CCAMP Working Group D. Papadimitriou (Alcatel)
Internet Draft Z. Lin (New York City Transit)
Category: Informational J. Drake (Calient)
J. Ash (ATT)
Expiration Date: October 2003 A. Farrel (Movaz)
L. Ong (Ciena)

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Requirements for Generalized MPLS (GMPLS) Usage and Extensions for Automatically Switched Optical Network (ASON)

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1. Abstract

The Generalized MPLS (GMPLS) suite of protocol has been defined to control different switching technologies as well as different applications. These include support for requesting TDM connections including SONET/SDH and Optical Transport Networks (OTNs).

This document concentrates on the signaling aspects of the GMPLS suite of protocols. It identifies the features to be covered by the signalling protocol to support the capabilities of an Automatically Switched Optical Network (ASON). This document provides a problem

statement and additional requirements on the GMPLS signaling protocol to support the ASON functionality.

2. 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.

3. Introduction

The GMPLS suite of protocol specifications provides support for controlling different switching technologies as well as different applications. These include support for requesting TDM connections including SONET/SDH (see ANSI T1.105 and ITU-T G.707, respectively) as well as Optical Transport Networks (see ITU-T G.709). In addition, there are certain capabilities that are needed to support Automatically Switched Optical Networks control planes (their architecture is defined in [ITU-T G.8080]). These include generic capabilities such as call and connection separation and more specific capabilities such as support of soft permanent connections.

This document concentrates on the signaling aspects of the GMPLS suite of protocols (see [RFC 3471]). It discusses functional requirements that lead to additional extensions to GMPLS to support the capabilities as specified in the above referenced document. A terminology section is provided in Appendix.

Problem Statement:

The Automatic Switched Optical Network (ASON) architecture describes the application of an automated control plane for supporting both call and connection management services (for a detailed description see [ITU-T G.8080]).

The ASON control plane specification is meant to be applicable to different transport technologies (e.g., SDH/SONET, OTN) in various networking environments (e.g., inter-carrier, intra-carrier). Also, ASON model distinguishes reference points (representing points of protocol information exchange) defined (1) between an administrative domain and a user (2) between administrative domains and (3) between areas of the same administrative domain and when needed between control components (or simply controllers) within areas. A full description of the ASON terms and relationship between ASON model and GMPLS protocol suite may be found in [IPO-ASON].

This document describes the use of GMPLS signalling (and in particular, [RFC 3471]) to provide call and connection management (see [ITU-T G.7713]). The following functionality are expected from the GMPLS protocol suite: (a) support for soft permanent connection capability (b) support for call and connection separation (c) support for extended restart capabilities during control plane failures (d) support for extended label usage (e) support for crankback capability (f) support for additional error cases.

4. Requirements for Extending Applicability of GMPLS to ASON

The applicability statements regarding how the GMPLS suite of protocols may be applied to the ASON architecture can be found in [IPO-ASON] and [IPO-REQS]. The former includes a summary of the ASON functions as well as a detailed discussion of the applicability of the GMPLS protocol suite.

The next sections detail the requirements concerning the functions including:

- Support for soft permanent connection capability
- Support for call and connection separation
- Support for extended restart capabilities during control plane failures
- Support for extended label usage
- Support for crankback capability
- Support for additional error cases

Note: support of the above functions is independent of any user-to-network interface and is therefore not constrained nor restricted by its implementation specifics (see [ITU-T G.8080] and [ITU-T G.7713])

4.1 Support for Soft Permanent Connection (SPC) Capability

An SPC is a combination of a permanent connection at the source user-to-network side, a permanent connection at the destination user-to-network side, and a switched connection within the network. An Element Management System (EMS) or a Network Management System (NMS) typically initiates the establishment of the switched connection by communicating with the ingress node. The latter then sets the connection using the distributed GMPLS signaling protocol. For the SPC, the communication method between the EMS/NMS and the ingress node is beyond the scope of this document (so it is for any other function described in this document).

The end-to-end connection is thus created by associating the incoming interface of the switched connection initiating (also referred to as ingress node) network node with the switched connection within the network and the outgoing interface of the switched connection terminating (also referred to as egress node) network node. An SPC connection is illustrated in the following Figure, which shows user's node A connected to a provider's node B via link #1, user's node Z connected to a provider's node Y via link #3, and an abstract link #2 connecting provider's node B and node Y.

```
 ---       ---                 ---       ---
| A |--1--| B |-----2-//------| Y |--3--| Z |
 ---       ---                 ---       ---
```

In this instance, the connection on link #1 and link #3 are both provisioned (permanent connections that may be simple links). In contrast, the connection over link #2 is set up using the

distributed control plane. Thus the SPC is composed of the splicing of link #1, #2 and #3.

Thus to support the capability to request a SPC connection:

- The GMPLS signaling protocol must be capable of supporting the ability to indicate the outgoing link and label information used when setting up the destination provisioned connection.

- In addition, due to the inter-domain applicability of ASON networks, the GMPLS signaling protocol should also support the indication of the service level requested for the SPC. In the case where an SPC spans multiple domains, indication of both source and destination endpoints controlling the SPC request may be needed. These may be done via the source and destination signalling controller addresses.

4.2 Support for Call and Connection Separation

A call may be simply described as "An association between endpoints that supports an instance of a service" [ITU-T G.8080]. Thus, it can be considered as a service provided between two end-points, where several calls may exist between them. To each call multiple connections may be associated. The call concept provides an abstract relationship between two users, where this relationship describes (or verifies) at which extent the users are willing to offer (or accept) service to each other. Therefore, a call does not provide the actual connectivity for transmitting user traffic, but only builds a relationship by which subsequent connections may be made.

A property of a call is to contain multiple connections, where each connection may be of a different type and where each connection may exist independently of other connections within the same call, i.e., each connection is setup and released with separate Path/Resv messages. For example, a call may contain a set of basic connection and virtual concatenated connections (see [GMPLS-SONET] for corresponding connection signaling extensions).

The concept of the call allows for a better flexibility in how end-points set up connections and how network offers services to users. In essence, a call allows:

- Support for virtual concatenation where each connection can travel on different diverse paths

- Facilitate upgrading strategy of the control plane operations, where a call control (service provisioning) may be separate from actual nodes hosting the connections (where the connection control may reside)

- Identification of the call initiator (with both network call controller as well as destination user) prior to connection, which may result in decreasing contention during resource reservation

- General treatment of multiple connections which may be associated for several purposes; for example a pair of working and recovery connections may belong to the same call.

To support the introduction of the call concept, GMPLS signaling should include a call identification mechanism and allow for end-to-end call capability exchange.

For instance, a feasible structure for the call identifier (to guarantee global uniqueness) may concatenate a globally unique fixed ID (e.g., may be composed of country code, carrier code) with an operator specific ID (where the operator specific ID may be composed of a unique access point code û such as source LSR address û and a local identifier). Other formats shall also be possible depending on the call identification conventions between parties involved in the call setup process.

4.3 Support for Extended Restart Capabilities

Various types of failures may occur affecting the ASON control plane. Requirements placed on the control plane failure recovery by [ITU-T G.8080] include:

- Any control plane failure must not result in releasing established connections.

- Upon recovery from a control plane failure, the recovered node must have the ability to recover the status of the connections established before failure occurrence.

- Upon recovery from a control plane failure, the recovered node must have the ability to recover the connectivity information of its neighbors.

- Upon recovery from a control plane failure, connections in the process of been established (i.e. pending connection setup requests) may be released.

- Upon recovery from a control plane failure, connections in the process of been released must be released.

4.4 Support for Extended Label Usage

Labels are defined in GMPLS (see [RFC 3471]) to provide information on the resources used on link local basis for a particular connection. The labels may range from specifying a particular timeslot, a particular wavelength to a particular port/fiber.

In the ASON context, the value of a label MAY not be consistently the same across a link. For example, the figure below illustrates the case where two GMPLS capable nodes (A and Z) are interconnected

across two non-GMPLS capable nodes (B and C), where these nodes are all SONET/SDH nodes providing, e.g., a VC-4 service.

```
 -----                          -----
|     |    ---      ---     |     |
|  A  |---| B |---| C |---|  Z  |
|     |    ---      ---     |     |
 -----                          -----
```

Labels have an associated implicit imposed structure based on [GMPLS-SONET] and [GMPLS-OTN]. Thus, once the local label is exchanged with its neighboring control plane node, the structure of the local label MAY not be significant to the neighbor node since the association between the local and the remote label may not necessarily be the same. This issue does not present a problem in a simple point-to-point connections between two control plane-enabled nodes where the timeslots are mapped 1:1 across the interface. However, once a non-GMPLS capable sub-network is introduced between these nodes (as in the above figure, where the sub-network provides re-arrangement capability for the timeslots) label scoping MAY become an issue.

In this context, there is an implicit assumption that the data plane connections between the GMPLS capable edges already exist prior to any connection request. For instance, node A's outgoing VC-4's timeslot #1 (with SUKLM label=[1,0,0,0,0]) as defined in [GMPLS-SONET]) may be mapped onto node BÆs outgoing VC-4's timeslot #6 (label=[6,0,0,0,0]) may be mapped onto node C's outgoing VC-4's timeslot #4 (label=[4,0,0,0,0]). Thus by the time node Z receives the request from node A with label=[1,0,0,0,0], the node Z's local label and the timeslot no longer corresponds to the received label and timeslot information.

As such to support this capability, a label association mechanism has to be used by the control plane node to map the received (remote) label into a locally significant label. The information necessary to allow mapping from received label value to a locally significant label value may be derived in several ways including:

- Manual provisioning of the label association
- Discovery of the label association

Either method may be used. In case of dynamic association, this implies that the discovery mechanism operates at the timeslot/label level before the connection request is processed at the ingress node. Note that in the case where two nodes are directly connected, no association is required. In particular, for directly connected TDM interfaces no mapping function (at all) is required due to the implicit label structure (see [GMPLS-SONET] and [GMPLS-OTN]). In such instances, the label association function provides a one-to-one mapping of the received to local label values.

4.5 Support for Crankback

Crankback has been identified as a requirement for ASON networks. It allows an LSP setup request to be retried on an alternate path that detours around a blocked link or node upon a setup failure.

Crankback mechanisms can also be applied to LSP restoration by indicating the location of the failure link or node. This would significantly improve the successful recovery ratio for failed LSPs, especially in situations where a large number of setup requests are simultaneously triggered. [GMPLS-CRANK] specifies crankback GMPLS-based signalling mechanisms.

4.6 Support for Additional Error Cases

To support the ASON network, the following additional category of error cases are defined:

- Errors associated with basic call and soft permanent connection support. For example, these may include incorrect assignment of IDs for the Call or an invalid interface ID for the soft permanent connection.

- Errors associated with policy failure during processing of the new call and soft permanent connection capabilities. These may include unauthorized request for the particular capability.

- Errors associated with incorrect specification of the service level.

5. Security Considerations

Per [ITU-T G.8080], a connection cannot be established until the associated call has been set up. Also, policy and authentication procedures are applied prior to the establishment of the call (and can then also be restricted to connection establishment in the context of this call).

This document introduces no new security requirements to GMPLS signalling (see [RFC3471]).

6. Acknowledgements

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7. References

7.1 Normative References

[RFC-2026]   S.Bradner, "The Internet Standards Process --

Revision 3", BCP 9, RFC 2026, October 1996.

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

[RFC-3209] D.Awduche et al., "RSVP-TE: Extensions to RSVP for LSP Tunnels," RFC 3209, December 2001.

[RFC-3471] L.Berger (Editor) et al., "Generalized MPLS - Signaling Functional Description," RFC 3471, January 03.

[ITUT G.8080] ITU-T Rec. G.8080/Y.1304, "Architecture for the Automatically Switched Optical Network (ASON)," November 2001 (and Revision, January 2003).

[GMPLS-CRANK] A.Farrel (Editor), "Crankback Routing Extensions for MPLS Signaling," Work in Progress, draft-iwata-mpls-crankback-05.txt, March 2003.

[GMPLS-SONET] E.Mannie and D.Papadimitriou (Editors), "GMPLS Extensions for SONET and SDH Control, Work in Progress," draft-ietf-ccamp-gmpls-sonet-sdh-08.txt, February 2003.

[GMPLS-OTN] D.Papadimitriou (Editor), "GMPLS Signalling Extensions for G.709 Optical Transport Networks Control," Work in progress, draft-ietf-ccamp-gmpls-g709-03.txt, November 2002,

7.2 Informative References

[IPO-ASON] Aboul-Magd (Editor) et al., "Automatic Switched Optical Network (ASON) Architecture and Its Related Protocols," Work in progress, draft-ietf-ipo-ason-02.txt, March 2002.

[IPO-REQS] Y.Xue (Editor) et al., "Optical Network Service Requirements," Work in progress, draft-ietf-ipo-carrier-requirements-05.txt.

[ITUT G.7713] ITU-T Rec. G.7713/Y.1304, "Distributed Call and Connection Management," November 2001.

8. Author's Addresses

Dimitri Papadimitriou (Alcatel)
Francis Wellesplein 1,

B-2018 Antwerpen, Belgium
Email: dimitri.papadimitriou@alcatel.be

Zhi-Wei Lin (New York City Transit)

2 Broadway, Room C3.25
New York, NY 10004
Email: zhiwlin@nyct.com

John Drake (Calient)
5853 Rue Ferrari,
San Jose, CA 95138, USA
Email: jdrake@calient.net

Adrian Farrel (Movaz Networks)
7926 Jones Branch Drive,
McLean, VA 22102, USA
Email: afarrel@movaz.com

Gerald R. Ash
AT&T Labs, Room MT D5-2A01
200 Laurel Avenue
Middletown, NJ 07748, USA
Email: gash@att.com

Lyndon Ong (Ciena)
5965 Silver Creek Valley Road
San Jose, CA 95138, USA
Email: lyong@ciena.com

Appendix - Terminology

This draft defines the following terms:

Administrative domain: See Recommendation G.805.

Call: association between endpoints that supports an instance of a service.

Connection: concatenation of link connections and sub-network connections that allows the transport of user information between the ingress and egress points of a sub-network.

Control plane: performs the call control and connection control functions. Through signaling, the control plane sets up and releases connections, and may restore a connection in case of a failure.

(Control) Domain: represents a collection of entities that are grouped for a particular purpose. G.8080 applies this G.805 recommendation concept (that defines two particular forms, the administrative domain and the management domain) to the control plane in the form of a control domain. The entities that are grouped in a control domain are components of the control plane.

External NNI: interfaces are located between protocol controllers between control domains.

Internal NNI: interfaces are located between protocol controllers within control domains.

Link: See Recommendation G.805.

Management plane: performs management functions for the Transport Plane, the control plane and the system as a whole. It also provides coordination between all the planes. The following management functional areas are performed in the management plane: performance, fault, configuration, accounting and security management

Management domain: See Recommendation G.805.

Transport plane: provides bi-directional or unidirectional transfer of user information, from one location to another. It can also provide transfer of some control and network management information. The Transport Plane is layered; it is equivalent to the Transport Network defined in G.805.

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