Rakuten SRv6 uSID with network slicing use cases

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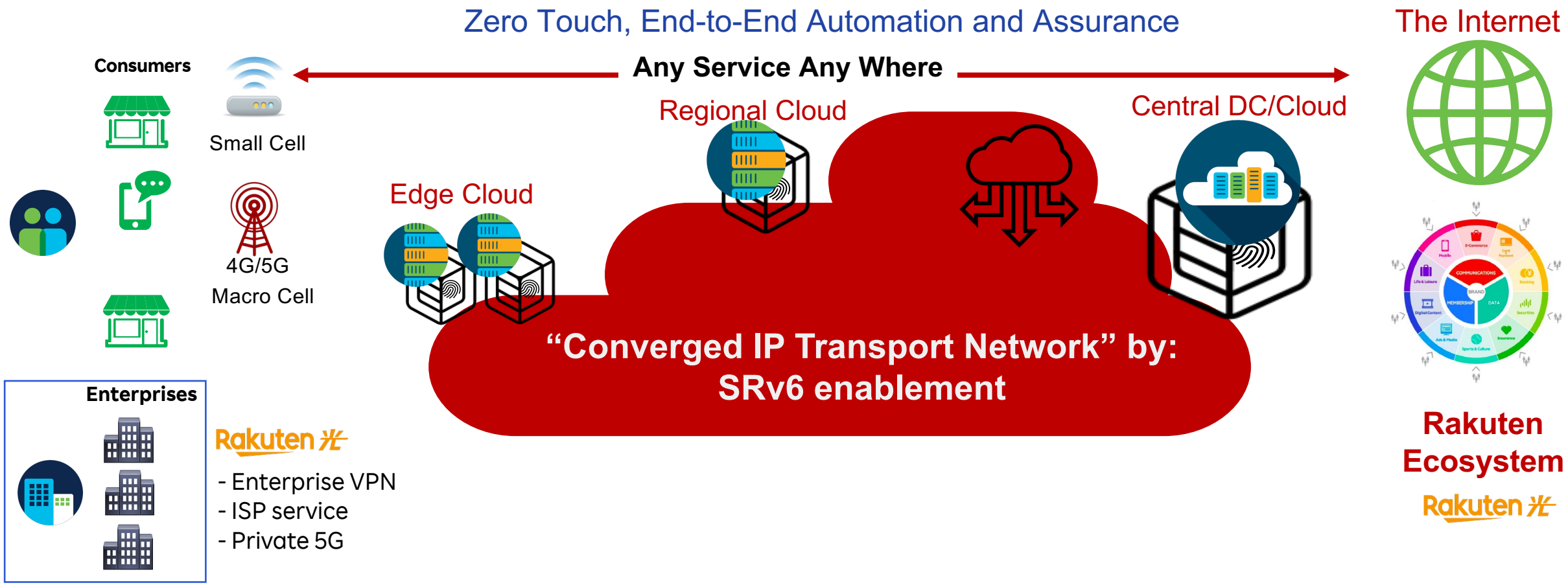
Agenda

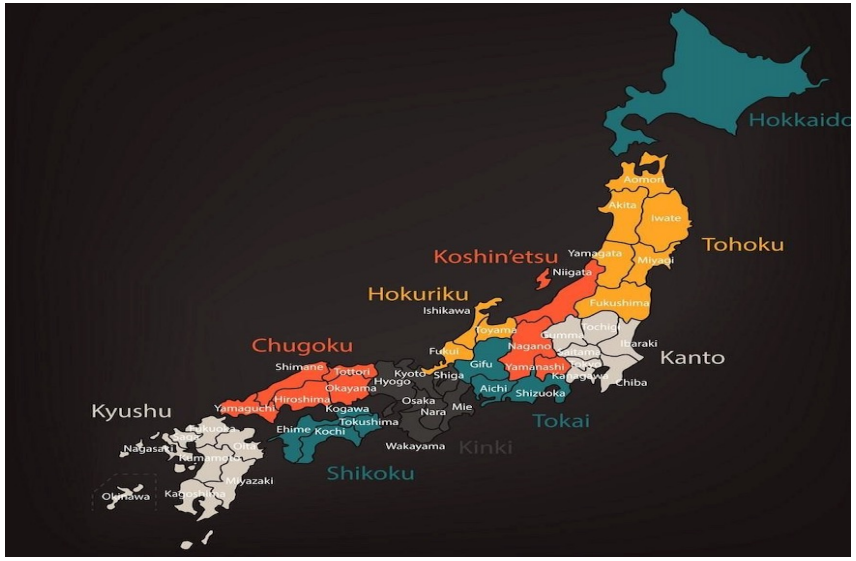
- SRv6 Network as a platform
- SRv6 u-SID design & benefits
- end-to-end 5G network slicing
- Key learnings
- Summary & Conclusion

Rakuten SRv6 Network as a Platform



SRv6 Design

SRV6 uSID encapsulation



SRv6 Blocks:

- ULA addressing with route summarization on boundary nodes.
- uSID block in /32, uSID ID in 16-bits, uSID Node Locator in /48.
- Loopbacks and Locator blocks are synchronized.

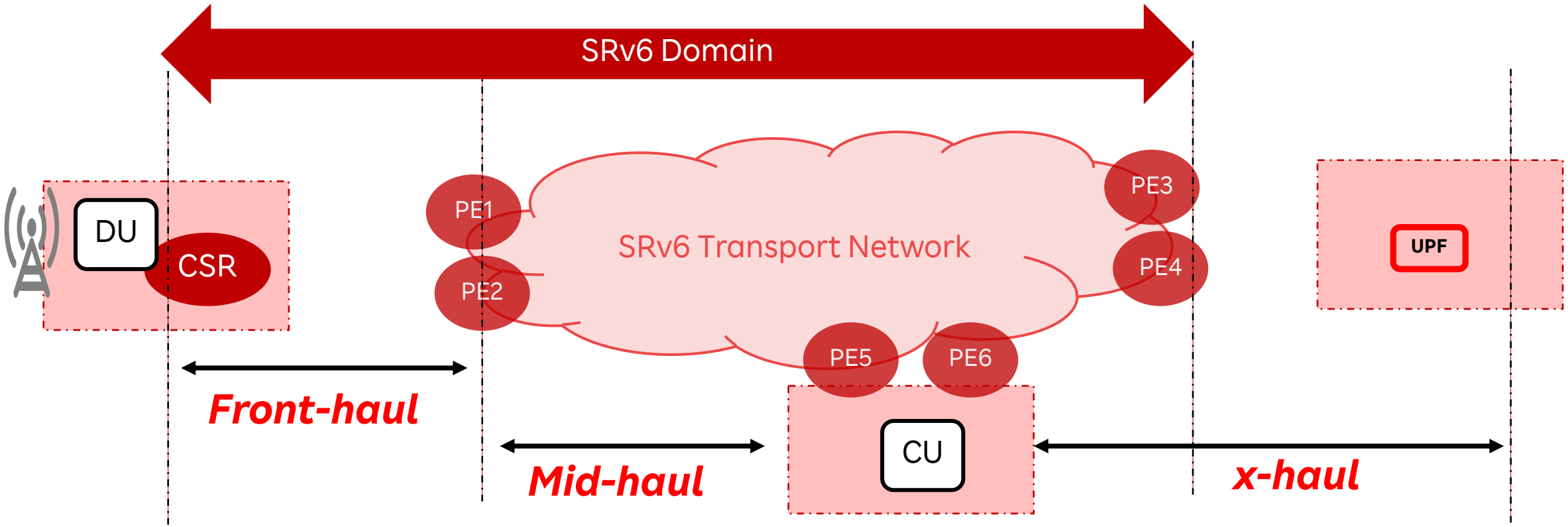
SRv6 Infrastructure:

- TI-LFA, Remote u Loops and Weighted SRLG Protections.
- Unreachable Prefix Advertisement (UPA) for rapid convergence (Node Failure).

SRv6 Services:

- Features: L3VPNs / EVPN / Flex-Algo.
- End-to-end network slicing.
- Guaranteed SLAs –Ultra low Latency Paths, Bandwidth Optimization using Demand-Matrix and Path Tracing.
- Next-Gen SDN-Controller using ng-API

Distributed O-RAN with SRv6

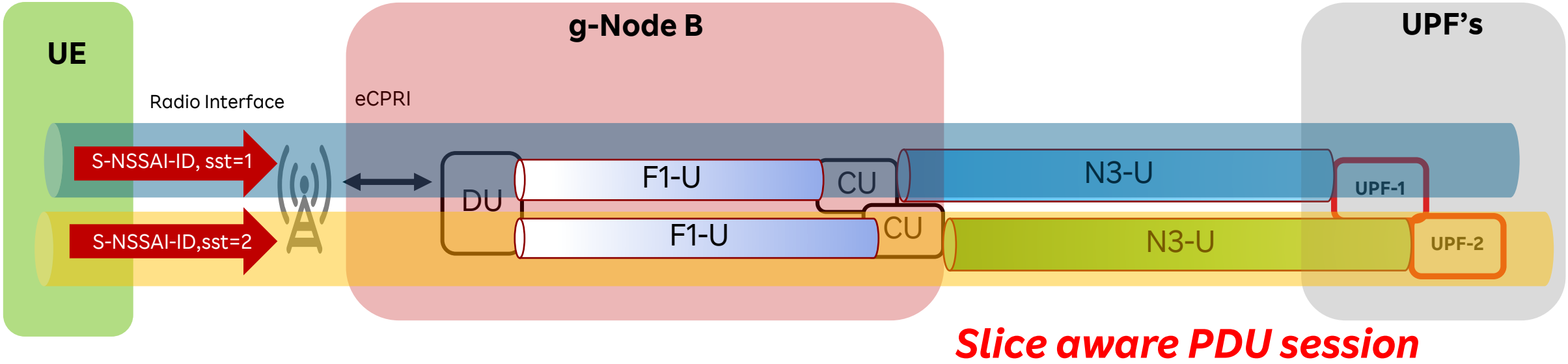


- ***SRv6 vCSR Integerated with DU in a Distributed O-RAN architecture.***
- Multiple SRv6 block for the CSR different from Infra blocks.
- Massive SRv6 scale with approx. 50k Locator space.
- Flex-Algo provides the SRv6 traffic engineering capability.

Effectiveness of u-SID: Compression Algorithm

- SRv6 Native
  - Perfect integration with SRH (RFC8754) and SRv6 Network Programming (RFC 8986).
- *SRv6 efficient compression mechanism*
  - Highest number of uSID's with lowest MTU overhead.
- Seamless Deployment
  - Host and Legacy access can interwork.
  - Host nodes push 6 uSID's with "classic" IPinIP (6 uSID's in DA)
- Longest match lookup
  - CIDR & Longest-match lookup : Leveraging feature of any IP NPU longest-match lookup.
- Line rate validation of 24 uSID's push on ***Cisco NCS 5700 platform (J2).***

End-to-end network slicing state of art

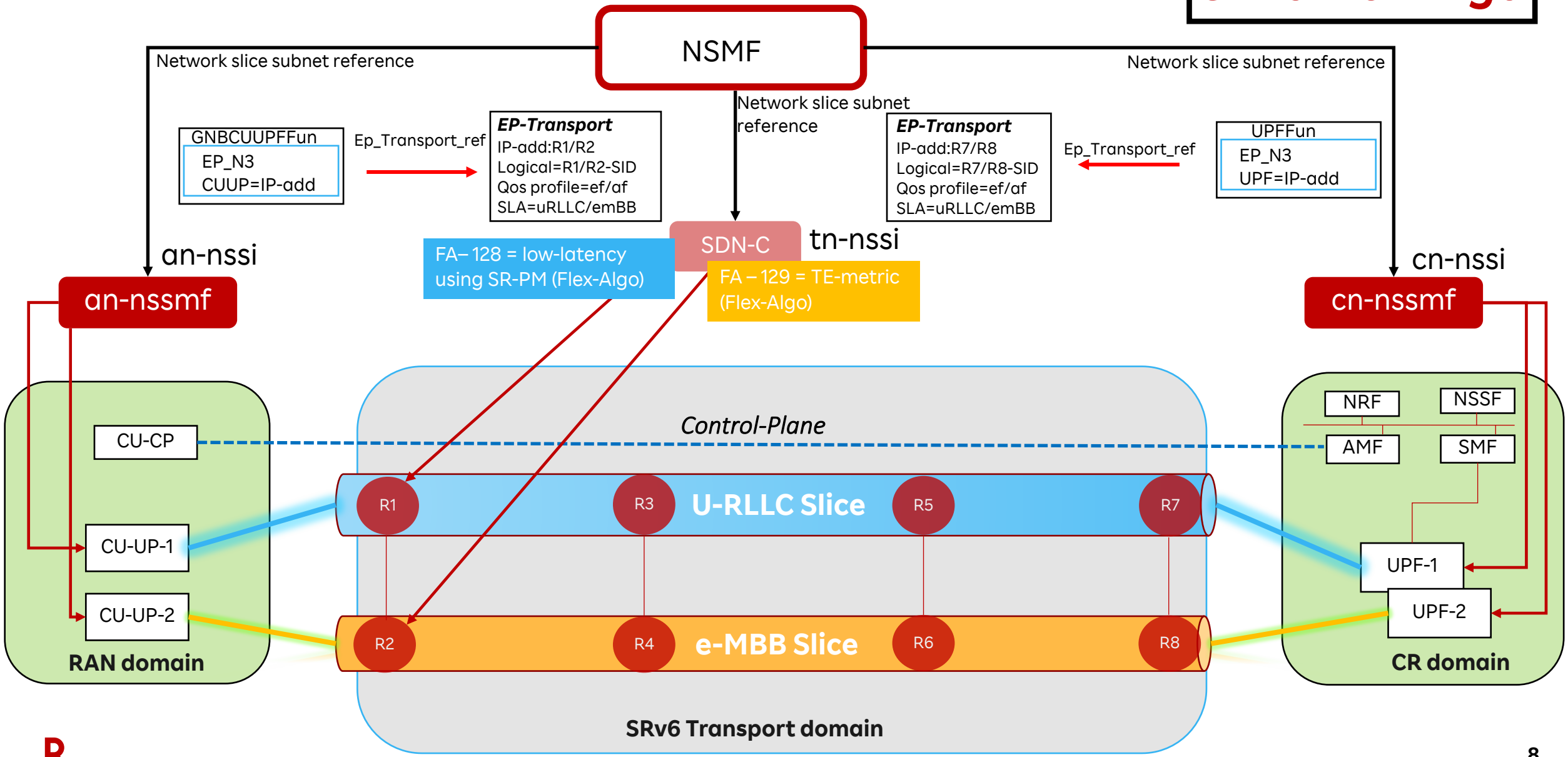


Slice aware PDU session

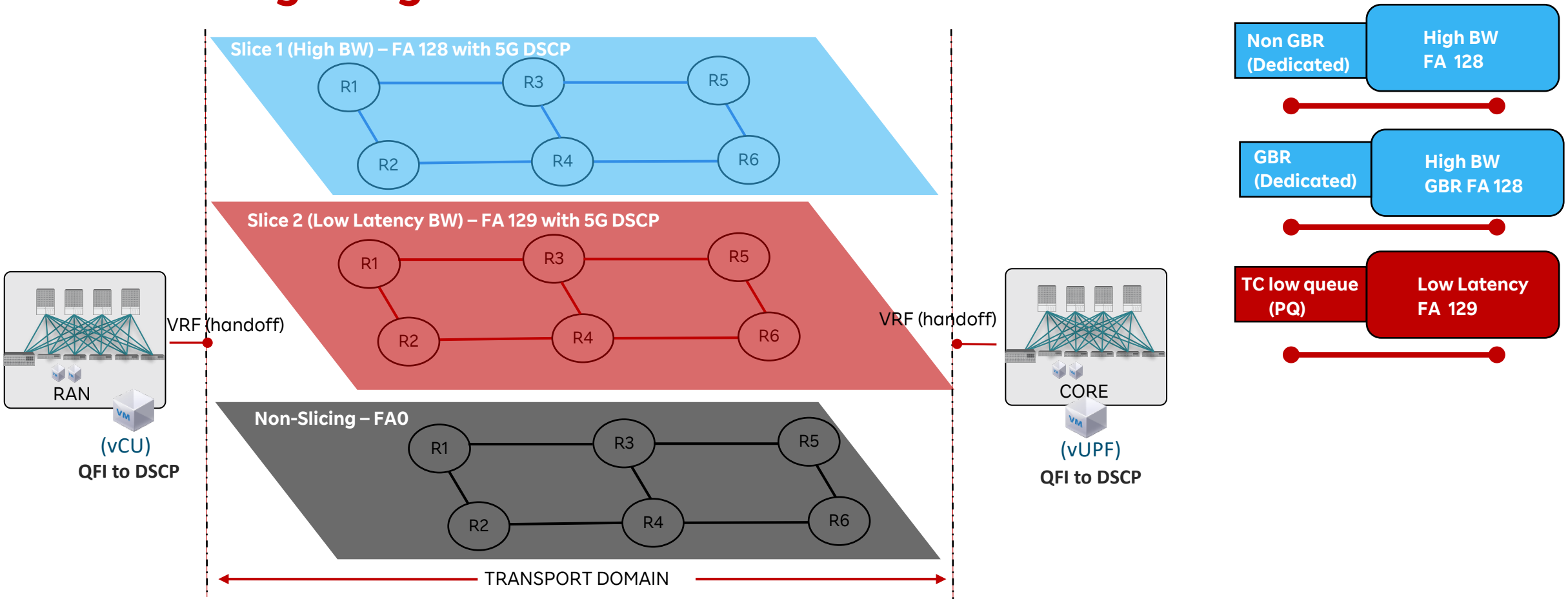
- ***UE subscribe multiple slices*** using per slice PDU connections.
- Dedicated network functions are allocated in each domain (RAN and Core).
- Transport domain allocates the dedicated forwarding planes for **F1-U** and ***N3-U tunnels*** per slice.
- **TN Slice mapping using [N:1] model against RAN/CR Slice**

Slice creations using NSMF (Dynamic Slicing)

SRv6 Flex-Algo



Hard Slicing using FA with resource reservations



- Slicing architecture key building blocks are ***VPNs, QoS and Flex-Algo.***
- 5QI QoS aware TN domain with QFI to DSCP mappings i.e ***5G DSCP Transport Domain.***
- Flex-Algo plane at the granularity of the 5QI-aware model.
- Simplified architecture with no per path state and lower SID depth – Ultra scalability.

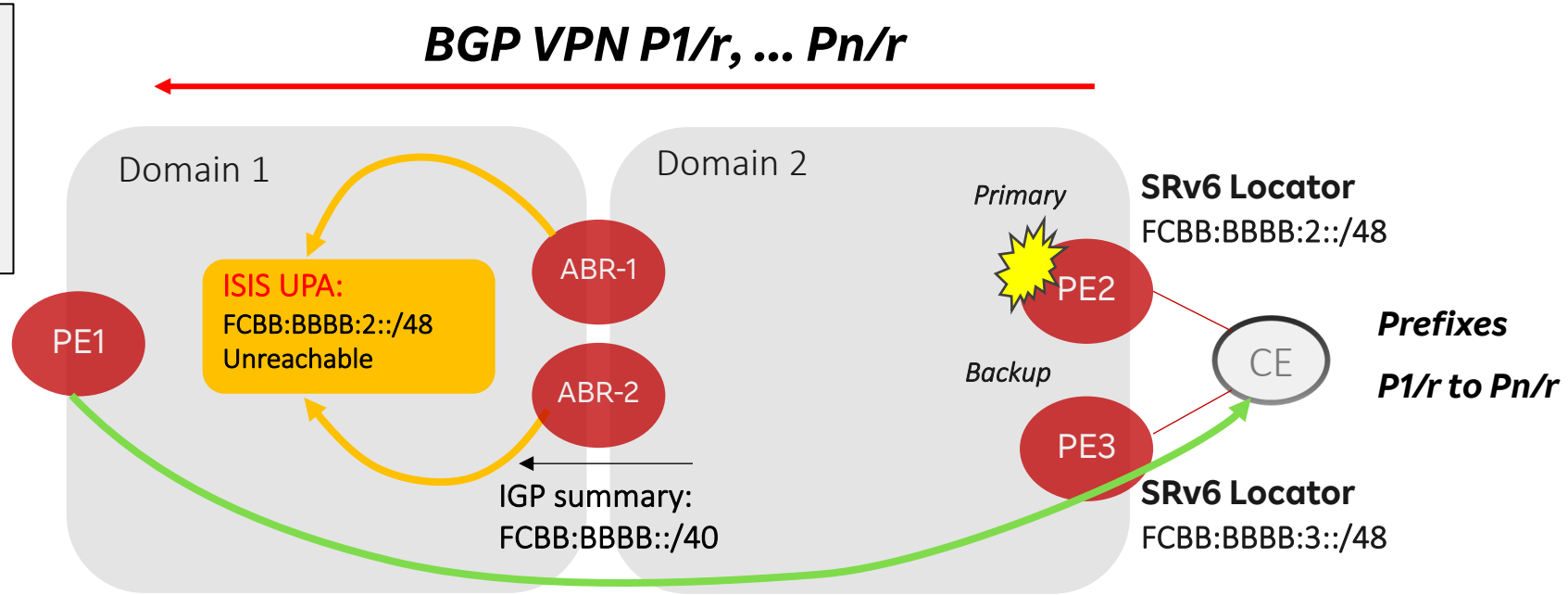
Key Learnings

Planned Feature: Rakuten SRv6 Road-map

IGP summarization supress multi-domain failures solved using

Unreachable Prefix Advertisement (UPA)

VRFA FIB on PE1
P1/r, …Pn/r
~~primary: via PE2~~
~~resolved via FCBB:BBBB::/40~~
backup: via PE3
resolved via FCBB:BBBB::/40



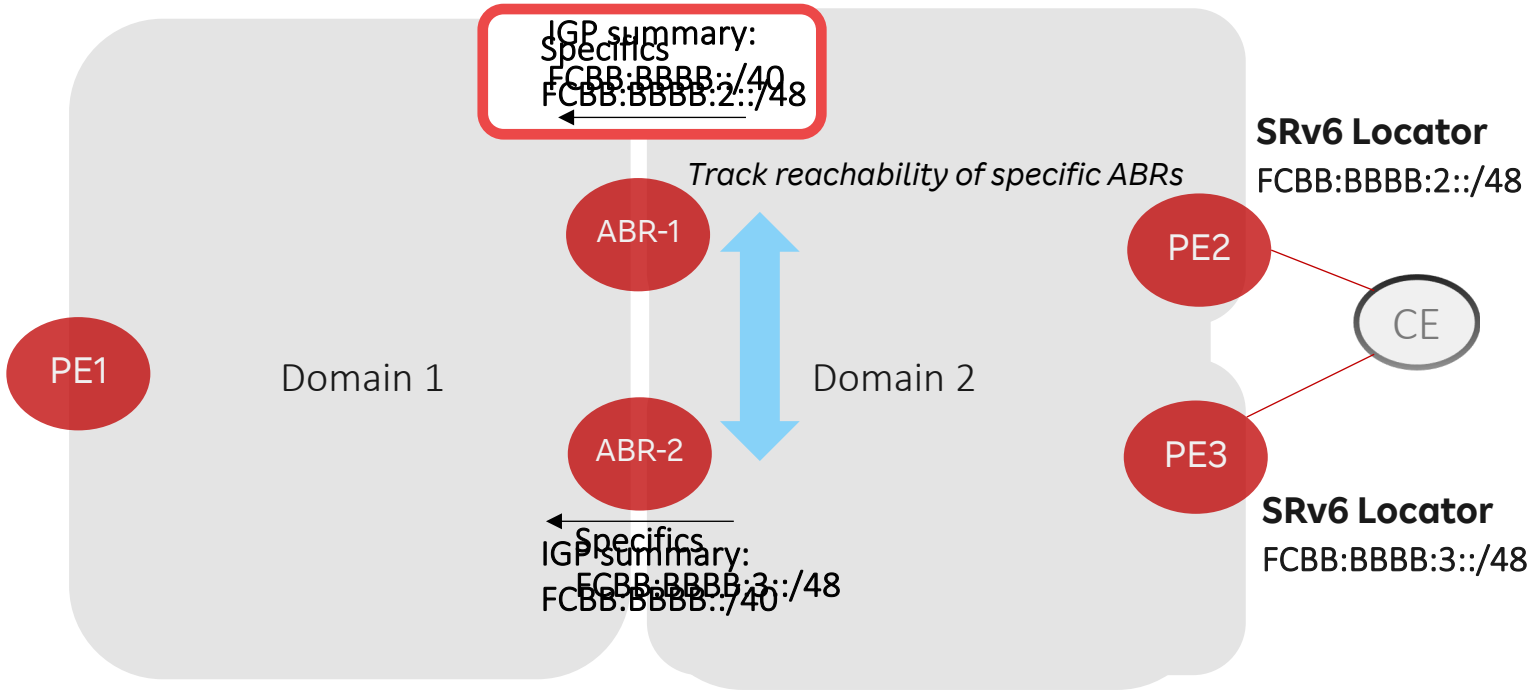
- ABR generates a UPA when it detects local unreachability of PE2 and PE2 is part of summary address.
- ***PE1 triggers BGP PIC upon reception of UPA related to PE2.***
- ***Succesfully validated in Rakuten Lab.***

Key Learnings

Planned Feature: Rakuten SRv6 Road-map

Area partitioning causes the loss of connectivity due to non supression of summary prefixes

solved using **Area Partitioning Feature (AP-SRv6)**

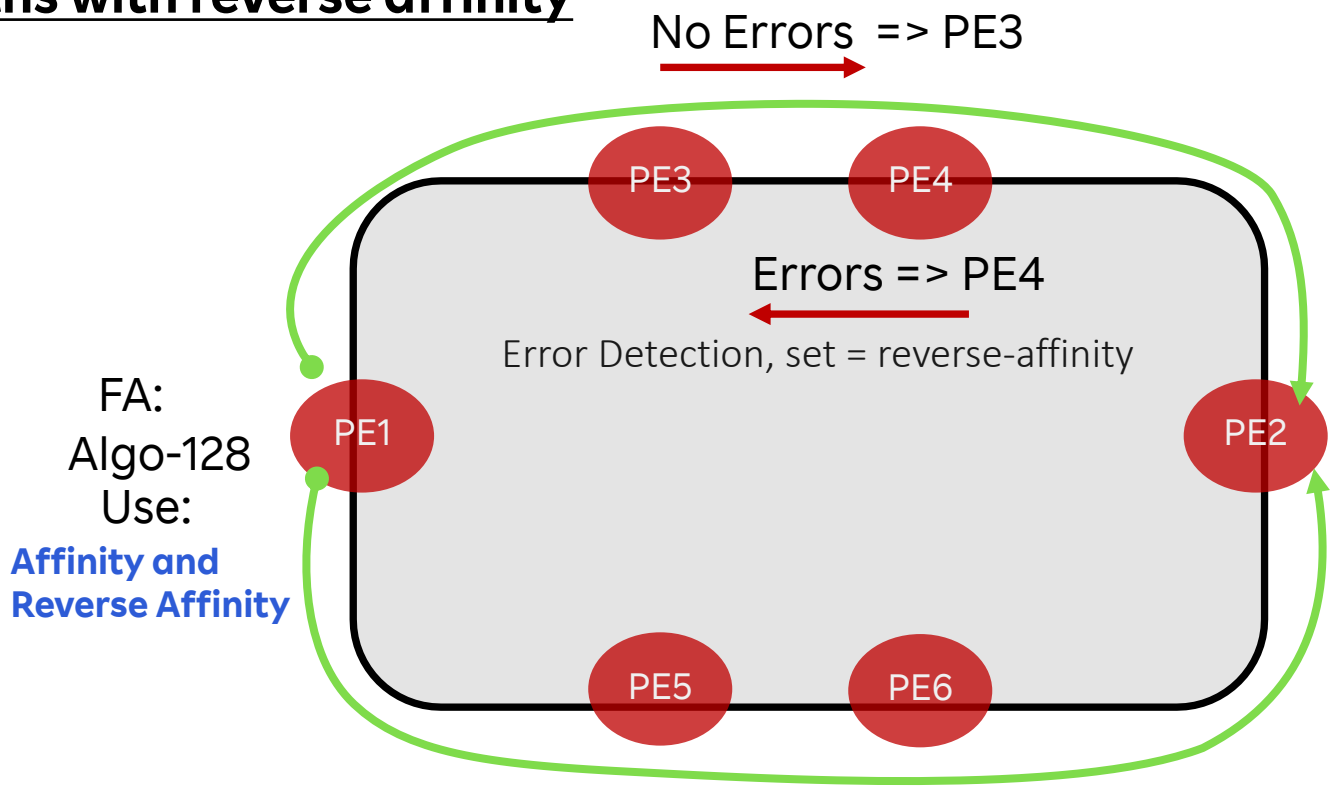


- ABR on detection will stop advertising the summary prefix
- *Summary will be re-routed **via alternate ABR or via specific /48 advertisenments***
- *Revert to summary after partition removal.*

Key Learnings

Planned Feature: Rakuten SRv6 Road-map

Reliable paths with reverse affinity



- Extend Flex-Algo to enable link exclusion on a given affinity.
- ***Affinity set for the reverse path***
- *Flex-Algo express the intent for low latency path with affinity exclusion.*

Key Learnings

ECMP FEC optimization – ECMP FEC

- Merchant-silicon ASICs (J/J+) have constraint resources.
- ECMP FEC – FEC for ECMP next hops
- ECMP-FEC resource - used to program forwarding towards destinations with ECMP – 4,000 entries.

How can SRv6 allow an operator to scale the network – Best Practices!!

Underlay

- Use L2 LAG Bundles vs L3 Paths – ECMP!!
- Use LFA paths instead of TI-LFA (Backup)!!
- Limit SRv6 u-loop – Prefix Based ACL!! (Planned feature)

Overlay

- Use L3-VPNs – Per VRF!!
- Prefer BGP PIC (A/B) instead of BGP multi-path (A/A) – L3 VPNs!!
- Use EVPN (A/B) instead of (A/A)!!
- SR Policy: Use first SID as uA – Unipath FEC!!

Key Learnings

SID Depths

J1 Family

- For VPN Service traffic over SRv6 Policy, PE can support impose ***3-way points*** in underlay with SRv6 uSID encap.
- For VPN Service traffic over SRv6 Policy, PE can support impose ***6-way points*** in underlay with SRv6 uSID encap. (**Recycling**)

J2 Family

- For VPN Service traffic over SRv6 Policy, PE can support impose ***24-way points*** in underlay with SRv6 uSID encap.
- No requirement of **Recycling**

Summary & Conclusions

- ✓ SRv6 design brings network simplicity & efficiency to the Rakuten network.
- ✓ SRv6 uSID supports ultra scalability for the 5G SA deployments due to native IPv6 forwarding architecture.
- ✓ Extensibility is the key advantage with SRv6 with no boundaries. It can be extended to Mobile Network –[RAN and Core domains].

Thank you

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