You make **possible**

Path to an Intent based Transport SDN Infrastructure:

Segment Routing and EVPN Network Evolution Strategies and Usecases

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BRKSPG-2014

Agenda

- The Case for Intent based Network Transport
- Transport Network Evolution
- BGP VPN Services Evolution
- Application Driven, SDN Ready Transport Networks
- Summary

Glossary

- SR – Segment Routing
- SRTE – Segment Routing Traffic Engineering
- PCE– Path Computation Element
- SR-PCE – Segment Routing Path Computation Element
- PCC – Path Computation Client
- PCEP – Path Computation Element Protocol
- BGP-LS – BGP Link State Protocol
- NSO – Network Services Orchestrator
- EPE – Egress Peer Engineering (SR SID for eBGP Peers)
- ODN – On Demand Next Hop

The Case for Intent based Transport Network

You make customer experience **possible**

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Forecast – Growth Ahead !!

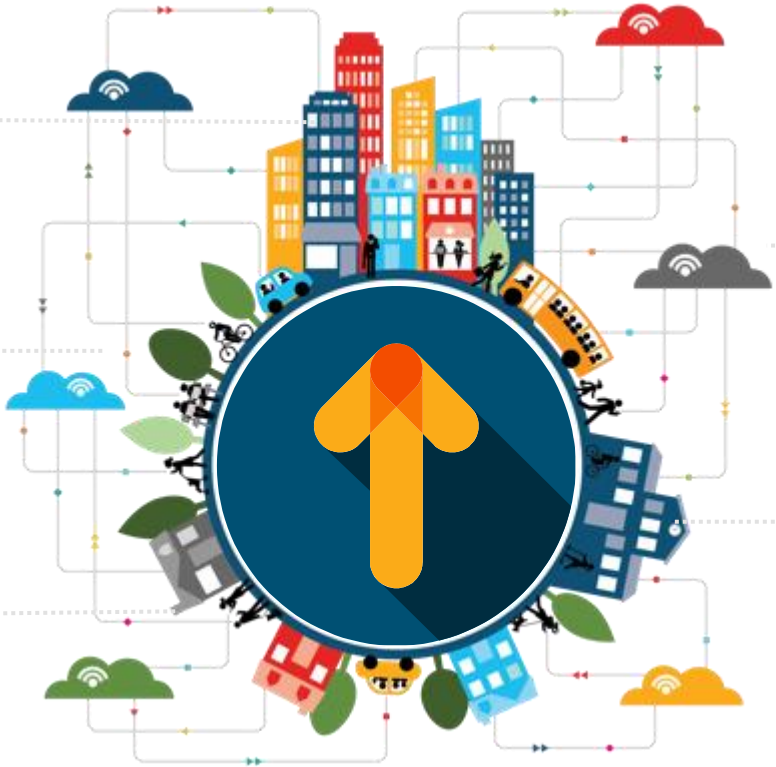
14.6B M2M

Connections by 2022

(51% of total)

12x Growth VR/AR

3.6x more devices than people



28.5B

Connected Devices

3.6 devices/person

85gbps pp/mo

More !!!!

Avg Broadband Speed to Double!!

5.7 billion mobile users in 2022**

3X global traffic increase**

**Cisco VNI 2019

More Services …. More Service Requirements !!

Bulk Update

High Bandwidth
SW Updates
Sporting Events

IOT

M2M Non-Critcal
Low intensity Bursts
Smart Services

Entertainment

AR, VR, Gaming
Upsell Opportunities
User Experience

Mission Critical

Ultra Reliable Low Latency
Public Health
Self Driving Cars

Private Network

Create your own Slice
Industry Verticals
Security, 5G

Drivers for Intent based networks !!!

What is Intent !!

in-ˈtent – noun: the act or fact of intending

in-ˈtent – adjective: directed with strained or eager attention

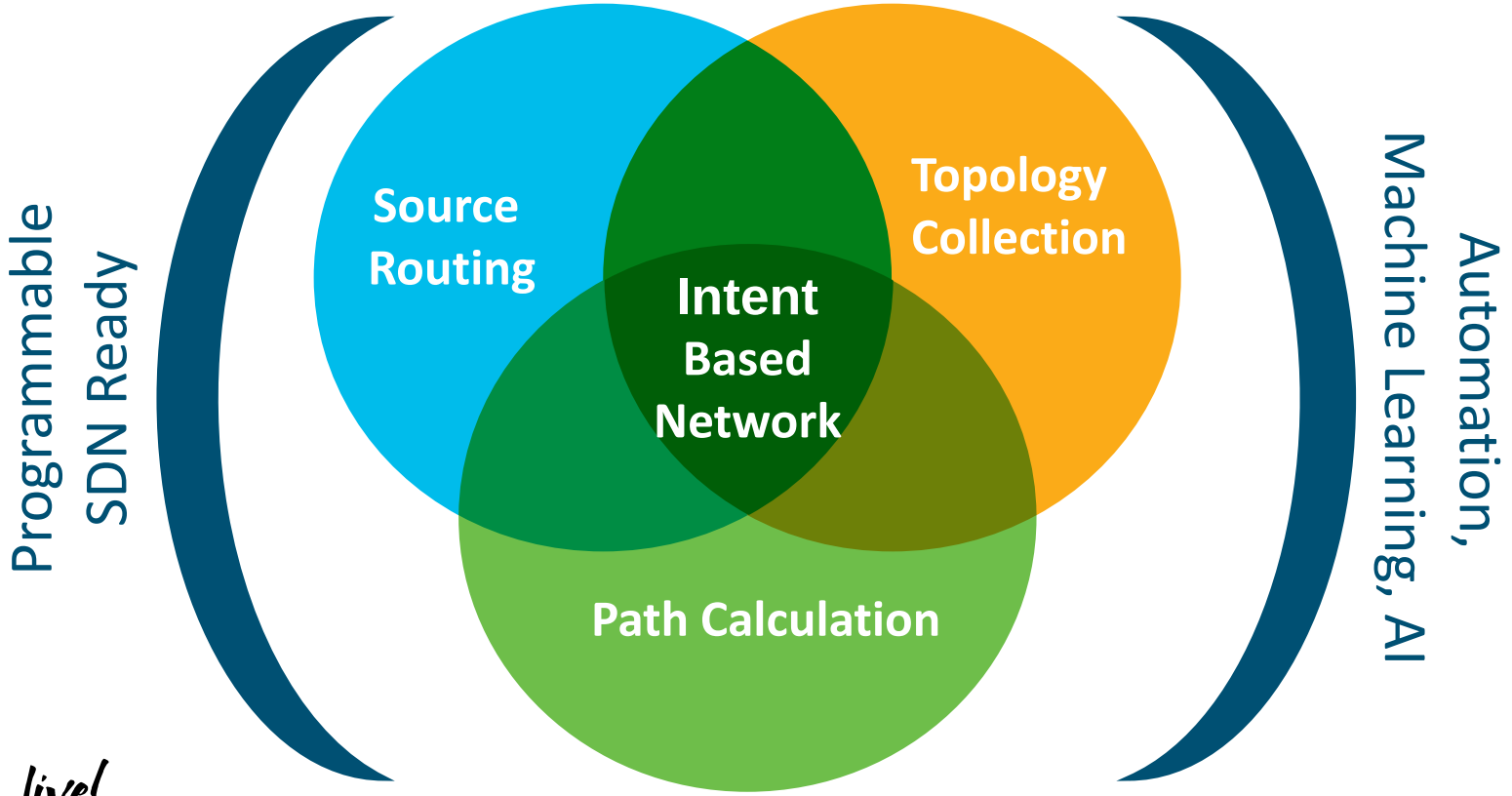
What is Intent !!

in-ˈtent – noun: the act or fact of intending

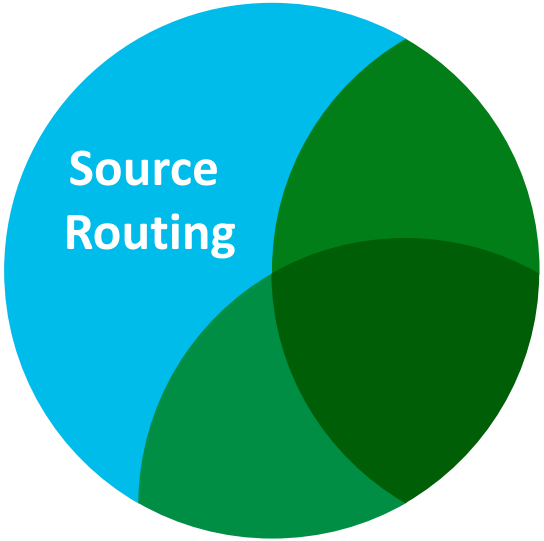
in-ˈtent – adjective: directed with strained or eager attention

in-ˈtent – networking: use of application specific algorithm(s), with specific constraints, directing packets to traverse a particular set of links and/or nodes in an effort to provide a pre-determined SLA

Evolving Transport Networks For SDN



What Makes up an Intent Based Network?



What, Why and How

- Ability to specify path of the packet by the source; not send to Next Hop and hope for the best
- Allows for path control at the source; make possible an “Intent based Path”
- Implemented using Segment Routing

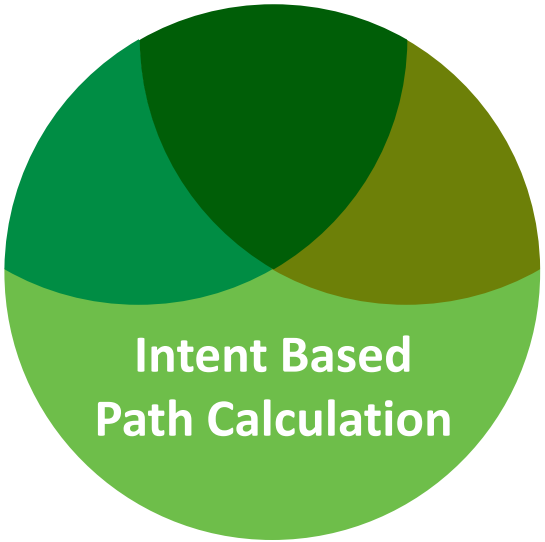
BRKRST-2124: Introduction to Segment Routing
BRKRST-3009: Troubleshooting Segment Routing

What Makes up an Intent Based Network?

What, Why and How

- Mechanism to learn detailed multi-domain topology with link-level attributes
- Required to create an end to end path across domains based on a “forwarding intent”
- BGP Link State (BGP-LS) used to learn IGP/BGP topology with all relevant link/node attributes
- Topology information may be passed to external applications for “Software Defined” path calculation

What Makes up an Intent Based Network?



What, Why and How

- With topology info and source-routing, an “intent-based” path can be calculated
- Ability to provide pre-defined SLA
- Dynamically adjust traffic path when network state changes (e.g. latency change on a link)
- Path calculation can be done on Headend or on centralized “Path Computation Element” (PCE)
- PCE can provide calculated path to nodes

BRKRST-3122: Segment Routing Technology Deep-dive and Advanced Usecases

Why Intent Based Networking?

A Foundation for Network Transformation

SDN Ready Transport

5G Ready Architecture

App driven Forwarding

Efficient Operation

Make and Save Money

Transport Network Evolution

You make the power of data **possible**

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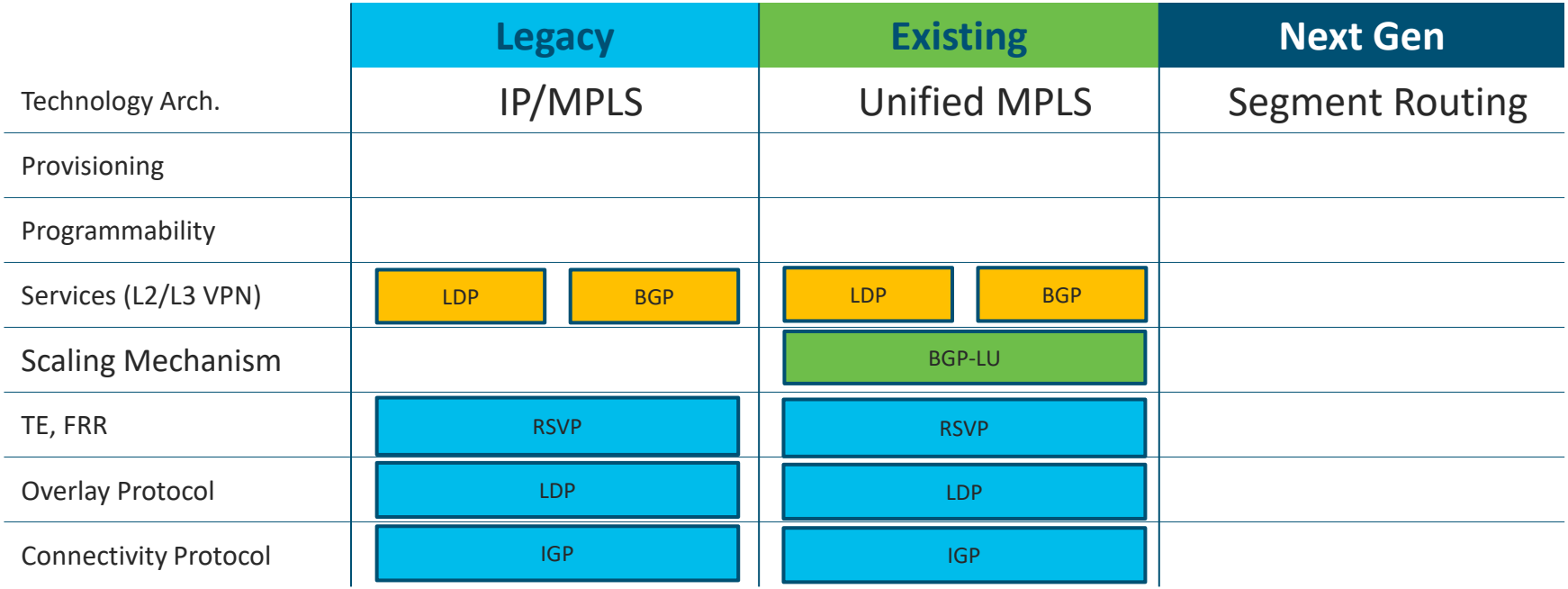
Transport Network Evolution

Network Evolution and Simplification Journey

	Legacy	Existing	Next Gen
Technology Arch.	IP/MPLS	Unified MPLS	Segment Routing
Provisioning			
Programmability			
Services (L2/L3 VPN)	LDP, BGP		
Scaling Mechanism			
TE, FRR	RSVP		
Overlay Protocol	LDP		
Connectivity Protocol	IGP		

Network Evolution and Simplification Journey



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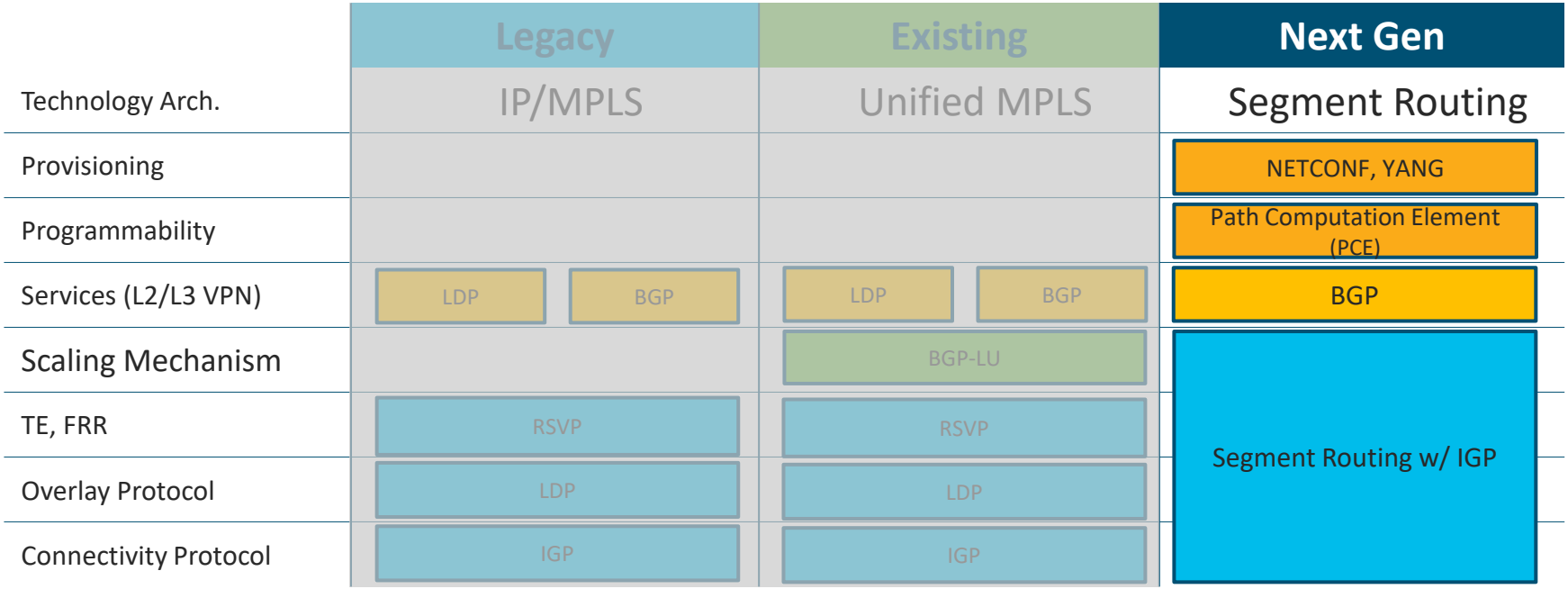
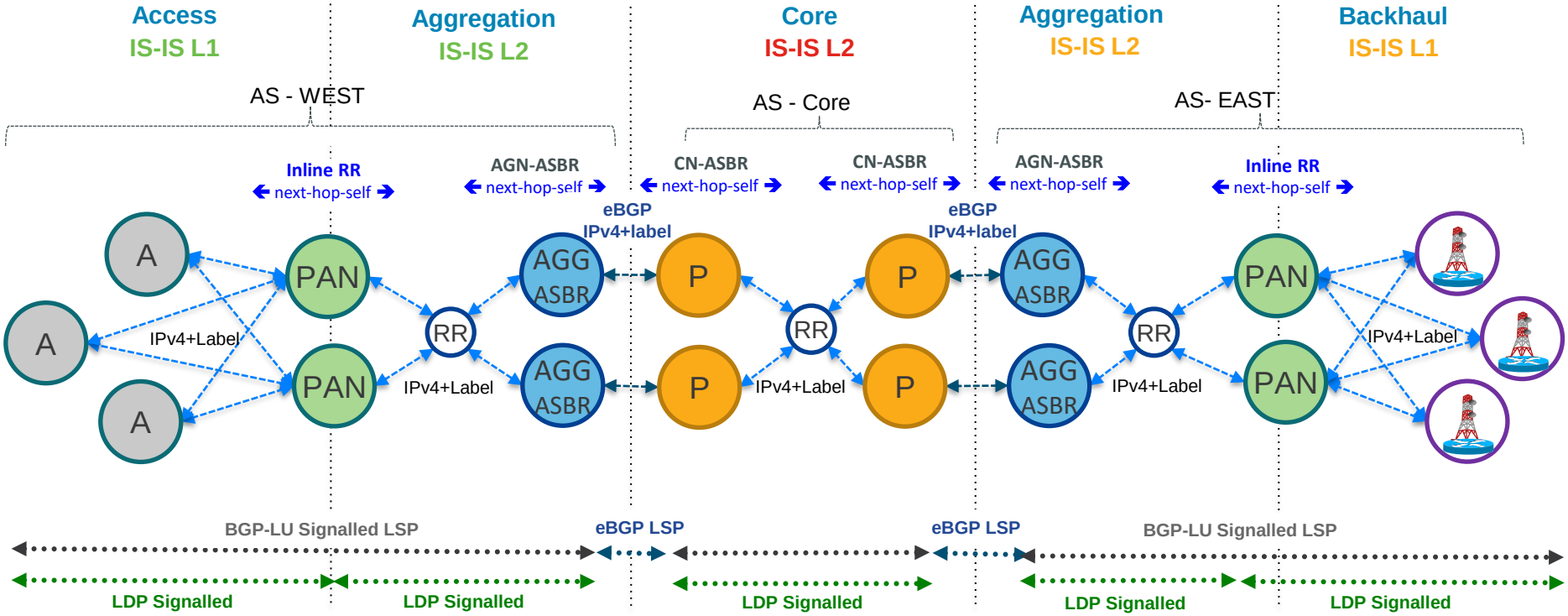


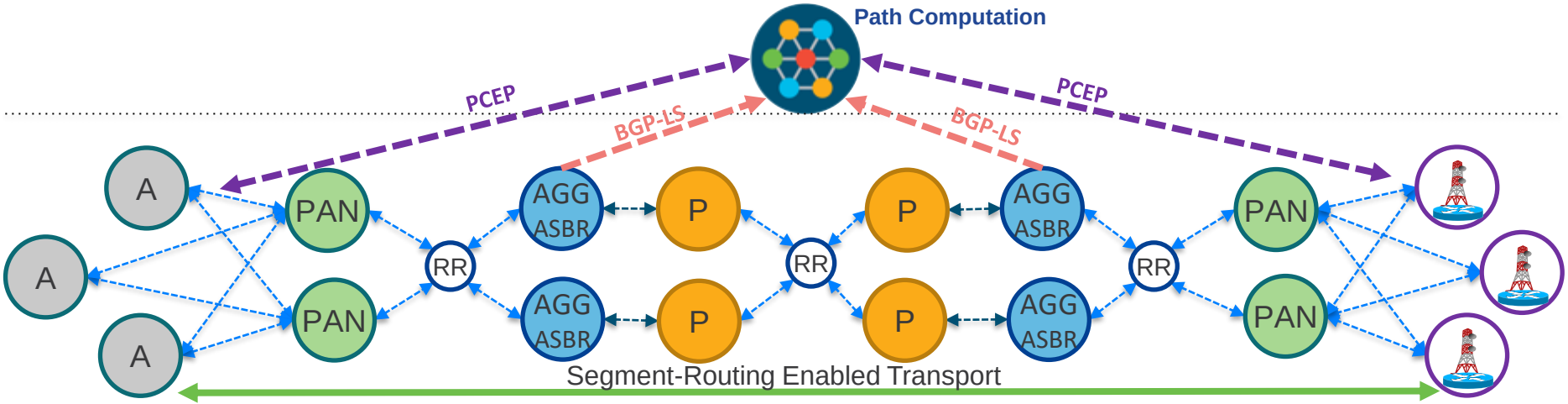
Where We Are …

Current Unified MPLS Baseline



Where Do We Want to Go…

Intent Based SDN Ready Transport



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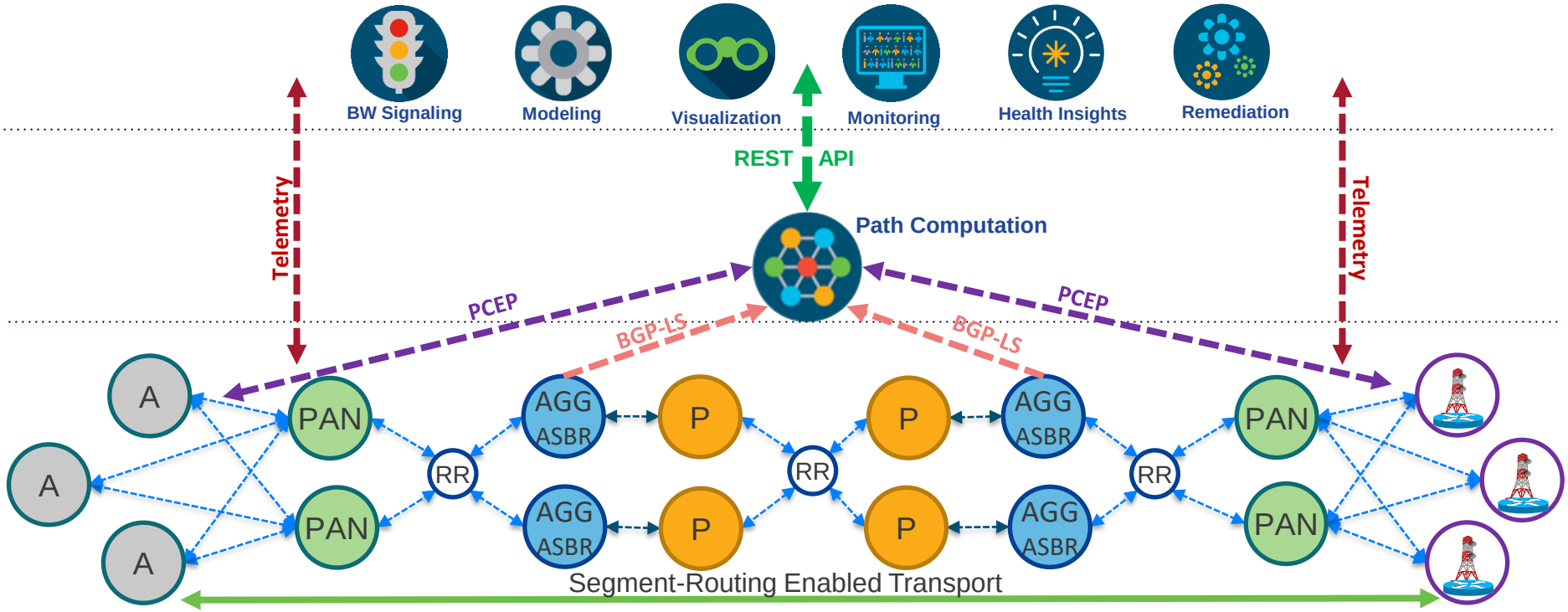

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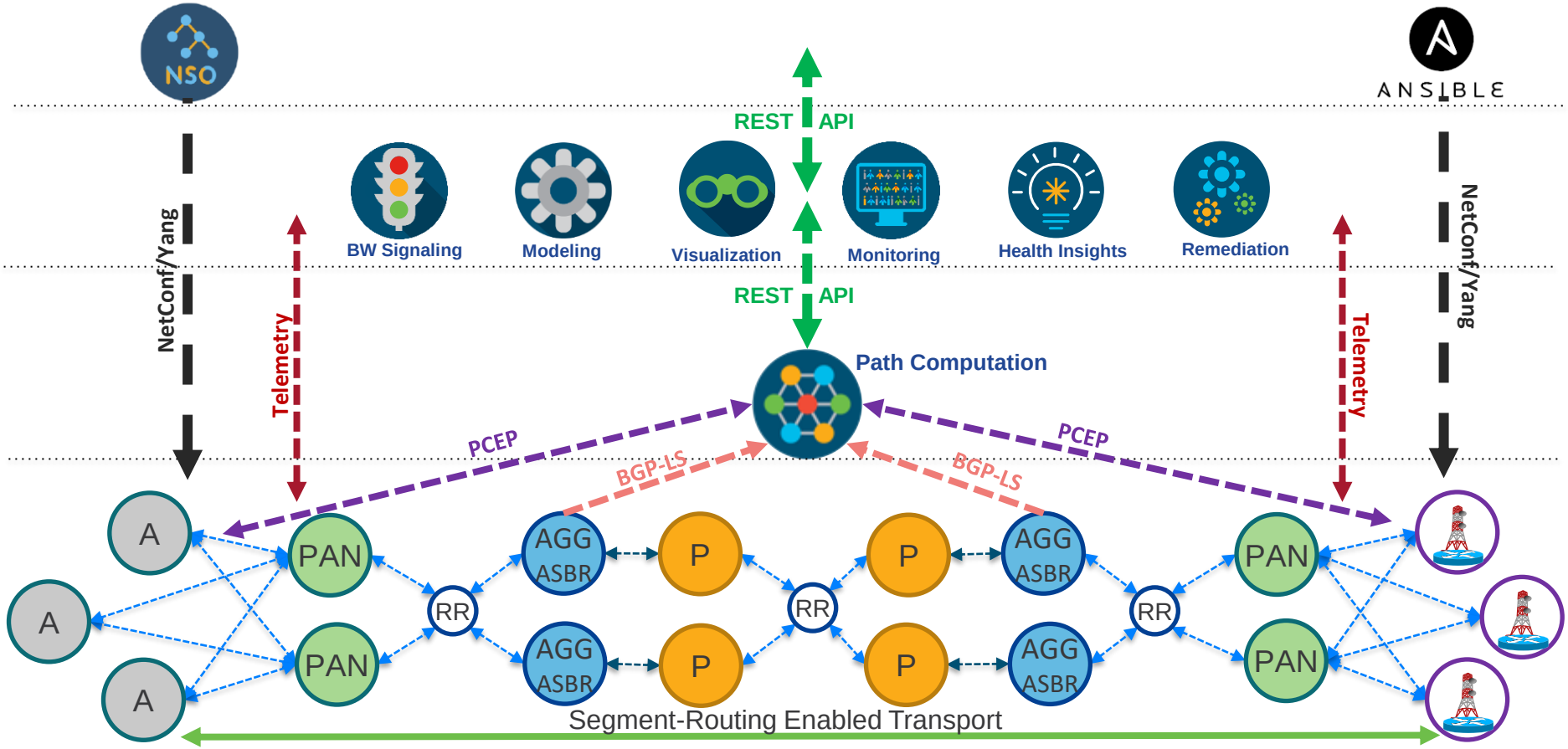
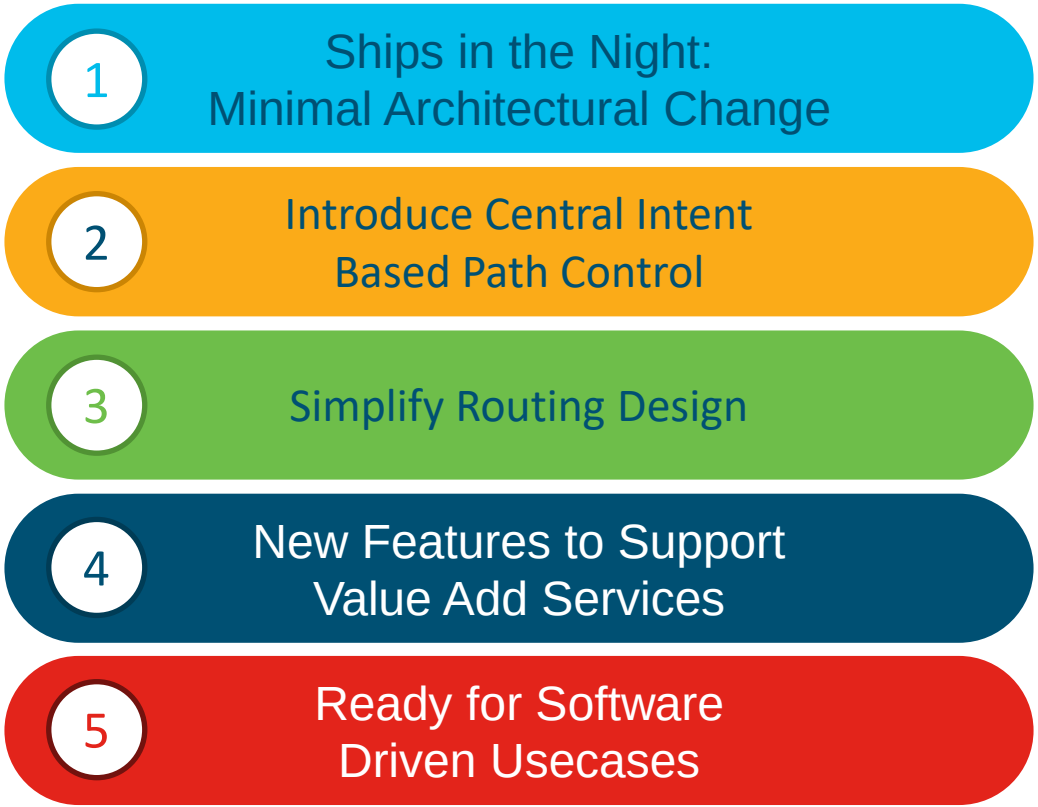


How Do We Get There?

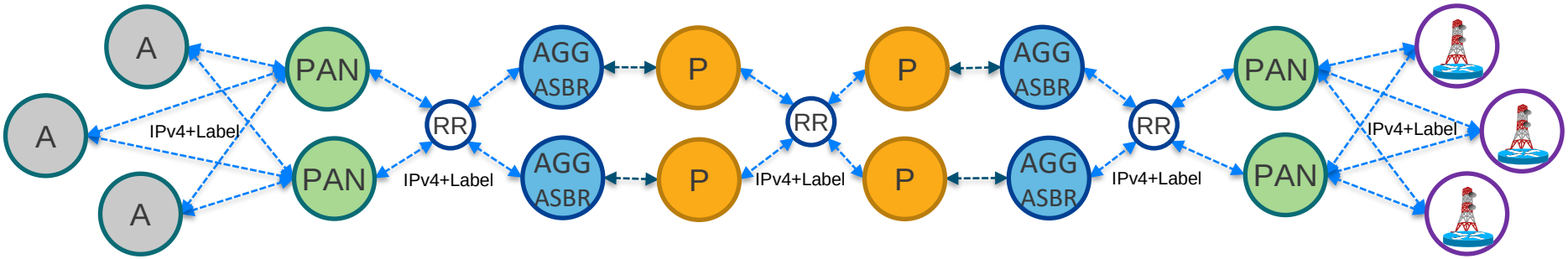
Multi-Step Network Evolution



Introducing Segment Routing Underlay Transport

Ships in the Night: MPLS-LDP Based Service Transport

- No Architectural Changes, minimal Configuration Changes
- All services continue using MPLS-LDP
- BGP still used for multi-domain path
- Intent cannot be defined yet, as services use MPLS-LDP Transport



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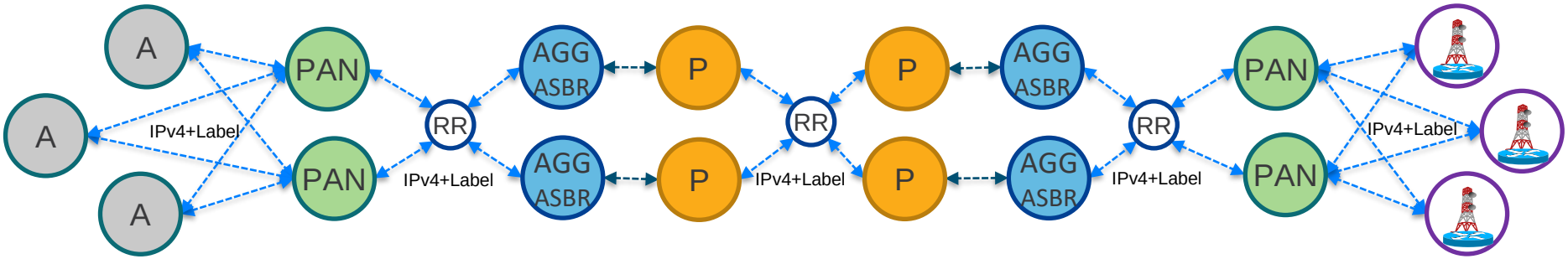
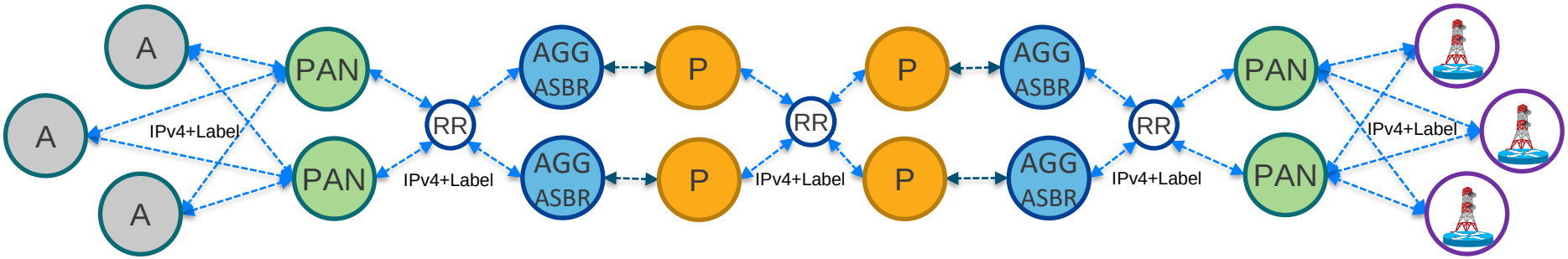
```
router isis 1
 address-family ipv4 unicast
  metric-style wide
  segment-routing mpls [sr-prefer]
 !
interface Loopback0
  passive
  address-family ipv4 unicast
   prefix-sid index 1
```



Introducing: Segment Routing Underlay Transport

Ships in the Night: SR Based Service Transport

- No fundamental architectural Changes
- BGP-SR used for Multi-Domain path
- Intent can now be defined on the headend using SRTE
- All path calculation done on headend
- Network Visibility required on headend



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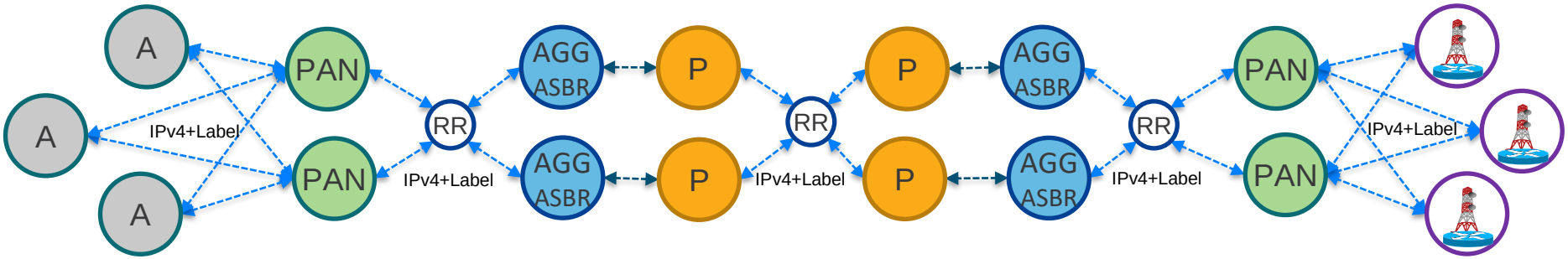
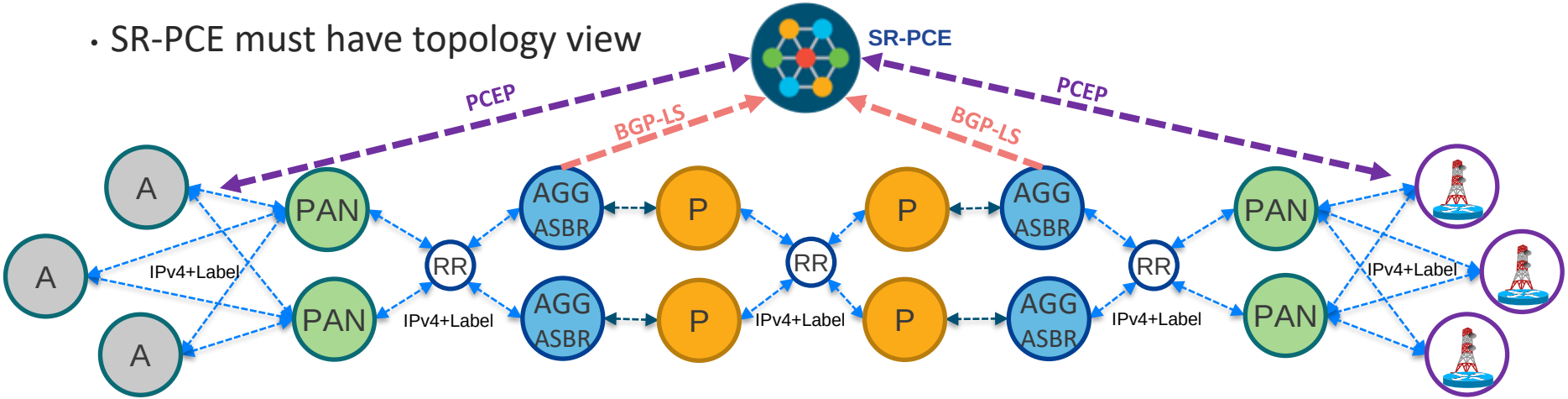
```
segment-routing
 traffic-eng
  policy POLICY1
   color 20 end-point ipv4 1.1.1.4
   candidate-paths
    preference 100
     dynamic
      metric
       type latency
      affinity
       exclude-any name high_cost_link
```



Centralized Traffic Control and Compute

PCE-PCC Relationship

- Offload Intent Based Path computation
- SR-PCE, as XRv9K device, can take requests to compute path
- Requesting node in called Path Computation Client (PCC)
- SR-PCE must have topology view



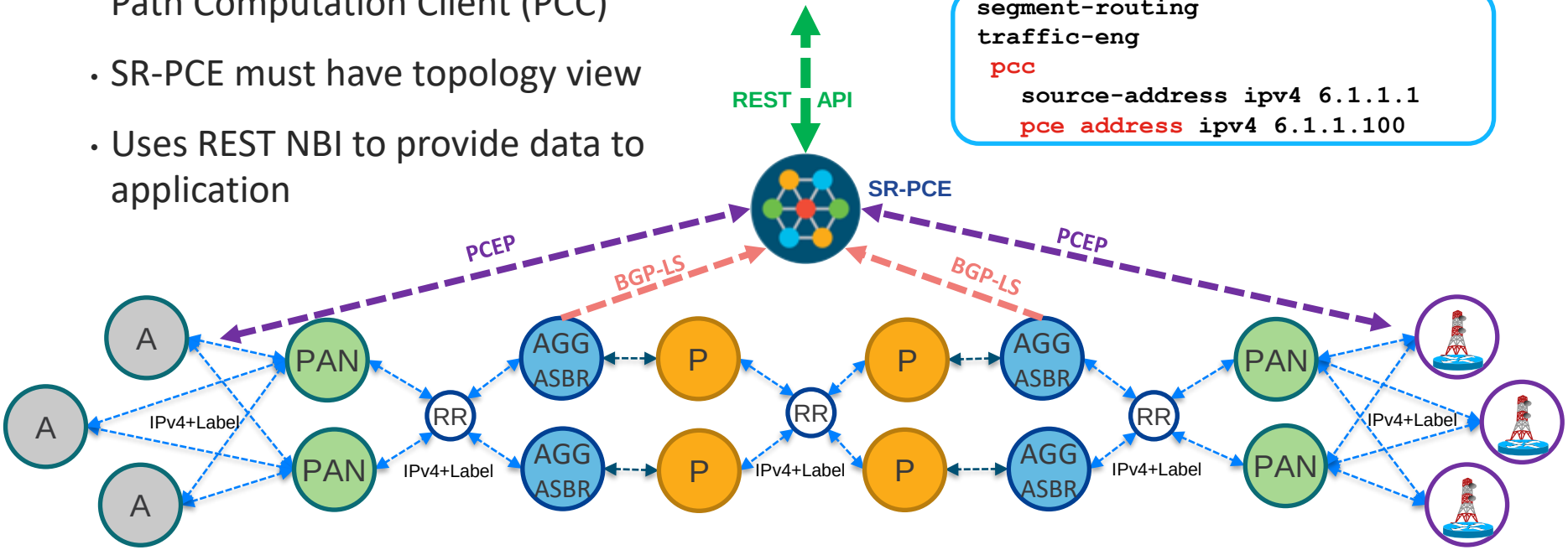
Centralized Traffic Control and Compute

PCE-PCC Relationship

- Offload Intent Based Path computation
- SR-PCE take path compute requests from Path Computation Client (PCC)
- SR-PCE must have topology view
- Uses REST NBI to provide data to application

```
pce
 address ipv4 6.1.1.100
 rest
```

```
segment-routing
traffic-eng
 pcc
   source-address ipv4 6.1.1.1
   pce address ipv4 6.1.1.100
```



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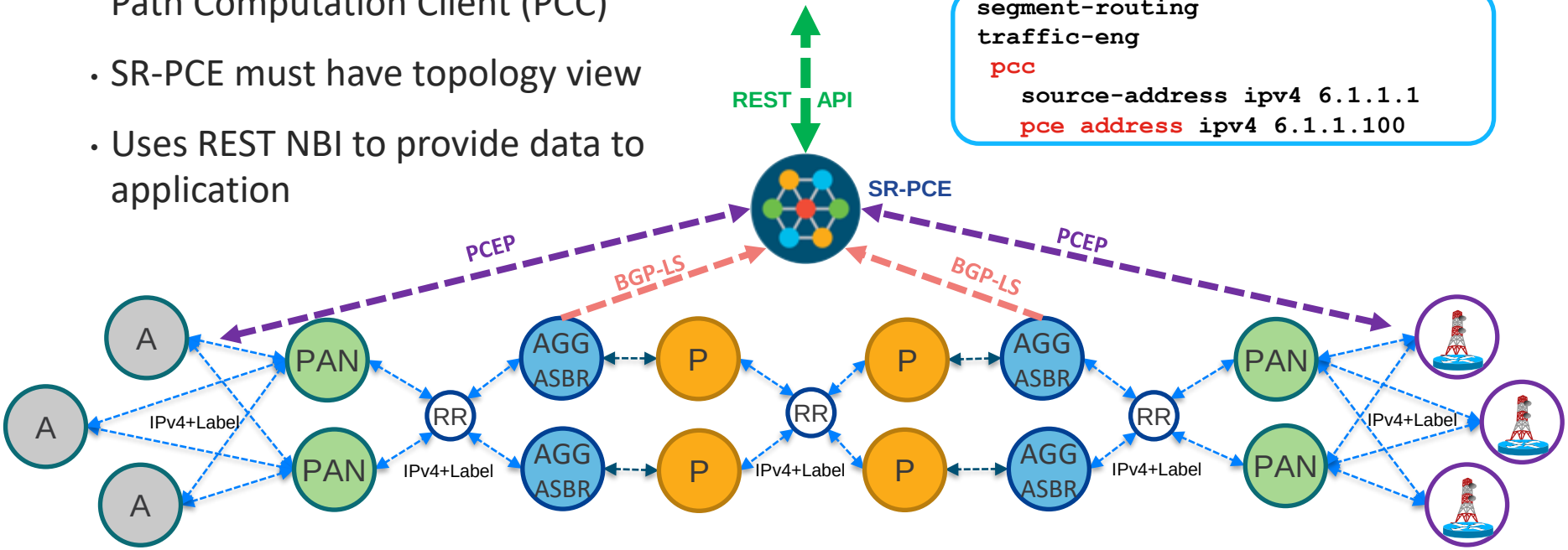
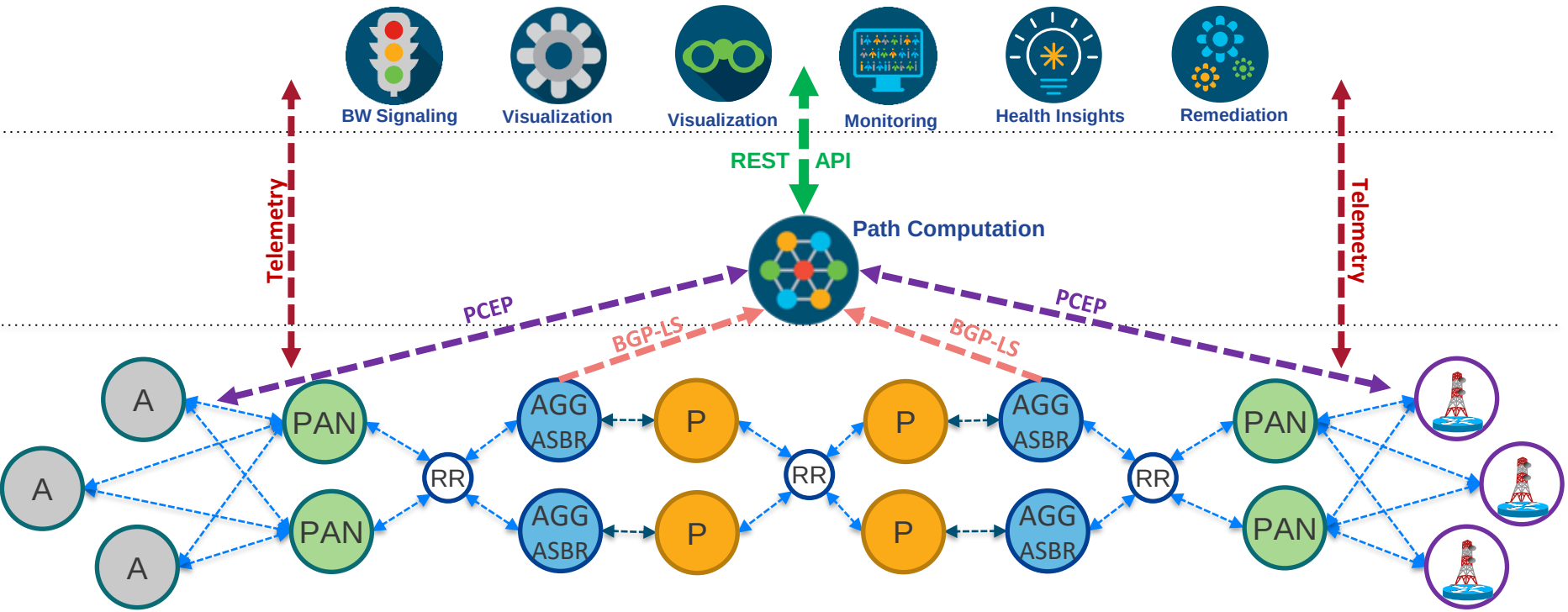


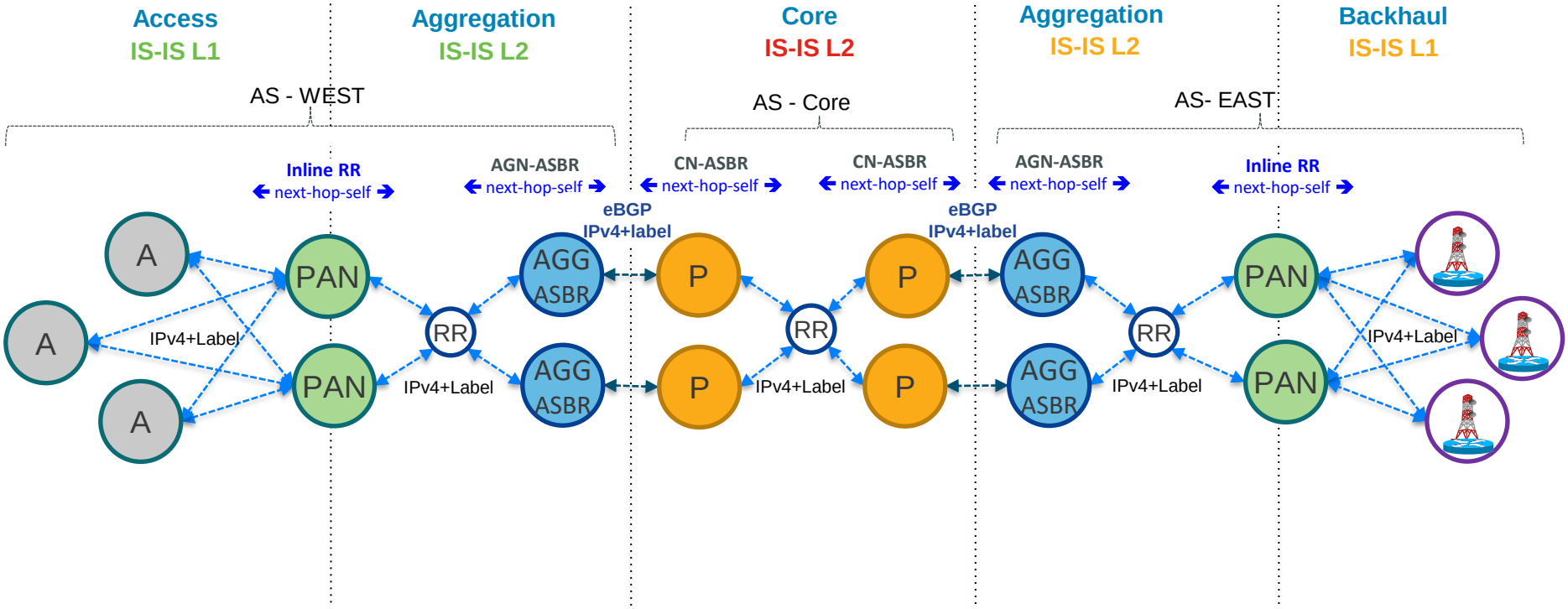
Intent Based Programmable Network: Transport now Ready for SDN



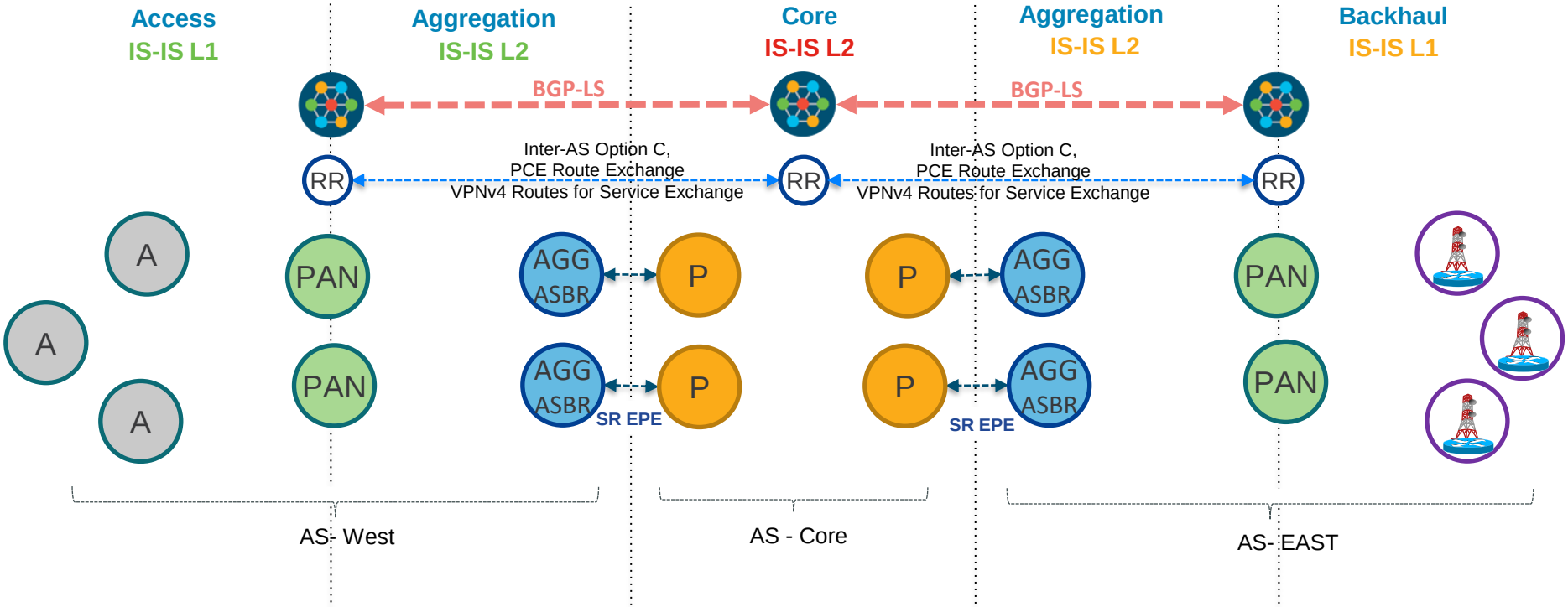
Reminder: How Do We Get There?

Multi-Step Network Evolution

Reminder: BGP-LU, with MPLS-LDP Design



Simplify Routing with SR-PCE Useage



What Just Happened?

- Access Nodes don't need BGP/IGP route to remote service nodes
- Simplified, scalable routing: No L1/L2 leaking, No BGP-LU routes
- PCE could be part of both L1/L2 areas and have reachability to Access Nodes
- RR could be part of both area to provide VPNv4 Route Exchange

Reminder: How Do We Get There?

Multi-Step Network Evolution

On-Demand Next Hop (ODN)

Value Proposition

Config Simplification

- No need for a per-destination intent policy
- ODN works as a “template”
- Specify only intent and color
- Intent applies to all routes/dest that matches the color

OnDemand Policy Instantiation

- Intent can be pre-configured
- No policy is instantiated or programmed
- Policy only instantiated when a route is received for that Intent
- Policy removed, once the route goes away, freeing up resources
- Very helpful for bursty, sporadic traffic .. Like IOT

Flex Algo & Segment Routing TE

Segment Routing (SR):
Use Default IGP Metric to forward traffic (**Default Algo**)
Ability to define a SID-List at the source for traffic forwarding

Segment Routing Traffic Engineering (SRTE):
Intent based forwarding that goes beyond IGP Best Path forwarding
Uses SID List to influence forwarding path

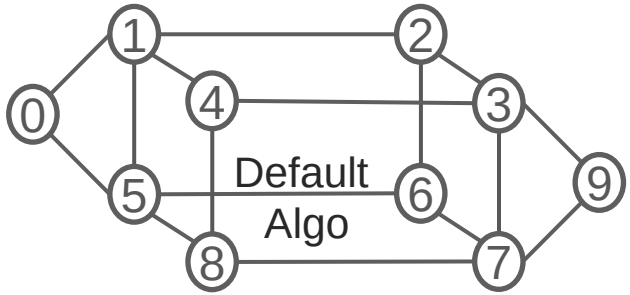
Flex-Algo
"Intent" become additional fwdg logic (i.e. algo) in IGP, enabling domain level forwarding tables
IGP distributes multiple metrics/Affinities – SPF, Low Latency, Constrained Nodes/Link etc
A Network node may or may not participate in Flex Algo, allowing sub-topologies to be created
Multiple Algo's may be operational in a given Network topology

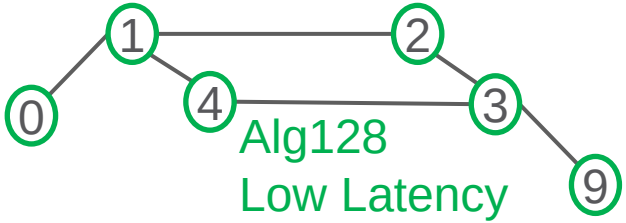
Network Slicing through Flex-Algo

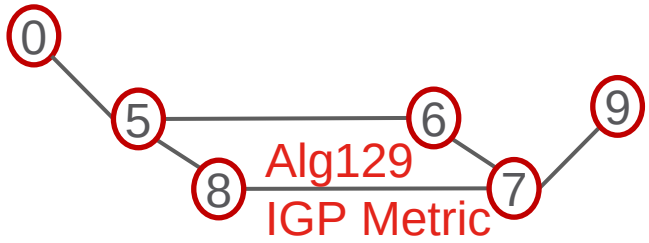
```
router isis 1
net 49.0001.0000.0000.0002.00
flex-algo 128
   metric-type latency

 !
interface Loopback0
 address-family ipv4 unicast
  prefix-sid index 2
  prefix-sid algorithm 128 absolute 16802

segment-routing
  traffic-eng
    on-demand color 100
       dynamic
          sid-algo 128
```







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segment-routing
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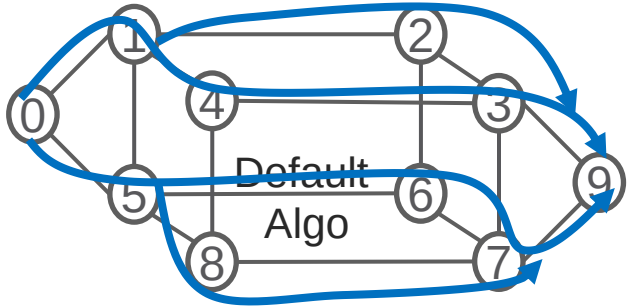
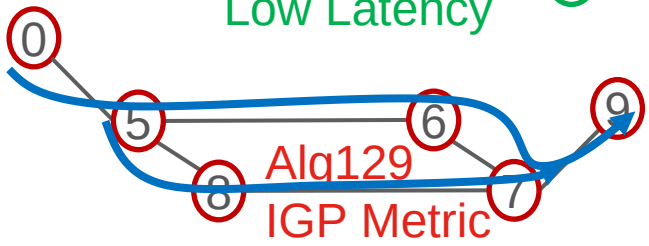
       dynamic
          sid-algo 128
```





Intent Statement: Secure Slice Usecase

1. Financial customer asks for a secure path E2E
2. Requests link-level encryption for any of its traffic
3. Using Lowest Latency possible is still part of their “intent”
4. **Your solution:** You will create a “Secure Network slice” using Flex algo that would avoid non-encrypted links

Reminder: How Do We Get There?

Multi-Step Network Evolution

New Services …. New Service Requirements !!

Bulk Update

High Bandwidth
SW Updates
Sporting Events

Intent Definition:
Bandwidth Signaling

IOT

M2M Non-Critcal
Low intensity Bursts
Smart Services

Intent Definition:
ODN

Entertainment

AR, VR, Gaming
Upsell Opportunities
User Experience

Intent Definition:
Latency Bound

Mission Critical

Ultra Reliable Low Latency
Public Health
Self Driving Cars

Intent Definition:
Low Latency

Private Network

Create your own Slice
Industry Verticals
Security, 5G

Intent Definition:
Flex-Algo
Constraints
Network Slicing

VPN Services Evolution

You make customer experience **possible**

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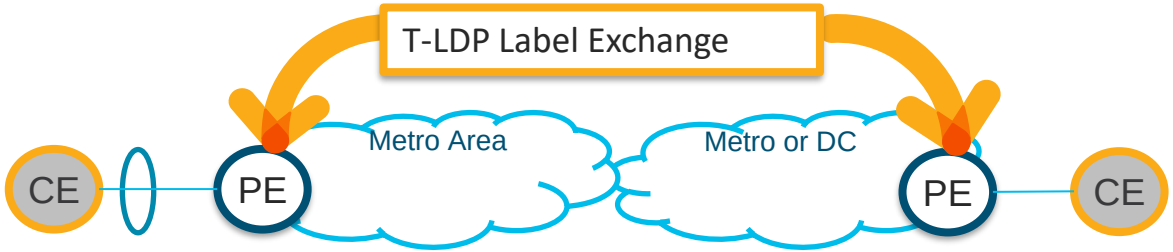
VPN Services Over Segment Routing

Layer 3 VPN	• Utilizes Multi-Protocol BGP (i.e. no dependency on LDP) • Segment Routing/Intent Based Forwarding enhances L3VPN Service
Layer 2 VPN	• Point to Point – EoMPLS • Multi-point VPLS/H-VPLS • If using LDP Signaling, services L2VPN services need to evolve for Segment Routing based network

Point to Point L2VPN → EVPN Evolution

EoMPLS



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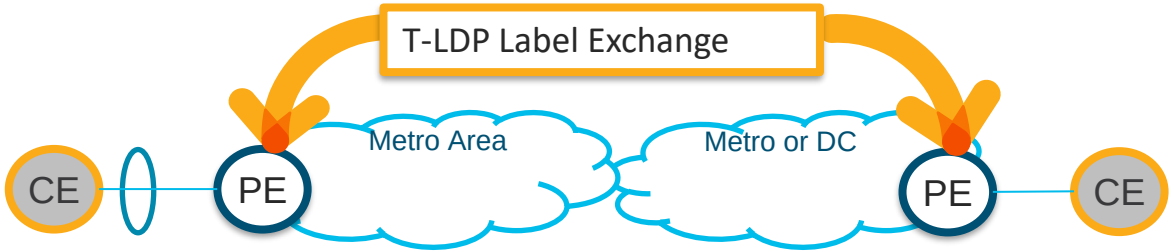
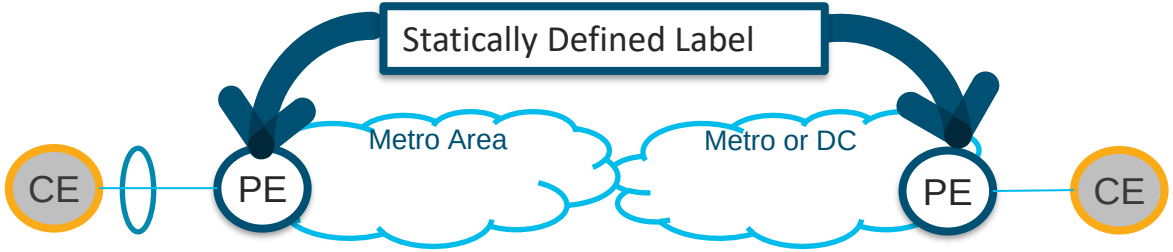


Static PW



Point to Point L2VPN → EVPN Evolution

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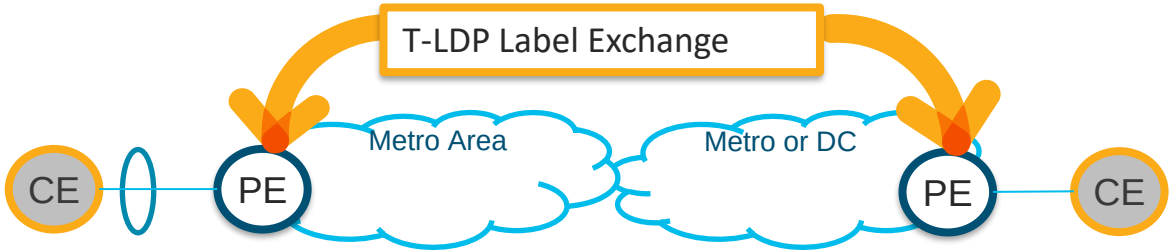

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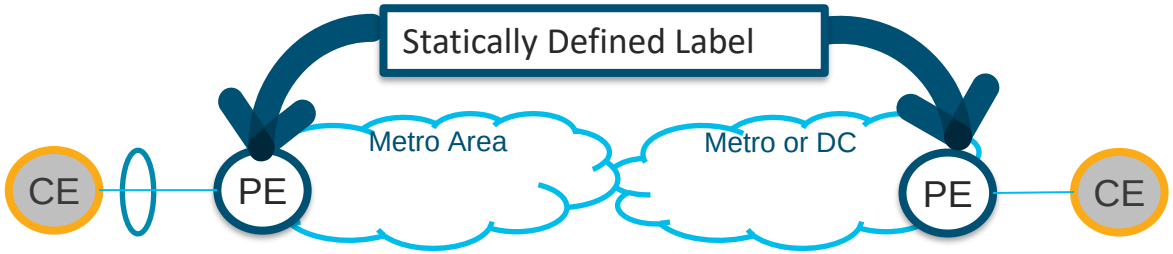
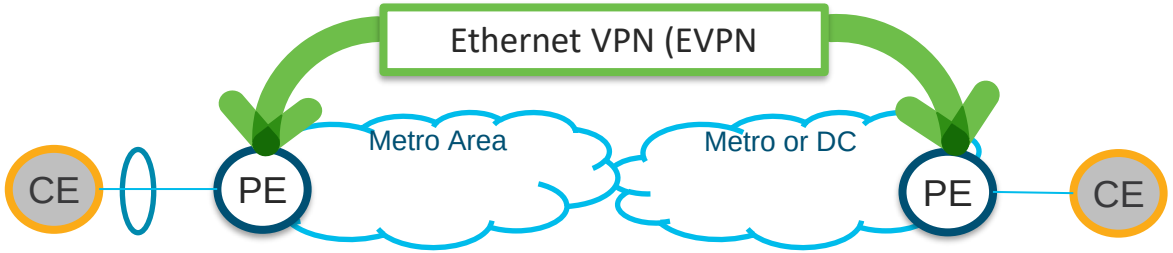
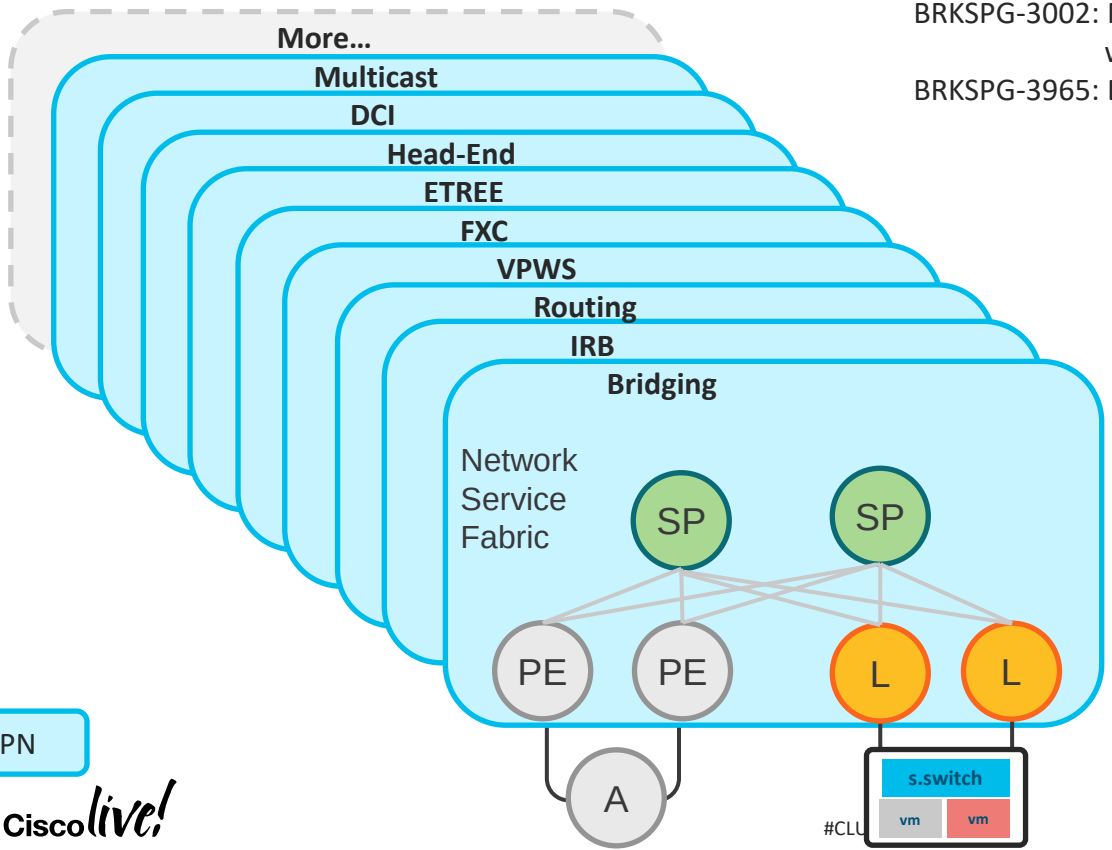


EVPN VPWS



Service Unification Through EVPN*



BRKSPG-3002: Network Service Fabric Architecture with EVPN

BRKSPG-3965: EVPN Deep Dive and Troubleshooting with IOS-XR Configuration examples for Service Provider Metro and Data Center

EVPN

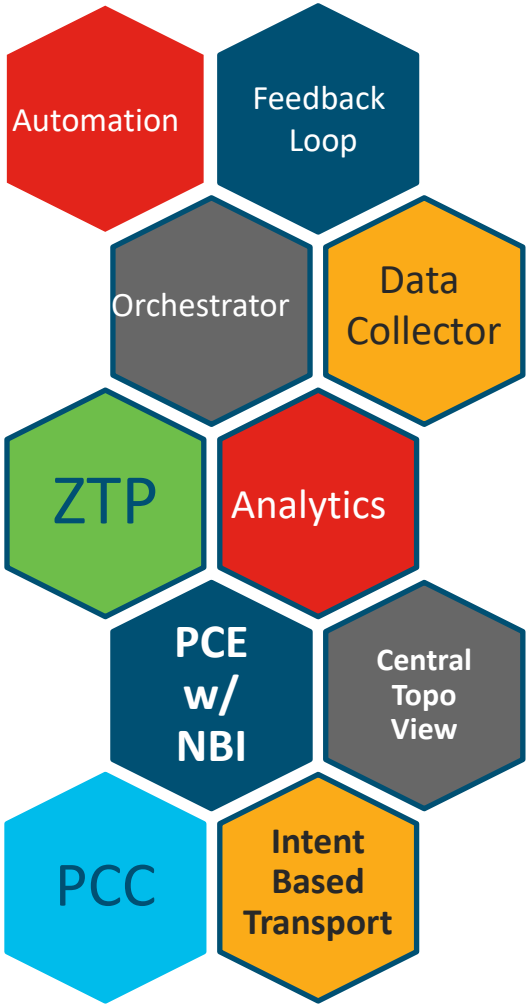
Application Driven, SDN Ready Transport Network Usecases

You make customer experience **possible**

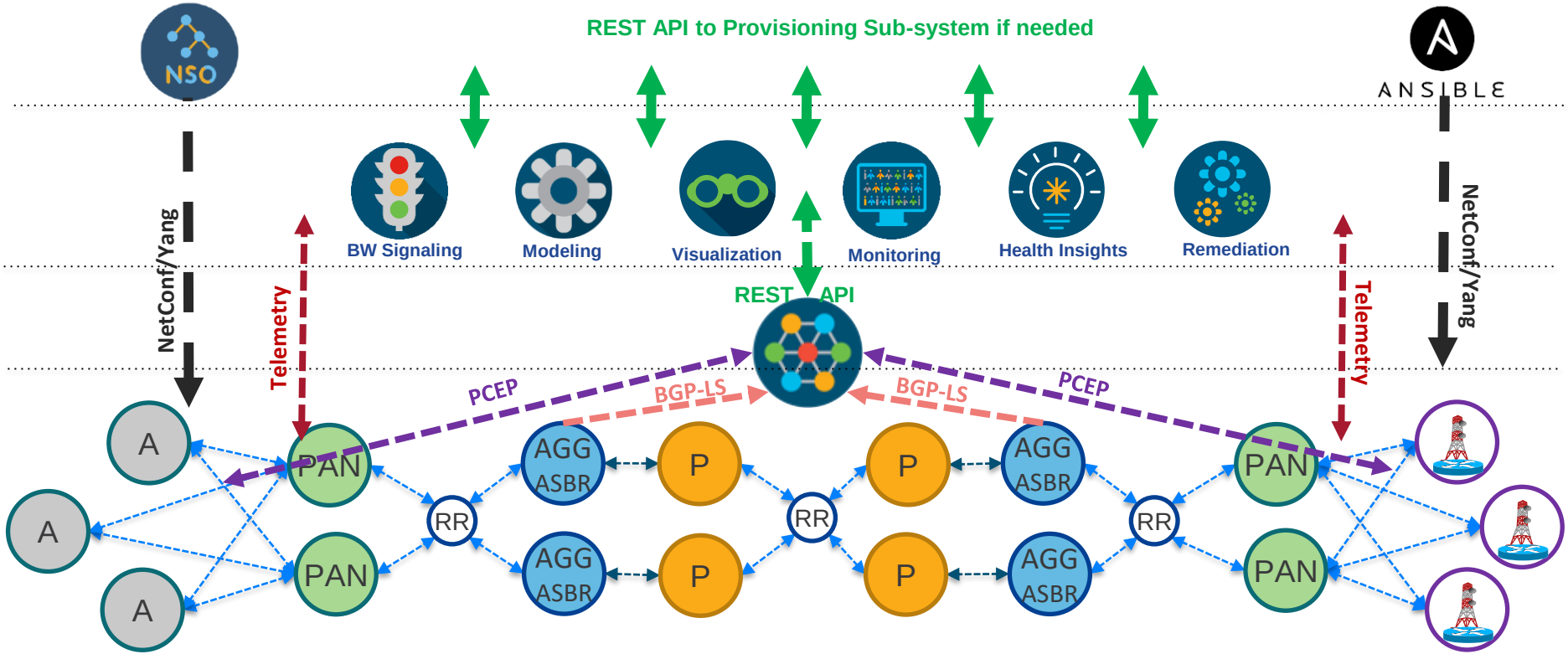
Cisco live!

A Recipe For Transport SDN

- Network Simplification and intent based transport paves the way
- Individual components for a “Transport SDN” architecture widely available
- Integration between various software components in key
- Applications interact with and actively drive Transport Network



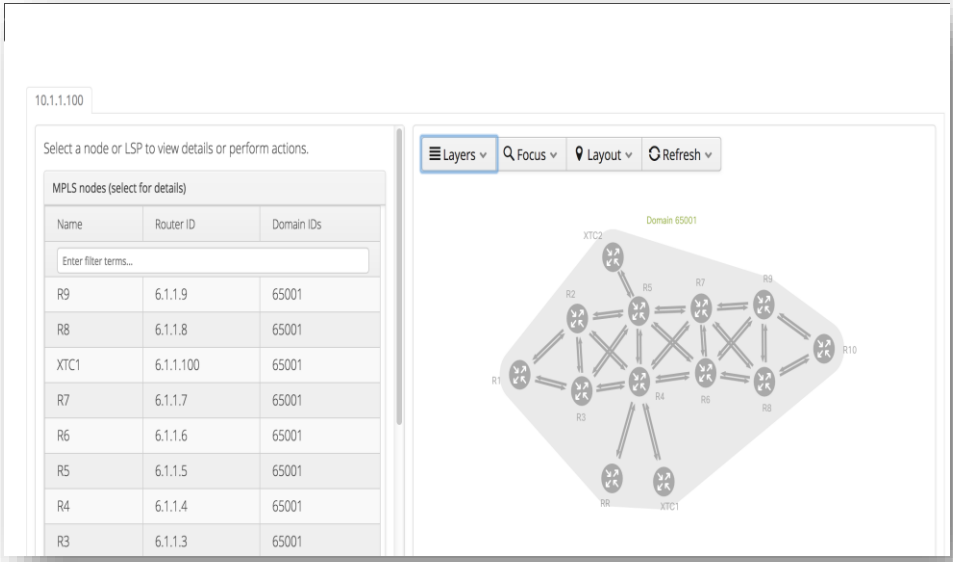
Intent Based SDN Ready Transport



Intent Based SDN Ready Transport Use Cases:

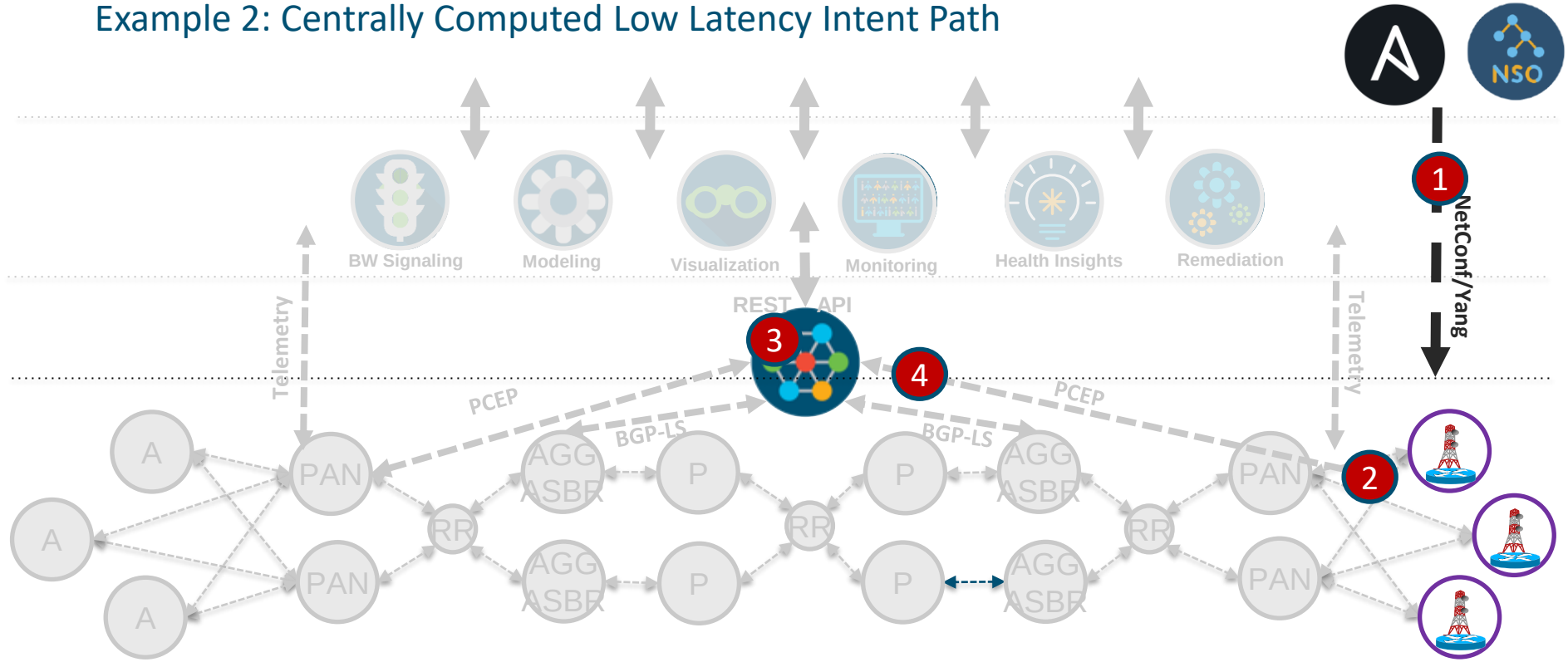
Example1: Centralized Control and Visualization for End-to-End Path

- SR-PCE enables REST API
- External Application gather Topology from SR-PCE
- Visualization includes:
  - Link/Node info
  - SID Allocation
  - Intent Based Path, if defined on nodes/PCE



Intent Based SDN Ready Transport Usecases:

Example 2: Centrally Computed Low Latency Intent Path



1. Provision Low Latency Service

2. Request LSP Computation

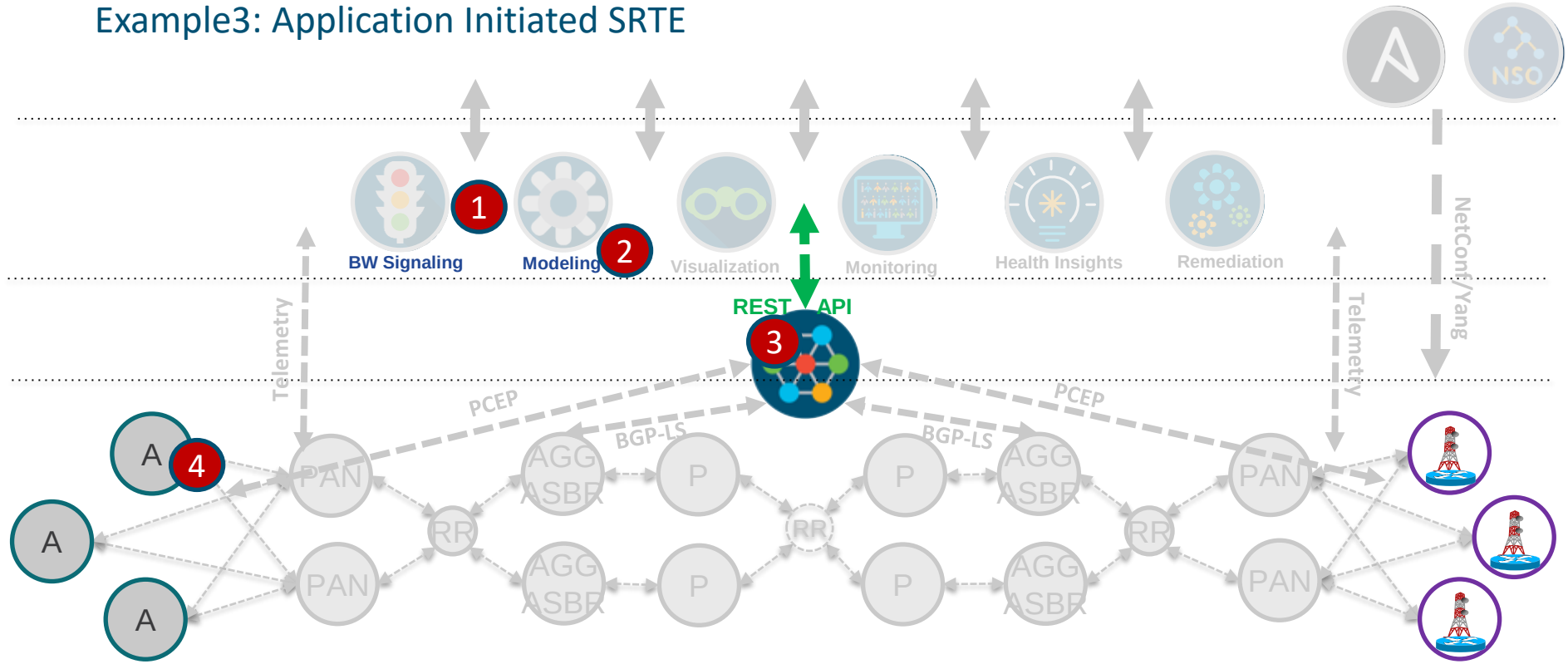
3. Perform Computation

4. Send Computed LSP

5. Applications Updated with new LSP

Intent Based SDN Ready Transport Usecases:

Example3: Application Initiated SRTE



1. Application Determines need for TE Path

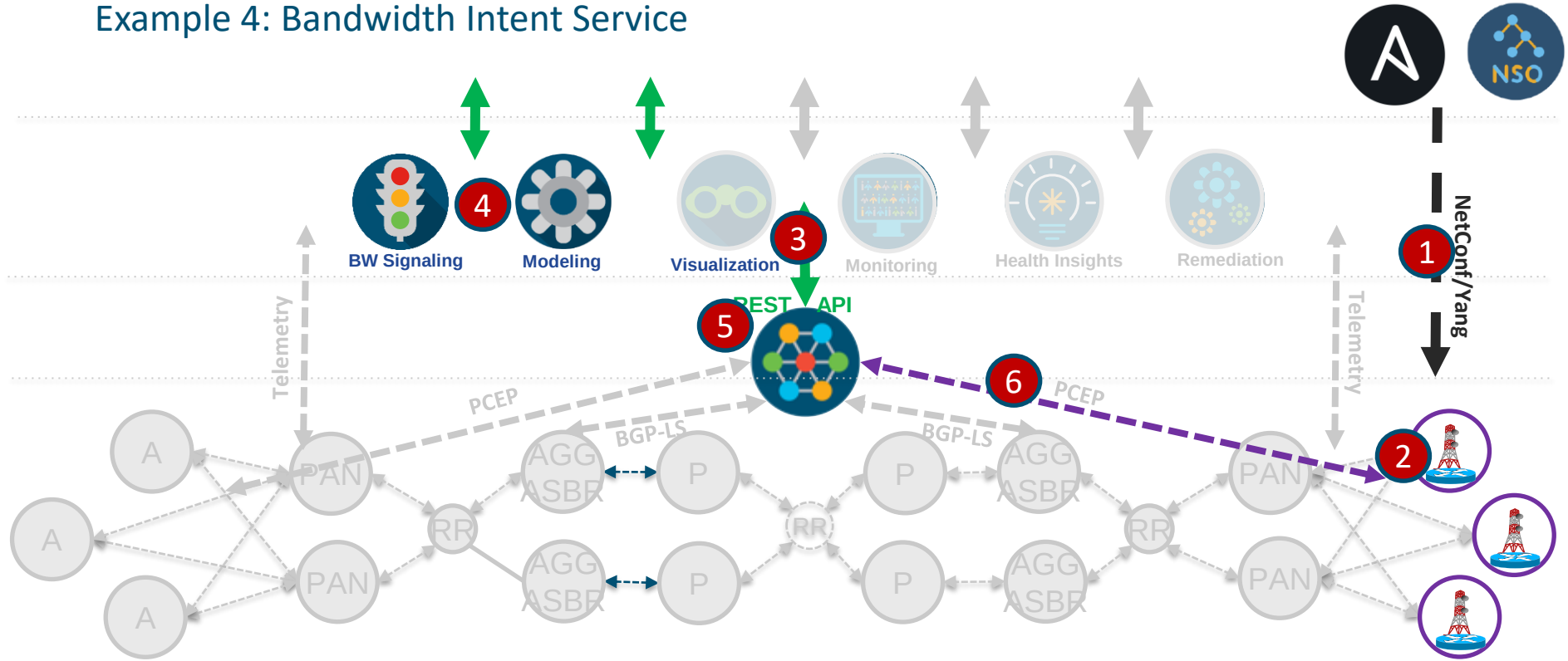
2. Application Computes new LSP

3. Application Instructs SR PCE of new LSP

4. Intent based LSP Path is instantiated on Headend

Intent Based SDN Ready Transport Usecases:

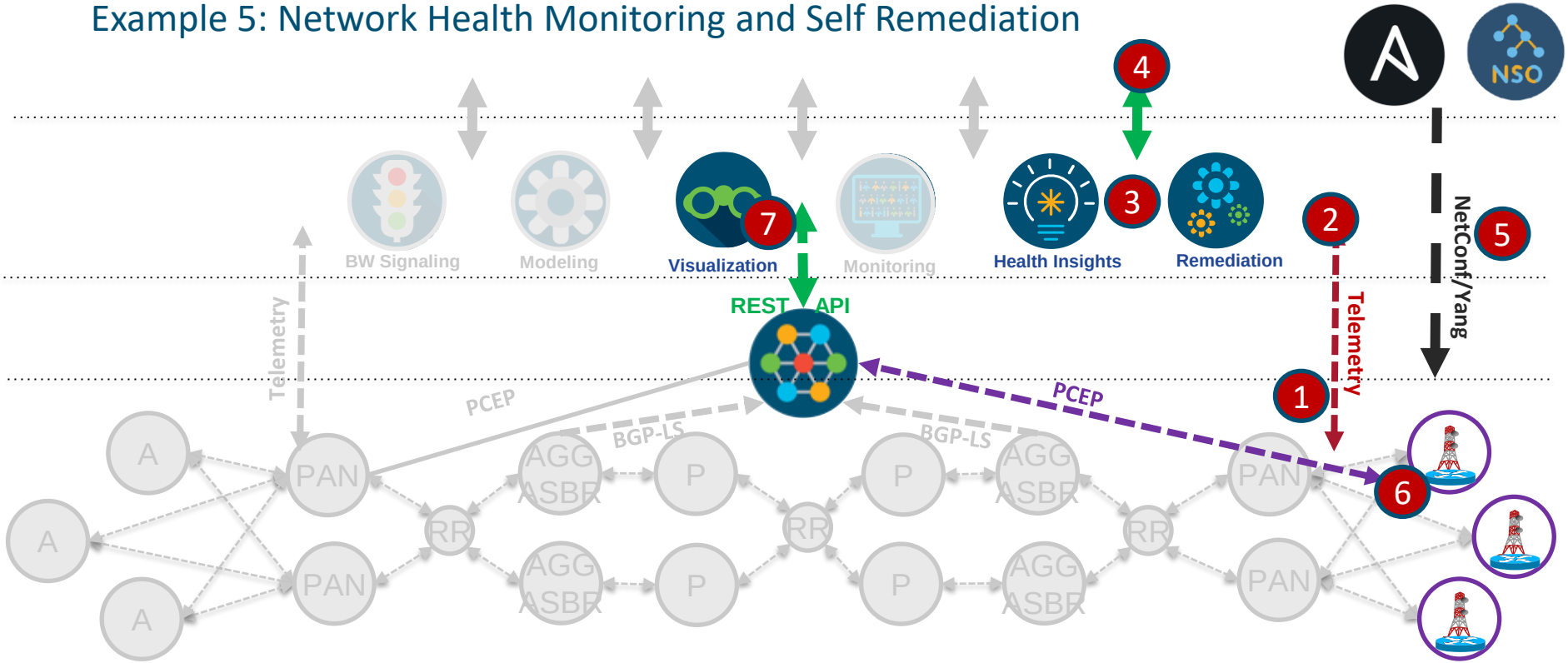
Example 4: Bandwidth Intent Service



1. New Service Requests BW
2. LSP Computation Requested
3. Computation Delegated to Application
4. LSP Path Computed
5. LSP Path sent to SR PCE
6. LSP Path with BW allocated sent to Headend

Intent Based SDN Ready Transport Usecases:

Example 5: Network Health Monitoring and Self Remediation



1. Network Telemetry Data (Model/Event)	2. Published on Data Bus for Subscribers	3. Applications Collect Data and Analyze	4. App Takes action, advices NSO	5. NSO makes n/w changes for continuity	6. PCC Requests new Path from PCE	7. PCE update Apps with new path

Summary

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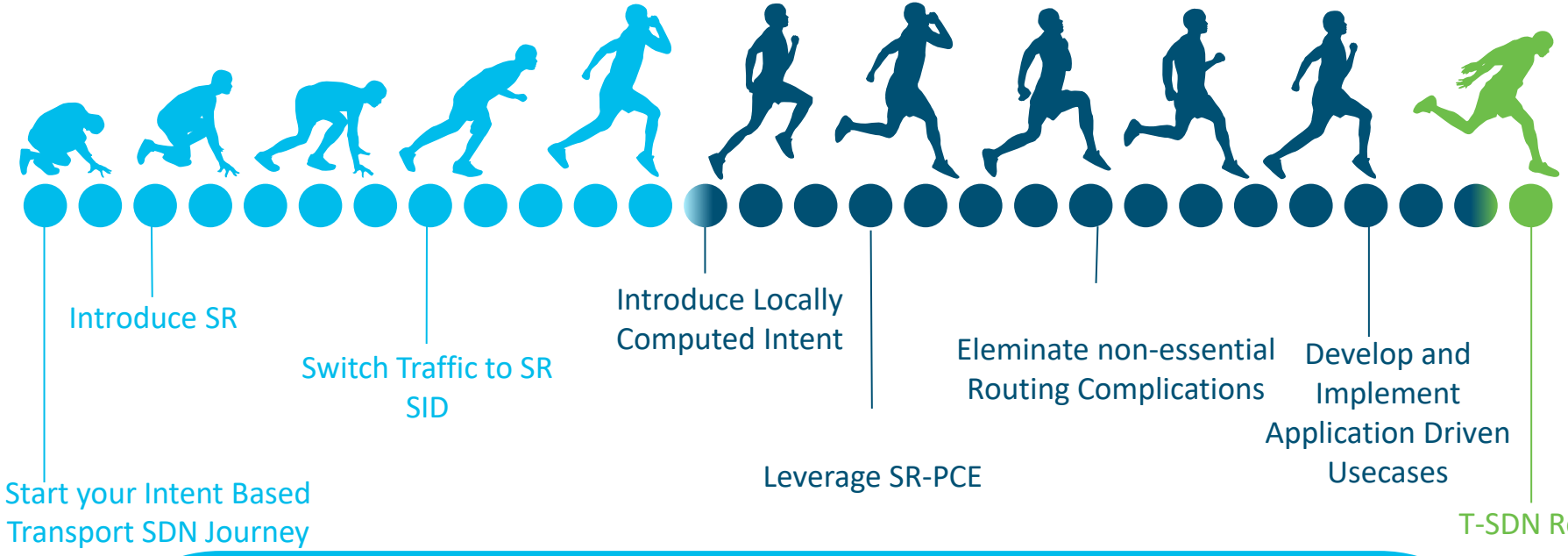
- No reservation required, just show up and get hands-on experience
- A great way to get hands-on experience on a lot of topics covered here

Session ID	Title
LABSPG-1020	MPLS Segment Routing Introduction
LABSPG-1327	Introduction to Segment Routing v6 (SRv6) with IOS-XR
LABSPG-2000	Network Slicing with Segment Routing Flex-Algorithm for 5G and other Applications
LABSPG-2001	Intent Based Networking using Segment Routing Traffic Engineering
LABSPG-2068	Configure and Implement BGP-EVPN with Segment Routing using IOS-XR
LABSPG-2109	Ethernet VPN (EVPN) Implementation and Troubleshooting
LABRST-1015	Introduction - Segment Routing for Policy Aware Network

Towards Intent Based Transport SDN Networks!!!



It all starts with Intent Based Programmable Transport

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