Network Working Group
Internet-Draft
Intended status: Standards Track
Expires: January 13, 2011

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July 12, 2010

Requirement for Multi Stages Multiplexing Configuration in G.709 Optical Transport Network

draft-fuxh-ccamp-multi-stage-multiplex-config-req-01

Abstract

Interworking between regions with 1.25G TS and 2.5G TS has been considered in G.709. Multi stages multiplexing/demultiplexing would be 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. If there are a large number of circuits that share the same endpoints (or even part of an overall path), it may be convenient from a management perspective to first multiplex those ODU0, ODU1 and ODUflex into ODU2 or ODU3 to minimize the number of connections that need to be made in intermediate nodes. The ODU2/ODU3 effectively creates a tunnel through the ODU4 network that the ODU0, ODU1 and ODUflex can use.

This document describes the requirement of multi stages multiplexing configuration assocaited with some specific scenarios 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].

Status of this Memo

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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 the carrier-carrier, regional-national core interconnection cases or network design based on tunnels. Multi stages multiplexing are used to support these multi-domain OTN applications.

This document describes the requirement for multi stages multiplex configuration in G.709 Optical Transport Network. There are multi-stage multiplexing application for some specific scenarios, but it is not a general requirement. This document just havs to associate the requirement with specific scenarios.

2. Typical Use Case

There may be two use cases to use multi stages multiplexing. But this document doesn't imply restrictions to scenarios for multi stages multiplexing. It just gives some examples of how the multi stage multiplexing can be used in the OTN network.

- interworking 1.25G TS and 2.5G TS OTN networks.

- carrier-carrier and regional-national core interconnection cases, or network design based on tunnels.

2.1. Multi Stages Multiplexing Configuration Requirement for Interworking Between Regions with 1.25G TS and 2.5G TS

In Figure 1, node 4, 5, 6 and 7 have ODU1 and ODU2 switching capability. All nodes only support 2.5G TS granularity. They can't support ODU0/ODUflex directly. They could not have any visibility to the ODU0/ODUflex.

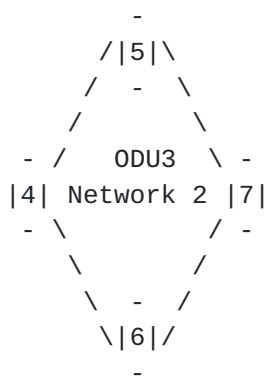

Figure 1

In Figure 2, operator deploys three new 10G OTN networks, such as ODU2 Network 1, ODU 2 Network 3 and ODU2 Network 4. All ODU2 networks are interconnected with ODU3 network by OTU3 link. All nodes of three ODU2 networks support the 1.25G TS granularity and are based on G.709 v3. All nodes in ODU2 Network 1 and ODU2 Network 4 can support ODU0, ODU1 and ODUflex switching capability. ODU2 Network 3 is only desirable to support GigE and ODUflex services, so all nodes in ODU2 Network 3 only support ODU0 and ODUflex for more economical cost. It doesn't support ODU1 (e.g., STM-16) application.

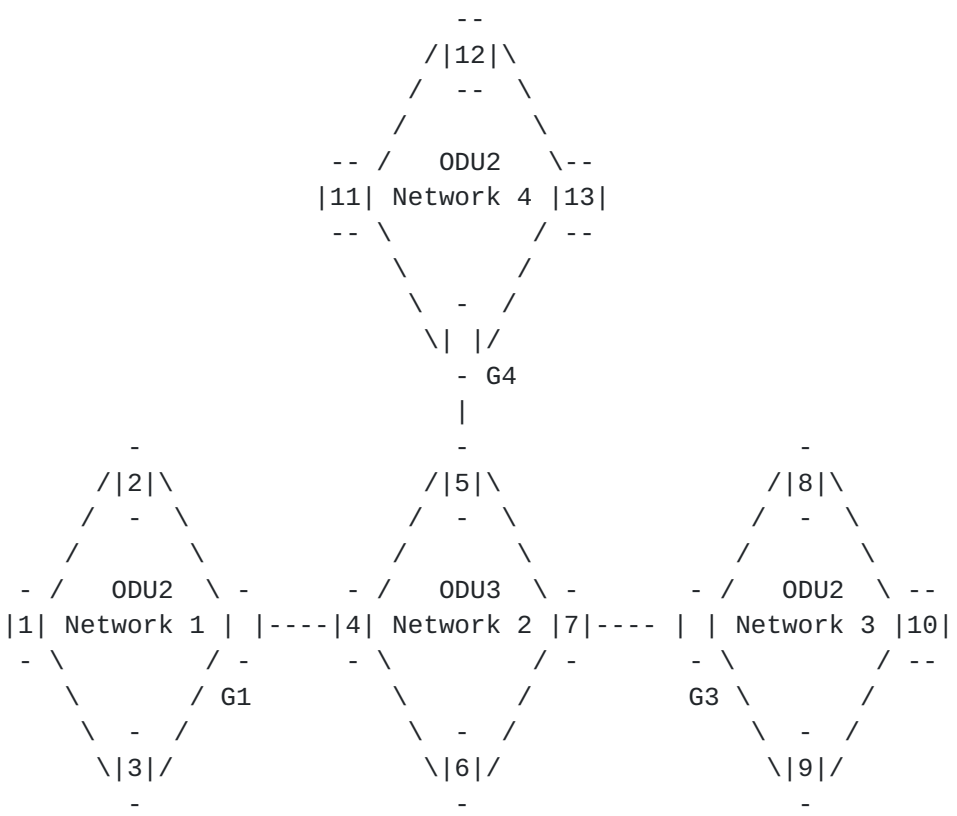

Figure 2

There are clear applications where 2 stages of multiplexing within one port 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. In order for the interworking between 1.25G TS and 2.5G TS networks, there must be some nodes which support multi stages multiplexing/demultiplexing to allow ODU0/ ODUflex to be supported across the legacy network. For example, ODU0 is mapped first to ODU1 or ODU2, and that ODU1/2 is then mapped into ODU3. Nodes in the legacy network switch the ODU1/ODU2 without having any visibility to the ODU0/ODUflex. Whether ODU1 or ODU2 should be created for end-to-end ODU0 service depends on multi stages multiplexing capability. Different nodes may support different multi stages multiplexing capabilities based on the network planning and the capability of network element.

G1 is supposed to support the following multi stages multiplexing/ demultiplexing capability.

o ODU0-ODU1-ODU3

- ODU0-ODU2-ODU3
- ODU1-ODU2-ODU3
- ODUflex-ODU2-ODU3

G3 is supposed to support the following multi stages multiplexing/ demultiplexing capability.

- ODU0-ODU2-ODU3
- ODUflex-ODU2-ODU3

G4 is supposed to support the following multi stages multiplexing/ demultiplexing capability. The operator limits the ODUflex application to the local network. There is no any multi-domain ODUflex application which goes into ODU2 Network 4 and vice versa. So it doesn't need to support the ODUflex-ODU2-ODU3 multiplexing.

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

There are several end-to-end services being provisioned by operator.

- E2E ODUflex 1 (e.g., 6*1.25G TS): It transit 1, 3, G1, 4, 6, 7, G3 and 8.
- E2E GigE 1: It transit 1, 3, G1, 4, 6, 7, G3, 9 and 10.
- E2E GigE 2: It transit 2, G1, 4, 5, G4, 11 and 12.
- E2E STM-16 1: It transit 1, 2, G1, 4, 5, G4 and 13.

The E2E ODUflex 1 (e.g., 6*1.25G TS) and GigE 1 services share the same ODU2 tunnel between G1 and G3. Multi stages multiplexing/ demultiplexing capability must be configured with ODU0-ODU2-ODU3 in G1 and G3 for GigE 1 service. Multi stages multiplexing/ demultiplexing capability must be configured with ODUflex-ODU2-ODU3 in G1 and G3 for ODUflex 1 service. There is an ODU 1 tunnel between G4 and G1 for the E2E GigE 2 service. Multi stages multiplexing/ demultiplexing capability must be configured with ODU0-ODU1-ODU3 in G1 and G4 for GigE 2 service. There is no any need to configure multi stages multiplexing/demultiplexing for E2E STM-16 1 service.

2.2. Multi Stages Multiplexing Configuration Requirement for Multi-Domain OTN Applications

In Figure 3, operator deploys three new OTN networks again, such as ODU2 Network 5, ODU3 Network 7 and ODU4 Network 6. ODU2 network 5 and ODU3 network 7 are interconnected with ODU4 network by OTU4 link. All nodes of three new OTN networks support the 1.25G TS granularity and are based on the G.709 v3. All nodes in ODU2 Network 5 support ODU0, ODU1 and ODUflex switching capability. All nodes in ODU3 Network 7 support ODU0, ODU1, ODUflex and ODU2 switching capability. All nodes in ODU4 Network 6 only support ODU2 and ODU3 switching capability.

In an ODU4 network, there are 80 tributary slots per ODU4. Suppose there are a large number of multi-domain ODU0 and ODUflex demands. If these multi-domain service share the same endpoints (or even part of an overall path), it may be convenient from a management perspective to first multiplex those ODU0 and ODUflex into ODU2 or ODU3 to minimize the number of connections that need to be made in intermediate nodes. It also minimizes managed entities made in core network and support carrier's carrier application. The ODU2/ODU3 effectively creates a tunnel through the ODU4 network that the ODU0, ODU1 and ODUflex can use.

In order for the tunnel network design, there must be some nodes which support ODU0, ODU1 and ODUflex to be mapped into ODU2/ODU3 first and that ODU2/ODU3 is then mapped into ODU4.

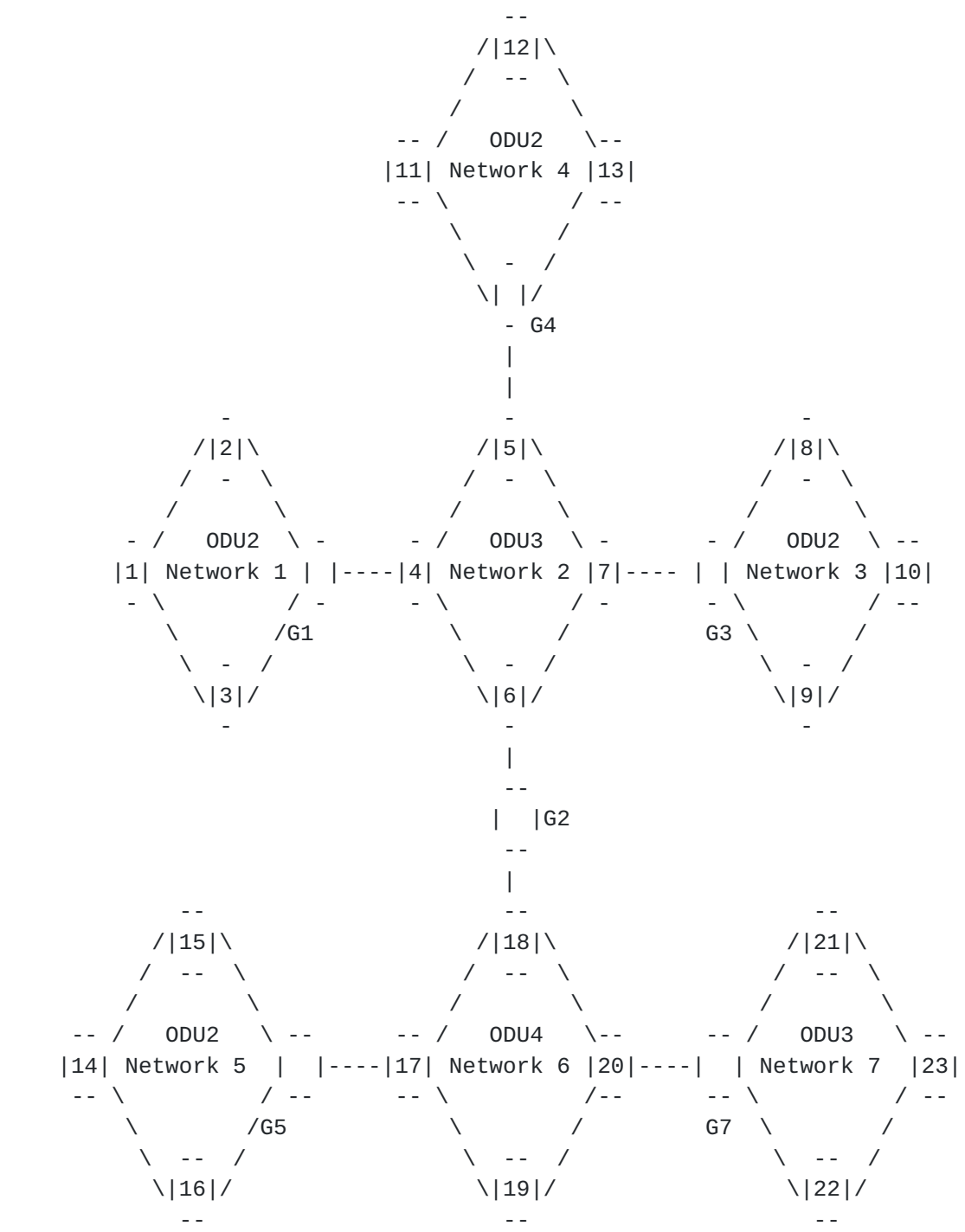

Figure 3

G5 is supposed to support the following multi stages multiplexing/ demultiplexing capability.

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

G7 is supposed to support the following multi stages multiplexing/ demultiplexing capability. The operator limits the ODU1 application to the local network. There is no any multi-domain ODU1 application which goes into ODU3 Network 7 and vice versa. It doesn't need to support the ODU1-ODU2-ODU4 and ODU1-ODU3-ODU4 multiplexing.

- ODU0-ODU2-ODU4
- ODU0-ODU3-ODU4
- ODUflex-ODU2-ODU4
- ODUflex-ODU3-ODU4

G2 provides demultiplexing to recover the ODU2 from ODU4 and an additional multiplexing of the ODU2 to ODU3 and vice versa.

There are several E2E services.

- E2E ODUflex 2 (e.g., 10*1.25G TS): It transit 16, G5, 17, 19, 20, G7, 22 and 23.
- E2E GigE 3: It transit 14, 15, G5, 17, 19, 20, G7 and 21.
- E2E GigE 4: It transit 15, G5, 17, 18, G2, 6, 7, G3, 9 and 10.
- E2E STM-16 2: It transit 15, G5, 17, 18, G2, 6, 4, G1, 3.

In Figure 3, the E2E ODUflex 2 (e.g., 10*1.25G TS) and GigE 3 services share the same ODU3 tunnel between G5 and G7. Multi stages multiplexing/demultiplexing capability must be configured with ODU0-ODU3-ODU4 in G5 and G7 for GigE 3 service. Multi stages multiplexing/demultiplexing capability must be configured with ODUflex-ODU3-ODU4 in G5 and G7 for ODUflex 2 service.

There is an ODU 2 tunnel between G5 and G3 for the E2E GigE 4

service. Multi stages multiplexing/demultiplexing capability must be configured with ODU0-ODU2-ODU4 in G5 for GigE 4 service. Multi stages multiplexing/demultiplexing capability must be configured with ODU0-ODU2-ODU3 in G3 for GigE 4 service.

There is an ODU 2 tunnel between G5 and G1 for the E2E STM-16 2 service. Multi stages multiplexing/demultiplexing capability must be configured with ODU1-ODU2-ODU4 in G5 for STM-16 2 service. Multi stages multiplexing/demultiplexing capability must be configured with ODU1-ODU2-ODU3 in G1 for STM-16 2 service.

3. Requirement for Multi Stages Multiplexing Configuration

3.1. Requirement in the level of the Data Plane

This section describes the basic requirements in the Data Plane to support the multi stages multiplexing configuration functions of this document. In order to introduce new ODU0 and ODUflex signals to an existing network and support multi-domain OTN application based on network tunnel design, if some nodes are designed to support multi stages multiplexing capability, following requirement for these node should be satisfied.

- If these nodes can support different multi stages multiplexing hierarchy (e.g., two or three stages, and so on) and multiple multi stages multiplexing capabilities. They must support the multi stages multiplexing configuration from Management Plane and/or Control Plane. They must support to check the local data plane capability to see if this kind of multi stages multiplexing/ demultiplexing from MP and/or CP is acceptable on specific interface.

3.2. Requirement in the level of Control Plane and Management Plane

This section describes the basic requirements for MP and CP to perform the multi stages multiplexing configuration.

- Management Plane:
  - From the perspective of Management Plane, it must get multi stages multiplexing/demultiplexing capability of each nodes for the service provision.
  - Management Plane must support to config the multi stages multiplexing hierarchy which is determined by path computation entity into the Data Plane for the E2E service.

- Control Plane:

  - From the perspective of Control Plane, it must get multi stages multiplexing/demultiplexing capability of each nodes for path computation. It can get multi stages multiplexing/ demultiplexing information by Management Plane configuration. Path computation entity can also use the IGP protocol or configurations from Management Plane to get these information.

  - Path computation element must select a proper kind of multi stages multiplexing/demultiplexing hierarchy of nodes along a specific E2E connection.

  - Signaling message must carry the multi stages multiplexing/ demultiplexing hierarchy that has been determined by path computation entity. Multi stages multiplexing/demultiplexing hierarchy for a specific service must be configured to data plane after the node which needs to be support multi stages multiplexing receives the signaling of service creation.

4. 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.

5. IANA Considerations

TBD

6. References

6.1. Normative References

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

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6.2. Informative References

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