                Requirements for Adding Optical Support to
         the General Switch Management Protocol version 3 (GSMPv3)

Status of this Memo

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Abstract

   This memo provides requirements for adding optical switching support
   to the General Switch Management Protocol (GSMP). It also contains
   clarifications and suggested changes to the GSMPv3 specification.

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 BCP 14, RFC 2119 [1].

1. Overview

   This document details the changes to GSMP necessary for the support
   of optical (non-transparent and all optical), SONET/SDH, and spatial
   switching of IP packets, Layer 2 (L2) frames and TDM data. When
   implemented, GSMP controllers will then be able to control: photonic
   cross-connects (optical-optical), transparent optical cross connects
   (optical-electrical-optical, frame independent), opaque cross
   connects (optical-electrical-optical, SONET/SDH frames), and

traditional TDM switches (all electrical). The resulting systems
could form IP based optical routers, optical label switches,
wavelength routers, and dynamic optical cross connects.

Several different generic models exist defining how to provide
control plane functionality in an optical network [2], [3], [4].
This document takes no position on which model is most appropriate
(e.g., single or multiple routing plane instances). The only
assumption is that the ability to separate the control mechanisms
from the data switching is as useful for the signaling of optical
paths (e.g., GMPLS) as it is for the signaling of L2 paths (e.g.,
MPLS). Therefore, the requirements contained within are focused only
on the separation of control functions from data functions in order
to provide a more flexible network architecture.

GSMPv3 [5] is well suited for providing the control interface
necessary for allowing an IP based controller to direct the
activities of an optical switch. In order for GSMP to operate
between controllers and optical switches and cross connects, support
for optical labels and service and resource abstractions must be
added to GSMP.

This document also includes changes recommended by implementers that
will facilitate easier development of a GSMP implementation. These
changes consist of rearranging PDU formats, clarification of flags,
transaction identifiers, and response codes.

2. Requirements for Optical Support

2.1. Label

2.1.1. Label Types

New labels are needed to identify the entities that are to be
switched in the optical fabric. These are longer than the labels
defined in GSMPv3 as they have physical and structural context. As
GMPLS [2], [3] has had very similar requirements for label formats,
alignment with GMPLS is proposed. This includes support for:

        - Digital Carrier Hierarchy (e.g., DS-1, E1)
        - SONET and SDH Hierarchy (e.g., OC-3, STM-1, VT1.5, VC-12)
        - Plesiochronous Data Hierarchy (PDH) labels [6]
        - OTN G.709 labels
        - Lambdas
        - Fibers

   GSMP MUST include support for all label types list above, as well as
   for label hierarchies and label lists as defined by GMPLS.
   Therefore, the ability to perform operations on groups of the above
   labels MUST also be supported (e.g., 5 OC-3s, contiguous wavebands).

2.1.2. Label Management Issues

   An updated label range message MUST be provided. There MUST also be
   support of multiplexing (e.g., no multiplexing, SONET, Gigabit
   Ethernet multiplexing etc).

2.2. Statistics messages

   Optical switches have a number of different statistics which are not
   in common with ATM, or Frame Relay switches. Consequently, the
   statistics messages SHOULD be updated to report Performance
   Monitoring statistics defined for all new optical transport
   technologies added to GSMP.

2.3. Configuration Issues

2.3.1. Switch Configuration

2.3.1.1. Layer Switching Identification

   Since an Optical Switch may be able to provide connection services at
   multiple transport layers (i.e., STS-3c, STS-1, VT-1.5, DS3, DS1),
   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.

2.3.2. Port Configuration

   The port configuration message supplies the controller with the
   configuration information related to a single port. Consequently,
   extensive additions will need to be made to this command.

2.3.2.1. Port Type extensions

   Port types MUST be added to support the mix of optical signals that
   can operate over a single fiber.

   The port information that MAY need to be conveyed includes [7]:

         - wavelengths available per interface
         - bit rate per wavelength
         - type of fiber

2.3.2.2. Supported Signal Type extensions

   Since a port on an optical switch may support signals at multiple
   transport layers, it is necessary to understand the signals
   supported, as well as the possible ways that one signal can be
   transported within another.

   For OTN, SONET/SDH and PDH optical switches, the Port configuration
   message MUST be extended to detail the different transport layer
   signals that are supported by a port. Furthermore, this extension
   MUST detail which signals may be transported by another signal.

   This mechanism MUST also provide information about optional
   capabilities (such as virtual concatenation and arbitrary
   concatenation for SONET/SDH) available on a port.

2.3.2.3. Trace Mechanism support Identification

   A number of transport layer signals include overhead channels that
   can be used to identify the source of a signal. Since they are
   embedded in the signal, only the network element has access to the
   signals. However, not all network elements have the capability to
   set or read the messages in these channels on every port.
   Consequently, this port attribute needs to be reported to the
   controller.

   The Port Configuration message MUST be extended to report which trace
   mechanisms are supported by a port.

2.3.2.4. Port Location Identification

   Since contemporary Optical switches have the ability to support tens
   of thousands of ports in hundreds of shelves located in as
   potentially as many bays, the current "Slot/Port" location identifier
   is inadequate.

   The Slot/Port Location Identifier MUST be extended to encode
   Bay/Shelf/Slot/Port.

2.3.2.5. Port-related Partitioning Extensions

   Partitioning can be done for any resource that exists in the network
   element. The GSMP partitioning draft currently defines ports and
   switching resources as partitionable resources. Since optical
   switches may support multiple transport network layers, an additional
   resource type is introduced: the transport layer signal.

   The point where a transport layer signal is inserted into a lower
   layer signal (called an "access point" by the ITU [8]), is very
   similar to a port. Therefore, when partitioning is done on a
   transport layer signal basis, the partition that is the user of the
   access point MUST have a port that associated with the access point.
   Labels will then be used in the to describe the subordinate signals.

2.3.3. Service Configuration

   While new capability sets MUST be added to support quality parameters
   in optical switches, no changes are foreseen to the service
   configuration message as its role to carry the service information as
   defined in the applicable service model.

2.4. Service Model Issues

   While one assumption of using optical media is that bandwidth is
   plentiful, it should be expected that traffic engineering will be
   necessary in any case [5]. GSMP provides the means for each
   connection to be created with specific attributes. Therefore,
   service parameters will need to be defined for each of the Different
   Optical technologies.

2.4.1. Transparent Optical

   Capability to control re-timing and re-shaping on a per port level
   MUST be added.

2.4.2. SONET/SDH and OTN

   The capability to control the adaptation parameters used when a
   transport signal is inserted into another transport signal MUST be
   added. These parameters SHOULD be modifiable at times other than
   adding a branch so that functions such as Tandem Connection
   Monitoring can be configured. Currently, the default set of service
   models in GSMP are all based on the services models defined
   elsewhere, e.g., the Intserv model [9], [10], the Diffserv [11]

model, ATM QoS models and the Frame relay forum QoS models. A
determination needs to be made of the applicable service models for
optical channel trails. These models MUST then be mapped to the GSMP
capability set mechanism.

2.5. Encapsulation issues

The working group needs to decide whether a new encapsulation is
required. In other words, will all optical switches used in either
the MPLS over Optics and the IP over optics applications require that
IP be implemented on the control channel connecting the GSMP
controller and Optical switch (the GSMP target).

A new encapsulation SHOULD be defined allowing the use of a non-IP
raw wavelength control connection.

Likewise, a new encapsulation SHOULD be defined allowing GSMP to be
used in legacy Data Communication Network (DCN) environments that use
OSI CLNP.

The security risks of additional non-IP encapsulations MUST be
described, since the mandatory to implement mechanism of IPsec is not
available for these control channels, as in the RFC 3293 Ethernet and
ATM cases. It is in scope to perform risk analysis and describe if
mechanisms for link-level security mitigate the risk.

2.6. MIB Issues

If a new encapsulation is defined, then the encapsulation group
SHOULD be updated. No other changes should be required.

2.7. OXC Transaction Model

2.7.1. Serial Transactions

Many existing OXCs use a command interface which assumes a serial
transaction model. That is, a new command cannot be issued or
processed until the existing command is completed. Under
provisioning control via a network management application, and with
non-dynamic path setup, this model has been adequate.

Moving to a dynamic path setup capability with a distributed control
plane, a parallel transaction model is likely required for
performance. This is particularly helpful when the performance of
setting up a TDM style connection is much slower than setting up an
L2 connection table. If the OXC is not able to support a parallel
transaction model, a GSMP controller MUST be informed of this and
adopt serial transaction behavior.

2.7.2. Bulk Transactions

   Again due to the time it may take some OXCs to setup TDM connections
   relative to L2 fabrics (e.g., VC-4/STS-1 SPE fabric in an HOVC/STS
   switch), support for sending multiple transactions in the same
   message is a useful optimization. When an OXC receives a bulk
   message, the individual transactions are acted upon and a single
   reply is sent. If parallel transactions are not supported, bulk
   messages can improve performance by reducing transaction overhead.
   Bulk transactions SHOULD be supported.

2.8. OXC Protection Capabilities

   To achieve good link protection performance (e.g., 50 ms after
   failure detection), SONET/SDH and some OXC systems use hardware based
   protection schemes (e.g., ring protection). Achieving this level of
   performance solely using a data control plane such as GMPLS is a
   serious challenge. An alternate approach is to utilize protection
   capabilities of an OXC with a dynamic control plane. An implication
   of this hybrid approach is that extensions are needed to GSMP to
   provision the behavior of an OXC in anticipation of a link failure.

   This differs from the strict master-slave relationship in GSMP for
   Layer 2 switches in that here the OXC is capable of taking an action
   independent of the GSMP controller and then informing the controller
   afterwards. Consequently, the GSMP port configuration command MUST
   be extended to allow autonomous protection behaviors to be
   provisioned into the Network Element.

   Furthermore, the controller MUST be able to provide the parameters
   for when reversion from a backup link to the original link is
   allowed. This may take the form of hold-off timers, BER parameters,
   or the requirement for controller directed reversion.

2.8.1. Non-Reserved Protection Links

   An example of protection OXC behavior is that when a link fails, a
   backup link may be used to protect traffic on. This backup link
   could be selected from a set of links, none of which are pre-
   reserved. A backup link could be shared with one or more "working"
   links which is a form of 1:n shared protection. Specifying the set
   of possible backup links SHOULD be done as an option to the Add-
   Branch message.

When a backup link is used or the OXC reverts back to the original
link, the control plane (i.e., signaling) may need to know about the
new path state in order to notify the operator, or take some other
OAM action (e.g., billing, SLA monitoring). An additional GSMP
message to inform the controller SHOULD be added to do this.

2.8.2. Dedicated Protection Links

   A more specialized form of restoration called "1+1" defines a
   (usually node disjoint) protection path in a transport/optical
   network for a given working path. At the ingress node to the path,
   the traffic signal is sent simultaneously along both working and
   protection paths. Under non-failure conditions at the egress node,
   only the last link of the working path is connected to the client.
   When any link in the working path fails, traffic on the working path
   ceases to be received at end of the path. The egress OXC detects
   this condition and then switches to use the last link of the
   protection path without the controller having to issue a Move-Input-
   Branch message. At no time is the ingress node aware which link the
   egress node is using. Selection of the protection path and all of
   its links is outside the scope of GSMP.

   Specification of the two output branches at the ingress node can be
   done with the usual Add-Branch semantics. The ingress node
   protection link is not shared with any other working link.

   Specification of the two input branches at the egress node should be
   done when the Add-Branch message is sent. This SHOULD be an option
   to that message. The egress node protection link is not shared with
   any other working link.

   When a protection link is used or the OXC reverts back to the working
   link, the control plane (i.e., signaling) may need to know about the
   new path state in order to notify the operator, or take some other
   OAM action (e.g., billing, SLA monitoring). An additional GSMP
   message to inform the controller SHOULD be added to do this.

   If an alternate input port is not specified with an original Add-
   Branch message, it MAY be specified in a subsequent Add-Branch
   message. In this case, it is useful to include information about
   existing users of the output port in that Add-Branch message. This
   helps the OXC immediately learn of the association between the new
   input port and an existing one. The association is used to enable
   OXC protection procedures. This capability MUST be added to the add-
   branch message.

Similar contextual information is needed for a Delete-Branch message so that the OXC can determine if a path becomes unprotected. This capability MUST be added to the Delete-branch message.

2.8.3. Protection Triggers

Aside from link or equipment failures, there are a variety of maintenance conditions that could cause the backup/protection link(s) to be used. These may include:

- Scheduled maintenance of the working link. Here the network operator deliberately takes a link out of service to perform maintenance.
- Reconfiguration of fiber/node/network which causes temporary need to use backup links.

It may be useful to specify these triggers when the backup/protection links are defined with the Add-Branch message. This depends on how the OXC is implemented to be aware of such triggers. This is for further study.

2.8.4. Protection Link Capabilities

When an OXC has the capability to perform protection switching independently from the Optical Call Controller (OCC), it may be useful for the OCC to be informed of these capabilities at switch and/or port configuration. Applications in the GSMP controller could use this information. For example, signaling clients could define a path protection scheme over multiple GSMP enabled OXCs. This is for further study.

2.9. Controller directed restoration

Bi-directional Connection Replacement

Connections in the transport network are inherently point-to-point bi-directional. Unfortunately, GSMPv3 currently does not allow for the B and R flags to be set on an add branch message. This means that it is not possible to do an atomic replacement of a bi-directional connection -- an action that is desirable for controller directed restoration. Consequently, the protocol MUST be changed to allow these flags to be used at the same time.

2.10. Support for optical burst switching

   GSMP for Optical Switching should also support optical burst
   switching. As described in [12], [13], and [14], part of burst
   switching connection setup includes reserving time on the transport
   medium for the client.

   This time is characterized by two parameters: a start time and the
   duration. These values MAY define a one-time reservation or a
   repeating 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 and, if the
   connection is allowed, MUST signal these parameters to the burst
   switching device to reserve the exact bandwidth required [12], [14].
   The burst switch MUST perform the switching operation autonomously,
   using the synchronization methods prescribed for the burst network it
   is operating in.

3. Requirements from Implementers

   This section describes requirements to GSMP v3 based on some
   implementation experience. They address areas of ambiguity, missing
   semantics, and configuration recommendations.

3.1. GSMP Packet Format

   The Basic GSMP Message Format in chapter 3.1.1 in [5] describes the
   common fields present in all GSMP messages except for the Adjacency
   protocol.

3.1.1. Message segmentation

   If a message exceeds the MTU of the link layer it has to be
   segmented. This was originally done with the "More" value in the
   Result field. The addition of the I flag and the SubMessage Number
   to the header has made the "More" value obsolete.

   The I flag and SubMessage numbers should be used in all messages that
   can be segmented.

3.1.1.1. SubMessage Number and I flag

   It should be specified if the SubMessage Number starts on 0 or 1 in a
   segmented message and what value the I flag should have in an message
   that is not segmented.

3.1.1.2. Message Length

   Clarification of what value should be used in the Length field for
   segmented messages. Specifically, does the Length field contain the
   total length of the message or the length of the current segment.

3.1.1.3. Message Segmentation example

   To avoid all ambiguity an example of message segmentation should be
   provided.

3.1.2. Transaction Identifier

   The Transaction Identifier in [5] does not distinguish between
   replies from a request with "AckAll" and "NoSuccessAck". It also
   does not provide any information about how to handle replies where
   the Transaction ID doesn't match a Transaction ID from a previously
   sent request.

   If multiple controllers are connected to a single switch and the
   switch sends an event message with "ReturnReceipt" set to all of
   them, there is no way for the switch to identify which controller the
   receipt is coming from.

   The "ReturnReceipt" value should not be permitted for Events.

3.2. Window Size

   The Switch Configuration Message defined in chapter 8.1 in [5]
   defines a Window size to be used by the controller when sending
   messages to the switch. It is not stated if this window should apply
   to all messages or only to messages that will always generate a
   reply.

   If messages that may not generate a reply should be counted against
   the window a time-out period when they are to be removed from the
   window should be defined.

   It is not defined if the window should be cleared when the adjacency
   is lost and later recovered.

3.3. Retransmission

   A retransmission policy with a well-designed exponential backoff
   should be used if no reply is received for a message with "AckAll"
   set.

3.4. Delete Branches Message

   The "Delete Branch Element" has a 4 bit Error field that should be
   redefined to match the size of the "Failure Response Codes".

3.5. Adjacency

   The chapter about how to handle a new adjacency and re-established
   adjacencies should be clarified.

3.5.1. Loss of Synchronization

   The switch must not reset the connection states if another adjacency
   has already been established since this would destroy an already
   valid state.

4. Security Considerations

   The security of GSMP's TCP/IP control channel has been addressed in
   [15]. Any potential remaining security considerations are not
   addressed in this requirements document.

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