

Network Working Group  
Internet Draft  
Expiration Date: January 2001

K. Kompella (Juniper Networks)  
Y. Rekhter (Cisco Systems)  
A. Banerjee (Calient Networks)  
J. Drake (Calient Networks)  
G. Bernstein (Ciena)  
D. Fedyk (Nortel Networks)  
E. Mannie (GTS Network)  
D. Saha (Tellium)  
V. Sharma (Tellabs)

## OSPF Extensions in Support of MPL(ambda)S

[draft-kompella-ospf-ompls-extensions-00.txt](#)

### 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/lid-abstracts.txt>

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

Internet Draft      [draft-ompls-ospf-extensions-00.txt](#)

July 2000

## [2.](#) Abstract

This document specifies extensions to the OSPF routing protocol in support of Multiprotocol Lambda Switching (MPL(ambda)S).

## [3.](#) Introduction

This document specifies extensions to the OSPF routing protocol in support of carrying link state information for Multiprotocol Lambda Switching (MPL(ambda)S). For motivations and overall architecture of MPL(ambda)S see [\[1\]](#). The set of required enhancements to OSPF are outlined in [\[2\]](#). This document enhances the routing extensions [\[3\]](#) required to support MPLS Traffic Engineering. Some of these enhancements also need to be carried in the signaling protocols [\[6\]](#).

The organization of the remainder of the document is as follows. In [Section 4](#), we describe the types of links that may be advertised in OSPF TE LSAs. In [Section 5](#), we define a new set of Type/Length/Value (TLV) triplets, and describe their formats.

## [4.](#) MPL(ambda)S Links

In this section we describe the various types of links that can be announced in OSPF TE LSAs, namely, normal links, non-packet links, and forwarding adjacencies.

### [4.1.](#) Normal links

If the nodes on both ends of a link can send and receive on a packet-by-packet basis, this link is a normal link. Control packets (OSPF protocol packets and signaling packets) and data packets can be sent over the link, so nothing special needs to be done.

### [4.2.](#) Non-packet links

If either node on the end of a bi-directional link cannot multiplex/demultiplex individual packets on that link (see [\[5\]](#)) then that link cannot be used for sending OSPF hellos and LSAs. In this case, a proxy control channel is needed for sending and receiving

control packets. From OSPF's point of view, the combination of the data link (in the context of this document, a non-packet link is also called a bearer channel) and the control channel is a single link; the TE attributes associated with this link are those of the bearer channel, but are sent over the control channel.

The association of a bearer channel with a control channel is by configuration. Note that for a bearer channel D to be associated with a control channel C, D and C should have the same end points, and that the same association must be made at both ends. The means by which it is verified that the two ends have the same associations is outside the scope of this document, however, see [7].

If there are several non-packet links between the same pair of nodes, the associated control channels may be logical interfaces over the same physical control link.

#### [4.2.1](#). Excluding data traffic from control channels

The control channels between nodes in an MPL(ambda)S network, such as optical cross-connects (OXC's) (see [1], [2]), SONET cross-connects and/or routers, are generally meant for control and administrative traffic. These control channels are advertised into OSPF as normal IP links as mentioned in the previous section; this allows the routing of (for example) RSVP messages and telnet sessions. However, if routers on the edge of the optical domain attempt to forward data traffic over these channels, the channel capacity will quickly be exhausted.

If one assumes that data traffic is sent to BGP destinations, and control traffic to IGP destinations, then one can exclude data traffic from the control plane by restricting BGP nexthop resolution. (It is assumed that OXC's are not BGP speakers.) Suppose that a router R is attempting to install a route to a BGP destination D. R looks up the BGP nexthop for D in its IGP's routing table. Say R finds that the path to the nexthop is over interface I. R then checks if it has an entry in its Link State database associated with the interface I. If it does, and the link is not packet-switch capable (see [5]), R installs a discard route for destination D. Otherwise, R installs (as usual) a route for destination D with nexthop I. Note that R need only do this check if it has packet-

switch incapable links; if all of its links are packet-switch capable, then clearly this check is redundant.

Other techniques for excluding data traffic from control channels may also be needed.

#### [4.3.](#) Forwarding Adjacency

An LSR uses MPLS TE procedures to create and maintain an LSP. The LSR then may (under its local configuration control) to announce this LSP as a link into OSPF. When this link is advertised into the same instance of OSPF as the one that determines the route taken by the LSP, we call such a link a "forwarding adjacency" (FA). For details about FAs (for example, their TE properties, the methodology for their use in constrained SPF path computation, etc) see [\[5\]](#).

#### [4.4.](#) Link Bundling

For each type of link just described, it is possible to "bundle" several links together, i.e., treat them as a single link from OSPF's point of view. For example, several normal links can be advertised as a single normal link.

The mechanisms for bundling, including the restrictions on when links can be bundled and the TE attributes of the bundle are described in [\[4\]](#).

### [5.](#) OSPF Routing Enhancements

In this section we define the routing enhancements on the various types of links that can be announced in OSPF TE LSAs, namely, normal links, non-packet links, and forwarding adjacencies. 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 MPL(ambda)S. Specifically, we add the following sub-TLVs:

1. Link Protection Type,
2. Link Descriptor, and
3. Shared Risk Link Group.

### [5.1. Link Protection Type sub-TLV](#)

The Link Protection Type sub-TLV represents the protection capability that exists on a link. It is desirable to carry this information so that it may be used by the path computation algorithm to set up LSPs with appropriate protection characteristics.

If the link has 1+1 protection, it means that a disjoint backup

bearer channel is reserved and dedicated for protecting the primary bearer channel. This backup bearer channel is not shared by any other connection, and traffic is duplicated and carried simultaneously over both channels.

If the link has 1:N protection, it means that for N primary bearer channels, there is one disjoint backup bearer channel reserved to carry the traffic. Additionally, the protection bearer channel MAY carry low-priority preemptable traffic. The bandwidth of backup bearer channels will be announced in the unreserved bandwidth sub-TLV at the appropriate priority.

If the link has ring protection, it means that the primary bearer channel is protected by the presence of an alternate link possibly using other links and nodes in the network.

In the Traffic Engineering LSA, the Link Protection Type sub-TLV is a sub-TLV of the Link TLV, with type 14, and length of four octets, the first of which can take one of the following values:

Value	Link Protection Type
0	Reserved (see signaling draft [6])



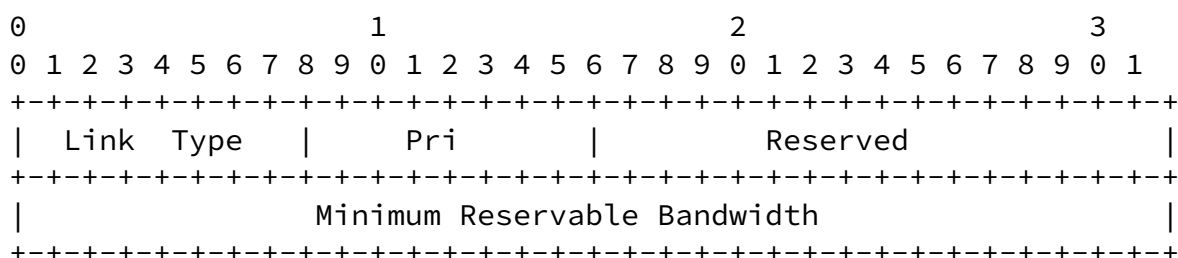
transport media of type OC-48.

In the Traffic Engineering LSA, the Link Descriptor sub-TLV is a sub-TLV of the Link TLV, with type 12. The length is the length of the list of Link Descriptors in octets. Each Link descriptor element consists of the following fields: the first field is a one-octet value which defines the link encoding type, the second field is a one-octet value which defines the lowest priority at which that link encoding type is available, the next two-octets are reserved, the next field is four-octets and specifies the minimum reservable bandwidth (in IEEE floating point format, the unit being bytes per second) for this link encoding type, and the last four-octets specifies the maximum reservable bandwidth (in IEEE floating point format, the unit being bytes per second) for this link encoding type. Link encoding type values are taken from the following list:

Value	Link Encoding Type
1	Standard SONET
2	Arbitrary SONET
3	Standard SDH
4	Arbitrary SDH
5	Clear
6	GigE
7	10GigE

The format of the Link Descriptors is shown in the next figure.

A link having Standard SONET (or Standard SDH) link encoding type can switch data at a minimum rate, which is given by the Minimum Reservable Bandwidth on that link, and the maximum rate is given by the Maximum Reservable Bandwidth on that link. In other words, the Minimum and Maximum Reservable Bandwidth represents the leaf and the







configured with the Link Descriptor Types. In the latter case, the Link Descriptor Type of the bundled link is set to the set union of the Link Descriptor Types for all the component links.

It is possible that Link Descriptor TLV will change over time, reflecting the allocation/deallocation of component links. In general, creation/deletion of an LSP on a link doesn't necessarily result in changing the Link Descriptor of that link. For example, assume that STS-1, STS-3c, STS-12c, STS-48c and STS-192c LSPs can be established on a OC-192 link whose Link Type is SONET. Thus, initially in the Link Descriptor the minimum reservable bandwidth is set to STS-1, and the maximum reservable bandwidth is set of STS-192. As soon as an LSP of STS-1 size is established on the link, it is no longer capable of STS-192c. Therefore, the node advertises a modified Link Descriptor indicating that the maximum reservable bandwidth is no longer STS-192, but STS-48. If subsequently there is another STS-1 LSP, there is no change in the Link Descriptor. The Link Descriptor remains the same until the node can no longer establish a STS-48c LSP over the link (which means that at this point more than 144 time slots are taken by LSPs on the link). Once this happened, the Link Descriptor is modified again, and the modified Link Descriptor is advertised to other nodes.

Note that changes to the Link Descriptor TLV will also affect the Unreserved Bandwidth sub-TLV with respect to bandwidth available on the link.

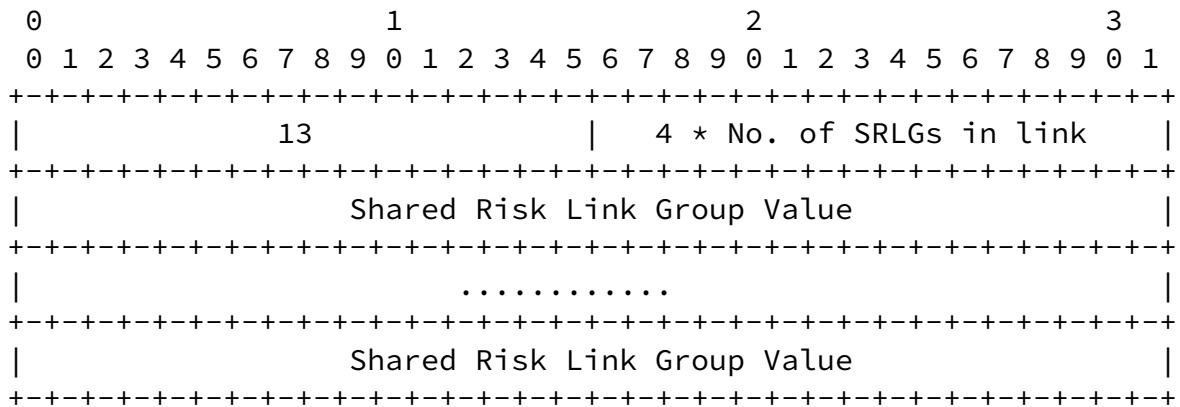
### [5.3. Shared Risk Link Group TLV](#)

A set of links may constitute a 'shared risk link group' (SRLG) if they share a resource whose failure may affect all links in the set. For example, two fibers in the same conduit would be in the same SRLG. A link may belong to multiple SRLGs. Thus the SRLG TLV describes a list of SRLGs that the link belongs to. An SRLG is identified by a 32 bit number that is unique within an IGP domain.

The SRLG of a LSP is the union of the SRLGs of the links in the LSP. The SRLG of a bundled link is the union of the SRLGs of all the component links. The SRLG values are an unordered list of 4 octet numbers that the link belongs to.

If an LSR is required to have multiple diversely routed LSPs to another LSR, the path computation should attempt to route the paths so that they do not have any links in common, and such that the path SRLGs are disjoint.

The SRLG sub-TLV is a sub-TLV of the Link TLV with type 13. 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 is as shown below:



The SRLG TLV starts with a configured value and does not change over time, unless manually reconfigured. The SRLG TLV is optional and if an LSA doesn't carry the SRLG TLV, then it means that SRLG of that link is unknown.

## [6.](#) Security Considerations

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

## [7.](#) Acknowledgements

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

---

Internet Draft      [draft-ompls-ospf-extensions-00.txt](#)

July 2000

## 8. References

- [1] Awduche, D., Rekhter, Y., Drake, J., Coltun, R., "Multi-Protocol Lambda Switching: Combining MPLS Traffic Engineering Control With Optical Crossconnects", [draft-awduche-mpls-te-optical-01.txt](#) (work in progress)
- [2] Basak, D., Awduche, D., Drake, J., Rekhter, Y., "Multi-protocol Lambda Switching: Issues in Combining MPLS Traffic Engineering Control With Optical Crossconnects", [draft-basak-mpls-oxc-issues-00.txt](#) (work in progress)
- [3] Katz, D., Yeung, D., "Traffic Engineering Extensions to OSPF", [draft-katz-yeung-ospf-traffic-01.txt](#) (work in progress)
- [4] Kompella, K., Rekhter, Y., Berger, L., "Link Bundling in MPLS Traffic Engineering", [draft-kompella-mpls-bundle-02.txt](#) (work in progress)
- [5] Kompella, K., Rekhter, Y., "LSP Hierarchy with MPLS TE", [draft-ietf-mpls-lsp-hierarchy-00.txt](#) (work in progress)
- [6] Optical MPLS Group, "MPLS Optical/Switching Signaling Functional Description" (work in progress)
- [7] Lang J., Mitra K., Drake J., Kompella K., Rekhter Y., Saha D., Berger L., and Basak D., "Link Management Protocol", [draft-lang-mpls-lmp-00.txt](#) (work in progress)

## 9. Authors' Information

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

Yakov Rekhter  
Cisco Systems, Inc.  
[170](#) West Tasman Drive  
San Jose, CA 95134  
Email: yakov@cisco.com

[draft-ompls-ospf-extensions-00.txt](#)

[Page 10]

---

Internet Draft      [draft-ompls-ospf-extensions-00.txt](#)

July 2000

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  
Terhulpsessesteeenweg, 6A  
[1560](#) Hoeilaart, Belgium  
Phone: +32-2-658.56.52  
E-mail: eric.mannie@gtsgroup.com

[draft-ompls-ospf-extensions-00.txt](#)

[Page 11]

---

Internet Draft      [draft-ompls-ospf-extensions-00.txt](#)

July 2000

Debanjan Saha  
Tellium Optical Systems  
[2](#) Crescent Place  
P.O. Box 901  
Ocean Port, NJ 07757  
Phone: (732) 923-4264  
Email: dsaha@tellium.com

Vishal Sharma  
Tellabs Research Center  
One Kendall Square  
Bldg. 100, Ste. 121  
Cambridge, MA 02139-1562  
Phone: (617) 577-8760  
Email: Vishal.Sharma@tellabs.com

