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OAM Requirements for Generalized Multi-Protocol Label Switching
(GMPLS) Networks


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Status of this Memo

Abstract

   This document describes requirements for operations and management
   (OAM) for Generalized Multi-Protocol Label Switching (GMPLS)
   networks, as well as for applications of GMPLS.

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**1**. **Introduction**

   This document describes requirements for control plane operations and
   management (OAM) for Generalized Multi-Protocol Label Switching
   (GMPLS) networks. It also describes OAM requirements associated with
   the interaction between the GMPLS Control Plane and Data Plane OAM.
   The OAM requirements specified in this document apply to GMPLS
   networks as well as to applications of GMPLS functions such as
   dynamic bandwidth broker applications.

   [RFC3945] describes how GMPLS extends Multi-Protocol Label Switching
   (MPLS) to support a variety of data plane technologies. The
   requirements set out in this document apply to all forms of GMPLS
   LSPs.

   Note that the requirements for OAM for GMPLS networks are built on
   the foundation requirements for OAM for MPLS networks [RFC4377], as
   well as the existing OAM techniques available in non-packet networks
   that may be controlled by GMPLS. These existing requirements are not
   repeated in this document except to illustrate new requirements.

**2**. **Terminology**

**2.1** **Conventions Used in this Document**

   Although this is not a protocol specification, 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] for clarity of
   presentation of requirements.

**2.2** **Key Terms**

   Definitions of key terms for MPLS OAM and GMPLS are found in
   [RFC3945] and [RFC4377], and the reader is assumed to be familiar
   with those definitions which are not repeated here.

   The reader may also find it helpful to be familiar with at least the
   terminology sections of the SONET/SDH and OTN architectures [G.709]
   and [G.784].

**2.3** **Acronyms**

```
  GMPLS:  Generalized Multi-Protocol Label Switching
     CE:  Customer Edge
    DoS:  Denial of Service
   ECMP:  Equal Cost Multipath
    LDP:  Label Distribution Protocol
    LSP:  Label Switched Path
    LSR:  Label Switching Router
    OAM:  Operations and Management
   OA&M:  Operations, Administration and Maintenance.
   RSVP:  Resource reSerVation Protocol
     SP:  Service Provider
     TE:  Traffic Engineering
  SONET:  Synchronous Optical Network
    SDH:  Synchronous Digital Hierarchy
    TDM:  Time Division Multiplexing
```

**3**. **Motivations**

OAM for MPLS networks has been established as a fundamental
requirement both through operational experience and through its
documentation in numerous Requests For Comment. Early MPLS OAM
documents developed specific solutions to individual issues or to
problems encountered in MPLS deployments. Coordination of the full
OAM requirements for MPLS was achieved in [RFC4377] and [RFC3609] in
recognition of the fact that the previous piecemeal approach could
lead to inconsistent and inefficient applicability of OAM techniques
across the MPLS architecture, and might require significant
modifications to operational procedures and systems in order to
provide consistent and useful OAM functionality.

Similarly, operational requirements for OAM have been established for
SONET/SDH/TDM networks. However, no requirements documents exist for
GMPLS networks which provide a comprehensive set of OAM requirements
which take into consideration both the GMPLS control plane protocols
and the underlying data planes. Since GMPLS networks pose some unique
configurations and problems for OAM not covered by existing
requirements or solutions documents, this document sets out the
requirements that need to be satisfied to fill this gap.

**4**. **General Requirements**

   The general requirements described in this section are inspired by
   those described for point-to-point MPLS in [RFC4377], and where the
   GMPLS network is a packet network it is expected that the solutions
   will be identical or very similar. The subsections below do not
   repeat material from [RFC4377], but simply give references to that
   document.

   However, where the requirements for GMPLS OAM differ from or are more
   extensive than those expressed in [RFC4377], additional text is
   supplied.

   Moreover, these requirements should be commonly applied to not only a
   single domain network but also an inter-domain network [RFC4726].

**4.1** **GMPLS Control Plane and Communications Channel**

   The GMPLS control plane SHOULD provide a health check function
   between GMPLS control entities.

   The control plane MUST provide a health check on the connectivity of
   the control channel, and this SHOULD be configurable for both on-
   demand operation and continual monitoring. This requirement applies
   both to in-band and out-of-band control channel support.

   If multiple control channels exist between two LSRs, the health check
   SHOULD be supported for each control channel.

   These functions MUST be independent of the underlying technology of
   the control plane or data plane.

**4.2** **Interaction Between the Management and Control Planes**

**4.2.1** **Signaling**

   It MUST be possible to monitor and manage the information about an
   LSP (including session name, attributes, source/destination pair, and
   route) created by the GMPLS control plane. Such management SHOULD be
   provided through MIB modules.

   It SHOULD be possible to monitor and distinguish the LSPs traversing
   any TE link in the network. In the event of any data plane event that
   affects any TE link, it MUST be possible for the management plane to
   correlate the data plane faults to the individual control plane LSPs.

   The control plane MUST allow the management plane administrative
   privileges, e.g., changing the operational status of an LSP for pre-
   planned maintenance and recovery-related operations. To support a
   pre-planned maintenance activity or during a control plane failure,

it SHOULD be possible for selected LSPs to be manually switched from

their primary route to their secondary route though the management
plane.

The management plane SHOULD have the ability to change the recovery
type of active LSPs (for example, from unprotected to 1+1 protected,
or from full LSP rerouting to pre-planned LSP rerouting) without
disrupting traffic on the LSPs.

It SHOULD also be possible for the management plane to change other
properties of LSPs without impacting data plane operations. These
properties include, but are not limited to:

- LSP recovery type
- recovery priorities
- reversion support
- TBD List to be completed

The management plane SHOULD provide a mechanism to force the switch-
over to a different route or to a rcovery LSP.

## 4.2.2 Routing

It MUST be possible to manage and monitor the GMPLS routing
information exchanged in the control plane and to manage and monitor
the process by which the informaiton is exchanged. Such management
SHOULD be provided through MIB modules.

Management SHOULD have access to at least the following GMPLS
properties of TE links:

- bandwidth
- switching type
- source/destination address pair

Mechanisms SHOULD be provided in the management plane to verify the
consistency of the connectivity information distributed by routing
mechanisms in the control plane with the physical connectivity in the
data plane.

## 4.2.3 Link Management

The management plane MUST be able to monitor and manage the status
of TE links, and status changes of TE links MUST be notified to the
management plane. This SHOULD be provided through MIB modules.

Link verification mechanisms using the data plane and the control
plane should be supported interactively without configuring each
plane independently.

**4.3** **Interaction Between the GMPLS Control Plane and Data Plane**

The GMPLS control plane supports operational separation from the data plane. Various applications (e.g., ASON Call support [RFC4974], and GMPLS recovery mechanisms [RFC4872], [RFC4873]) require the control plane to be aware of the data plane operational status. The operational state of the data plane SHOULD be automatically reported to the control plane. On the other hand, the operational state of the GMPLS control plane MUST NOT impact the operaitonal state of the data plane.

**4.4** **Detection of Label Switch Path Defects**

GMPLS decouples the data plane and the control plane. If the route of an LSP is traced in the control plane, the route information SHOULD include information about the data plane resources utilized by the LSP so that an operator can check the validity of the data plane by examining the data plane state directly. Mechanisms MAY be provided to automate this correlation functionality.

**4.5** **Diagnosis of a Broken Label Switch Path**

LMP [RFC4204] and LMP-WDM [RFC4209] are defined for use in GMPLS networks manage TE links. The functions provided include fault detection and fault isolation. The management plane SHOULD be able to access this informaiton to make correlations between broken data links and the implied status of both the TE links that the data links support and the LSPs that traverse the data links.

Additionally, LSPs may be used as data links to support TE links [RFC4206]. In this case, the management plane SHOULD be able to access LSP status information to make correlations between failed LSPs and the TE links that the LSPs support.

**4.6** **Path Characterization**

Path characterization function is the ability to indicate the detail of created LSPs.

The control plane MUST provide mechanisms to gather path characterization information. The informaiton collected by the control plane MUST be accessible to the management plane, and this access SHOULD be through a MIB module.

**4.7** **Service Level Agreement Measurement**

Existing data planes already provide various mechanisms to measure the level of service being provided. These mechanisms are technology-specific and include bit interleaved parity (BIP)-8 in SONET/SDH overhead, and error counts in forward error correction (FEC) function on OTN interfaces. These mechanisms operate distinct from the control plane.

Mechanisms MUST be provided in the management to control the use of these mechanisms and to gather the recorded information. It MUST be possible to correlate the infromation gathered to the LSPs and the services that the LSPs support.

Mechanisms MAY be provided thrugh the control plane to control the use of these mechanisms and to distribute the information recorded.

**4.8** **Frequency of OAM Execution**

This requirement is the same as for the MPLS OAM requirements. See [RFC4377] section 4.5.

**4.9** **Alarm Suppression, Aggregation, and Layer Coordination**

Alarm suppression function is required for in order to support link maintenance. The GMPLS control plane MUST provide the ability to control whether data plane components on the path of an LSP do or do not generate alarms in the case of data plane faults.

To avoid a stream of alarms, alarm aggregation may be implemented by LSRs and this may be achieved by determining the main cause and by prioritizing the alarms. This function MAY be managed through the control plane for data plane components on the path of an LSP.

Considering multi-layer GMPLS networks, such as a TDM switch capable network over a lambda switch capable network, the generated alarms MAY be correlated between layers by using the linkage information between control planes of different layers.

**4.10** **Support for OAM Interworking for Fault Notification**

MPLS OAM and GMPLS OAM SHOULD be interwork to support the operation of an MPLS-TE network over a GMPLS network [MPLS/GMPLS].

The operator SHOULD be able to control OAM function separately in each network, but SHOULD be able to coordinate the OAM funciton. For example, in the case of a data link failure in the GMPLS network, the it SHOULD be possible to configure the GMPLS OAM to apply priorities to the following actions:

   - report the data link failure to the management plane of the GMPLS
     network

   - report the data link failure to the management plane of the MPLS
     network

   - trigger recovery operations within the GMPLS network

   - trigger recovery operations within the MPLS network

## 4.11 Error Detection and Recovery

   Error detection and recovery SHOULD be applicable not only to a
   single domain network, but also an inter-domain network. Those
   operations SHOULD be automated through the control plane and the data
   plane.

## 4.12 Standard Management Interfaces

   Common interfaces for the control and the management of the GMPLS
   network are desired to facilitate wide deployment GMPLS networks.

   Some GMPLS MIB modules have been standardized in [RFC4631],
   [RFC4802], and [RFC4803] building on [RFC3811], [RFC3812], and
   [RFC3813]. [RFC4220] provides a MIB module for managing and
   monitoring TE links.

   Since only those MIB modules do not cover all the OAM requirements
   set out in this document, additional MIB modules SHOULD be developed
   such as [TED-MIB].

## 4.13  Detection of Denial of Service Attacks

   This requirement is the same as for the MPLS OAM requirements. See
   [RFC4377] section 4.10.

## 4.14 Per-LSP Accounting Requirements

   A GMPLS LSP may support MPLS LSPs hierarchically. By pointing out the
   GMPLS LSP, those MPLS LSPs over it SHOULD be managed and accounted.

## 5. Security Considerations

   This document introduces no new security issues beyond those detailed
   in the MPLS OAM requirements. See [RFC4377] section 5.

## 6. IANA Considerations

   This informational document makes no requests for IANA action.

## 7. References

### 7.1 Normative References

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## 8. Acknowledgments

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[10](#). Intellectual Property Statement

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