Rakuten Demand Matrix using SRv6 traffic accounting @SRv6 deployments

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Agenda

Rakuten SRv6 and 5G Network Slicing

Problem Statement

Novel approach using SRv6 accounting

Demand Matrix and ACP

Summary & Conclusion

SRv6 uSID reference deployment

SRv6 uSID

- SID Space: ULA allocation
- SID Format: F3216
- Blocks Synchronized: Loopback & Locators

Performance Measurement

- SRv6 PM probes: Unidirectional delay
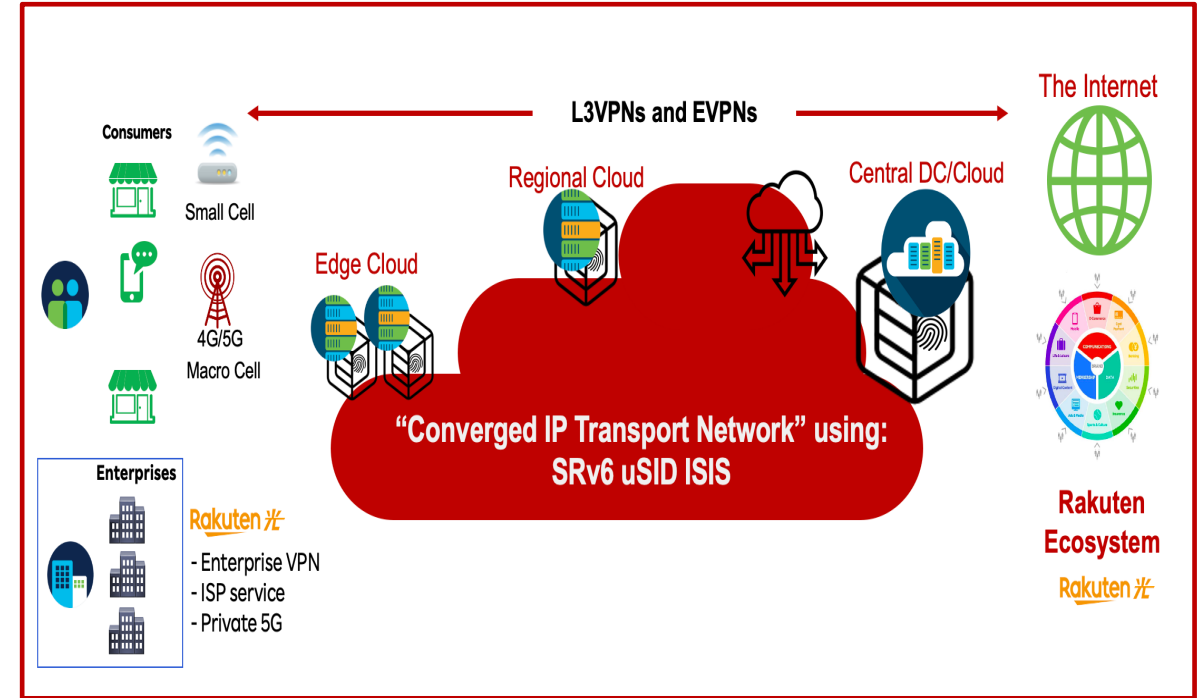- FA reverse Affinity solution: Link reliability

Flexible Algorithms

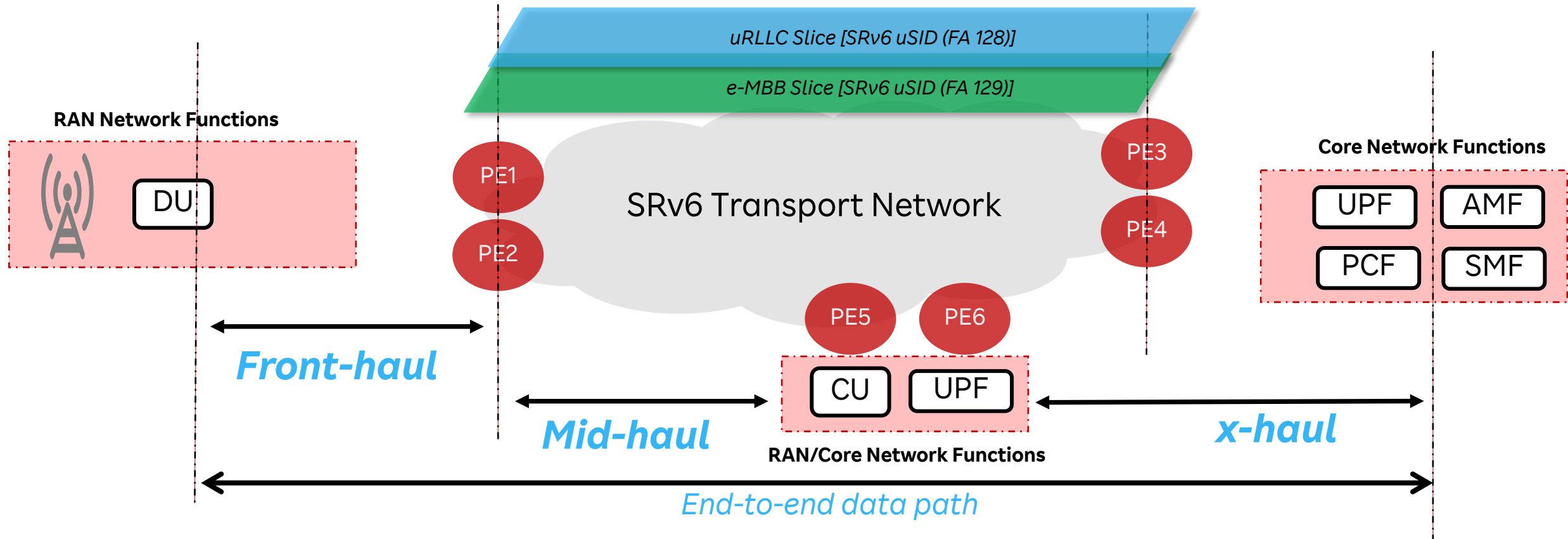- SRv6 uSID ISIS Flex-Algo: Traffic Engineering

TI-LFA & uLoop avoidance

Services

- L3VPN and EVPN-VPWS/ELAN
- SRv6 uSID BGP

Rakuten end-to-end 5G Network Slicing

uRLLC Slice [SRv6 uSID (FA 128)]

e-MBB Slice [SRv6 uSID (FA 129)]

RAN Network Functions

DU

SRv6 Transport Network

PE1

PE2

PE3

PE4

PE5

PE6

Core Network Functions

UPF

AMF

PCF

SMF

CU

UPF

RAN/Core Network Functions

Front-haul

Mid-haul

x-haul

End-to-end data path

End-to-end 5G Slicing Design with transport MBH using SRv6 Domain

– O-RAN compliant 7-2-x Deployment with functions distribution across the FH,MH and BH architecture.

Network Slice Subnet (NSS) Orchestration NBI deployment based on 3GPP rel 17+.

Multi-tenancy for different latency and Performance requirements.

Problem Statement

Capacity Planning: Challenges
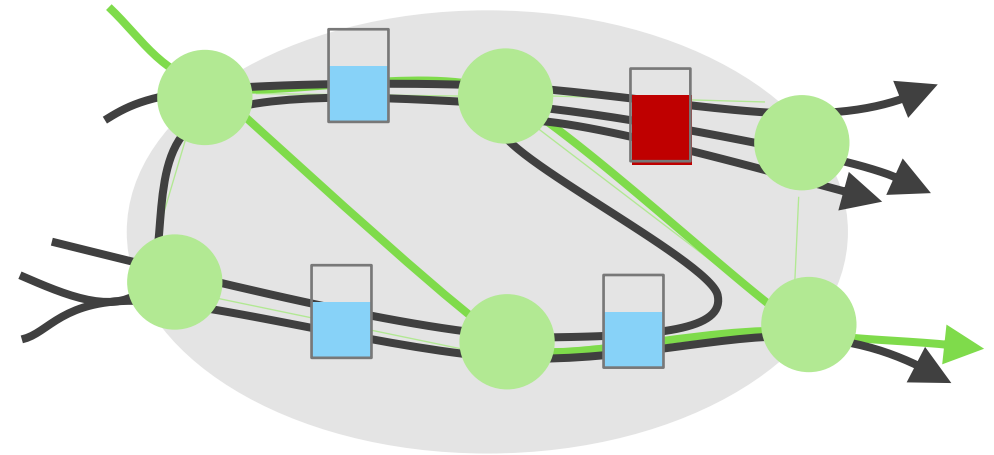
Bandwidth Guarantee

- Vulnerable to unexpected traffic growth
- Network Failures

Network State

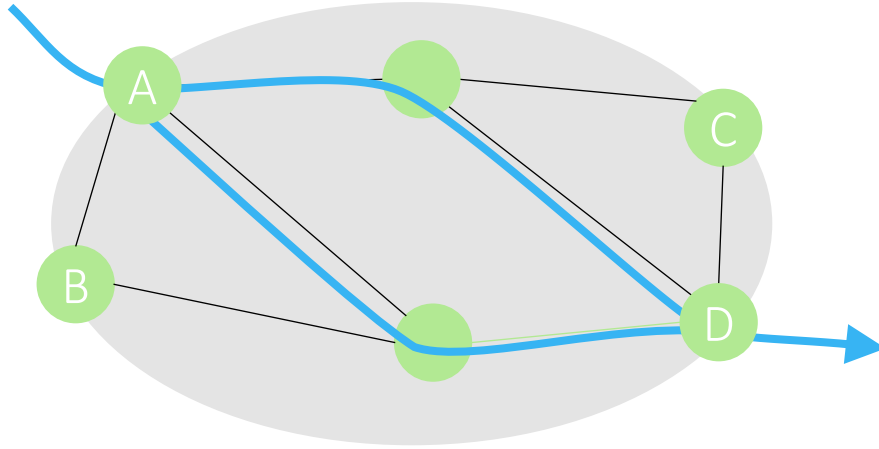- Anticipate common failures
- Provision for growth

Congestion Management

- Non-deterministic solutions

Major missing functionality of the IP suite: Demand-Matrix

Demand Matrix: Objective

Automated: DM acquisition should not require a dedicated team.

Up-to-date: Delivered on an hourly basis reflecting current network status.

Deterministic: Account for all the traffic, without sampling or approximations

Lightweight: Avoid heavy collection or processing infrastructure

The Novel Approach

Demand-Matrix: Using SRv6 accounting

Traffic from each source to each destination

- Over each routing path: IGP /FA & SR-Policy

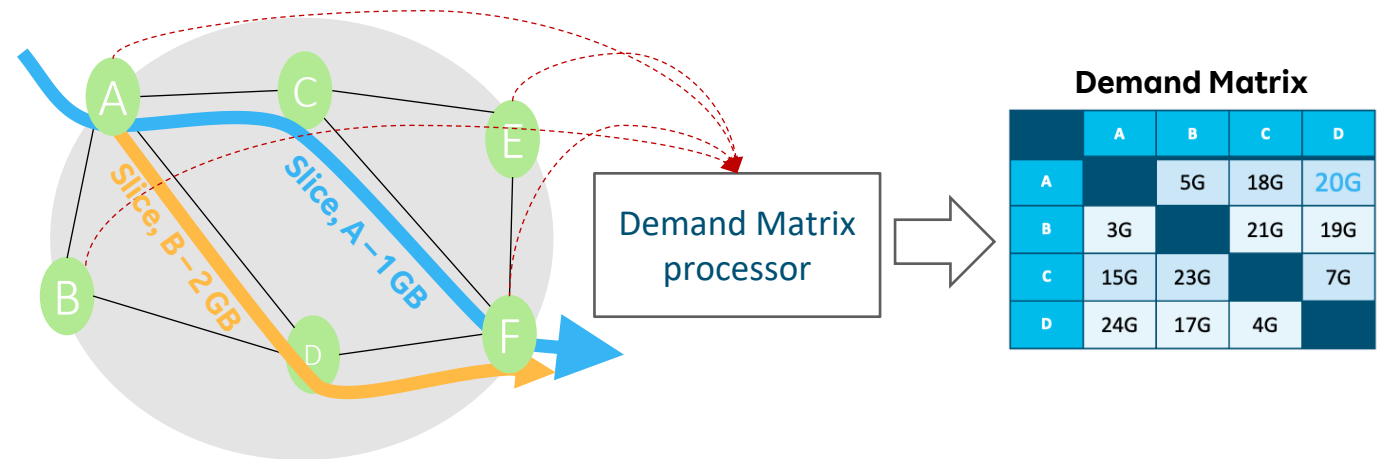- Per locator(-per COS) counters

Dedicated counters on each node

Exhaustive:

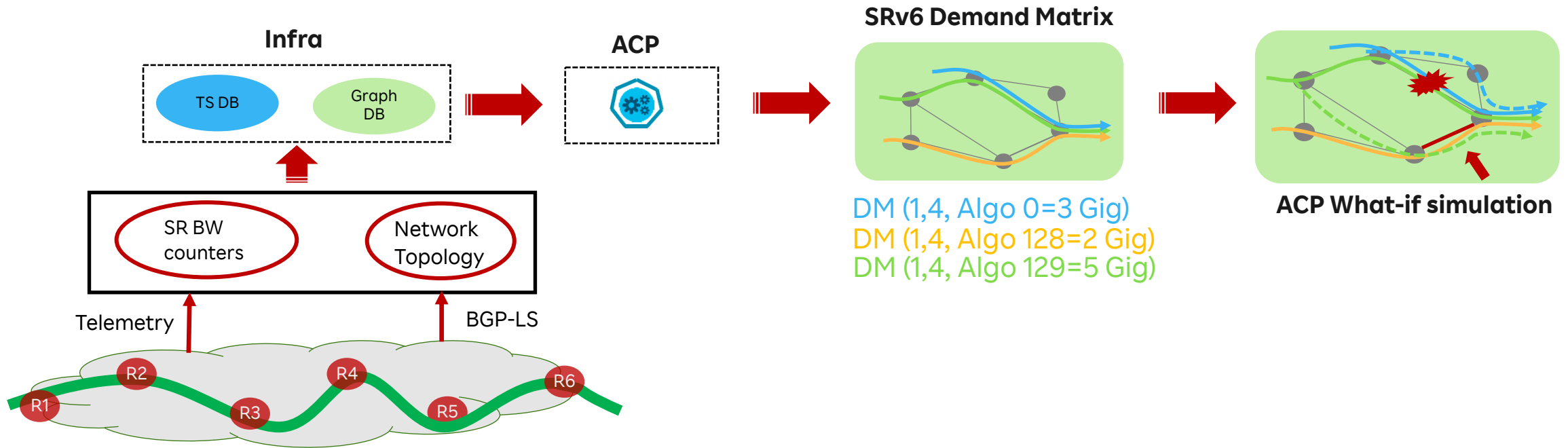- Account for every packet in hardware.

- Account on a per-demand basis.

Scalable & Deterministic solution

Scalable:

- 1K to 10k counters

- Key input to Capacity Planning and BW guarantees

Demand Matrix

	A	B	C	D
A		5G	18G	20G
B	3G		21G	19G
C	15G	23G		7G
D	24G	17G	4G	

End-to-end architecture with SRv6 Demand matrix

Infra

TS DB

Graph DB

ACP

SRv6 Demand Matrix

DM (1,4, Algo 0=3 Gig)
DM (1,4, Algo 128=2 Gig)
DM (1,4, Algo 129=5 Gig)

ACP What-if simulation

SR BW counters

Network Topology

Telemetry

BGP-LS

R1 R2 R3 R4 R5 R6

Counters stats pushed periodically via telemetry.

– Combined periodic and event-based reporting.

– Every hour at first, then more frequently (e.g., 15 min)

Supports DM Boundary Domain concept and all external interfaces are accounted.

– A few hundred counters per router

Mixed Deployments with Inter-working

– SR bandwidth counters and ACL based approach for inter-op scenarios.

Network Snapshot [Few Lab Results]

Network Snapshot reflecting Nodes, Links with IGP domains, IGP Adjacencies, Flex-Algo, Link capacity and Utilization levels

Cisco Automated Capacity Planning

Current Snapshot

Date and time (UTC): 2023-04-11, 16:10:17

Nodes

Show 10 entries   Search:

Name	Domain	IGP Identifier	Protocol	Type	IP version	SR algorithms
R1	0	0000.0000.0001	ISIS	L2	IPv6	0, 1
R2	0	0000.0000.0002	ISIS	L2	IPv6	0, 1
R3	0	0000.0000.0003	ISIS	L2	IPv6	0, 1
R4	0	0000.0000.0004	ISIS	L2	IPv6	0, 1
R5	0	0000.0000.0005	ISIS	L2	IPv6	0, 1
R6	0	0000.0000.0006	ISIS	L2	IPv6	0, 1
R7	0	0000.0000.0007	ISIS	L2	IPv6	0, 1
R8	0	0000.0000.0008	ISIS	L2	IPv6	0, 1
R9	0	0000.0000.0009	ISIS	L2	IPv6	0, 1
R10	0	0000.0000.0010	ISIS	L2	IPv6	0, 1

Showing 1 to 10 of 114 entries   Previous **1** 2 3 4 5 ... 12 Next

Interfaces

Show 10 entries   Search:

Name	Domain	Protocol	Type	IP version	Flex-Algos	Capacity (Mbps)	Utilization (Mbps)	Usage (%)
R1 (Gi0/0/0/1) - R4	0	ISIS	L2	IPv6		2000.000	856.940	42.85%
R1 (Gi0/0/0/2) - R2	0	ISIS	L2	IPv6		2000.000	617.905	30.90%
R1 (Gi0/0/0/3) - R5	0	ISIS	L2	IPv6		2000.000	876.759	43.84%
R1 (Gi0/0/0/4) - R19	0	ISIS	L2	IPv6		2000.000	769.682	38.48%
R1 (Gi0/0/0/5) - R25	0	ISIS	L2	IPv6		2000.000	798.277	39.91%
R10 (Gi0/0/0/1) - R13	0	ISIS	L2	IPv6		2000.000	615.808	30.79%
R10 (Gi0/0/0/2) - R11	0	ISIS	L2	IPv6		2000.000	745.820	37.29%
R10 (Gi0/0/0/3) - R14	0	ISIS	L2	IPv6		2000.000	990.980	49.55%
R10 (Gi0/0/0/4) - R67	0	ISIS	L2	IPv6		2000.000	950.981	47.55%
R10 (Gi0/0/0/5) - R73	0	ISIS	L2	IPv6		2000.000	989.122	49.46%

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Demand Matrix

Demand Matrix reflecting all the flows with volume of traffic per flow

Demands

Show [10 ▾] entries   Search: [   ]

Demand	▲	Volume (Mbps)	⇕	Path	⇕
R100 - R14 (fcbb:bb00:14::/48)		91.632		⊞	
R101 - R14 (fcbb:bb00:14::/48)		95.507		⊞	
R102 - R14 (fcbb:bb00:14::/48)		92.498		⊞	
R103 - R14 (fcbb:bb00:14::/48)		98.590		⊞	
R104 - R14 (fcbb:bb00:14::/48)		94.962		⊞	
R105 - R14 (fcbb:bb00:14::/48)		98.873		⊞	
R106 - R14 (fcbb:bb00:14::/48)		91.918		⊞	
R107 - R14 (fcbb:bb00:14::/48)		92.961		⊞	
R108 - R14 (fcbb:bb00:14::/48)		96.136		⊞	
R109 - R14 (fcbb:bb00:14::/48)		98.075		⊞	

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Demand Details Link

Cisco Automated Capacity Planning

Path for demand

From R100 to R14 (fcbb:bb00:14::/48)

Volume 91.632 Mbps

Links traversed by Demand

Search: [   ]

Link ▲	Advertised Link capacity (Mbps)	Demand bandwidth (Mbps)	Ratio
R100 (Gi0/0/0/2) - R101	2000.000	91.632	1
R101 (Gi0/0/0/2) - R102	2000.000	91.632	1
R102 (Gi0/0/0/1) - R18	2000.000	91.632	1
R18 (Gi0/0/0/1) - R14	2000.000	91.632	1

Cisco Automated Capacity Planning in nutshell

Automated (What-if) Analysis

- Continuous collecting of topology and SR bandwidth counters

- Every One Hour –
  - Compute per-slice demand matrix.
  - Simulate all single failure scenarios (link, node, and SRLG) per demand matrix.
  - Computes post convergence link utilizations.

- Extract 6 most relevant KPIs
  - Assess potential disruption in a glance
  - Identify hot and soft spots

- In-Deployment (Rakuten)
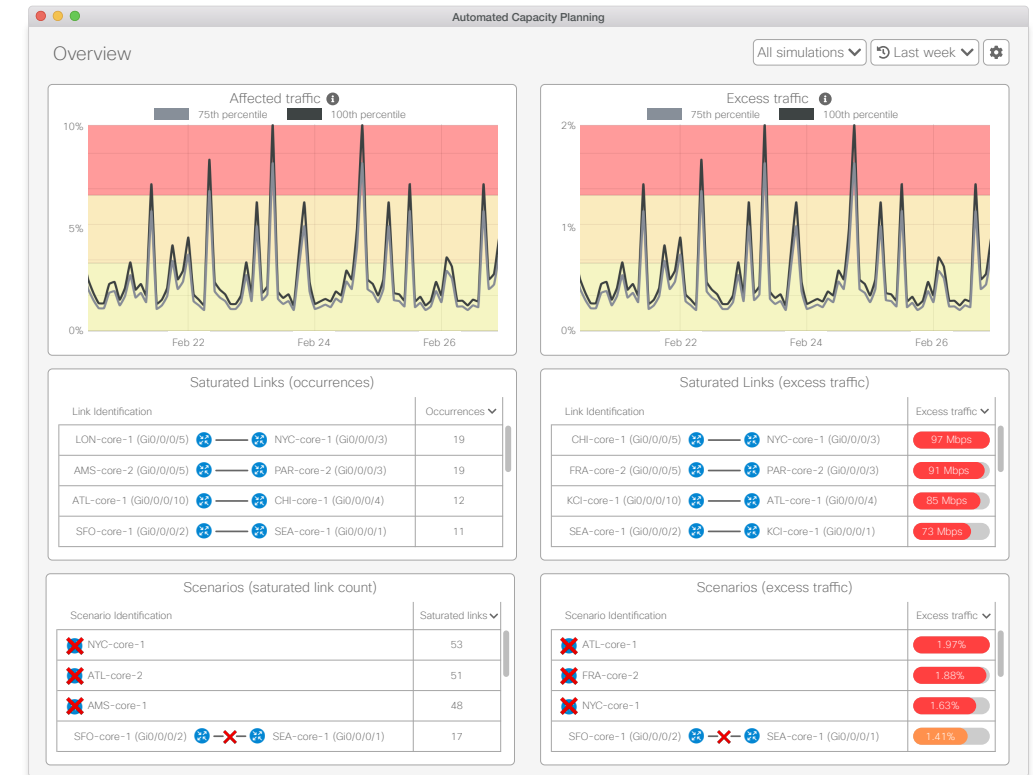
End-to-end capacity planning solution for SRv6 networks:

Hardware Counters → Deterministic Demand Matrix → Automated What-if Simulation & Analysis

Summary

SRv6 adds scalability and efficiency to network deployments.

SRv6 accounting provides a simple, scalable tool to build the Demand Matrix.

SRv6 Demand Matrix and ACP are essential for next generation capacity Planning solutions.

Thank you
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