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OSPF-TE Extensions for General Network Element Constraints

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Abstract

Generalized Multiprotocol Label Switching can be used to control a wide variety of technologies including packet switching (e.g., MPLS), time-division (e.g., SONET/SDH, OTN), wavelength (lambdas), and

spatial switching (e.g., incoming port or fiber to outgoing port or fiber). In some of these technologies network elements and links may impose additional routing constraints such as asymmetric switch connectivity, non-local label assignment, and label range limitations on links. This document describes OSPF routing protocol extensions to support these kinds of constraints under the control of Generalized MPLS (GMPLS).

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].

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1. Introduction

Some data plane technologies that wish to make use of a GMPLS control plane contain additional constraints on switching capability and label assignment. In addition, some of these technologies should be capable of performing non-local label assignment based on the nature of the technology, e.g., wavelength continuity constraint in WSON [WSON-Frame]. Such constraints can lead to the requirement for link by link label availability in path computation and label assignment.

[GEN-Encode] provides efficient encodings of information needed by the routing and label assignment process in technologies such as WSON and are potentially applicable to a wider range of technologies.

This document defines extensions to the OSPF routing protocol based on [GEN-Encode] to enhance the Traffic Engineering (TE) properties of GMPLS TE which are defined in [RFC3630], [RFC4202], and [RFC4203]. The enhancements to the Traffic Engineering (TE) properties of GMPLS TE links can be announced in OSPF TE LSAs. The TE LSA, which is an opaque LSA with area flooding scope [RFC3630], has only one top-level Type/Length/Value (TLV) triplet and has one or more nested sub-TLVs for extensibility. The top-level TLV can take one of three values (1) Router Address [RFC3630], (2) Link [RFC3630], (3) Node Attribute [RFC5786]. In this document, we enhance the sub-TLVs for the Link TLV and Node Attribute TLV in support of the general network element constraints under the control of GMPLS.

The detailed encoding of OSPF extensions are not defined in this document. [GEN-Encode] provides encoding detail.

2. Node Information

According to [GEN-Encode], the additional node information representing node switching asymmetry constraints includes Node ID, connectivity matrix. Except for the Node ID which should comply with Routing Address described in [RFC3630], the other pieces of information are defined in this document.

[RFC5786] defines a new top TLV named the Node Attribute TLV which carries attributes related to a router/node. This Node Attribute TLV contains one or more sub-TLVs.

Per [GEN-Encode], we have identified the following new Sub-TLVs to the Node Attribute TLV. Detail description for each newly defined Sub-TLV is provided in subsequent sections:

Sub-TLV Type	Length	Name
TBD	variable	Connectivity Matrix

In some specific technologies, e.g., WSON networks, Connectivity Matrix sub-TLV may be optional, which depends on the control plane implementations. Usually, for example, in WSON networks, Connectivity Matrix sub-TLV may appear in the LSAs because WSON switches are asymmetric at present. It is assumed that the switches are symmetric switching, if there is no Connectivity Matrix sub-TLV in the LSAs.

2.1. Connectivity Matrix

It is necessary to identify which ingress ports and labels can be switched to some specific labels on a specific egress port, if the switching devices in some technology are highly asymmetric.

The Connectivity Matrix is used to identify these restrictions, which can represent either the potential connectivity matrix for asymmetric switches (e.g. ROADMs and such) or fixed connectivity for an asymmetric device such as a multiplexer as defined in [WSON-Info].

The Connectivity Matrix is a sub-TLV (the type is TBD by IANA) of the Node Attribute TLV. The length is the length of value field in octets. The meaning and format of this sub-TLV are defined in Section 5.3 of [GEN-Encode]. One sub-TLV contains one matrix. The Connectivity Matrix sub-TLV may occur more than once to contain multi-matrices within the Node Attribute TLV.

3. Link Information

The most common link sub-TLVs nested to link top-level TLV are already defined in [RFC3630], [RFC4203]. For example, Link ID, Administrative Group, Interface Switching Capability Descriptor (ISCD), Link Protection Type, Shared Risk Link Group Information (SRLG), and Traffic Engineering Metric are among the typical link sub-TLVs.

Per [GEN-Encode], we add the following additional link sub-TLVs to the link-TLV in this document.

Sub-TLV Type	Length	Name
TBD	variable	Port Label Restrictions
TBD	variable	Available Labels
TBD	variable	Shared Backup Labels

Generally all the sub-TLVs above are optional, which depends on the control plane implementations. If it is default no restrictions on labels, Port Label Restrictions sub-TLV may not appear in the LSAs. In order to be able to compute label assignment, Available Labels sub-TLV may appear in the LSAs. For example, in WSON networks, without available wavelength information, path computation need guess

what lambdas may be available (high blocking probability or distributed wavelength assignment may be used).

3.1. Port Label Restrictions

Port label restrictions describe the label restrictions that the network element (node) and link may impose on a port. These restrictions represent what labels may or may not be used on a link and are intended to be relatively static. More dynamic information is contained in the information on available labels. Port label restrictions are specified relative to the port in general or to a specific connectivity matrix for increased modeling flexibility.

For example, Port Label Restrictions describes the wavelength restrictions that the link and various optical devices such as OXCs, ROADMs, and waveband multiplexers may impose on a port in WSON. These restrictions represent what wavelength may or may not be used on a link and are relatively static. The detailed information about Port label restrictions is described in [WSON-Info].

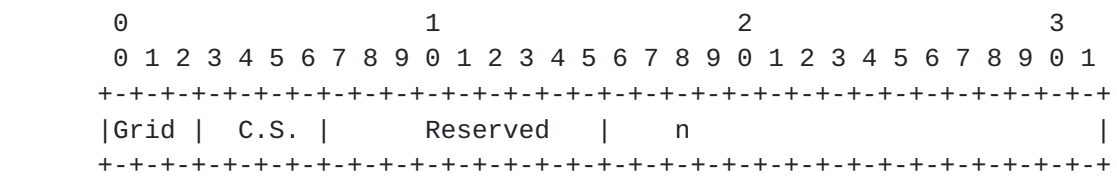
The Port Label Restrictions is a sub-TLV (the type is TBD by IANA) of the Link TLV. The length is the length of value field in octets. The meaning and format of this sub-TLV are defined in Section 5.4 of [GEN-Encode]. The Port Label Restrictions sub-TLV may occur more than once to specify a complex port constraint within the link TLV.

3.2. Available Labels

Available Labels indicates the labels available for use on a link as described in [GEN-Encode]. The Available Labels is a sub-TLV (the type is TBD by IANA) of the Link TLV. The length is the length of value field in octets. The meaning and format of this sub-TLV are defined in Section 5.1 of [GEN-Encode]. The Available Labels sub-TLV may occur at most once within the link TLV.

Note that there are five approaches for Label Set which is used to represent the Available Labels described in [GEN-Encode]. Usually, it depends on the implementation to one of the approaches. In WSON networks, considering that the continuity of the available or unavailable wavelength set can be scattered for the dynamic wavelength availability, so it may burden the routing to reorganize the wavelength set information when the Inclusive (/Exclusive) List (/Range) approaches are used to represent Available Wavelengths information. Therefore, it is RECOMMENDED that only the Bitmap Set be used for representation Available Wavelengths information.

The ''Base Label'' and ''Last Label'' in label set defined in [GEN-Encode] corresponds to base wavelength label and last wavelength label in WSON, the format of which is described as follows:



The detailed information related to wavelength label can be referred to [Lambda-Labels].

3.3. Shared Backup Labels

Shared Backup Labels indicates the labels available for shared backup use on a link as described in [GEN-Encode].

The Shared Backup Labels is a sub-TLV (the type is TBD by IANA) of the Link TLV. The length is the length of value field in octets. The meaning and format of this sub-TLV are defined in Section 5.2 of [GEN-Encode]. The Shared Backup Labels sub-TLV may occur at most once within the link TLV.

4. Routing Procedures

All the sub-TLVs are nested to top-level TLV(s) and contained in Opaque LSAs. The flooding of Opaque LSAs must follow the rules specified in [RFC2328], [RFC2370], [RFC3630], [RFC4203] and [RFC5786].

Considering the routing scalability issues in some cases, the routing protocol should be capable of supporting the separation of dynamic information from relatively static information.

In the WSON networks, the node information and link information can be classified as two kinds: one is relatively static information such as Node ID, Connectivity Matrix information; the other is dynamic information such as Available Wavelengths information. [GEN-Encode] give recommendations of typical usage of previously defined sub-TLVs which contain relatively static information and dynamic information. An implementation SHOULD take measures to avoid frequent updates of relatively static information when the relatively static information is not changed.

For node information, since the Connectivity Matrix information is static, the LSA containing the Node Attribute TLV can be updated with a lower frequency to avoid unnecessary updates.

For link information, a mechanism MAY be applied such that static information and dynamic information of one TE link are contained in separate Opaque LSAs, which are updated with different frequencies, to avoid unnecessary updates of static information when dynamic information is changed.

Note that as with other TE information, an implementation SHOULD take measures to avoid rapid and frequent updates of routing information that could cause the routing network to become swamped. A threshold mechanism MAY be applied such that updates are only flooded when a number of changes have been made to the label availability (e.g., wavelength availability) information within a specific time. Such mechanisms MUST be configurable if they are implemented.

5. Security Considerations

This document does not introduce any further security issues other than those discussed in [RFC 3630], [RFC 4203].

6. IANA Considerations

[RFC3630] says that the top level Types in a TE LSA and Types for sub-TLVs for each top level Types must be assigned by Expert Review, and must be registered with IANA.

IANA is requested to allocate new Types for the sub-TLVs as defined in Sections 2.1, 3.1, 3.2 and 3.3 as follows:

6.1. Node Information

This document introduces the following sub-TLVs of Node Attribute TLV (Value TBD, see [RFC5786]):

Type	sub-TLV
TBD	Connectivity Matrix

6.2. Link Information

This document introduces the following sub-TLVs of TE Link TLV (Value 2):

Type	sub-TLV
TBD	Port Label Restrictions
TBD	Available Labels
TBD	Shared Backup Labels

7. References

7.1. Normative References

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7.2. Informative References

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