Path Computation Element Communication Protocol (PCEP) Extension for Fine Granularity Metro Transport Network (fgMTN)

draft-han-pce-fgmtn-00

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Introduction

- MTN [ITU-T_G.8310] integrates packet and TDM technologies, enabling compatibility with Ethernet protocol stacks while meeting differentiated requirements of the 5G era.
- On this basis, the fgMTN technology [ITU-T_G.8312.20] incorporates fine-grained slicing into the MTN architecture, providing a low-cost, refined, hard-isolated, and fine-grained bearer channels.
- However, the current MTN management and control standard [ITU-T_G.8350] only defines the functions of topology and resource collection and does not specify specific protocols.
- [draft-han-pce-path-computation-fg-transport] describes that the PCEP-LS can be extend to enable the collection of link-state and TE information from MTN networks.
- This document extends PCEP-LS to report the fgMTN topology resource information, and provides the PCEP extension to support the fgMTNP path setup information.

Path Computation Requirements for fgMTN

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

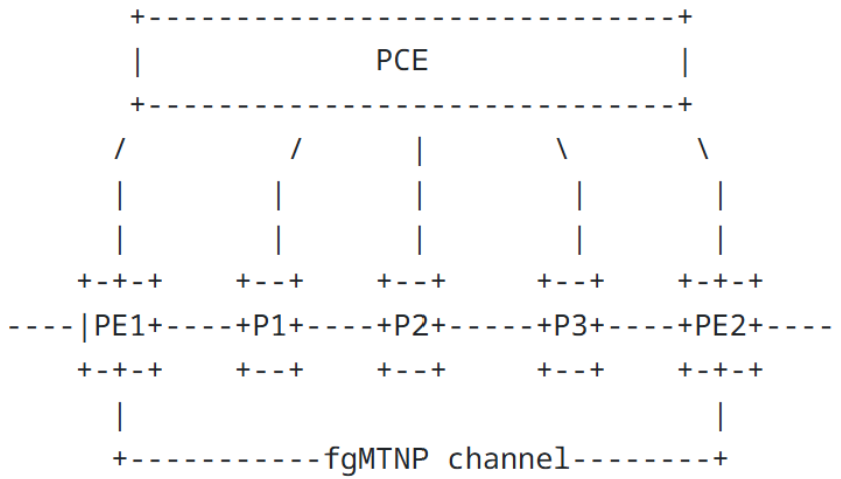
- Traditional 5G MTN channel are static pre-configured.
- One 5Gbps MTN channel support up to 480 fgMTN connections.
- One 10GE Ethernet channel support up to 960 fgMTN connections.

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.

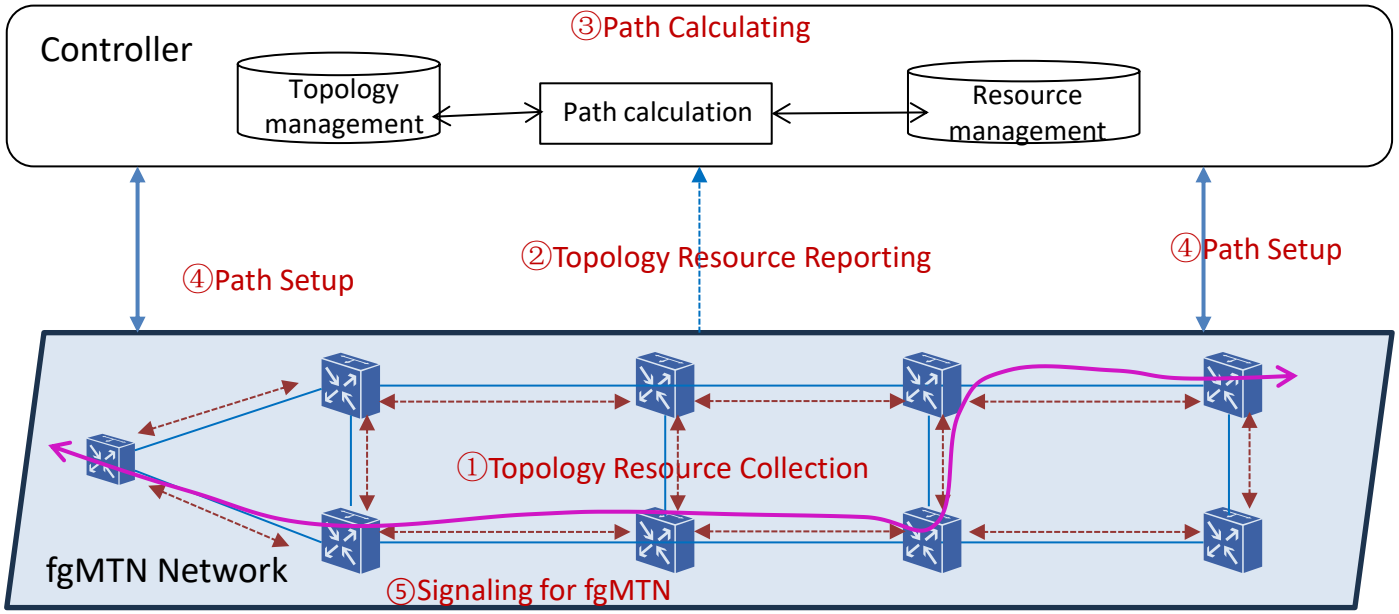
Path Computation Extension Requirements for Fine-Granularity Transport Network(draft-han-pce-path-computation-fg-transport-02) have been presented in CCAMP in IETF 125 meeting.

Use Cases of Fine-grain Path Computation



1. Fine-grain path set-up
2. Fine-grain resource management
3. Fine-grain path update (e.g. hitless bandwidth adjustment)
4. Fine-grain path removal
5. Service awareness and mapping at the PE nodes

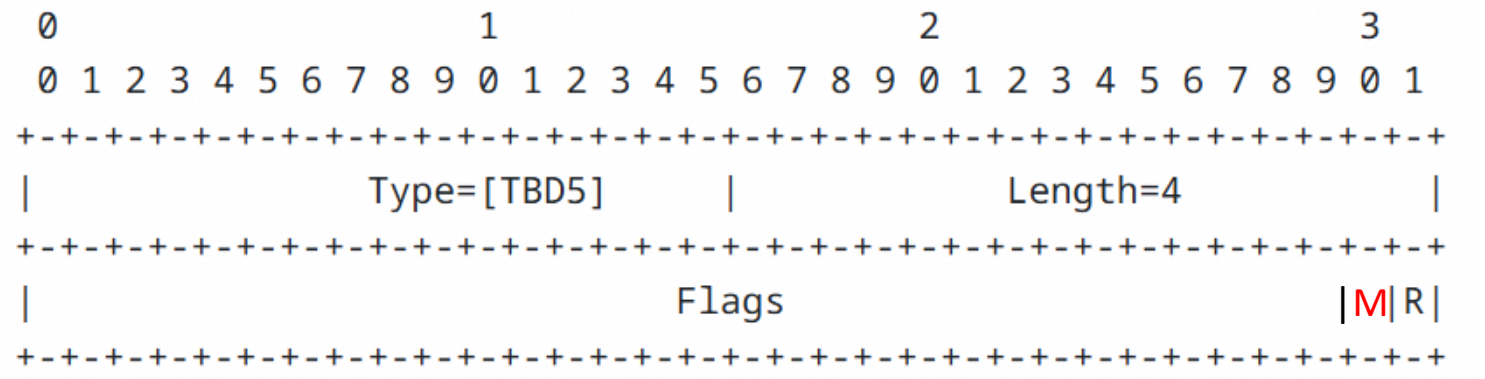
Hybrid centralized control and distributed control architecture for fgMTN



- **Centralized control PCE collects topology resource information and calculates the route for fgMTNP channel**, and the path computation results are delivered to PE1.
- **Distributed control protocols between devices allocates TDM calendar slot resources** hop-by-hop.

Topology Resource Information Reporting --OPEN Object Extensions

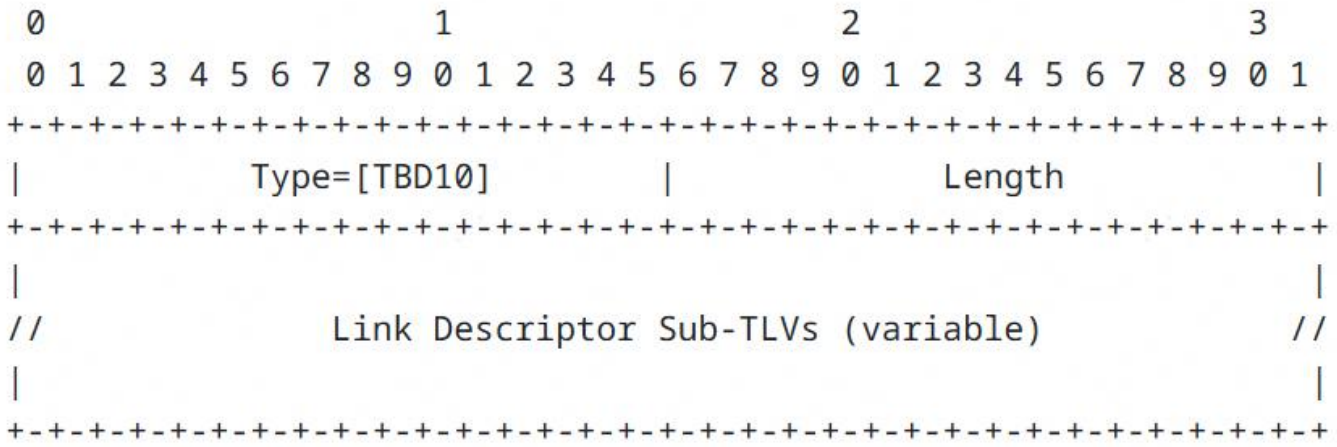
- [draft-ietf-pce-pcep-ls] defines LS-CAPABILITY TLV in the OPEN Object for link-state (and TE) distribution via PCEP capability advertisement.
- A new flag is defined in the flags field of the LS-CAPABILITY TLV to indicate the support of fgMTN resource information reporting.



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 kind 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.

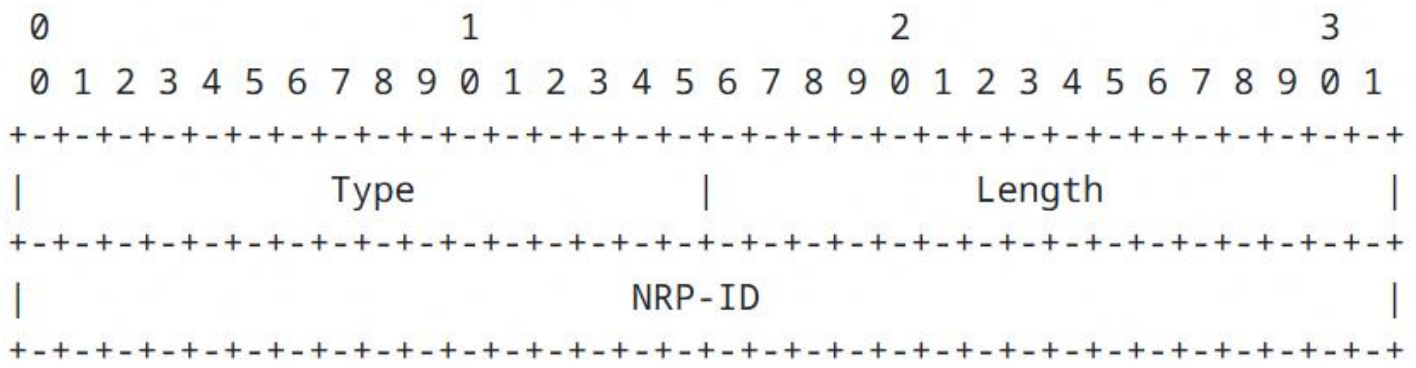
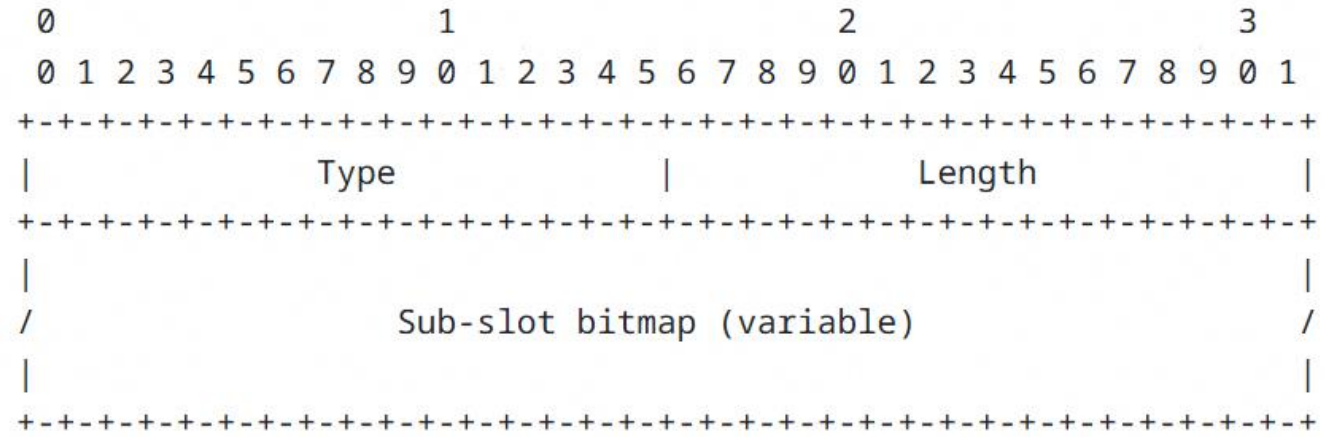


Figure 1: Parent NRP ID Sub-TLV

- 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)

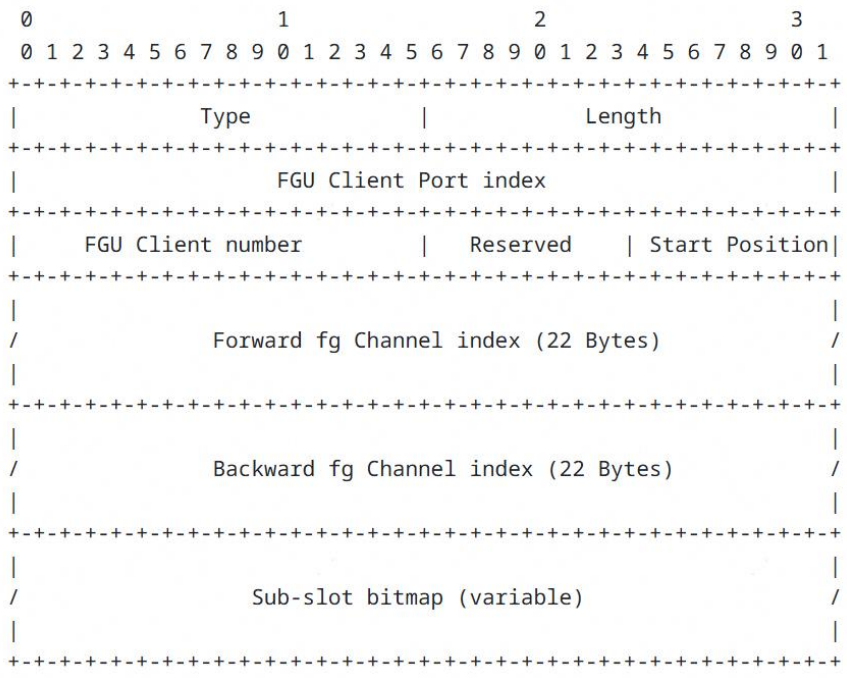
- **Sub-Slot BitMap Sub-TLV:** indicates the timeslot's occupation status of all FGU clients in the link. This sub-TLV is an optional sub-TLV MAY be included in the Link Descriptors TLV.



- 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)

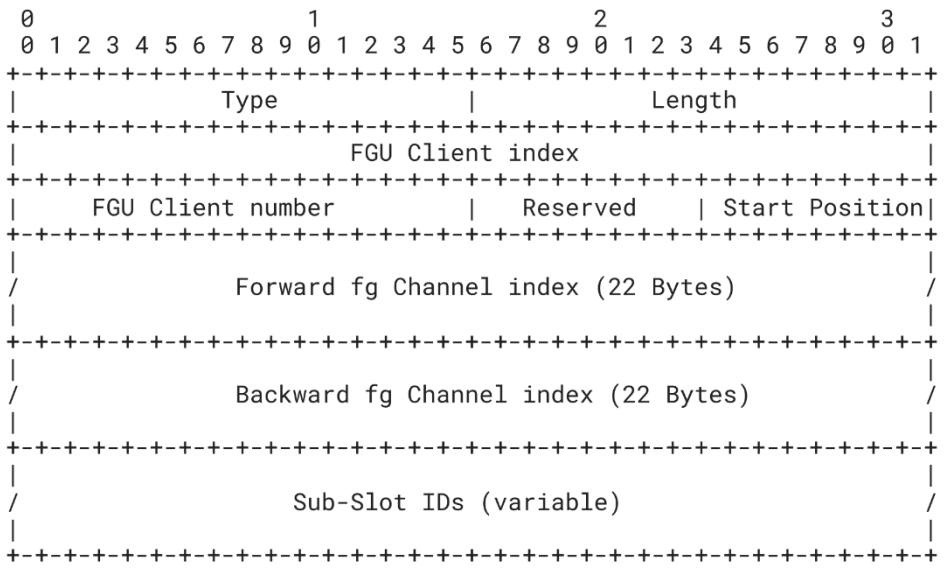
- **FGU Client Sub-Slot Bitmap Relationship Sub-TLV:** indicates the relationship between the occupied timeslots(expressed by bitmap) and corresponding FGU Clients.



- **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)

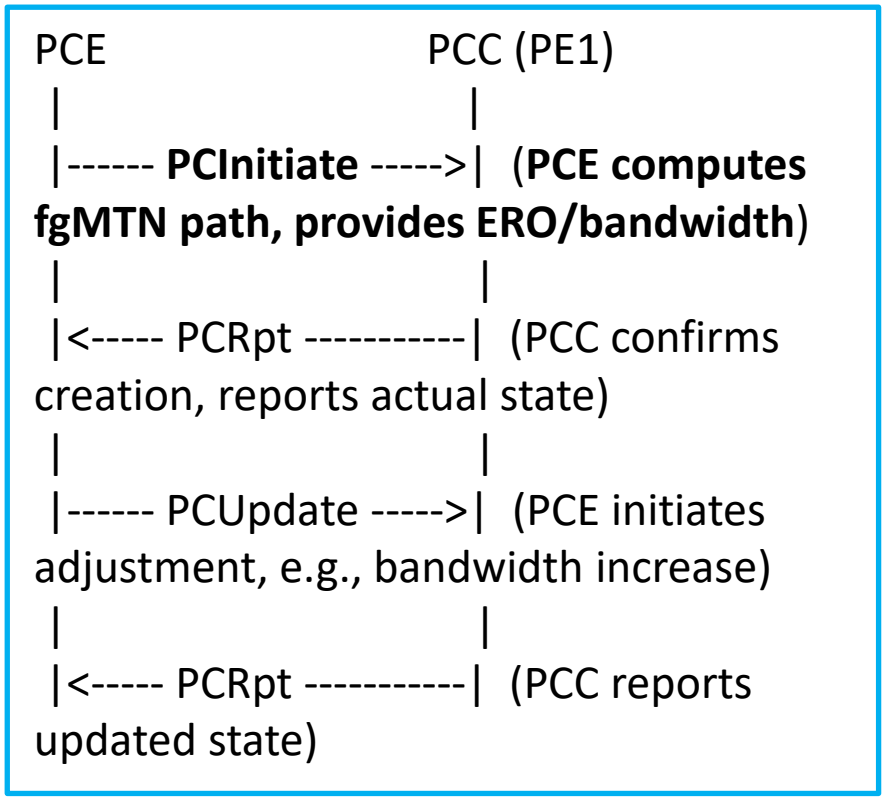
- **FGU Client Sub-Slot Relationship Sub-TLV:** indicates the relationship between the occupied timeslots(expressed by enumeration value) and corresponding FGU Clients.



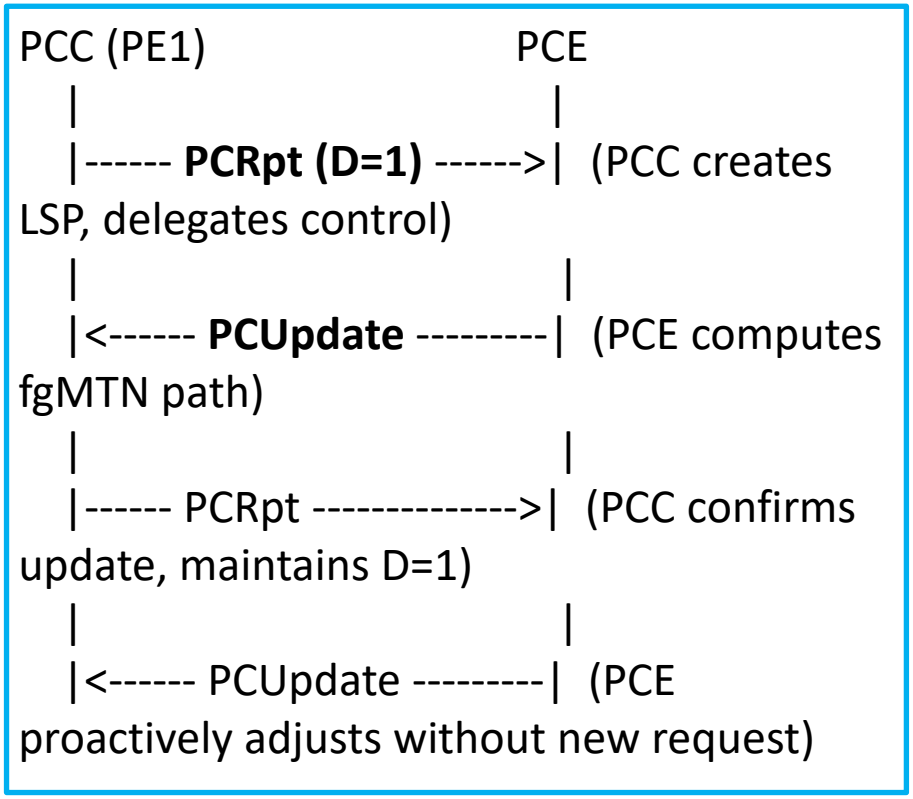
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- **Backward fg Channel index:** backward fg channel identifier. It has the same structure with the Forward fg Channel index.
- **Sub-slot IDs:** variable, indicates the occupation state of all the sub-slots of the FGU.

Path Setup-PCEP Interaction between PCC and PCE for fgMTN path setup

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



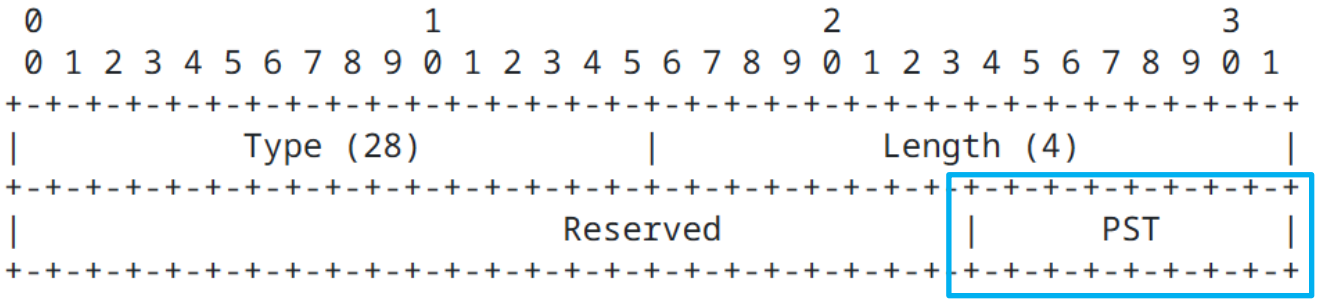
PCE-Initiated Centralized Control



PCC-Initiated with Delegation

PATH-SETUP-TYPE TLV

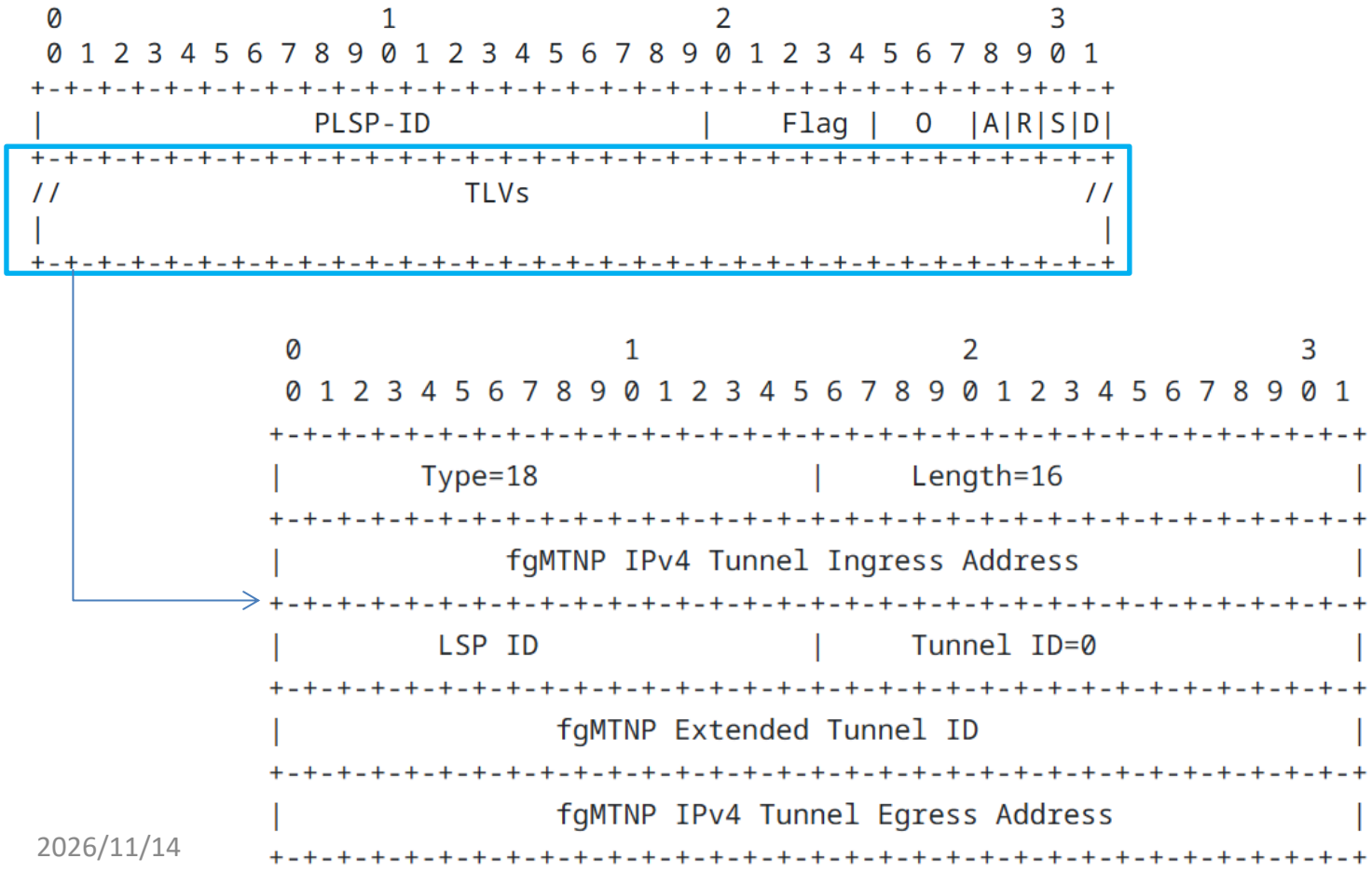
- PCE must be able to specify the fgMTN path, while the PCC must be able to take corresponding control-plane and forwarding plane based on the fgMTN PST.
- **PST=TBD1(**needs to be allocated by IANA**): Traffic-engineering path is setup for fgMTN LSP.**



- 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.

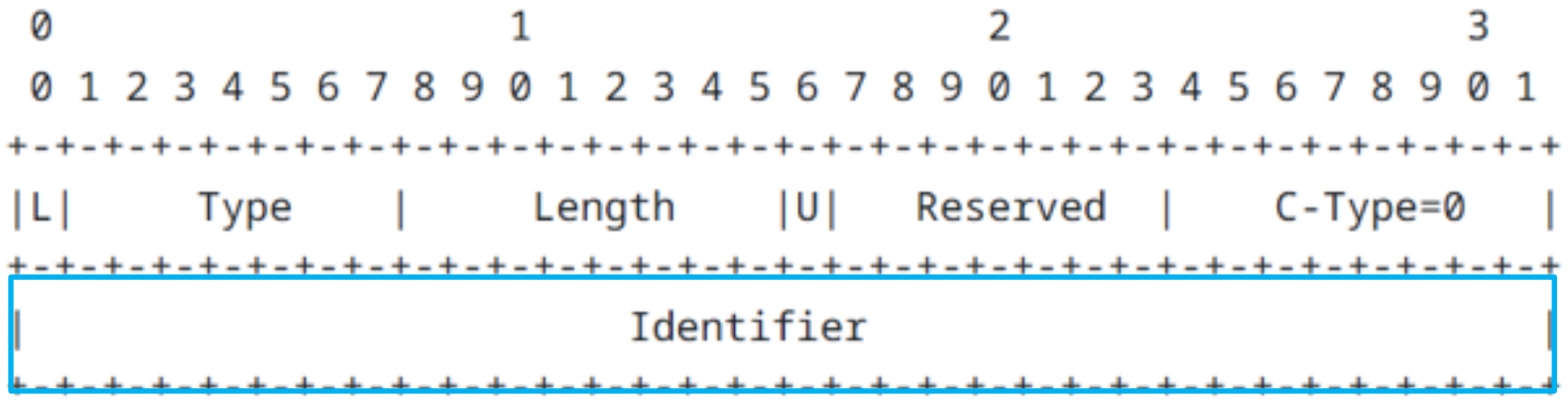
LSP Object

- 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

- FgMTN path computed by a PCE are represented in an ERO is a strictly sequence of fgMTN-ERO subject, 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.

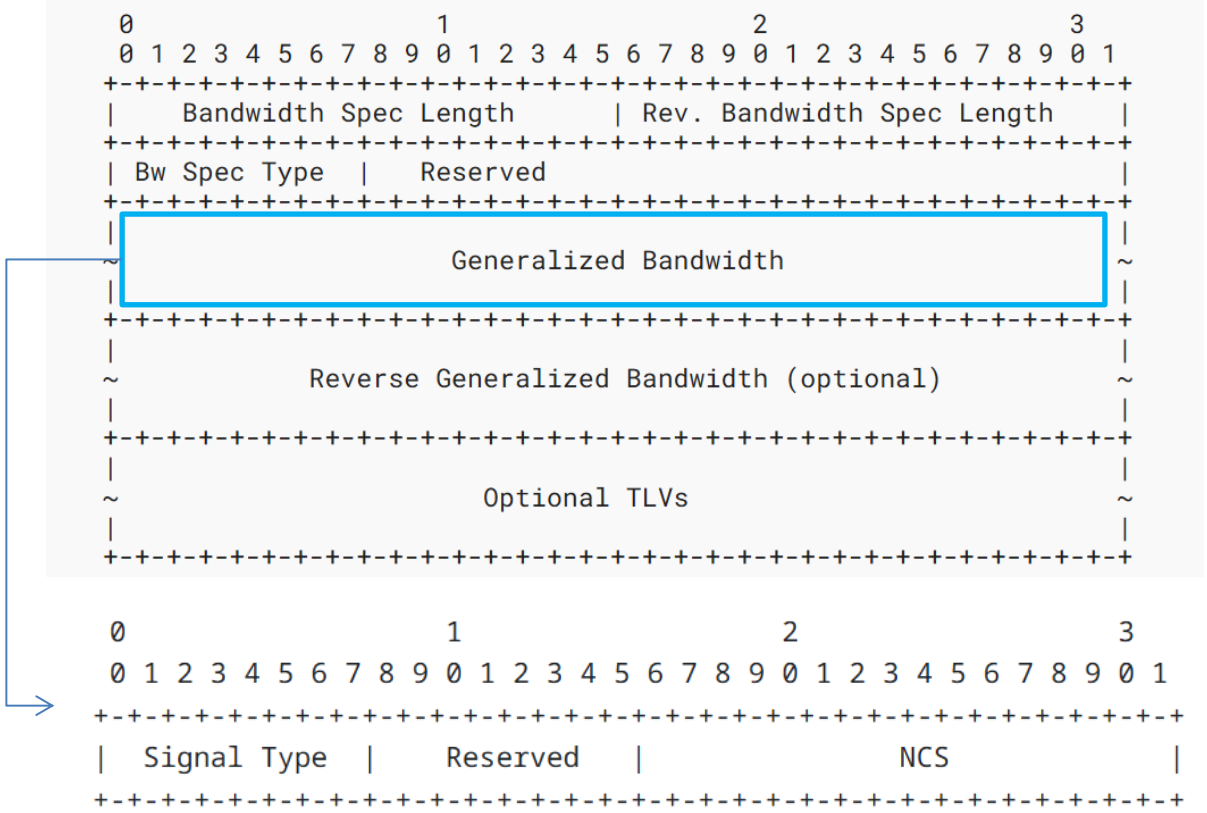


- **Identifier is a unique identifier for server lay port (5Gbps MTN port or 10GE interface) that is enabled in fine grain mode.**

BANDWIDTH Object

- BANDWIDTH object defined in RFC8779 is resued for fgMTN.

Bw Spec Type= TBD2(needs to be allocated by IANA): 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 of this fgMTNP.

Next Step

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

- Comments welcome.

Thank you!