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IGP Extensions for Advertising Link Numbers

Abstract

   This document describes OSPF and IS-IS extensions for distributing
   the link numbers assigned to the links originating at a node.

Requirements Language

   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] [RFC8174]
   when, and only when, they appear in all capitals, as shown here.

Status of This Memo

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1. Introduction

When the links originating at each node in a network are numbered
from 1 to the number of the such links for that node, an efficient
stateless multicast along an explicit P2MP path can be achieved
through using the link numbers of the links on the path to represent
the path.

This document proposes OSPF and IS-IS extensions for distributing
the link numbers assigned to the links originating at a node which
will support such multicast. After a controller such as PCE as a
controller has the link numbers of the links originating at every
node, for an explicit P2MP path, the controller can send the ingress
the path represented by the link numbers of the links on the path.

1.1. Terminology

LSA: Link State Advertisement.

OSPF: Open Shortest Path First.

LSP: Link State Protocol data unit.

IS-IS: Intermediate System to Intermediate System.

MT: Multi-Topology.

TE:
     Traffic Engineering.

2. Extensions to OSPFv2

This section describes extensions to OSPFv2 for distributing the
link numbers assigned to the links of a node.

[RFC7684] defines the OSPFv2 Extended Link TLV to advertise the
information about a link. Multiple Link TLVs for the links of a
router are included in the OSPFv2 Extended Link Opaque LSA of the
router. The OSPFv2 Extended Link TLV has the following format:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|            Type (1)           |        Length (Variable)      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   Link Type   |                  Reserved                     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                            Link ID                            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                           Link Data                           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                        Sub-TLVs (variable)                    |
~                                                               ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
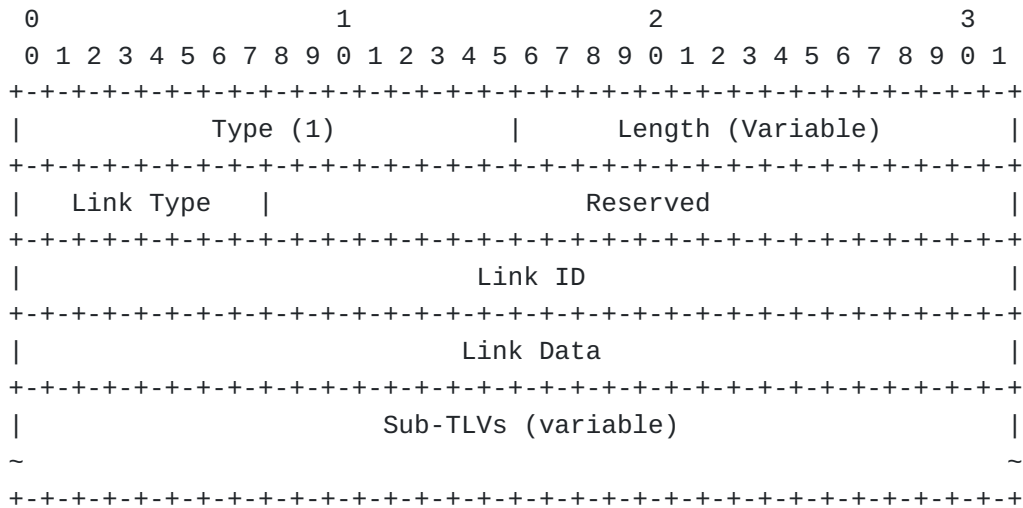
                  Figure 1: OSPFv2 Extended Link TLV

Type: 1.

Length: Variable, dependent on Sub-TLVs.

Link Type, Link ID and Link Data: They are defined in Section A.4.2
   of [RFC2328].

Reserved: MUST be set to 0 on transmission and MUST be ignored on
   reception.

Under the OSPFv2 Extended Link TLV for a link, a Link Number Sub-TLV
is defined for distributing the link number assigned to the link by
the router originating the LSA. A Link Number Sub-TLV is included in
the Link TLV for a link of Link Type Point-to-Point, Broadcast
(i.e., link to LAN or Transit Network), or stub (i.e., link to stub
network). The Link Number Sub-TLV has the following format:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|            Type (TBD1)         |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|          Link Number           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

                    Figure 2: Link Number Sub-TLV

   Type: TBD1. (Note this is the Sub-TLV Type, not the Link Type.)

   Length: 2.

   Link Number: A 2-octet field carrying the link number assigned to
      the link when the Link Type of the link in the OSPFv2 Extended
      Link TLV containing this Sub-TLV is 1 (i.e., Point-to-Point
      connection to another router), 2 (i.e., connection to a Transit
      Network or LAN), or 3 (i.e., connection to a stub network).

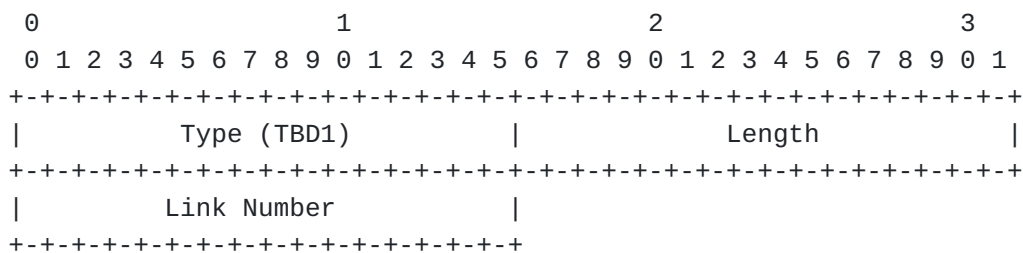## 3. Extensions to OSPFv3

   This section describes extensions to OSPFv3 for distributing the
   link numbers assigned to the links of a node.

   [RFC8362] defines the OSPFv3 Extended Router LSA, which may include
   multiple Router-Link TLVs.

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|            LS Age              |1|0|1|            0x21         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                          Link State ID                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       Advertising Router                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       LS Sequence Number                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|          LS Checksum           |             Length           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   0   |N|x|V|E|B|                 Options                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                              TLVs                             |
:                                                               :
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
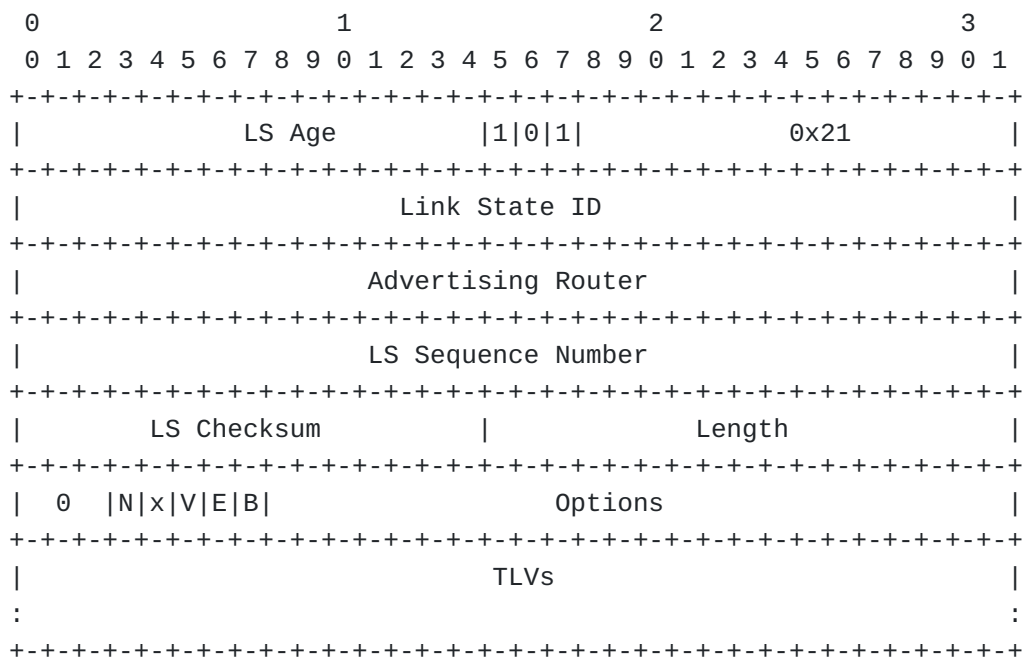
                    Figure 3: Extended Router-LSA

A Router-Link TLV defines a single router link.


```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   Type (1 - Router-Link)     |        Length (Variable)      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Link Type  |       0        |              Metric            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                        Interface ID                          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    Neighbor Interface ID                     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Neighbor Router ID                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                         Sub-TLVs                             |
:                                                              :
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
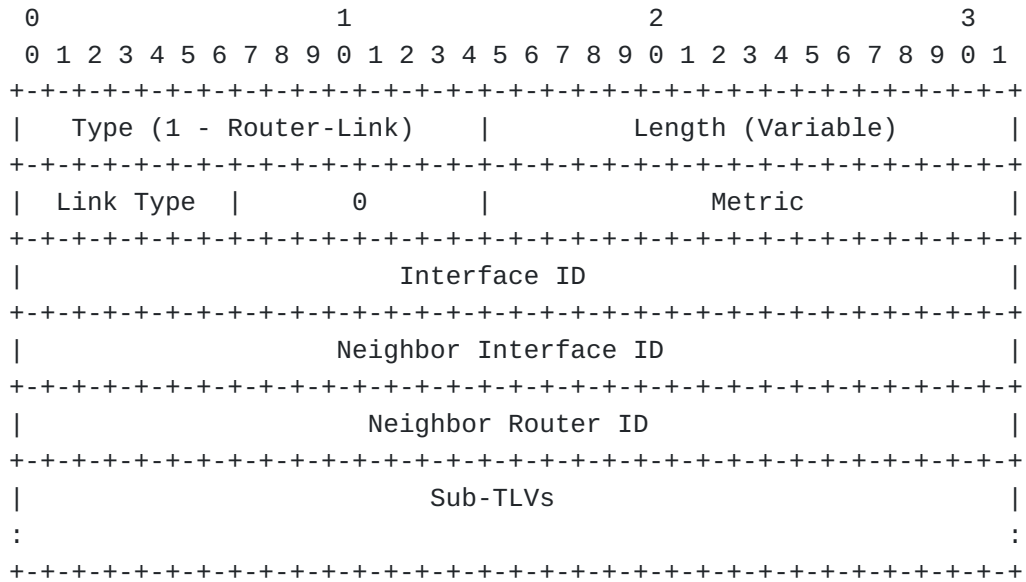
Figure 4: Router-Link TV

Under the Router-Link TLV for a link, a Link Number Sub-TLV is defined. This Sub-TLV has the same format as the Link Number Sub-TLV defined above for the OSPFv2 Extended Link TLV.

The Router-Link TLV for a link may include a Link Number Sub-TLV for distributing the link number assigned to the link by the router originating the LSA.

4. Extensions to IS-IS

This section describes extensions to IS-IS for distributing the link numbers assigned to the links of a node.

The Extended IS Reachability TLV (Type 22) defined in [RFC5305] may contain Sub-TLVs (such as those for TE (Traffic Engineering)) that apply to a link/interface to a neighbor. To encode multiple links or interfaces to neighbors, the structure inside TLV is repeated.

The Multi-Topology (MT) Intermediate Systems TLV (Type 222) defined in [RFC5120] may contain Sub-TLVs (such as those for TE) that apply to a link/interface. It is aligned with the Extended IS Reachability TLV (Type 22) but has an additional two bytes in front at the beginning of the TLV for MT-ID.

A Link Number Sub-TLV is defined and used in the Extended IS Reachability TLV (Type 22) and/or MT Intermediate Systems TLV (Type 222) to advertise the link numbers assigned to the links of a node.

The Link Number Sub-TLV has the following format:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Type (TBD3)  |     Length    |           Link Number         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 5: IS-IS Link Number Sub-TLV

Type: TBD3.

Length: 2.

Link Number: A 2-octet field carrying the link number assigned to
   the link.

5. Security Considerations

TBD.

6. IANA Considerations

Under "OSPFv2 Extended Link TLV Sub-TLVs registry" as defined in
[RFC7684], IANA is requested to assign a registry value for Link
Number Sub-TLV as follows:

Value	Description	reference
=======	=============	===========
TBD1	Link Number	This document

Under "OSPFv3 Extended-LSA Sub-TLVs registry" as defined in
[RFC8362], IANA is requested to assign a registry value for Link
Number Sub-TLV as follows:

Value	Description	reference
=======	=============	===========
TBD2	Link Number	This document

Under "Sub-TLVs for TLVs 22, 23, 25, 141, 222, and 223" for IS-IS
TLV Codepoints, IANA is requested to assign a codepoint for Link
Number Sub-TLV as follows:

```
+============+==================+==+==+==+===+===+===+============+
|Sub-TLV Type|Sub-TLV Name      |22|23|25|141|222|223|reference   |
+============+==================+==+==+==+===+===+===+============+
| TBD3       |Link Number       |y |n |n | n | y | n |This document|
+------------+------------------+--+--+--+---+---+---+------------+
```

7. Acknowledgements

TBD.

8. References

8.1. Normative References

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