PCEP Extensions for Fine Granularity Metro Transport Network (fgMTN) Topology Resource Information Reporting & Path Setup

draft-han-pce-ls-fgmtn-reporting-00
draft-han-pce-fgmtn-setup-00
draft-han-pce-path-computation-fg-transport-02

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Path Computation Requirements for fgMTN/fgOTN

With the proposal of new service demand, the transport technologies of Metro Transport Network (MTN) and Optical Transport Network (OTN) are both moving towards fine- grain hard slices.

Path Computation Extension Requirements for Fine-Granularity Transport Network(draft-han-pce-path-computation-fg-transport-02) have been presented in CCAMP before.

a) **The number of fine-grain fgMTN TDM channels will significantly increase**.

- One 5Gbps MTN channel support up to 480 fgMTN connections.
- One 10GE Ethernet channel support up to 960 fgMTN connections.

b) **According to service requirements (e.g. private line services) , fgMTN paths may change frequently and dynamically**.

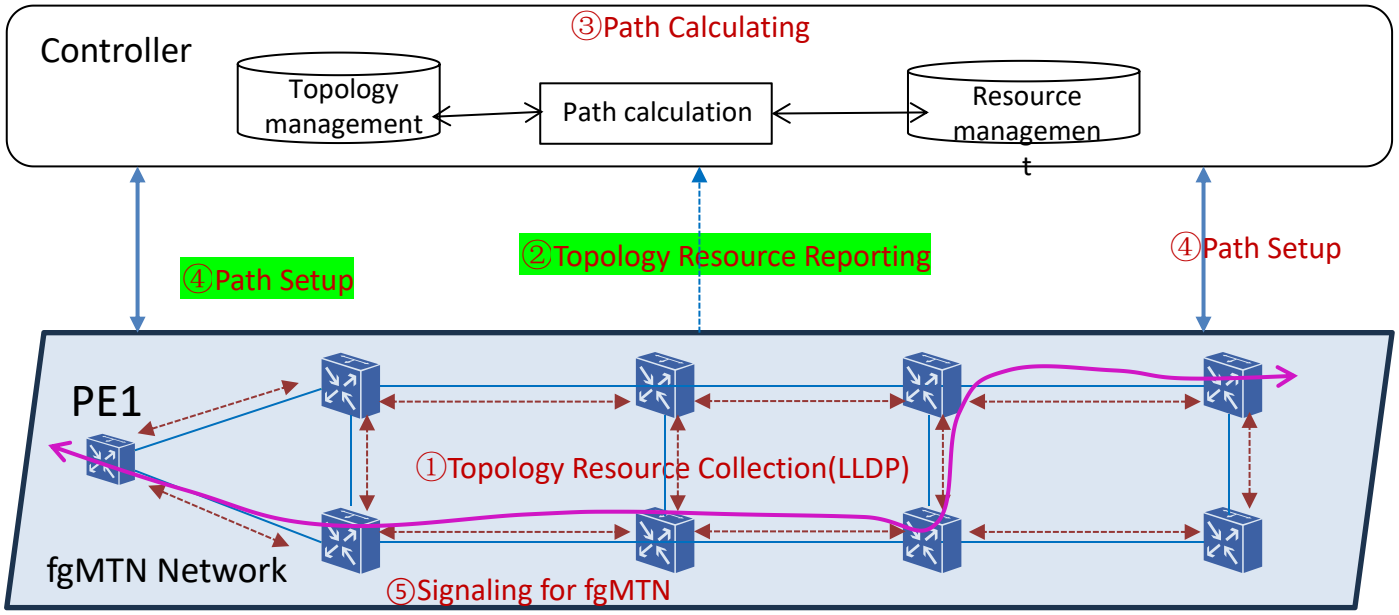
- An fgMTN channel can carry and be dedicated to serving a specific CBR (Constant Bit Rate) or Ethernet service.
- When the services appear or end, or its bandwidth changes, or the destination address changes, they will cause changes in fine-grain channels.

https://datatracker.ietf.org/doc/draft-han-pce-path-computation-fg-transport/

fgMTN Control and Management Architecture

Centralized control PCE

Distributed control protocols



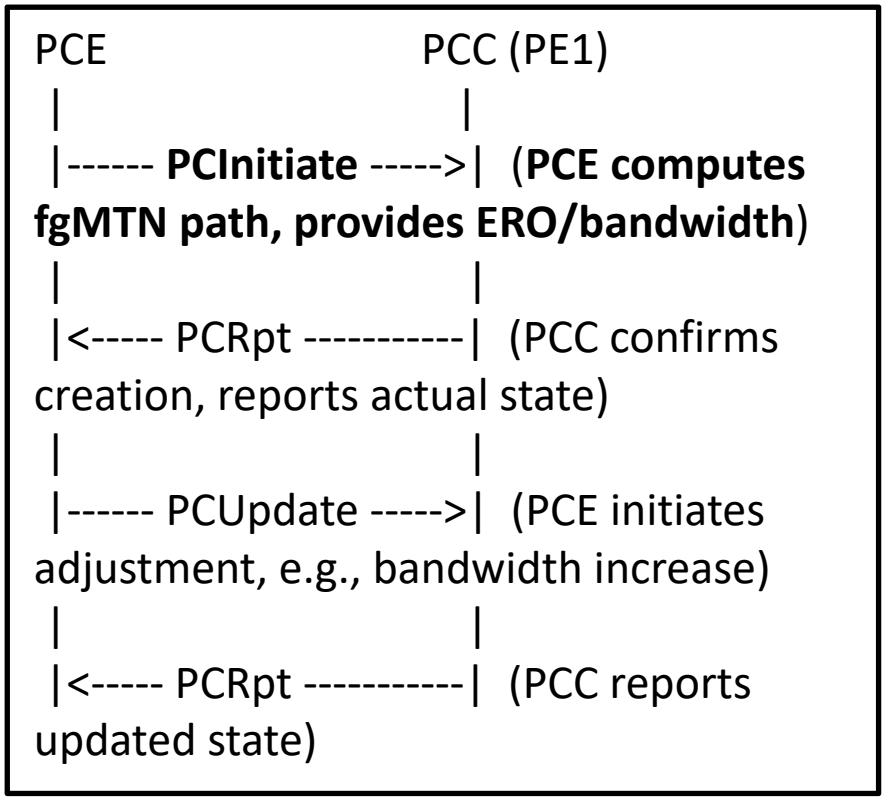
- Centralized control PCE collects topology resource information and calculates the route for fgMTNP channel, and the path computation results are delivered to PE1 (head end).
- Distributed control protocols between devices allocates TDM calendar slot resources **hop-by-hop**.
- Both topology resource reporting and path setup have not defined for fgMTN. PCE can be extended to meet the fgMTN requirements.

Extensions for fgMTN Topology Resource Information Reporting in PCEP-LS

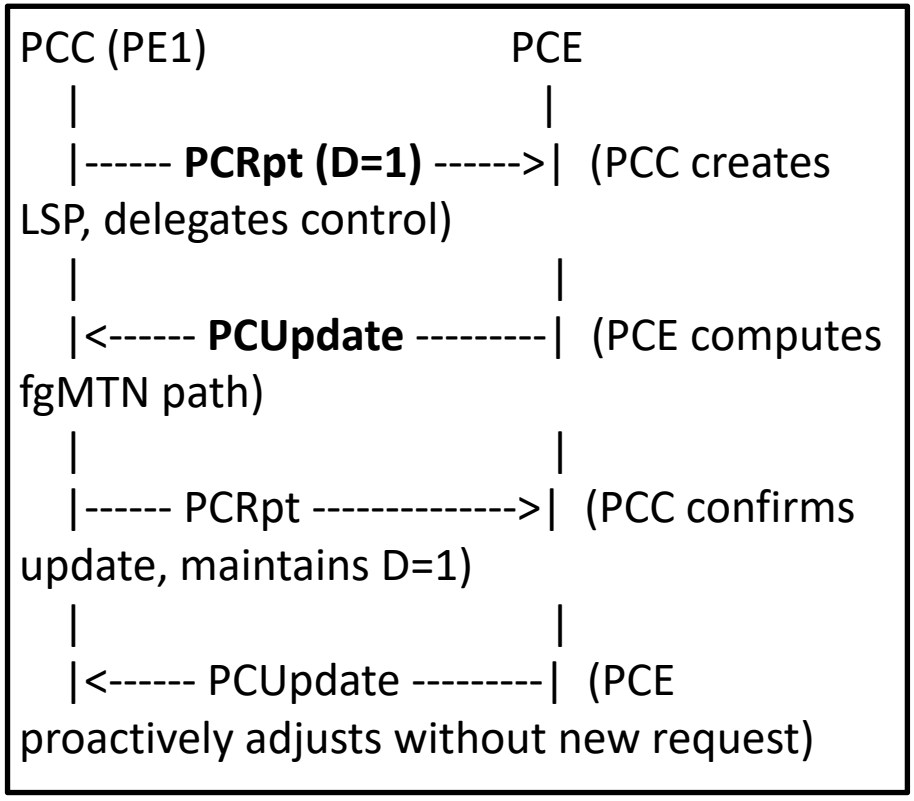
- PCEP-LS is extended by defining several new sub-TLVs for the LS object to report the fgMTN topology resource information, which includes timeslot occupation status of links and the relationship between the fgMTN client and the occupied timeslots.
  - OPEN Object Extensions : a new flag ***M*** in LS-CAPABILITY TLV flag field for fgMTN capability
  - LS Object Extensions：four kinds of Link Descriptor Sub-TLVs to describe the fgMTN resource information
    - Parent NRP ID sub-TLV：indicates the NRP ID (slice ID) that the link belongs to.
    - Sub-Slot BitMap Sub-TLV: indicates the timeslot's occupation status of all FGU clients in the link.
    - FGU Client Sub-Slot Bitmap Relationship Sub-TLV：indicates the relationship between the occupied timeslots(expressed by bitmap) and corresponding FGU Clients.
    - FGU Client Sub-Slot Relationship Sub-TLV：indicates the relationship between the occupied timeslots(expressed by enumeration value) and corresponding FGU Clients.

fgMTN path setup： PCE and PCC Interaction

- Both PCE-Initiated centralized control and PCC-Initiated with delegation can supported for fgMTN path setup.



PCE-Initiated Centralized Control



PCC-Initiated with Delegation

Object Extensions for fgMTN Path Setup in PCEP (1/2)

- A New path setup type (PST) value dedicated to fgMTN paths
  - OPEN object of Open message: The fgMTN PST capability is advertised during session establishment via the PATH-SETUP-TYPE-CAPABILITY TLV (Type 34) carried within the OPEN object of Open message, enabling capability negotiation between PCE and PCC.
  - stateful operations: the PATH-SETUP-TYPE TLV (Type 28) bearing the fgMTN PST value is encapsulated within the SRP (stateful PCE Request Parameters) object (Object-Class 33) of PCRpt, PCUpd, and PCInitiate message, ensuring consistent PST identification throughout LSP state synchronization, delegated updates, and PCE-initiated path establishment.
- LSP Object Extension (Object-Class 32)
  - The LSP object defined in [RFC8231] is utilized to represent an fgMTN LSP. Two new TLVS are specified: **fgMTN IPV4-LSP-IDENTIFIERS TLV and fgMTN IPV6-LSP-IDENTIFIERS TLV** , which respectively specify the ingress and egress IPv4 or IPv6 addresses of the fgMTN tunnel, together with the fgMTN tunnel identifier.

Object Extensions for fgMTN Path Setup in PCEP (2/2)

- ERO Object Extension (Object-Class 7)
  - The fgMTN path encoded in ERO adheres to a strictly hop-by-hop paradigm without IP addresses. Each **fgMTN ERO subobject** contains a strict hop indicator (with L-bit set to 0, enforcing strict hop), a new 7-bits Type indicates fgMTN, and a server layer port identifier (representing either a 5Gbps MTN port or a 10GE interface enabled in fine-grained mode).
- BANDWIDTH Object Extension (Object-Class 5)
  - BANDWIDTH Object specified in [RFC8779] is employed for fgMTN bandwidth specification. A new **Bw Spec Type** defined for fgMTN, wherein the corresponding parameter, carried in the GENERALIZED-BANDWIDTH TLV (Type 3), expresses the number of fine-grained TDM calendar slots (fgCSs) allocated to the fgMTN LSP.

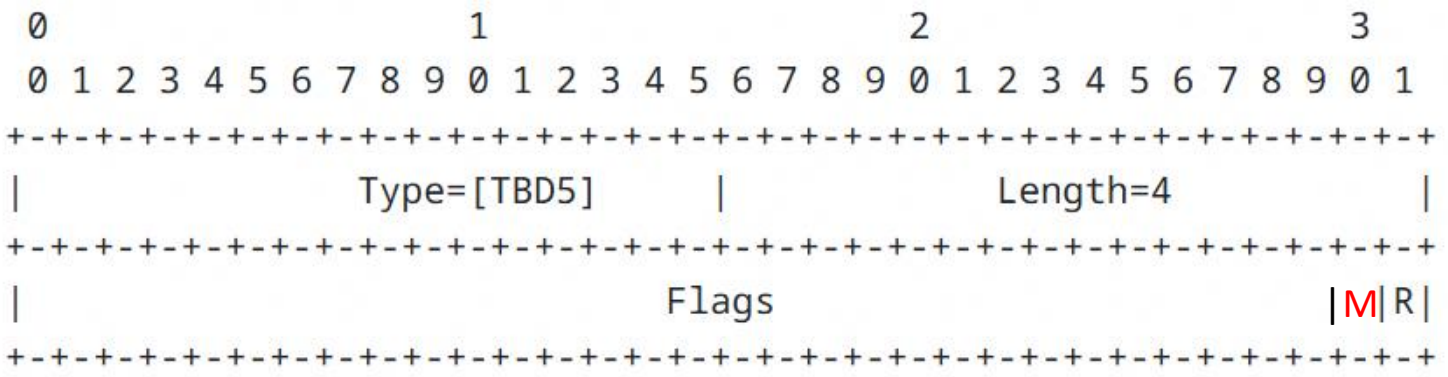
Next Step

- This draft mainly proposed to extend PCEP object for the fine-grain metro transport network (fgMTN).
- The specific procedures will be detailed in the next version.
- Comments welcome.

Thank you!

Topology Resource Information Reporting --OPEN Object Extensions

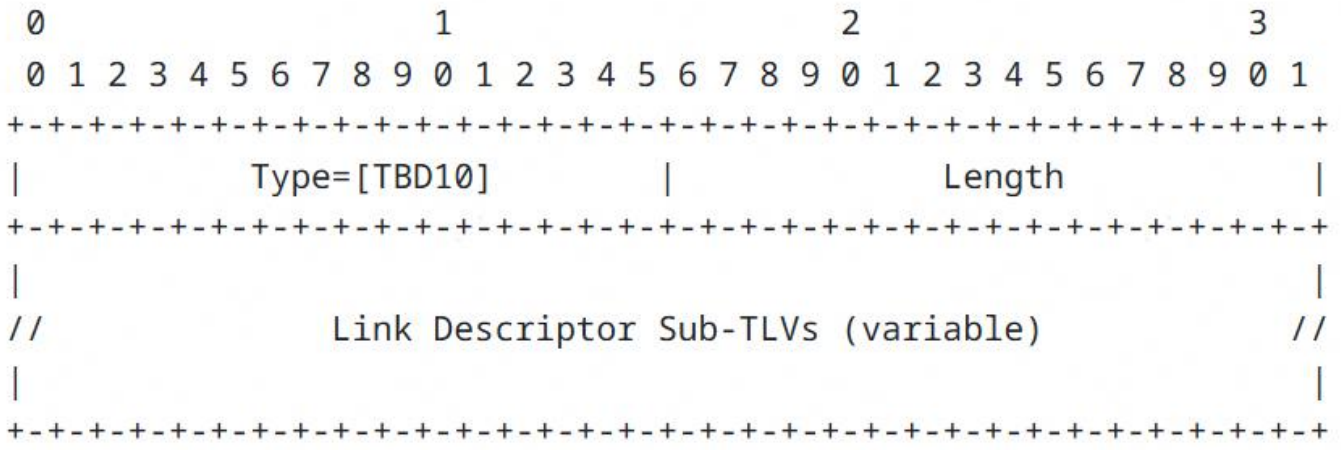
- [draft-ietf-pce-pcep-ls] defines LS-CAPABILITY TLV in the OPEN Object for link-state (and TE) distribution via PCEP capability advertisement.
- A new flag is defined in the flags field of the LS-CAPABILITY TLV to indicate the support of fgMTN resource information reporting.



M: if set to 1 by a PCC, the M Flag indicates that the PCC allows the reporting of fgMTN resource information learned via other means like LLDP; if set to 1 by a PCE, the M Flag indicates that the PCE is capable of receiving fgMTN resource information.

LS Object Extensions

- LS object[draft-ietf-pce-pcep-ls] contains a set of TLVs used to specify the target node's or link's information.
- LS object includes the Link Descriptors TLV. This TLV contains Link Descriptors for each link. The value of it contains one or more Link Descriptor Sub-TLVs.
- This draft defines four kinds of Link Descriptor Sub-TLVs to describe the fgMTN resource information.



Format of Link description TLV

LS Object Extensions (1/4)

- **Parent NRP ID sub-TLV:** indicates the NRP ID that the link belongs to. This sub-TLV is an optional sub-TLV MAY be included in the Link Descriptors TLV.

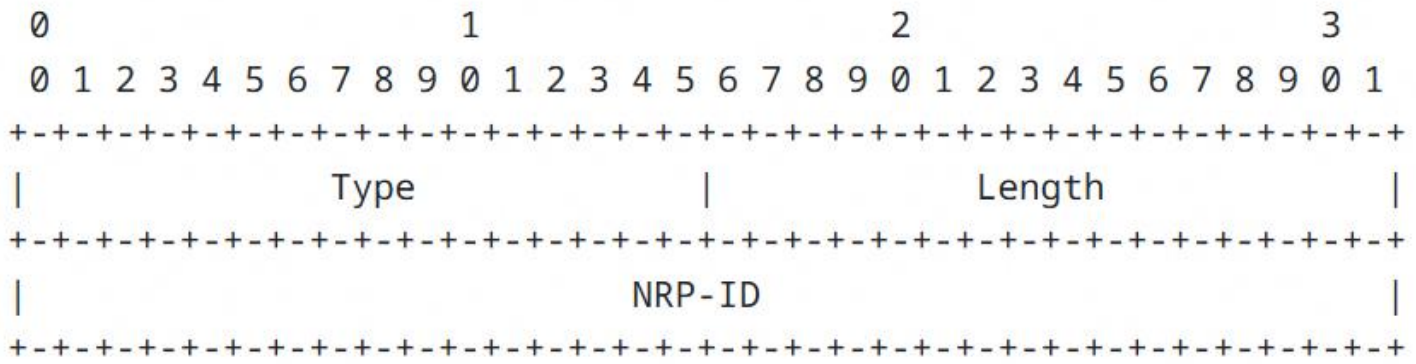
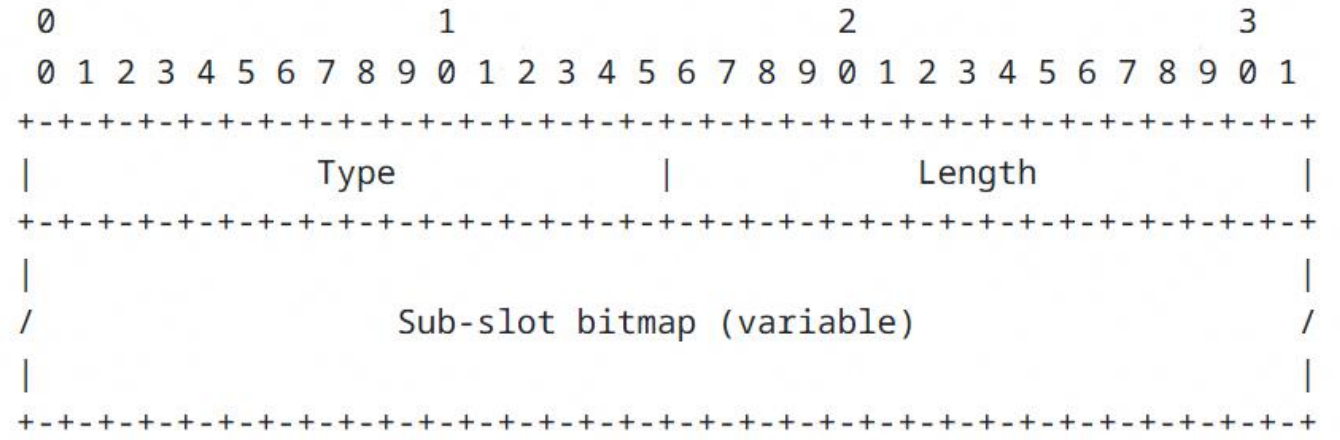


Figure 1: Parent NRP ID Sub-TLV

- Type: TBD1, needs to be allocated by IANA.
- Length: the length of NRP-ID, equals to 4.
- NRP-ID: the value of NRP-ID is the slice ID of the service-layer interface (MTN client or GE/10GE interface) of a fine-grained interface.

LS Object Extensions (2/4)

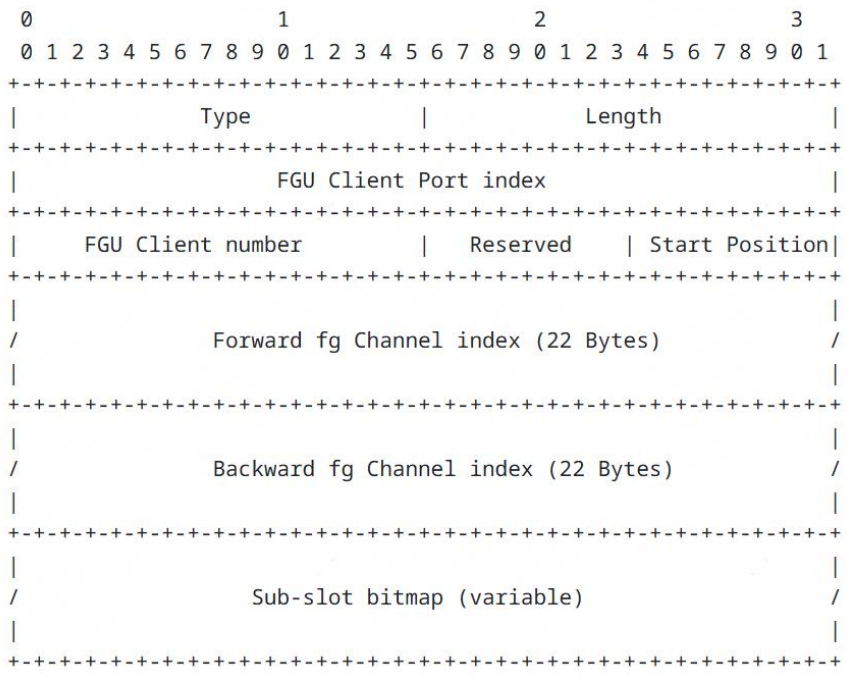
- **Sub-Slot BitMap Sub-TLV:** indicates the timeslot's occupation status of all FGU clients in the link. This sub-TLV is an optional sub-TLV MAY be included in the Link Descriptors TLV.



- Type: TBD2, needs to be allocated by IANA.
- Length: the length of sub-slot bitmap, variable.
- Sub-slot bitmap: variable, indicates the occupation state of all the timeslots of the link, each bit represents a timeslot. If the last bits are all zeros, the padding can be omitted.

LS Object Extensions (3/4)

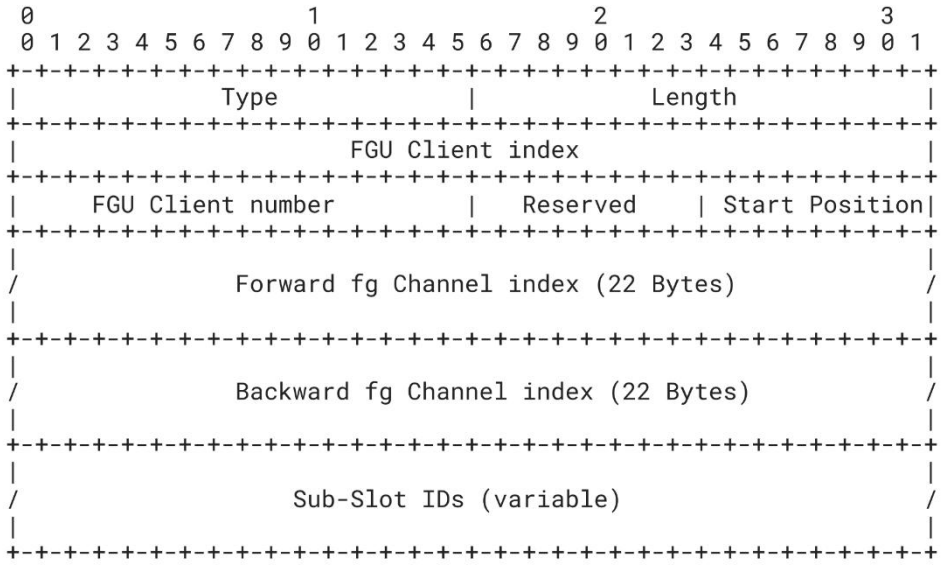
- **FGU Client Sub-Slot Bitmap Relationship Sub-TLV:** indicates the relationship between the occupied timeslots(expressed by bitmap) and corresponding FGU Clients.



- **FGU Client Port index:** the local FGU client port identifier allocated by the device itself.
- **FGU Client number:** the FGU client identifier negotiated by the source and destination device, which is unique within a MTN client.
- **Start Position:** the start position of the timeslots occupied by the current FGU client.
- **Forward fg Channel index:** forward fg channel identifier. It is a unique channel ID on the entire network, which is identified by the combination of the source device's MPLS LSR ID, fg Channel ID, and LSP ID.
- **Backward fg Channel index:** backward fg channel identifier. It has the same structure with the Forward fg Channel index.
- **Sub-slot bitmap:** variable, indicates the occupation state of all the sub-slots of the FGU.

LS Object Extensions (4/4)

- **FGU Client Sub-Slot Relationship Sub-TLV:** indicates the relationship between the occupied timeslots(expressed by enumeration value) and corresponding FGU Clients.



- **FGU Client Port index:** the local FGU client port identifier allocated by the device itself.
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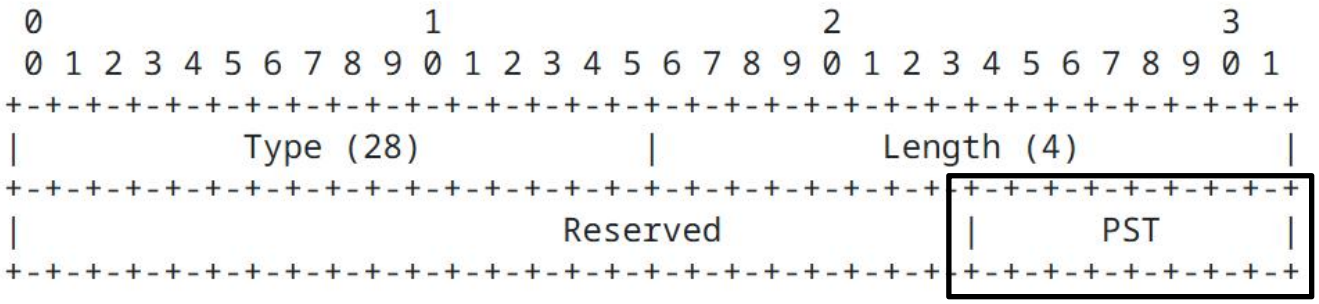
- **Forward fg Channel index:** forward fg channel identifier. It is a unique channel ID on the entire network, which is identified by the combination of the source device's MPLS LSR ID, fg Channel ID, and LSP ID.
- **Backward fg Channel index:** backward fg channel identifier. It has the same structure with the Forward fg Channel index.
- **Sub-slot IDs:** variable, indicates the occupation state of all the sub-slots of the FGU.

fgMTN PCEP PATH SETUP Extensions(1/4)

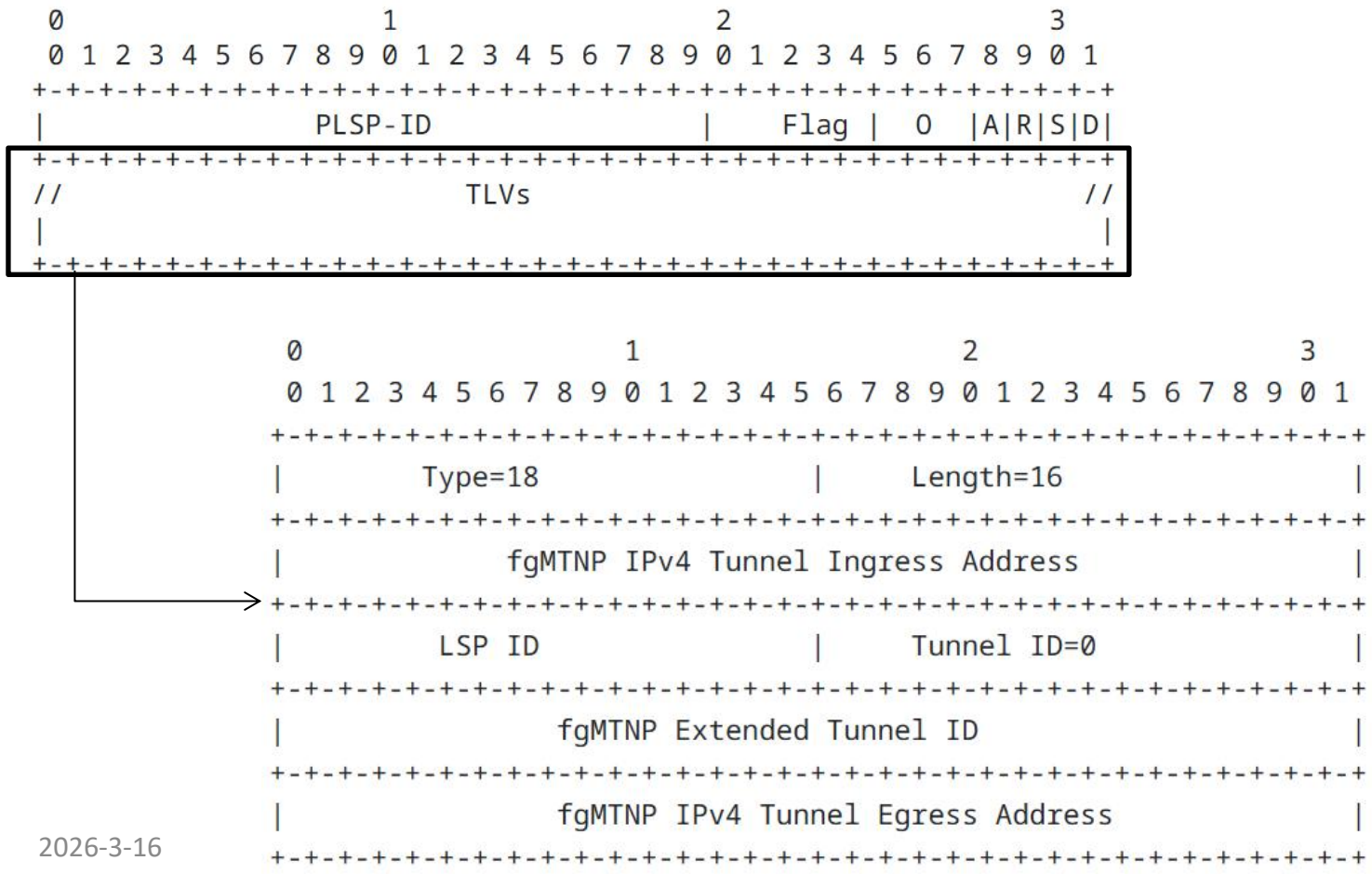
- PCE must be able to specify the fgMTN path, while the PCC must be able to take corresponding control-plane and forwarding plane based on the fgMTN PST.
- **PST: Traffic-engineering path is setup for fgMTN LSP.**



- In addition, PATH-SETUP-TYPE-CAPABILITY TLV, defined in RFC8408, can be reused in fgMTN. The PCEP speaker carries fgMTN PST within PATH-SETUP-TYPE-CAPABILITY TLV of OPEN object, indicating support for fgMTN PST during the PCEP initialization phase.

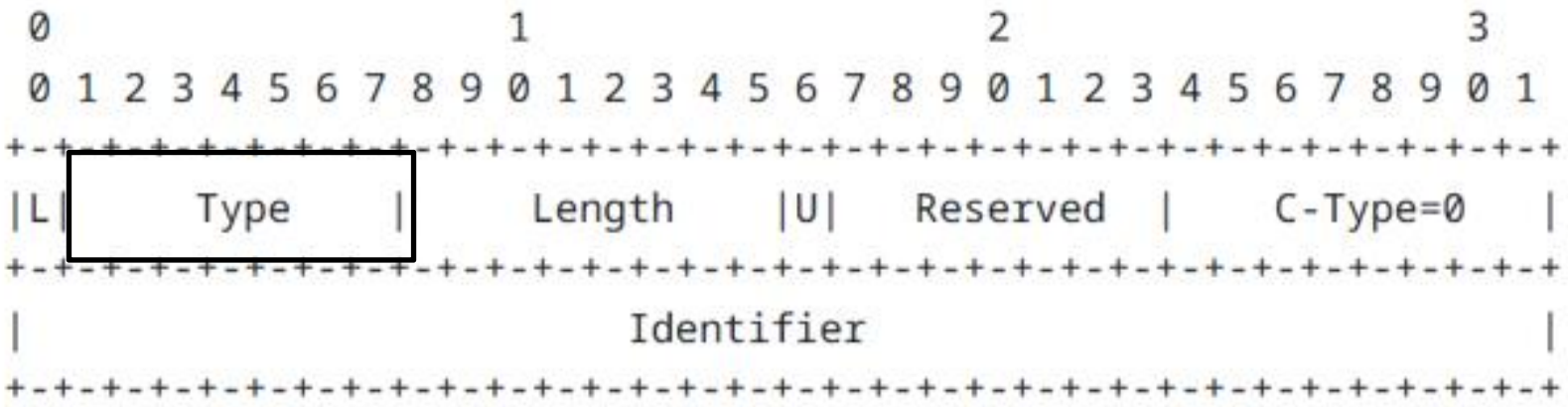
LSP Object(2/4)

- LSP object defined in [RFC8231] can be used for fgMTN LSP.
- TLVs includes the **fgMTN IPV4-LSP-IDENTIFIERS TLV and fgMTN IPV6-LSP-IDENTIFIERS TLV** .



ERO Object(3/4)

- FgMTN path computed by a PCE are represented in an ERO is hop-by-hop identifiers indicating the server layer port of fgMTN, without corresponding IP addresses.
- Each fgMTN-ERO subobject can reuse the ERO subobject defined in [RFC3473] represents each hop of MTN port identifier for fgMTN LSP.

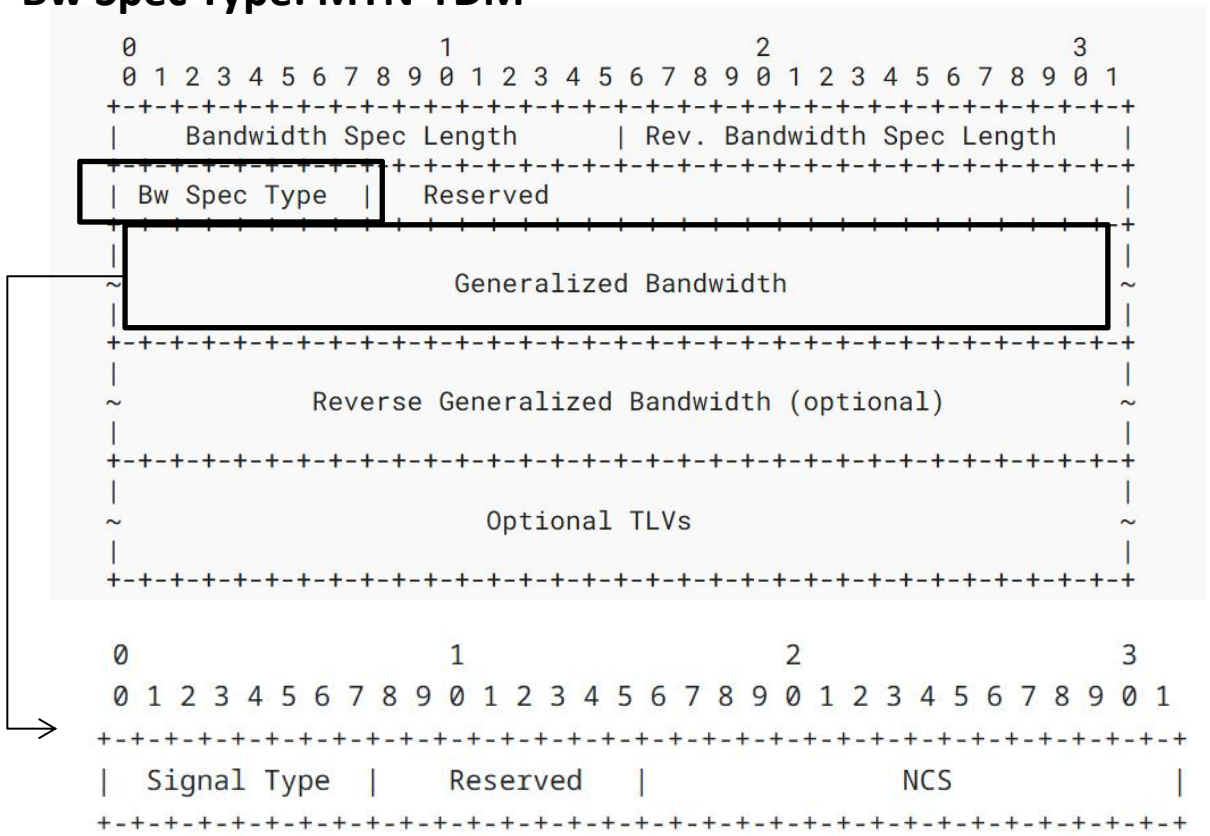


- L-bit set to 0 indicates strict hop indicator
- 7 bits Type indicate the fgMTN Type
- Identifier is a unique server layer port identifier of network element (representing either a 5Gbps MTN port or a 10GE interface enabled in fine-grained mode).

BANDWIDTH Object(4/4)

- BANDWIDTH object defined in [RFC8779] is reused for fgMTN.

Bw Spec Type: MTN-TDM



- Signal Type : 8 bits This value indicates the fgMTN LSP.
- NCS (Number of Calendar Slots): 16 bits This field indicates the number of fgCSs for this fgMTNP LSP.