The bridge to possible

Design, Deploy and Manage Transport Slices using SDN Controller and Assurance

Transport Slicing made easy with Crosswork Network Controller

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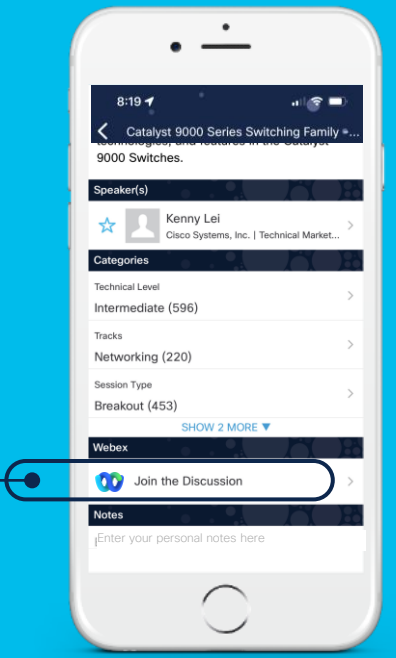


Agenda

- Introduction
- Slicing: Overview & Definitions
- Transport Slice Automation: Standards, Models & Machinery
- Transport Slice Automation: Crosswork Network Controller (CNC)
- Demo – Deep Dive
- Conclusion

Introduction

- Slicing is developing quickly and seen as a key capability for 5G
- In 5G, end-to-end slicing typically covers RAN, Transport, DC and the Mobile Core
  - Different domains covered by different organizations/SDOs
- Automation is critical as slice use cases become more complex
- Cisco has a powerful and complete toolset for Transport Slicing including Segment Routing, FlexAlgo, QOS, L2/L3 VPNs…
- Crosswork Network Controller is Cisco's SDN solution to orchestrate and automate Transport Network Slicing

What is 5G Network Slicing?
An E2E Business Service (not just the transport)

5G Network Slicing is fundamentally an end-to-end partitioning of the network resources and network functions so that selected applications/services/connections may run in isolation from each other for a specific business purpose
and meet a business level SLA

Its about offering:

1) End to End Service Level Agreements (SLAs)
2) SLOs: Delay, jitter, loss, availability
3) SLEs: Disjoint paths, encrypted paths, etc.

- **Hard slicing** refers to the provision of resources in such a way that they are dedicated to a specific slice service. (dedicated routers, Control plane, dedicated links, TDM-like, etc)
- **Soft slicing** refers to the provision of resources in such a way that whilst the slices are logically separated they share the same packet based network resources with intelligent QoS and forwarding.

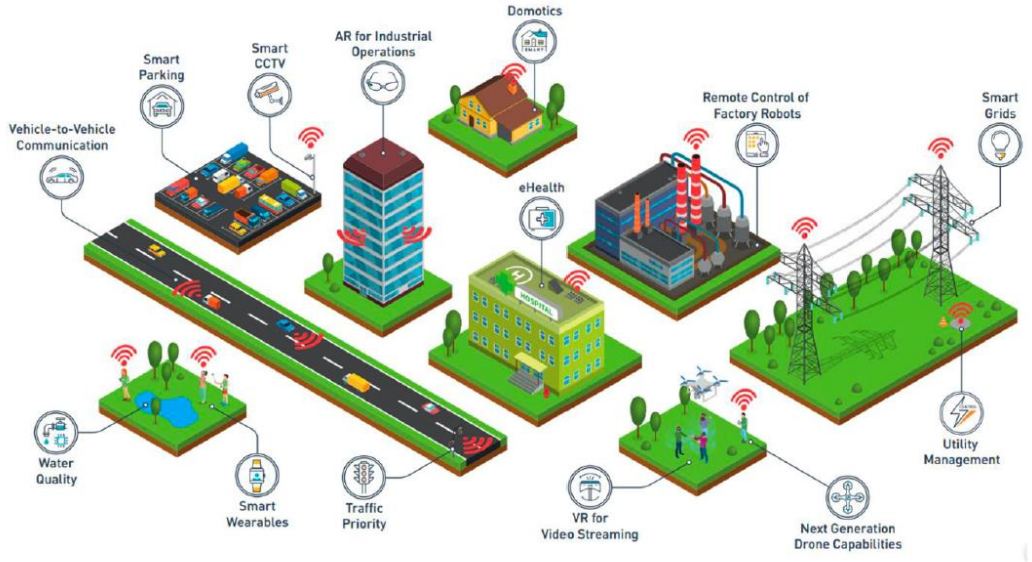
Why do you care about 5G Network Slicing?

Drive differentiated service and new revenue stream

New Customers
Increase adoption of 5G among Enterprises

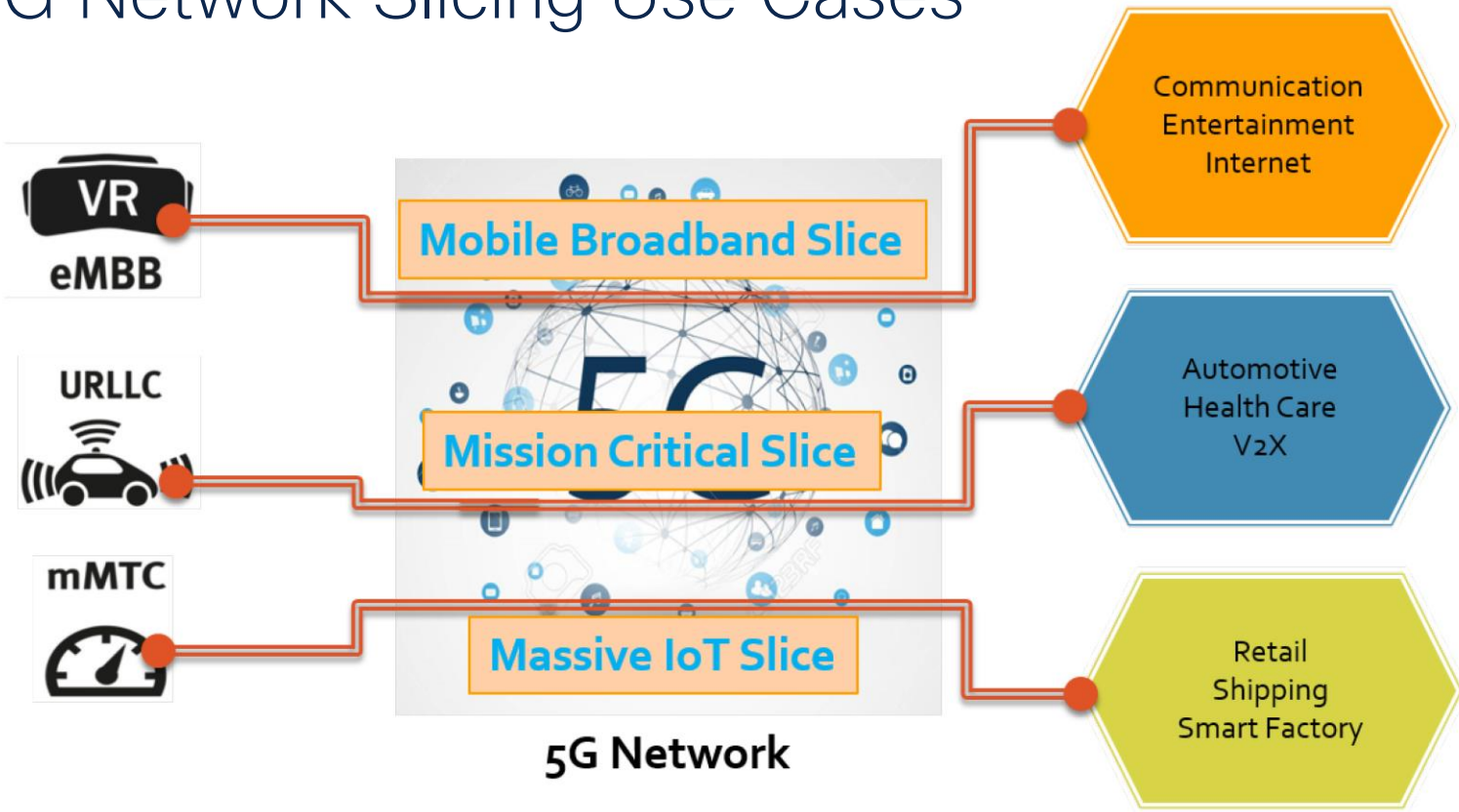
New Services
Capture a larger share of the value chain

New Business Models
Premium pricing for demanding use cases



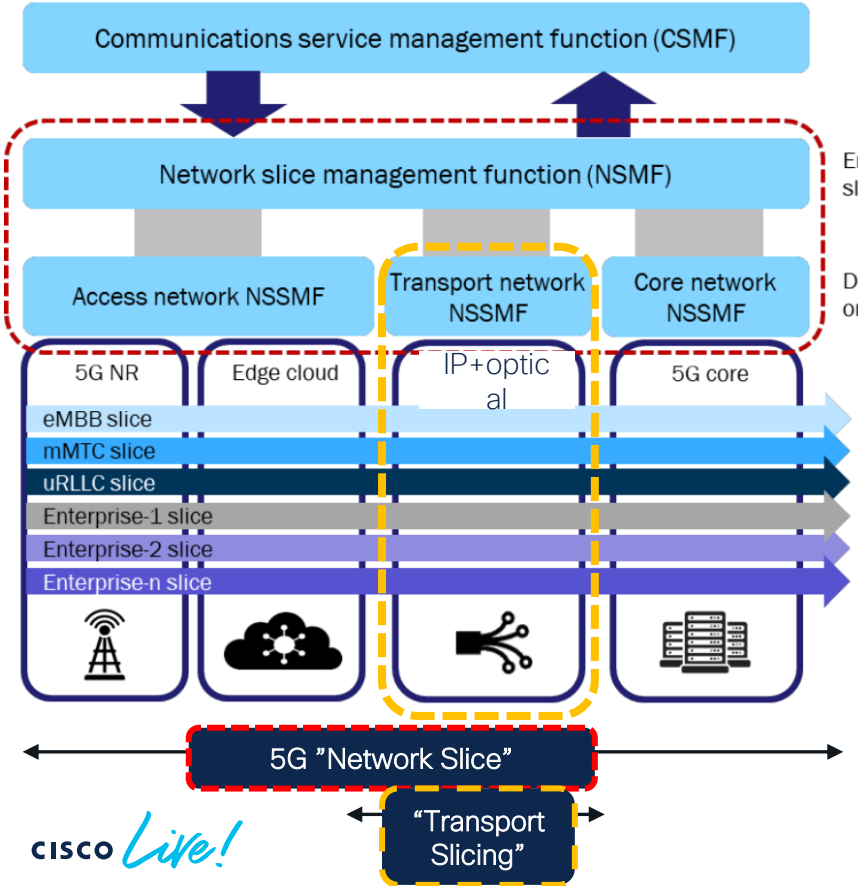
Source: Analysys Mason, 2020

5G Network Slicing Use Cases



Slicing: Overview and Definitions

Defining Transport Slicing Scope: 3GPP reference architecture for 5G network slicing

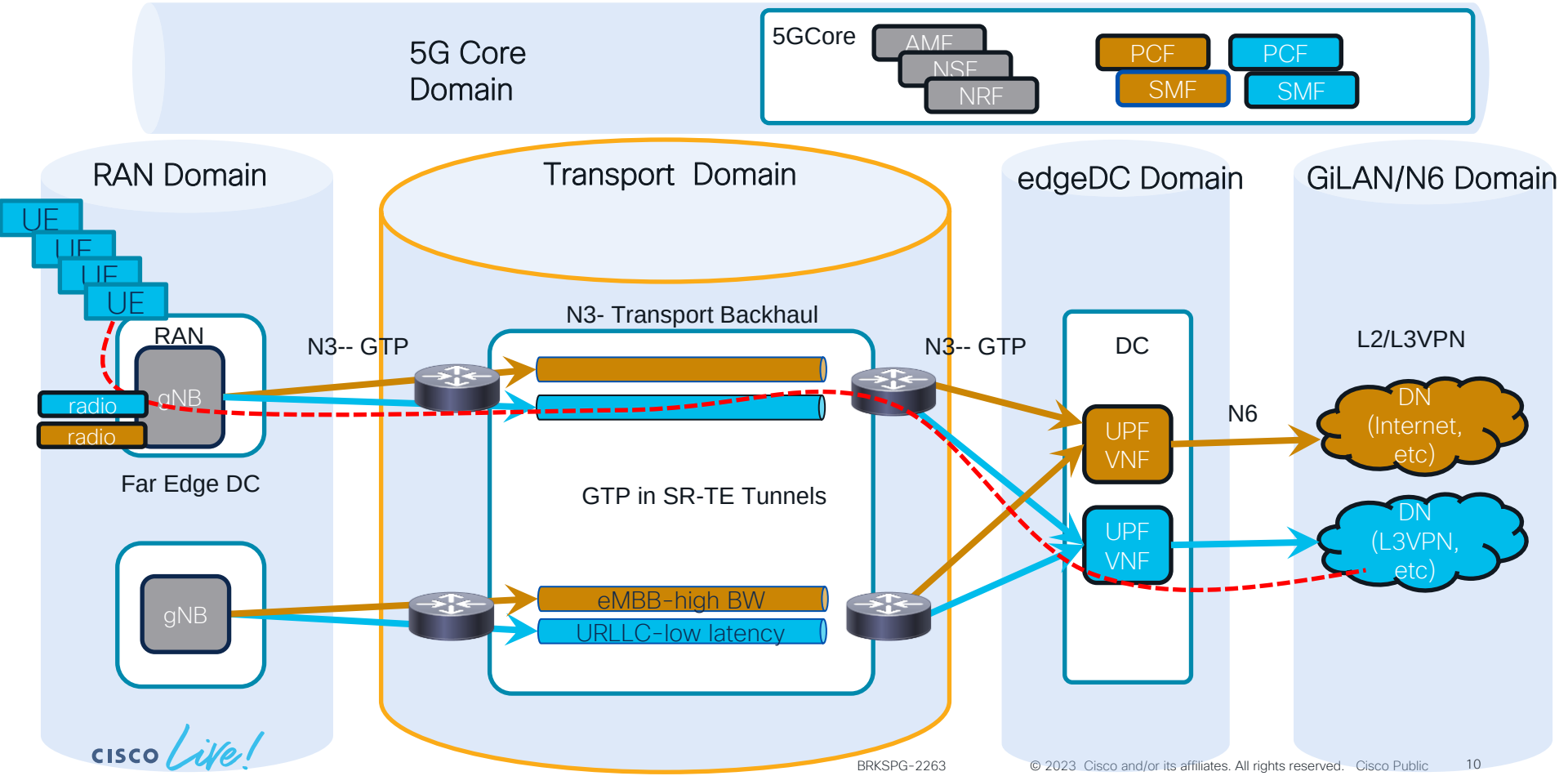


NSMF= Network Slice Mgmt. Function
NSSMF= Network Slice Subnet Mgmt.Function
NST= Network Slice Template
NSST= Network Slice Subnet Template
NSI= Network Slice Instance
NSSI= Network Slice Subnet Instance

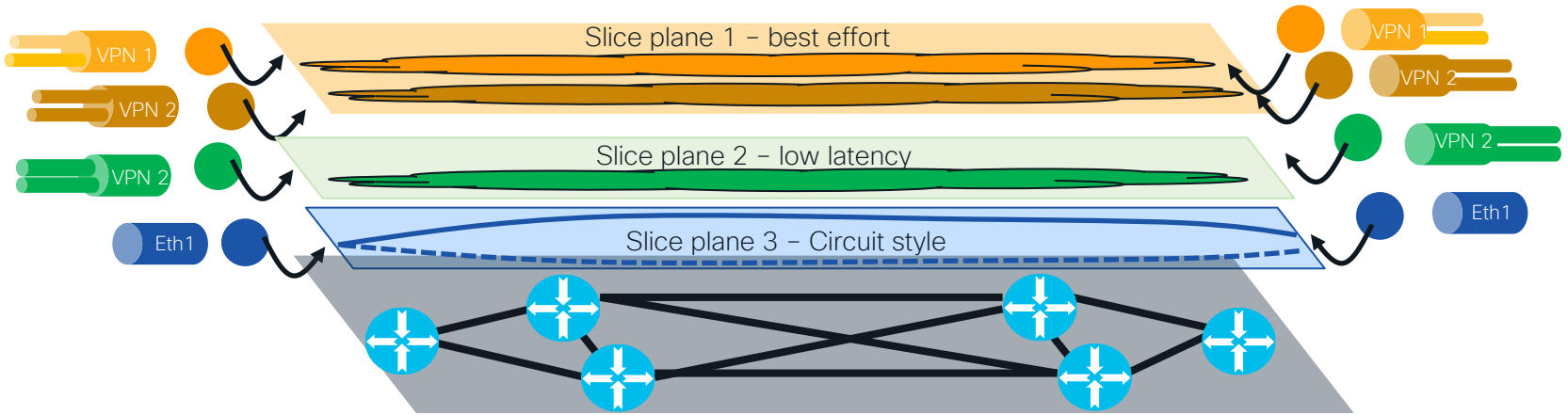
Scope of 5G *Network* slice management

Scope of *Transport* slice management

Example of a 5G Network Slice Service which spans multiple“Domains”



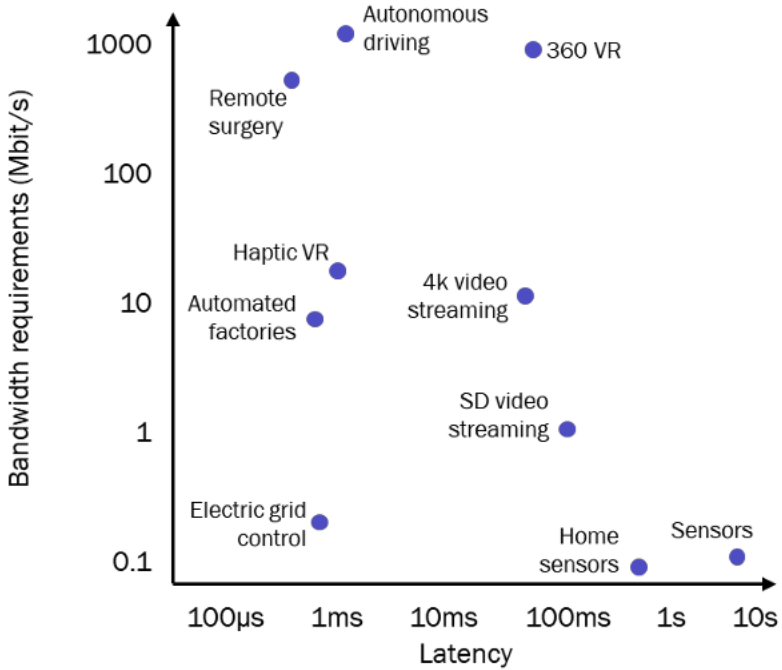
Toolset for Transport Slicing and Multi-service



- Packet services (O-RAN WG9)
  - EVPN VPWS services for FH with priority queuing
  - BGP L3 VPN for O-RAN 7.2X M-Plane
  - BGP L3 VPNs for midhaul / backhaul control plane and user plane – 4G and 5G
- Circuit Style services
  - Controller computation with end-to-end b/w admission control and reservation

- Traffic pushed into correct transport slice plane
  - SR ODN and Automated Steering
- Forwarding behaviours with SR policies, FlexAlgo, QoS and admission control
- Monitoring transport and service layers (SR PM, VPN PM)
- A single slice could involve multiple VPNs, Data Plane, Control Plane, N6 / GiLAN

5G Network Performance Requirements for Transport Slicing Use Cases



Source : Analsys Mason

Transport Slice Automation: Standards, Models & Machinery

cisco Live!

Transport Slicing is Defined by Multiple SDOs…

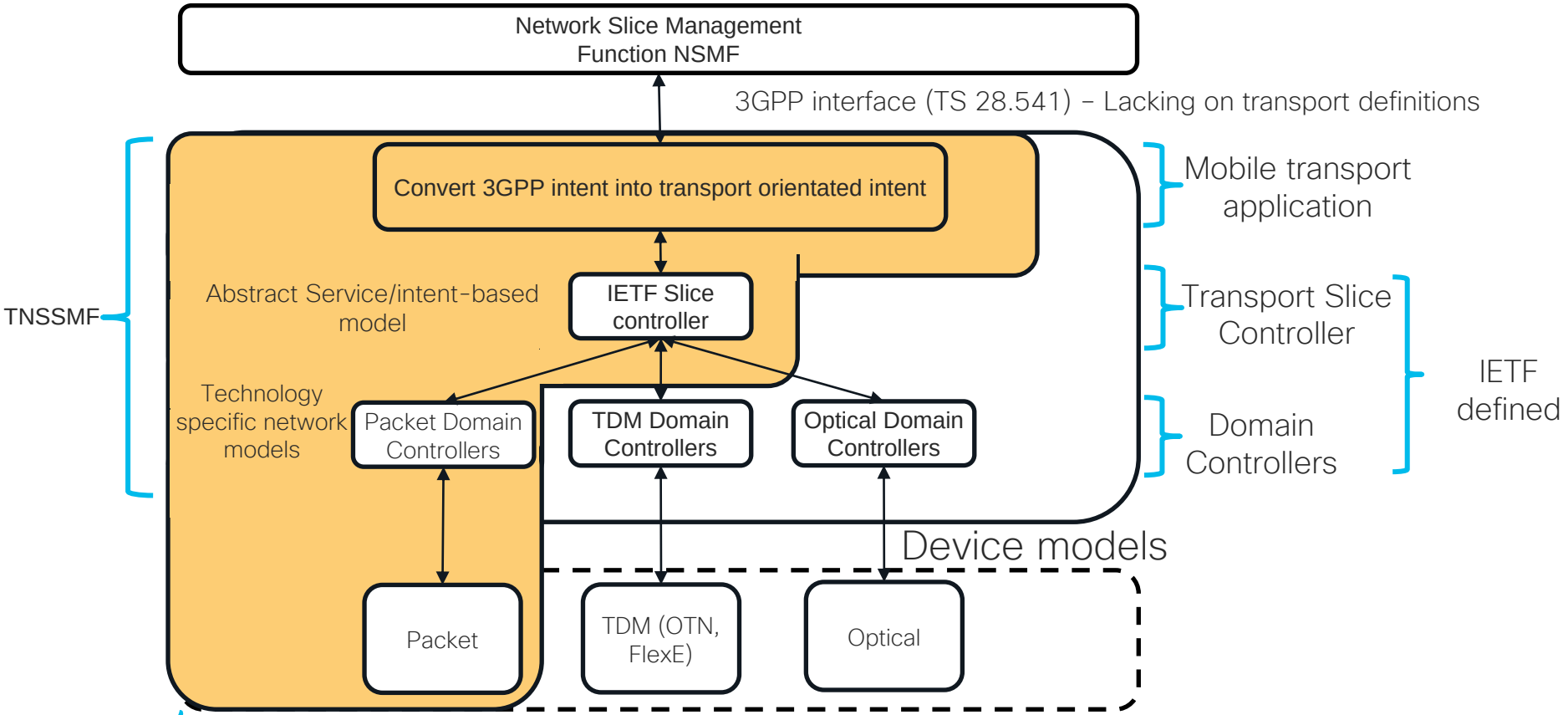
- Defines 5G slicing and 5G Slicing management end-to-end
- No real focus on Transport slicing
- Helps however to position Transport slicing management (T-NSSMF) in a larger context

- TEAS working group defines Transport slicing model and use cases
- Cisco is actively contributing to the working group and Slice Yang model definition

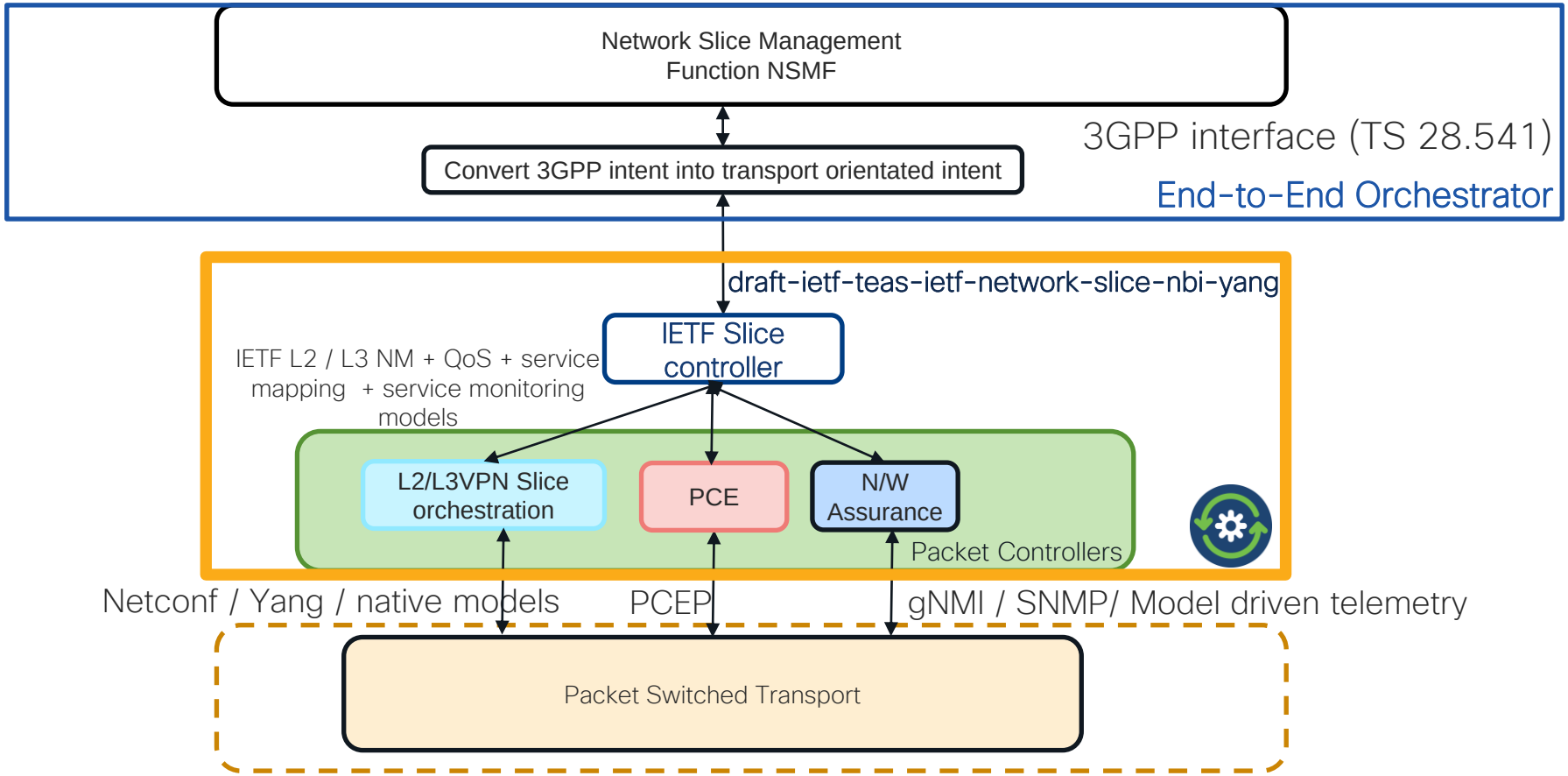
- O-RAN focuses on the RAN side of the 5G network
- And in particular the fronthaul portion of Transport slicing
- Cisco is actively contributing at defining the Transport architecture in this context

And many others… Broadband Forum, MEF,

From 3GPP to IETF: Transport NSSMF



Transport NSSMF and Crosswork Network Controller



Cisco Slicing Directionally Following IETF Slicing Drafts

Network Working Group
Internet-Draft
Intended status: Informational
Expires: 27 April 2023

A. Farrel, Ed.
Old Dog Consulting
J. Drake, Ed.
Juniper Networks
R. Rokui
Ciena
S. Homma
NTT
K. Makhijani
Futurewei
L.M. Contreras
Telefonica
J. Tantsura
Microsoft
24 October 2022

Framework for IETF Network Slices
draft-ietf-teas-ietf-network-slices-16

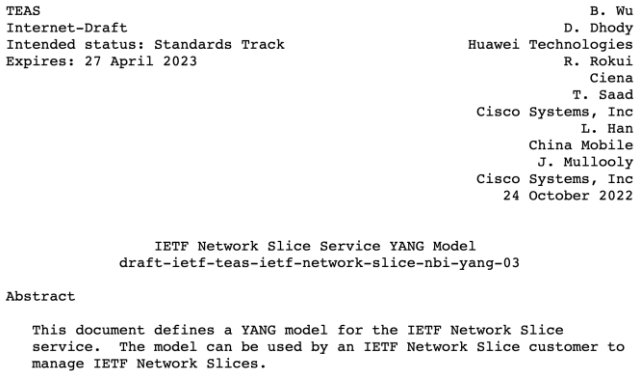
Abstract

This document describes network slicing in the context of networks built from IETF technologies. It defines the term "IETF Network Slice" and establishes the general principles of network slicing in the IETF context.

The document discusses the general framework for requesting and operating IETF Network Slices, the characteristics of an IETF Network Slice, the necessary system components and interfaces, and how abstract requests can be mapped to more specific technologies. The document also discusses related considerations with monitoring and security.

This document also provides definitions of related terms to enable consistent usage in other IETF documents that describe or use aspects of IETF Network Slices.

- IETF TEAS working group is defining Transport/Network Slices: Framework, Use Cases, Models…
  - draft-ietf-teas-ietf-network-slices-16
  - draft-ietf-teas-ietf-network-slice-use-cases-01
  - draft-ietf-teas-ietf-network-slice-nbi-yang-03
- Cisco is actively contributing to those drafts
- CNC will implement the Slice Service Yang models and follow IETF guidelines in general



TEAS
Internet-Draft
Intended status: Standards Track
Expires: 27 April 2023

B. Wu
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24 October 2022

IETF Network Slice Service YANG Model
draft-ietf-teas-ietf-network-slice-nbi-yang-03

Abstract

This document defines a YANG model for the IETF Network Slice service. The model can be used by an IETF Network Slice customer to manage IETF Network Slices.

Transport Slice Automation: Crosswork Network Controller (CNC)

Transport Slice Lifecycle and Automation
Challenges and Requirements

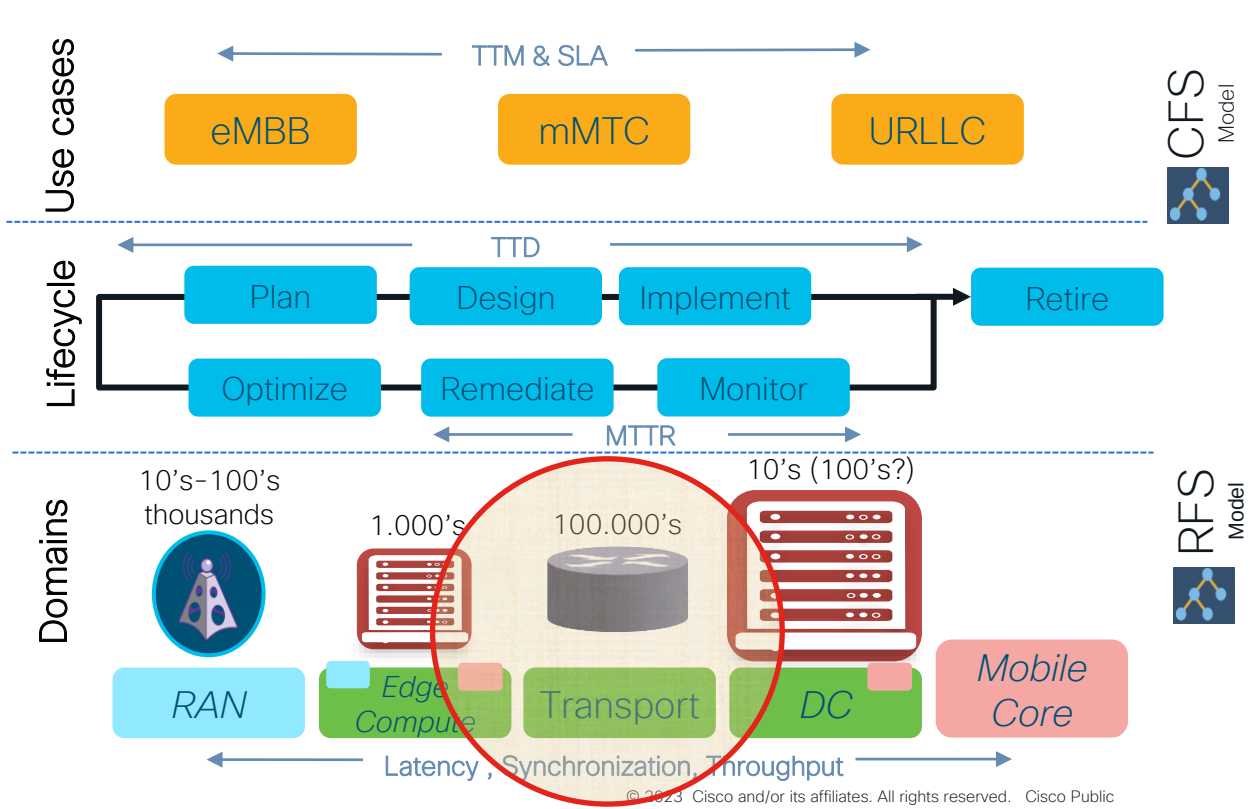
SLA: Service Level Agreement
SLE: Service Level Expectations

Transport Slice Automation Challenges

- Multiple building blocks: L2/L3 VPNs, SR, FlexAlgo, QOS…
- Powerful yet complex toolset
- Slices to offer different level of SLA/Constraints

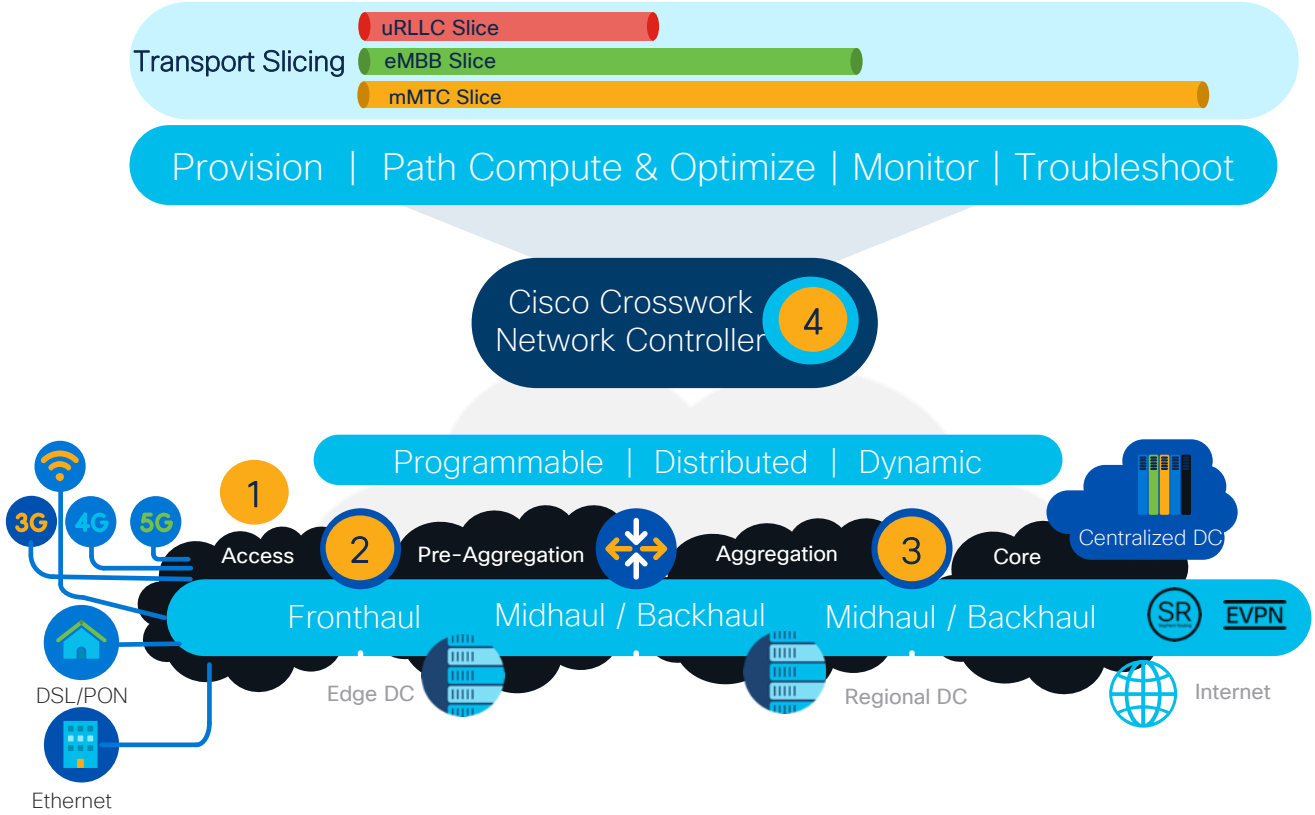
Transport Slice Automation Expectations

- Need for Transport Slice Abstraction to hide the toolset complexity
- Need for a complete lifecycle management
- SLA/SLE(*) monitoring and management
- Integrated with a larger cross-domain orchestration architecture



Transport Slicing Made Easy with Crosswork Network Controller

Roadmap



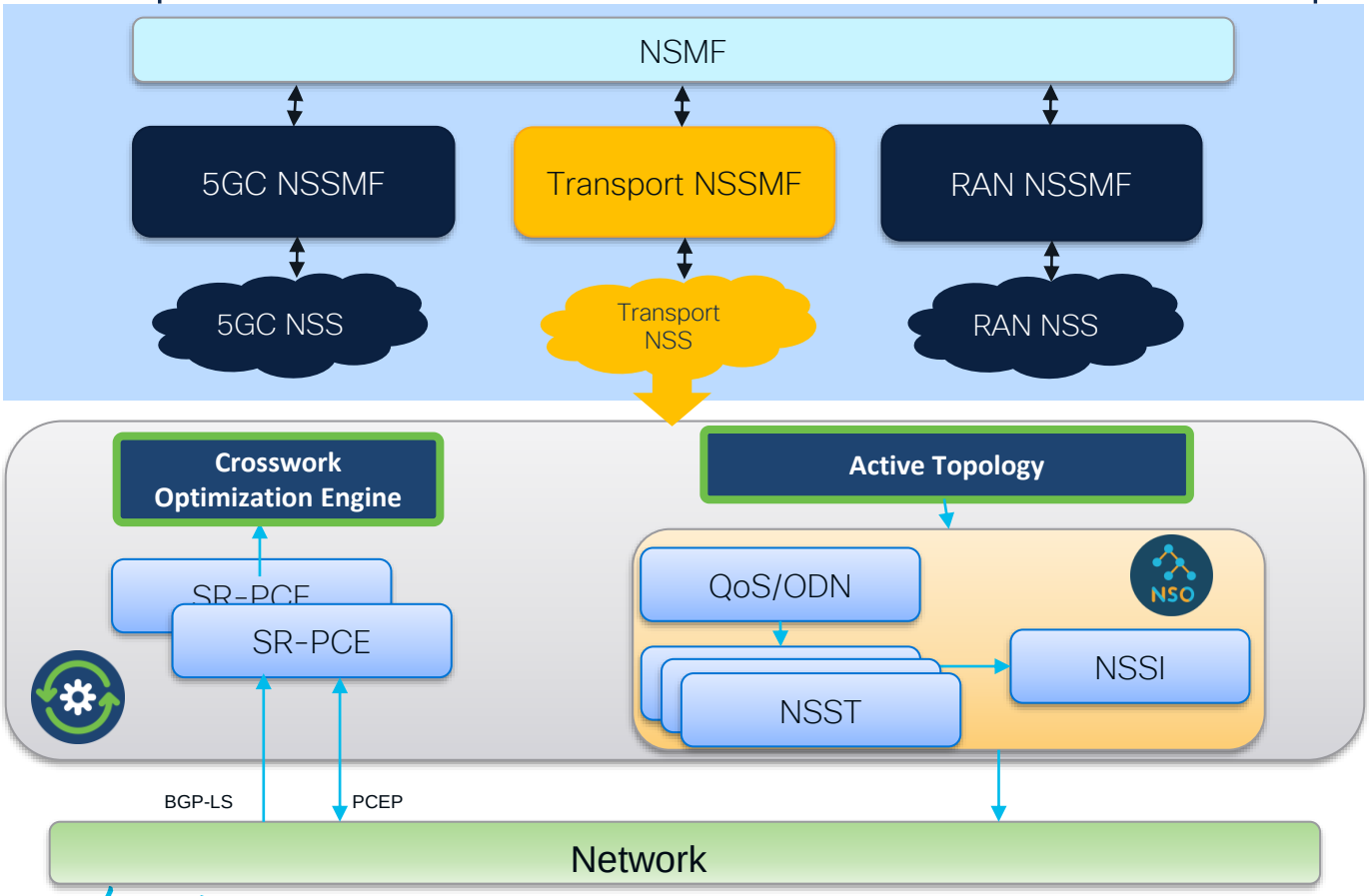
Challenges

1. Cumbersome Service Provisioning
2. Bandwidth swings, Congestion and Over capacity
3. Maintaining SLA
4. Siloed tools, fragmented visibility

Outcomes

- \+ Intent-based Automated Provisioning
- \+ Dynamic Traffic Engineering
- \+ Closed loop Automation
- \+ Integrated service lifecycle management

Transport Slice – Crosswork Automation Components



NSSMF – Crosswork Network Controller

Crosswork Network Controller (CNC)

Automation solution for Deploying and Operating IP Transport networks

CNC 4.1

Roadmap

Intent-based Automated Provisioning	Service Provisioning (L2VPN, L3VPN)	Service-Oriented Transport Provisioning (SR-MPLS, SRv6, RSVP-TE)	5G Transport Slicing	
Dynamic Traffic Engineering	Bandwidth-Aware Path Control	Flexible Algorithm	Local Congestion Mitigation	
Closed loop Automation	Real-time Network Optimization			
Integrated service lifecycle management	Visualization	Optimization	Service Health Monitoring	Network Health Monitoring

Transport Slicing Health and SLA Visibility

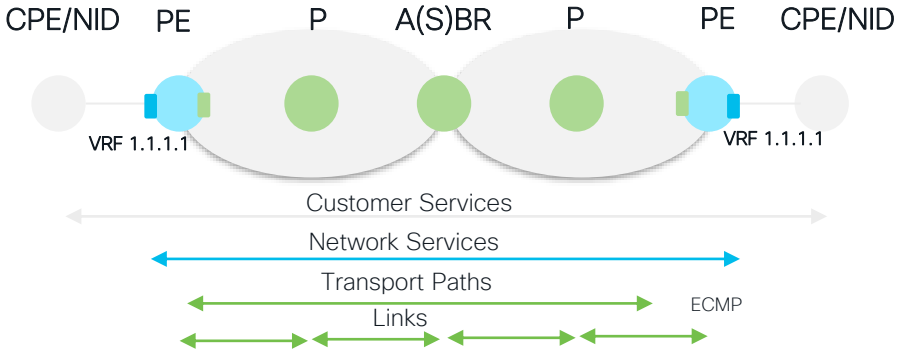
Key KPIs monitoring

Customer Experience

Network Health

Layer	From ..To	Scale	Probes	Type	Metrics
Customer service	*CPE/NID/HOST*	*Per VPN scale*	***In CPE/NID and high priority***	*OTT Probes*	
Transport Network Services (L2 VPN/L3 VPN)	PE/VRF to PE/VRF	Full PE mesh	Internal or External (depend of PE capability and needs/requirments)	IP probes (VRF to VRF) , L2 probes	TWAMP for– L3 VPN *(Embedded & Accedian)* • Delay/Latency • Delay Variation/Jitter • *Loss (Accedian & SR-PM Roadmap)* Y.1731 for L2 VPN *(Embedded & Accedian Roadmap)* • Delay/Latency • Delay Variation/Jitter • Loss (SD, DS)
Transport Path (Policy Monitoring)	PE to PE	Full mesh x ECMP	Internal and limited to critical policies (can't be full mesh)	SR PM (per policy)	• Delay (TWAMP Light) • Liveness (SR-Policy and end points) • Bandwidth (Interface Counter)
Transport Link	Intf-Intf	All links	**Integrated (internal) and high priority**	SR PM (per link)	• Delay (TWAMP Light) • Delay Variation/Jitter • *Bandwidth* (Interface Counter – Roadmap)* • *Packet Drop* (Interface Counter –Roadmap)* • *Synthetic Loss (Roadmap)* • *Loss per Bundle (Roadmap)*

Visibility of Transport SDN Health
Descriptive analytics via contextualized key metric data for device, link, path, L2/L3 VPN service



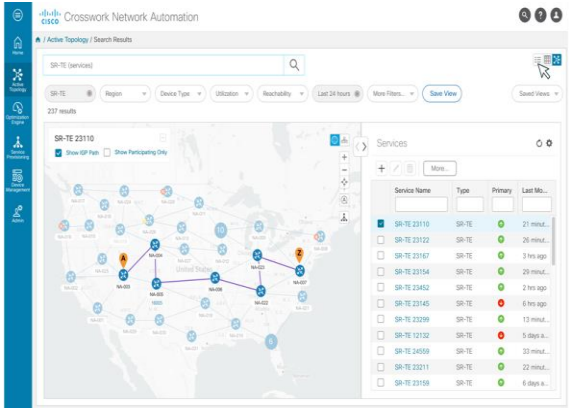
CNC Strategy to address Customers' Requirements

- Slice provisioning
  - Intent-based slice definition that abstracts the underlying components: L2, L3, QOS, FlexAlgo, SRv6, OAM…
- Slice Catalog that includes pre-defined slice templates (SLO-SLE)
- Slice provisioning through Standardized APIs IETF Slice Yang Model exposed to E2E Orchestrator
- Slice visualization
  - Per Transport Slice Observability that includes
    - VPN
    - SR-TE Paths / Flex-Algo Paths
- Slice performance monitoring in near real-time
    - Path Performance (Latency/Loss/Jitter)
    - BW statistics
    - Future: QoS statistics

Cisco 5G Transport Slice Automation

Building Blocks

- FlexAlgo support
- SRv6 support
- L2VPN/L3VPNs
- QOS support



Slice Creation Abstraction

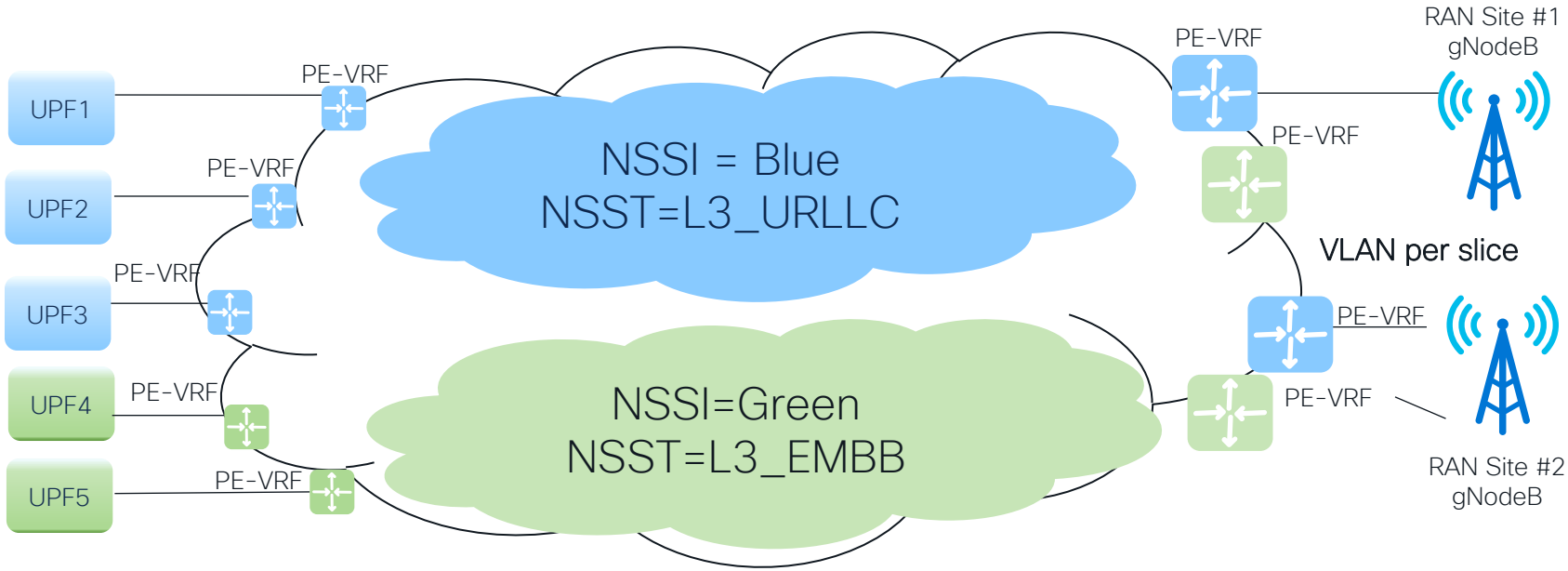
- Simplified API/UI to abstract the Slice components
- Slice Template Catalog

NSST Name	Slice Type Value	Description	QoS Plane Profile	Forwarding Plane Policy
eMBB	1	Use High BW links	Soft-Shared-Queues	IGP
URLLC	2	Use low-delay links	Soft-Shared-Queues	min-delay
mMTC	3	Use low-delay links	Soft-Shared-Queues	min-delay
Encrypted	4	Transit MACsec encrypted links only	Soft-Shared-Queues	encrypt
Disjoint-Path-Top-Rail	5	Only transit links marked top-rail	Soft-Shared-Queues	top-rail
Disjoint-Path-Bottom-Rail	6	Only transit links marked bottom-rail	Soft-Shared-Queues	bottom-rail
20ms-max-delay	7	Delay not to exceed 20ms e2e	Soft-Shared-Queues	NTE-20ms
30ms-max-delay	9	Delay not to exceed 30ms e2e	Soft-Shared-Queues	NTE-30ms

Slice Lifecycle

- Overlay maps
- KPI collection and Closed-Loop Automation
- Network Optimization

Dedicated Slice: Any-to-Any

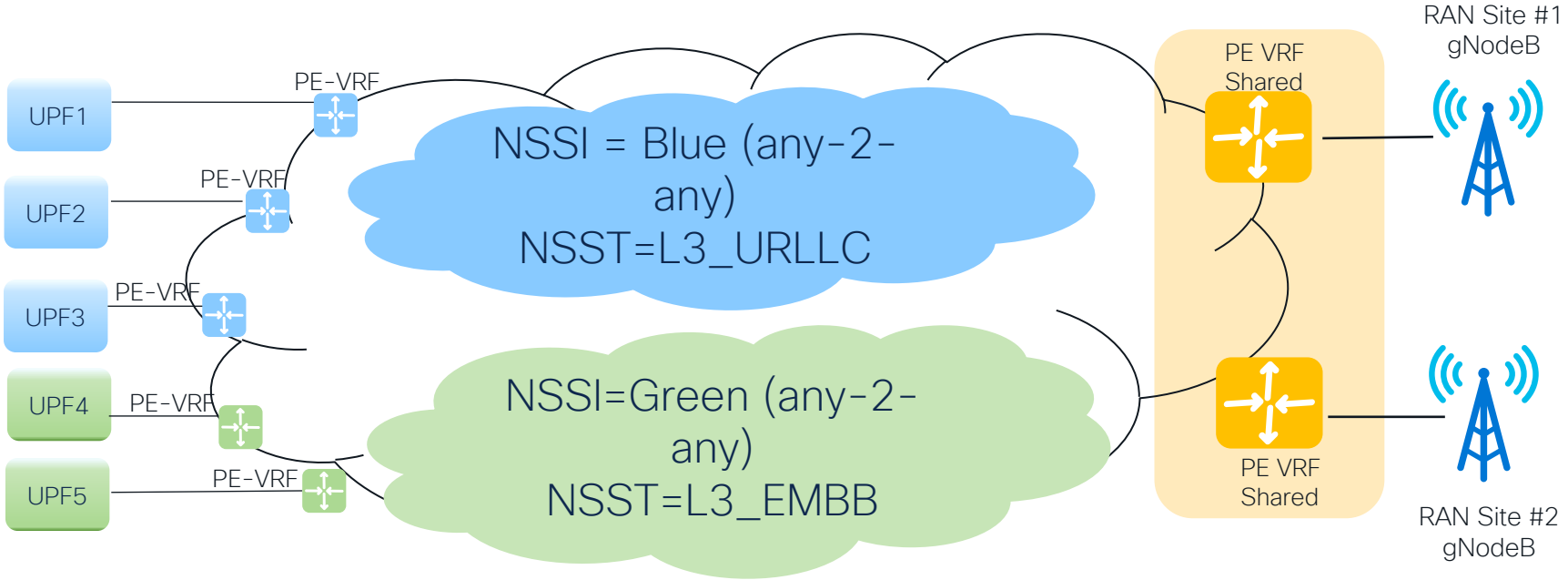


Blue sites talk to Blue – Sites Colored for SR-TE Policy
Green sites talk to Green- sites Colored for SR-TE Policy

Dedicated Slicing

- Dedicated L3VPN transport slice instantiations will have a unique NSSI name to identify the transport slice
- All endpoints in the dedicated L3VPN NSSI will use the transport behavior specified in the referenced NSST entry.
- All endpoints communicate with each other
- Endpoints in different dedicated L3VPN NSSIs can NOT communicate with each other
- A dedicated L3VPN NSSI endpoint can belong to only one NSSI slice service at a time
- Dedicated L3VPN NSSIs can be updated to change their transport “behavior” (just point to a different NSST entry)
- Dedicated L3VPN NSSIs can optionally connect to shared L3VPN NSSIs

Shared Slice : Any to Any



Blue sites talk to Blue and to Gold sites
Blue slice can attach to shared gold slice.
Gold sites talk to Gold (any2any)
Blue sites Do NOT talk to Green (directly or via Gold)

Green sites talk to Green and to Gold sites
Green slice can also attach to shared gold slice
Gold sites talk to Gold (any2any)
Green sites Do NOT talk to Blue (directly or via Gold)

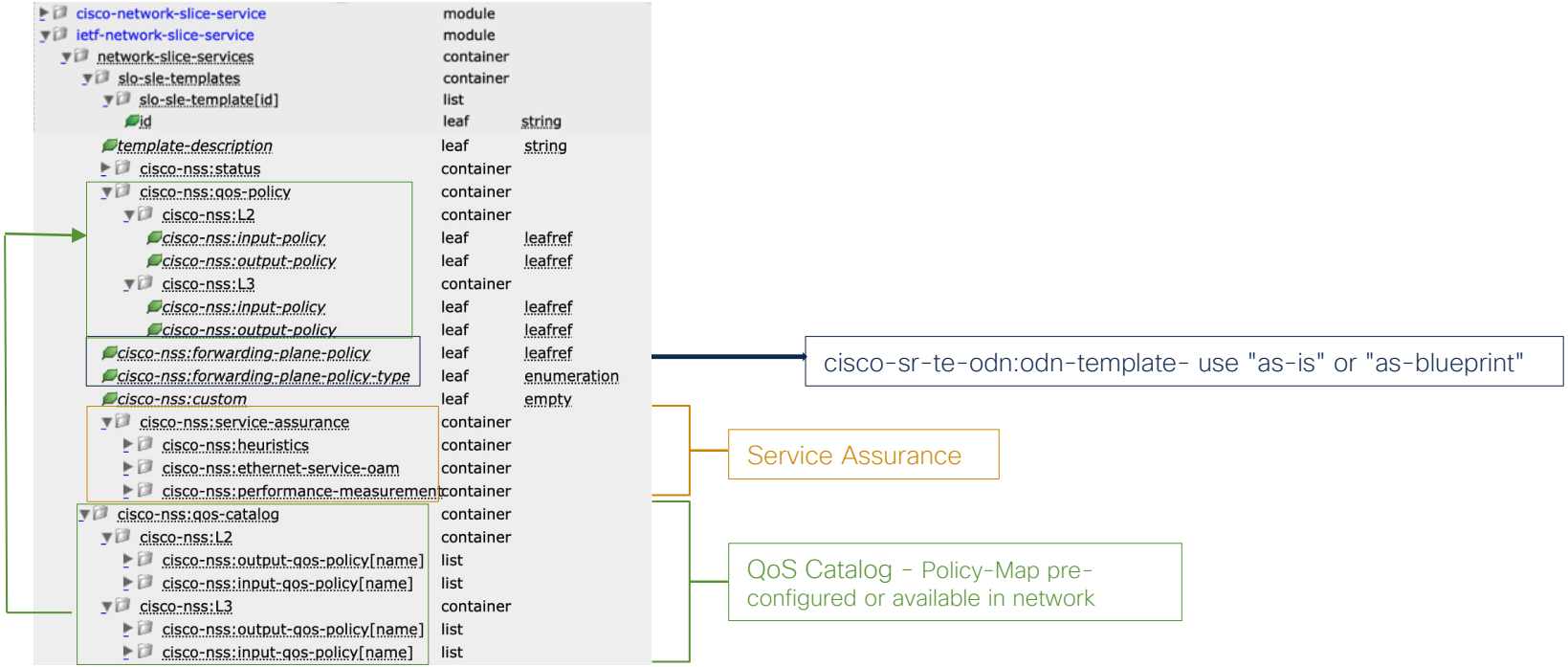
Shared Slicing :

- Shared L3VPN NSSIs are typically static and are usually built once as “infrastructure”. The sites are shared, in that they can belong to multiple dedicated L3VPN NSSIs slices simultaneously
- Shared L3VPN Slice instantiations will have a unique NSSI name to identify the transport slice (just like dedicated transport slices)
- Shared L3VPN NSSIs can support connectivity to multiple dedicated L3VPN NSSIs simultaneously (using extranet VPN machinery).
- While these dedicated NSSIs can access the shared site, they can not access each other. This is possible due to the MPLS-VPN extranet configurations.

IETF Network Slice NB Model – SLO-SLE Templates

Provisioning : - https://datatracker.ietf.org/doc/html/draft-ietf-teas-ietf-network-slice-nbi-yang-02

Yang Tree – SLO SLE Template



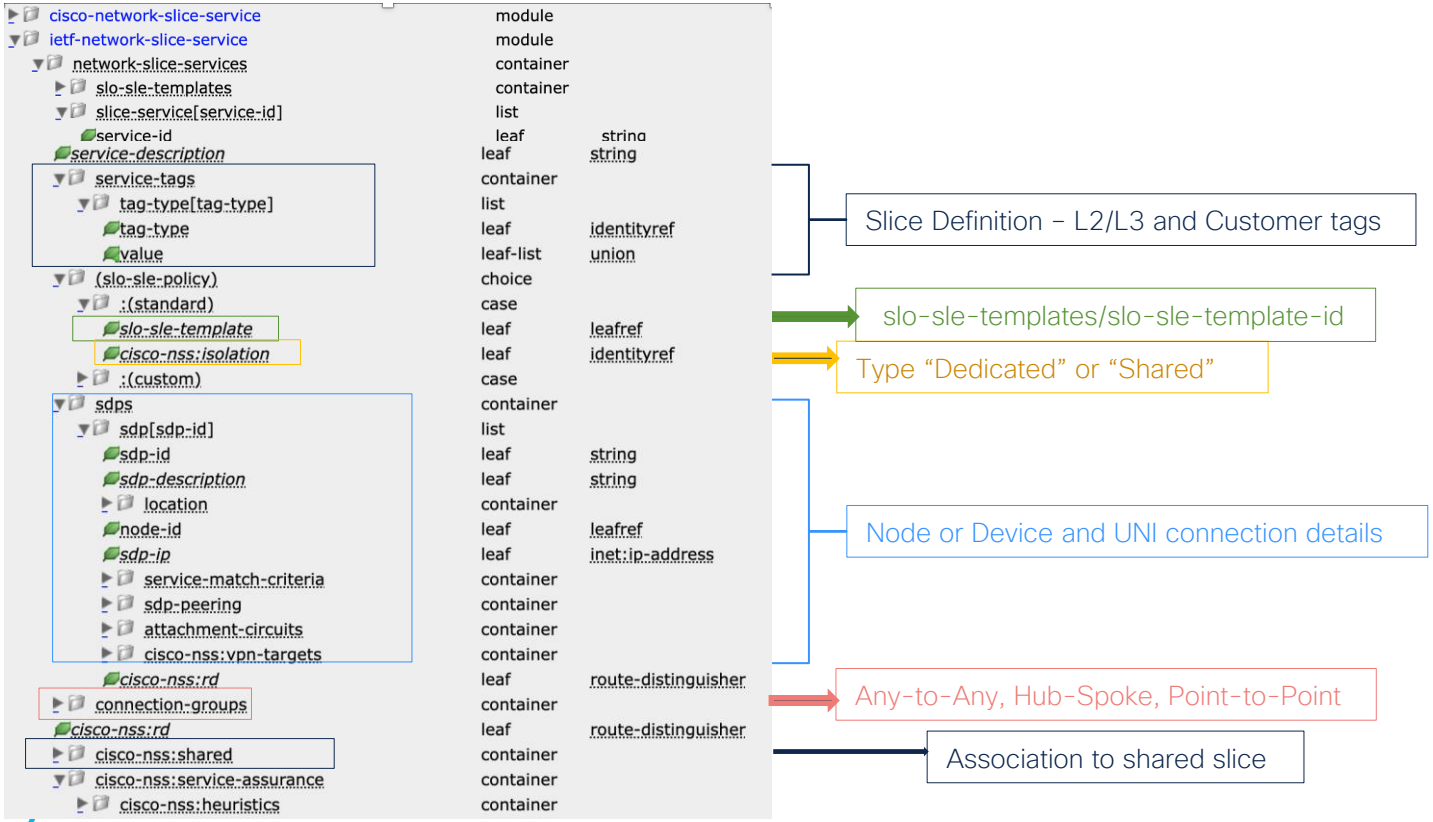
Continued...

Transport Slicing – SLO SLE Template

NSST Details		QoS Details				Forwarding Plane Policy Details	Service Assurance Details		
NSST Name	Description	L2 QoS input Profile	L2 QoS output profile	L3 QoS input Profile	L3 QoS output profile	SR – ODN Template	Service Health	Performance measurement	Ethernet Service OAM
eMBB-BW	Use High BW links	Ingress_COS1	Egress-H_BW	Ingress_COS1	Egress-H_BW	igp	Basic	liveliness-profile	Y1731-profile
URLLC	Take lowest possible latency path with high reliability	Ingress_COS3	Egress_LL	Ingress_COS5	Egress-H_BW	latency	Advanced	delay-profile	Y1731-profile

IETF Network Slice Model – Network Slice Service

Yang Tree – Slicing Service



Demo

Transport Slicing Automation Demo

1. CNC as Transport Slice Manager
2. Dedicated Slice – L3 - Any-Any with eMBB
3. Update Slice Type to URLLC
4. Associate Shared Slices – Type L3
5. Dedicated Slice – L2 – P2P

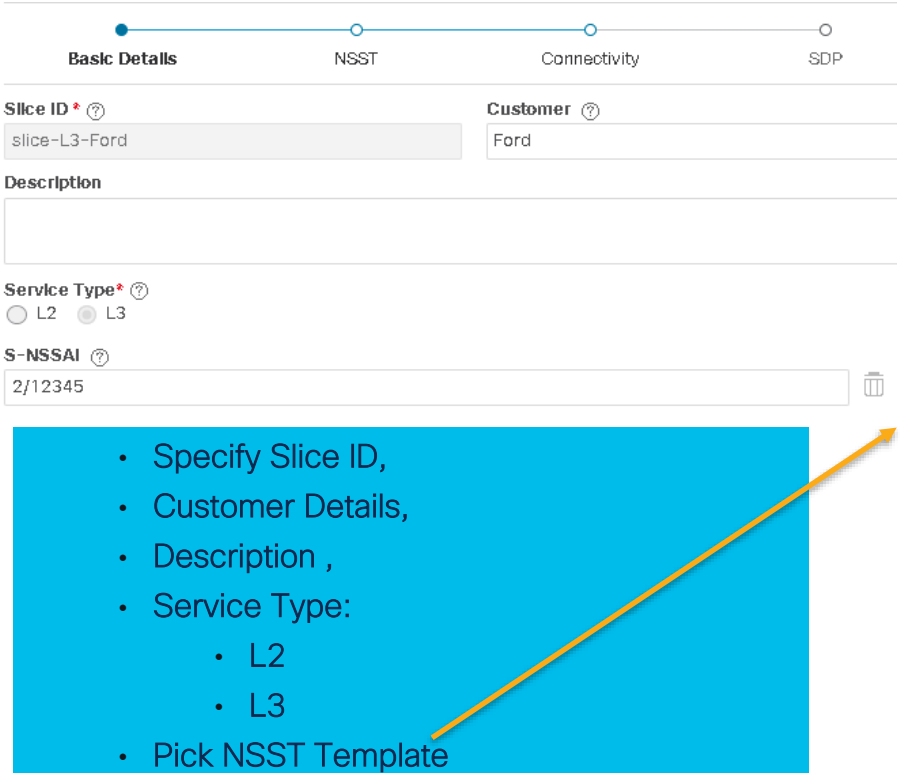
Transport Slice Template Catalog

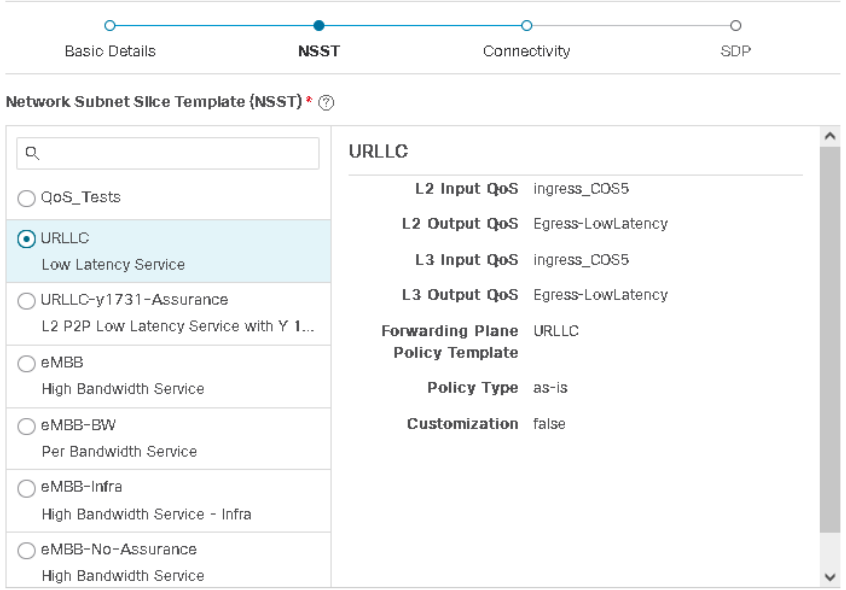
NSST Name	Description	QoS			
		L2 Input QoS	L2 Output QoS	L3 Input QoS	L3 Output QoS
QoS_Tests		ingress_COS3		ingress_COS3	Egress-High_Bw_Apps
URLLC	Low Latency Service	ingress_COS5	Egress-LowLatency	ingress_COS5	Egress-LowLatency
URLLC-y1731-Assurance	L2 P2P Low Latency Service with...	ingress_COS5	Egress-LowLatency	ingress_COS5	Egress-LowLatency
eMBB	High Bandwidth Service	ingress_COS1	Egress-High_Bw_Apps	ingress_COS1	Egress-High_Bw_Apps
eMBB-BW	Per Bandwidth Service	ingress_COS1	Egress-High_Bw_Apps	ingress_COS1	Egress-High_Bw_Apps
eMBB-Infra	High Bandwidth Service - Infra				
eMBB-No-Assurance	High Bandwidth Service	ingress_COS1	Egress-High_Bw_Apps	ingress_COS1	Egress-High_Bw_Apps

Forwarding Plane		
Forwarding Plane Policy	Policy Type	Customizat...
	as-is	false
URLLC	as-is	false
URLLC	as-blueprint	true
eMBB	as-is	false
eMBB	as-blueprint	true
eMBB	as-is	false
eMBB	as-blueprint	true

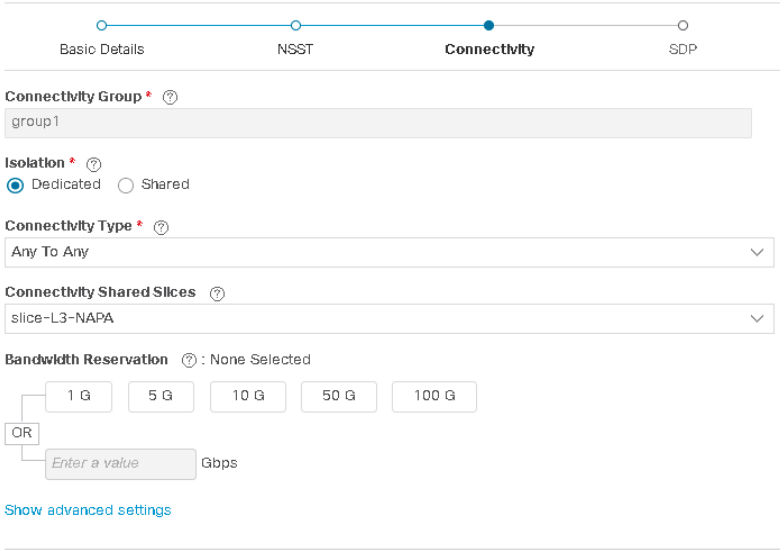
- Pre-defined and User-defined slice templates
- Template includes:
  - Template Name
  - Description
  - Input/Output QOS
  - Forwarding policy – as-is / as-blueprint
  - (Future) SLA/SLO parameters
- Templates can be created/modified through GUI or API

Simplified Transport Slice Creation



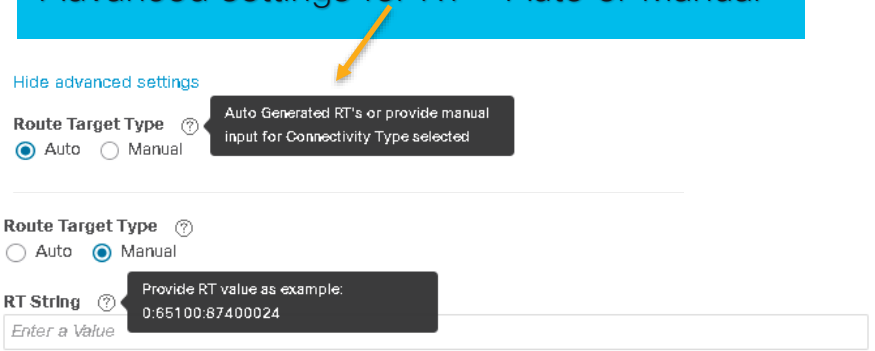


Simplified Transport Slice Creation

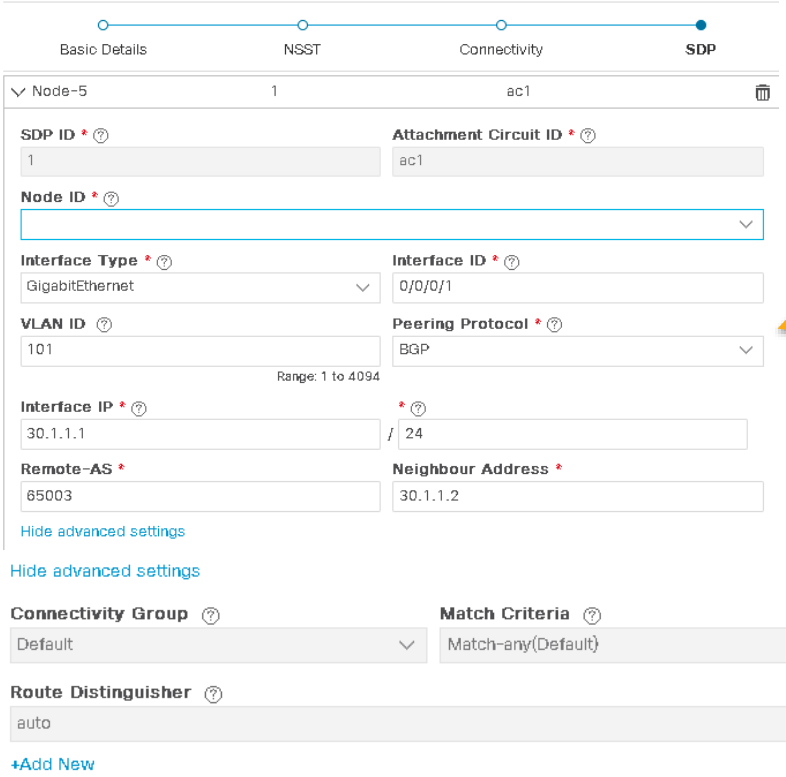


- Isolation :
  - Dedicated
  - Shared
  - Custom- Bandwidth…
- Specify Connectivity Type :
  - Any-to-Any,
  - Hub-Spoke,
  - Point-to-Point,

Advanced settings for RT - Auto or Manual



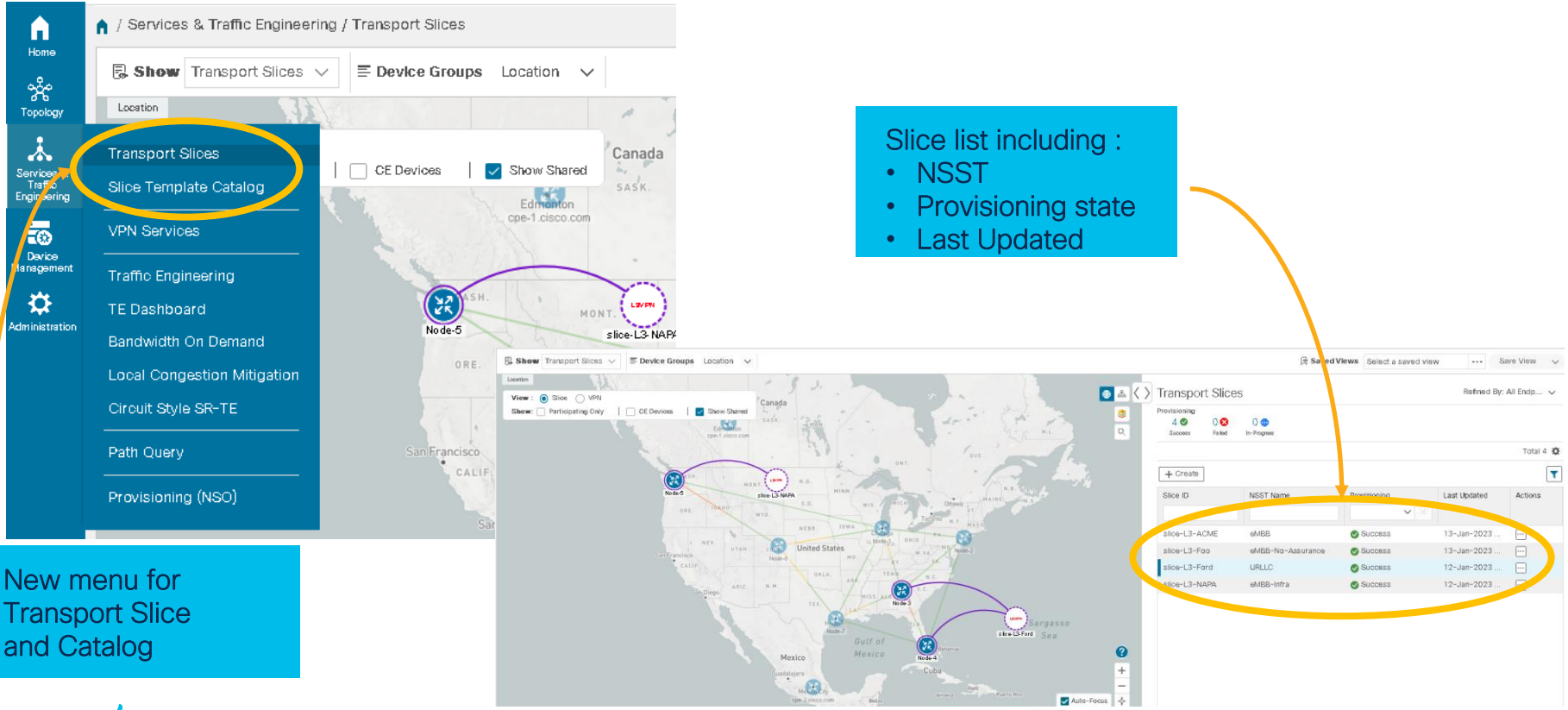
Simplified Transport Slice Creation



- Define Service Demarcation Points (SDP's):
  - Node –ID
  - Attachment Circuit (AC) :
    - Interface ID,
    - Interface IP and Subnet Mask
    - Peering- None/BGP :
      - Remote AS
      - neighbor address

Advanced Settings:
RD – Auto set at global settings or configure manual RD

Transport Slicing in CNC 5.0: Visualization



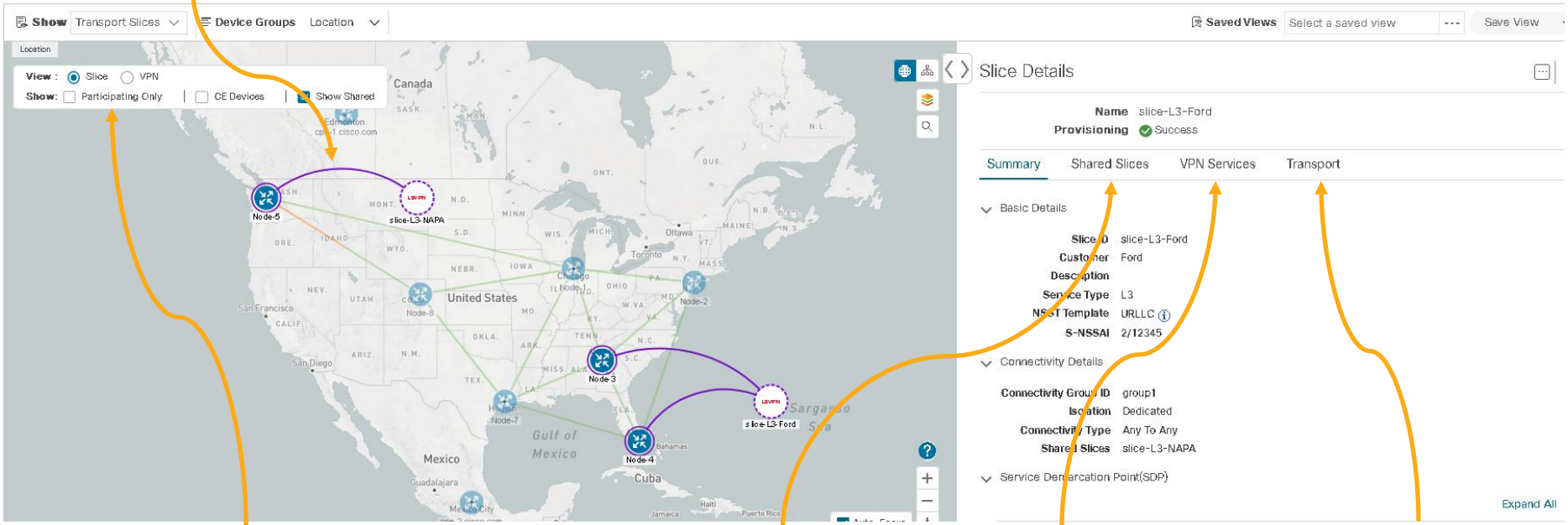
Slice list including :

- NSST
- Provisioning state
- Last Updated

New menu for Transport Slice and Catalog

Navigate the Slice components: VPN, Transport

Display a slice on the map



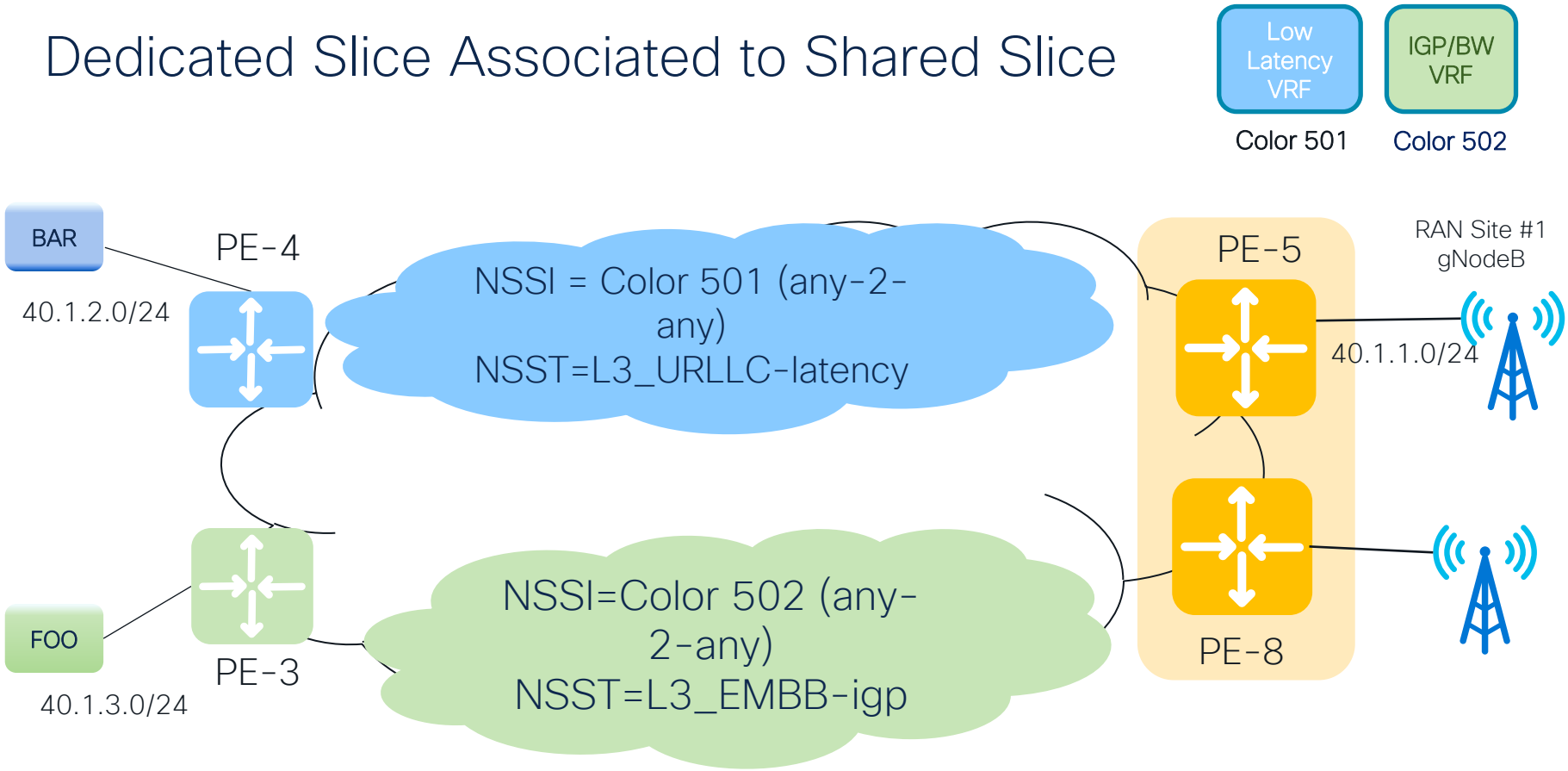
View Slice and VPN view along with Shared Slices and CE (Neighbor) connected in Logical View

Visualize Shared Slices associated to dedicated slice

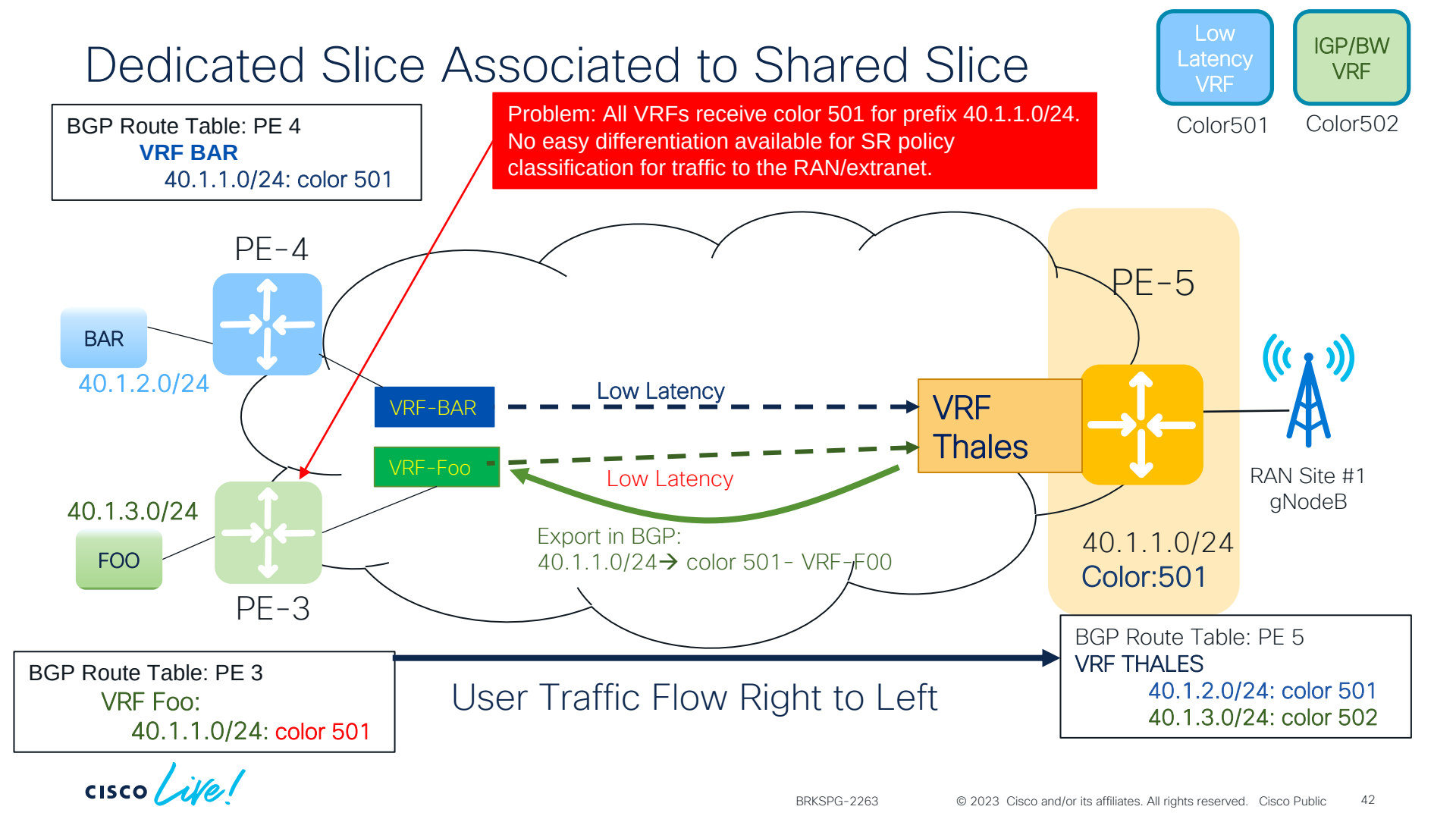
From the VPN list, display VPN details including Assurance data if monitoring is enabled

From the Transport list, display SR TE details including SR-PM data if SR-PM is enabled

Dedicated Slice Associated to Shared Slice



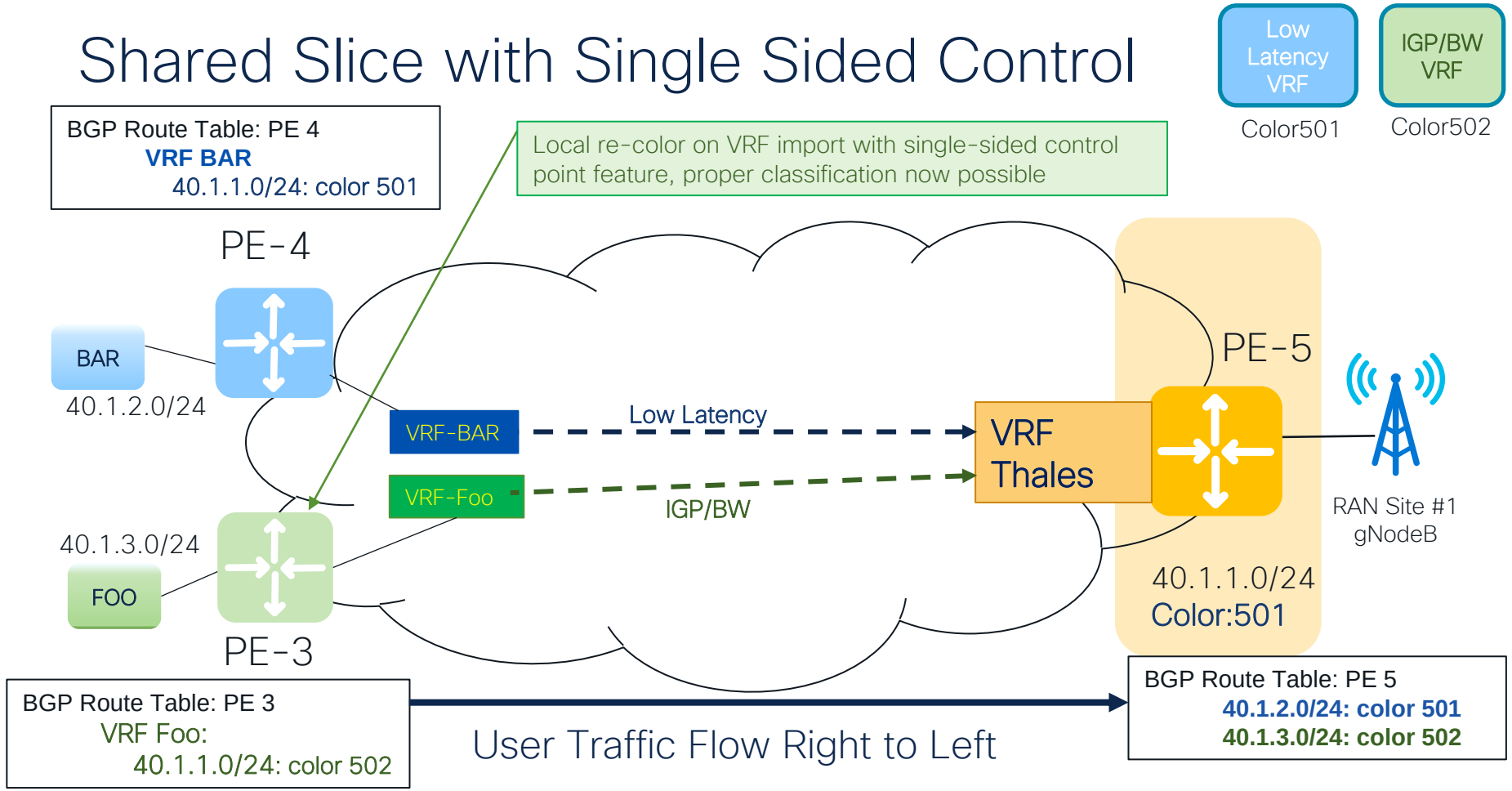
Dedicated Slice Associated to Shared Slice



Shared Slicing : Single Sided Control

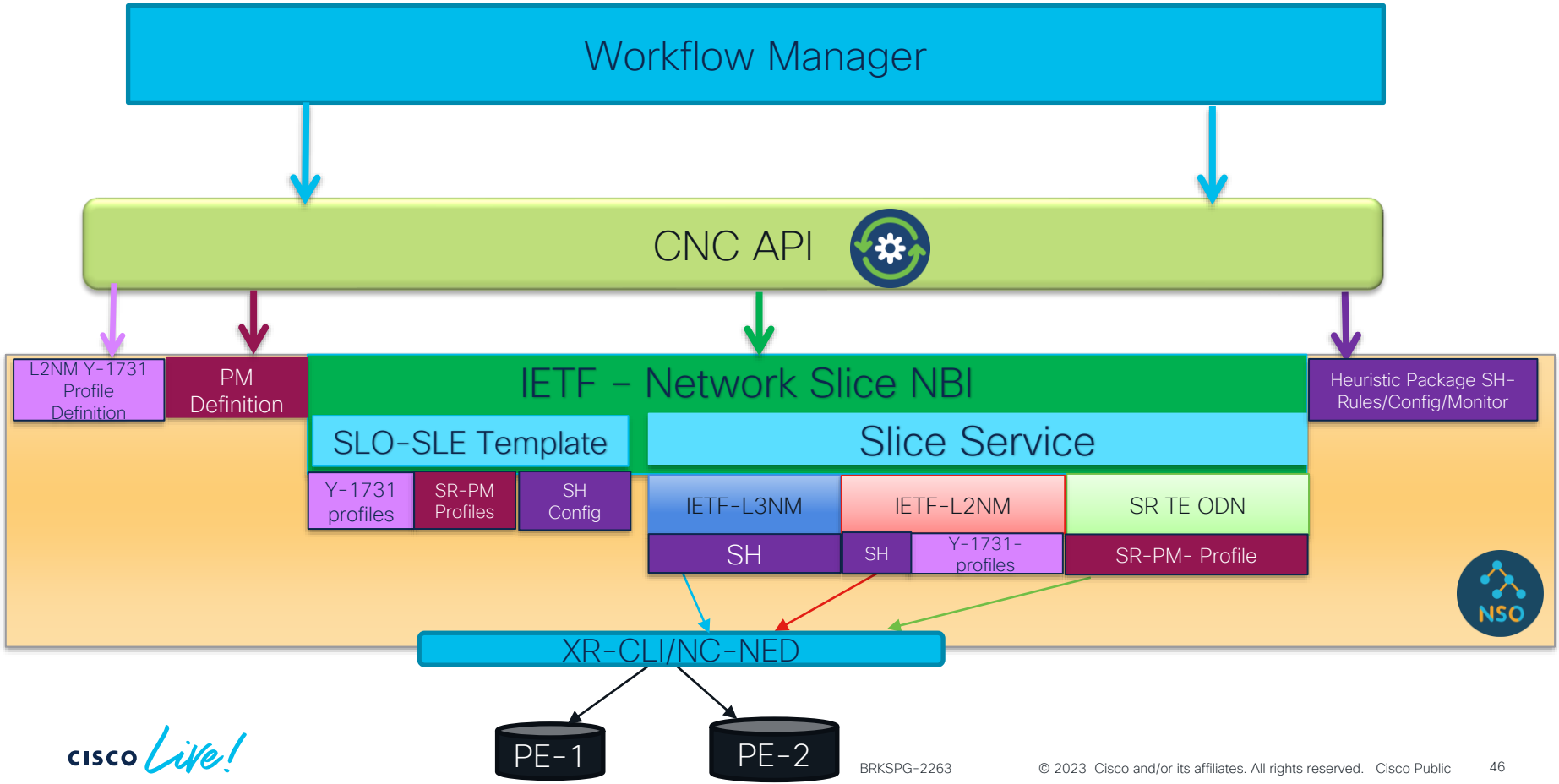
- Multiple dedicated NSSIs (each with unique NSSTs) need to connect to a shared NSSI endpoint which may also have a different NSST.
- The forwarding-path to an NSSI endpoint for traffic it *receives* will match it's specified NSST path forwarding behavior by using BGP coloring and ODN SR
- By enabling single-sided control knob, the dedicated NSSI can override the forwarding-path selection for traffic transmission to the shared NSSI from the dedicated NSSI sites.

Shared Slice with Single Sided Control



Transport Slicing Workflow

Transport Slicing – Provisioning Flow



Slicing Workflow – L2 with Service Assurance – Designer

PM FP	• Configure TWAMP Protocol on every device. • Create PM Profile and PM Service – delay and liveness
SR TE FP	• ODN Template - IGP with metric • ODN Template- Latency with metric
Resource Pools Package: Create Resource Pools- ID Pool	• EVI ID • EVI Source and Target • SR-TE Color Pool • MEP ID Pool for Y 1731 • Pool for Route Target
L2NM FP	• Create Y 1731 Profile – delay, loss, synthetic loss • L2NM Bootstrap – Map Resource pools for Hub/Spoke – RT, EVI ID and EVI- Source & Target

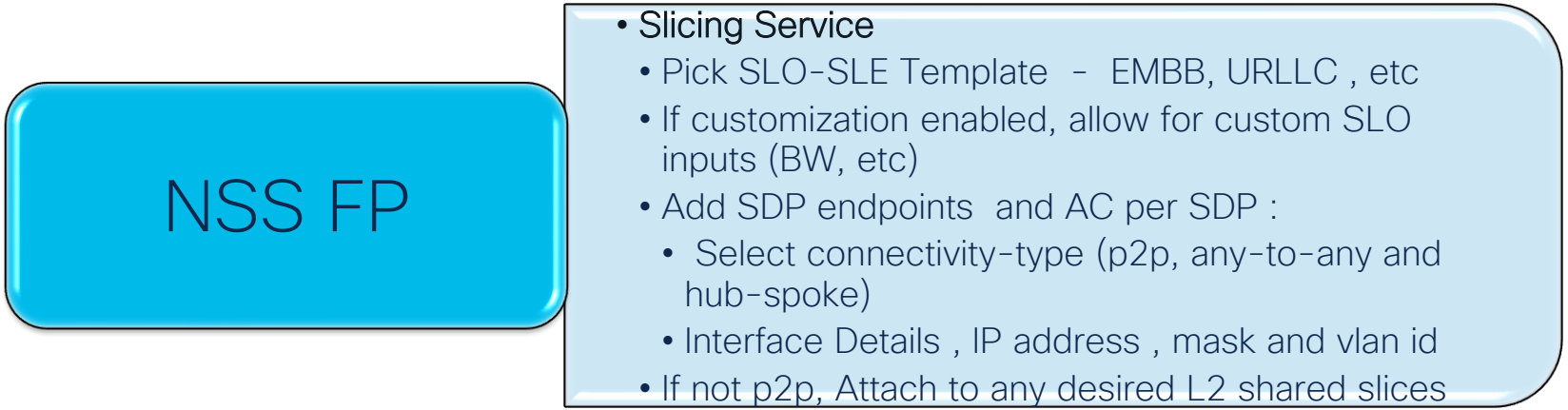
Continued…

Slicing Workflow – L2 with Service Assurance – Designer

NSS FP

- Global Config : Bootstrap :
  - Map Resource pools : SR-TE ODN –Internal Pool
  - Parent Route Policy for P2P (EVPN – VPWS based)
  - Route Distinguisher : Auto or Manual
  - Map Resource pools: MEP ID Pool
- SLO-SLE-Template:
  - Catalog : QoS Policy : L2 mapped to preconfigured policy-maps in network.
  - Create Catalog of slice types (EMBB, URLLC, etc) :
    - add forwarding plane policy referencing pre-created SR-TE ODN templates – (ex. igp and latency)
    - Set forwarding plane policy template to use “as-is” or “as-blueprint”
      - If as-blueprint selected, allow for custom support to be selected.
    - Select Y 1731 profile for P2P Service Assurance
    - Select PM Service for SR-PM monitoring on SR-TE ODN
    - Select Heuristic Package – Rules and Config

Slicing Workflow – L2 with Service Assurance - Operator



Slicing Workflow – L3 with Service Assurance – Designer

PM FP

- Configure TWAMP Protocol on every device.
- Create PM Profile and PM Service – delay and liveness

SR TE FP

- Create ODN Template - IGP with metric
- Create ODN Template- Latency with metric

Resource Pools Package

- Create Resource Pool - ID Pool for Route Target
- Create Resource Pool - ID Pool for SR-TE Color

Continued…

Slicing Workflow – L3 with Service Assurance - Designer

NSS FP

- Global Config
  - Map Resource pools : SR-TE ODN –Internal Pool
  - Map Resource pools : Route Target pool
- SLO-SLE-Template:
  - Catalog : QoS Policy : L3 mapped to preconfigured policy-maps in network.
  - Create Catalog of slice types (EMBB, URLLC, etc) :
    - add forwarding plane policy referencing pre-created SR-TE ODN templates – (ex. igp and latency)
    - Set forwarding plane policy template to use “as-is” or “as-blueprint”
    - If as-blueprint selected, allow for custom support to be selected.
  - Select PM Service for SR-PM monitoring on SR-TE ODN
  - Select Heuristic Package – Rules and Config

Continued…

Slicing Workflow – L3 with Service Assurance - Operator

- Slicing Service
  - Pick SLO-SLE Template - EMBB, URLLC , etc
  - If customization enabled, allow for custom SLO inputs (BW, etc)
  - Add SDP endpoints and AC per SDP :
    - Select connectivity-type (any-to-any and hub-spoke)
    - Interface Details , IP address , mask and vlan id
    - Peering Details :
      - None
      - BGP – remote AS and neighbor IP
    - Advanced Settings for additional route targets
  - Attach to any desired L3 shared slices

Roadmap & Conclusion

Path to Transport Slicing Automation

CNC 2.0

Flat L2/L3
SR TE
Real-time network optimization
Bandwidth Optimization
Local Congestion Mitigation (LCM)
Zero Touch Provisioning (ZTP)

CNC 3.0
November 2021

L2NM/L3NM
SR TE/MPLS TE
SRv6
FlexAlgo
Service Health

CNC 4.0
(July 2022)

NSO LSA
Service Health extensions

CNC 5.0
(1QCY23)

Transport Slicing MVP
Slice Model
Slice provisioning
Slice Template Catalog

CNC 6.0
2HCY23

Transport Slicing Advanced Features
SLA monitoring
Multiple Transport options: Circuit-Style, SRv6

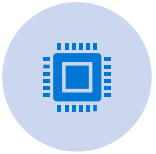
Summary

5G slicing will require a high degree of automation in order to support B2B and B2C services

A layered, model driven, intent based Multi-Domain automation approach offers modularity and alignment to well proven SW programmability principles

Well-defined per-domain primitives (service models) will provide the basis for modularity

Declarative and Intent based service models are the future. Key cloud principle.



Cisco is taking a lead industry position to define the key dimensions of Transport Slicing for Automation

Automation needs to include slice resource planning/pre-checks, service assurance (SLA probing), telemetry/monitoring/reporting, visualization and optimization

Innovations around Intent Based Orchestration, YANG Service Modeling and Segment Routing will provide key functionalities needed for transport slicing and its automation.

What to Expect Next… CNC 6.0 and Beyond..

- SLA and **Assurance monitoring** at the slice level
- **SLA parameters** to be part of the Slice Catalog
- Leverage on **Accedian** probing and **AIOps** solution
- **Closed-loop** scenarios for Transport Slicing
- Multiple transport options: **SRv6, Circuit-Style…**
- **Multiple VPN** per slice
- **QOS** management
- **Workflow** engine to be introduced to enhance the solution
- **HCO** to be part of the Slicing solution when multiple controllers and/or Optical are needed

Key Takeaways

- Slicing has become a trend with 5G Networks but can actually be applied in various contexts
- Cisco has a complete toolset to implement Transport Slicing:
  Segment Routing, FlexAlgo, QOS, L2/L3 VPNs, SR-PM, OAM…
- CNC is the network controller to **orchestrate and automate Transport Slicing**
- CNC 5.0 will make Slicing orchestration and automation even simpler by:
  - **Abstracting the Cisco toolset under a Slice model**
  - **Exposing an IETF API for integration with end-to-end orchestrators**

Call to Action

- Please reach out to us at “ask_crosswork_network_automation@cisco.com” if you have Transport Slicing opportunity
- Solicit participation in upcoming CNC 5.0 EFT (End of Feb 2023)
- For more questions and discussions
  - Meet the Speaker: BRKSPG-2263 - MTS-1004
  - Wednesday, Feb 8: -- 9:40 AM - 10:10 AM CET
  - Meet the Speaker: Area 2

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Session ID	Title	Presenter	Date	Time
BRKSP-2637	Network Automation with Routed Optical Networking (RON) Architecture	Domenico Zini	Tuesday, Feb 7	3:30 PM - 4:30 PM CET
BRKSPG-2263	**Design, Deploy and Manage Transport Slices using SDN Controller and Assurance**	**Sujay Murthy**	**Tuesday, Feb 7**	**5:00 PM - 6:30 PM CET**
BRKSPG-2028	Management of IP+Optical Networks Using an SDN Controller Architecture	Phil Bedard	Wednesday, Feb 8	12:00 PM - 1:30 PM CET
BRKSPG-2664	Automate 5G datacentre and transport components with NSO Cross-Domain Function Packs.	Shambhu Mishra	Wednesday, Feb 8	1:30 PM - 2:30 PM CET
BRKSPG-2474	Reduce Resolution Time with a Service-Centric Approach to Troubleshooting	Paola Arosio	Wednesday, Feb 8	4:45 PM - 5:45 PM CET
BRKMPL-2131	Deploying VPNs Over Segment Routed Networks Made Easy	Krishnan Thirukonda	Thursday, Feb 9	8:45 AM - 10:15 AM CET
PSOSPG-2011	Accelerating the Benefit of Router Optical Networking with Crosswork Automation	Domenico Zini	Thursday, Feb 9	12:30 PM - 1:00 PM CET
BRKSP-2250	Eliminate Congestion Surprises and Fire Drills Forever with Crosswork Cloud-Traffic Analysis as a Service	Dan Backman	Thursday, Feb 9	3:45 PM - 4:45 PM CET
BRKSPG-2031	Deploying XR Programmability in Production Networks	Mike Korshunov	Friday, Feb 10	11:00 AM - 12:30 PM CET

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