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Service Provider Requirements for Ethernet control with GMPLS
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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.

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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 became one of the solutions for service providers to provide enterprise WAN/LAN services. IEEE standardization activities of Provider Backbone Bridge(PBB) [IEEE802.1ah] 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 connection-oriented 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 [RFC5145] and [RFC5146], 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 [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 Backbone Core Bridges (BCBs) or Backbone Edge Bridges (BEBs).

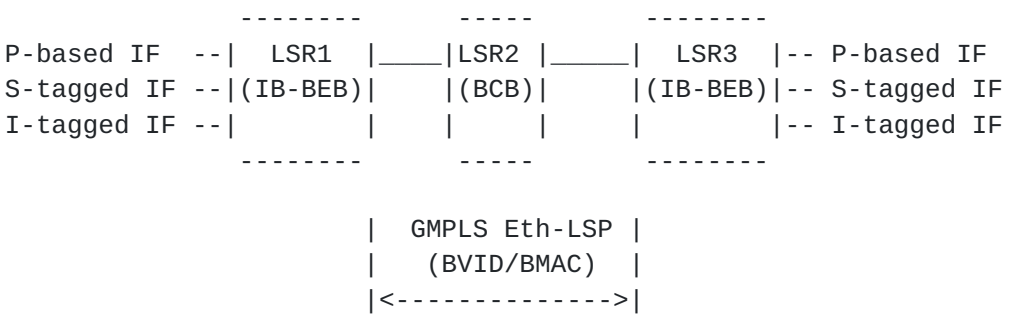

Figure 1 Single layer GMPLS controlled PBB-TE network

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.

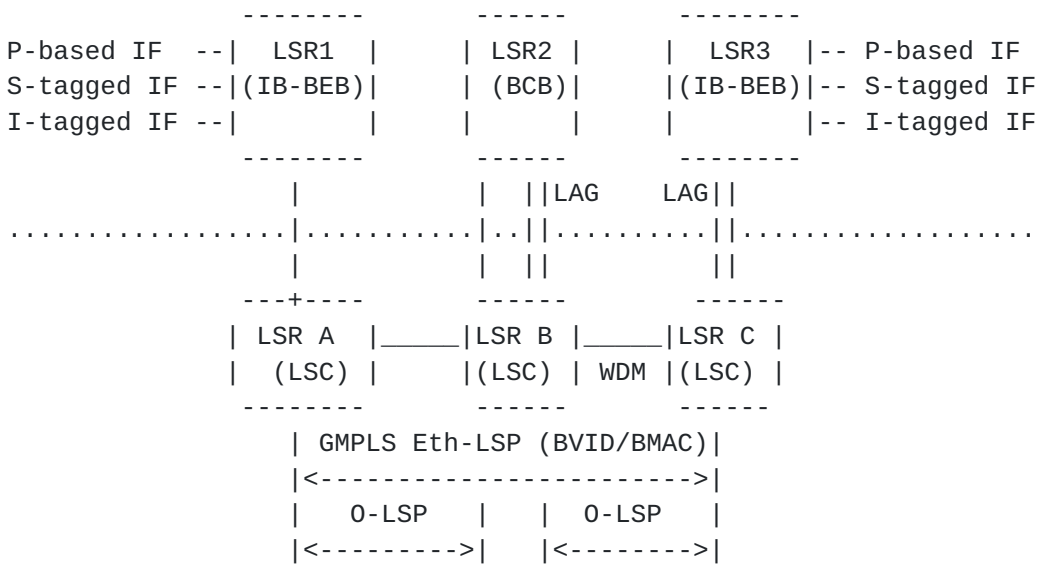

Figure 2 Multi-layer GMPLS controlled Ethernet label switched network

4. Requirements

Section 4.1 to 4.6 describe requirements for single layer Ethernet label swicth 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 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 for these configuration between neighbors. On the other hand, the extension should be minimized by making use of [RFC4394] and [IEEE802.1AB].

4.1.3. Addressing

All service interfaces, TE-Link IDs and Data-link IDs MUST be able to be indicated by standard IEEE MAC address format, but Node ID should be with IP addresses.

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

To provide the service such as a content distribution, the creation of uni-directional P2MP Eth-LSPs should be supported. Also, to provide E-tree type services with multicast traffic, the creation of bi-directional P2MP Eth-LSPs should be supported. The MP2MP requirement is for further study.

4.2.4. Asymmetric bandwidth

To provide the service which has asymmetric traffic pattern such as a kind of E-tree type services, the creation of asymmetric bandwidth bi-directional Eth-LSPs should be supported. The bandwidth modification of Eth-LSPs in operation should be also supported.

4.2.5. QoS control

The routing and signaling extensions to control QoS based on Ethernet traffic parameters defined in [MEF10.1] should be supported. Unused bandwidth per CoS should be exhanged by routing extensions like [RFC4124] and the CoS and bandwidth profile such as CIR, CBS, EIR and EBS for a requested LSP should be carried by signaling extensions for bandwidth accounting and traffic control at a local level.

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 [IEEE802.1ag] 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

1:1 protection, Shared protection and dynamic restoration should be supported. Protection and Restoration may be triggered by Ethernet OA&M function such as CC, AIS and RDI [IEEE802.1ag] , [Y.1731].

4.5. Link Aggregation Group (LAG) related functionality

Link Aggregation is beneficial functionality to realize flexible reconfiguration of logical link bandwidth and reliable Ethernet label switched networks. The availability of link bandwidth between peer Ethernet switches can be enhanced.

The solution should support Link Bundling mechanism described in [RFC4201] to explicitly assign the links forming LAG.

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. It should use the existing Link Bundling mechanism to assign bandwidth to dynamically formulated LAG.

4.7.2. Other requirements

The architecture and requirements for MPLS-GMPLS inter-working are described in [RFC5145] and [RFC5146]. Some of the requirements described in [RFC5146] 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 [RFC5146] 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

- Number of advertised VLANs

- Number of MEPs and MIPs.

5. Security Considerations

The extension for GMPLS controlled Ethernet label switching should be considered under the same security as current work. This extension will not change the underlying security issues.

6. IANA Considerations

This document has no actions for IANA.

7. Acknowledgements

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