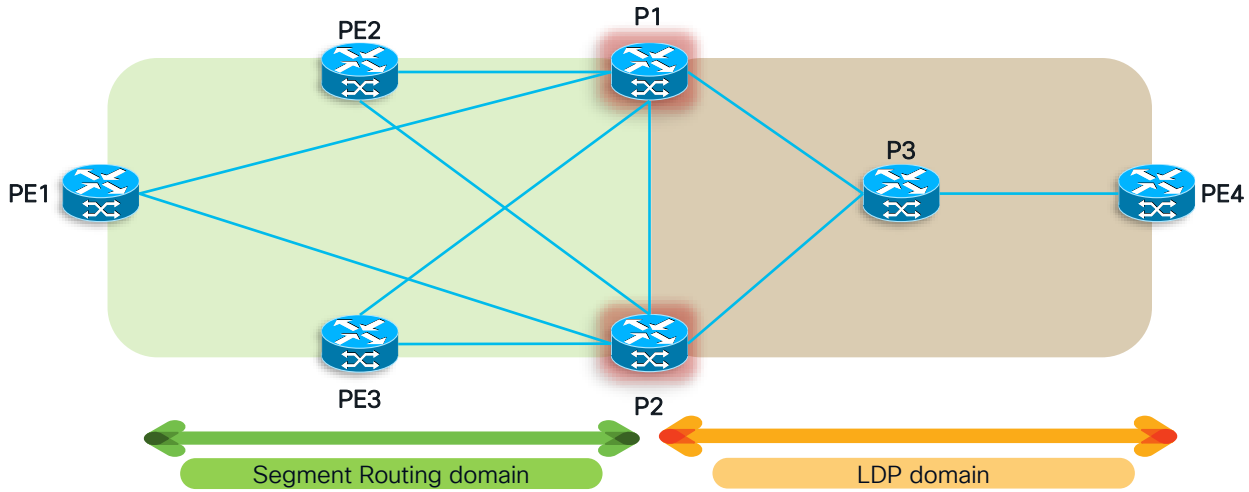




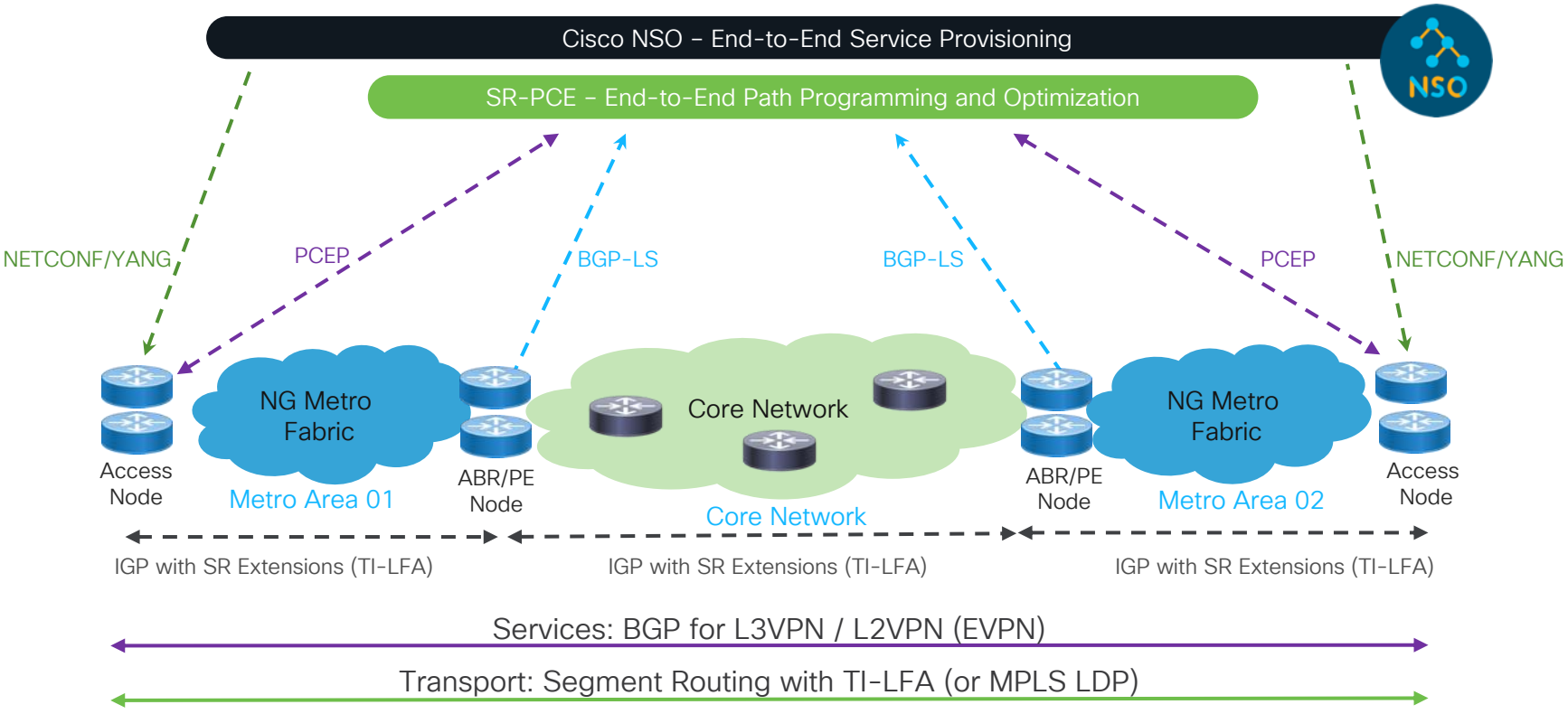
SR & LDP Interoperability

- Interoperability using SR Mapping Server (SRMS)
- Functionality integrated within IOS-XR and IOS-XE
- SRMS assigns SIDs for non-SR capable nodes

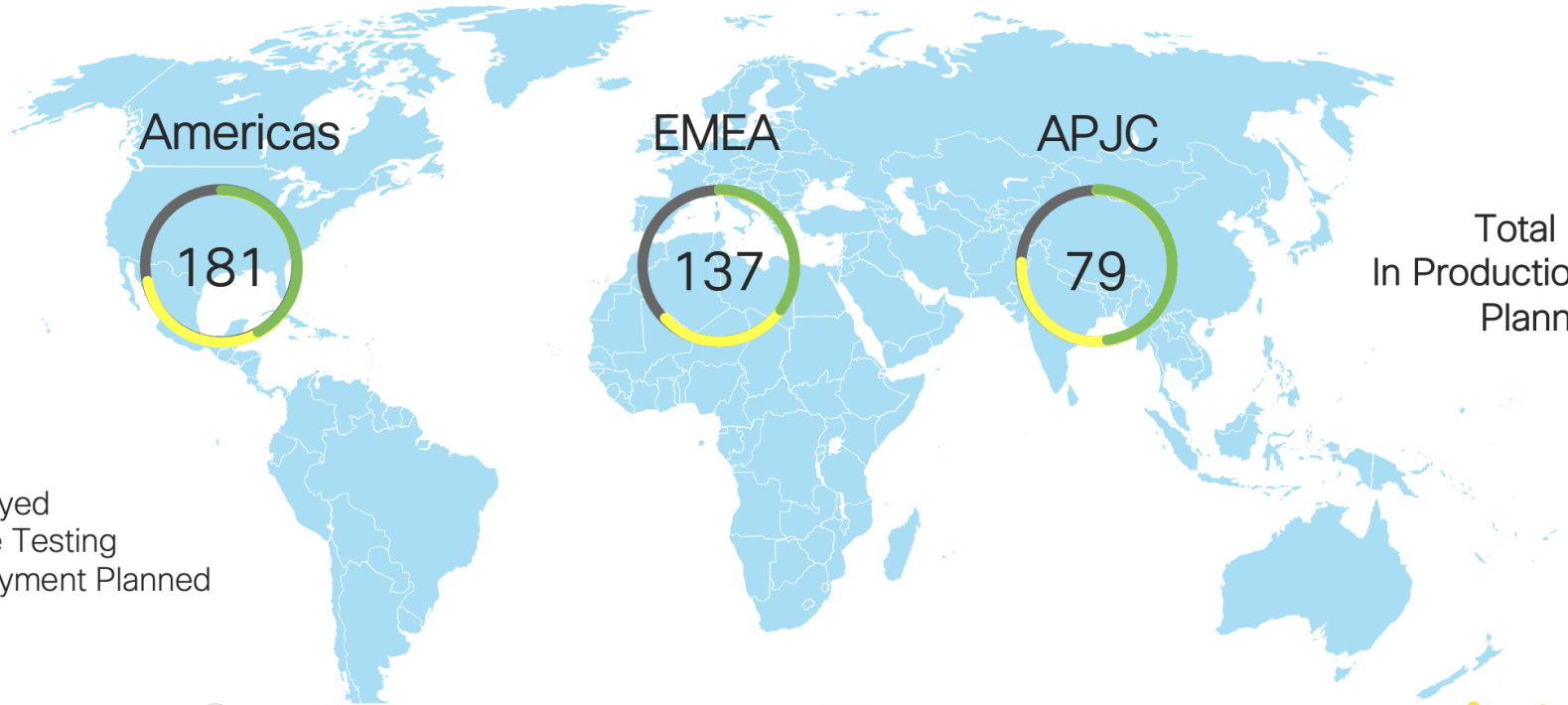
- Two modes / functionalities:
  - SR Mapping Server
  - SR Mapping Client



Converged SDN Transport



From Thought to Deployment Leadership



NG-MPLS Architectures - Services

BGP control plane (L3VPN & EVPN)

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EVPN: Value Proposition

Create New Revenue Streams

- Stateless SFC and NFV
- E-LAN, E-LINE, E-TREE, L3, IRB Services

Deploy with Ease

- Seamless Brownfield Integration
- Same principles and operational experience as IP VPNs

Protect Investments

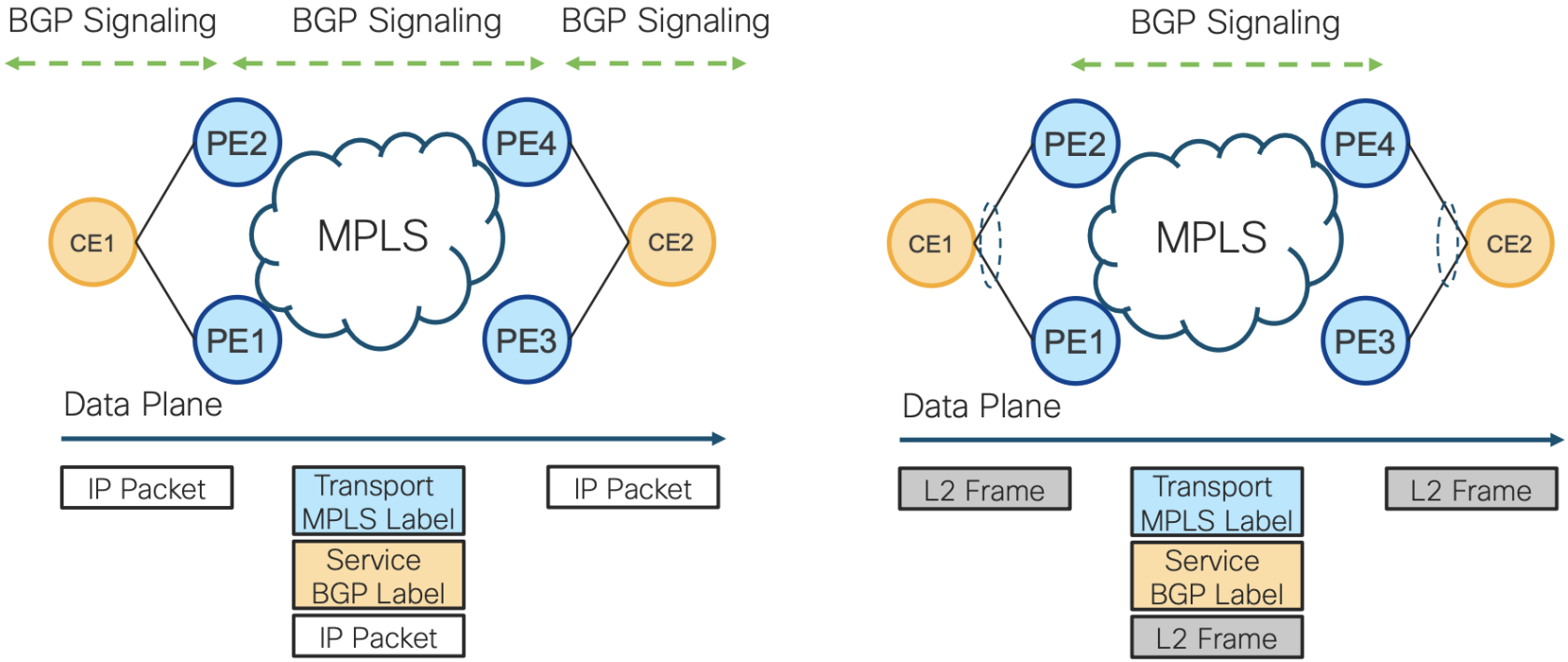
- Unified Networks on single overlay
- Simplify protocols and operations
- Industry adoption and standardization

Increase Availability

- Workload Mobility
- Optimal forwarding
- All-Active Redundancy with Fast Convergence

Fast, Resilient, Flexible Unified Services

EVPN



EVPN advantages

Integrated Services

- Integrated Layer 2 and Layer 3 VPN services
- L3VPN-like principles and operational experience for scalability and control

Network Efficiency

- All-active Multi-homing & PE load-balancing (ECMP)
- Fast convergence (link, node, MAC moves)
- Control-Place (BGP) learning. PWs are no longer used.
- Optimized Broadcast, Unknown-unicast, Multicast traffic delivery

Service Flexibility

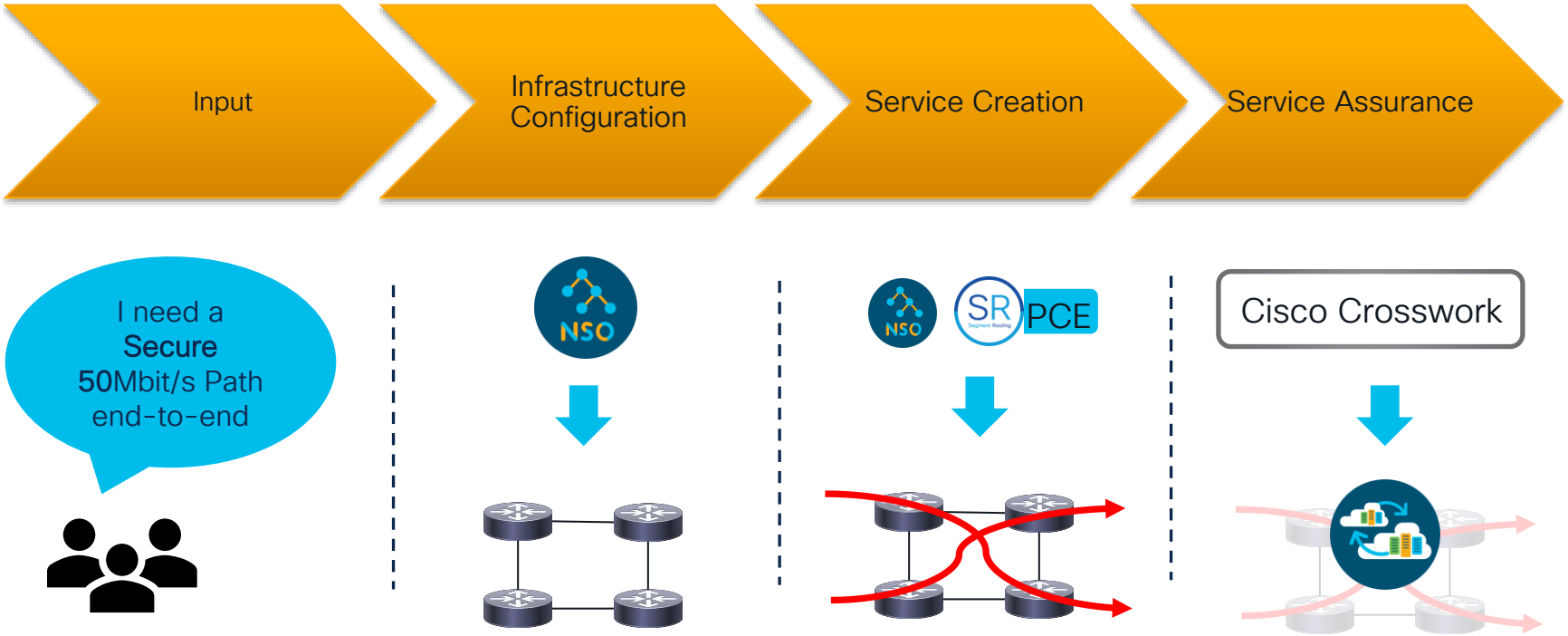
- Choice of MPLS, VxLAN or SRv6 data plane encapsulation
- Support existing and new services types (E-LAN, E-Line, E-TREE)
- Peer PE auto-discovery. Redundancy group auto-sensing

Investment Protection

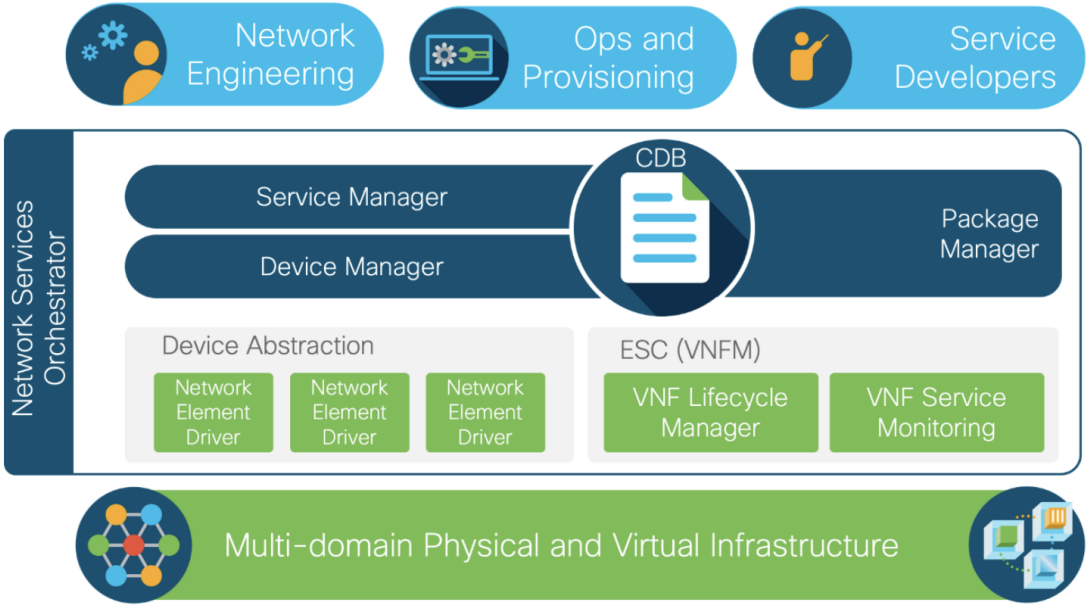
- Fully support IPv4 and IPv6 in the data plane and control plane
- Open-Standard and Multi-vendor support

Automation & Orchestration

Automation & Orchestration key Pillars

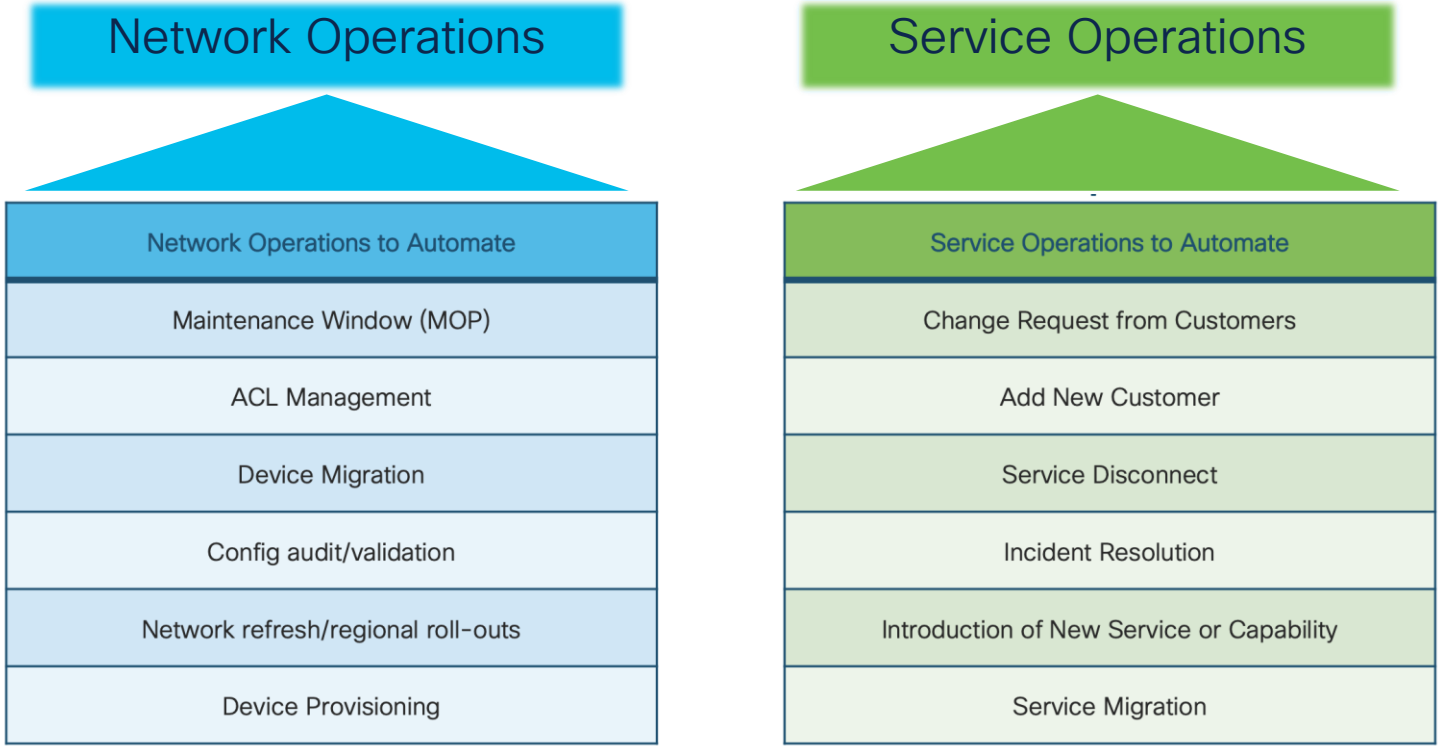


Network Services Orchestrator (NSO)



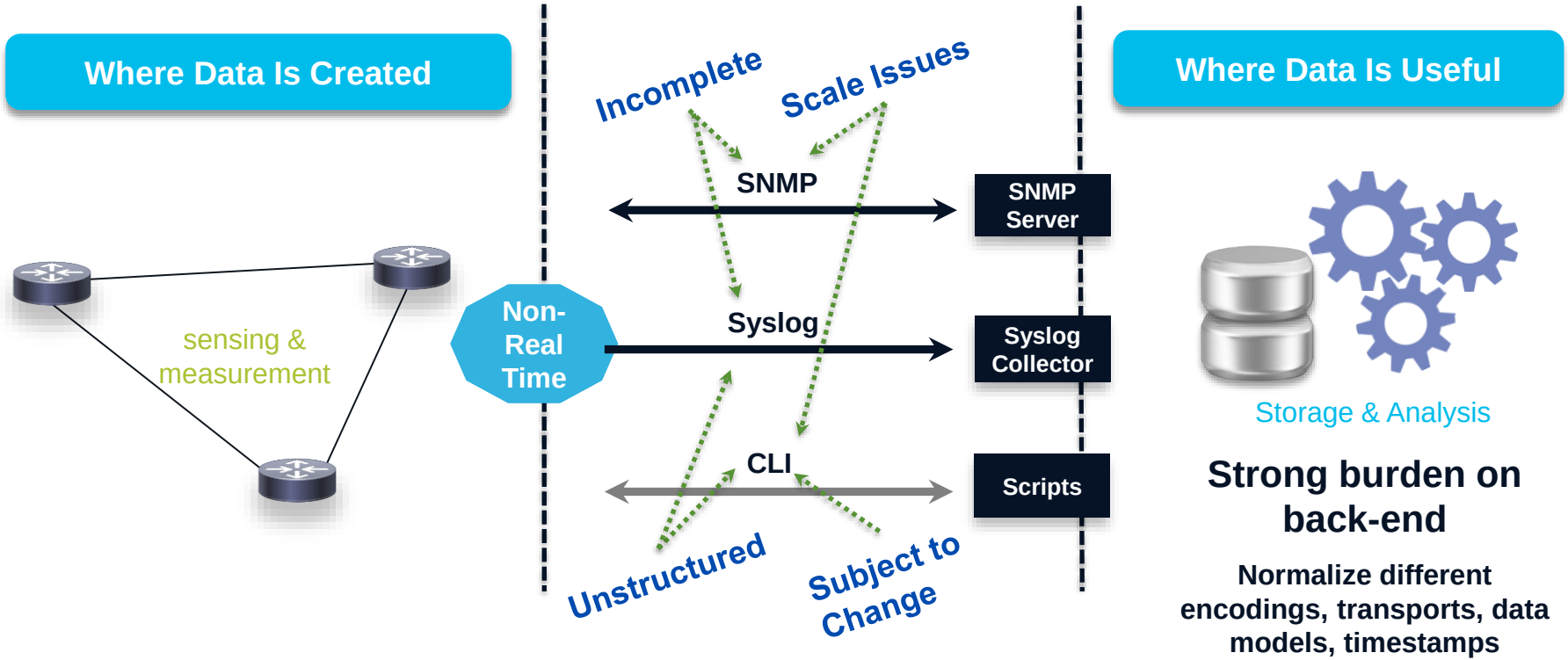
- Orchestration across multidomain and multi-layer for network-wide, centralized policy and services
- Seamless integration with northbound tooling
- Loosely-coupled and modular architecture leveraging open APIs and standard protocols
- Model-driven, end-to-end service lifecycle and customer experience focused

Common NSO use-cases



Industry's broadest multivendor support

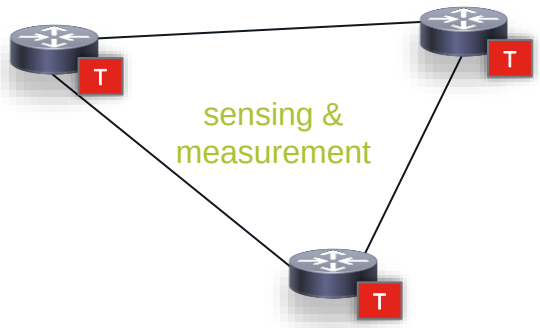
Traditional Monitoring



Game Changer.. Telemetry

- Telemetry data is described using YANG, a structured data modelling language, encoded in **JSON**, **XML** or using **GPB** (Google Protocol Buffers) and is then streamed over **TCP**, **UDP** or **gRPC**.

Where Data Is Created



Real Time

Removing limitations and complexity

- **Push** Paradigm
- Streaming & Event Driven
- One consistent way to access to Statistics, Oper State & Events @ all layers
- High Performance: 10 sec
- Multiple Encodings (JSON, XML, GPB) & Transport (TCP, UDP, gRPC)

Where Data Is Useful

Storage & Analysis

Volume – Scale of Data
Velocity – Analysis of Streaming Data
Variety – Different Forms of Data

Model Driven Telemetry

Monitoring
and Visualizations

Grafana

Storage
Time Series Database

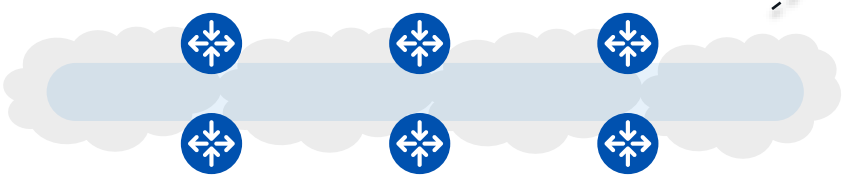
InfluxDB

Collector/Receiver
Decodes to text

telegraf

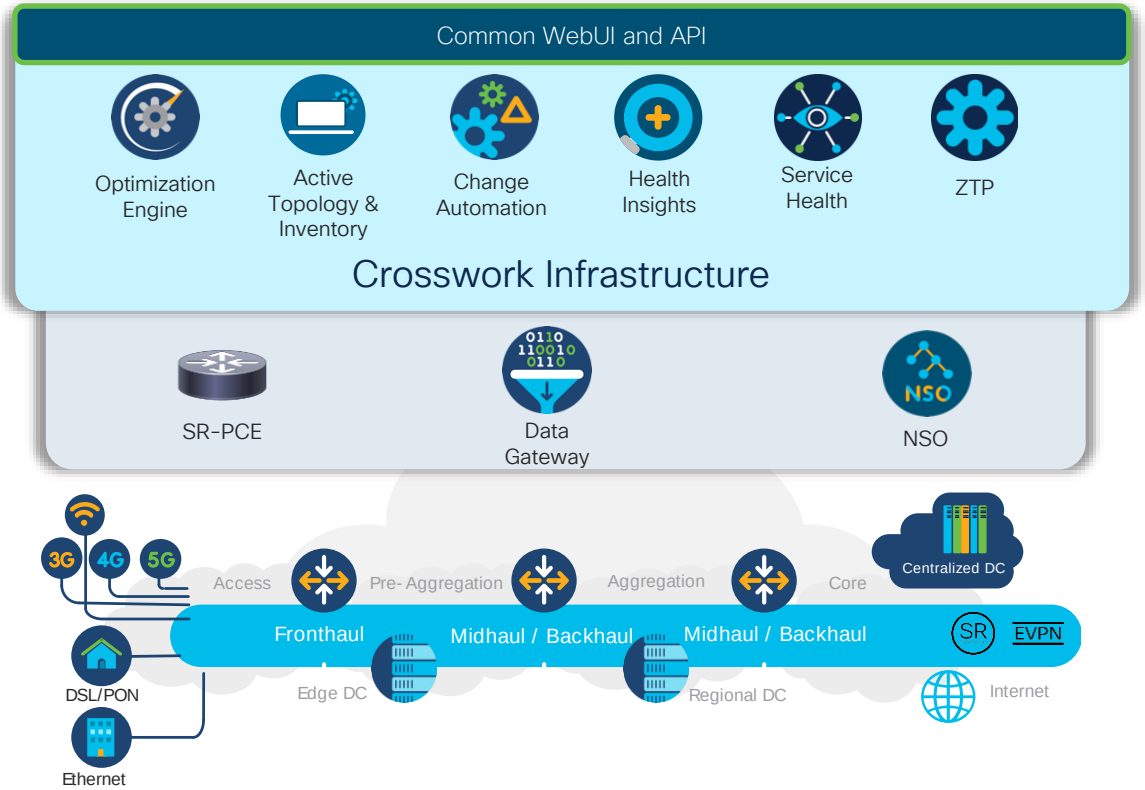
gRPC
gNMI
NETCONF

Network Infrastructure

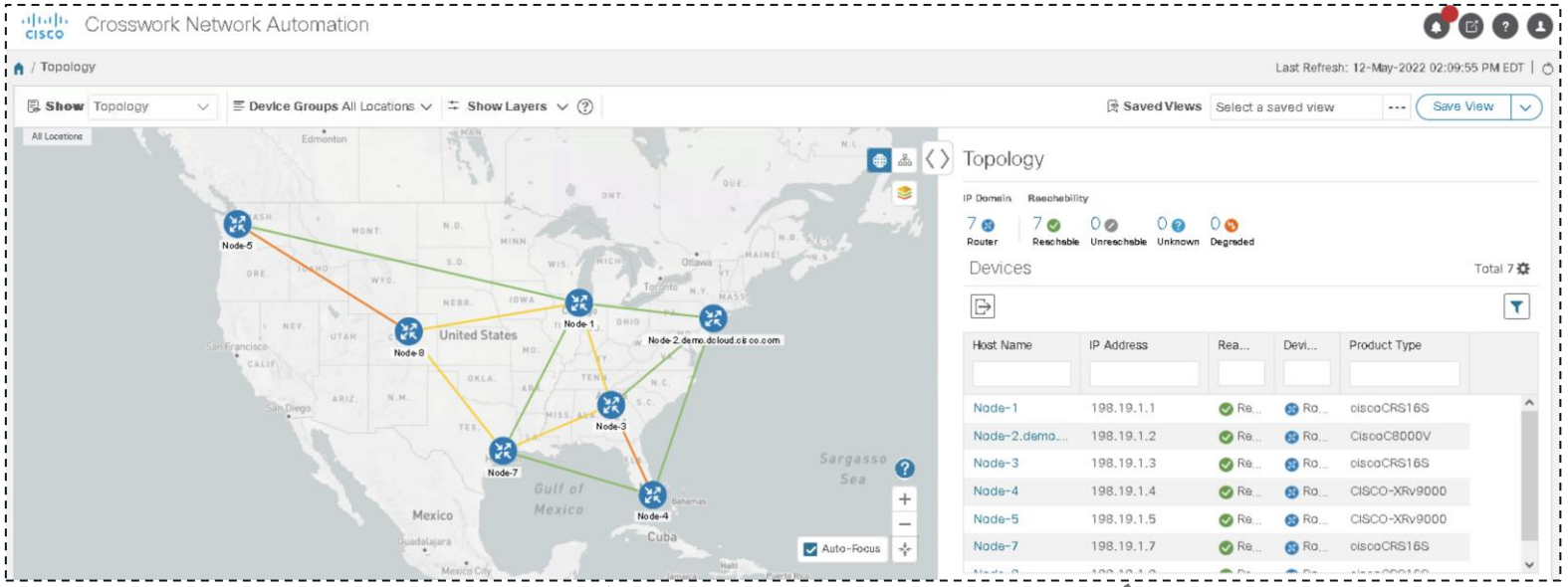


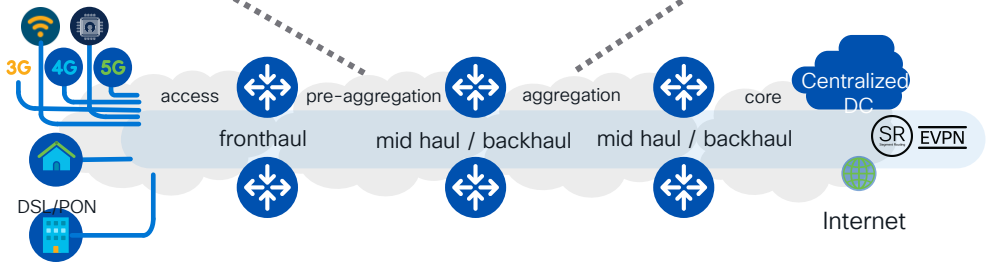
- Streaming Telemetry with open source solutions:
  - TIG (Telegraf, InfluxDB, Grafana)

Crosswork Network Controller – Functional View



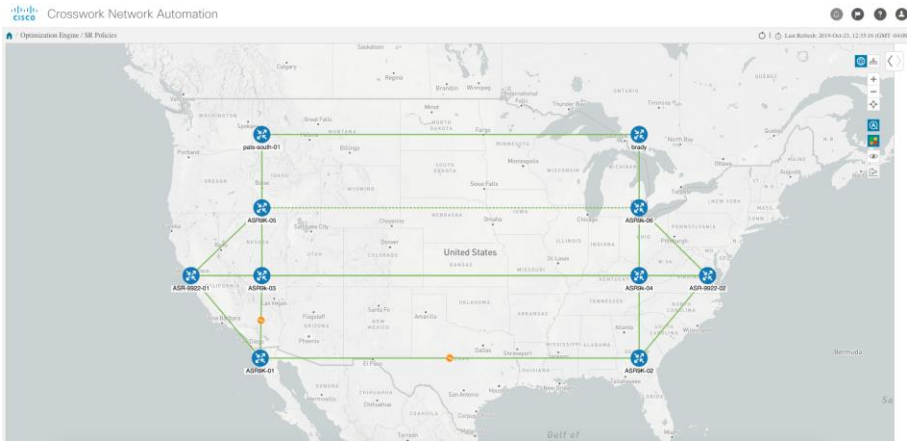
Crosswork Network Automation





CNC Use Case with Traffic Engineering

- In steady state traffic path allows for optimal delivery of market data, voice, video, etc
- However, if a link becomes congested in the primary path, operator wishes to route the critical data to an alternate SR TE path
- This is accomplished using 3 components:
  - Model Driven Telemetry configured to monitor link utilization
  - Automation Playbook to find an alternate path to Avoid the link/nodes that are congested (ie. Find a new segment list)
  - A programmatic ability to have a new Path instantiated to avoid the link using the PCE controller (SR-PCE)



Other Automation options

Napalm

Conclusion

Converged SDN Transport

- Dramatic reduction in Time To Market for services
- Improved customer experience (availability, latency, capacity, features and on-demand delivery)
- Use Segment Routing for the Transport Layer
- BGP as a Unified Services Control Plane across SP Netowrk
- Cisco Crosswork Network Controller as the “God Box”

You want to try Crosswork and SR in a LAB environment?

Technical Session Surveys

- Attendees who fill out a minimum of four session surveys and the overall event survey will get Cisco Live branded socks!
- Attendees will also earn 100 points in the Cisco Live Game for every survey completed.
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