DetNet
Flow Definition and Identification, Features and Mapping to/from TSN

DetNet – TSN joint workshop
IETF / IEEE 802, Bangkok

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Topics

- Overview
- Data plane
  - MPLS based PSN
  - Native IP
  - DetNet mapping to/from TSN
- DetNet service/flow parameters

Overview
DetNet essentials

- DetNet
  - operates at the IP/MPLS layer
  - is for networks that are under a single administrative control or within a closed group of administrative control.
  - is NOT for large groups of domains such as the Internet.

- DetNet service provides a capability for the delivery of data flows with
  - (1) extremely low packet loss rates and/or
  - (2) bounded end-to-end delivery latency

Note1: These characteristics are accomplished by dedicating network resources such as link bandwidth and buffer space to DetNet flows and/or classes of DetNet flows, and by protecting packets (e.g., by replicating them along multiple paths.

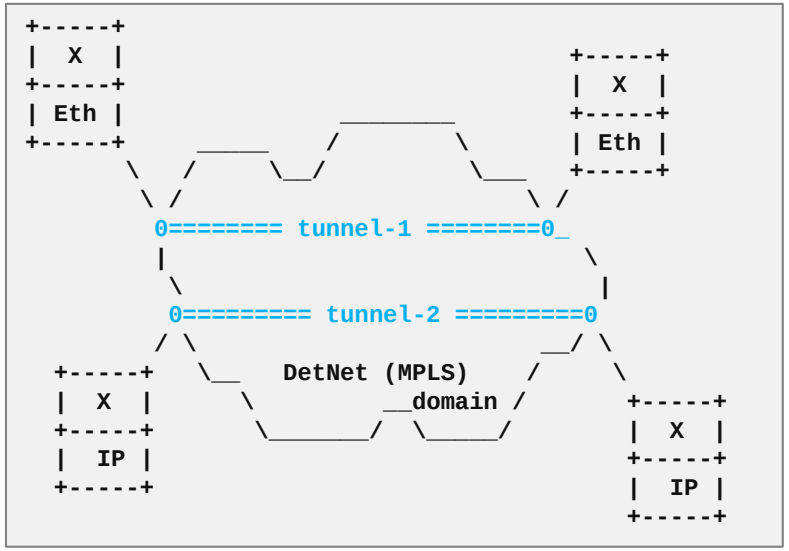
Note2: Unused reserved resources are available to non-DetNet flows as long as all guarantees are fulfilled.

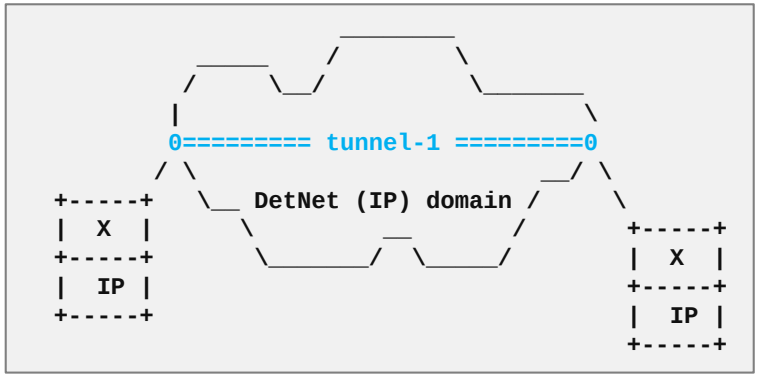
Data plane
MPLS and native IP networks

Data flows over DetNet network
- L2 → DetNet Layer 2 service
- L3 → DetNet Routing service

Data plane for DetNet over
- an MPLS-based Packet Switched Network (PSN)
- an IP-based Packet Switched Network (PSN)

DetNet functions require flow attributes from data plane
- Flow-ID
- Sequence number





MPLS data plane
draft-ietf-detnet-dp-sol-mpls-01

MPLS data plane – Basics
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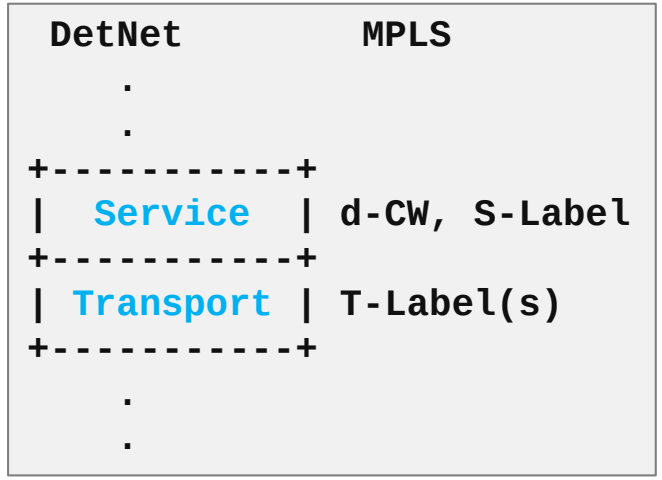
- DetNet data plane operation
  - DetNet flows over an MPLS-based Packet Switched Network (PSN)
  - DetNet service for IP and Ethernet hosts
  - DetNet specific encapsulation is defined: DetNet PW

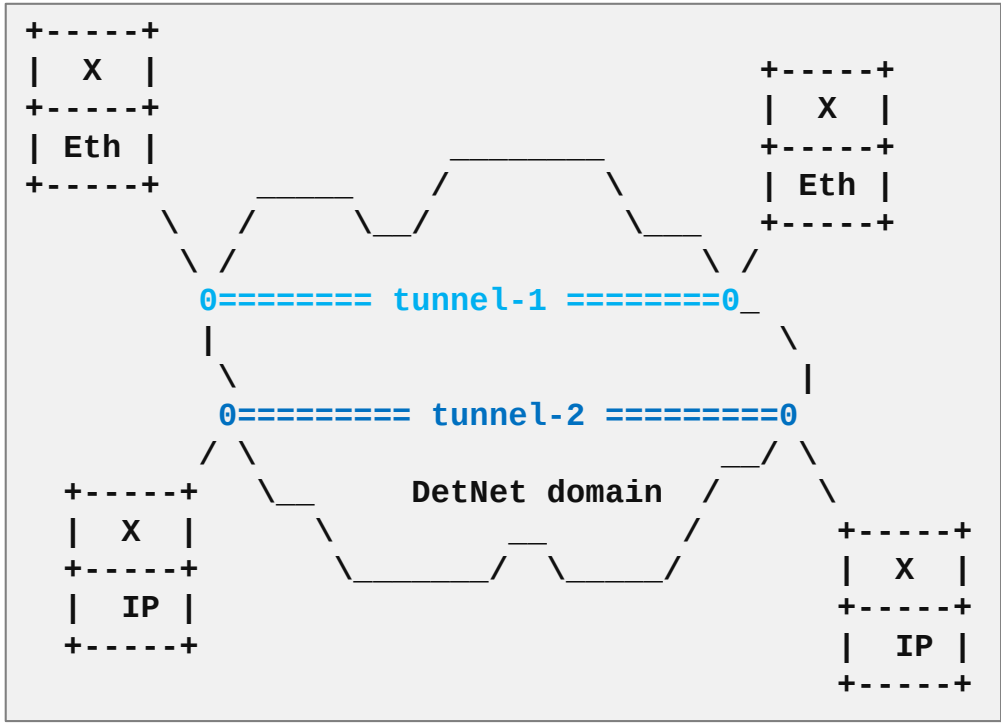


- DetNet Architecture
  - DetNet service sub-layer:
    - provides DetNet service protection and reordering
    - supported based on existing pseudowire (PW) encapsulations and mechanisms
  - DetNet transport sub-layer:
    - provides congestion protection (low loss, assured latency, and limited reordering)
    - supported based on existing MPLS Traffic Engineering encapsulations and mechanisms

MPLS data plane – End-system
Encapsulation

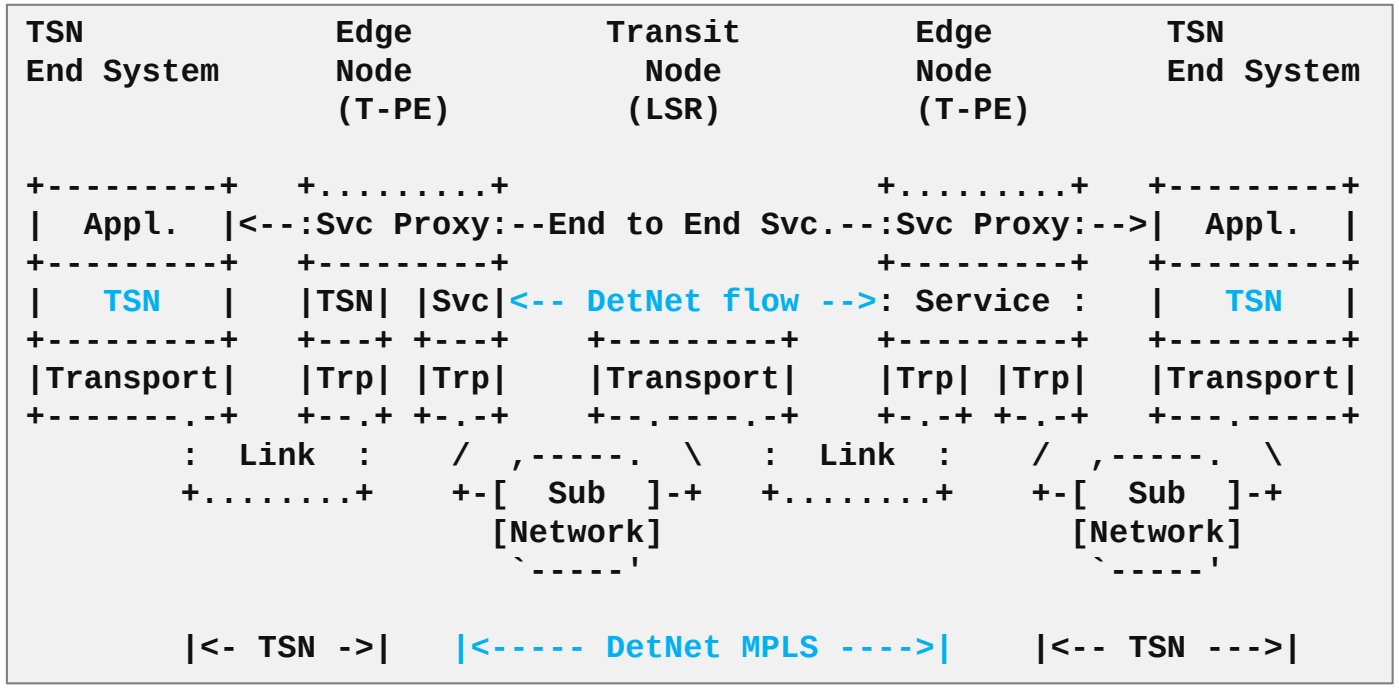
- Two types of end-systems are distinguished:
  - L2 (Ethernet) end-system: application directly over L2.
  - L3 (IP) end-system: application over L3.

- Two types of services are distinguished:
  - DetNet Layer Two Service:
    L2 headers MUST either be kept, or provision must be made for their reconstruction at egress from the DetNet domain
  - DetNet Routing Service (IP over MPLS):
    IP headers are modified per standard router behavior, e.g., TTL handling.



MPLS data plane – Scenarios
TSN over DetNet MPLS Enabled Network

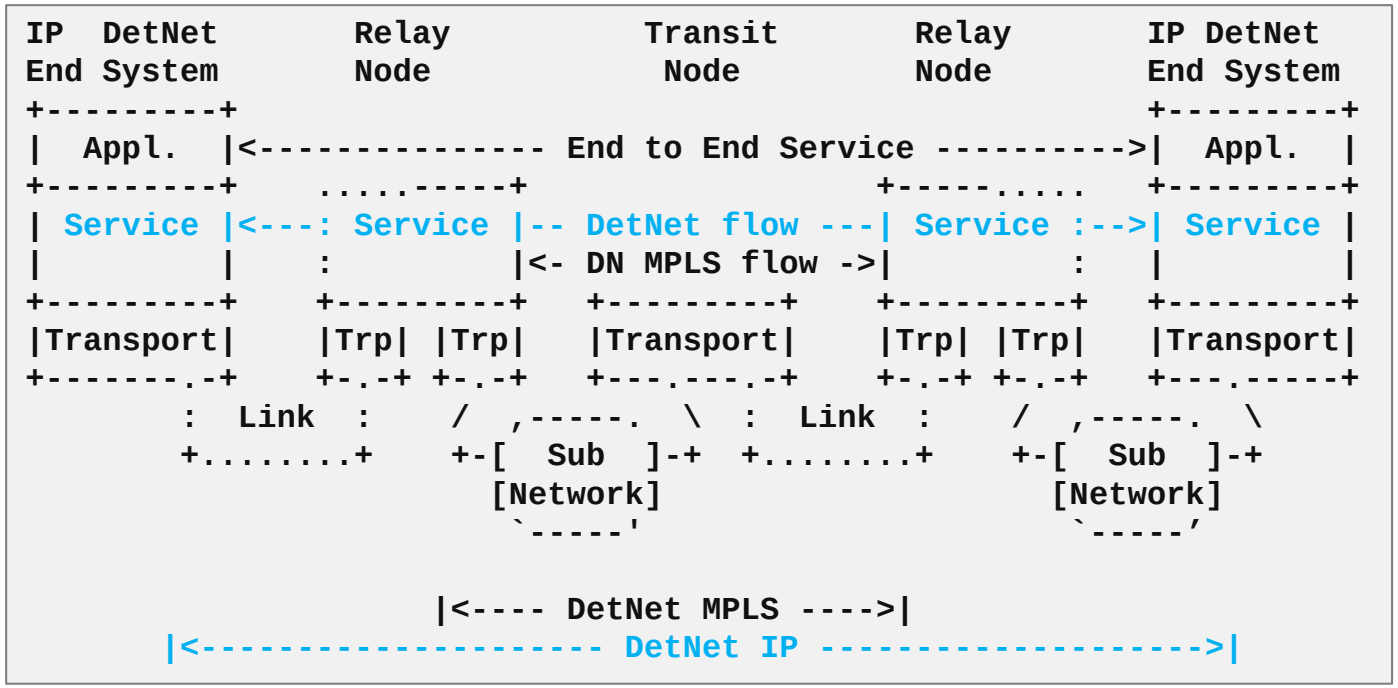
- TSN end systems originate Ethernet encapsulated traffic
- DetNet Edge Nodes
  - sit at the boundary of a DetNet domain
  - are responsible for mapping non-DetNet aware traffic to DetNet services
  - support the imposition and disposition of the required DetNet encapsulation.
  - functionally similar to pseudowire (PW) Terminating Provider Edge (T-PE) nodes which use MPLS-TE LSPs.
- Transit nodes
  - are normal MPLS LSRs
  - are generally unaware of the special requirements of DetNet flows



This conceptually parallels L2VPN services

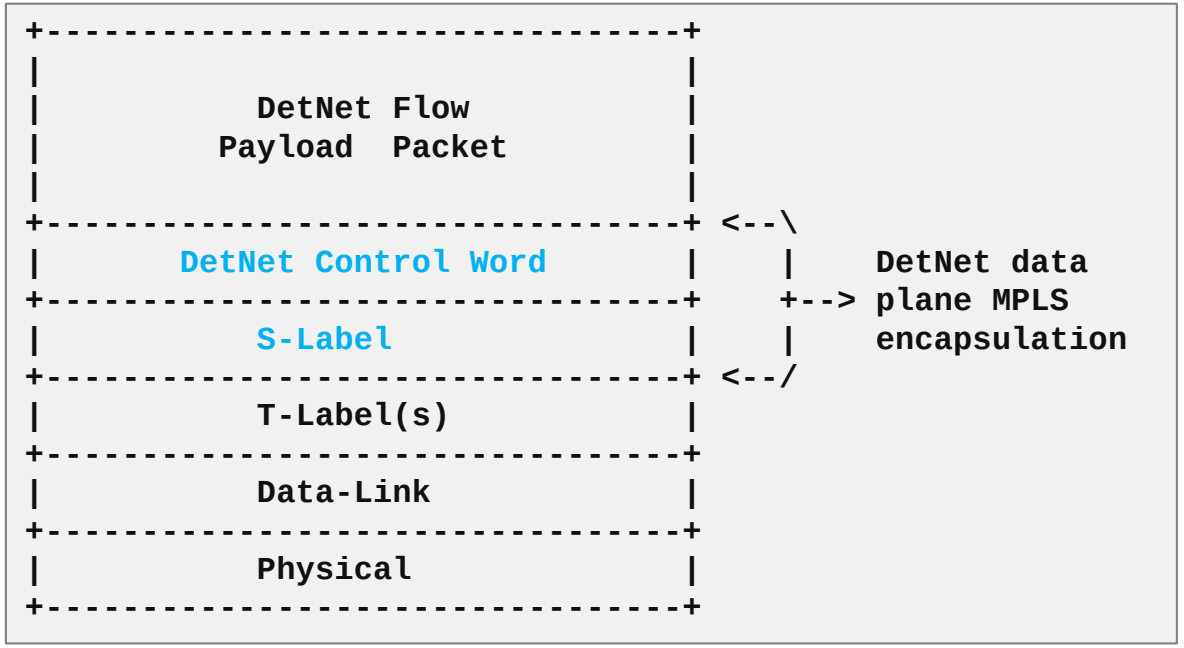
MPLS data plane – Scenarios
DetNet IP Over MPLS Network

- IP flow is mapped to one or more PWs and MPLS (TE) LSPs
- Relay nodes
  - map each DetNet flow to MPLS PWs
  - are functionally similar to PW S-PEs or, when at the edge of an MPLS network, T-PEs
- Transit node
  - is MPLS (TE) LSP aware and performs switching based on MPLS labels, and need not have any specific knowledge of the DetNet service

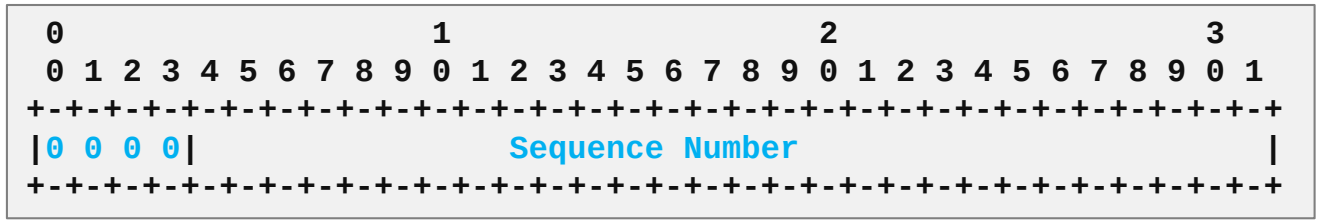


MPLS data plane – Encapsulation
DetNet PW

- MPLS-based DetNet data plane encapsulation:
  - DetNet control word (d-CW) containing sequencing information for packet replication and duplicate elimination purposes, and the OAM indicator.
  - DetNet service Label (S-label) that identifies a DetNet flow to the peer node that is to process it.
  - Zero or more MPLS transport LSP label(s) (T-label) used to direct the packet along the label switched path (LSP) to the next peer node along the path.
  - The necessary data-link encapsulation is then applied prior to transmission over the physical media.



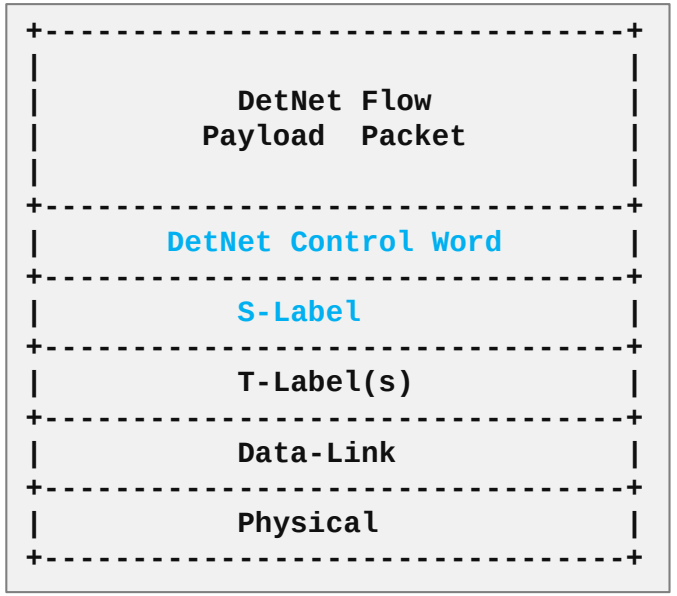
MPLS data plane – Encapsulation
DetNet control word



- d-CW:
  - d-CW MUST always be present in a packet (even if it is not used)
  - A DetNet control word (d-CW) conforms
    - to the Generic PW MPLS Control Word (PWMCW) defined in [RFC4385]
  - Two sequence number sizes are supported:
    - 16 bits and 28 bits.
  - The sequence number size
    - in use for the d-CW associated with a DetNet flow (S-Label) is configured either by a controller plane or manually for each DetNet flow.
  - Zero is an ordinary sequence number with no special meaning

Note: there is a Sequence number format mismatch between TSN and DetNet

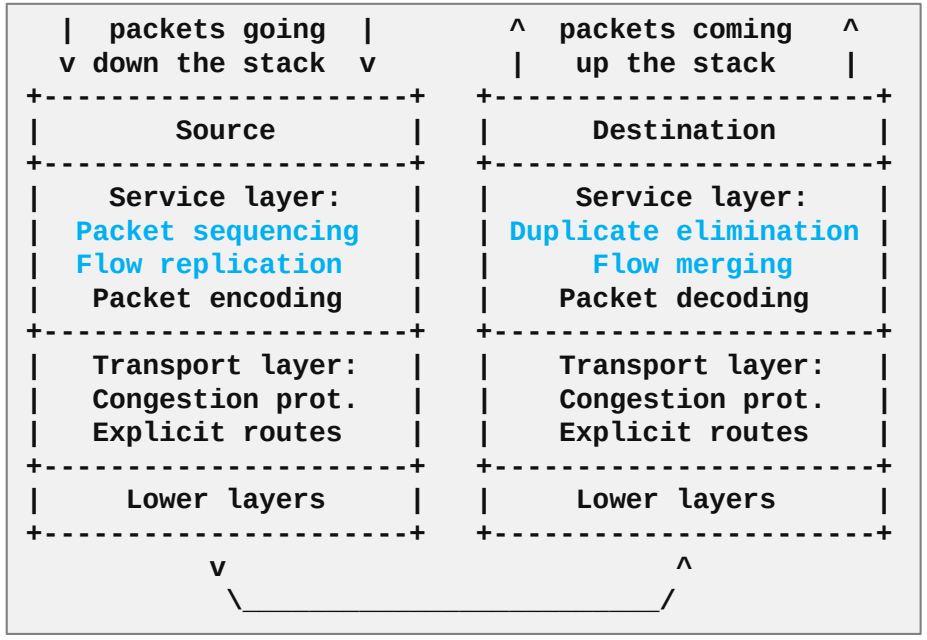
MPLS data plane – Encapsulation
Flow and payload type

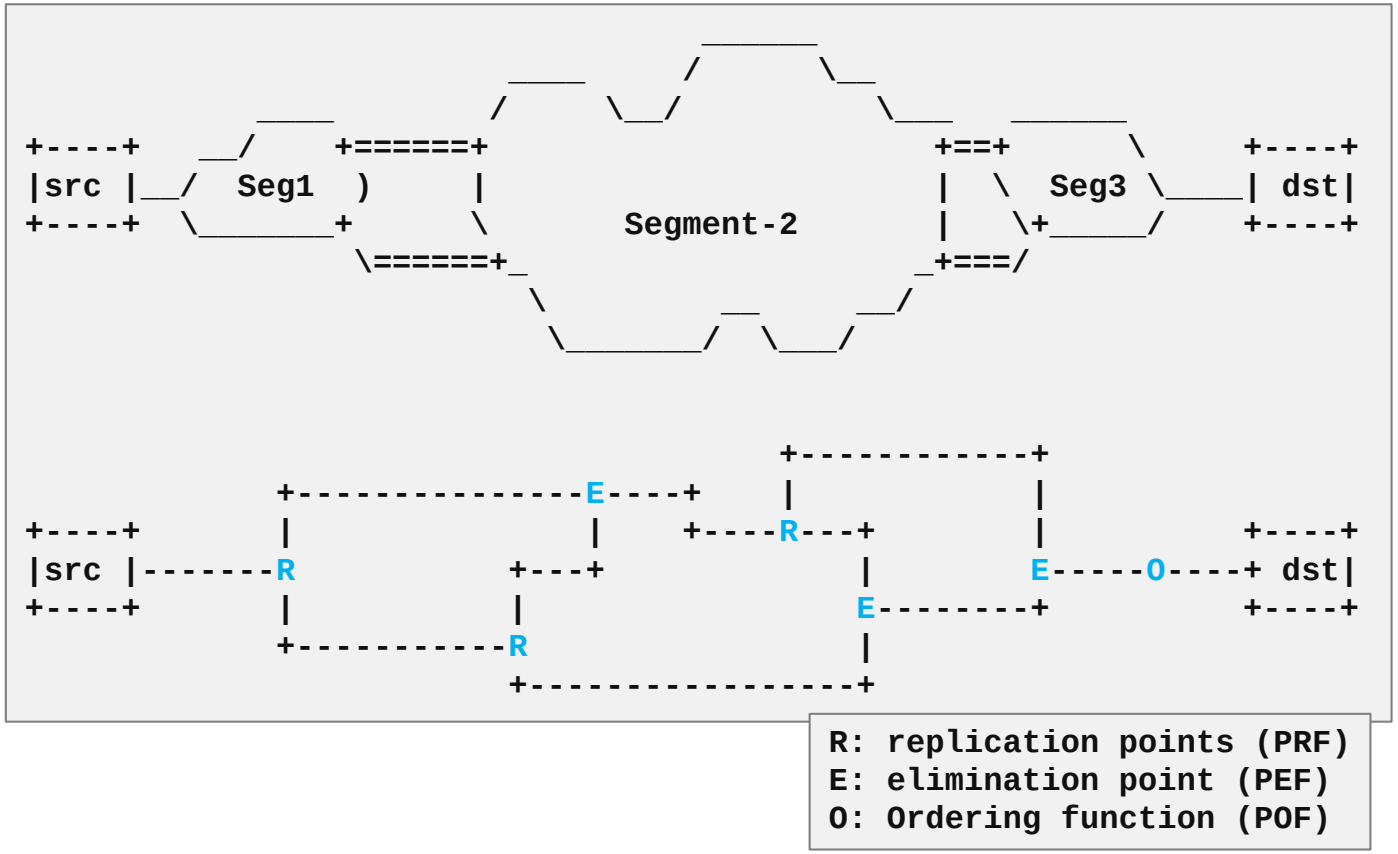


- DetNet Flow identification
  - at a DetNet service sub-layer is realized by an S-label
  - S-label is allocated from the platform label space
  - S-label MUST be at the bottom label of the label stack and MUST precede the d-CW
- Indication of the DetNet Payload Type
  - only nodes that needs to know the payload type of a flow are the DetNet ingress node and the DetNet egress nodes
  - packet type is indicated to the egress edge node through the value of the S-label

MPLS data plane – Service Layer
PREOF

- PREOF: Collective name for Packet Replication, Elimination, and Ordering Functions.
- Node behaviors covered:
  - Edge node
  - Relay node





IP data plane
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IP data plane – Basics
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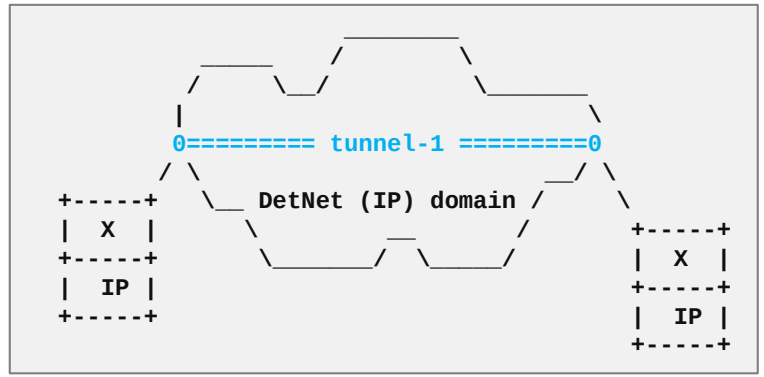


- DetNet data plane operation
  - for IP hosts and routers that provide DetNet service to IP encapsulated data
  - No DetNet specific encapsulation is defined to support IP flows, rather existing IP header information is used to support flow identification and DetNet service delivery ("6-tuple" based flow identification)
- DetNet Architecture
  - DetNet service sub-layer: provides DetNet service protection and reordering
  - DetNet transport sub-layer: provides congestion protection (low loss, bounded latency, and limited reordering, controller plane based service protection)

Note: As no DetNet specific headers are added only transport layer functions are supported

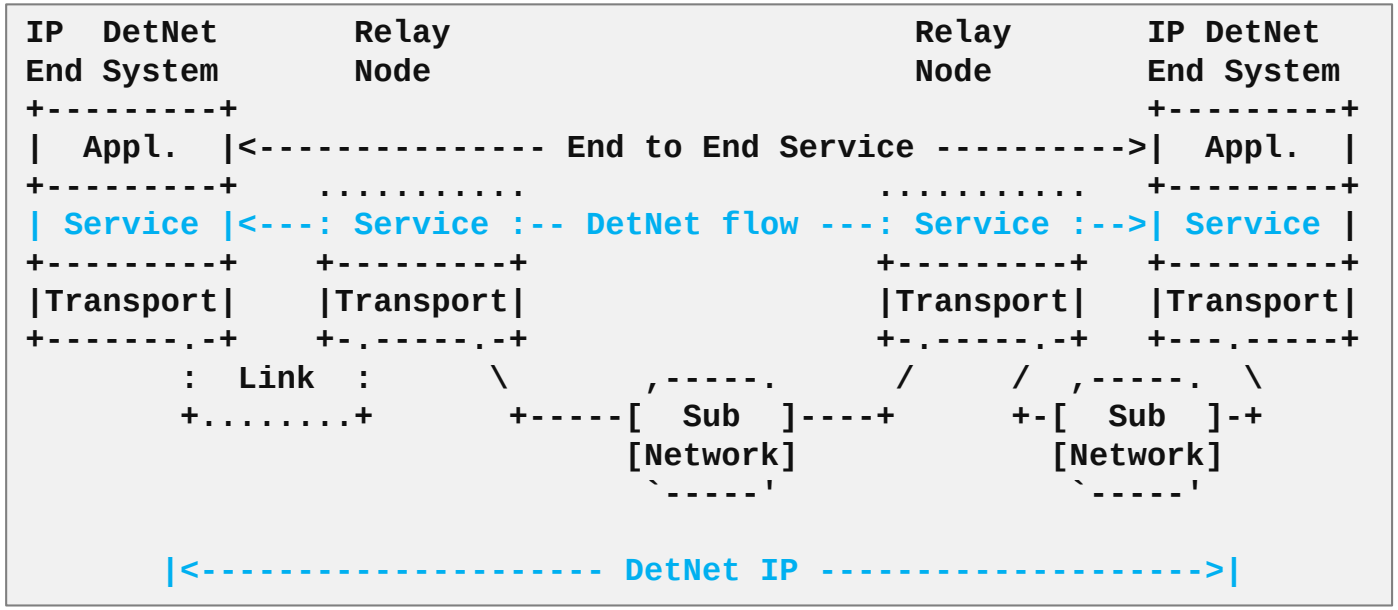
Note2: Service protection can be provided on a per sub-net basis using technologies such as MPLS and IEEE802.1 TSN

Out-of-scope:

Operation of IEEE802.1 TSN end systems over DetNet enabled IP networks is out-of-scope. While TSN flows could be encapsulated in IP packets by an IP End System or DetNet Edge Node in order to produce DetNet IP flows, the details of such are out-of-scope.

IP data plane – Scenarios
Simple DetNet (DN) Enabled IP Network

- DetNet enabled end systems originate IP encapsulated traffic
- Relay nodes
  - understand the transport requirements of the DetNet flow and ensure that node, interface and sub-network resources are allocated to ensure DetNet service requirements
  - are DetNet service aware but do not perform any DetNet service sub-layer function



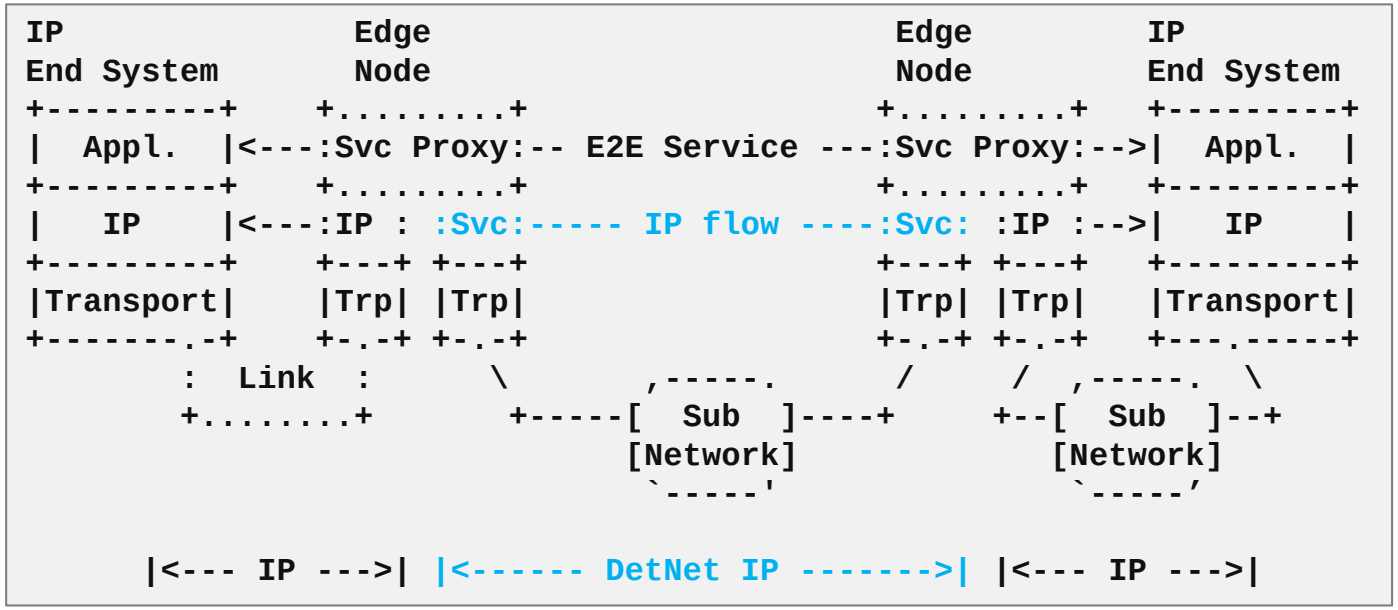
- Service protection:
  - May be provided at sub-network / link (e.g., 802.1TSN), but not by DetNet IP

IP data plane – Scenarios
Non-DetNet aware IP end systems with IP DetNet Domain

- End systems are not DetNet aware

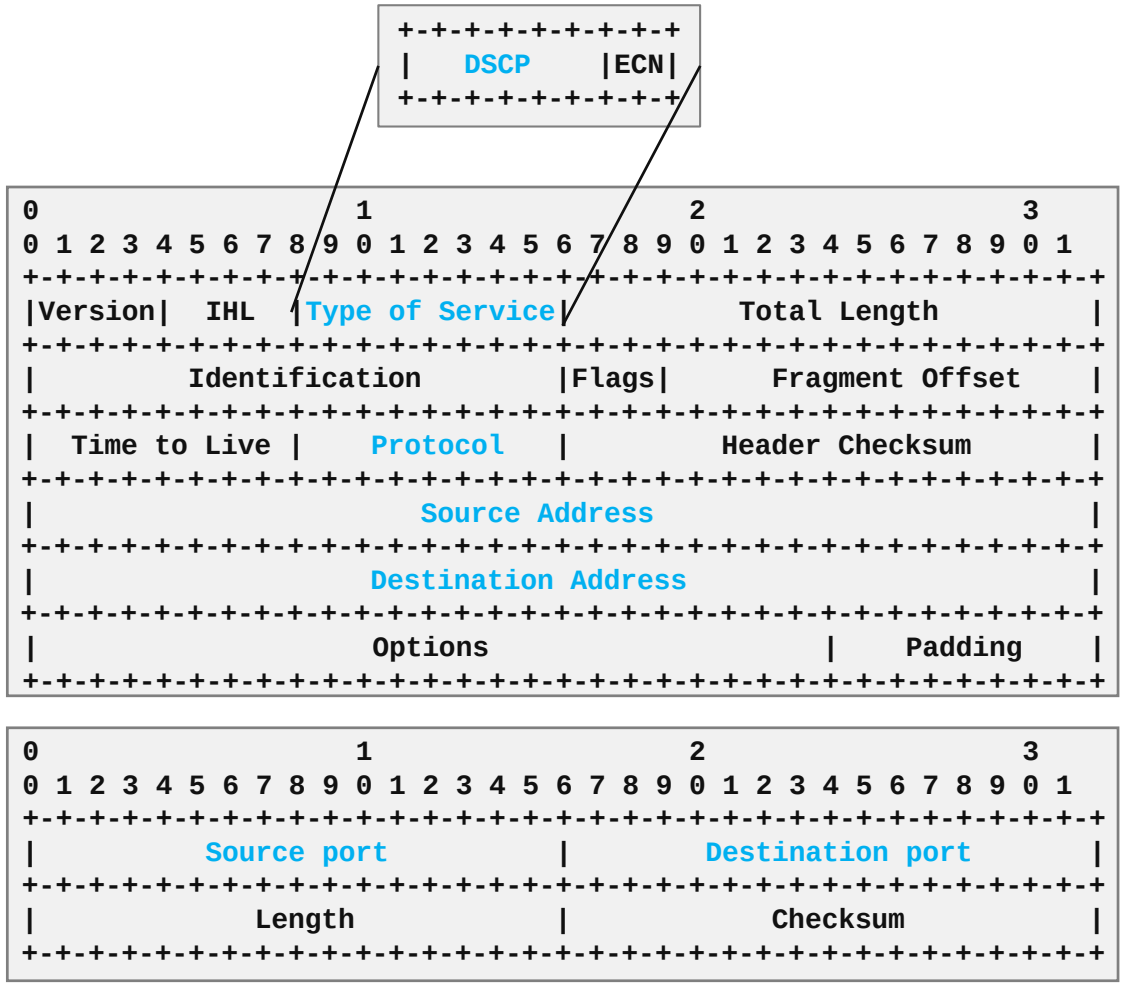
- Edge nodes
  - edge nodes sit at the boundary of the DetNet domain and act as DetNet service proxies for the end applications by initiating and terminating DetNet service for the non-DetNet aware IP flows

- Flow identification
  - existing header information can be used



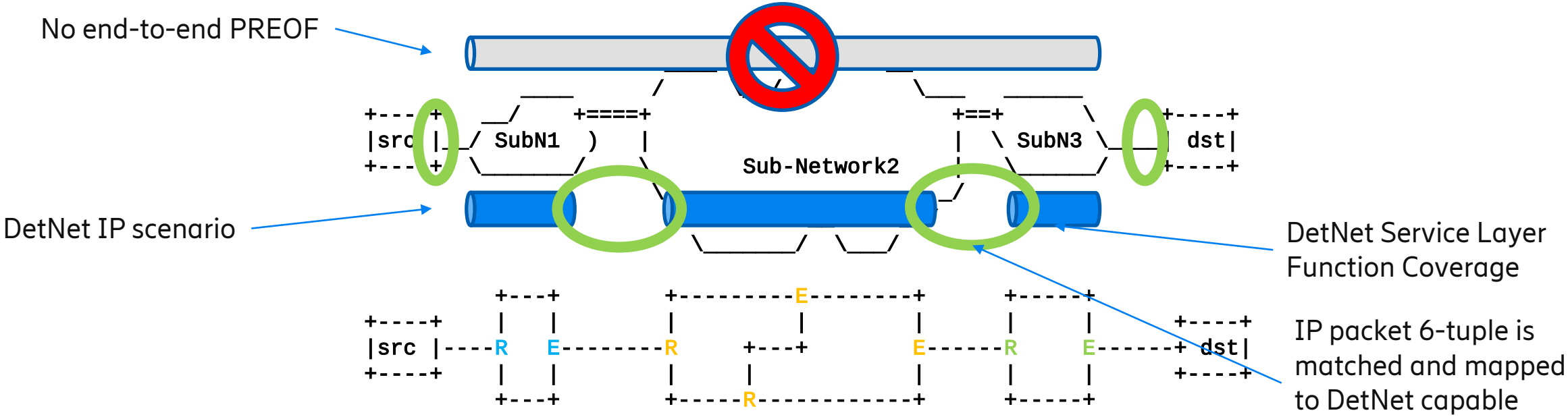
IP data plane – Flow identification
6-tuple

- Flow identification
  - based on IP (both IPv4 and IPv6) header information.
  - "6-tuple": the traditional 5-tuple + DSCP
    - IP source and destination address fields,
    - the next level protocol or header field,
    - the next level protocol specific fields (e.g. TCP or UDP source and destination ports or IPSec AH/ESP SPI field)
    - the IPv4 Type of Service or IPv6 Traffic Class field (i.e., DSCP)
  - any of the fields can be ignored (wildcarded), and bit masks, prefix based longest match, and ranges can also be used
  - Under discussion:
    - IPv6 flow label, other upper layer protocol header information



IP data plane – Service Protection
NOT end-to-end

- Service Protection
  - is done within each link / sub-network independently using the domain specific mechanisms (due the lack of a unified end to end sequencing information that would be available for intermediate nodes).



Note: POF (if any) per sub-network, not shown on the figure

Mapping DetNet to/from TSN
IETF data plane drafts, IEEE 802.1CB

Mapping to TSN – IP/MPLS data plane
Concept

- Goal:
  - TSN functions have to identify flows those require TSN treatment (i.e., VLAN/dst-MAC)

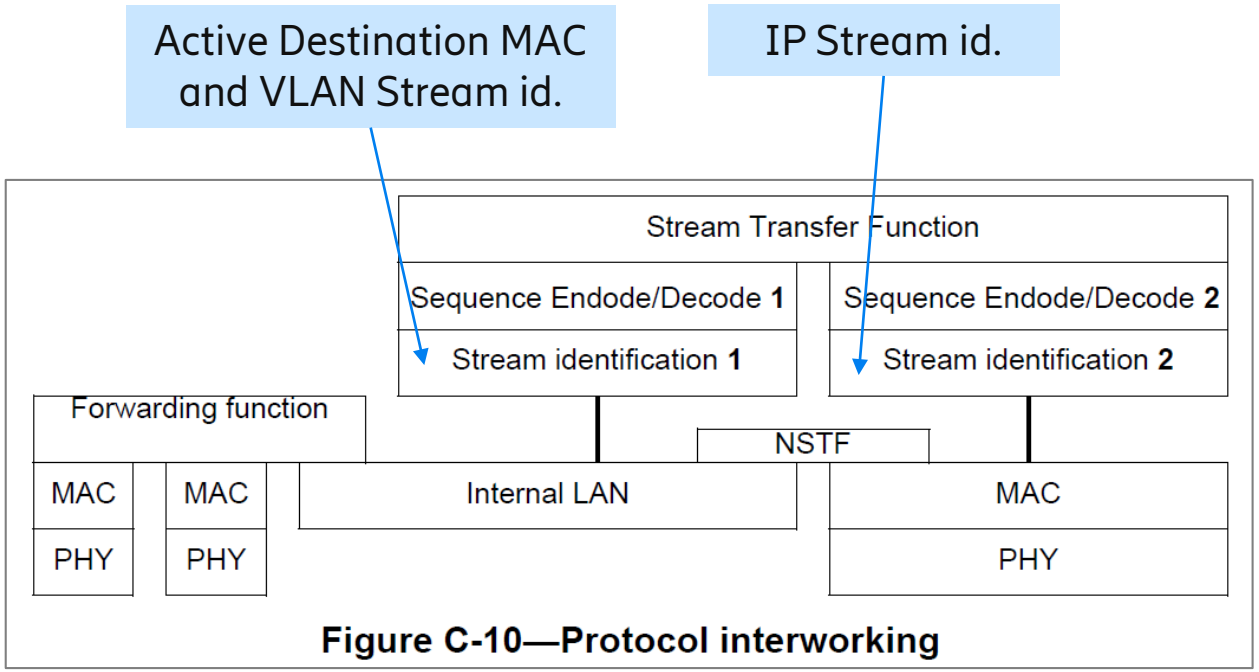


Figure C-10—Protocol interworking

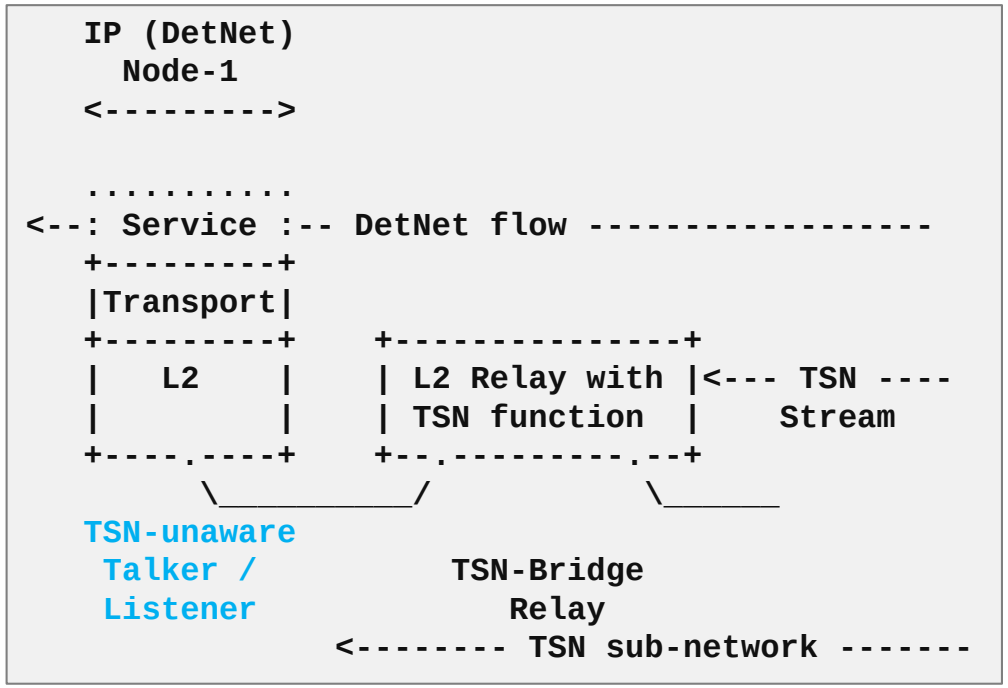
- Concept:
  - DetNet Flow and TSN Stream mapping is based on the active Stream Identification function, that operates at the frame level.
  - E.g.,
    - Function 1 could be the Active Destination MAC and VLAN Stream identification
    - Function 2 could be the IP Stream identification
  - Protocol interworking required at both (ingress and egress) end of a TSN sub-network

- Note: Work in progress to extend stream identification (IEEE P802.1CBdb)

Mapping to TSN – TSN-unaware
DetNet nodes without any TSN functions

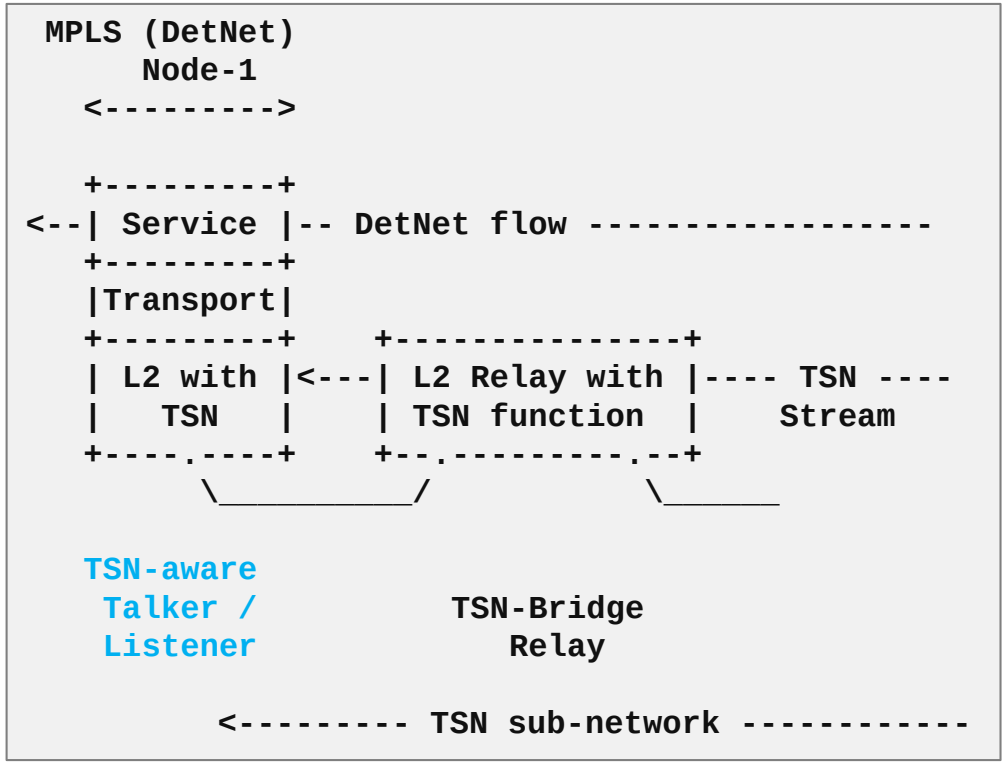
- Limitation:
  - Active stream identification defined only for IP header
  - MPLS labels are not recognized

- Mapping DetNet IP data plane:
  - IP DetNet nodes without any TSN functions can be treated as TSN-unaware Talker or Listener.
  - Relay nodes in the TSN sub-network MUST modify the Ethernet encapsulation of the IP DetNet flow (e.g., MAC translation, VLAN-ID setting, Adding Sequence number, etc.) to allow proper TSN specific handling of the flow inside the sub-network.



Mapping to TSN – TSN-aware
DetNet nodes with TSN functions (MPLS example)

- Mapping:
  - TSN capable MPLS (DetNet) nodes are TSN end stations
  - Maps DetNet flows to/from TSN Streams
- TSN end station required capabilities includes the following TSN components:
  - For recognizing flows:
    - Stream Identification (MPLS-flow-aware)
  - For FRER used inside the TSN domain, additionally:
    - Sequencing function
    - Sequence encode/decode function
  - For FRER when the node is a replication or elimination point, additionally:
    - Stream splitting function
    - Individual recovery function



Note: IEEE P802.1CBdb extends stream identification
Note2: Sequence number format mismatch may be a problem

DetNet Flow / Service parameters
draft-ietf-detnet-flow-information-model-02

DetNet Flow / Service parameters
draft-ietf-detnet-flow-information-model-02

- Flows leveraging DetNet service
  - unicast or multicast data flows for an application with constrained requirements on network performance, e.g., low packet loss rate and/or latency.
- Flows have the following attributes:
  - DataFlowSpecification
    - …
    - IPv6FlowLabel
    - MplsLabel
  - TrafficSpecification
  - FlowRank
- Service parameters
  - Bandwidth
  - Delay parameters:
    - Maximum latency
    - Packet Delay Variation (PDV)
  - Loss parameters:
    - Maximum Packet Loss Ratio (PLR)
    - Maximum consecutive loss tolerance
  - Maximum allowed mis-ordering
  - Connectivity type
  - Service rank

Note: orange text highlight differences to IEEE802.1Qcc

Questions …