   An In-Band Data Communication Network For the MPLS Transport Profile

Abstract

   The Generic Associated Channel (G-ACh) has been defined as a
   generalization of the pseudowire (PW) associated control channel to
   enable the realization of a control/communication channel that is
   associated with Multiprotocol Label Switching (MPLS) Label Switched
   Paths (LSPs), MPLS PWs, MPLS LSP segments, and MPLS sections between
   adjacent MPLS-capable devices.

   The MPLS Transport Profile (MPLS-TP) is a profile of the MPLS
   architecture that identifies elements of the MPLS toolkit that may be
   combined to build a carrier-grade packet transport network based on
   MPLS packet switching technology.

   This document describes how the G-ACh may be used to provide the
   infrastructure that forms part of the Management Communication
   Network (MCN) and a Signaling Communication Network (SCN).
   Collectively, the MCN and SCN may be referred to as the Data
   Communication Network (DCN). This document explains how MCN and SCN
   messages are encapsulated, carried on the G-ACh, and demultiplexed
   for delivery to the management or signaling/routing control plane
   components on an MPLS-TP node.

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1. Introduction

   The associated channel header (ACH) is specified in [RFC4385]. It is
   a packet header format for use on pseudowires (PWs) in order to
   identify packets used for Operations, Administration, and Maintenance
   (OAM) and similar functions.

   The use of the ACH is generalized in [RFC5586] and can be applied on
   any Multiprotocol Label Switching (MPLS) Label Switching Path (LSP).
   This is referred to as the Generic Associated Channel (G-ACh) and is
   intended to create a control/management communication channel
   associated with the LSP that can be used to carry packets used for
   OAM and similar functions (e.g., control/management plane messages).

   The purpose of a packet carried on the G-ACh is indicated by the
   value carried by the Channel Type field of the ACH and a registry of
   values is maintained by IANA ([RFC4446] and [RFC4385]). The ACH is
   referred to in this document as the G-ACh header.

   The MPLS transport profile (MPLS-TP) is described in [MPLS-TP] and in
   [RFC5654]. MPLS-TP is the application of MPLS to construct a packet
   transport network. It constitutes a profile of MPLS that enables
   operational models typical in transport networks, which includes
   additional OAM, survivability, and other maintenance functions not
   previously supported by MPLS.

   Label Switching Routers (LSRs) in MPLS networks may be operated using
   management protocols or control plane protocols. Messaging in these
   protocols is normally achieved using IP packets exchanged over IP-
   capable interfaces. However, some nodes in MPLS-TP networks may be
   constructed without support for direct IP encapsulation on their
   line-side interfaces and without access to an out-of-fiber data

communication network. In order that such nodes can communicate
using management plane or control plane protocols, channels must be
provided, and the only available mechanism is to use an MPLS label.

The G-ACh provides a suitable mechanism for this purpose, and this
document defines processes and procedures to allow the G-ACh to be
used to build a Management Communication Network (MCN) and a
Signaling Communication Network (SCN), together known as the Data
Communication Network (DCN) [G.7712].

It should be noted that the use of the G-ACh to provide connectivity
for the DCN is intended for use only where the MPLS-TP network is not
capable of encapsulating or delivering native DCN messages.

1.1. Requirements

The requirements presented in this section are based on those
communicated to the IETF by the ITU-T.

1. A packet-encapsulation mechanism must be provided to support the
   transport of MCN and SCN packets over the G-ACh.

2. The G-ACh carrying the MCN and SCN packets shall support the
   following application scenarios:

   a. The G-ACh interconnects two adjacent MPLS-TP nodes (used when
      the server layer does not provide a Management Communication
      Channel (MCC) or a Signalling Communication Channel (SCC)).

   b. The G-ACh is carried by an MPLS-TP tunnel that traverses
      another operator's domain (the carrier's carrier scenario).

3. The G-ACh shall provide two independent channels: an MCC to build
   the MCN and an SCC to build the SCN. The G-ACh packet header
   shall indicate whether the packet is an MCC or an SCC packet in
   order to forward it to the management or control plane application
   for processing. This facilitates easy demultiplexing of control
   and management traffic from the DCN, and enables separate or
   overlapping address spaces and duplicate protocol instances in the
   management and control planes.

4. The channel-separation mechanism shall not preclude the use of
   separate rate limiters and traffic-shaping functions for each
   channel (MCC and SCC), ensuring that the flows do not exceed their
   assigned traffic profiles. The rate limiters and traffic shapers
   are outside the scope of the MCC and SCC definitions.

5. The G-ACh that carries the MCC and SCC shall be capable of carrying different OSI layer 3 (network layer) PDUs. These shall include IPv4, IPv6, and OSI PDUs. The G-ACh header of the MCC/SCC packet shall indicate which layer 3 PDU is contained in the payload field of the packet such that the packet can be delivered to the related layer 3 process within the management and control plane application, respectively, for further processing.

6. The G-ACh is not required to provide specific security mechanisms. However, the management or control plane protocols that operate over the MCC or SCC are required to provide adequate security mechanisms in order to not be susceptible to security attacks.

1.2. 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 [RFC2119].

2. Procedures

Figure 1 depicts the format of an MCC/SCC packet that is sent on the G-ACh. The Channel Type field indicates the function of the ACH message and so, to send an MCC/SCC packet on the G-ACh, the MCC/SCC message is prepended with an ACH with the Channel Type set to indicate that the message is an MCC or SCC message. The ACH MUST NOT include the ACH TLV Header [RFC5586], meaning that no ACH TLVs can be included in the message. A two-byte Protocol Identifier (PID) field indicates the protocol type of the payload DCN message.
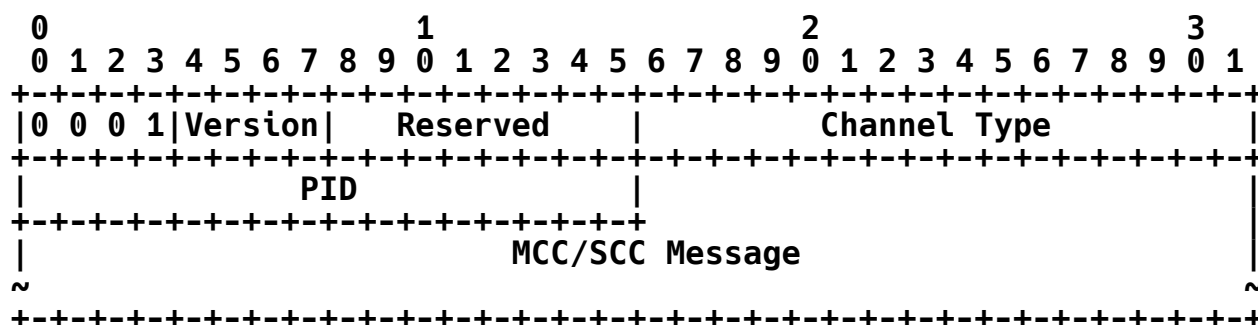
```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|0 0 0 1|Version|    Reserved     |         Channel Type         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|              PID                |                              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+                              |
|                          MCC/SCC Message                      |
~                                                               ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 1: G-ACh MCC/SCC Packet

o The Channel Type field determines whether the message is an MCC or an SCC message. See Section 5 for the codepoint assignments.

o The presence of the PID field is deduced from the Channel Type
  value indicating MCC or SCC. The field contains an identifier of
  the payload protocol using the PPP protocol identifiers ([RFC1661],
  [RFC3818]).

When the G-ACh sender receives an MCC message that is to be sent over
the MCC, the sender creates the G-ACh header, sets the Channel Type
field to MCC, fills in the PID to indicate the MCC layer 3 PDU type,
and prepends the MCC message with the G-ACh header. The same
procedure is applied when a control plane message is to be sent over
the SCC. In this case, the sender sets the Channel Type field to
SCC.

If the G-ACh is associated with an MPLS section, the Generic
Associated Channel Label (GAL) is added to the message as defined in
[RFC5586]. The Time to Live (TTL) field MUST be set to 1, and the
S-bit of the GAL MUST be set to 1.

If the G-ACh is associated with an LSP, the GAL is added to the
packet and the LSP label is pushed on top of the GAL as defined in
[RFC5586]. The TTL field of the GAL MUST be set to 1, and the S-bit
of the GAL MUST be set to 1.

Note that packet processing for DCN packets in the G-ACh is, in
common with all G-ACh MPLS packets, subject to the normal processing
of the Traffic Class (TC) field of the MPLS header. This could be
used to enable prioritization of different DCN packets.

The DCN channel MUST NOT be used to transport user traffic and SHALL
only be used to carry management or control plane messages.
Procedures that ensure this (such as deep packet inspection) are
outside the scope of this specification.

When a receiver has received a packet on the G-ACh with the ACH
Channel Type set to MCC or SCC, it SHALL look at the PID field. If
the PID value is known by the receiver, it delivers the MCC/SCC
message to the appropriate processing entity. If the PID value is
unknown, the receiver SHALL silently discard the received packet, MAY
increment a counter that records discarded or errored messages, and
MAY log an event.

It must be noted that according to [RFC5586], a receiver MUST NOT
forward a GAL packet based on the GAL label as is normally the case
for MPLS packets. If the GAL appears at the bottom of the label
stack, it MUST be processed as described in the previous paragraph.

Note that there is no requirement for MPLS-TP devices to support IP
or OSI forwarding in the fast (forwarding) path. Thus, if a message
is received on the MCC or SCC and is not targeted to an address of
the receiving MPLS-TP node, the packet might not be forwarded in the
fast path. A node MAY apply layer 3 forwarding procedures in the
slow or fast path and MAY discard or reject the message using the
layer 3 protocol if it is unable to forward it. Thus, protocols
making use of the DCN should make no assumptions about the forwarding
capabilities unless they are determined a priori or through the use
of a routing protocol. Furthermore, it is important that user data
(i.e., data traffic) is not routed through the DCN, as this would
potentially cause the traffic to be lost or delayed and might
significantly congest the DCN.

2.1. Pseudowire Setup

Provider Edge nodes (PEs) may wish to set up PWs using a signaling
protocol that uses remote adjacencies (such as LDP [RFC5036]). In
the absence of an IP-based control plane network, these PEs MUST
first set up an LSP tunnel across the MPLS-TP network. This tunnel
can be used both to carry the PW once it has been set up and to
provide a G-ACh-based DCN for control plane communications between
the PEs.

3. Applicability

The DCN is intended to provide connectivity between management
stations and network nodes, and between pairs of network nodes, for
the purpose of exchanging management plane and control plane
messages.

Appendix A of [NM-REQ] describes how Control Channels (CCh) that are
the links in an MPLS-TP DCN can be out-of-fiber and out-of-band, in-
fiber and out-of-band, or in-band with respect to the user data
carried by the MPLS-TP network. That appendix also explains how the
DCN can be constructed from a mix of different types of links and how
routing and forwarding can be used within the DCN to facilitate
multi-hop delivery of management and control plane messages.

The G-ACh used as described in this document allows the creation of a
"data channel associated CCh" (type 6 in Appendix A of [NM-REQ]) and
an "in-band CCh" (type 7 in Appendix A of [NM-REQ]). In the former
case, the G-ACh is associated with an MPLS-TP section. In the latter
case, the G-ACh is associated with an MPLS-TP LSP or PW and may span
one or more hops in the MPLS-TP network.

There is no need to create a CCh for every LSP between a pair of
MPLS-TP nodes. Indeed, where the nodes are physically adjacent, the
G-ACh associated with the MPLS-TP section would normally be used.
Where nodes are virtually adjacent (that is, connected by LSP
tunnels), one or two of the LSPs might be selected to provide the CCh
and a back-up CCh.

4. Security Considerations

The G-ACh provides a virtual link between MPLS-TP nodes and might be
used to induce many forms of security attack. The MPLS data plane
does not include any security mechanisms of its own; therefore, it is
important that protocols using the DCN apply their own security.
Protocols that operate over the MCN or SCN are REQUIRED to include
adequate security mechanisms, and implementations MUST allow
operators to configure the use of those mechanisms.

5. IANA Considerations

Channel Types for the Generic Associated Channel are allocated from
the IANA PW Associated Channel Type registry defined in [RFC4446] and
updated by [RFC5586].

IANA has allocated two further Channel Types as follows:
  0x0001 Management Communication Channel (MCC)
  0x0002 Signaling Communication Channel (SCC)

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.

[RFC4385] Bryant, S., Swallow, G., Martini, L., and D. McPherson,
           "Pseudowire Emulation Edge-to-Edge (PWE3) Control Word for
           Use over an MPLS PSN", RFC 4385, February 2006.

[RFC4446] Martini, L., "IANA Allocations for Pseudowire Edge to Edge
           Emulation (PWE3)", BCP 116, RFC 4446, April 2006.

[RFC5586] Bocci, M., Ed., Vigoureux, M., Ed., and S. Bryant, Ed.,
           "MPLS Generic Associated Channel", RFC 5586, June 2009.

6.2. Informative References

[G.7712]   ITU-T Recommendation G.7712, "Architecture and
           specification of data communication network", June 2008.

   [MPLS-TP]   Bocci, M., Bryant, S., Frost, D., and L. Levrau, "A
               Framework for MPLS in Transport Networks", Work in
               Progress, October 2009.

   [NM-REQ]   Lam, K. and S. Mansfield, "MPLS TP Network Management
               Requirements", Work in Progress, October 2009.

   [RFC1661]   Simpson, W., Ed., "The Point-to-Point Protocol (PPP)", STD
               51, RFC 1661, July 1994.

   [RFC3818]   Schryver, V., "IANA Considerations for the Point-to-Point
               Protocol (PPP)", BCP 88, RFC 3818, June 2004.

   [RFC5036]   Andersson, L., Ed., Minei, I., Ed., and B. Thomas, Ed.,
               "LDP Specification", RFC 5036, October 2007.

   [RFC5654]   Niven-Jenkins, B., Ed., Brungard, D., Ed., Betts, M., Ed.,
               Sprecher, N., and S. Ueno, "Requirements of an MPLS
               Transport Profile", RFC 5654, September 2009.

7. Acknowledgements

Authors' Addresses

   Dieter Beller
   Alcatel-Lucent Germany
   EMail: dieter.beller@alcatel-lucent.com

   Adrian Farrel
   Old Dog Consulting
   EMail: adrian@olddog.co.uk