SRv6 for Deterministic Networking

draft-geng-spring-srv6-for-detnet-00
draft-geng-dp-sol-srv6-01

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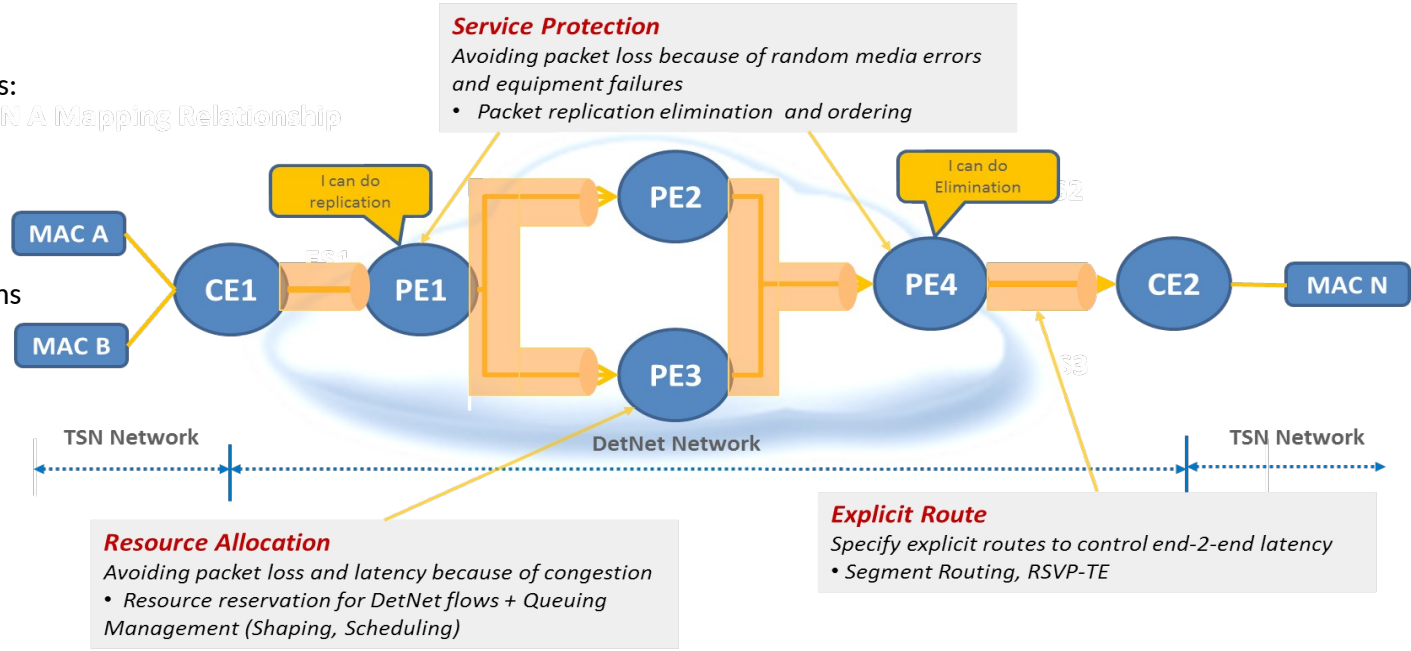
Why Deterministic Networking?

Use case category	Use Cases	User Experienced Data Rate	E2E Latency	Speed	Reliability
eMBB	UHD, VR, AR…	DL: 1 Gbps, UL: 500 Mbps	10 ms	Pedestrian	High
	High speed train	DL: 50 Mbps, UL: 25 Mbps	10 ms	Up to 500 km/h	High
	3D Connectivity: Aircrafts	DL: 15 Mbps, UL: 7.5 Mbps	10 ms	Up to 1000 km/h	Extremely High
	Ultra-low cost networks	DL: 10 Mbps, UL: 10 Mbps	50 ms	0-50 km/h	Low
	50 Mbps everywhere	DL: 50 Mbps, UL: 25 Mbps	10 ms	0-120 km/h	Medium
	Tactile internet	DL: 50 Mbps, UL: 25 Mbps	<1 ms	Pedestrian	Medium
Mission Critical IoT	Automatic traffic control/driving	DL: 50 kbps~10 bps; UL: a few bps~10 Mbps	1 ms	0-500 km/h	Extremely High
	Collaborative robots				
	Remote object manipulation –Remote surgery				
	eHealth: Extreme Life Critical	DL: 10 Mbps, UL: 10 Mbps	10 ms	0-500 km/h	Extremely High
	Public safety				
	3D Connectivity: Drones				
Massive IoT	Smart wearables (clothes)	Low (typically 1-100 kbps)	Seconds to hours	0-500 km/h	Medium
	Sensor networks				
	Mobile video surveillance	DL: 300 Mbps, UL: 50 Mbps	10 ms	0-120 km/h	Medium
	News and information	DL: Up to 200 Mbps UL: Modest (e.g. 500 kbps)	<100 ms	0-500 km/h	Medium
	Local, Regional, National				
	Natural disaster	DL: 0.1-1 Mbps, UL: 0.1-1 Mbps	not critical	0-120 km/h	High

- New Applications in 5G
  - AR, VR
  - Industry
  - IoT
- New Requirement for Network
  - Strict SLA Guarantee: E2E Latency, Reliability…
- New Technologies?
  - Deterministic Networking(DetNet)
  - DetNet provides a capability to carry specified data flows for real-time applications with extremely low data loss rates and bounded latency within a network domain

DetNet Overview

- Key Technologies
  - Resource Allocation:
    - e.g., buffer space or link bandwidth, for DetNet flow
    - Resource allocation addresses two of the DetNet QoS requirements: latency and no congestion loss packet loss.
  - Service Protection:
    - DetNet flow is replicated and transmitted through non-parallel paths at the same time
    - Redundant DetNet flows are eliminated in a merge node.
    - No packet loss when one of the path fails compared to traditional switchover from active path to standby path
  - Explicit Route:
    - The paths are typically explicit routes so that they do not normally suffer temporary interruptions caused by the convergence of routing



Implement DetNet in an SRv6 Domain

- Why SRv6?
  - Source Routing: SRv6 could steer the DetNet flows through the network according to an explicit path with allocated resources;
  - Network Programming: SRv6 applies instructions (functions) to packets in some special nodes (or even all the nodes) along the path in order to guarantee, e.g., *service* protection and congestion protection.
  - Meta Data: SRH TLVs support meta-data for segment processing, which could be used to carry DetNet meta data, e.g., flow identification and sequence number.
- Why not?!

**RFC 8402: Segment Routing Architecture*
**draft-ietf-6man-segment-routing-header-26: IPv6 Segment Routing Header (SRH)*

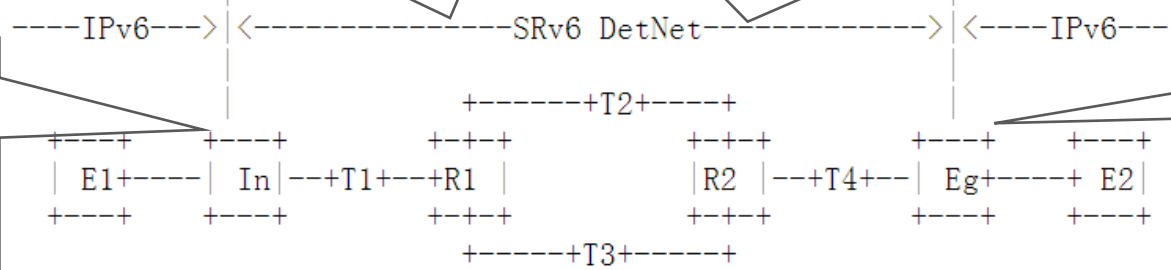
SRv6 for DetNet Service Protection

Data Plane

Replicates the payload and IPv6 Header with the SRH Binding two different SRv6 Policies respectively

Eliminates the redundant packets. Binds a new SRv6 Policy to the survival packet, which steers the packet from Relay Node 2 to Egress.

Inserts the SRv6 Policy that will steer the packet from Ingress to the destination. Flow Identification and Sequence Number are carried in the SRH

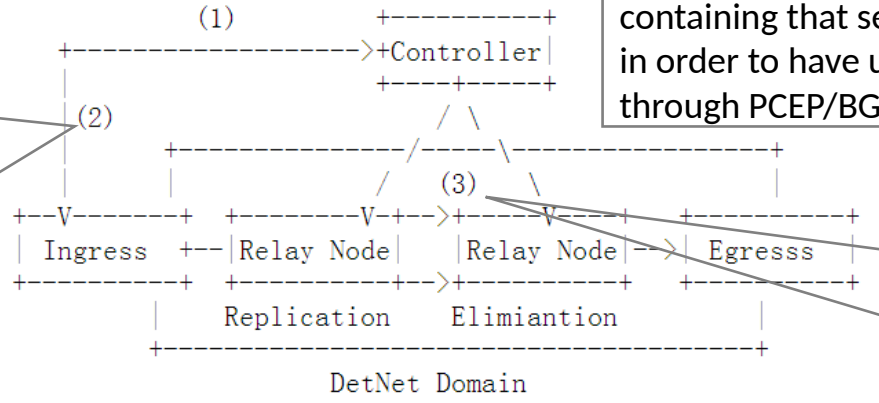


Decapsulates the outer Ipv6 header. Sends the inter packet to the End Station 2.

Control Plane

Edge node->Controller: Sends a path computation requirement containing that service protection in order to have ultra-reliability through PCEP/BGP extensions.

Controller->Edge node: Computes a P2MP2P path, including replication nodes and elimination nodes. Send the path computation result to the edge node through PCEP/BGP extensions



Controller->Relay Node : Replication node and elimination node should be configured to identify DetNet flows by flow identifications; After replication or elimination, the explicit path to the next relay is also required through BGP extensions or Netconf YANG.

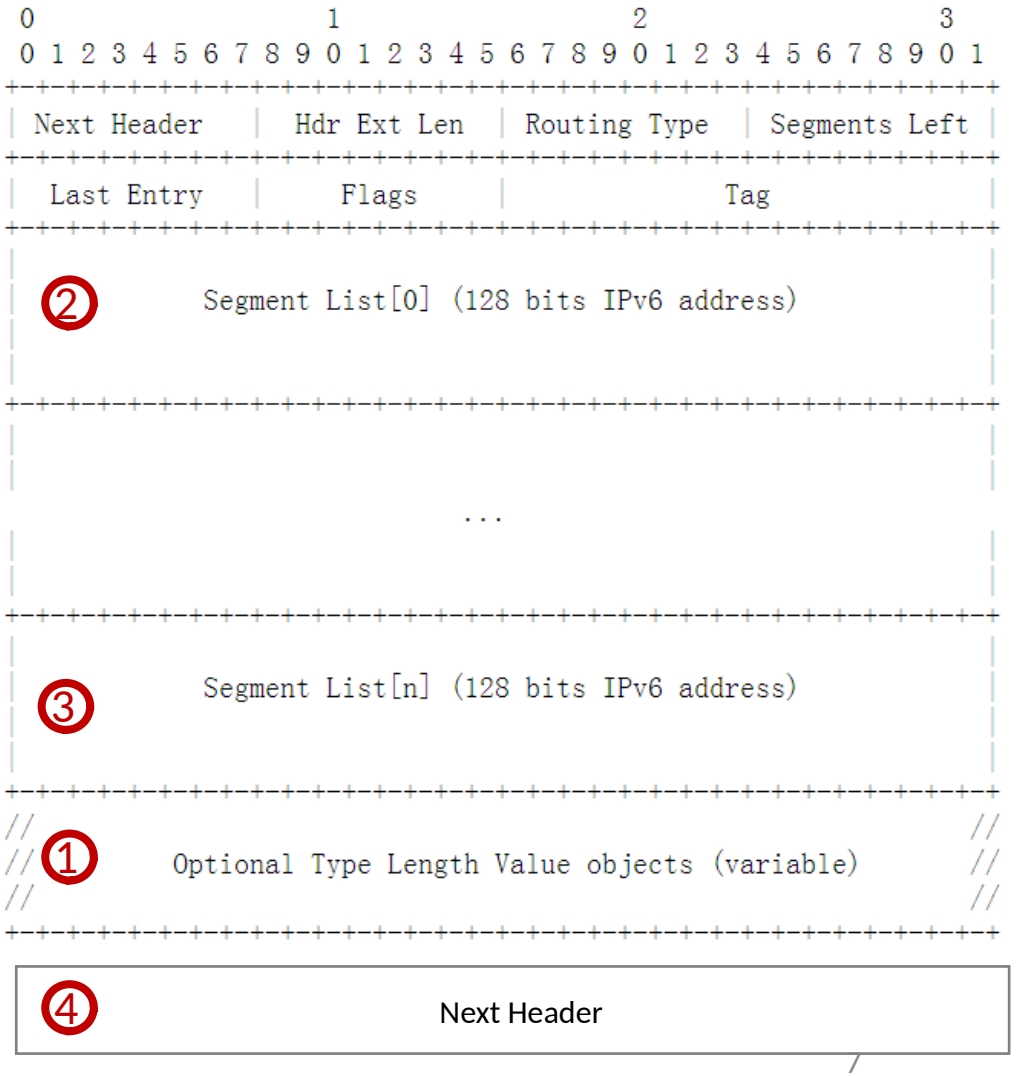
DetNet SRv6 Data Plane Requirement

- A method of identifying the DetNet payload type;
- A suitable explicit route to deliver the DetNet flow ; (e.g., Segment List in SRH)
- A method of indicating packet processing, such as PREOF; (detailed in next slides)
- A method of identifying the DetNet flow; (detailed in next slides)
- A method of carrying DetNet sequence number; (detailed in next slides)
- A method of carrying queuing and forwarding indication to do congestion protection; (not now)

DetNet SRv6 Data Plane Solution

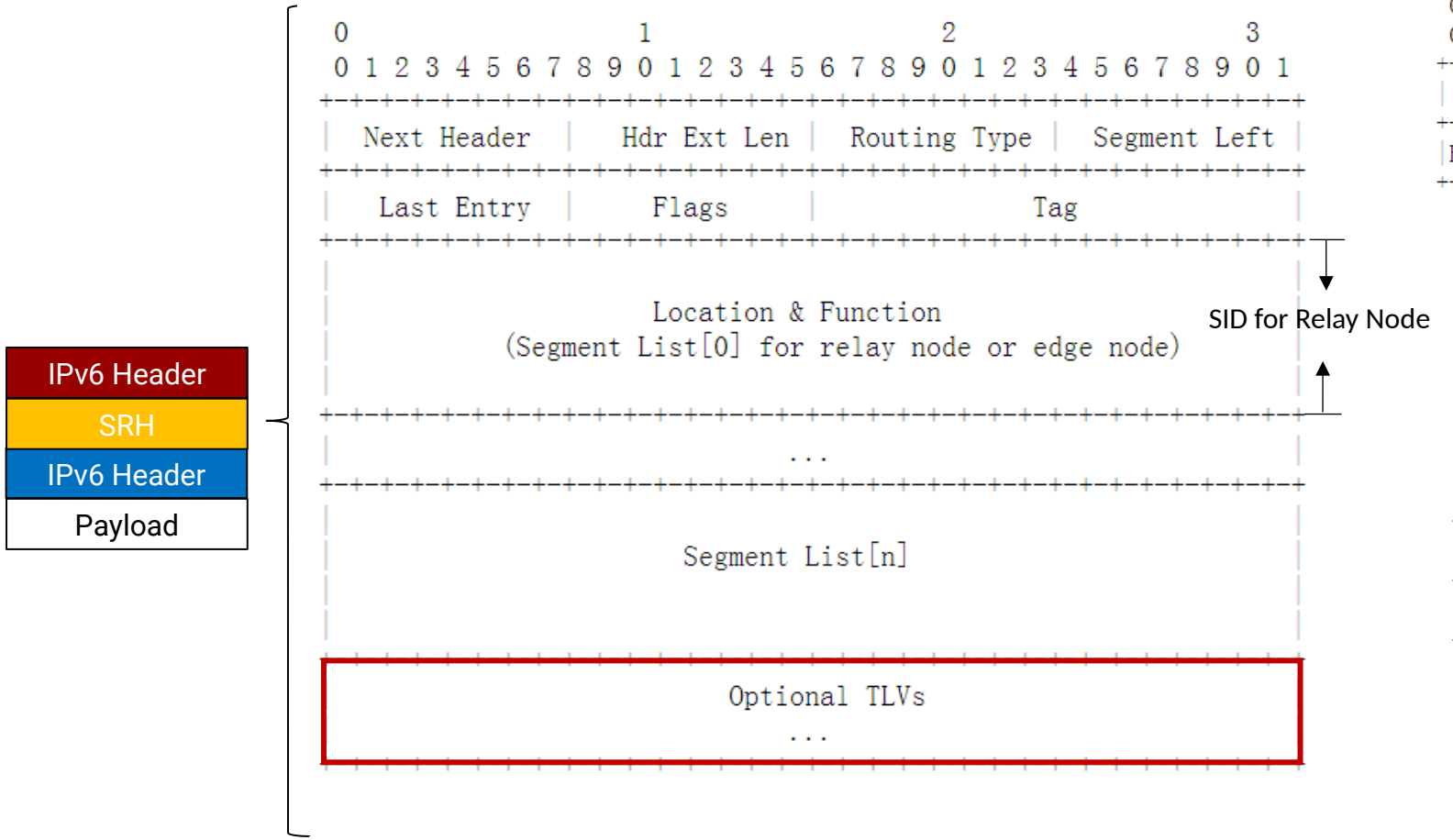
Flow Identification(20bits) and Sequence Number(28bits) a e carried in:

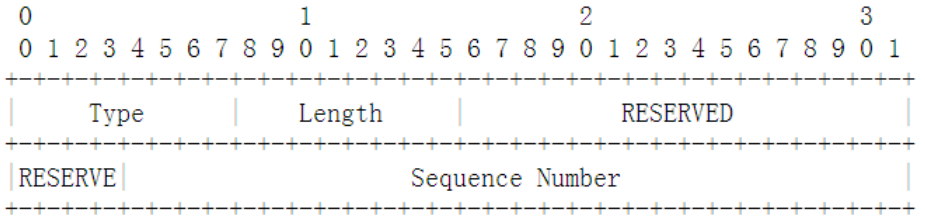
- **Option1:** SRH TLVs
- **Opiton2 :** arguments in the SID for Relay Node
- **Option3:** DetNet SID in segment list
- **Option4:** DetNet SRH inside the SRH (Not Reasonable)



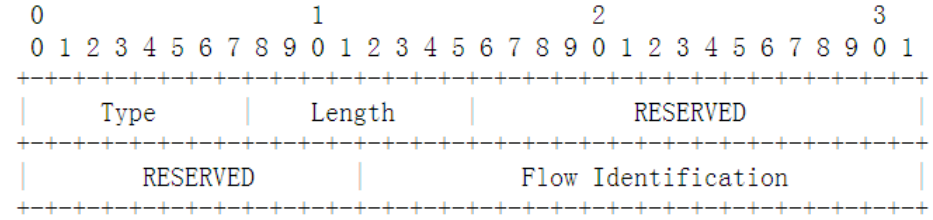
SRv6 Data Plane Solution Option1-Encapsulation

- Flow Identification(32bits) and Sequence Number(32bits) are carried as TLVs





- Type: 8bits, to be assigned by IANA.
- Length: 8.
- RESERVED: 28 bits, MUST be 0 on transmission and ignored on receipt.
- Flow Identification: 20 bits, which is used for identifying DetNet flow.



- Type: 8 bits, to be assigned by IANA.
- Length: 8.
- RESERVED: 20 bits. MUST be 0 on transmission and ignored on receipt.
- Sequence Number: 28 bits, which is used for indicating sequence number of a DetNet flow.

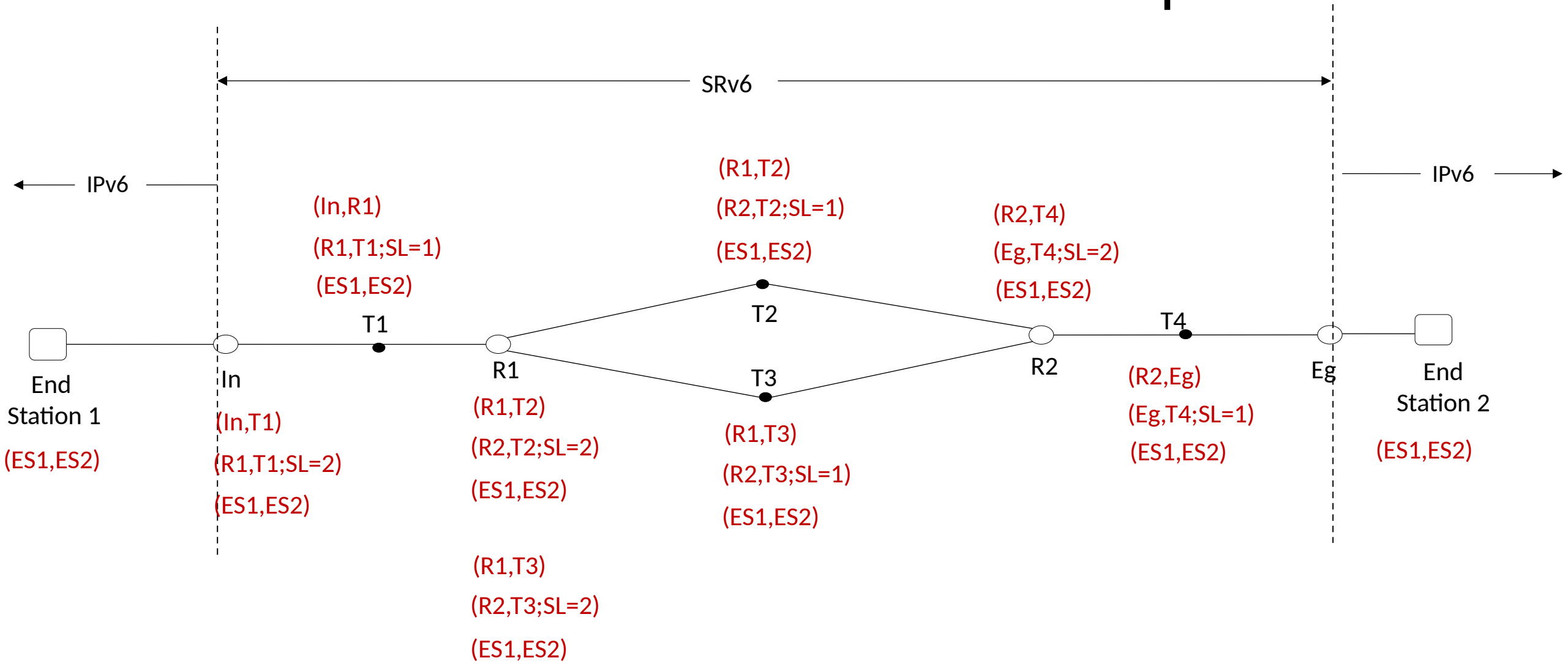
SRv6 Data Plane Solution Option1-Replication Function

- End. B. Replication: Packet Replication Function
    1. IF NH=SRH & SL>0 THEN
    2. extract the DetNet TLV values from the SRH
    3. create two new outer IPv6+SRH headers: IPv6-SRH-1 and IPv6-SRH-2; Insert the policy-instructed segment lists in each newly created SRH (SRH-1 and SRH-2). Also, add the extracted DetNet TLVs into SRH-1 and SRH-2.
    4. remove the incoming outer IPv6+SRH header.
    5. create a duplication of the incoming packet.
    6. encapsulate the original packet into the first outer IPv6+SRH header: (IPv6-SRH-1) (original packet)
    7. encapsulate the duplicate packet into the second outer IPv6+SRH header: (IPv6-SRH-2) (duplicate packet)
    8. set the IPv6 SA as the local address of this node.
    9. set the IPv6 DA of IPv6-SRH-1 to the first segment of the SRv6 Policy in of SRH-1 segment list.
    10. set the IPv6 DA of IPv6-SRH-2 to the first segment of the SRv6 Policy in of SRH-2 segment list.
    11. ELSE
    12. drop the packet

SRv6 Data Plane Solution Option2-Elimination Function

- End. B. Elimination: Packet Elimination Function
    1. IF NH=SRH & SL>0 & "the packet is not a redundant packet" , THEN
    2. do not decrement SL nor update the IPv6 DA with SRH[SL]
    3. extract the value of DetNet TLVs from the SRH
    4. create a new outer IPv6+SRH header
    5. insert the policy-instructed segment lists in the newly create SRH and add the retrieved DetNet TLVs in the newly created SRH
    6. remove the incoming outer IPv6+SRH header.
    7. set the IPv6 DA to the first segment of the SRv6 Policy in the newly created SRH
    8. ELSE
    9. drop the packet

DetNet SRv6 Data Plane Solution Example

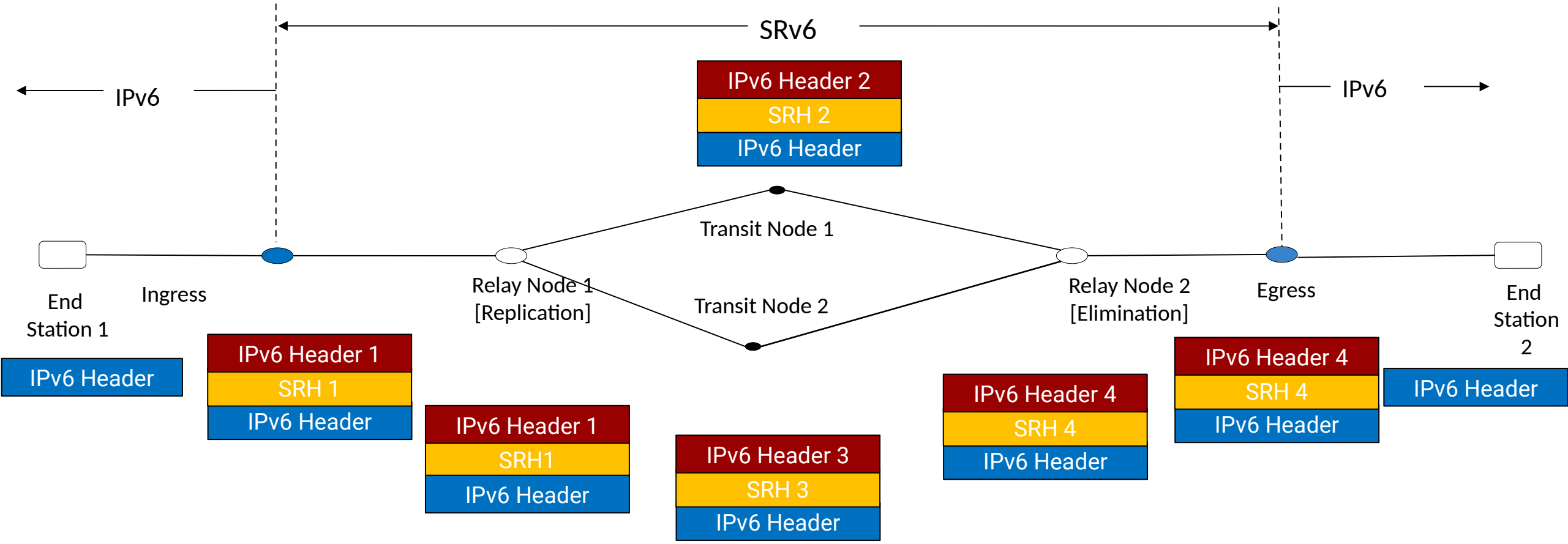


Next Step

- Collect Feedback from SPRING
- Comments and discussions in the mailing list
- Seek for Corporation

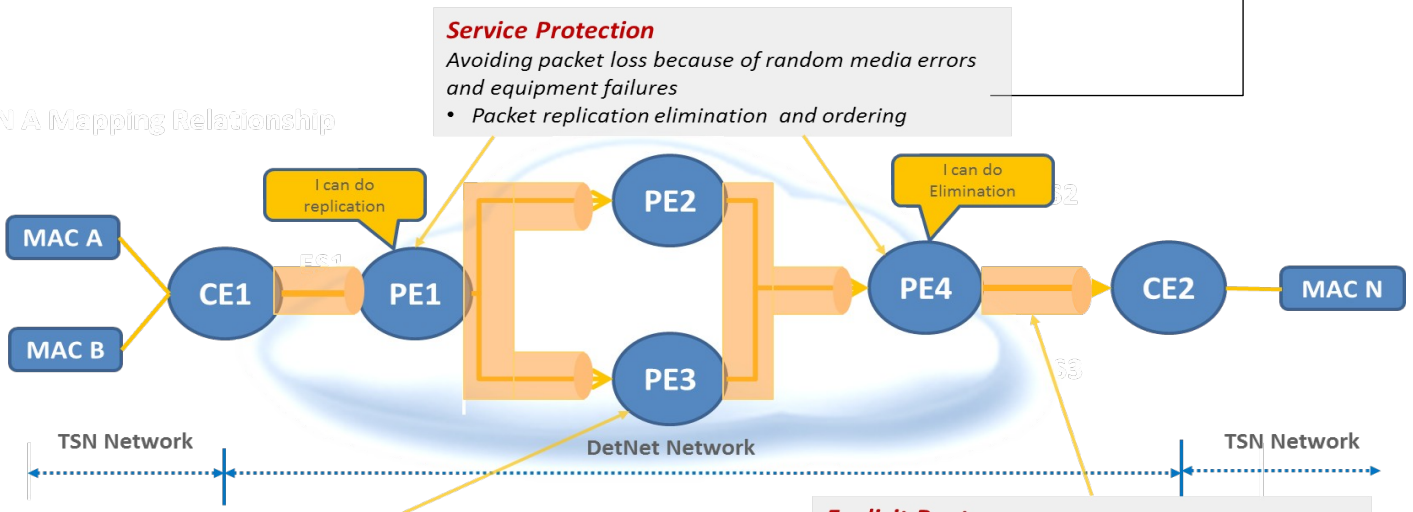
Thanks

SRv6 Based PREOF

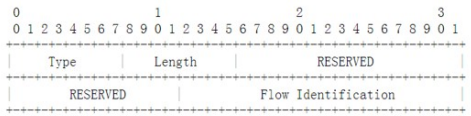


SRv6 based DetNet

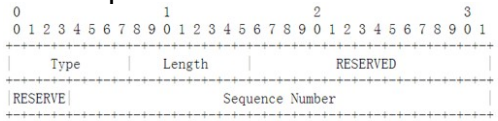
- SRv6 Network Programming:
  - Service Protection:
    - Carry Flow Identification and Sequence Number in optional TLV;
    - Define new functions for packet replication & elimination
  - Resource Allocation
    - Define new functions for scheduling/reserved resource
  - Explicit Path
    - SID List indicates the explicit route



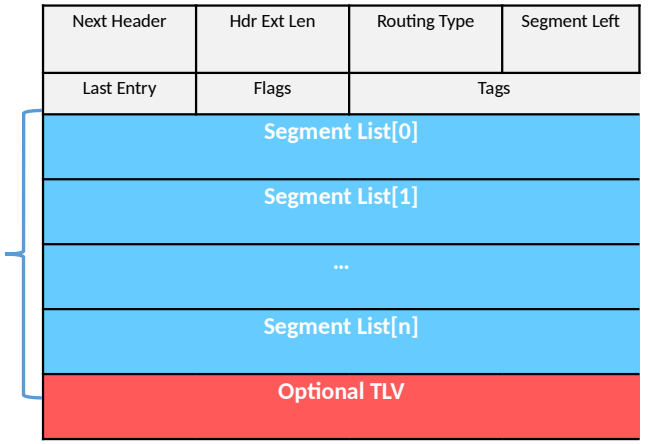
Flow Identification TLV



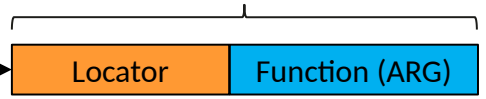
Sequence Number TLV



SRv6 SID List



SRv6 SID (128bit)



New functions for DetNet, e.g., packet replication /elimination / scheduling