Abstract

Generalized Multi-Protocol Label Switching (GMPLS) is applicable to Ethernet switches supporting Provider Backbone Bridge Traffic Engineering (PBB-TE) networks. The GMPLS controlled Ethernet label switch network not only automates creation of Ethernet Label Switched Paths (Eth-LSPs), it also provides sophisticated Eth-LSP recovery mechanisms such as protection and restoration of an Eth-LSP. This document describes the requirements for the set of solutions of GMPLS controlled Ethernet label switch networks.
1. Introduction

Scalability and manageability of Ethernet switch networks has continuously improved, and the deployment of Ethernet switches supporting Provider Bridging (PB) [IEEE802.1ad] has become one of the solutions for service providers to provide enterprise WAN/LAN services. IEEE standardization activities of Provider Backbone Bridge (PBB) [IEEE 802.1ah] and PBB for Traffic Engineering (PBB-TE) [IEEE802.1Qay] provide an opportunity not only for enhancing the scalability, manageability, and controllability of the Ethernet service networks, but also for more efficiently deploying access/metro access networks.
Generalized Multi-Protocol Label Switching (GMPLS) provides the framework for handling and controlling various types of switching technologies, namely packet switching with various label formats TDM switching, and wavelength switching [RFC3945]. Therefore, the combined use of GMPLS and PBB-TE is a fairly suitable "use case" that contributes to enhancing the flexibility of Ethernet Label Switched Path (Eth-LSP) over Ethernet switch networks without defining additional connection layers.

This document describes requirements for GMPLS protocols to control Ethernet label switch networks and comprises mainly two parts. The first one is the requirements for GMPLS extension for controlling Ethernet layer. The second one includes the requirements for GMPLS extensions to support multi-layer operation. Although a large portion of requirements in the second scope coincides with the description in [Interwk-fwk] and [Interwk-req], some of important requirements are also described in this document.

2. Conventions used in this document

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [RFC2119].

3. Reference model

3.1 Single Layer

This document describes requirements based on the reference model depicted in Fig. 1. The first reference model is an intra-domain and single layer GMPLS controlled Ethernet label switching network in which Eth-LSPs traverse over between Back Bone Core Bridges (BCBs) or Back Bone Edge Bridges (BEBs).

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Figure 1 Single layer GMPLS controlled PBB-TE network
The BEBs provide mainly three types of service interfaces, namely Port based service interface (P-based IF), S-tagged service interface (S-tagged IF), and I-tagged service interface (I-tagged IF) [IEEE802.1ah]. The "P-based IF" and "S-tagged IF" are connected to the I-component of a BEB (I-BEB), while the I-tagged IF is connected to the B-component of a BEB (B-BEB). "S-tagged IF" can perform various types of mapping between Service VLAN ID (S-VID) and Backbone instance Service Identifier (I-SID). Here, S-VID is assigned within customer network domain or Provider Bridge (PB) domain. On the other hand, I-SID is defined between I-components of BEBs.

3.2 Multi-layer

The second reference model is Ethernet and L1 (such as TDM, OTN, etc) multi-layer network. Each Ethernet switch node behaves as a border node between the Ethernet layer and optical Layers. Each BCB or BEB terminates Optical Label Switched Path (O-LSPs) with Ethernet encoding type and some O-LSPs dynamically form LAG. Thus, some Eth-LSPs traverse over multiple O-LSPs, while other Eth-LSPs traverse over single O-LSPs.

Also, it is technically possible to form multiple layer Ethernet switch networks. Namely, the reference model is defined as the case that Ethernet switch network substitutes L1 network in Fig.2, and realizes MAC in MAC Ethernet transport. The routing information of optical layer may be isolated (overlay model), shuffled (peer model), or virtualized with FA-LSPs (augmented model) for Ethernet switch layer.

![Multi-layer GMPLS controlled Ethernet label switched network](image-url)

**Figure 2 Multi-layer GMPLS controlled Ethernet label switched network**
4. Requirements

Section 4.1 to 4.6 describe requirements for single layer Ethernet label switch network based on the reference model from Fig.1. In addition, section 4.7 describes requirements for multiple layer network with Ethernet layer and circuit switch layer (such as wavelength switched layer and so on). Finally, section 4.8 describes generic requirements applicable to single and multiple layer networks.

4.1 Control plane architecture and functionality

4.1.1 In-band control plane channel

The solution should be able to establish in-band control channel, while preserving the solution of out-band control channel. The solution should include negotiation mechanism to specify bandwidth and priority of control-channel between peer Ethernet switches.

4.1.2 Neighbor discovery mechanism

The solution MUST be able to realize automatic neighbor discovery as realized in current PB or PBB networks. Namely, the solution MUST support an automatic negotiation mechanism to exchange information of Node ID, TE-Link ID, Data-link ID (in the case of link Bundling), and IP address of the control channel. On the other hand, the extension should be minimized by making use of [IEEE 802.1AB].

4.2 Ethernet LSP control

4.2.1 Prevention of Loops

The solution should have reliability to prevent creating loops of Eth-LSPs. Specifically if the solution supports numbered TE-Link addressing, the solution should define a methodology and protocol extensions if needed to detect or prevent loops.

4.2.2 Service control

The solution should control various types of service interfaces defined in [IEEE802.1ah]. The service types of Egress port

1) Port based service interface
2) S-tagged service interface
   a) one-to-one mapping of S-VIDs to I-SIDs
   b) bundled mapping of S-VIDs to I-SIDs
      such as many-to-one, all-to-one, transparent mapping
3) I-tagged service interface should be controllable in addition to assignment of Egress port itself.

Also, the solution should be flexible to following operational scenarios,
1) Any change of mapping of S-VIDs to I-SIDs
2) Flexibility to nest or stitch higher layer Eth-LSPs.
3) Any change of bandwidth of Eth-LSPs. Here, the solution of bandwidth modification scenario may include bundling of multiple Eth-LSPs.

4.2.3 P2MP and MP2MP requirements

Detail requirements will be described in future version.

4.3 OA&M related functionality

OAM mechanisms must be defined for GMPLS controlled E-LSPs. Since the data plane is still Ethernet based, the mechanisms should capitalize on existing IEEE802.1ad and Y.1731 mechanisms.

Also, the solution should provide admin status control mechanism to coordinate with Connectivity Fault Management (CFM) functionality [IEEE802.1ag].

4.4 Protection and Restoration related functionality

Detail requirements will be described in future version.

4.5 Link Aggregation Group (LAG) related functionality

Link Aggregation is beneficial functionality to realize reliable Ethernet label switched networks. The availability of connection between peer Ethernet switches can be enhanced in the case of single link failure, if member links of the LAG are diversely routed. In this operational scenario, LAG provides for link protection functionality.

The solution should include methodology to explicitly assign the links forming LAG a desired link type (which is similar sense to assign link protection type described in [RFC3471]).

4.5.1 Failure or deletion of LAG member link

The solution should include functionality to prioritize Eth-LSPs, specifically when total bandwidth of Eth-LSPs exceeds total bandwidth
of healthy LAG members after the failure of one or more LAG member links.

The solution should provide for rerouting an Eth-LSP setup over a failed member link in a LAG to another member link in the LAG.

4.5.2 Recovery or addition of LAG member link

The solution should include functionality to re-optimize Eth-LSP paths after the addition of a LAG member link, i.e. reversion of failed Eth-LSPs after the failure of the LAG member link, or reallocation of other Eth-LSPs traversing congested Links after the addition of LAG member link.

4.6 Inter-domain Ethernet LSP

The solution should take into account possible future extension to control inter-domain Eth-LSPs. Here, the possible extensions are Eth-LSPs traverse over

1) I-tagged service interfaces
2) S-tagged service interfaces, and
3) C-tagged service interfaces.

4.7 Multi-layer network

4.7.1 Dynamic formation of LAG

The solution should include dynamic formation of a LAG after the creation or deletion of optical LSPs which interconnect ports of Ethernet switches.

4.7.2 Other requirements

The architecture and requirements for MPLS-GMPLS inter-working are described in [Interwk-fwk] and [Interwk-req]. Some of the requirements described in [Interwk-req] are valid even for the case of GMPLS-GMPLS interworking between Ethernet label switched network and L1 network. In other words,

1) End-to-End signaling of Eth-LSPs
2) Triggered establishment of L1 LSPs
3) Avoiding complexity and risks.

should be satisfied even for GMPLS control plane for Ethernet. For more details, see [Interwk-req] and MPLS-TE client network written in the document should be understood as Ethernet client network.

Regarding to routing issue,

1) Advertisement of Ethernet label switch network information via L1 GMPLS networks
2) Selective Advertisement of Ethernet label switched network information via a Border node
should be satisfied even in the case of GMPLS-GMPLS inter-working. Note that there is significant difference between MPLS-TE and GMPLS controlled Ethernet from the view point of methodology to create control channel.

4.8 Scalability

The solution MUST be designed to scale according to following metrics.
- Number of nodes
- Number of TE-Links
- Number of LSPs
- Number of service ports
- Number of bundled S-VLANs mapped to I-SID and Eth-LSPs.

5. Security considerations

TBD

6. IANA considerations

TBD

7. References

7.1 Normative References

[IEEE802.1ad] IEEE Computer Society, "Virtual Bridged Local Area Networks - Amendment 4 : Provider Bridges", P802.1ad/D6.0, Draft, Work in Progress

[IEEE802.1ah] "IEEE standard for Provider Backbone Bridges", work in progress.


[IEEE 802.1AB] "IEEE Standard for Local and Metropolitan Area Networks, Station and Media Access Control Connectivity Discovery".

Aggregation of Multiple Link Segments, "P802.3ad, March 2000.


7.2 Informative References


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