       GMPLS Asymmetric Bandwidth Bidirectional Label Switched Paths (LSPs)

Abstract

   This document defines a method for the support of GMPLS asymmetric
   bandwidth bidirectional Label Switched Paths (LSPs). The approach
   presented is applicable to any switching technology and builds on the
   original Resource Reservation Protocol (RSVP) model for the transport
   of traffic-related parameters. This document moves the experiment
   documented in RFC 5467 to the standards track and obsoletes RFC 5467.

Status of This Memo

   This is an Internet Standards Track document.

   This document is a product of the Internet Engineering Task Force
   (IETF). It represents the consensus of the IETF community. It has
   received public review and has been approved for publication by the
   Internet Engineering Steering Group (IESG). Further information on
   Internet Standards is available in Section 2 of RFC 5741.

   Information about the current status of this document, any errata,
   and how to provide feedback on it may be obtained at
   http://www.rfc-editor.org/info/rfc6387.

Copyright Notice

Table of Contents

1. Introduction

   GMPLS [RFC3473] introduced explicit support for bidirectional Label
   Switched Paths (LSPs). The defined support matched the switching
   technologies covered by GMPLS, notably Time Division Multiplexing
   (TDM) and lambdas; specifically, it only supported bidirectional LSPs
   with symmetric bandwidth allocation. Symmetric bandwidth
   requirements are conveyed using the semantics objects defined in
   [RFC2205] and [RFC2210].

GMPLS asymmetric bandwidth bidirectional LSPs are bidirectional LSPs
that have different bandwidth reservations in each direction.
Support for bidirectional LSPs with asymmetric bandwidth was
previously discussed in the context of Ethernet, notably [RFC6060]
and [RFC6003]. In that context, asymmetric bandwidth support was
considered to be a capability that was unlikely to be deployed, and
hence [RFC5467] was published as Experimental. The MPLS Transport
Profile, MPLS-TP, requires that asymmetric bandwidth bidirectional
LSPs be supported (see [RFC5654]); therefore, this document is being
published on the Standards Track. This document has no technical
changes from the approach defined in [RFC5467]. This document moves
the experiment documented in [RFC5467] to the standards track and
obsoletes [RFC5467]. This document also removes the Ethernet-
technology-specific alternative approach discussed in the appendix of
[RFC5467] and maintains only one approach that is suitable for use
with any technology.

1.1. Background

   Bandwidth parameters are transported within RSVP ([RFC2210],
   [RFC3209], and [RFC3473]) via several objects that are opaque to
   RSVP. While opaque to RSVP, these objects support a particular model
   for the communication of bandwidth information between an RSVP
   session sender (ingress) and receiver (egress). The original model
   of communication, defined in [RFC2205] and maintained in [RFC3209],
   used the SENDER_TSPEC and ADSPEC objects in Path messages and the
   FLOWSPEC object in Resv messages. The SENDER_TSPEC object was used
   to indicate a sender's data generation capabilities. The FLOWSPEC
   object was issued by the receiver and indicated the resources that
   should be allocated to the associated data traffic. The ADSPEC
   object was used to inform the receiver and intermediate hops of the
   actual resources available for the associated data traffic.

   With the introduction of bidirectional LSPs in [RFC3473], the model
   of communication of bandwidth parameters was implicitly changed. In
   the context of [RFC3473] bidirectional LSPs, the SENDER_TSPEC object
   indicates the desired resources for both upstream and downstream
   directions. The FLOWSPEC object is simply confirmation of the
   allocated resources. The definition of the ADSPEC object is either
   unmodified and only has meaning for downstream traffic, or is
   implicitly or explicitly ([RFC4606] and [RFC6003]) irrelevant.

1.2. Approach Overview

   The approach for supporting asymmetric bandwidth bidirectional LSPs
   defined in this document builds on the original RSVP model for the
   transport of traffic-related parameters and GMPLS's support for
   bidirectional LSPs.

The defined approach is generic and can be applied to any switching
technology supported by GMPLS. With this approach, the existing
SENDER_TSPEC, ADSPEC, and FLOWSPEC objects are complemented with the
addition of new UPSTREAM_TSPEC, UPSTREAM_ADSPEC, and
UPSTREAM_FLOWSPEC objects. The existing objects are used in the
original fashion defined in [RFC2205] and [RFC2210], and refer only
to traffic associated with the LSP flowing in the downstream
direction. The new objects are used in exactly the same fashion as
the old objects, but refer to the upstream traffic flow Figure 1
shows the bandwidth-related objects used for asymmetric bandwidth
bidirectional LSPs.

```
        |---|         Path        |---|
        | I |------------------->| E |
        | n |   -SENDER_TSPEC    | g |
        | g |   -ADSPEC          | r |
        | r |   -UPSTREAM_FLOWSPEC| e |
        | e |                    | s |
        | s |         Resv       | s |
        | s |<-------------------|   |
        |   |   -FLOWSPEC        |   |
        |   |   -UPSTREAM_TSPEC  |   |
        |   |   -UPSTREAM_ADSPEC |   |
        |---|                    |---|
```
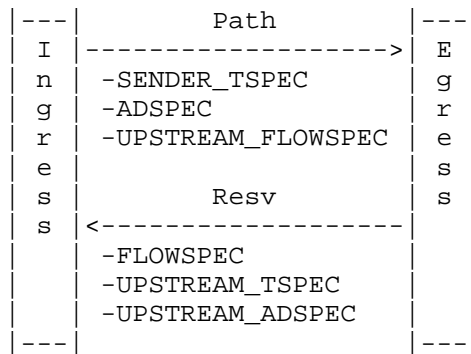
Figure 1: Generic Asymmetric Bandwidth Bidirectional LSPs

The extensions defined in this document are limited to Point-to-Point
(P2P) LSPs. Support for Point-to-Multipoint (P2MP) bidirectional
LSPs is not currently defined and, as such, not covered in this
document.

1.3. 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 [RFC2119].

2. Generalized Asymmetric Bandwidth Bidirectional LSPs

The setup of an asymmetric bandwidth bidirectional LSP is signaled
using the bidirectional procedures defined in [RFC3473] together with
the inclusion of the new UPSTREAM_FLOWSPEC, UPSTREAM_TSPEC, and
UPSTREAM_ADSPEC objects.

The new upstream objects carry the same information and are used in
the same fashion as the existing downstream objects; they differ in
that they relate to traffic flowing in the upstream direction while

the existing objects relate to traffic flowing in the downstream
direction. The new objects also differ in that they are carried in
messages traveling in the opposite direction.

2.1. UPSTREAM_FLOWSPEC Object

   The format of an UPSTREAM_FLOWSPEC object is the same as a FLOWSPEC
   object [RFC2210]. This includes the definition of class types and
   their formats. The class number of the UPSTREAM_FLOWSPEC object is
   120 (of the form 0bbbbbbb).

2.1.1. Procedures

   The Path message of an asymmetric bandwidth bidirectional LSP MUST
   contain an UPSTREAM_FLOWSPEC object and MUST use the bidirectional
   LSP formats and procedures defined in [RFC3473]. The C-Type of the
   UPSTREAM_FLOWSPEC object MUST match the C-Type of the SENDER_TSPEC
   object used in the Path message. The contents of the
   UPSTREAM_FLOWSPEC object MUST be constructed using a format and
   procedures consistent with those used to construct the FLOWSPEC
   object that will be used for the LSP, e.g., [RFC2210] or [RFC4328].

   Nodes processing a Path message containing an UPSTREAM_FLOWSPEC
   object MUST use the contents of the UPSTREAM_FLOWSPEC object in the
   upstream label and the resource allocation procedure defined in
   Section 3.1 of [RFC3473]. Consistent with [RFC3473], a node that is
   unable to allocate a label or internal resources based on the
   contents of the UPSTREAM_FLOWSPEC object MUST issue a PathErr message
   with a "Routing problem/MPLS label allocation failure" indication.

2.2. UPSTREAM_TSPEC Object

   The format of an UPSTREAM_TSPEC object is the same as a SENDER_TSPEC
   object, which includes the definition of class types and their
   formats. The class number of the UPSTREAM_TSPEC object is 121 (of
   the form 0bbbbbbb).

2.2.1. Procedures

   The UPSTREAM_TSPEC object describes the traffic flow that originates
   at the egress. The UPSTREAM_TSPEC object MUST be included in any
   Resv message that corresponds to a Path message containing an
   UPSTREAM_FLOWSPEC object. The C-Type of the UPSTREAM_TSPEC object
   MUST match the C-Type of the corresponding UPSTREAM_FLOWSPEC object.
   The contents of the UPSTREAM_TSPEC object MUST be constructed using a
   format and procedures consistent with those used to construct the
   FLOWSPEC object that will be used for the LSP, e.g., [RFC2210] or
   [RFC4328]. The contents of the UPSTREAM_TSPEC object MAY differ from

contents of the UPSTREAM_FLOWSPEC object based on application data
transmission requirements.

When an UPSTREAM_TSPEC object is received by an ingress, the ingress
MAY determine that the original reservation is insufficient to
satisfy the traffic flow. In this case, the ingress MAY tear down
the LSP and send a PathTear message. Alternatively, the ingress MAY
issue a Path message with an updated UPSTREAM_FLOWSPEC object to
modify the resources requested for the upstream traffic flow. This
modification might require the LSP to be re-routed, and in extreme
cases might result in the LSP being torn down when sufficient
resources are not available along the path of the LSP.

2.3. UPSTREAM_ADSPEC Object

The format of an UPSTREAM_ADSPEC object is the same as an ADSPEC
object. This includes the definition of class types and their
formats. The class number of the UPSTREAM_ADSPEC object is 122 (of
the form 0bbbbbbb).

2.3.1. Procedures

The UPSTREAM_ADSPEC object MAY be included in any Resv message that
corresponds to a Path message containing an UPSTREAM_FLOWSPEC object.
The C-Type of the UPSTREAM_TSPEC object MUST be consistent with the
C-Type of the corresponding UPSTREAM_FLOWSPEC object. The contents
of the UPSTREAM_ADSPEC object MUST be constructed using a format and
procedures consistent with those used to construct the ADSPEC object
that will be used for the LSP, e.g., [RFC2210] or [RFC6003]. The
UPSTREAM_ADSPEC object is processed using the same procedures as the
ADSPEC object and, as such, MAY be updated or added at transit nodes.

3. Packet Formats

This section presents the RSVP message-related formats as modified by
this section. This document modifies formats defined in [RFC2205],
[RFC3209], and [RFC3473]. See [RFC5511] for the syntax used by RSVP.
Unmodified formats are not listed. Three new objects are defined in
this section:

     Object name   Applicable RSVP messages
     ---------------   ------------------------
     UPSTREAM_FLOWSPEC   Path, PathTear, PathErr, and Notify
                                 (via sender descriptor)
     UPSTREAM_TSPEC   Resv, ResvConf, ResvTear, ResvErr, and
                                 Notify (via flow descriptor list)
     UPSTREAM_ADSPEC   Resv, ResvConf, ResvTear, ResvErr, and
                                 Notify (via flow descriptor list)

The format of the sender description for bidirectional asymmetric
LSPs is:

```
<sender descriptor> ::=  <SENDER_TEMPLATE> <SENDER_TSPEC>
                         [ <ADSPEC> ]
                         [ <RECORD_ROUTE> ]
                         [ <SUGGESTED_LABEL> ]
                         [ <RECOVERY_LABEL> ]
                         <UPSTREAM_LABEL>
                         <UPSTREAM_FLOWSPEC>
```

The format of the flow descriptor list for bidirectional asymmetric
LSPs is:

```
<flow descriptor list> ::= <FF flow descriptor list>
                         | <SE flow descriptor>

<FF flow descriptor list> ::= <FLOWSPEC>
                         <UPSTREAM_TSPEC> [ <UPSTREAM_ADSPEC> ]
                         <FILTER_SPEC>
                         <LABEL> [ <RECORD_ROUTE> ]
                         | <FF flow descriptor list>
                         <FF flow descriptor>

<FF flow descriptor> ::= [ <FLOWSPEC> ]
                         [ <UPSTREAM_TSPEC>] [ <UPSTREAM_ADSPEC> ]
                         <FILTER_SPEC> <LABEL>
                         [ <RECORD_ROUTE> ]

<SE flow descriptor> ::= <FLOWSPEC>
                         <UPSTREAM_TSPEC> [ <UPSTREAM_ADSPEC> ]
                         <SE filter spec list>
```

<SE filter spec list> is unmodified by this document.

4. Compatibility

This extension reuses and extends semantics and procedures defined in
[RFC2205], [RFC3209], and [RFC3473] to support bidirectional LSPs
with asymmetric bandwidth. Three new objects are defined to indicate
the use of asymmetric bandwidth. Each of these objects is defined
with class numbers in the form 0bbbbbbb. Per [RFC2205], nodes not
supporting this extension will not recognize the new class numbers
and will respond with an "Unknown Object Class" error. The error
message will propagate to the ingress, which can then take action to
avoid the path with the incompatible node or can simply terminate the
session.

5. IANA Considerations

   The IANA has made the assignments described below in the "Class
   Names, Class Numbers, and Class Types" section of the "RSVP
   PARAMETERS" registry.

5.1. UPSTREAM_FLOWSPEC Object

   The class named UPSTREAM_FLOWSPEC has been assigned in the 0bbbbbbb
   range (120) with the following definition:

      Class Types or C-types:

      Same values as FLOWSPEC object (C-Num 9)

5.2. UPSTREAM_TSPEC Object

   The class named UPSTREAM_TSPEC has been assigned in the 0bbbbbbb
   range (121) with the following definition:

      Class Types or C-types:

      Same values as SENDER_TSPEC object (C-Num 12)

5.3. UPSTREAM_ADSPEC Object

   The class named UPSTREAM_ADSPEC has been assigned in the 0bbbbbbb
   range (122) with the following definition:

      Class Types or C-types:

      Same values as ADSPEC object (C-Num 13)

6. Security Considerations

   This document introduces new message objects for use in GMPLS
   signaling [RFC3473] -- specifically the UPSTREAM_TSPEC,
   UPSTREAM_ADSPEC, and UPSTREAM_FLOWSPEC objects. These objects
   parallel the existing SENDER_TSPEC, ADSPEC, and FLOWSPEC objects but
   are used in the opposite direction. As such, any vulnerabilities
   that are due to the use of the old objects now apply to messages
   flowing in the reverse direction.

   From a message standpoint, this document does not introduce any new
   signaling messages or change the relationship between LSRs that are
   adjacent in the control plane. As such, this document introduces no
   additional message- or neighbor-related security considerations.

See [RFC3473] for relevant security considerations and [RFC5920] for a more general discussion on RSVP-TE security discussions.

7. References

7.1. Normative References

   [RFC2205]   Braden, R., Ed., Zhang, L., Berson, S., Herzog, S., and
               S. Jamin, "Resource ReSerVation Protocol (RSVP) --
               Version 1 Functional Specification", RFC 2205, September
               1997.

   [RFC2119]   Bradner, S., "Key words for use in RFCs to Indicate
               Requirement Levels", BCP 14, RFC 2119, March 1997.

   [RFC2210]   Wroclawski, J., "The Use of RSVP with IETF Integrated
               Services", RFC 2210, September 1997.

   [RFC3209]   Awduche, D., Berger, L., Gan, D., Li, T., Srinivasan, V.,
               and G. Swallow, "RSVP-TE: Extensions to RSVP for LSP
               Tunnels", RFC 3209, December 2001.

   [RFC3473]   Berger, L., Ed., "Generalized Multi-Protocol Label
               Switching (GMPLS) Signaling Resource ReSerVation
               Protocol-Traffic Engineering (RSVP-TE) Extensions", RFC
               3473, January 2003.

7.2. Informative References

   [RFC4606]   Mannie, E. and D. Papadimitriou, "Generalized Multi-
               Protocol Label Switching (GMPLS) Extensions for
               Synchronous Optical Network (SONET) and Synchronous
               Digital Hierarchy (SDH) Control", RFC 4606, August 2006.

   [RFC4328]   Papadimitriou, D., Ed., "Generalized Multi-Protocol Label
               Switching (GMPLS) Signaling Extensions for G.709 Optical
               Transport Networks Control", RFC 4328, January 2006.

   [RFC5511]   Farrel, A., "Routing Backus-Naur Form (RBNF): A Syntax
               Used to Form Encoding Rules in Various Routing Protocol
               Specifications", RFC 5511, April 2009.

   [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.

   [RFC5920]   Fang, L., Ed., "Security Framework for MPLS and GMPLS
               Networks", RFC 5920, July 2010.

   [RFC5467]   Berger, L., Takacs, A., Caviglia, D., Fedyk, D., and J.
                Meuric, "GMPLS Asymmetric Bandwidth Bidirectional Label
                Switched Paths (LSPs)", RFC 5467, March 2009.

   [RFC6003]   Papadimitriou, D., "Ethernet Traffic Parameters", RFC
                6003, October 2010.

   [RFC6060]   Fedyk, D., Shah, H., Bitar, N., and A. Takacs,
                "Generalized Multiprotocol Label Switching (GMPLS)
                Control of Ethernet Provider Backbone Traffic Engineering
                (PBB-TE)", RFC 6060, March 2011.

Authors' Addresses

   Attila Takacs
   Ericsson
   Konyves Kalman krt. 11.
   Budapest, 1097
   Hungary

   EMail: attila.takacs@ericsson.com

   Lou Berger
   LabN Consulting, L.L.C.

   EMail: lberger@labn.net

   Diego Caviglia
   Ericsson
   Via A. Negrone 1/A
   Genova-Sestri Ponente,
   Italy

   Phone: +390106003738
   Fax:
   EMail: diego.caviglia@ericsson.com

   Don Fedyk
   Alcatel-Lucent
   Groton, MA
   USA

   EMail: donald.fedyk@alcatel-lucent.com

   Julien Meuric
   France Telecom Orange
   2, avenue Pierre Marzin
   Lannion Cedex,   22307
   France

   EMail: julien.meuric@orange.com