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**OSPF-TE Extension for Multi Stages Multiplexing Configuration in G.709
Optical Transport Network
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Abstract

Multi stages multiplexing configuration requirement is defined in [MULTI-STAGES-MULTIPLEXING-CONFIG-REQ] document. Multi stages multiplexing configuration framework is defined in [MULTI-STAGES-MULTIPLEXING-CONFIG-FRW] document. They describe some scenarios for the interworking between regions with 1.25G TS and 2.5G TS and the multi-domain OTN applications based on the tunnel design. Multi stages multiplexing is desirable to facilitate the introduction of new ODU0 and ODUFlex signals to an existing network without having to upgrade every node in the network. So ODU0/ODUFlex can be mapped into ODU1/ODU2/ODU3 and transit across the 2.5G TS region. Multi stages multiplexing/demultiplexing are also used to support the multi-domain OTN applications based on the tunnel design. From the perspective of Management Plane and Control Plane, they must get multi stages multiplexing/demultiplexing capability of each gateway nodes for path computation. This document describes the OSPF-TE extension for multi stages multiplexing configuration in G.709 Optical Transport Network.

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

G.709 has supported a single stage of ODU multiplexing. The practical consequence of this in OTN v1 is an ODU1 can be mapped directly to a tributary slot of an ODU3, without having to be first mapped into an ODU2. The motivation for this architecture is reducing complexity. In the normal progression of things, new additions to the OTN were expected to be at faster bit rates, and thus the single stage concept could be easily maintained going forward.

The introduction of ODU0 and ODUFlex to the OTN hierarchy creates a situation where the newly added ODUk signals have a bit rate that is lower than any of the existing signals, which presents some different challenges because the new signals can be clients of the existing signals. As a result, there are clear applications where multi stages of multiplexing would be desirable to facilitate the introduction of these new ODU0 and ODUFlex signals to an existing network without having to upgrade every node in the network. Using multi stages of multiplexing allows the operator to confine the new rates to only those nodes that need to support them.

A second potential application for multi stages outside of an upgrade scenario would be a network design based on tunnels. Multi stages multiplexing are used to support the multi-domain OTN applications based on the tunnel design.

From the perspective of Control Plane, path computation entity must get multi stages multiplexing/demultiplexing capability of each gateway nodes for path computation. This document describes the OSPF-TE extension in order for multi stages multiplexing configuration in G.709 Optical Transport Network.

2. OSPF-TE Extension for Multi Stages Multiplexing Configuration

Multi stages multiplexing/demultiplexing capability information must be flooded into the path computation entity and the routing domain by gateway nodes with the IGP protocol. LSAs which are advertised by gateway nodes must carry multi stages multiplexing/demultiplexing capability information. Multi stages multiplexing/demultiplexing capability should be configured by Management Plane (e.g., Network Planning Tool) or discovered by the gateway node based on the switching and adaptation capability of switching fabrics and cards.

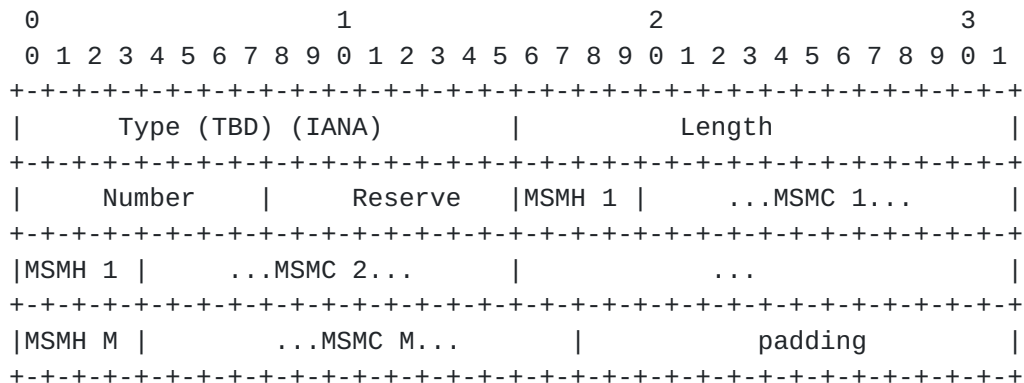
This document defines extensions to the OSPF routing protocol which is defined in [[RFC3630](#)], [[RFC4202](#)], and [[RFC4203](#)] in order for multi stages multiplexing configuration. The TE LSA, which is an opaque

LSA with area flooding scope [[RFC3630](#)], has only one top-level Type/Length/Value (TLV) triplet and has one or more nested sub-TLVs. One of the top-level TLVs is Link [[RFC3630](#)] value. This document enhances the sub-TLVs for the Link TLV to support Multi Stages Multiplexing Configuration.

2.1. Multi Stages Multiplexing Capability Constraint Sub-TLV

The Link top-level TLV is defined in [[RFC3630](#)], [[RFC4203](#)]. 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. In order to make path computation entity get the multi stages multiplexing capability information of gateway node, this document add an additional sub-TLV to the Link-TLV. If there is no any multi stages multiplexing configuration for operator, This sub-TLV is optional for OTN application. Single stage multiplexing capability don't need to be indicated by this sub-TLV.

Multi Stages Multiplexing Capability Constraint is a sub-TLV of the Link TLV. The type of this sub-TLV will be assigned by IANA, and length is eight octets. The value field of this sub-TLV contains multi stages multiplexing capability information which is supported by link port.



- o Number (8 bits): Indicates the total number of multi stages multiplexing capability which is supported by the link port.
- o Reserve (8 bits): for future use.
- o (MSMH 1, MSMC 1), (MSMH 2, MSMC 2), ... , (MSMH M, MSMC M): Indicates each multi stages multiplexing capability detailed information.

- * MSMH 1, MSMH2, ... , MSMH M (4 bits): Indicates the Multi Stages Multiplexing Hierarchies (MSMH).
- * MSMC 1, MSMC 2, ... ,MSMC M: Indicates the multi stages multiplexing capability. The length of Multi Stages Multiplexing Capability (MSMC) information depends on the multi stages multiplexing hierarchies (MSMH). The length of MSMC is $(MSMH+1) * 4$. Each ODUk (k=1, 2, 3, 4, 2e, flex) is indicated by 4 bits. Following is the Signal Type for G.709 Amendment 3.

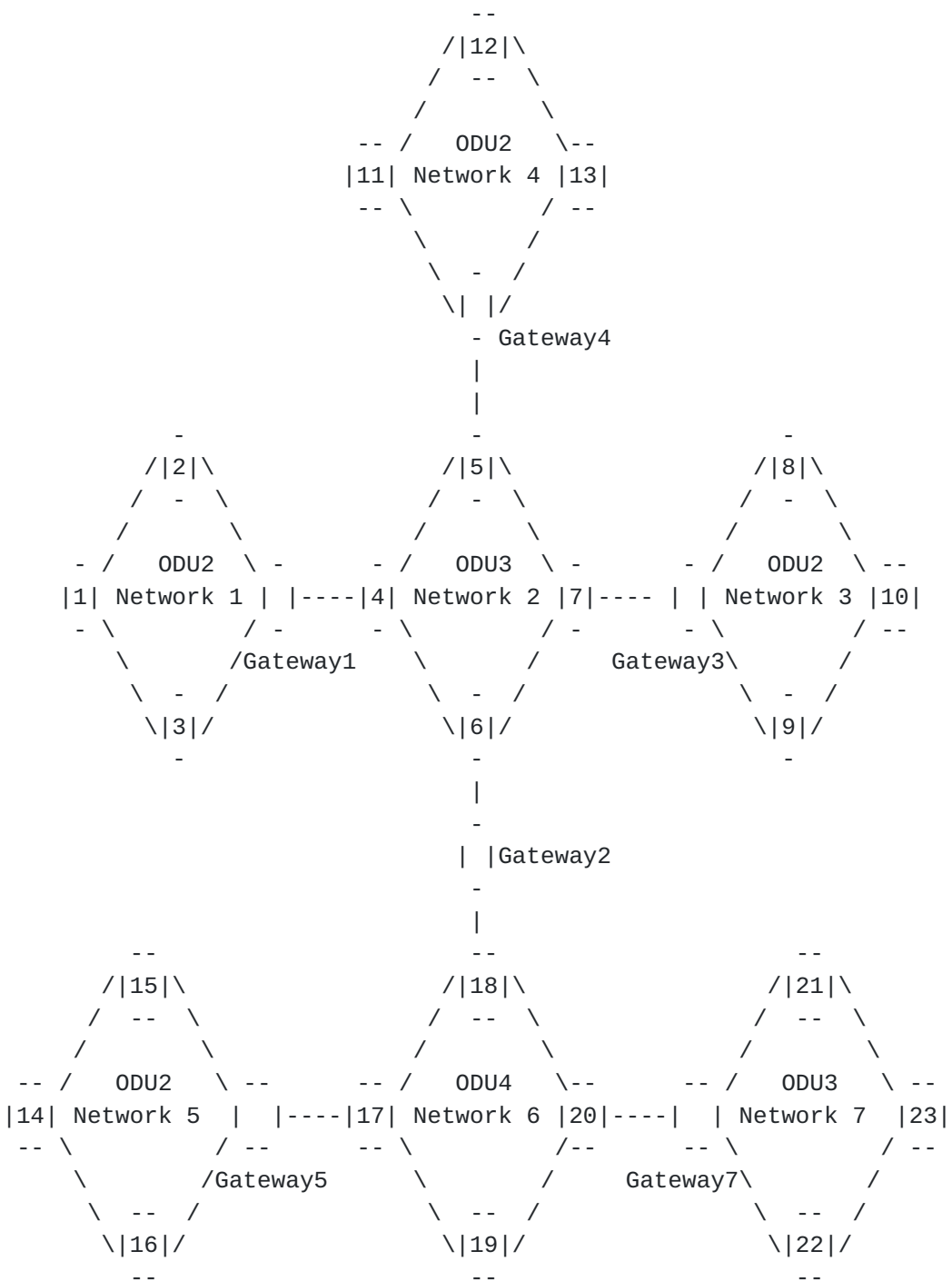
Value	Type
-----	----
0000	ODU0
0001	ODU1
0010	ODU2
0011	ODU3
0100	ODU4
0101	ODU2e
0110	ODUflex
7-15	Reserved (for future use)

- o The padding is used to make the Multi Stages Multiplexing Capability sub-TLV 32-bits aligned.

2.2. Multi Stages Multiplexing Capability OSPF-TE Extension Example

In the following figure, different gateway nodes support different multi stages multiplexing/demultiplexing capability. From the perspective of Control Plane, it must get multi stages multiplexing/demultiplexing capability of each gateway nodes for path computation. So the path computation entity can select a proper kind of multi stages multiplexing/demultiplexing of gateway nodes along a specific E2E connection.

Gateway 2 provides demultiplexing to recover the ODU2 from ODU4 and an additional multiplexing of the ODU2 to ODU3 and vice versa.



Gateway 1 supports the following multi stages multiplexing/ demultiplexing capability.

- o ODU0-ODU1-ODU3

- o ODU0-ODU2-ODU3
- o ODU1-ODU2-ODU3
- o ODUFlex-ODU2-ODU3

The value of Multi Stages Multiplexing Capability Constraint Sub-TLV is as followings:

```

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 (TBD)      |      Length(12)      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      4      | Reserve |0 1 0|0 0 0 0|0 0 0 1|0 0 1 1|0|
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|1 0|0 0 0 0|0 0 1 0|0 0 1 1|0 1 0|0 0 0 1|0 0 1 0|0 0 1 1|0 1 0|
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|0 1 1 0|0 0 1 0|0 0 1 1|padding
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

Gateway 3 supports the following multi stages multiplexing/demultiplexing capability.

- o ODU0-ODU2-ODU3
- o ODUFlex-ODU2-ODU3

The value of Multi Stages Multiplexing Capability Constraint Sub-TLV is as followings:

```

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 (TBD)      |      Length(8)      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      2      | Reserve |0 1 0|0 0 0 0|0 0 1 0|0 0 1 1|0|
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|1 0|0 1 1 0|0 0 1 0|0 0 1 1|padding
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

Gateway 4 supports the following multi stages multiplexing/demultiplexing capability. It doesn't support the ODUFlex-ODU2-ODU3 multiplexing. The operator limits the ODUFlex application to the local network. There is no any multi-domain ODUFlex application which goes into ODU2 Network 4.

- o ODU0-ODU1-ODU3
- o ODU0-ODU2-ODU3

The value of Multi Stages Multiplexing Capability Constraint Sub-TLV is as followings:

```

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 (TBD)      |      Length(8)      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      2      | Reserve |0 1 0|0 0 0 0|0 0 0 1|0 0 1 1|0|
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|1 0|0 0 0 0|0 0 1 0|0 0 1 1|      padding      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

Gateway 5 supports the following multi stages multiplexing/demultiplexing capability.

- o ODU0-ODU2-ODU4
- o ODU0-ODU3-ODU4
- o ODU1-ODU2-ODU4
- o ODU1-ODU3-ODU4
- o ODUflex-ODU2-ODU4
- o ODUflex-ODU3-ODU4

The value of Multi Stages Multiplexing Capability Constraint Sub-TLV is as followings:

```

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 (TBD)      |      Length(16)      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      6      | Reserve |0 1 0|0 0 0 0|0 0 1 0|0 1 0 0|0|
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|1 0|0 0 0 0|0 0 1 1|0 1 0 0|0 1 0|0 0 0 1|0 0 1 0|0 1 0 0|0 1 0|
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|0 0 0 1|0 0 1 1|0 1 0 0|0 1 0|0 1 1 0|0 0 1 0|0 1 0 0|0 1 0|0 1|
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```



```

|1 0|0 0 1 1|0 1 0 0|           padding           |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

Gateway 7 supports the following multi stages multiplexing/demultiplexing capability. It doesn't support the ODU1-ODU2-ODU4 and ODU1-ODU3-ODU4 multiplexing. The operator limits the ODU1 application to the local network. There is no any multi-domain ODU1 application which goes into ODU3 Network 7.

- o ODU0-ODU2-ODU4
- o ODU0-ODU3-ODU4
- o ODUFlex-ODU2-ODU4
- o ODUFlex-ODU3-ODU4

The value of Multi Stages Multiplexing Capability Constraint Sub-TLV is as followings:

```

      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 (TBD)      |      Length(12)      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      4      | Reserve |0 1 0|0 0 0 0|0 0 1 0|0 1 0 0|0|
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|1 0|0 0 0 0|0 0 1 1|0 1 0 0|0 1 0|0 1 1 0|0 0 1 0|0 1 0 0|0 1 0|
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|0 1 1 0|0 0 1 1|0 1 0 0|           padding           |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

2.3. Routing Procedure

TBD

3. Security Considerations

The use of control plane protocols for signaling, routing, and path computation opens an OTN to security threats through attacks on those protocols. The data plane technology for an OTN does not introduce any specific vulnerabilities, and so the control plane may be secured using the mechanisms defined for the protocols discussed. For further details of the specific security measures refer to the documents that define the protocols ([RFC3473], [RFC4203], [RFC4205], [RFC4204], and [RFC5440]). [GMPLS-SEC] provides an overview of

security vulnerabilities and protection mechanisms for the GMPLS control plane.

4. IANA Considerations

TBD

5. References

5.1. Normative References

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", [BCP 14](#), [RFC 2119](#), March 1997.

[I-D.ietf-ccamp-gmpls-g709-framework]
Zhang, F., Li, D., Li, H., Belotti, S., Han, J., Betts, M., Grandi, P., and E. Varma, "Framework for GMPLS and PCE Control of G.709 Optical Transport Networks", [draft-ietf-ccamp-gmpls-g709-framework-00](#) (work in progress), April 2010.

5.2. Informative References

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