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General Switch Management Protocol (GSMP) v3 for Optical Support

Status of this Memo

Abstract

This document describes the GSMPv3 for the support of optical switching. GSMP controller SHOULD control optical label switches and manage optical resources on them. This document describes the extended functions of GSMP for optical switching and explains operational mechanisms to implement them. It SHOULD be referred with [1] for the complete implementation.

Conventions

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.

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1. Introduction

This document describes the extended functions and requirements of GSMPv3 for the support of optical switching. GSMPv3 is an asymmetric protocol to control and manage the label switch. The label switches that are used for optical switching are all optical cross-connects (optical-optical-optical), transparent optical cross connects (optical-electrical-optical, frame independent).

In order for GSMP to operate between the controller and optical switched and cross connects, optical labels, services for optical switching, and resource abstractions MUST be defined and added to

GSMP, since the basic optical resources which are used in connection setup are different with them of the legacy networks.

One of the main roles of GSMP is to support restoration capabilities of optical switches and the connection. By extending the management messages of GSMP, this function MUST be implemented.

For the complete implementation this document MUST be referred with [1].

2. Common Definitions and Procedures for Optical Support.

Common definitions and procedures which are not mentioned in this document follow [1].

2.1 Labels

Labels are the basic identifier for a connection. In order to setup connections in optical switch, new labels MUST be defined. The newly defined labels identify the entities that are to be switched in the optical switches. GMPLS defines packet switching capable, TDM switching capable, lambdas switching capable, fiber switching capable interfaces, and it introduces the needs of generalized labels to support them [3][4]. So far, GMPLS does not defined the labels to be used for optical switching (label formats and encoding schemes), but GSMP MUST support the all types of label that to be defined in GMPLS. The following lists are the labels to be supported in the optical switching [2][3][4].

- a single fiber in a bundle
- a single waveband within a fiber
- a single wavelength within a waveband (or a fiber)
- an optical burst within a wavelength

2.1.1 Labels for Wavelength and Fiber

The label indicates a fiber or a wavelength to be used for a connection establishment in optical switching. Value of the label only has significance between two neighbors, and the receiver MAY need to convert the received value into a value that has local significance.

2.1.2 Labels for Waveband

A Waveband is a set of contiguous wavelengths which can be switched together to a new waveband [3][4]. It MAY be desirable for an optical cross connect to optically switch multiple wavelengths as a unit since it MAY reduce the distortion on the individual wavelengths and MAY allow tighter separation of the individual wavelengths. The

Waveband Label is defined to support such a waveband switching. The waveband label can be encoded in three parts; waveband ID, start label, and end label. The start label and the end label represent the

lowest value wavelength and the highest value wavelengths.

2.1.3 Labels for optical burst

The label for optical burst represents the label for switching optical burst data in time domain in a wavelength. However, this label is not defined yet.

2.1.4 Label Range

The basic label range to be used in each port is specified by the Port Configuration or All Port Configuration message. The Label Range message allows the range of labels supported by a specified port to be changed. The controller MUST allocate the label range with consideration of optical characteristics when assigning the labels for a connection because the connection is established per optical burst, wavelength, waveband, and fiber in optical domain. Since the basic label range varies in switches and the labels for the connections can be different due to the optical characteristics, GSMP does not treat them. However, the following lists SHOULD be considered and the available label ranges can be applied in the Label Range message.

- When allocating a label for a wavelength, the label SHOULD be allocated for it with consideration of wavelength continuity. For satisfying the requirement of wavelength continuity in a connection, the label SHOULD be allocated to maintain the same wavelength for it. The controller MUST manage the available labels and support the constraint.

- The labels to be used for waveband switching MUST be contiguous, because the waveband switching is possible only in the set of contiguous wavelengths. The decision mechanism for the available label range is out of scope of GSMPv3.

2.2 Protection and Restoration Capability in GSMP

The GSMP controller MUST support the protection and restoration capabilities because the optical switch delivers several Gbps data traffic in a single wavelength. To achieve fast protection and restoration, the optical switch is capable of taking an action independent of the GSMP controller, then it informs the controller after completing the restoration [2]. This differs from the master-slave relationship in GSMP. Therefore, the GSMP port configuration command MUST be extended to allow autonomous protection mechanism. The current GSMP connection management also MUST be extended to support this function.

2.2.1 Dedicated and shared recovery mechanisms

In the dedicated protection, both working and backup path deliver the traffic simultaneously from an ingress node to an egress node. The

egress node of the path selects one of them as a working path according to the received signal status from the previous node. Since the backup path also delivers the traffic it MUST be established by using the Add Branch message. When any link in the working path fails, the egress node switches over from the failed working path to the backup path without noticing the GSMP controller automatically.

After completing the recovery of the failed path, the switch reports the fact of configuring a new connection to the controller. When the failed original path is repaired the controller determines how to deal with the path according to the revertible or nonrevertible mode. In the revertible mode, the currently used backup path is changed to the repaired original path by using the Move Input Branch message which includes the new port and label of which values are used for the original connection. In the nonrevertible mode, the controller deletes the repaired original working path by using the Delete Branch message, or uses it as a new backup path for the currently used backup path by using the Add Branch message.

In 1:N shared protection, N working paths share the one backup path. In a different way of the dedicated protection, the shared path does not deliver any traffic since the controller does not know which working paths will use it. The controller uses the Reservation message to reserve a connection for the backup path. When a link fails among the N working paths, the controller issues the Add Branch message to restore the traffic through the failed working path into the new backup path

2.2.2 Revertible and Non-revertible mode

In the revertible mode, when the failed working path is repaired, the controller restores the currently used backup path to the original working path. The GSMP controller MUST keep the information for the working path. The controller issues the Move Input/Output Branch messages with the new port and label of which values are that of the working path to restore it. After restoring, the backup path is deleted by using the Delete message or continuously used as a backup purpose.

In non-revertible mode, the working path is not restored from the currently used backup path even though it is repaired. The original working path can be used as a new backup path by using the Add Branch message (1+1 dedicated protection), or the Reservation message (1:N shared protection)

2.3 GSMP support for optical switching systems

GSMP SHOULD control and manage the optical cross-connect systems as label switches. The optical cross-connect (OXC) is a space division

switch that can switch an optical data stream on an input port to an output port.

The OXC system can be consist of switching fabric, multiplexer/demultiplexer, wavelength converter, and optical-electrical/electrical-optical converter. Multiple wavelengths are multiplexed or demultiplexed into a fiber. Multiple fibers belongs to a fiber bundle. A wavelength, a waveband, and a fiber can be used to establish a connection in an optical switch. They SHOULD be recognized at a port in the OXC since they are connection entities. When the OXC has optical-electrical conversion at the input port and electrical-optical conversion at the output port it is called as opaque OXC. Or, when it processes optical data stream all optically it is called as transparent OXC. Wavelength converter SHOULD be used to resolve output port contention when two different connections try to be established in a same output port. Since the wavelength converter can work only within a limited operating range, the limited numbers of wavelengths are used at the output port. It limits the available wavelengths at the output port.

In order to control and manage the OXC systems, GSMP SHOULD be located as a subset of functions for it and MUST know the current switch, port and service configuration information. GSMP controller SHOULD identify the connection entities at the OXC and match them with the optical labels.

2.3.1 Capability of GSMP for optical burst switching

GSMPv3 SHOULD also support data burst switching as a new connection entity in optical domain. As described in [9],[10], connection setup for optical burst includes reserving time on the transport medium for the client.

This time is characterized by two parameters: a start time and the duration of data burst. These values MAY define a fast one-way reservation. Upon a request for setup of a burst connection, the GSMP controller MUST perform appropriate Connection Admission Control for the time and duration specified. If the connection is allowed, it MUST signal these parameters to the burst switching device to reserve the exact bandwidth required [9],[10]. The burst switch MUST perform the switching operation autonomously, using the synchronization methods prescribed for the burst network it is operating in.

3. Connection Management Messages

3.1 General Message Definitions

Connection management messages, which are used for establishing, releasing, modifying, and verifying connections across the switch by the controller, can operate in the optical domain, as the same mechanisms. However, it is not possible to process each packet in

optical domain so that such a traffic parameter can not be used to specify the connection. Connection management messages also SHOULD support the OXC restoration capabilities.

3.2 Add Branch Message

The Add Branch message is used to setup a connection. Especially, it MUST support restoration capabilities in the optical domain. For 1+1 dedicated protection, it is required to make an additional connection as a backup path to protect an original connection against failure. Additional fields are not required in the Add Branch message to support the restoration capabilities since the two connections are used for data traffic and an egress node selects one between them so that they functions same. However, the controller SHOULD know the whole statues of the switch.

3.3 Move Output Branch Message

The Move Output Branch message is used to change the current output port label to the new output port label for re-establishing the existing connection. It can be used to support restoration capabilities. Since to re-establish output port of a switch at an ingress node is to change a start point of the current connection, it can be used for 1:1 protection or 1:N shared protection where an ingress node begins a connection. Upon a fault occurring, in order to setup a new backup path instead of the failed working path, the new port in upstream node SHOULD be connected to the current connection by using this message. Because, the ingress node also takes responsibility for recovery, as well as the egress node.

3.4 Move Input Branch Message

The Move Input Branch message is used to change the current input port label to the new input port label for re-establishing the existing connection. It is also used to support restoration capabilities. It is used for the revertible mode that is to move back to the original connection from a backup connection after a recovery completed. The new port/label in this message uses that of the original connection.

4. Reservation Management Messages

The Reservation Management message that reserves resources for a connection before establishing a connection SHOULD reserve optical resources, such as data burst, wavelengths, a set of wavelengths for waveband switching, and fibers. In order to use the reservation management messages, optical resources which the OXC supports SHOULD be defined. It can be used to support restoration capabilities for reserving backup connections. Especially, 1:N shared protection scheme reserves a spare connection which is reserved for N working connections so that this MUST use the reservation request messages for reserving a backup connection. The reserved connection identified by the reservation ID SHOULD be informed to N working connections. In

the reservation request message, the input label and output label of the reserving branch SHOULD be assigned. After a fault occurs, the

recovery procedure to make a backup connection just follows the ordinary connection setup procedure in [1].

5. State and Statistics Messages

The State and Statistics messages can be used to monitor the statistics related to ports and connection for optical transmission. It allows the controller to request the state and statistics of the switch.

5.1 Statistics Messages

The statistics messages are used to query the performance statistics related to ports and connections for optical transmission. Since the current statistics messages in [1] report the statistics related to traffic states per cells, or frames, the new fields SHOULD be added into the message for querying the optical support. The Port Statistics message requests the statistics for the ports of the switch. The Connection Statistics message allows the controller to report the performances and statistics of the connection itself. The statistics elements to monitor in the OXC are following.

- signal degradation
- loss of signal

As a result of performance analysis through the statistics messages, the new connection can be requested when the controller finds the much degraded performance on the connection. Therefore, the statistics message to detect a fault SHOULD be defined, but the fault detection mechanism is out of scope of this document.

6. Configuration Messages

The configuration messages allow the controller to discover the capabilities of optical switch. Switch configuration, port configuration, and service configuration messages are defined for these functions.

6.1 Switch Configuration Message

Since an optical switch MAY be able to provide connection services at multiple transport layers, and not all switches are expected to support the same transport layers, the switch will need to notify the controller of the specific layers it can support. Therefore, the switch configuration message MUST be extended to provide a list of the transport layers for which an optical switch can perform switching. The following lists are the possible switching layers.

- switching per optical burst
- switching per a single wavelength
- switching per a waveband
- switching per a single fiber
- switching per a fiber bundle

6.2 Port Configuration Message

The port configuration message supplies the controller with the configuration information related to a single port. In the OXC, the new port types SHOULD be defined in GSMP. Port types MUST be added to support the mix of optical signals that can operate over a single fiber. Basically the port can be used per wavelength, per fiber, and per fiber bundle. Moreover, the OXC can have many bays which contain hundreds of shalves which have tens of thousands of port. Therefore, physical bay and shelve identifiers also SHOULD be defined and encoded in port configuration message. The port configuration information that MAY need to be conveyed includes:

- available wavelengths per interface
- bit rate per wavelength (port)
- type of fiber

6.3 Service Configuration Message

The Service Configuration message requests the optical switch for the configuration information of the supported services. The requested services are identified in the service ID in the Add Branch message or the Reservation message. The service model is defined with traffic parameter, QoS parameter, and traffic control elements in [1], but these parameters can not be used to specify the optical services. Therefore this message SHOULD be modified to support optical services with newly defined capability sets. The services supported at optical switches SHOULD be defined for dealing with optical burst, wavelength, waveband, and fiber connection.

7. Event Messages

The Event messages allow the switch to inform the controller of certain asynchronous events. The asynchronous events include mainly port states indication. The indication of these asynchronous events related to ports can provide a port failure to the controller and it can initiate a fault recovery mechanism.

8. Failure Response Codes

This chapter describes the failure and warning states which can occur in setup optical connections. The following lists are the codes that

SHOULD be defined and added in the Failure Response messages. These codes MAY be added when the services for optical switching are defined. The code numbers will be assigned in IANA.

- no available wavelength at a port
- no available backup link for protection
- waveband connection setup fails
- reservation for optical burst fails

9. Security Considerations

This document does not have any security concerns. The security requirements using this document are described in the referenced documents

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