The bridge to possible

Simplify Your Network & Services Using the Flexibility & Programmability of SRv6

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Why prioritize IPv6 again?

IPv4 address space is exhausted.
IPv6 is the only viable long-term alternative to IPv4.
IPv4-to-IPv6 transition solutions are now readily available & widely deployed.

IPv6 adoption is increasing rapidly in all segments.

End-user devices, service provider networks & services are all adopting IPv6 in various degrees.

IPv6 is designed for advanced innovation.

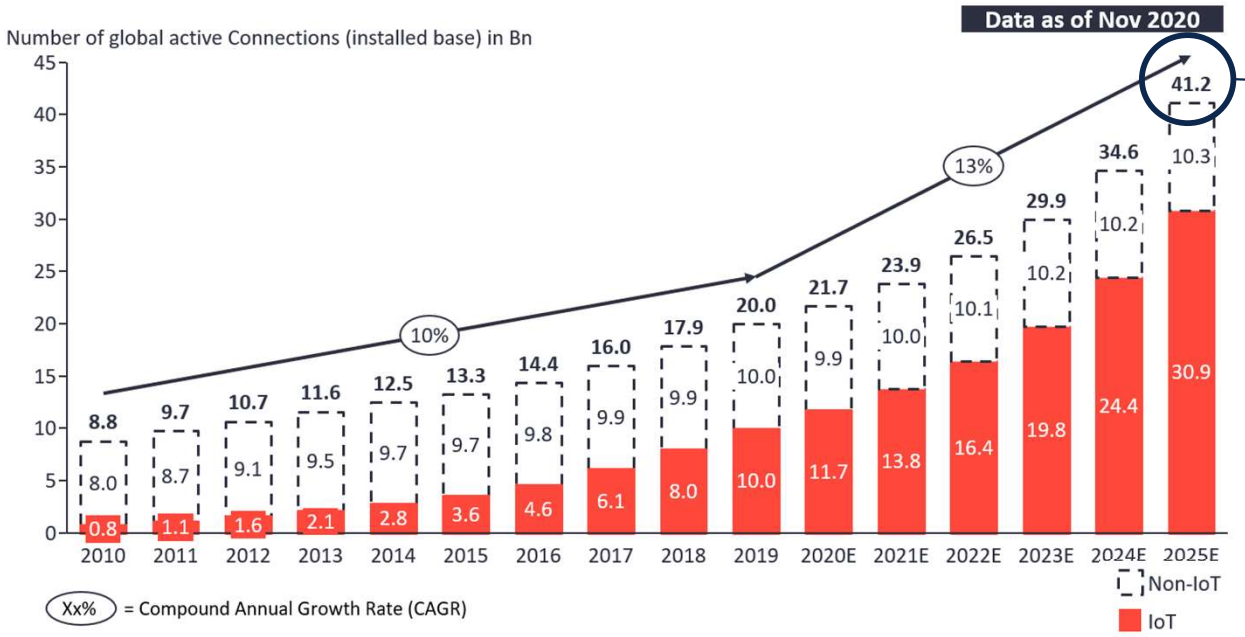
IPv6 supports extensions for new applications in the future. **E.g., SRv6**
IoT, 5G, Cloud Computing & newer technologies are all fueled by innovations in IPv6.

Network requirements are becoming complex

Network requirements in 2022 & beyond

Total number of device connections (incl. Non-IoT)

20.0Bn in 2019– expected to grow 13% to 41.2Bn in 2025



>40 Billion connections to the network from IoT & devices

IoT, 5G & cloud need **IPv6**'s address space.

Note: Non-IoT includes all mobile phones, tablets, PCs, laptops, and fixed line phones. IoT includes all consumer and B2B devices connected – see IoT break-down for further details

Source(s): IoT Analytics - Cellular IoT & LPWA Connectivity Market Tracker 2010-25

Source

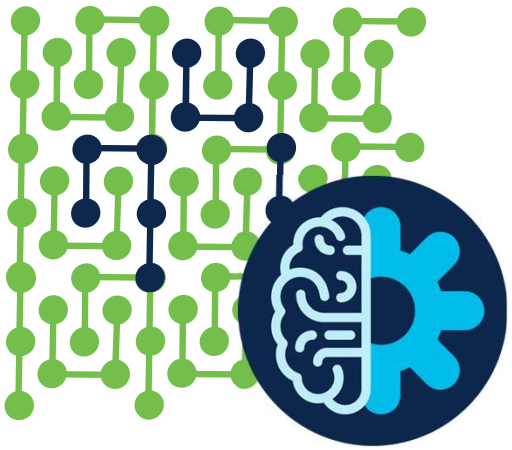
Network requirements in 2022 & beyond

Network-Application Interaction

GUARANTEED SLA

IPv6 protocol innovation **SRv6** combined with network slicing offer service creation speed & simple SLA assurance.

Network requirements in 2022 & beyond



Programmable networks & service orchestration

Extensibility of IPv6 allows new features to be added in open, programmable ways without changing existing device hardware.

Simplifying while scaling up

Protocol Simplification
IPv6 IGP routing [No LDP, RSVP-TE, BGP-LU]

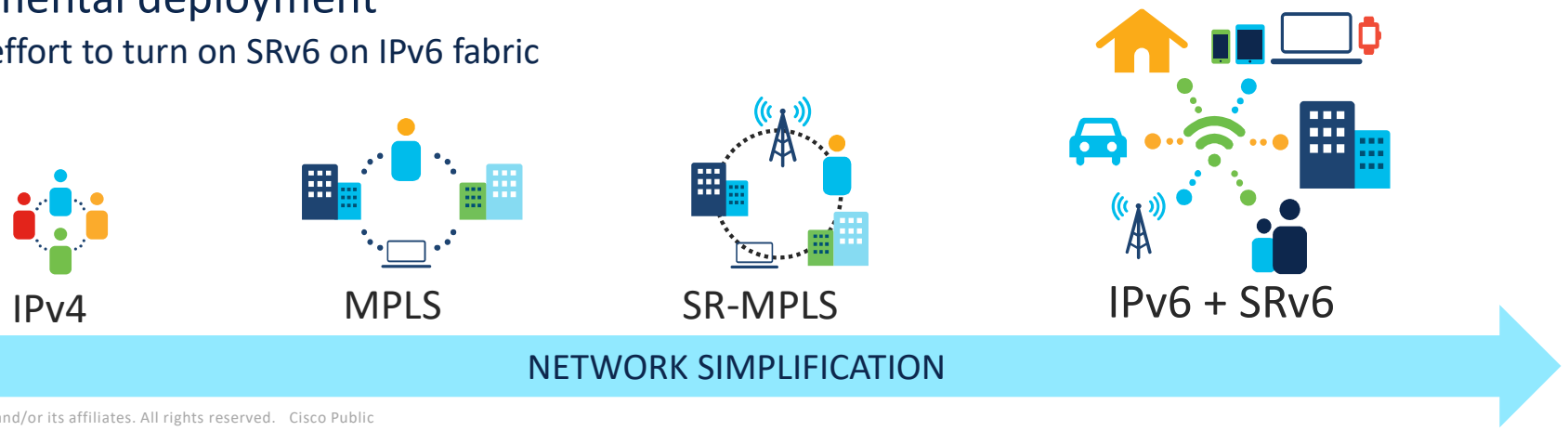
Stateless Fast Reroute
IGP-based FRR with no RSVP-TE state management

Engineered for SDN
NETCONF/YANG, SR-PCE, Model-driven Telemetry

Incremental deployment
Trivial effort to turn on SRv6 on IPv6 fabric

Simplify for higher scale
Multi-domain scalability
Simplified with stateless core

Hardware-friendly operation
Leverages mature hardware capabilities
Avoids extra lookup in indexed tables



ASR 9000 is optimized for IPv6

ASR 9000 accelerates IPv6 innovation

ASR 9000 supports IPv6 & SRv6 in hardware for superior forwarding performance.

IOS XR supports hardened IPv6, including Cisco innovation SRv6.

5th Generation ASR 9000 silicon is hardware optimized for IPv6.

New compact chassis offer low-power, high-throughput 400G options.

5th Generation ASR 9000 platforms are capable of forwarding IPv6 at 400G line rate!

IPv6 features & performance on ASR 9000

IPv6 Forwarding

- >300 Mpps per NPU
- 400 Gbps line rate throughput capacity
- 6 Million IPv6 FIB table
- 16K VRF

Dual-stack features

6PE
– IPv6 global routing across MPLS core

6VPE
– IPv6 L3VPN across MPLS core

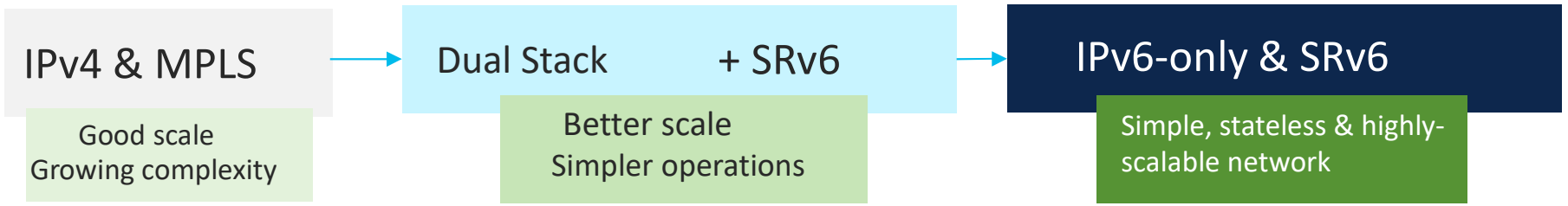
Native IPv6 features

OSPFv3
ISIS
MP-BGP IPv6
IPv6 multicast

SRv6 Services

SRv6 L2VPN
SRv6 L3VPN

Path to simplifying networks with IPv6 & SRv6



TRANSITION

Build IPv6 fabric & upgrade to SRv6 services on-demand

- IPv4 & IPv6 protocols run in parallel
- Build IPv6 fabric on P/PE routers
- Incremental upgrade to SRv6 on PEs for L2/L3VPN services

LONG-TERM

End-to-end IPv6 with on-demand SRv6 services

- IPv6-everywhere, SRv6 on-demand
- Programmable SRv6 network over stateless IPv6 fabric

SRv6 Simplified IPv6 Fabric

SRv6 Over IPv6 Fabric

DATA PLANE

- **Native IPv6 (Brown field migration)**
- **SRv6 (SRv6 extension header)**

CONTROL PLANE

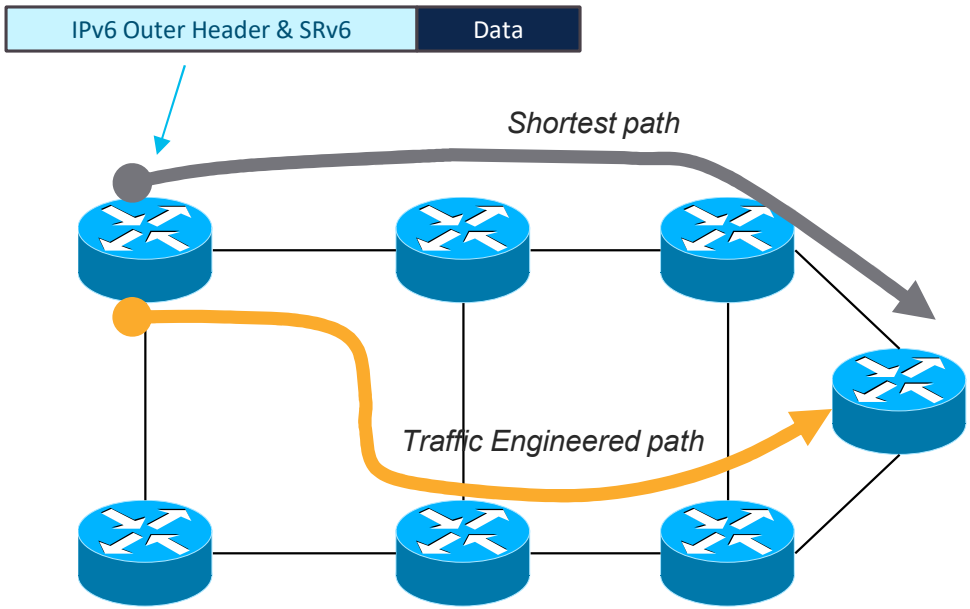
- **Routing protocols with extensions (IS-IS, OSPF, BGP)**
- **SDN controller (BGP, PCEP, NETCONF/YANG)**

PATH OPTIONS

- **Dynamic (Optimized CSPF computation)**
- **Explicit (expressed in the packet)**

SRv6 Function and Service

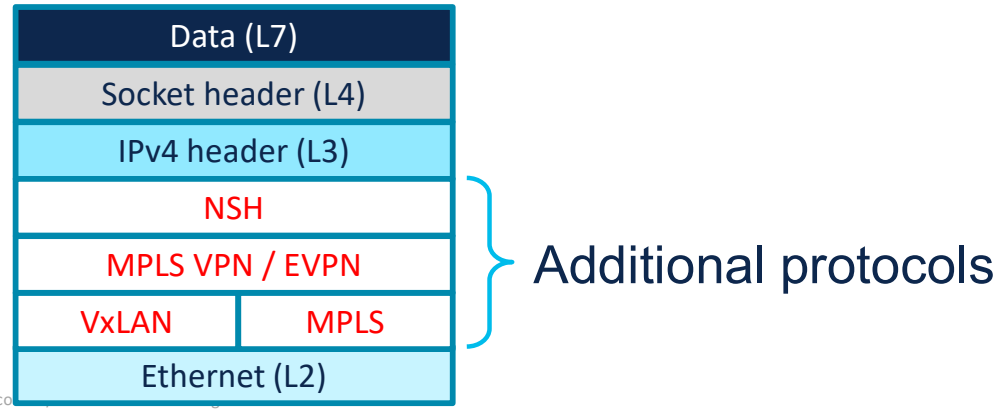
- Over stateless IPv6 fabric
- Path expressed in the packet



IPv4 Network Service Buildup

Network Functions	IPv4
Reachability	IPv4 Header
Engineered Load Balancing	MPLS Entropy Label, VxLAN UDP
VPN	MPLS VPN, VxLAN, 6PE/VPE
Traffic Engineering	RSVP-TE, SR-TE MPLS
Source Routing	SR-TE MPLS
Service Chaining	NSH

IPv4 Address space 32-bit
No optional header to support
- VPN
- Traffic Engineering
- Service Chaining
- Engineered Flow optimization
- Source-Routing

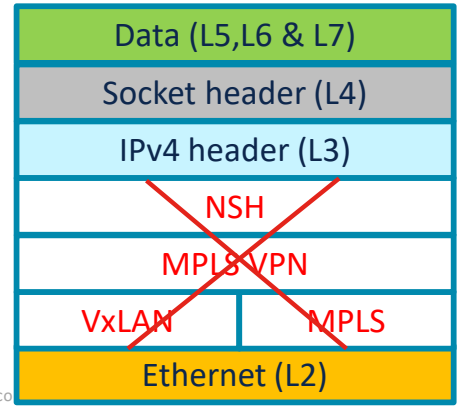


SRv6 Simplified Solution

Network Functions	IPv6
Reachability	IPv6 Header
Engineered Load Balancing	IPv6 Header
VPN	IPv6 Header
Traffic Engineering	IPv6 Header
Source Routing	IPv6 Header
Service Chaining	IPv6 Header

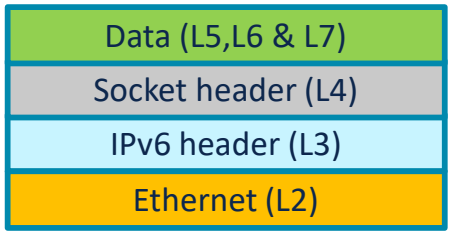
IPv6 Address 128bits
IPv6 Flow Header
- Engineered Flow optimization

SRv6 Header
- VPN
- Traffic Engineering
- Source-Routing
- Service Chaining



SR v6 Segment Routing

Simplicity
(back to OSI model)



SRv6 unleashes IPv6 fabric potential

Leverage IPv6 huge address space for end-to-end services

Hyperscale provided by IPv6 Prefix summarization (not possible in MPLS)

Fast convergence enabled by IPv6/SRv6 for Services

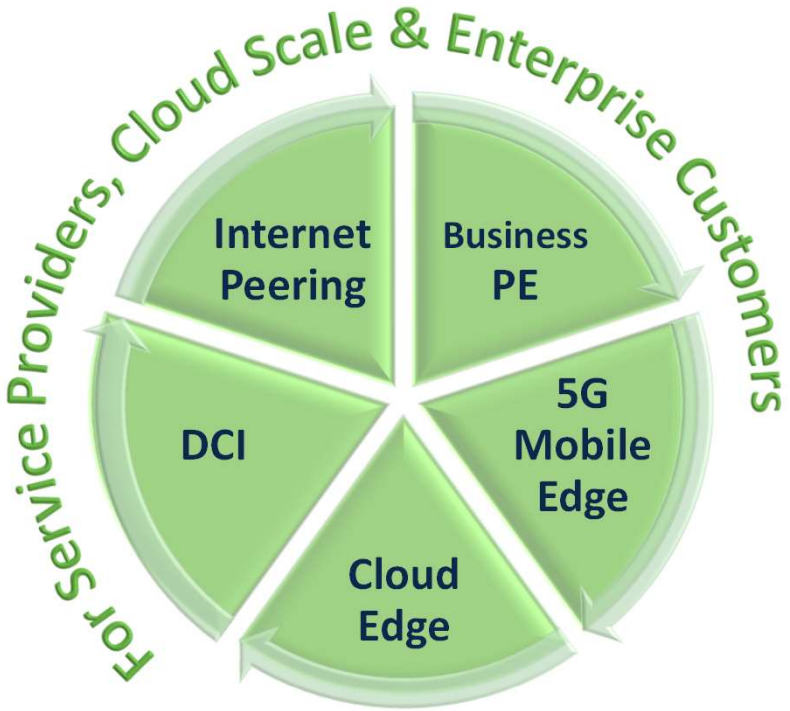
No need for additional MPLS/RSVP headers

Seamless deployment with classic IPv6 (non-SRv6) nodes

SRv6-based services only required on edge nodes

ASR 9000 IPv6 Forwarding optimization

5th Gen line card hashing based IPv6 forwarding



ASR 9000 Market Segments

SRv6 Scale & Efficiency

SRv6 Base-format Network Programming

SRv6 Optimized for HW processing

Integrate underlay & Tenant use-cases

SRv6 provides network intelligence for SW processing

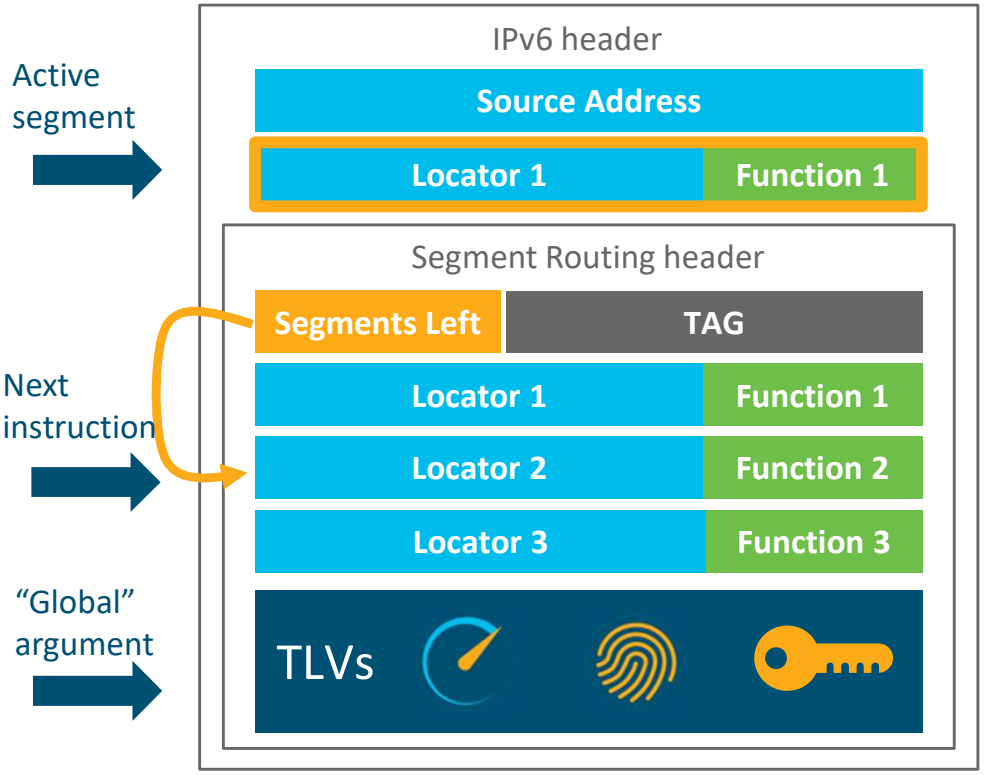
Encoding service as a function of the SID

NFV, Container, Service-Chaining

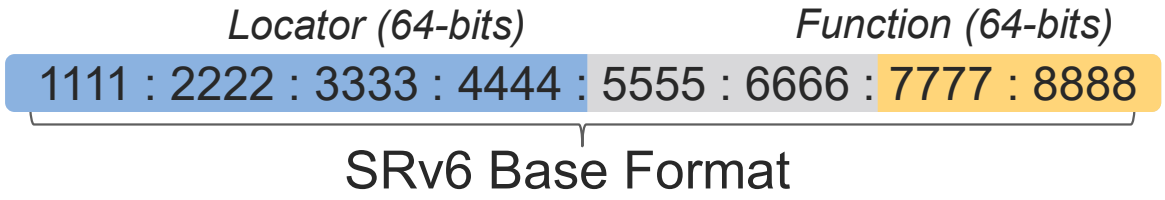
SRv6 allows for huge simplification and enables IPv6 to be self-sufficient

Ultra-scale and end-to-end policy

Stateless network programming

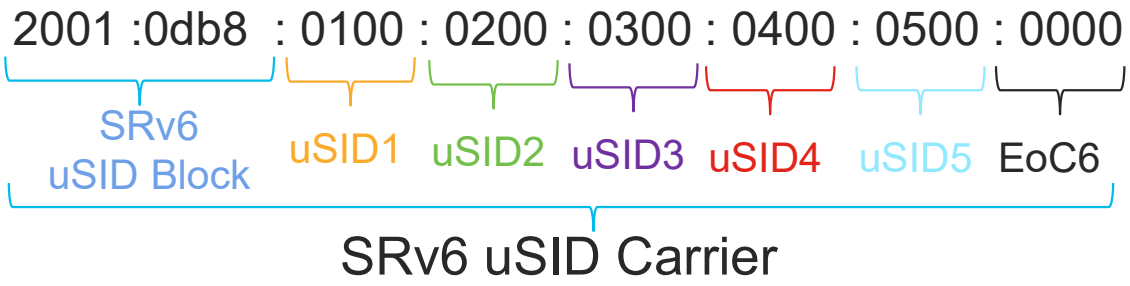


SRv6 Micro-segment vs Base-format



Micro-segment (uSID) F3216 format: (32+16x6=128)

- uSID Block size: 32 bits
- uSID size: 16 bits



SRV6 Encapsulation

```
SA:2001::1
DA:2001:db8:0:4:1:0:0:0
NH:RH

Type:4(SRH)
NH:IPv4|SL:1
Segment List:
[0]: 2001:db8:0:5:45:0:0:0
[1]: 2001:db8:0:4:1:0:0:0
[2]: 2001:db8:0:3:48:0:0:0
[3]: 2001:db8:0:2:1:0:0:0
[4]: 2001:db8:0:1:42:0:0:0

SA:7.5.4.3
DA:11.6.19.71
Port:UDP

UDP Header/Data
```

SRV6 uSID Encapsulation

```
SA:2001::1
DA:2001:db8:100:200:300:400:500::
NH:Ipv4

SA:7.5.4.3
DA:11.6.19.71
Port:UDP

UDP Header/Data
```

SRv6 Micro-segment (uSID) Advantages

SRv6 uSID provides multi-domain ultra-scale & small header for MTU efficiency

Simplified network instructions

Shift & Forward uSID

Dataplane Benefits -

Lowest MTU efficiency (up to 6 uSIDs without SRH)

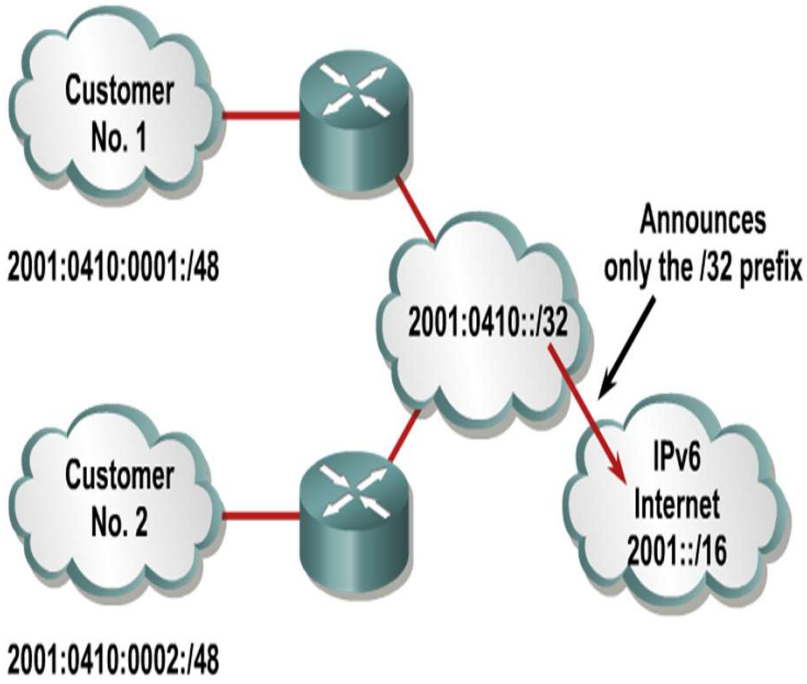
IP summarization and longest match is POWERFUL

Control Plane Benefits -

Scalable of Multi-domain globally unique uSID

No new protocol extensions required

SRv6 uSID richness function provide network services and intelligence



SRv6 Extended the Value of SR-MPLS

New Revenue Services

Real-Time Low Latency Services
Path Disjointness (Network Multi-plane)
Bandwidth Optimization
Point-to-Multipoint with Tree-SID
Inter-domain Egress Peer Engineering (EPE)

Network Availability

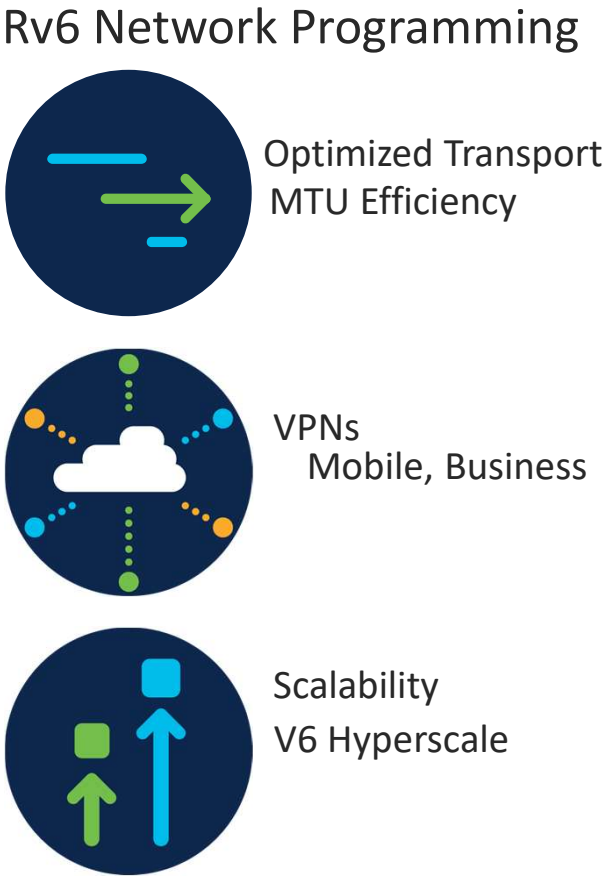
Protect with automatic TI LFA FRR
Stabilize with Microloop avoidance
Operate with Advanced blackhole detection
Monitor with SR Performance Measurement toolkit

Intent-Based Traffic Engineering

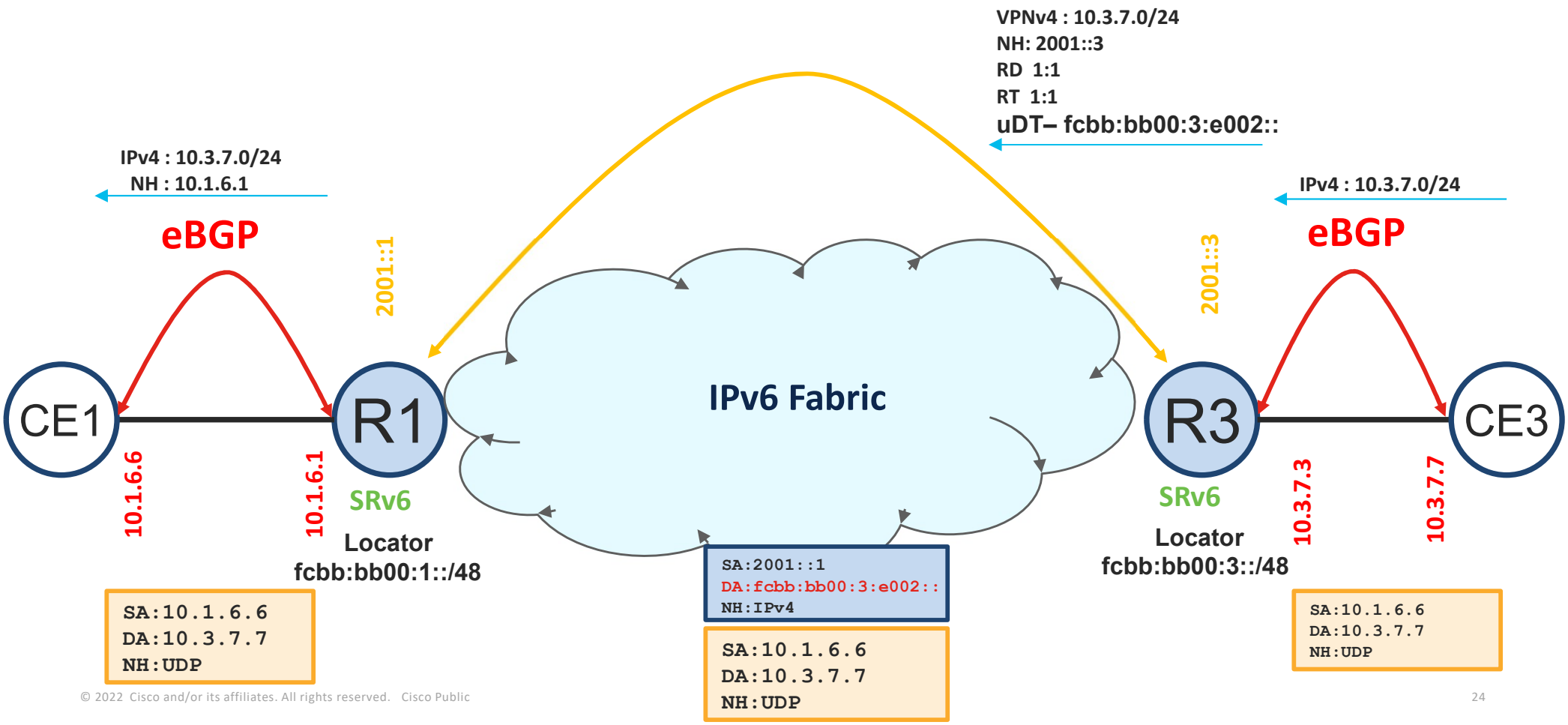
Multi-plane Network Slicing using IGP Flex Algorithms
On-Demand Next-Hop (ODN) + Automated steering (AS)
Multi-Domain intent with SR-PCE
Intent-Based Per-Flow Automated Steering

SRv6 Service Instruction Bounding to uSID

- L2VPN, L3VPN, EPE Peering Optimization
- Network Slicing: Min Cost, Min Delay
- Measurement (Absolute packet loss)
- Traffic Engineering
- Disjoint Path
- TI-LFA / uLoop avoidance
- NFV / Service Chaining

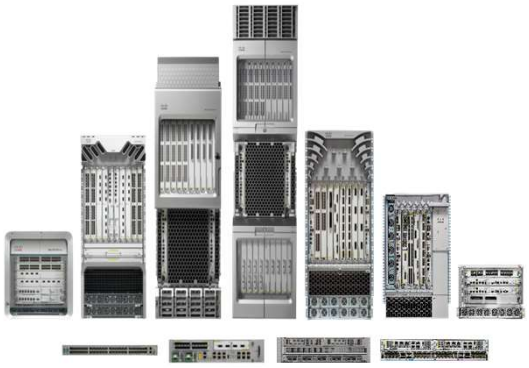


ASR 9000 SRv6 L3VPN Edge Service



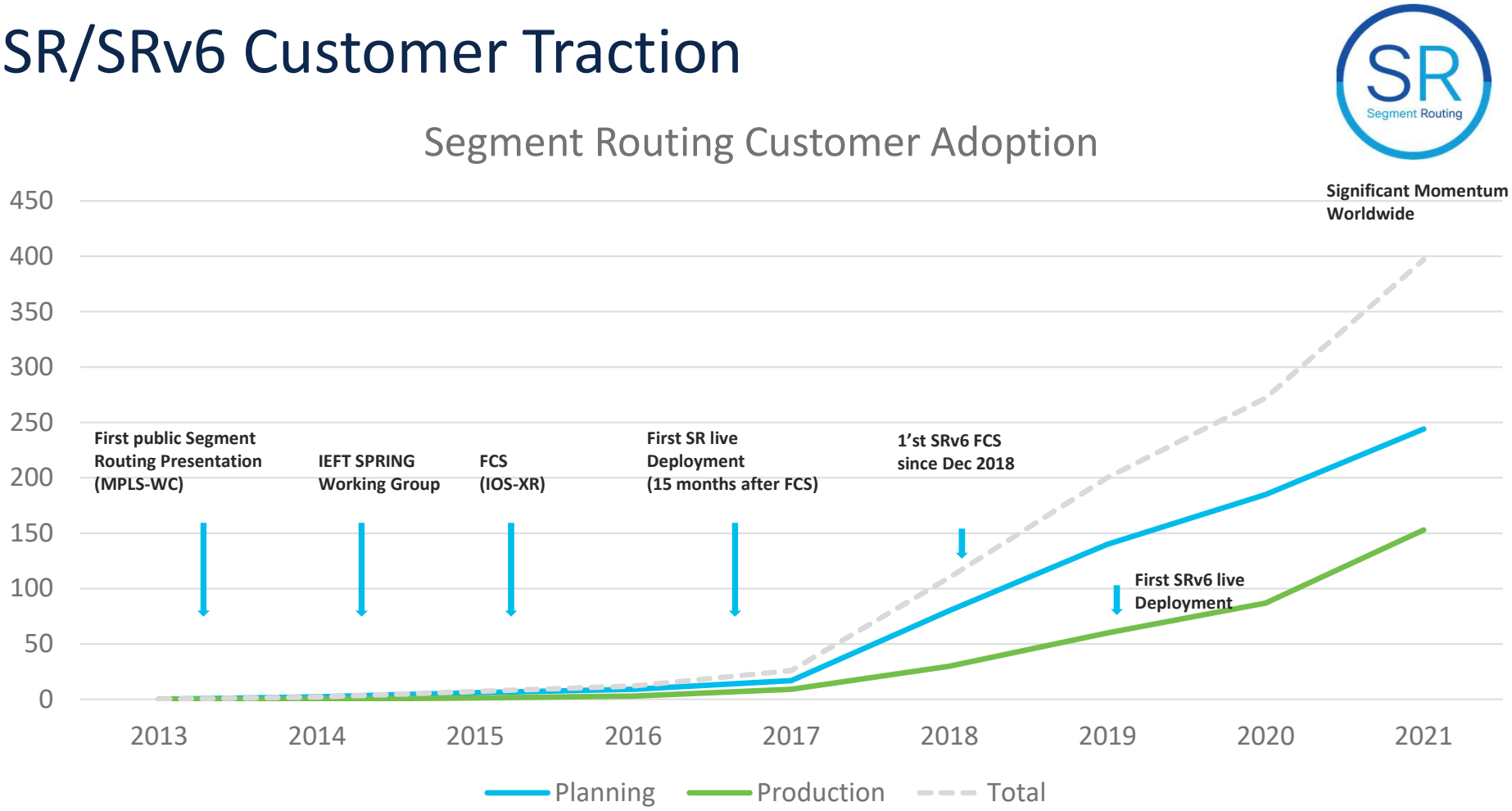
SRv6 on ASR 9000 Summary

- ASR 9000 optimized IPv6/SRv6 forwarding and scale
- The list of segments are divided over multiple SRHs
- SRv6 uSID enabled the Services
  - L2VPN, L3VPN
  - TI-LFA Failure protection
  - Microloop Avoidance
  - Traffic Engineering
  - Inter-domain Policy
  - …



ASR 9000 Family

SR/SRv6 Customer Traction



Cisco Leading on SRv6 Standardization

- **RFC 8402** – Proposed Standard
  - SR-MPLS with MPLS data plane and Label SID's
  - SRv6 with SRH and SRv6 SID's
- **RFC 8754** – Proposed Standard
  - SRv6 Data Plane: SRH and SRv6 SID
- **RFC 8986** – Proposed Standard
  - SRv6 Network Programming
- **RFC Coming Soon**
  - Control Plane (ISIS, BGP-LS)
  - Policy
  - OAM
  - BGP

RFC 8986 — *SRv6 Network Programming*

RFC 8754 — *IPv6 Segment Routing Header*

100M *live subscribers* over SRv6

SIMPLICITY ALWAYS PREVAILS

Cisco SR/SRv6 EANTC Interoperability Test

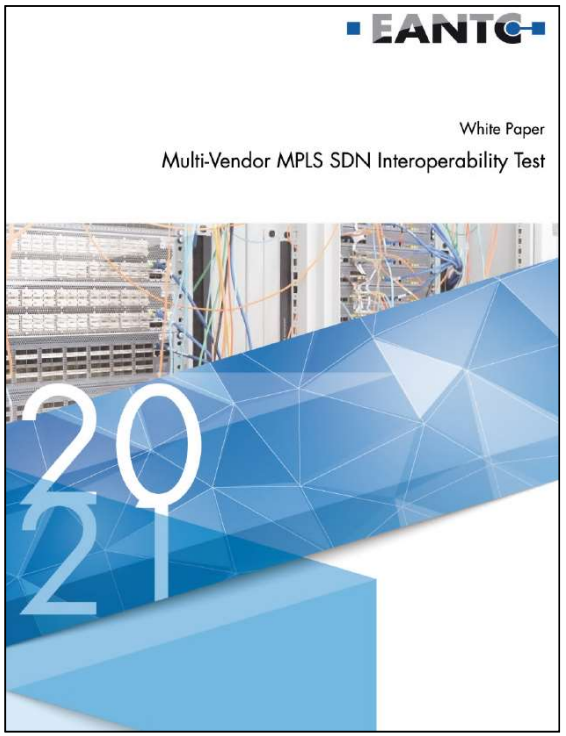
Cisco has a longstanding involvement with EANTC SRv6 interop tests

Observe SRv6 momentum continues across the industry

SRv6 interop tests with participation from all major vendors

Mature and full set of SRv6 implementation compared to vendors

Only vendor that participated with both merchant silicon (NCS 5500) and custom silicon (ASR 9000) platforms



https://eantc.de/showcases/2021/mpls_sdn_interop.html

SoftBank

Cisco Supports SoftBank on First Segment Routing IPv6 Deployment in Prep for 5G

Press Release - https://newsroom.cisco.com/press-release-content?type=webcontent&articleId=1969030

Cisco Supports SoftBank on First Segment Routing IPv6 Deployment in Prep for 5G

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BARCELONA, Spain, Feb. 24, 2019 /PRNewswire/ -- Mobile World Congress -- Cisco announced today its collaboration with SoftBank on the world's first Segment Routing IPv6 (SRv6) deployment.

With the anticipation of the coming 5G era, Cisco has been assisting SoftBank to deploy state-of-the-art Segment Routing IPv6 (SRv6) networks nationwide to build a future network architecture that is extremely scalable, with improved reliability, flexibility and agility, all while helping to reduce CapEx and OpEx.

Current mobile networks are deployed as divided networks, with several layers and complicated control plane processing, which makes it difficult to respond to strict quality requirements like in the case of 5G. Deploying SRv6 in a 5G mobile network simplifies network layers and integrates user plane functions from end-to-end with only IPv6 protocol, making things simple, controllable, and flexible.

Routing IPv6 (SRv6) networks nationwide to build a future network architecture that is extremely scalable, with improved reliability, flexibility and agility, all while helping to reduce CapEx and OpEx.

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"Converging 5G features into the end-to-end IPv6 layer with Segment Routing capabilities, is the key to embodying 5G in a simple, scalable architecture," **said Mr. Junichi Miyakawa, Representative Director & CTO for SoftBank.** "With the depth of portfolio and strong network knowledge that Cisco brings to the table, we knew together we could bring our vision to life."

"SoftBank has kept an intense focus on improving service quality for its customers, which can be challenging when trying to reduce costs," **said Sumeet Arora, Senior Vice President of Service Provider Networks, Cisco.** "With the launch of SRv6 network programming, it is pioneering the next phase of IP networking through automation, and championing

Indosat Ooredoo and Cisco to Bring SRv6 and Converged SDN Transport Network to Indonesia with ASR 9000

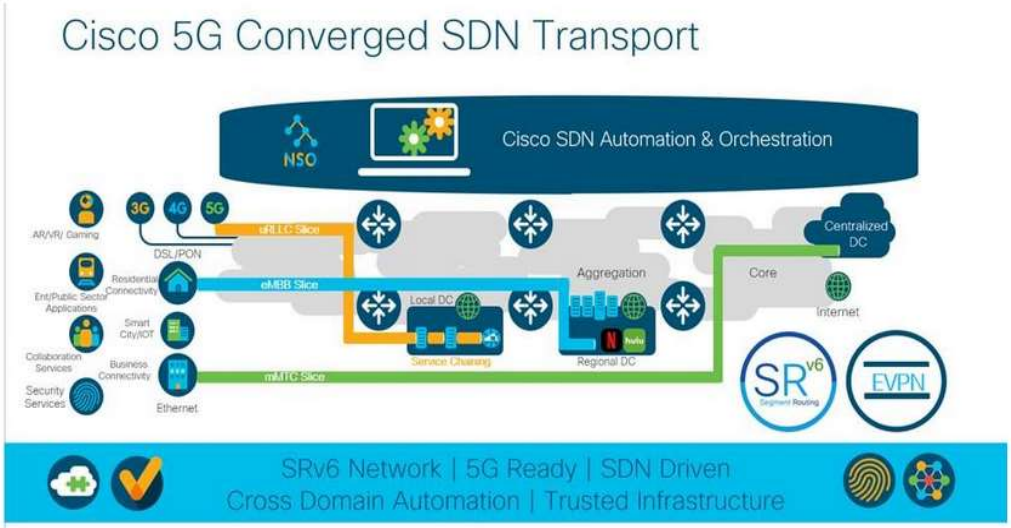
Press Release - https://indosatooredoo.com/en/about-indosat/corporate-profile/press-release/indosat-ooredoo-dan-cisco-menghadirkan-jaringan-transport-dengan-srv6-dan-sdn-terkonvergensi-di-indonesia

Jakarta, 10 November 2020 - Indosat Ooredoo is proud to announce that they are now ready to build a 5G-ready transport network based on new converged Software-defined Networking (SDN) and Segment Routing IPv6 (SRv6) architecture, powered by Cisco. Indosat Ooredoo and Cisco will continue their decades-long partnership to deliver the advanced transport platform in West and Central Java.

The transformation to a converged SDN transport network simplifies the network, optimizes capacity and improves scalability while maintaining a consistent and superior network latency. The SDN transport network is capable of concurrently supporting enterprise, business and consumer broadband as well as fixed and mobile services.

The new network is end-to-end IP enabled with segment routing IPv6, providing a unified, policy- aware network architecture with seamless integration between the transport and the data center domains. Segment routing also provides the network with the most cost-effective end-to-end network slicing and low latency capabilities, which are key 5G requirements.

This critical milestone will completely transform Indosat Ooredoo's transport network architecture, delivering on its promise to build one of the most modern transport networks in Southeast Asia. With this transformation, together with on-going extensive fiber optic deployment, Indosat Ooredoo's transport network will be ready for future demands of high quality and scalable connectivity services with consistent, superior customer experience to both consumers and enterprises.



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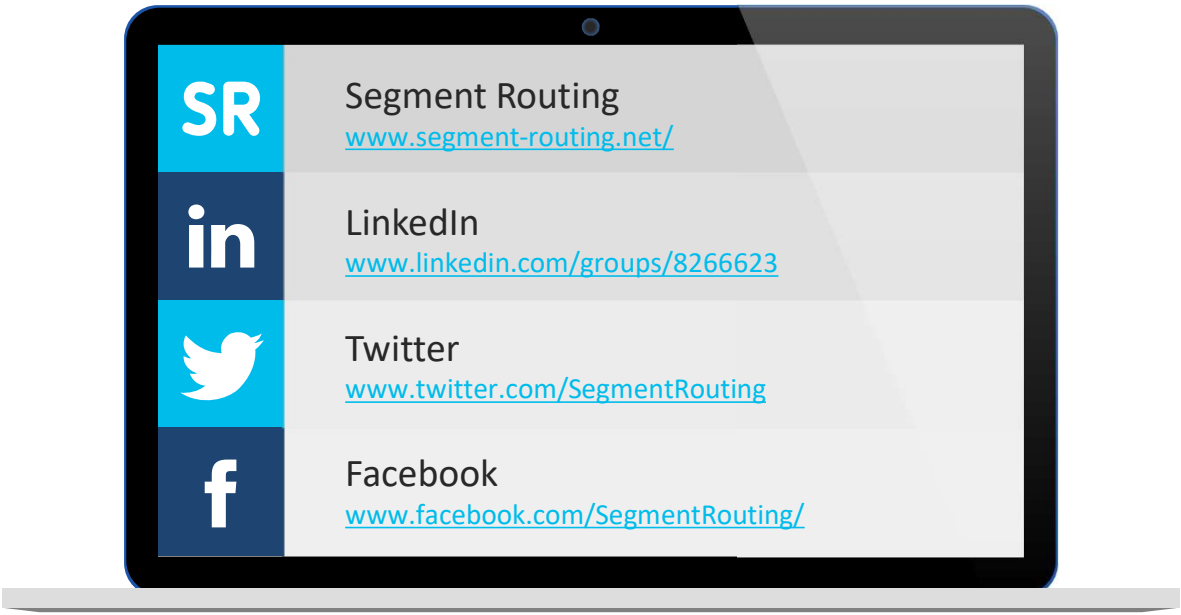

Segment Routing, Part I / II / III Textbooks

Available on Kindle and in paperback

The bridge to possible