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Let's go

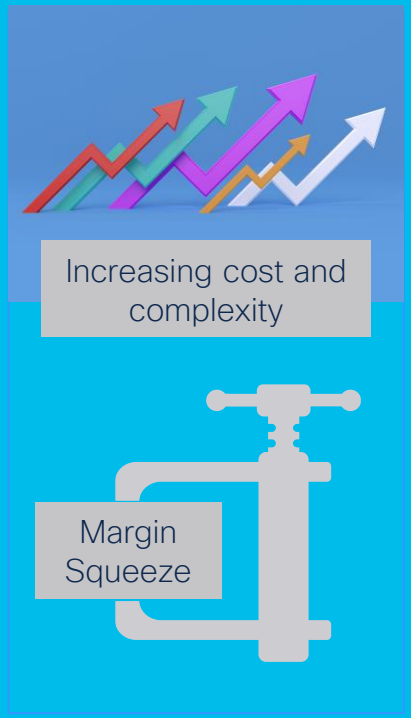
The bridge to possible

Automate Service Provisioning, Optimization and Assurance with SDN Controller

Cisco Crosswork Network Automation

Deepak Bhargava, Leader, Product Management @deebhargava
Sujay Murthy, Technical Marketing Engineer, @ Sujay_Murthy

Operational Dilemma



Challenges

- Increasing Infrastructure Complexity and Scale
- Proliferation of services and traffic types
- Multiple tools, fragmented observability
- Lack of Cohesive Automation framework and tools
- Limited in-house software expertise

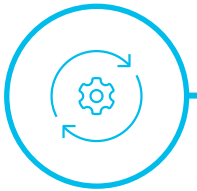
Automation is Key to drive Operational Agility

Agility is Essential in Operationalizing Mass-infrastructure Networks

Agenda

- Why Automation is Critical?
- Demands of Next-Generation Automation Solution
- Introduction to Crosswork Network Controller (CNC)
- Exploring Opportunities for Automation
  - Visualization, Provisioning, Optimization, Assurance
- Maximizing Automation benefits for Next-Generation Networks
  - Segment Routing, 5G transport Slicing, Routed Optical Networking (RON)
- Conclusion

Why Automation is Critical?



Deliver services at machine speed with repeatable quality

81% Reduction in time to launch new services

Make quicker, smarter planning and operations decisions

55% Reduction in operating expenses

Bridge and synchronize business and IT processes

47% Increase in new services revenue

Source: Economic Benefits of Network Automation, ACG Research

Demands of Next-Generation Automation Solution

Challenges

- Increasing Infrastructure Complexity and Scale
- Proliferation of services and traffic types
- Multiple tools, fragmented observability
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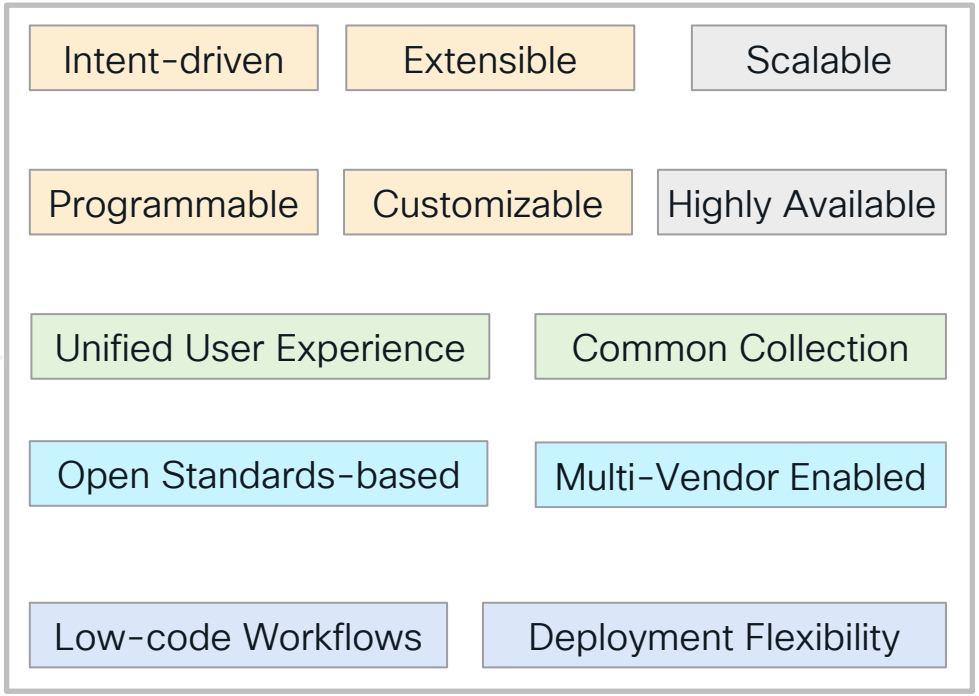
- Limited in-house software expertise



Focus on Outcome-driven Automation

Crosswork Network Automation Pillars

Automate processes by bringing together visibility, insights and actions in a closed loop

Visibility
Verify and monitor customer experience

Insights
Correlate data, identify trends and patterns

Action
Automate processes to create a nimble organization

Cisco Crosswork Network Controller (CNC)

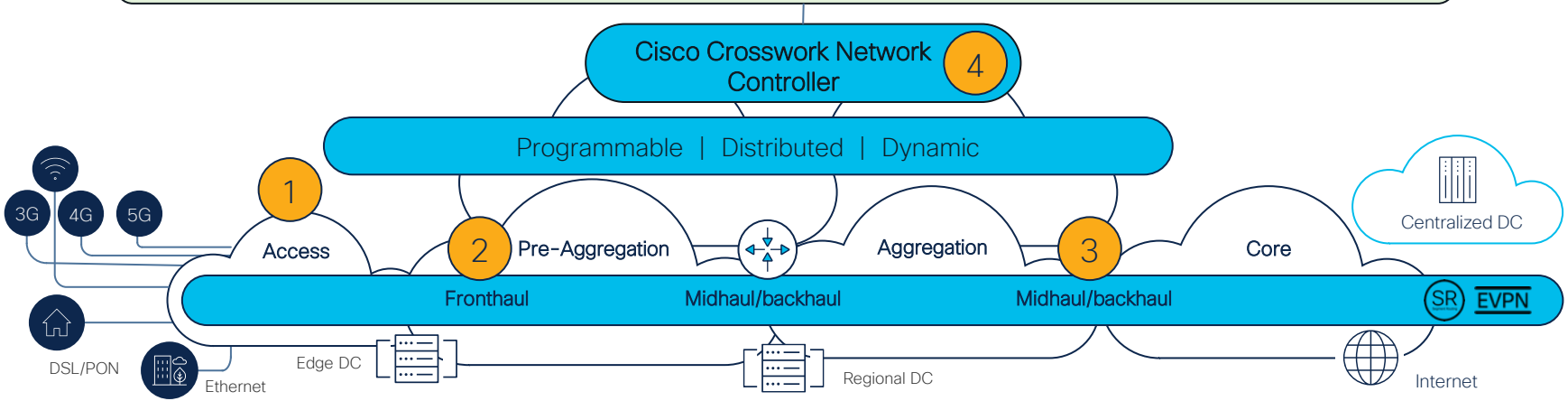
Simplify operational lifecycle – Converged SDN transport automation

Challenges

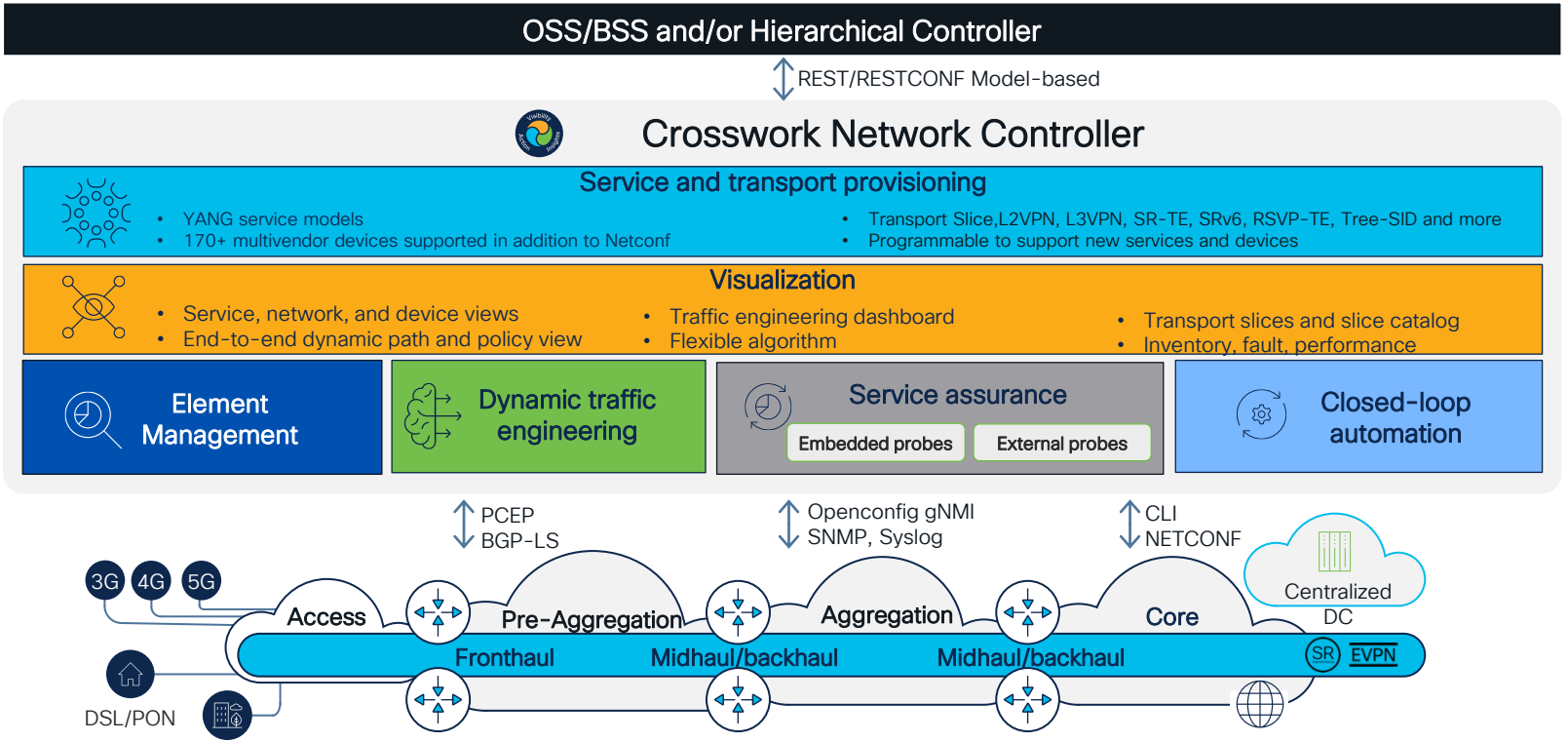
1. Time-consuming service provisioning
2. BW swings, over capacity
3. Congestions and service impacting conditions
4. Siloed, ineffective tools (high OpEx)

Outcomes

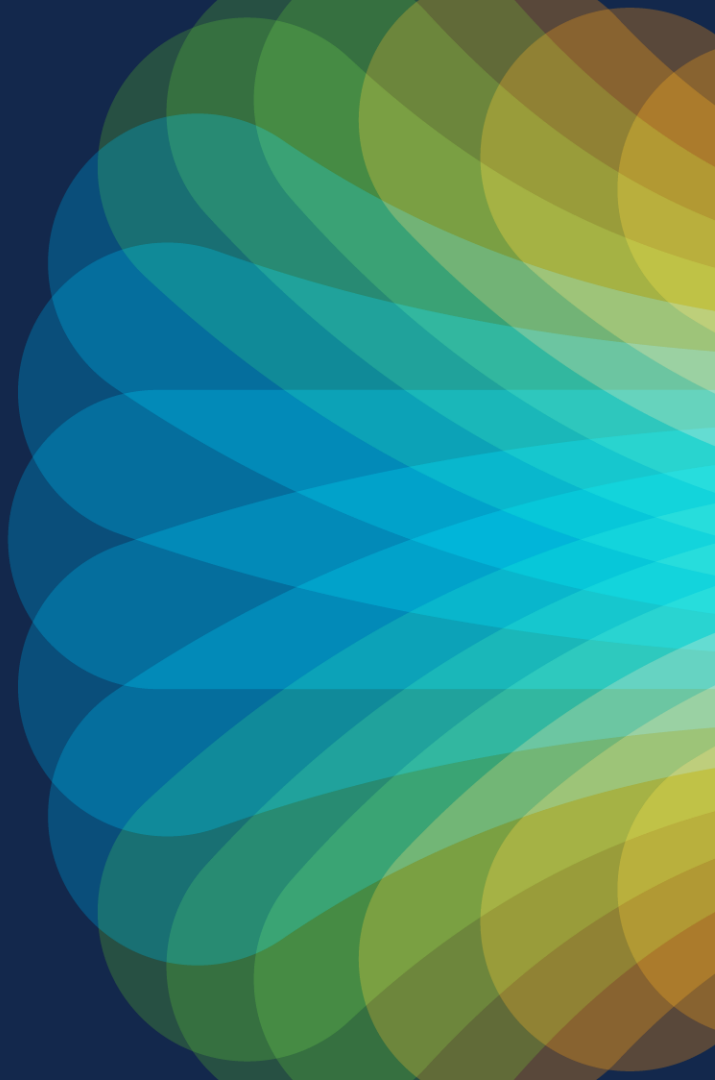
+ Intent-based automated provisioning
+ Dynamic BW management
+ Closed loop automation
+ Turnkey solution – Across lifecycle



Integrated Service and Device Management

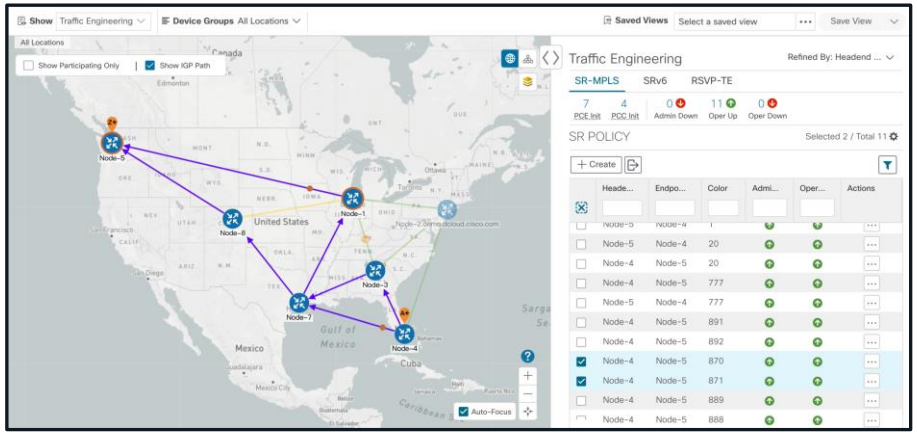


Exploring Opportunities for Automation



Real-Time Network Visualization

Visibility, Insights and Action



Visibility is Paramount

Challenges:

- Real-time visibility – End-to-end view of transport network

Solution:

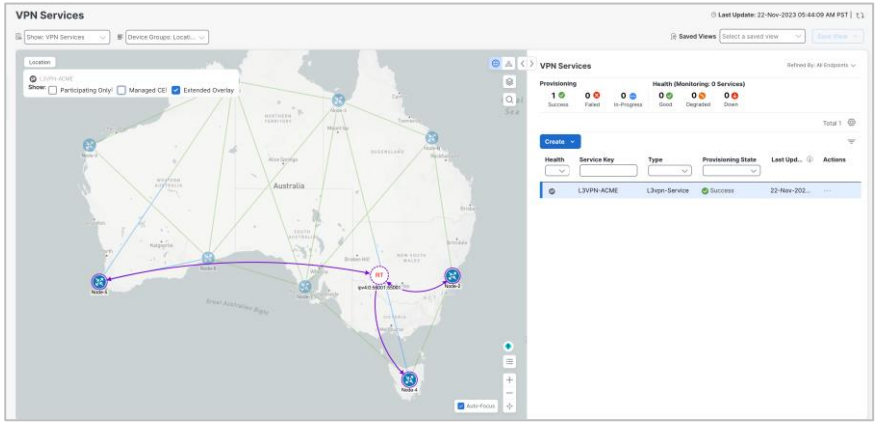
- Discovery of network via BGP-LS
- Real time visualization of topology, services, policies and history of changes, link congestion, latency, etc.
- Real time automatic detection of topology changes.

Outcome:

- Automatic topology discovery with real time information
- Accurate real time view into the network with details of intent, traffic engineering constraints
- Rapid detection of anomalies improving operational efficiency

Service & Transport Provisioning

Intent-based Automation



SR Policy SLA Objectives and Constraints	
Objective	Latency/IGP/TE Metric Minimization
Constraints	Affinities, Disjoint Paths, Bandwidth

✓ Rapid Time-To-Value

Challenges:

- Cumbersome and time-consuming service provisioning
- Missing transport and service context linkage and visibility, satisfy service specific performance objectives, such as low latency

Solution:

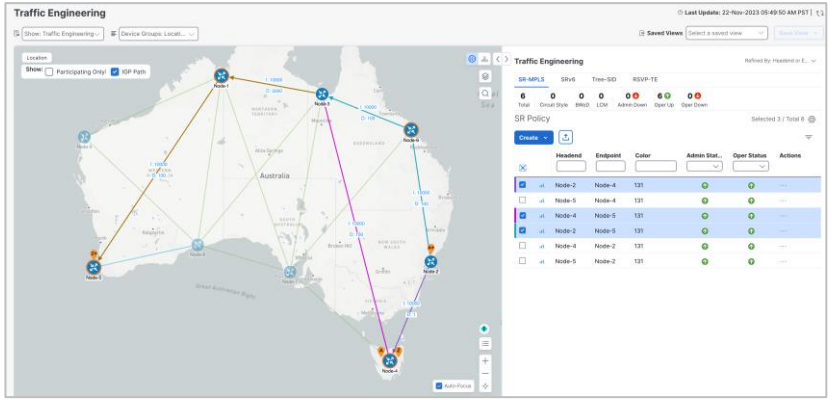
- Intent-based automated provisioning
- Customizable service intent with explicit SLA definitions
- Service Topology Visualization with actionable operational context (Health, Path changes, etc)

Outcome:

- Rapid Time to Value with provisioning reduced from weeks to minutes

Real-time Network Optimization

Closed loop Automation



SR Policy SLA Objectives and Constraints	
Objective	Latency/IGP/TE Metric Minimization
Constraints	Affinities, Disjoint Paths, Bandwidth

Preserved Service Intent

Challenges:

- Manual re-optimization based on network changes is not scalable and poses risk to target SLAs

Solution:

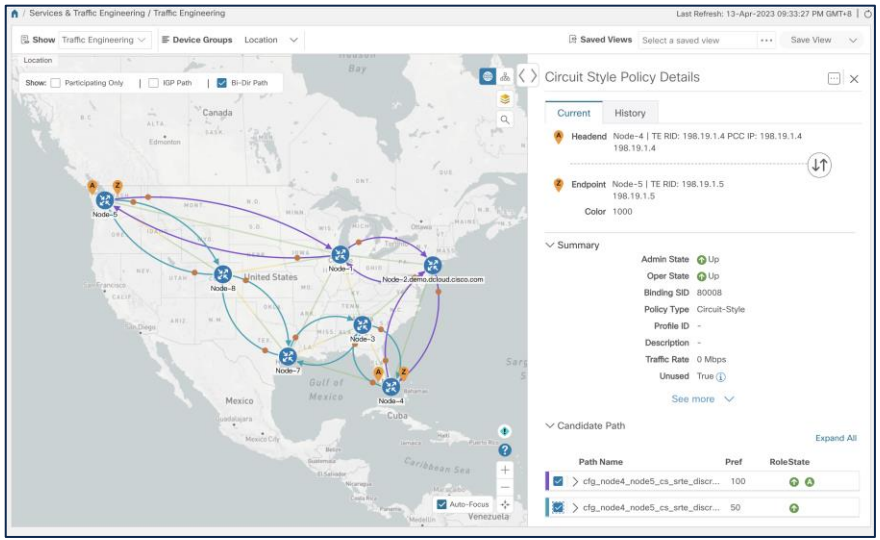
- Define policy intent once
- Automatically detect topology changes
- Real-time re-computation of paths in violation of ‘optimization metric’ aka intent
- Optimized path is automatically provisioned

Outcome:

- Preserved service policy Intent and associated SLAs
- Enhanced operational agility with real time action
- Optimal utilization of network capacity

SR Circuit Style Provisioning and Visualization

Maximize the benefits of unified Segment Routing infrastructure



Challenges:

- Deliver services with bandwidth reservation and path protection over Segment Routing
- Leverage the Segment Routing infrastructure to carry any kind of services including OTN, TDM, PLE

Solution:

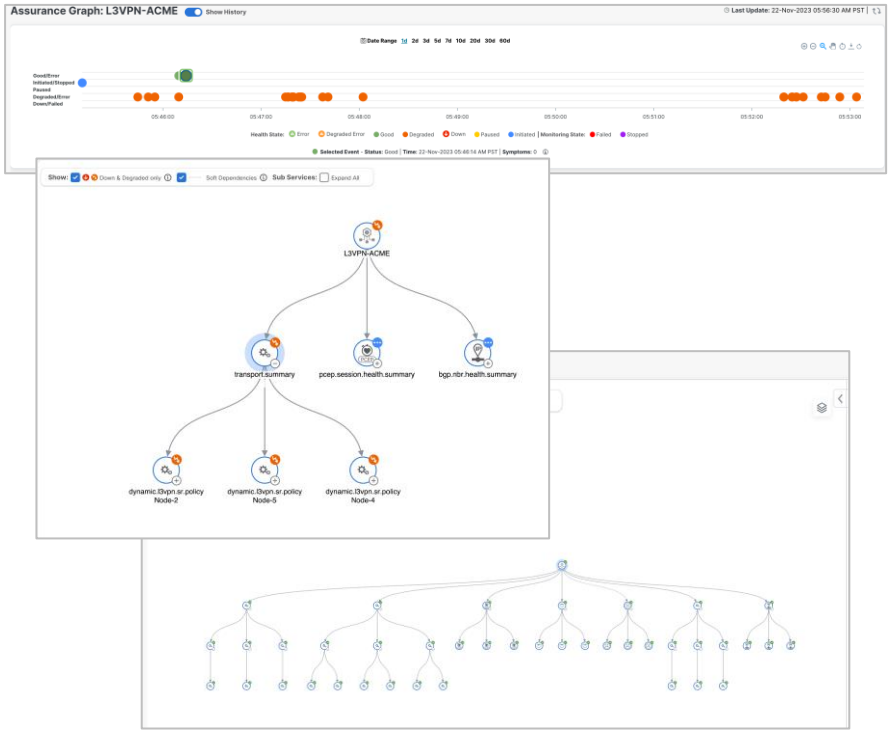
- Pre-book some bandwidth in the network to be used by these Circuit-Style policies
- Use the SDN Controller for bandwidth bookkeeping and path computation
- Use the SDN Controller to compute bi-directional, co-routed paths with path protection (under 50ms)

Outcome:

- One unified Segment Routing infrastructure can be used to carry any kind of services, including the most demanding one

Service Assurance

Enhanced end-user experience with expedited troubleshooting



Challenges:

- Decoupled Service Provisioning and monitoring
- Disconnect between customer service experience and network health

Solution:

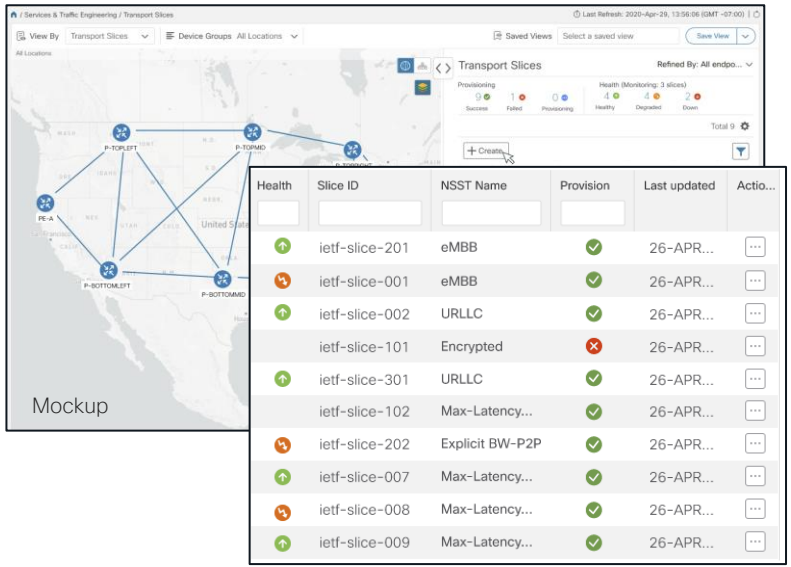
- End-to-end service health monitoring
- Proactive causality models
- Linkage between service and underlying components

Outcome:

- Reduction in Time to Detect service issues and remediation
- Improved user experience and operator productivity

Transport Slicing Automation

Simplify Slice Lifecycle Management



Challenges

- Automation of slice lifecycle functions
- Ensure delivery of distinct SLA/SLO requirements

Solution

- Service catalog with templates for common slice types
- Utilize existing CNC capabilities: Provisioning, Monitoring, Traffic engineering and closed loop optimization

  L2VPN/L3VPN, SR TE, SRv6, FlexAlgo
- Leverage Circuit-Style Capabilities for bandwidth reservations
- SLA monitoring with QoS* and End-to-End network measurements
- Open, standards-based NBI (IETF slide YANG model)

Outcome

- Simplified deployment of 5G services with designated SLA
- New revenue stream can be enabled via Differentiated service offering

*In Planning

Demo:
Operational Benefits of Automation

Operationalizing Mass-Infrastructure Networks

Foundation for closed-loop automation and zero-touch networks

Workflow

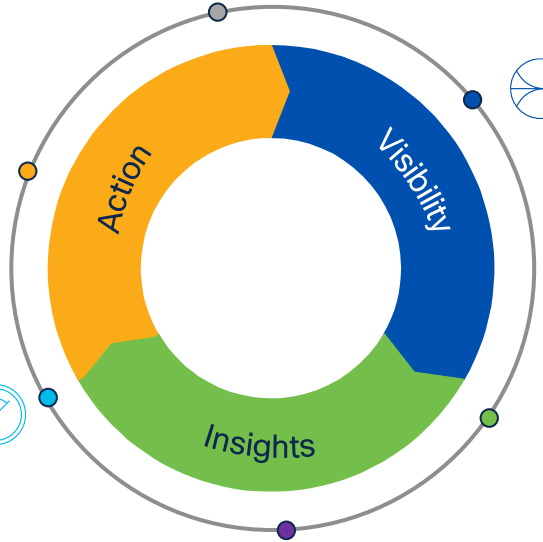
Low-code automation workflow

Visualization

Multi-vendor, multi-layer single pane of glass with Crosswork Hierarchical Controller (HCO), and leading IP SDN visibility with Crosswork Network Controller (CNC).

Service provisioning

200+ customers, 170+ multi-vendor devices supported. All Top 10 SP's use Network Service Orchestration (NSO) in production.



Optimization

SR and SRv6 path optimization leadership
Top-rated IP SDN Controller per leading operators

Automated Assurance

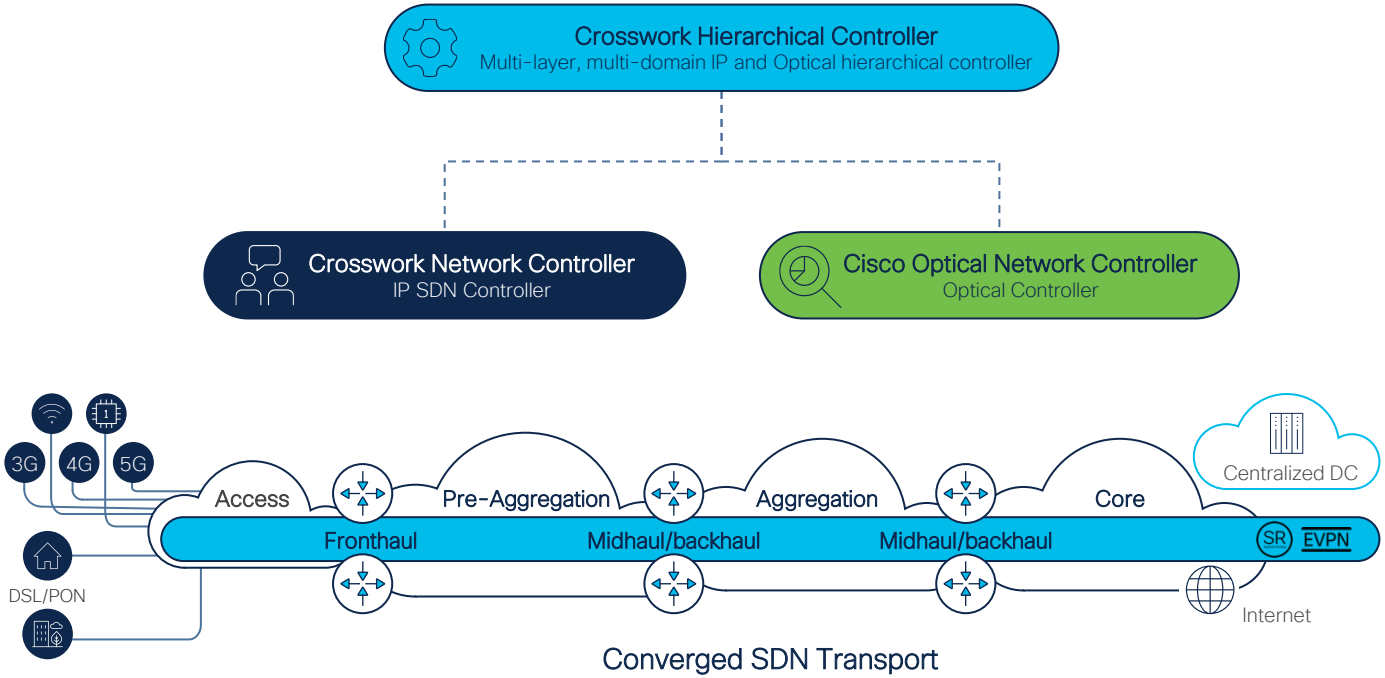
Assurance IP services in CNC and IP/Optical in HCO.
Accedian Acquisition Intent for SLA guarantee

Planning

WAE evolving to be part of the Crosswork SDN Platform

Cisco Crosswork Automation Portfolio

Operationalizing Mass-infrastructure Networks



Crosswork Workflow
Low-code automation workflow

NSO
Service Orchestration

EPNM
EMS, device lifecycle management

WAN Automation Engine
Capacity planning tool

Maximizing Automation Benefits for Next-Generation Networks

Common Challenges

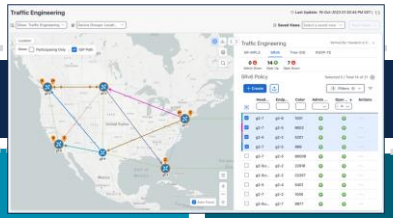
- Deployment simplicity
- Visibility
- Actionable health monitoring
- Expedited remediation
- Resource usage optimization
- Migration to next generation technologies

SR-MPLS/SRv6: Unlocking the Benefits

SR/SRv6 Unlocked with Crosswork Automation

SR/SRv6 Innovations			Simplicity and Automation
Service Creation at Hyper Scale		SRv6 Network Visualization	Automated Service & Transport Provisioning
		Real-time Low Latency path	
Advanced Traffic Engineering (TE)		Disjoint Paths Color Affinity	TE with Simplicity and Scale
		Intent-based Automated Steering	Granular TE control and SLAs
Centralized Path Compute (PCE)		IGP Flexible Algorithms	Operational Simplification
Enhanced OAM & Telemetry		Intent-based Network Slicing	
		Service Awareness + Infrastructure Visibility	Improved service health and End-user Experience

Migration to SRv6 from MPLS underlay



Cisco Crosswork Network Automation

Design SRv6 network topology	Introduce a new SRv6 RR	• Enable IPv6 Routing • SRv6 on first set of PEs • SRv6 on the rest of the PEs	Remove MPLS from the network	Post migration network checks
Design and Plan	Prepare	Operate and Optimize		

WAE

NSO/CWM

Crosswork Network Controller

Migration to SRv6 from MPLS underlay

Phase 1

Existing IPv4 Network

MPLS underlay/BGP services

-Step 1: Enable IPv6 routing

-Step 2: Introduce new RR for SRv6

Phase 2

SRv6 on first set of PEs

-*SRv6* PEs advertise VPN services to both RRs (dual connected PEs)

-Use BGP best-path selection to prefer SRv6 or MPLS

.

Phase 3

SRv6 on remaining PEs

-*All* PEs advertise VPN services to both RRs (dual connected PEs)

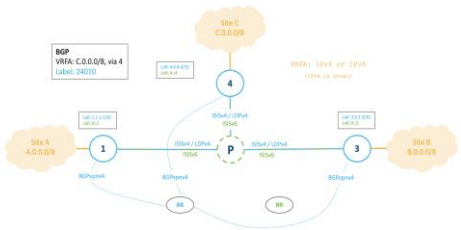
-Use BGP best-path selection to prefer SRv6 or MPLS

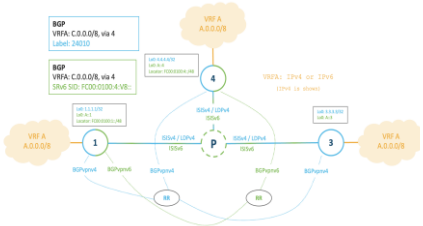
Phase 4

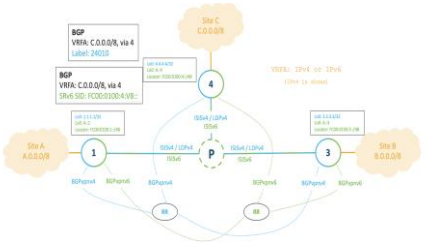
Remove MPLS

- Left with IPv6 (or SRv6) underlay and SRv6 BGP service

Today's CNC demo

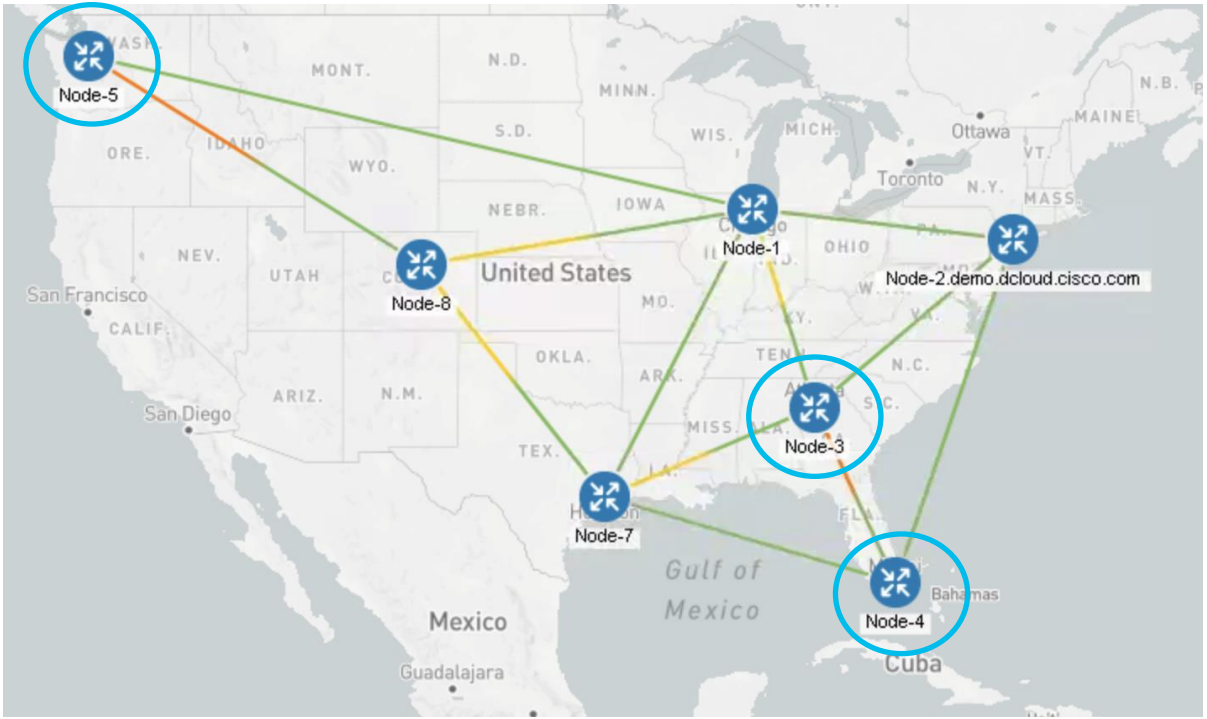






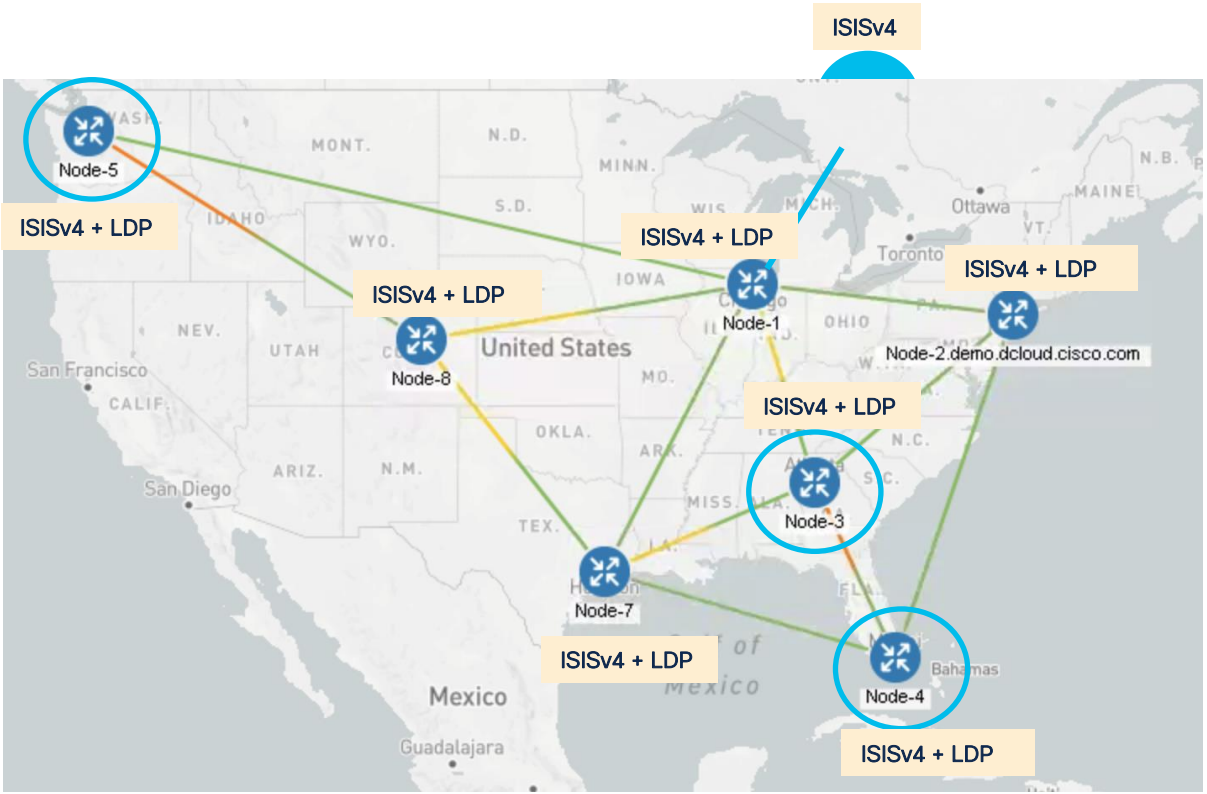
Demo: Simplify Migration to SRv6

Topology:



L3VPN – MPLS LDP to SRv6 Migration

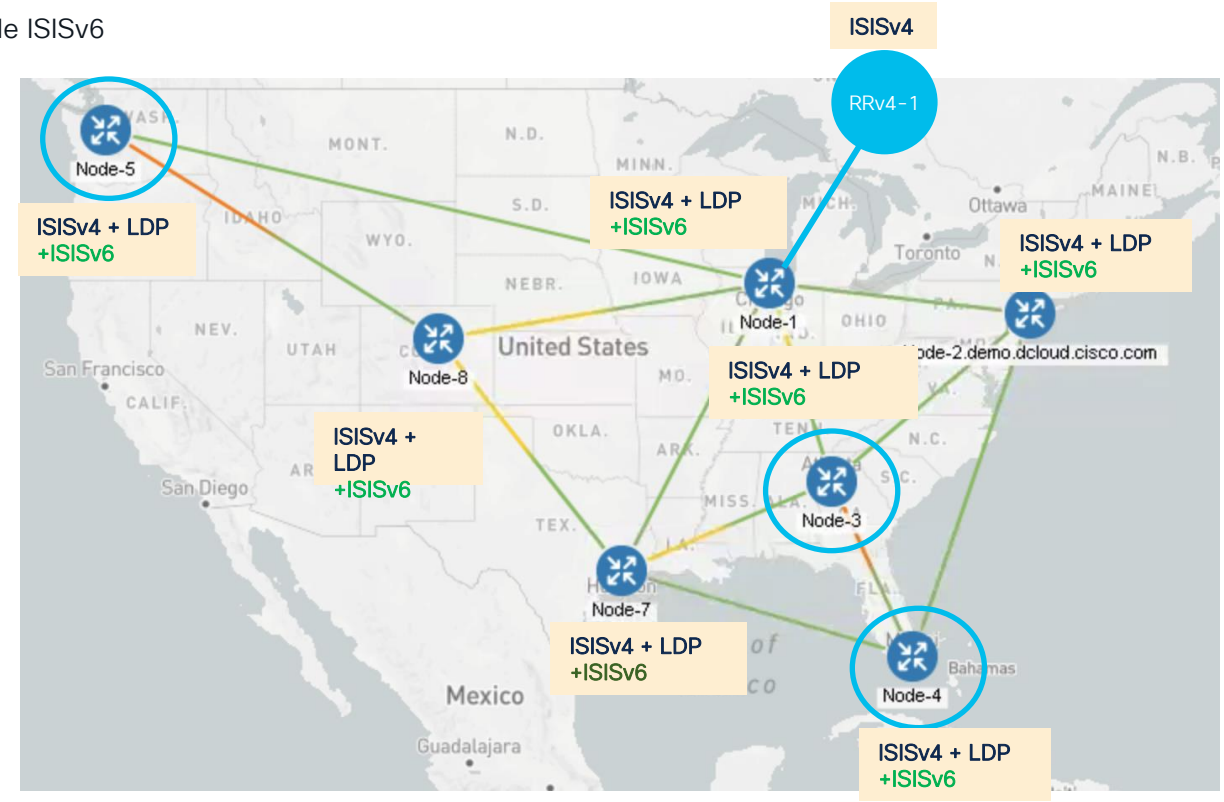
VRF:VPN-201
MPLS VRF



L3VPN – MPLS LDP to SRv6 Migration

Step1: Enable ISISv6

VRF:VPN-201
MPLS VRF

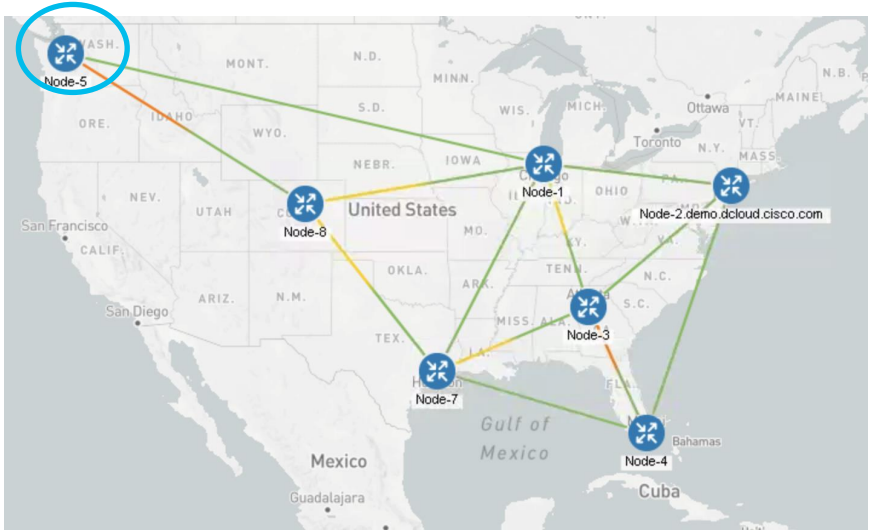


Node5

```
interface Loopback 0
 ipv6 address fcdd:dd00:305::1/128
 no shutdown
exit
interface GigabitEthernet 0/0/0/0
 ipv6 enable
 no shutdown
exit
router isis 1
 address-family ipv6 unicast
  metric-style wide
  router-id Loopback0
  advertise link attributes
 exit
 interface GigabitEthernet0/0/0/0
  circuit-type level-2-only
  point-to-point
  address-family ipv6 unicast
   metric 100
  exit
 exit
 interface Loopback0
   passive
  address-family ipv6 unicast
  exit
 exit
exit
!
!
```

L3VPN – MPLS LDP to SRv6 Migration – CNC Device Details

Step1: Enable ISISv6



Device Details

Details | Links | Alarms | Inventory

Summary

Host Name	Node-5
Alarms	1 | 3
Reachability	Reachable
IP Address	198.19.1.5
Geo Location	Latitude 47.603832, Longitude -122.330062
Device Type	Router
Device Group	Location > All Locations > Unassigned Devices
Product Type	Cisco IOS XRv 9000 Router
Connect To Device	SSH IPv4
Last Update	26-May-2023 03:49:19 PM PDT

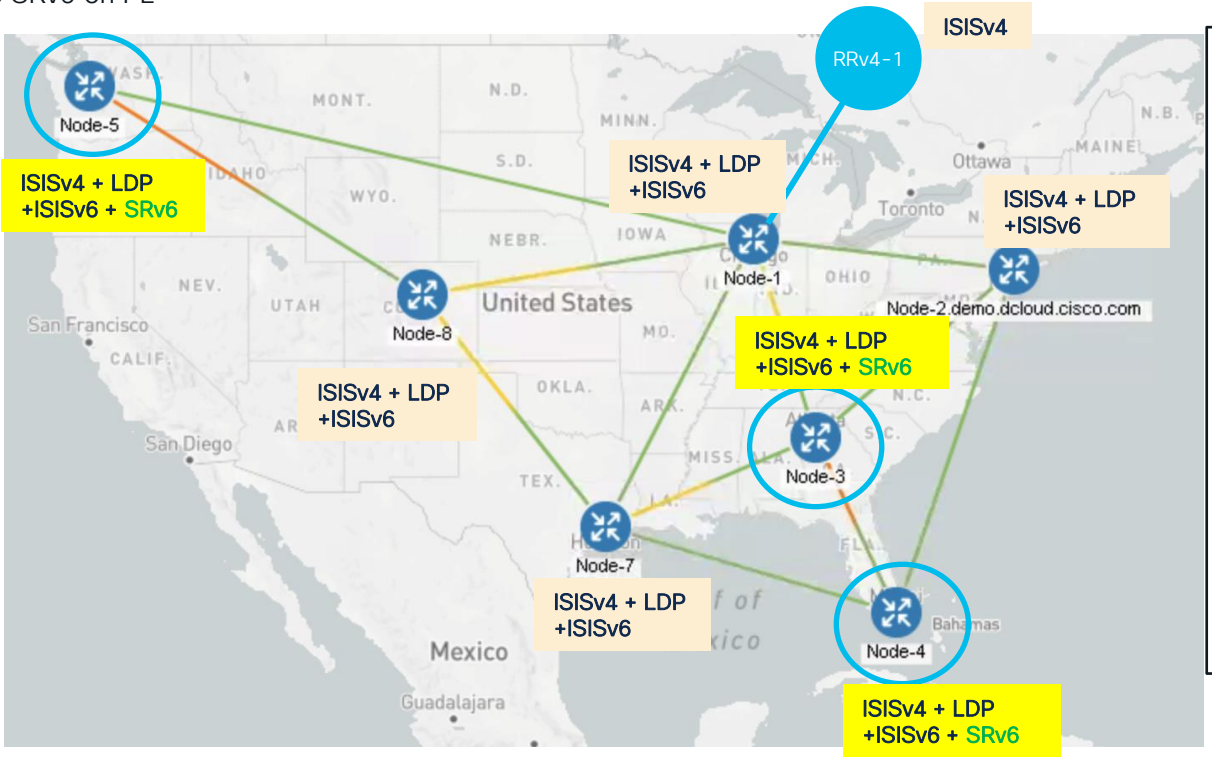
Routing

TE Router ID	198.19.1.5
IPv6 Router ID	fcdd:dd00:305::1
ISIS System ID	0010.0100.0005 Level-2
ASN	65000

L3VPN – MPLS LDP to SRv6 Migration

Step2: Enable SRv6 on PE

VRF:VPN-201
MPLS VRF



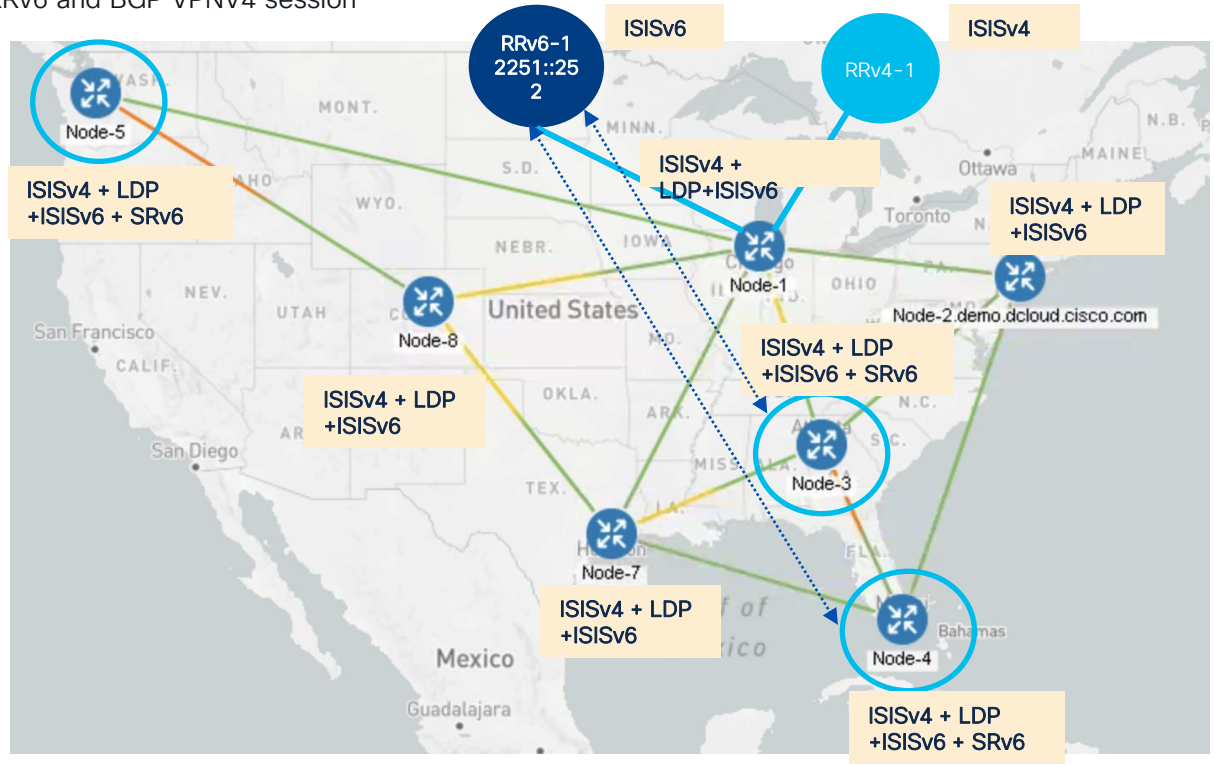
Node5

```
router isis 1
address-family ipv6 unicast
 segment-routing srv6
  locator loc_be
  exit
 exit
exit
exit
segment-routing
 srv6
  encapsulation
   source-address fcdd:dd00:305::1
  !
  locators
   locator loc_be
    micro-segment behavior
    unode psp-usd
    prefix fcdd:dd00:305::/48
   !
  !
 !
!
!
```

L3VPN – MPLS LDP to SRv6 Migration

Step3: Add RRv6 and BGP VPNV4 session

VRF:VPN-201
MPLS VRF



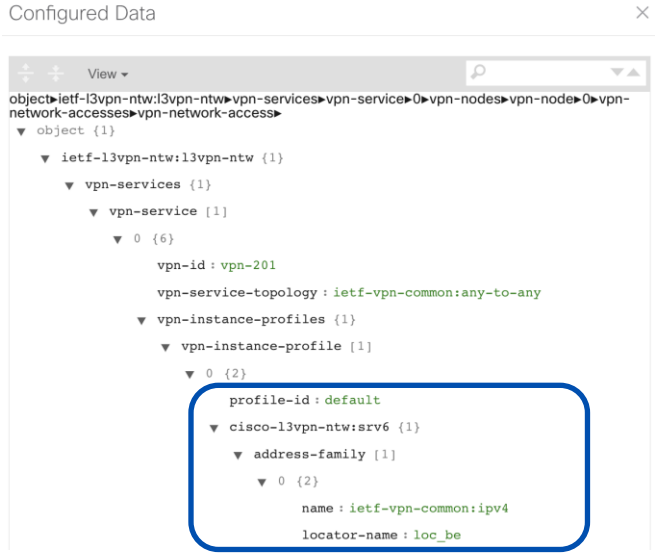
Node 5

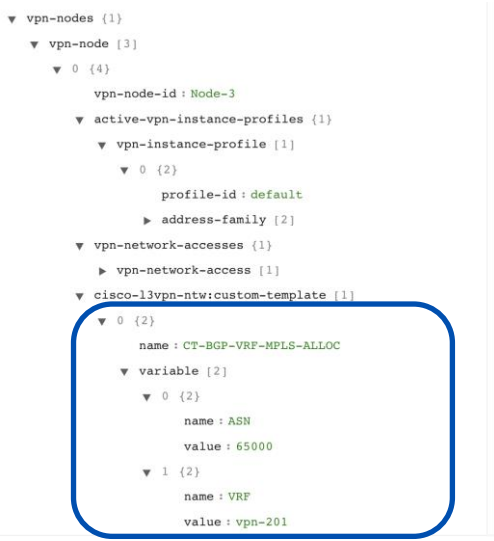
```
router bgp 65000
 neighbor 2251::252
  remote-as 65000
  update-source Loopback0
  address-family vpnv4 unicast
   route-policy vpn-transport out
   encapsulation-type srv6
  exit
 exit
exit
```

L3VPN – MPLS LDP to SRv6 Migration

Step4: Enable Dual connected VRF, MPLS preferred on SRv6 PE's

VRF:VPN-201
MPLS VRF
Dual Connected

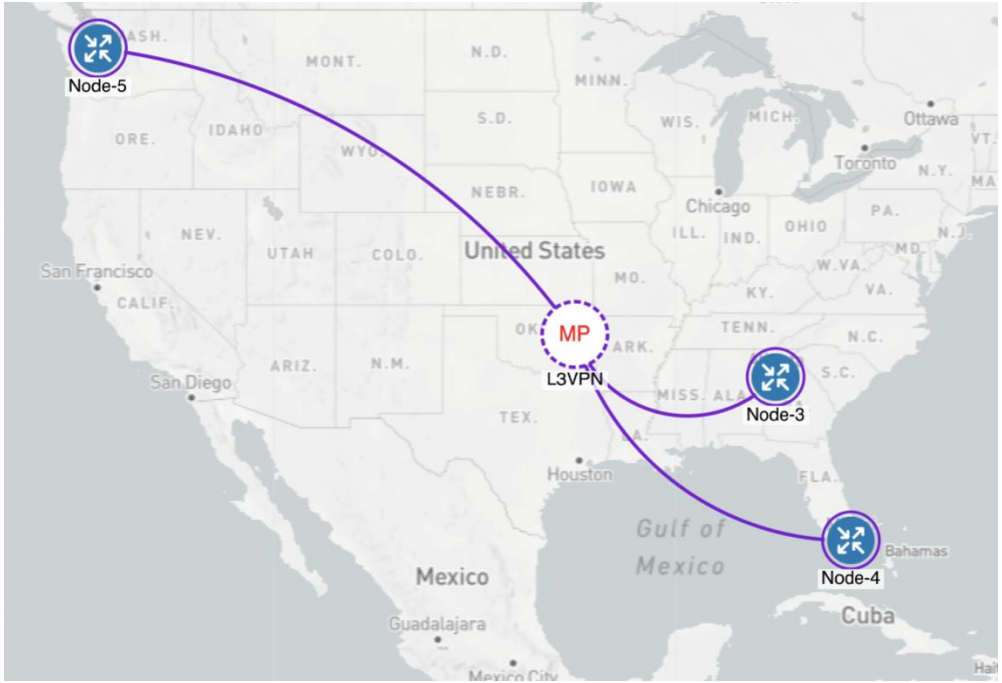




L3VPN – MPLS LDP to SRv6 Migration

Step4: Enable Dual connected VRF, MPLS preferred on SRv6 PE's

VRF:VPN-201
MPLS VRF
Dual Connected



Node5

```
router bgp 65000
 vrf vpn-201
  address-family ipv4 unicast
   mpls alloc enable
  segment-routing srv6
   locator loc_be
  !
 !
!
!
```

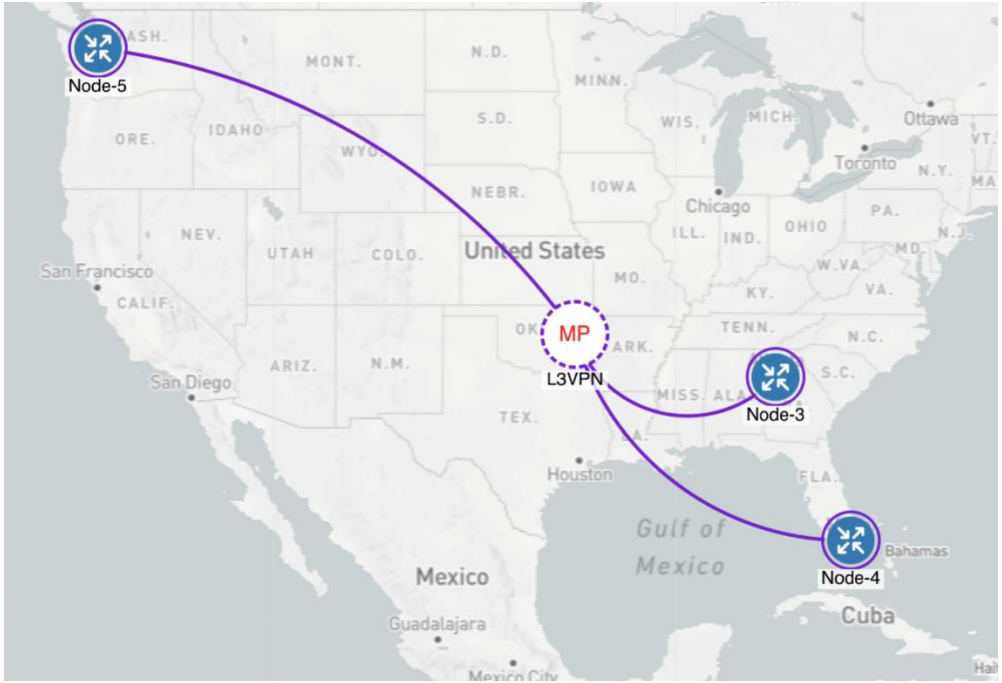
Verification : Prefixes are learned from both RR RR-1 / MPLS is best path

```
RP/0/RP0/CPU0:Node-5#sh bgp vpnv4 unicast
Thu Jun  1 17:51:44.499 UTC
BGP router identifier 198.19.1.5, local AS number 65000
BGP generic scan interval 60 secs
Non-stop routing is enabled
BGP table state: Active
Table ID: 0x0
BGP main routing table version 46
BGP NSR Initial initsync version 1 (Reached)
BGP NSR/ISSU Sync-Group versions 0/0
BGP scan interval 60 secs

Status codes: s suppressed, d damped, h history, * valid, > best
              i - internal, r RIB-failure, S stale, N Nexthop-discard
Origin codes: i - IGP, e - EGP, ? - incomplete
   Network            Next Hop            Metric LocPrf Weight Path
Route Distinguisher: 198.19.1.3:0
Route Distinguisher Version: 46
*>i30.1.3.0/24        198.19.1.3               0    100      0 ?
* i                   fcdd:dd00:303::1
                                               0    100      0 ?
Route Distinguisher: 198.19.1.4:0
Route Distinguisher Version: 45
*>i30.1.4.0/24        198.19.1.4               0    100      0 ?
* i                   fcdd:dd00:304::1
                                               0    100      0 ?
Route Distinguisher: 198.19.1.5:0 (default for vrf vpn-201)
Route Distinguisher Version: 44
*>i30.1.3.0/24        198.19.1.3               0    100      0 ?
*>i30.1.4.0/24        198.19.1.4               0    100      0 ?
*> 30.1.5.0/24        0.0.0.0                  0             32768 ?

Processed 5 prefixes, 7 paths
```

L3VPN – MPLS LDP to SRv6 Migration

Step 5: Use SRv6 between the Dual Connected PEs

VRF:VPN-201
MPLS VRF
Dual Connected



Node5

```
route-policy vpn-transport
  apply vpn-201-transport
 pass
end-policy
!
route-policy vpn-201-transport
 if extcommunity rt matches-any
(201:201) then
   set local-preference 150
 endif
end-policy
!
```

Verification : Prefixes are learned from both RR RR-2 / SRv6 is best path

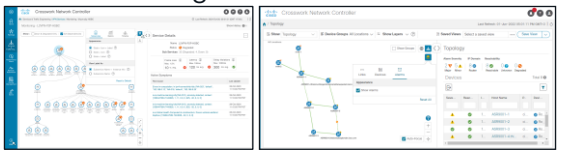
```
RP/0/RP0/CPU0:Node-5#sh bgp vpnv4 unicast
Thu Jun  1 17:57:13.246 UTC
BGP router identifier 198.19.1.5, local AS number 65000
BGP generic scan interval 60 secs
Non-stop routing is enabled
BGP table state: Active
Table ID: 0x0
BGP main routing table version 50
BGP NSR Initial initsync version 1 (Reached)
BGP NSR/ISSU Sync-Group versions 0/0
BGP scan interval 60 secs

Status codes: s suppressed, d damped, h history, * valid, > best
              i - internal, r RIB-failure, S stale, N Nexthop-discard
Origin codes: i - IGP, e - EGP, ? - incomplete
   Network            Next Hop            Metric LocPrf Weight Path
Route Distinguisher: 198.19.1.3:0
Route Distinguisher Version: 49
* i30.1.3.0/24        198.19.1.3               0    100      0 ?
*>i                   fcdd:dd00:303::1
                                               0    150      0 ?
Route Distinguisher: 198.19.1.4:0
Route Distinguisher Version: 47
* i30.1.4.0/24        198.19.1.4               0    100      0 ?
*>i                   fcdd:dd00:304::1
                                               0    150      0 ?
Route Distinguisher: 198.19.1.5:0 (default for vrf vpn-201)
Route Distinguisher Version: 50
*>i30.1.3.0/24        fcdd:dd00:303::1
                                               0    150      0 ?
*>i30.1.4.0/24        fcdd:dd00:304::1
                                               0    150      0 ?
*> 30.1.5.0/24        0.0.0.0                  0             32768 ?

Processed 5 prefixes, 7 paths
```

5G: Transport Slicing Automation

5G Transport Network Slicing Automation

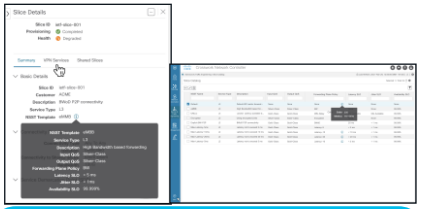
Transport slice SLA

- Proactive SLA monitoring per Slice
- SLA breach notification/reporting
- Service Centric approach to monitoring
- Slice intent to infra telemetry tie
- Active probing with infrastructure monitoring correlation



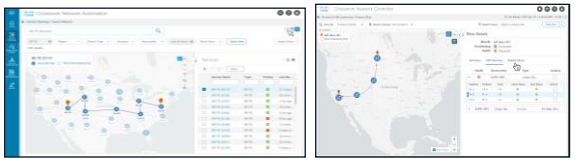
Transport slice optimization

- Optimize slice based on service intent
- Path computation per slice based on SLA



Transport slice orchestration

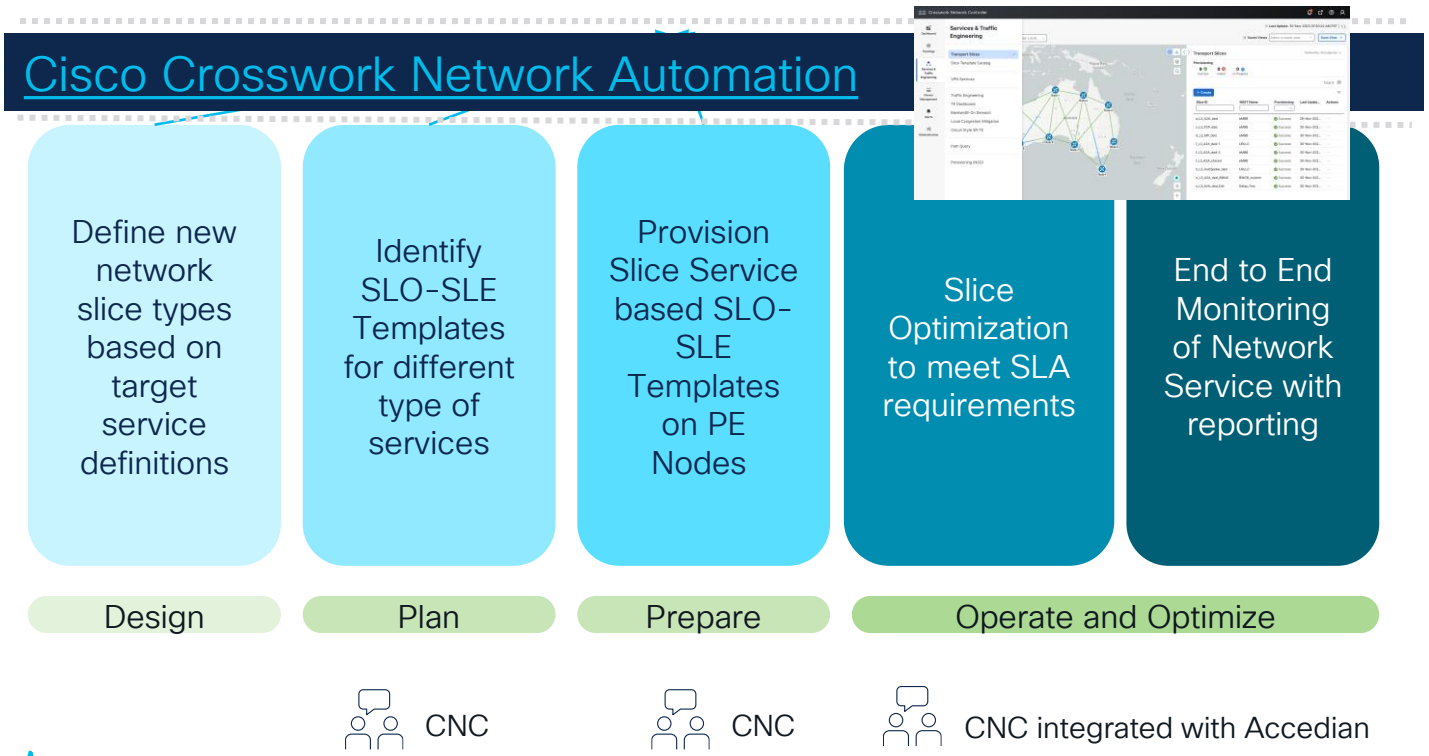
- Intent-based slice definition
- Abstracted Slice model based on IETF model



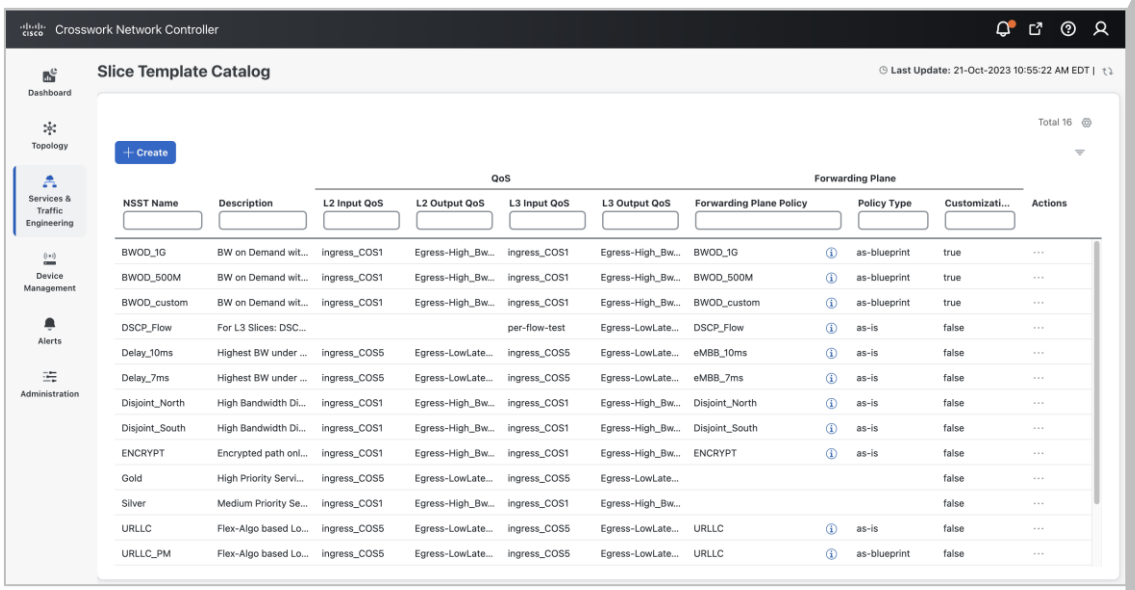
Transport slice visualization

- Overlay maps
- Slice details: Type, Template, VPNs, Transport

Transport Network Slice Lifecycle



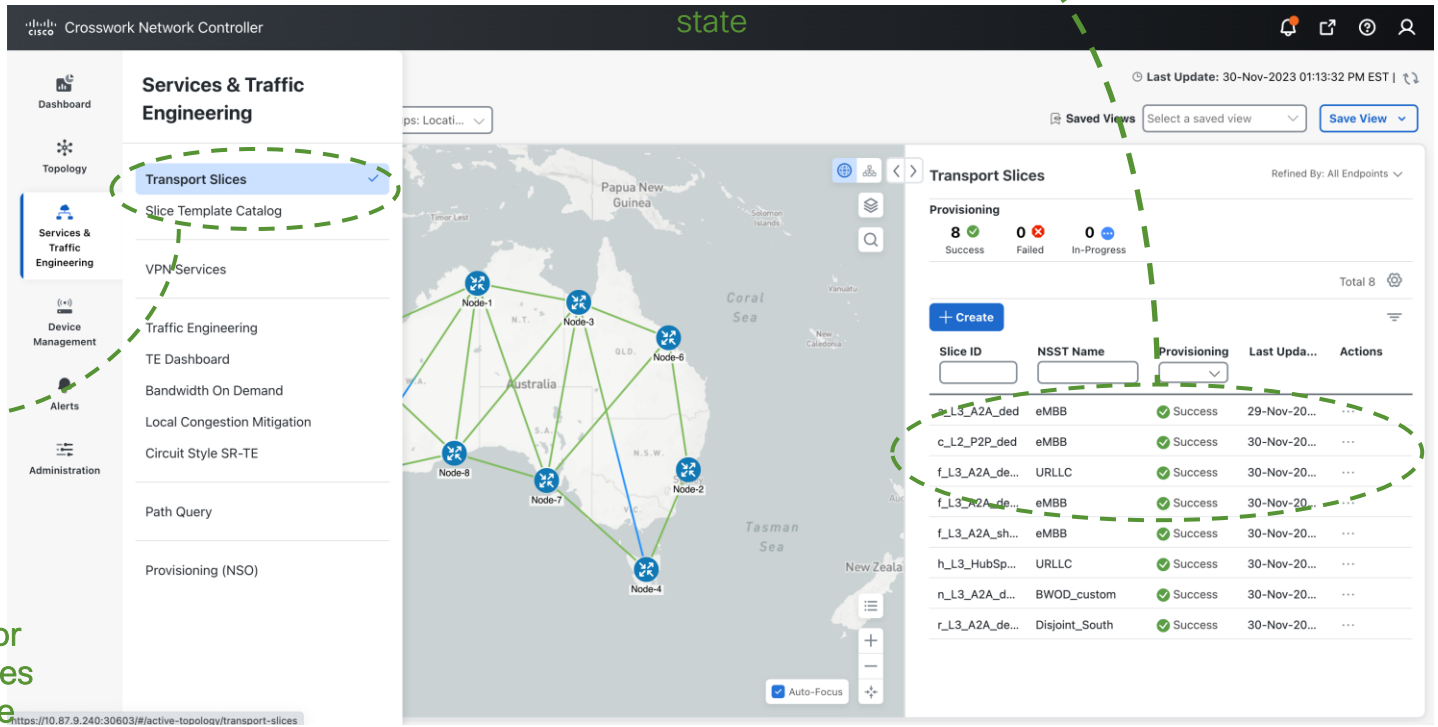
Slice Template Catalog



- User-defined slice templates
  - Template Name
  - Description
  - Input/Output QOS
  - Forwarding plane policy
  - Allow for BWoD customizations
  - Service Assurance parameters
- Templates can be created through GUI or API
- Path forwarding policies can be shared across multiple Slice Instances

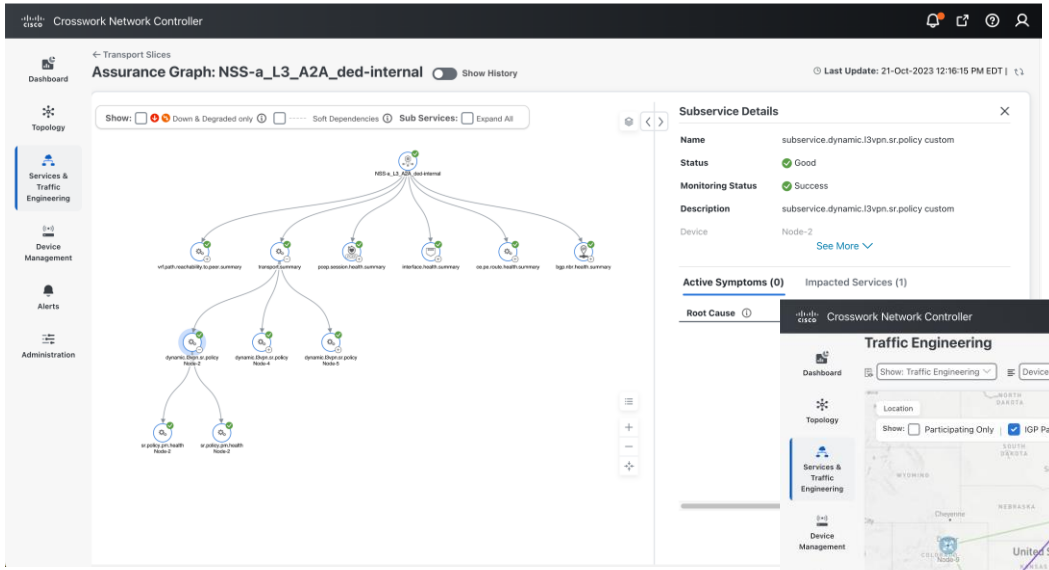
Visualizing Slices with Crosswork Network Controller

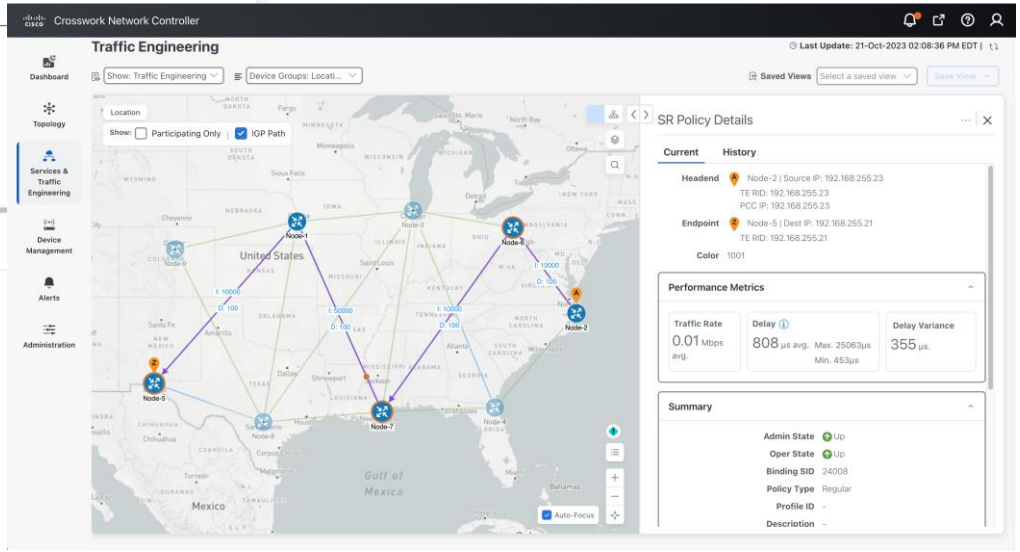
Slice list with Intent and provisioning state



New menu for Slice Instances and Template Catalog

Slice Assurance and Performance Insights



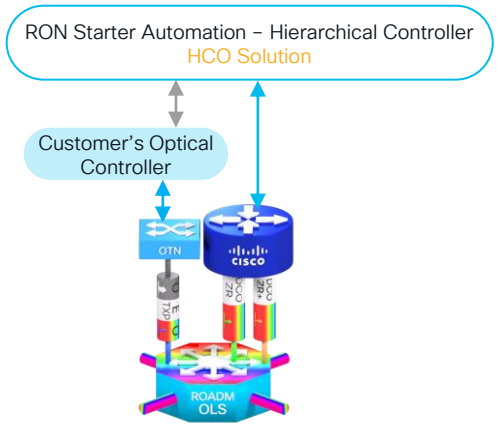


Routed Optical Networks (RON)

Architectural Transition with Crosswork Automation

Customer adoption Stage 1
Integrating Transponders

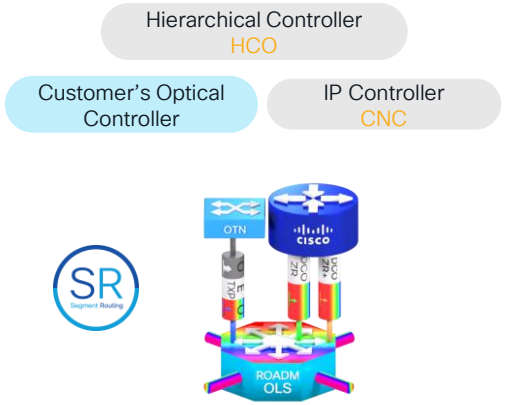
- Introduce RON Starter Automation (Cisco-only Routers with ZR/ZR+)
- HCO-based Solution for ZR/ZR+ & Optical OLS
  - Single Pane of Glass Visualization
  - E2E Optical Circuit Assurance
  - E2E Optical Circuit Provisioning



Customer adoption Stage 2
ON SDN Transition → SR Control Plane

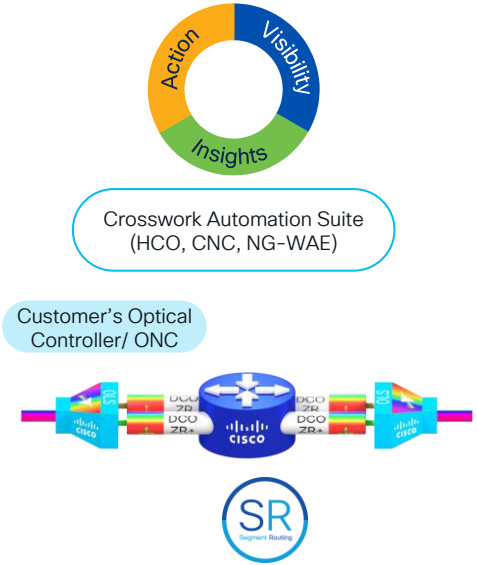
- Introduce CNC to HCO
- Leverage RON Automation Essentials Bundle

- SDN Transformation to SR(v6) Control Plane
- CNC IP Path Optimization & Orchestration
- PLE Bandwidth Reservation
- CNC EMS in Q2CY24 for Element Management



Customer adoption Stage 3
Complete RON Transformation

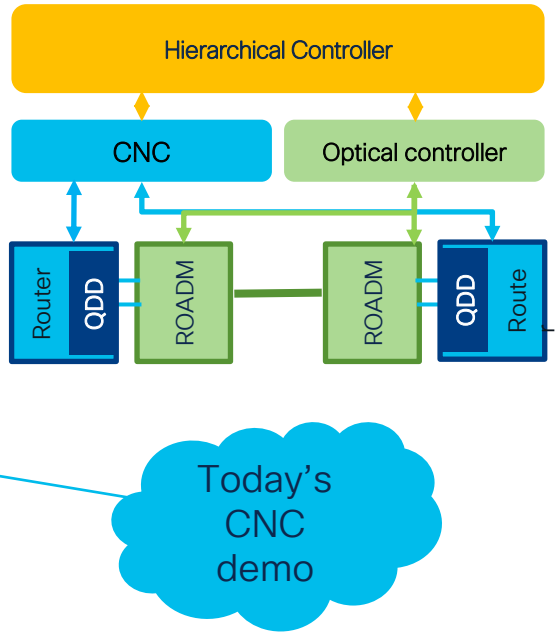
- Complete lifecycle across including Planning
- (+CONC for Cisco Optical)



** will be integrated in CNC

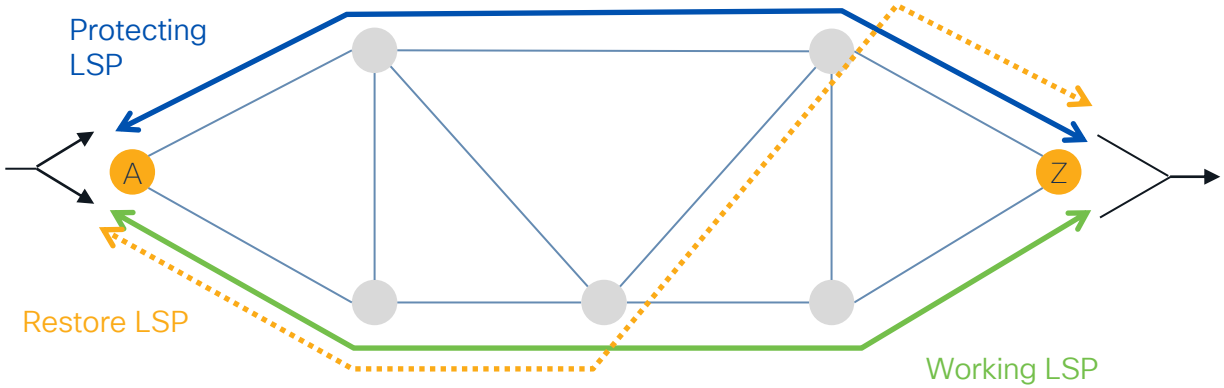
Maximizing Automation Benefits in RON

Wavelength Provisioning	✓
Optical Circuit Assurance and Troubleshooting	✓
Multilayer Visualization & History View	✓
Management and Verification of optical to IP connections	✓
SR/ SRv6 Control Plane SDN Automation	✓
IP Element Management & IP SDN Path Optimization	✓
IP Service Assurance & Service Orchestration	✓
Private Line Emulation Automation (SR-CS bandwidth reservation, provisioning, assurance)	✓



Demo: Automating PLE lifecycle

What is Private Line Emulation aka PLE



Sub-wavelength / Private Line services	Dedicated E-Line	Switched E-Line

PLE
- Bit transparent and respectful of sync (DCR)
- Multiprotocol (Sonet/SDH, OTN, FC, Eth)

EVP-VPWS
- Ethernet only
- No special HW required

Circuit-style SR (CS-SR)
- Guaranteed bandwidth
- persistent, co-routed, bi-directional paths
- 1:1 End-to-end path protection and restoration

SR
- Scale and simplicity

Automation Outcomes and Benefits

Agility is Essential in Operationalizing Mass-infrastructure Networks

Automation is Key to drive Operational Agility

Automation Outcomes and Benefits

Agility is Essential in Operationalizing Mass-infrastructure Networks

Accelerate Time To Market 	• Rapid Service, transport and slice provisioning • Reinforced differentiation with granular TE control and SLAs • Faster introduction of new services with model-based approach
Improve Service Delivery 	• Preserved service policy intent and SLAs • Effective mitigation of network congestion • Optimal utilization of network resource with real-time optimization
Boost Operational Agility 	• Automated changes minimizing configuration errors • Abstraction of complexity in a heterogenous environment • Enhanced productivity with unified UI and workflows

Crosswork Network Automation Related Sessions

- Design, Deploy and Manage Transport Slices using SDN Controller and Assurance - BRKSPG-2263
- Managing and operating Segment Routing based networks with Cisco SDN solution - TECOPS-2582
- Automated Assurance for Premium Service Quality of Experiences Across Mass Scale Infrastructures - PSOSP-1725
- Reduce Resolution Time with a Service-Centric Approach to Troubleshooting - BRKSPG-2474
- Crosswork Network Controller on AWS - DEVNET-2213
- Network Planning and the Evolution of WAE - BRKOPS-1643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