SRV6 – DEPLOYMENT CASE STUDY

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XL axiata

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AGENDA

- SRv6 Industry Outlook
  - Quick Update
- SRv6 Deployment @ XL Axiata
  - SRv6 Design
  - Deployment Challenges
  - Future Goals

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SRV6 INDUSTRY OUTLOOK

QUICK UPDATE

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SRv6: What's all the hype about ? (vs MPLS)

Operational Simplicity: Stateless, Programmable, Single data plane across DC/Metro/Core, BGP Free Transport (BGP-LU isn't required for scaling the networks, DCI GW not required)

High Availability: Reliable link/node protection with TI-LFA, Load-balancing with IPv6 flow label

Scalability and Efficiency: IPv6 scale, Locator summarization, Longest Prefix Match (just like Internet routing), Shim Less vs VxLAN/MPLS Label

Seamless Integration: IPv6 data plane, Non-SRv6 routers co-existence, can also leverage 6PE MPLS in absence of IPv6 Core, Seamless & Better Migration than MPLS → SR-MPLS

Application-aware routing: Applications can program SRv6 and define constraints as most of the end Hosts & Applications support IPv6

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SRv6: Industry Standards & Evolution

Ready to consume

TI-LFA

Prefix Summarization

Flexible Algorithm

VPN services

SR Policy

OAM

SRv6-MPLS Interworking

Multicast: BIERin6, SR-P2MP

SRH Compression: CSID Flavors–NEXT-C-SID (uSID)

Still cooking

SRH Compression: CSID Flavors–NEXT-C-SID & REPLACE-C-SID

Inter-Op/Multiple data-plane (https://datatracker.ietf.org/doc/draft-ietf-spring-srv6-srh-compression/)

Multicast: Replication Segment (https://www.ietf.org/archive/id/draft-ietf-spring-sr-replication-segment-16.txt)

Analytics & Telemetry: Sensors, Flows

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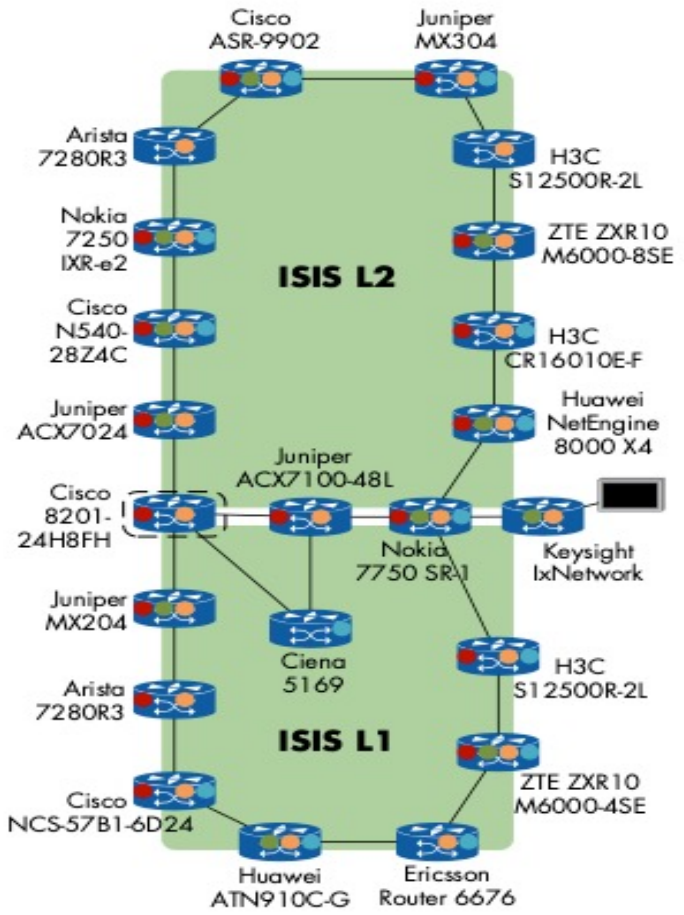
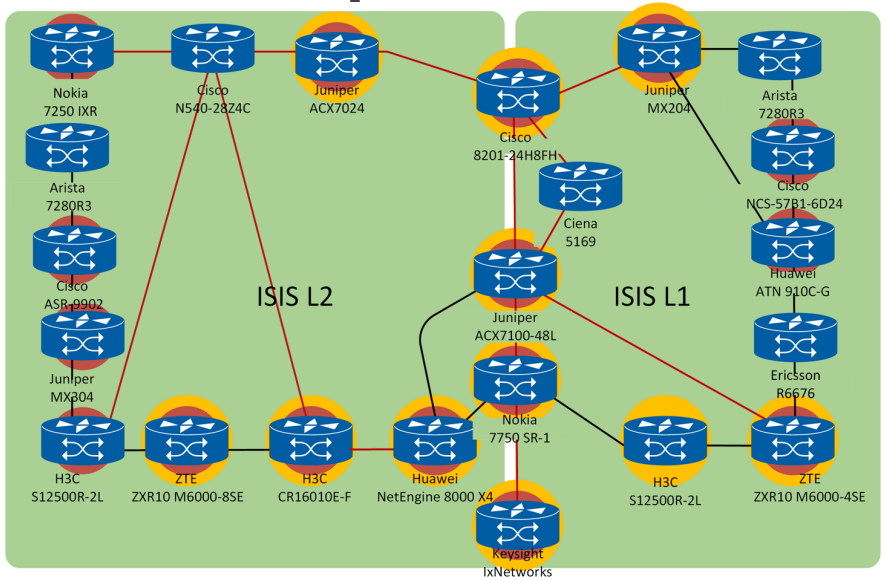
SRv6 Multi-Vendor Interop 2024

Arista	Cisco	Microchip	ZTE
Arrcus	Huawei	Nokia	Ericsson
Calnex	Juniper	Ribbon	
Ciena	Keysight	Spirent	





Juniper Participation

ACX5448-M	MX304
ACX7024	PTX10004
ACX71000-48L	QFX10002-72Q
MX10008	QFX5110-48S
MX204	QFX5120-32C
MPC10E	QFX5120-48Y
Paragon Insights	QFX5210-64C
Paragon Pathfinder	

2024 SRv6 uSID

- SRv6 Micro Sid (uSID):
  - GRT (uDT4, uDT6, uDT46)
  - L3VPN (uDT4, uDT6, uDT46)
  - EVPN E-Line
  - EVPN E-LAN
  - EVPN T5
  - SRv6 locator summarization
  - SRv6 transposition
  - SRv6 TE policies with explicit paths
  - SRv6 Flex-Algo
    - Dynamic latency metric
    - Admin groups
    - FA constraints (max latency, min bandwidth, reverse affinity)

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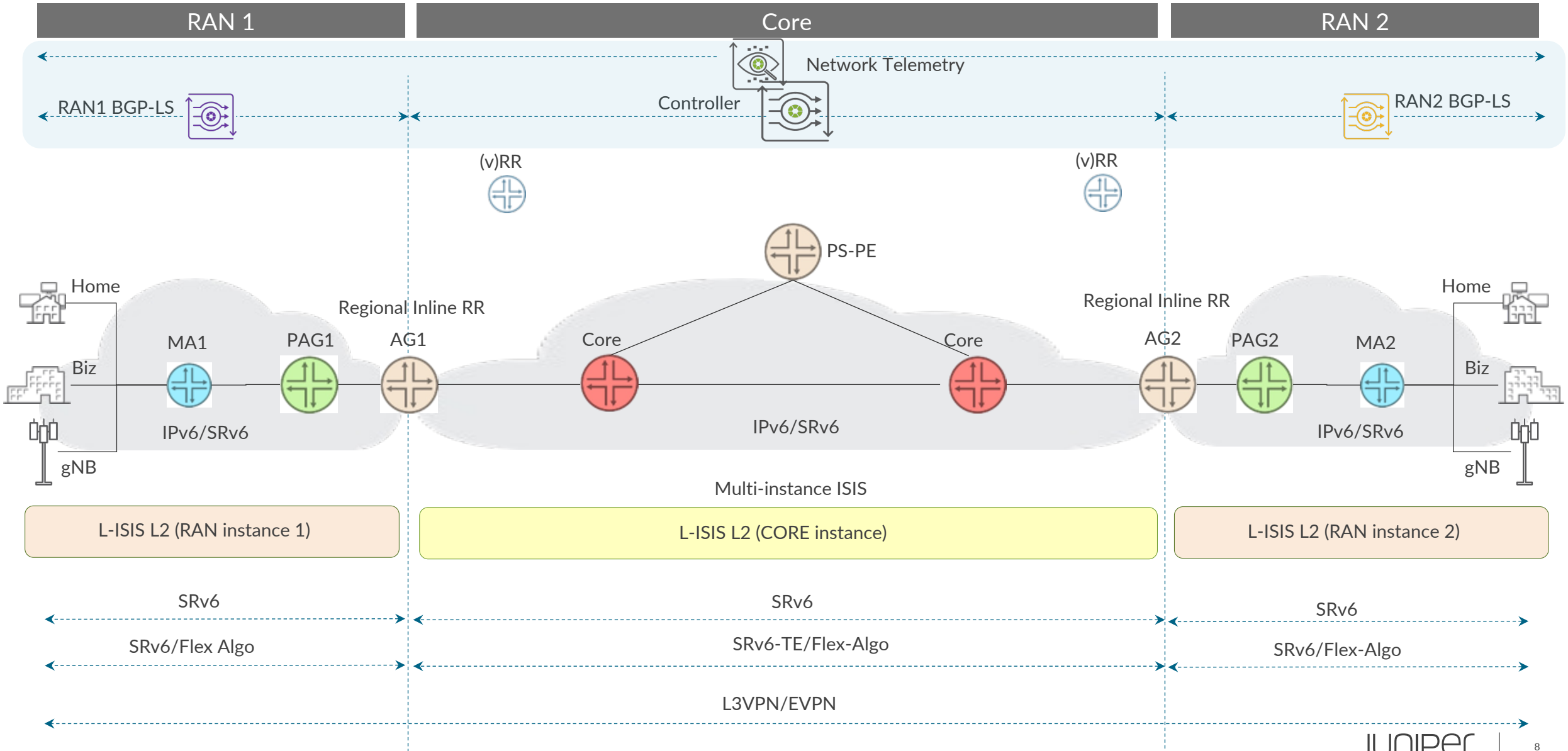
High-level Transport Architecture



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LOCATOR ADDRESSING DESIGN

Locator Design

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IPBB

Locator Block (28bit) for cross-region			Node ID (20bit) for cross-region			
Locator Block (32bit)				Node ID (16bit)		
Prefix	Reserved	Flex Algo	Region	Sub Region	Reserved	NE ID
20 bits	4 bits	4 bits	4 bits	4 bits	4 bits	8 bits
FC00:A	0	0	0	0-F	0-F	00-FF
Fixed	16 instances	16 instances	16 instances	16 instances	16 instances	256 instances

IPRAN

Locator Block (28bit) for cross-region			Node ID (20bit) for cross-region			
Locator Block (32bit)				Node ID (16bit)		
Prefix	Reserved	Flex Algo	Region	PAG Ring	Sub Ring	NE ID
20 bits	4 bits	4 bits	4 bits	8 bits	4 bits	4 bits
FC00:A	0	0	2-F	00-FF	0-F	0-F
Fixed	16 instances	16 instances	16 instances	256 instances	16 instances	16 instances

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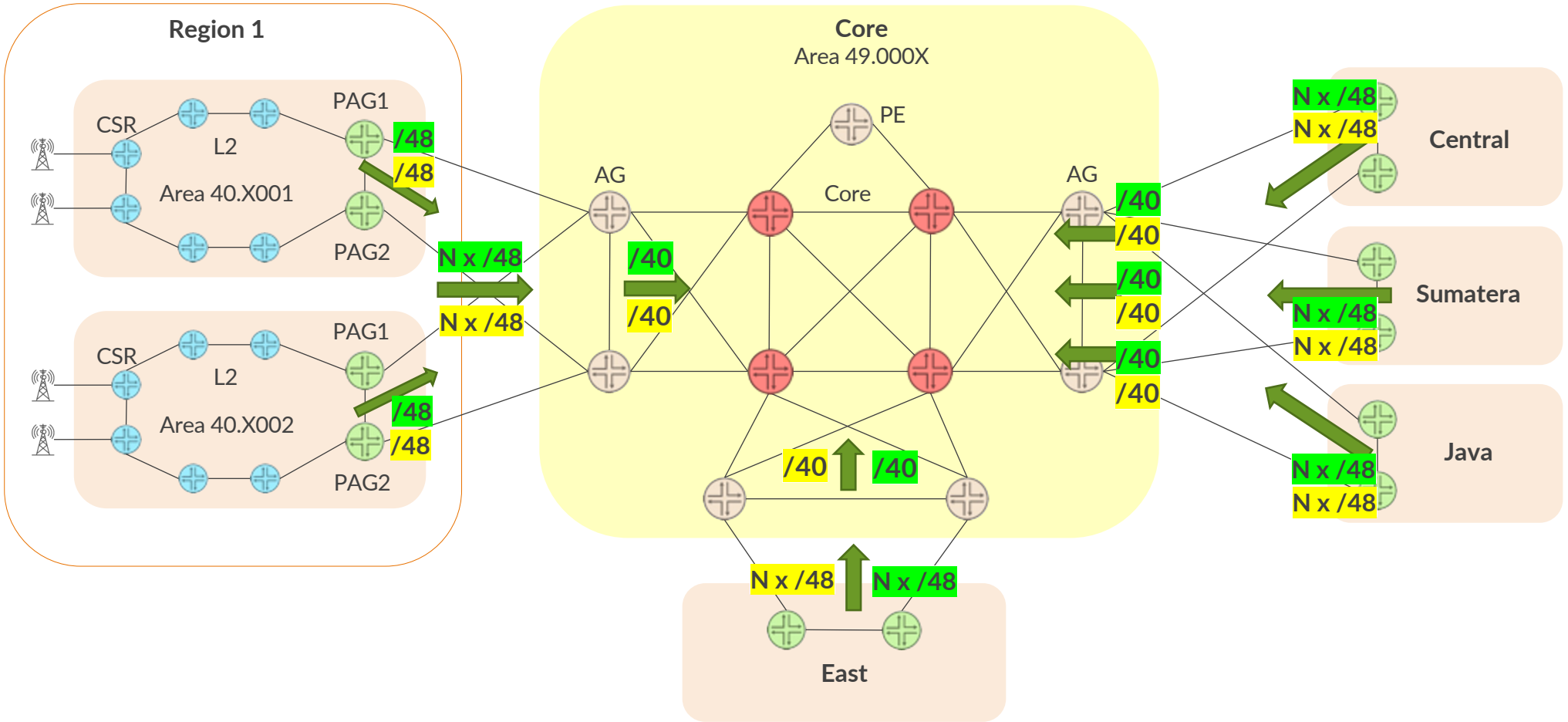
Prefix & Base Locator Summarization



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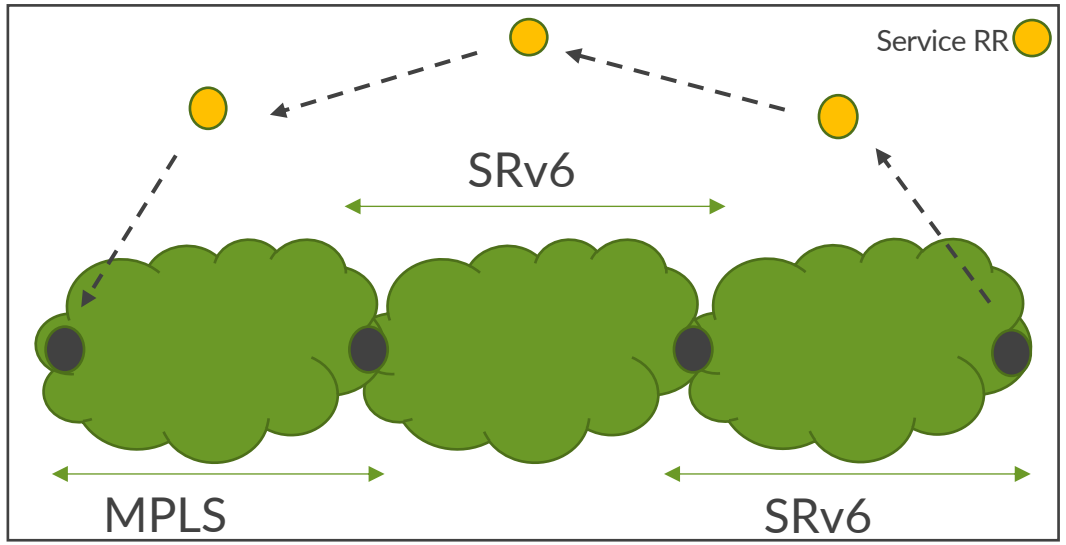
SRv6 <-> MPLS Interworking

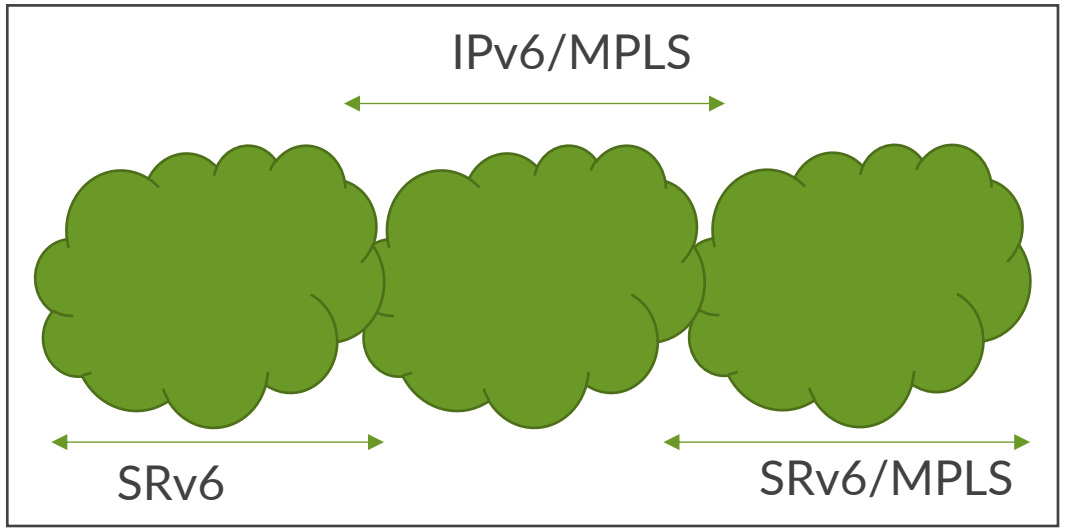
Transport scenarios

- Provide mechanisms for SRv6 domains to talk to SRv6 Domains Over IPv6 Networks
- SRv6 ABRs to advertise SRv6 Aggregate locators across the SRv6 network
- SRv6 domain can service constraints using color/flex-algo/SRv6-TE.

Gateway Interworking scenarios

- Provides service routes interworking at SRv6/MPLS ABR/GW routers
- SRv6 SID to Label mapping for both SRv6 to MPLS and MPLS to SRv6
- Option-AB and Option-B scenarios for SRv6 ←→ SRv6





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CSR-SRv6 <-> PS-PE (4G L3VPN)
SRv6 Services in Production Network

SRv6/MPLS RAN <-> IPBB (SRv6)

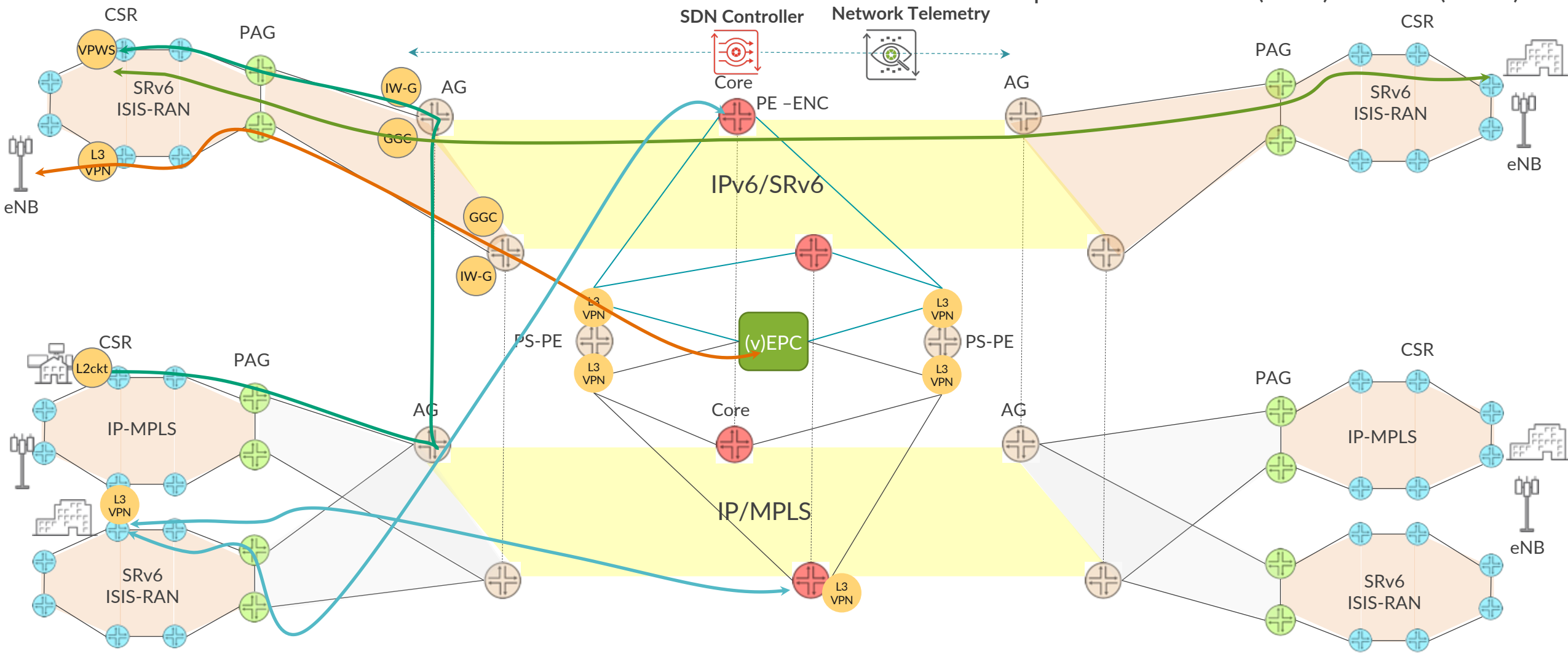
Mobile: eNB (CSR-SRv6) <-> vEPC (PS-PE-MPLS)

Fttx VPWS: CSR (SRv6) <-> PS-PE (MPLS)

Enterprise-EVPN : CSR (SRv6) <-> CSR(SRv6)

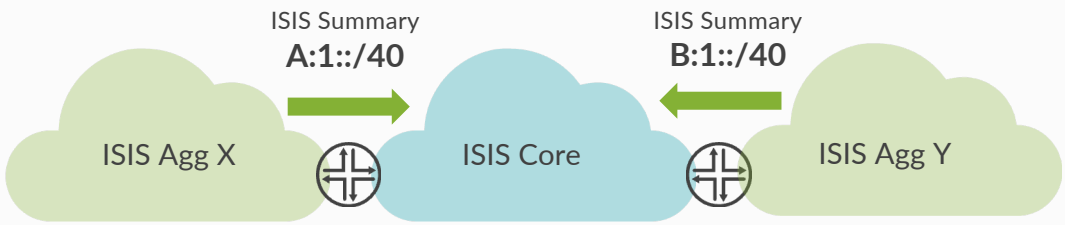
Enterprise-L3VPN : CSR (SRv6) <-> PE-ENC (SRv6)

Enterprise-L3VPN : CSR (SRv6) <-> CSR (MPLS)

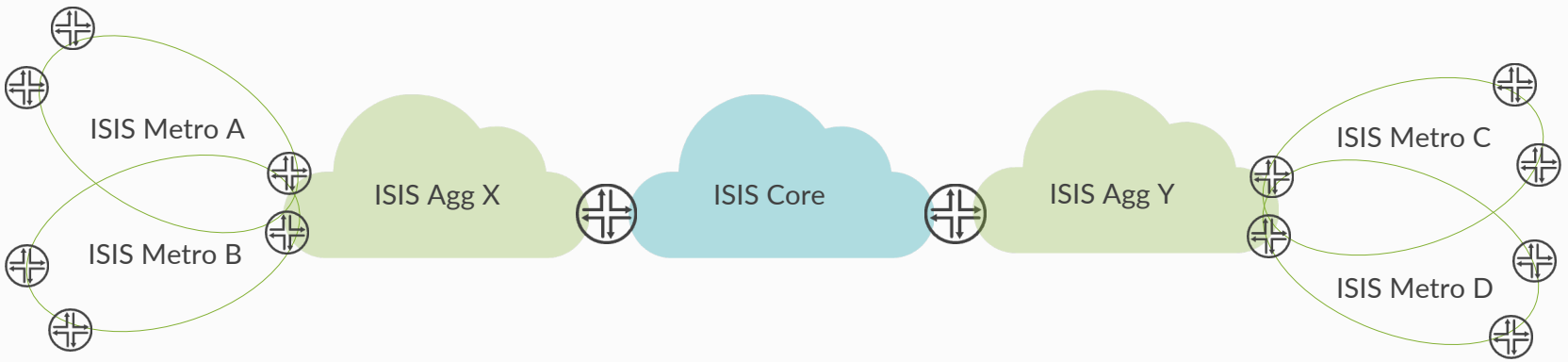


Key Architecture Enablers

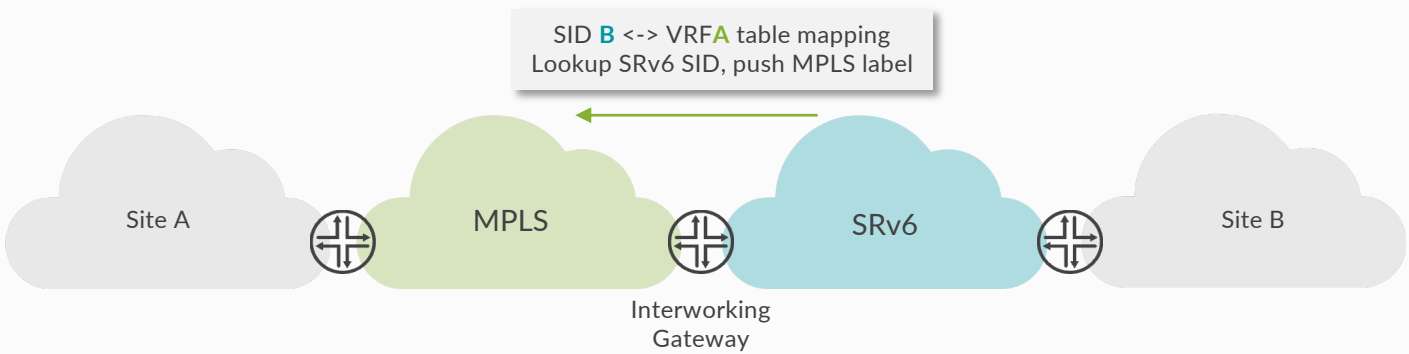
Locator Summarization



Multi-instance ISIS



SRv6-MPLS Interworking



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SRV6 DEPLOYMENT

- Experience & Challenges

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XL Axiata: SRv6 Background and Design Objectives

Challenge

- Multi-vendor, Brown-field fragmented network.
- Most of the equipment lacking SRv6 capability.
- Ongoing 5G rollout plan and deadlines.

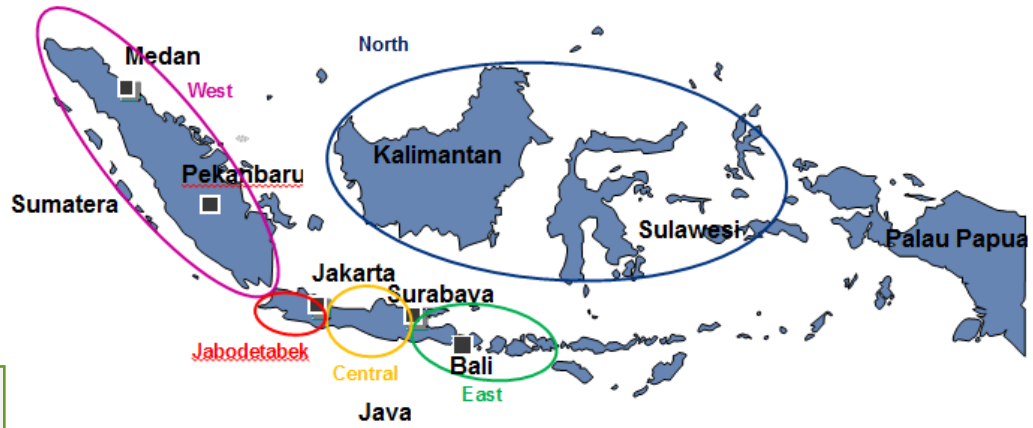
Approach

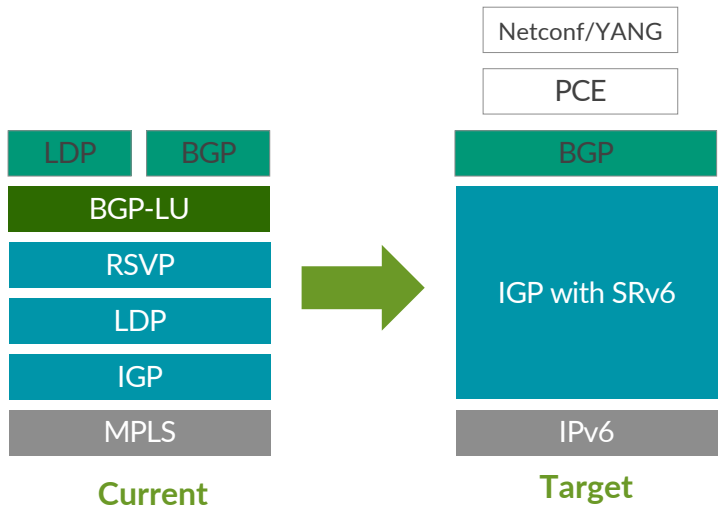
Pragmatic

- Leverage existing install base.Co-existence of old and new platforms for speedy rollout and minimal disruption.
- Dual-stack first, enable SRv6 where possible and interwork with MPLS for service and business continuity.
- Focus on the network transformation first, SDN later.

Outcomes

- Architecture simplification using SRv6.
- SRv6 scales the network for 5G expansion.
- Future use-cases: Network slicing, Edge Compute, Dynamic traffic engineering.





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Challenges deploying SRv6 Design in a Multi Vendor Environment….

XL Axiata has deployed Multi-Vendor SRv6 Network across Huawei, Cisco, ZTE & Juniper platforms

Lack of SRv6 Skills

Specialized Skills compared to existing MPLS skills

Different terminology vs MPLS

Distinct best practices, different than MPLS

… per vendor

Complex Brownfield Deployment & IOT

Long Design Validation cycle for Multi Vendor IOT

Hybrid Model, MPLS in some sites and SRv6 at new sites

Business Applications across hybrid ecosystem

… prevents optimal service delivery

Inconsistent Ops during Co-existence

Multiple data plane (MPLS & SRv6)

Troubleshooting overhead in Hybrid state

Inconsistent network behavior due to SRv6 Summarization

Siloed visibility in some cases due to absence of consistent SRv6 OAM

… hinder IT operations performance

Platform Limitations Capabilities

Different capabilities across different vendors (SRv6 compression)

Some vendors were not IETF compliant

Software Roadmap variations across different platforms & vendors

… limits problem-solving

Controlling costs

Extended deployment schedule due to feature gaps

Multiple cost reports per vendor/region

TTM for new products constrained due to SRv6 Migration

Additional Opex

… leads to unpredictable costs

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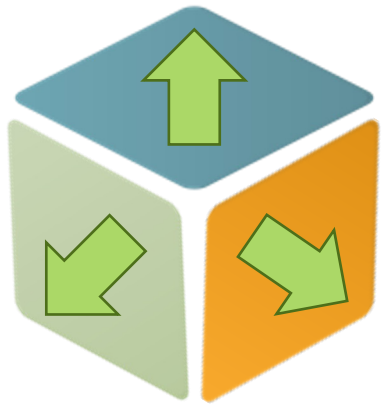
Multi Vendor SRv6 IOT

Key *"considerations"* for a successful multi-vendor SRv6 deployment



3 "P" Approach

1

Locator Addressing

- Plan Addressing based on GUA or ULA – Design Pre-requisite
  - IPv6 Infrastructure (GUA) and SRv6 Locator (ULA) as a potential option
- SRv6 Locator Block Length – Plan ahead based on the vendor mix
  - Different Vendors might have a preference based on their compression solution
  - Next-C-SID prefers 16, 32 and **48**
  - Replace-C-SID prefers 48, 56, **64**, 72 and 80

2

Services

- Global Internet, L3VPN and EVPN services over SRv6 transport (SRv6 BGP based Overlay services RFC9252)
  - SRv6 SID Structure sub-sub-TLV
    - Plan, verify and validate the use of sub-sub TLV for L3 & L2 services
- SRv6 OAM – Plan for Standardized OAM toolkit which'll work across vendors

3

Interworking with MPLS

- Plan for Seamless Interworking with existing MPLS Transport & Services
  - Co-Existence with MPLS or the use of single IPv6 data plane
  - SRv6 <> MPLS L3VPN Interworking Gateway functionality
  - SRv6 <> MPLS Interdomain Solution

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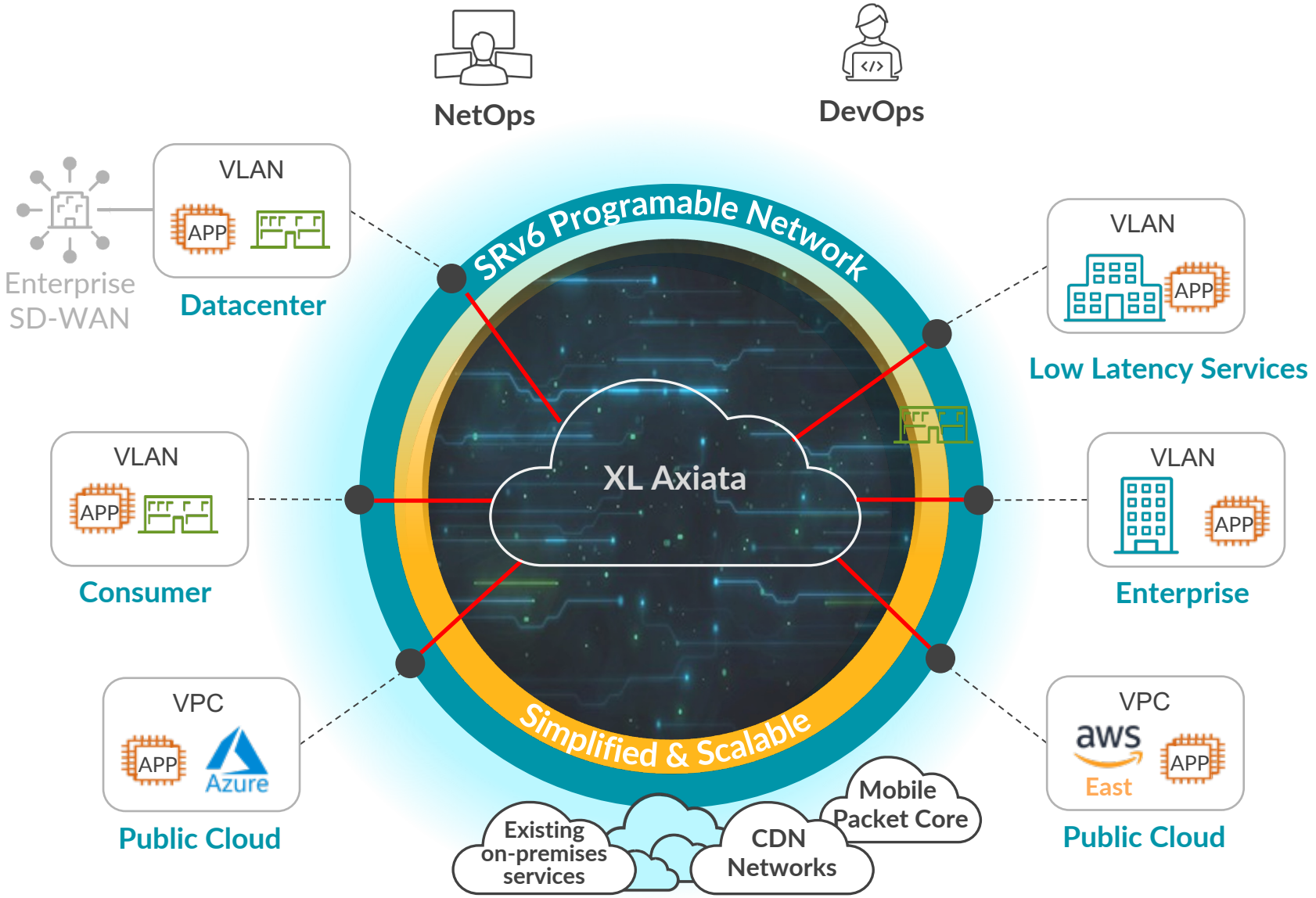
XL Axiata SRv6 Network....*the good* after the 3-year journey

- Massive Scale & Flexibility
- Cost Optimization
- Programmability Close Loop Automation
- Any Service Anywhere



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FUTURE GOALS

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SRv6 Deployment Goals 2024

SRV6 Deployment	• SRv6 Compression – NEXT-CSID based Services (DT46/DX2/DT2) • SRv6 <> MPLS Interworking Option B • Flex-Algo Deployment with Delay "Metric" using Twamp-Lite ***(Multi-Vendor-Juniper, Cisco, ZTE & Huawei)***
Automated Service Prioritization	• Ensure customer SLAs are delivered • Link Delay Measurement and Delay Based Routing • Granular Service Prioritization.
Smarter Bandwidth Utilization	• Utilize inter-region links more efficiently • Allow all traffic to use optimal paths; re-grade based on Link utilization and congestion. • Intelligently congest inter-region links and maintain SLAs.
Services	• END.DT46 – L3VPN, Global • END.DX2 – EVPN-VPWS • ***END. DT2 – EVPN-ELAN (Multi-Vendor-Juniper, Cisco, ZTE & Huawei)***

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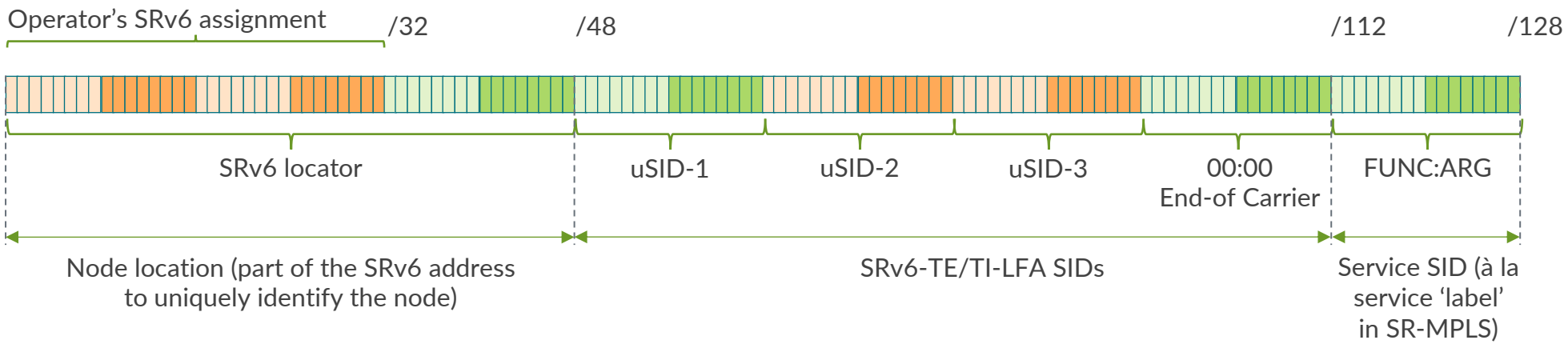
NEXT-CSID - uSID

- SRH requirement for TI-LFA / TE will be minimized (potentially even removed for typical TI-LFA applications, or less advanced TE) with uSID (NEXT-CSID), where multiple SIDs can be embedded in single 128-bit address field. https://www.ietf.org/archive/id/draft-ietf-spring-srv6-srh-compression-13.txt
  - Example: /32 allocated to the operator, 100k nodes, 5 slices (flex-algo), 5 Regions
    - Per region SRv6 locators → 16 bits (2^{16} = 65,536) from address space enough for 100k locators → SRv6 locator is /48 (32+16)
    - 128 – 48 = 80 bits left for uSID and FUNC:ARG
    - 16-bit long uSID → 16 bits left for FUNC:ARG



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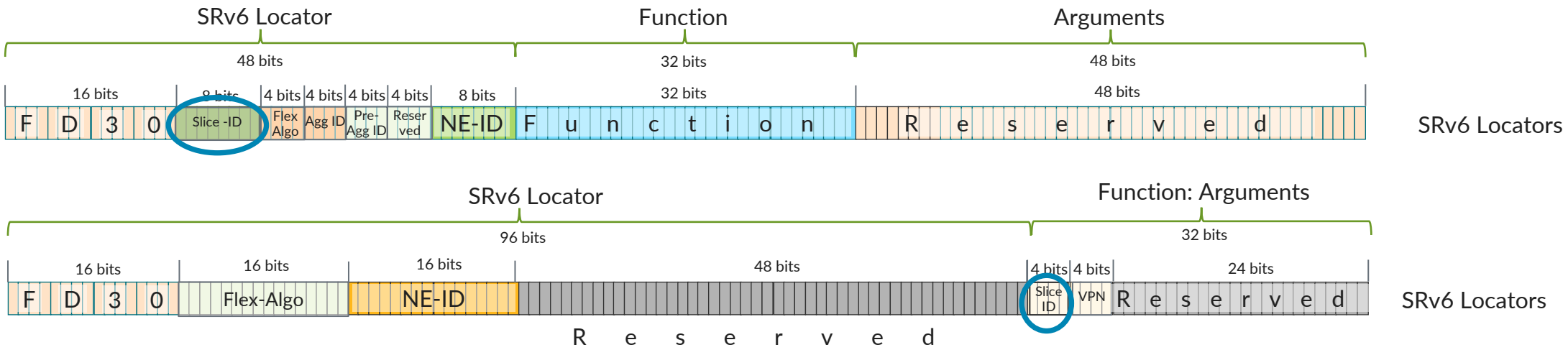
SRv6 Network Slicing

Slice ID in the SID

- SRv6 Locator, or SRv6 SID (END.DT4, END.DT6, END.DT46) can have dedicated space (few bits) to carry Slice ID (see below some examples)
- Transit router classifies packets to appropriate slice based on this slice ID and puts the packet to the slice on the link, where each slice on the link has capacity guarantees.



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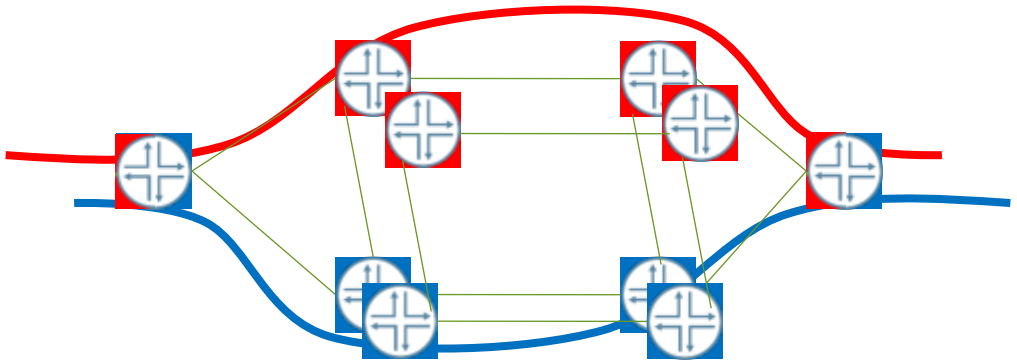
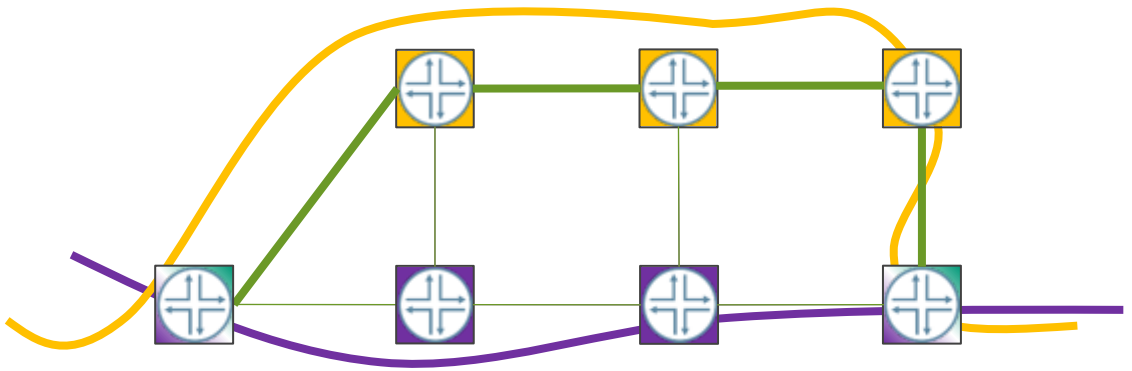
Flex-Algo: Low Latency / Service Diversity

- Separate Routing Planes with Geographical or Service Diversity Constrains



- Low Latency using Link Delay Metric (ISIS Twamp-Lite)



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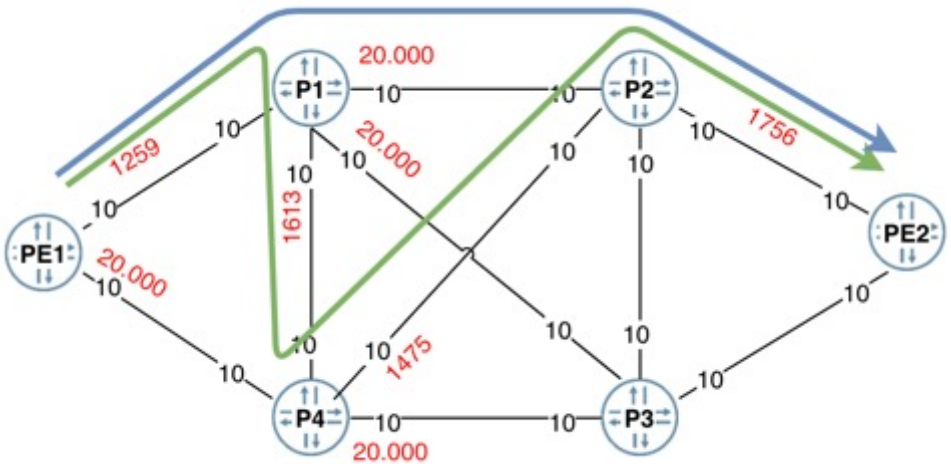
Using Flex-Algo with Delay-Metric in Action

- PE1 chooses least **metric** blue path to PE2 by default
- PE1 chooses least **delay-metric** green path to PE2 in Algo 129
- Default metric is 10
- Some links use static delay-metric of 20ms
- Other links use TWAMP light dynamic delay-metric calculation
- All devices participate in SRv6 Algo 129



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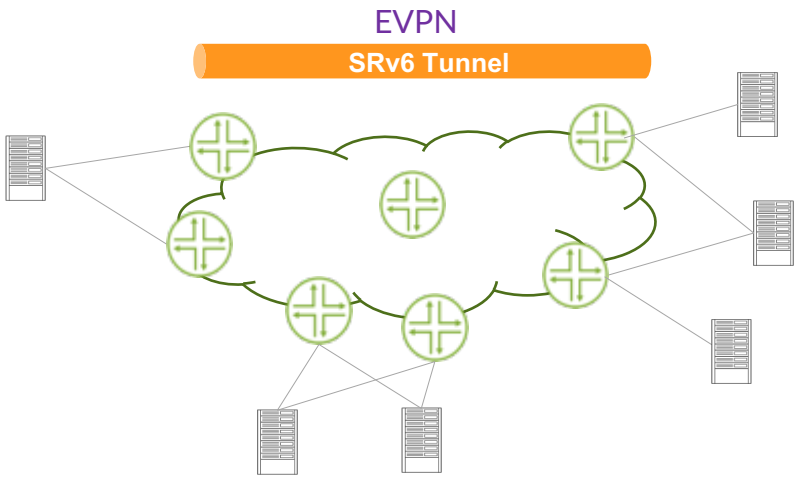
EVPN over SRv6 with SRv6 SRH / uSID

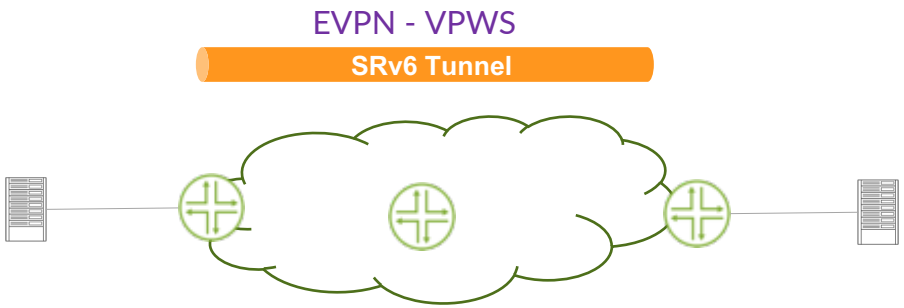
EVPN



EVPN service covers:

End.DT4/DT6/DT46 – Layer 3 table lookup
End.DX2U - Layer 2 unicast cast
End.DT2M – Layer 2 flooding

EVPN VPWS



EVPN VPWS service covers:

End.DX2 - Layer 2 cross connect

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Summary

1 SRv6 Evolution

Standards are evolving fast

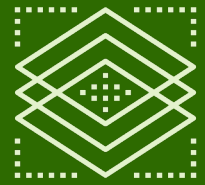
Join the standardization efforts

2 Deployment experience

Inter-op testing is key

Plan, Test and Validate

3 Future Use-case



NW Slicing, Edge DC and more …

Bring Your Own Use-case

THANK YOU

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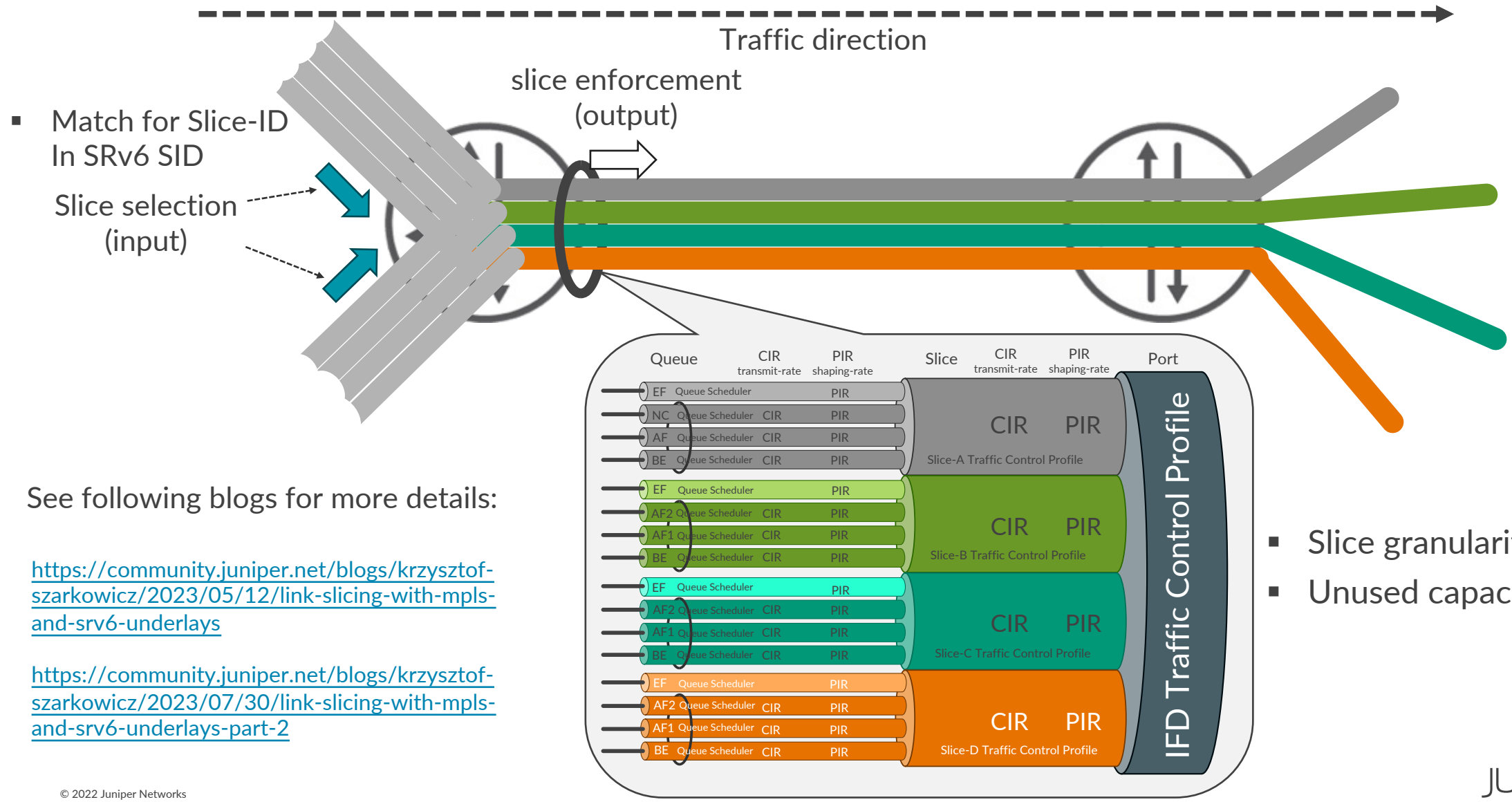
Guaranteed Link – Network Slicing

Link Channelization/Partitioning with SLA



- Slice granularity
- Unused capacity sharing

See following blogs for more details:

https://community.juniper.net/blogs/krzysztof-szarkowicz/2023/05/12/link-slicing-with-mpls-and-srv6-underlays

https://community.juniper.net/blogs/krzysztof-szarkowicz/2023/07/30/link-slicing-with-mpls-and-srv6-underlays-part-2

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