1. Status of this Memo

This document is an Internet-Draft and is in full conformance with all provisions of Section 10 of RFC2026.

Internet-Drafts are working documents of the Internet Engineering Task Force (IETF), its areas, and its working groups. Note that other groups may also distribute working documents as Internet-Drafts.

Internet-Drafts are draft documents valid for a maximum of six months and may be updated, replaced, or obsoleted by other documents at any time. It is inappropriate to use Internet-Drafts as reference material or to cite them other than as "work in progress."

The list of current Internet-Drafts can be accessed at http://www.ietf.org/ietf/1id-abstracts.txt

The list of Internet-Draft Shadow Directories can be accessed at http://www.ietf.org/shadow.html.
2. Abstract

This document specifies encoding of extensions to the OSPF routing protocol in support of Generalized Multi-Protocol Label Switching (GMPLS). The description of the extensions is specified in [GMPLS-ROUTING].

3. Summary for Sub-IP Area

3.1. Summary

This document specifies encoding of extensions to the OSPF routing protocol in support of Generalized Multi-Protocol Label Switching (GMPLS). The description of the extensions is specified in [GMPLS-ROUTING].

3.2. Where does it fit in the Picture of the Sub-IP Work

This work fits squarely in either the CCAMP or OSPF box.

3.3. Why is it Targeted at this WG

This draft is targeted at the CCAMP or the OSPF WG, because this draft specifies the extensions to the OSPF routing protocols in support of GMPLS, because GMPLS is within the scope of the CCAMP WG, and because OSPF is within the scope of the OSPF WG.

3.4. Justification

The WG should consider this document as it specifies the extensions to the OSPF routing protocols in support of GMPLS.
4. Introduction

This document specifies extensions to the OSPF routing protocol in support of carrying link state information for Generalized Multi-Protocol Label Switching (GMPLS). The set of required enhancements to OSPF are outlined in [GMPLS-ROUTING].

5. OSPF Routing Enhancements

In this section we define the enhancements to the TE properties of GMPLS TE links that can be announced in OSPF TE LSAs. The Traffic Engineering (TE) LSA, which is an opaque LSA with area flooding scope [3], has only one top-level Type/Length/Value (TLV) triplet and has one or more nested TLVs for extensibility. The top-level TLV can take one of two values (1) Router Address or (2) Link. In this document, we enhance the sub-TLVs for the Link TLV in support of GMPLS. Specifically, we add the following sub-TLVs:

1. Link Local Identifier,
2. Link Remote Identifier,
3. Link Protection Type,
4. Shared Risk Link Group, and
5. Interface Switching Capability Descriptor.

This brings the list of sub-TLVs of the TE Link TLV to:

<table>
<thead>
<tr>
<th>Sub-TLV Type</th>
<th>Length</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>Link type</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>Link ID</td>
</tr>
<tr>
<td>3</td>
<td>variable</td>
<td>Local interface IP address</td>
</tr>
<tr>
<td>4</td>
<td>variable</td>
<td>Remote interface IP address</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>Traffic engineering metric</td>
</tr>
<tr>
<td>6</td>
<td>4</td>
<td>Maximum bandwidth</td>
</tr>
<tr>
<td>7</td>
<td>4</td>
<td>Maximum reservable bandwidth</td>
</tr>
<tr>
<td>8</td>
<td>32</td>
<td>Unreserved bandwidth</td>
</tr>
<tr>
<td>9</td>
<td>4</td>
<td>Resource class/color</td>
</tr>
<tr>
<td>11</td>
<td>4</td>
<td>Link Local Identifier</td>
</tr>
<tr>
<td>12</td>
<td>4</td>
<td>Link Remote Identifier</td>
</tr>
<tr>
<td>14</td>
<td>4</td>
<td>Link Protection Type</td>
</tr>
<tr>
<td>15</td>
<td>variable</td>
<td>Interface Switching Capability Descriptor</td>
</tr>
<tr>
<td>16</td>
<td>variable</td>
<td>Shared Risk Link Group</td>
</tr>
<tr>
<td>32768-32772</td>
<td>-</td>
<td>Reserved for Cisco-specific extensions</td>
</tr>
</tbody>
</table>
5.1. Link Local Identifier

A Link Local Identifier is a sub-TLV of the Link TLV with type 11, and length 4.

5.2. Link Remote Identifier

A Link Remote Identifier is a sub-TLV of the Link TLV with type 12, and length 4.

5.3. Link Protection Type

The Link Protection Type is a sub-TLV of the Link TLV, with type 14, and length of four octets, the first of which is a bit vector describing the protection capabilities of the link. They are:

- 0x01 Extra Traffic
- 0x02 Unprotected
- 0x04 Shared
- 0x08 Dedicated 1:1
- 0x10 Dedicated 1+1
- 0x20 Enhanced
- 0x40 Reserved
- 0x80 Reserved

5.4. Shared Risk Link Group (SRLG)

The SRLG is a sub-TLV of the Link TLV with type 16. The length is the length of the list in octets. The value is an unordered list of 32 bit numbers that are the SRLGs that the link belongs to. The format of the value field is as shown below:
5.5. Interface Switching Capability Descriptor

The Interface Switching Capability Descriptor is a sub-TLV of the Link TLV with type 15. The length is the length of value field in octets. The format of the value field is as shown below:

```
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Switching Cap |   Encoding    |           Reserved            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Max LSP Bandwidth at priority 0 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Max LSP Bandwidth at priority 1 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Max LSP Bandwidth at priority 2 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Max LSP Bandwidth at priority 3 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Max LSP Bandwidth at priority 4 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Max LSP Bandwidth at priority 5 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Max LSP Bandwidth at priority 6 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Max LSP Bandwidth at priority 7 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Switching Capability-specific information (variable) |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

The Switching Capability (Switching Cap) field contains one of the following values:
The Encoding field contains one of the values specified in Section 3.1.1 of [GMPLS-SIG].

Maximum LSP Bandwidth is encoded as a list of eight 4 octet fields in the IEEE floating point format, with priority 0 first and priority 7 last. The units are bytes (not bits!) per second.

The content of the Switching Capability specific information field depends on the value of the Switching Capability field.

When the Switching Capability field is PSC-1, PSC-2, PSC-3, or PSC-4, the specific information includes Interface MTU, Minimum LSP Bandwidth, and padding. The Interface MTU is encoded as a 2 octets integer. The Minimum LSP Bandwidth is is encoded in a 4 octets field in the IEEE floating point format. The units are bytes (not bits!) per second. The padding is 2 octets, and is used to make the Interface Switching Capability Descriptor sub-TLV 32-bits aligned.

When the Switching Capability field is L2SC, there is no specific information.

When the Switching Capability field is TDM, the specific information includes Minimum LSP Bandwidth, an indication whether the interface supports Standard or Arbitrary SONET/SDH, and padding. The Minimum LSP Bandwidth is encoded in a 4 octets field in the IEEE floating point format. The units are bytes (not bits!) per second. The indication whether the interface supports Standard or Arbitrary SONET/SDH is encoded as 1 octet. The value of this octet is 0 if the interface supports Standard SONET/SDH, and 1 if the interface supports Arbitrary SONET/SDH. The padding is 3 octets, and is used to make the Interface Switching Capability Descriptor sub-TLV 32-bits aligned.

When the Switching Capability field is LSC, there is no specific information.

The Interface Switching Capability Descriptor sub-TLV may occur more than once within the Link TLV (this is needed to handle interfaces
that support multiple switching capabilities).

6. Implications on Graceful Restart

The restarting node should follow the OSPF restart procedures [OSPF-RESTART], and the RSVP-TE restart procedures [GMPLS-RSVP].

Once the restarting node re-establishes at least one OSPF adjacency, the node should originate its TE LSAs. These LSAs should be originated with 0 unreserved bandwidth until the node is able to determine the amount of unreserved resources taking into account the resources reserved by the already established LSPs that have been preserved across the restart. Once the restarting node determines the amount of unreserved resources, taking into account the resources reserved by the already established LSPs that have been preserved across the restart, the node should advertise these resources in its TE LSAs.

Neighbors of the restarting node should continue advertise the actual unreserved bandwidth on the TE links from the neighbors to that node.

Regular graceful restart should not be aborted if a TE LSA or TE topology changes. TE graceful restart need not be aborted if a TE LSA or TE topology changes.

7. Security Considerations

The sub-TLVs proposed in this document does not raise any new security concerns.

8. Acknowledgements

The authors would like to thank Suresh Katukam, Jonathan Lang and Quaizar Vohra for their comments on the draft.
9. References

        draft-katz-yeung-ospf-traffic-04.txt (work in progress)

[GMPLS-SIG] "Generalized MPLS - Signaling Functional Description",
        draft-ietf-mpls-generalized-signaling-04.txt (work in progress)

[GMPLS-RSVP] "Generalized MPLS Signaling - RSVP-TE Extensions",
        draft-ietf-mpls-generalized-rsvp-te-06.txt (work in progress)

[GMPLS-ROUTING] "Routing Extensions in Support of Generalized MPLS",
        draft-ietf-ccamp-gmpls-routing-01.txt (work in progress)

[OSPF-RESTART] "Hitless OSPF Restart",
        draft-ietf-ospf-hitless-restart-02.txt
        (work in progress)

10. Authors’ Information

Kireeti Kompella
Juniper Networks, Inc.
1194 N. Mathilda Ave
Sunnyvale, CA 94089
Email: kireeti@juniper.net

Yakov Rekhter
Juniper Networks, Inc.
1194 N. Mathilda Ave
Sunnyvale, CA 94089
Email: yakov@juniper.net
Ayan Banerjee  
Calient Networks  
5853 Rue Ferrari  
San Jose, CA 95138  
Phone: +1.408.972.3645  
Email: abanerjee@calient.net

John Drake  
Calient Networks  
5853 Rue Ferrari  
San Jose, CA 95138  
Phone: (408) 972-3720  
Email: jdrake@calient.net

Greg Bernstein  
Ciena Corporation  
10480 Ridgeview Court  
Cupertino, CA 94014  
Phone: (408) 366-4713  
Email: greg@ciena.com

Don Fedyk  
Nortel Networks Corp.  
600 Technology Park Drive  
Billerica, MA 01821  
Phone: +1-978-288-4506  
Email: dwfedyk@nortelnetworks.com

Eric Mannie  
GTS Network Services  
RDI Department, Core Network Technology Group  
Terhulpsesteenweg, 6A  
1560 Hoeilaart, Belgium  
Phone: +32-2-658.56.52  
E-mail: eric.mannie@gtsgroup.com