Network Working Group   W. Cheng
Internet-Draft   L. Wang
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Expires: September 3, 2018   China Mobile
                                                             M. Chen
                                                              Huawei
                                                           R. Zigler
                                                            Broadcom
                                                             S. Zhan
                                                                 ZTE
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Path Segment in MPLS Based Sement Routing Network
draft-cheng-spring-mpls-path-segment-01

Abstract

   An SR path is identified by an SR segment list, one or partial
   segments of the list cannot uniquely identify the SR path.

   This document introduces the concept of Path Segment that is used to
   identify an SR path. When used, it is inserted at the ingress node
   of the SR path and immediately follows the last segment of the SR
   path. The Path Segment will not be popped off until it reaches the
   egress of the SR path, it can be used by the egress node to implement
   end-2-end SR path protection or performance measurement (PM)
   (especially for measuring packet loss of real traffic) of an SR path.

Requirements Language

   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].

Status of This Memo

   This Internet-Draft is submitted in full conformance with the
   provisions of BCP 78 and BCP 79.

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   Internet-Drafts are draft documents valid for a maximum of six months
   and may be updated, replaced, or obsoleted by other documents at any

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1. Introduction

   Segment Routing (SR) [I-D.ietf-spring-segment-routing] is a source
   routed forwarding method that allows to directly encode forwarding
   instructions (called segments) in each packet, hence it enables to
   steer traffic through a network without the per-flow states
   maintained in the transit nodes. Segment Routing can be instantiated
   on MPLS data plane or IPv6 data plane. The former is called SR-MPLS

[I-D.ietf-spring-segment-routing-mpls], the latter is called SRv6
[I-D.ietf-6man-segment-routing-header]. SR-MPLS leverages the MPLS
label stack to construct SR path, and SRv6 uses the Segment Routing
Header to construct SR path.

In an SR-MPLS network, when a packet is transmitted along an SR path,
the labels in the MPLS label stack will be swapped or popped. So
that no label or only the last label may be left in the MPLS label
stack when the packet reaches the egress node. Thus, the egress node
cannot determine from which ingress node or SR path the packet comes.

However, to support use cases like end-2-end 1+1 path protection,
bidirectional path correlation or performance measurement(PM), the
ability to implement path identification is the pre-condition.

Therefore, this document introduces a new segment that is referred to
as Path Segment. A Path Segment is defined to unique identify an SR
path in a specific context. (e.g., in the context of the egress node
or ingress node of an SR path, or within an SR domain). It is
normally used by egress nodes for path identification or correlation.
Path Segment can only apply to SR-MPLS.

2. Path Segment

This document introduces two options for SR path identification: one
label solution and two labels solution.

[Editor notes: it is supposed that the WG will discuss and decide
which one is preffered.]

2.1. One Label Solution

The Path Segment is a single label that is assigned from the Segment
Routing Local Block (SRLB) or Segment Routing Global Block (SRGB) of
the egress node of an SR path. It means that the Path Segment is
unique in the context of the egress node of SR paths. When Path
Segment is used, a Path label MUST be inserted at the ingress node
and MUST immediately follow the last label of the SR path.

If the Path label is the bottom label, the S bit MUST be set. The
value of the TC field MUST be set to the same value as the last
segment label of the SR path. The value of the TTL field MUST be set
to the same value of the last segment label of the SR path.

Normally, the intermediates node will not see the Path Segment label
and do not know how to process it even if they see it. A Path
Segment label presenting to an intermediate node is error situation.

The egress node MUST pop the Path label and deliver it to relevant
components for further processing.

The label stack with Path Segment is as below (Figure1):

```
            +--------------------+
            |        ...         |
            +--------------------+
            |      Label 1       |
            +--------------------+
            |      Label 2       |
            +--------------------+
            |        ...         |
            +--------------------+
            |      Label n       |
            +--------------------+
            |     Path Label     |
            +--------------------+
            |        ...         |
            +--------------------+
```

      Figure 1: Label Stack with Path Segment

   Where:

   o The Label 1-n are the segment labels that are used to direct how
      to steer the packets along the SR path.

   o The Path Label identifies the SR path in the context of the egress
      node of the SR path.

2.1.1. Path Segment Assignment

   Several ways can be used to assign the Path Segment. One way is that
   the Path Segment label is directly assigned by the egress node of an
   SR path. Where the ingress node of the SR path can directly send a
   request to the egress node to ask for a Path label. With this way,
   it needs to set up a communication channel between the ingress node
   and the egress node. New protocols or extensions to existing
   protocol may be required.

   Another candidate way is to leverage a centralized controller (e.g.,
   PCE) to assign the Path label. The ingress node sends a request to
   the PCE to compute a SR path and indicate that a Path label is
   desired. The PCE will compute the path as required. Once the path
   computed, the PCE will send a request (with computed path and
   relevant information) to the egress node to ask for a Path label for

the SR path. The egress node will allocate a label to the SR path
and build mapping relationship between the label and the path. A
reply will be sent back to the PCE, the PCE will send a reply to the
ingress node about the path information and the corresponding Path
Segment label.

With either way or the variations, the final purpose is to assign a
label from the egress node's label space, hence a single label is
enough for path identification. Then the ingress node can insert the
Path Segment label into the label stack when needed, and the egress
node can use that Path Segment to implement relevant functionalities.

2.2. Two Labels Solution

Two segments (Source segment and Path segment) are used to identify
an SR path. The Source segment is a global node segment, it can
uniquely identify a node within an SR domain. It MUST NOT be used
for forwarding and indicates that a Path segment immediately follows.
The Path segment is a local segment generated at the ingress node to
identify an SR path. The combination of Source segment and Path
segment can uniquely identify an SR Path with an SR domain.

A node that enables Path segment function will be assigned two node
segments. One is for forwarding just as defined in
[I-D.ietf-spring-segment-routing], the other is for source
identification. The corresponding label of the Source Segment is
indexed in the SRGB of the node to which the Source Segment will be
presented.

The Path segment label is a local label that is assigned to an SR
path at the ingress node.

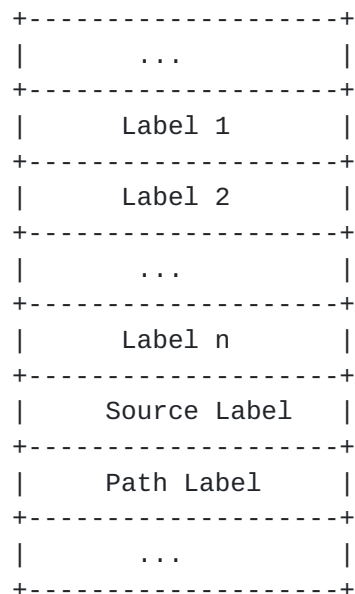The label stack with Source and Path segments is as below (Figure 2):

```
            +--------------------+
            |         ...        |
            +--------------------+
            |      Label 1       |
            +--------------------+
            |      Label 2       |
            +--------------------+
            |         ...        |
            +--------------------+
            |      Label n       |
            +--------------------+
            |    Source Label    |
            +--------------------+
            |     Path Label     |
            +--------------------+
            |         ...        |
            +--------------------+
```

       Figure 2: Label Stack with Source and Path Segments

    Where:

    o The Label 1-n are the segment labels that are used to direct how
       to steer the packets along an SR path, and the "label n" is the
       last label of the SR path or the label that directs forwarding
       packets to the node to which the Source Segment will be presented.

    o The Source Label identifies the source of the SR path. The value
       of the TC and TTL fields of the Source Label MUST be set to the
       same values as the label (e.g., the Label n) it follows.

    o The Path Label identifies the SR path in the context of source
       node. If the Path label is the bottom label, the S bit MUST be
       set. The value of the TC and TTL fields SHOULD be set to the same
       values as the Source label.

    The Source and Path label MUST be inserted at the ingress node of an
    SR path. And they MUST immediately follow the label that directs
    forwarding packets to the node (e.g., the egress or an intermediate
    node) to which the Source Segment (as the stack top label) and Path
    Segment are presented.

    If a node receives a packet with an unknown Source Label, the packet
    MUST be discarded and an error SHOULD be reported.

    The Source label and Path label MUST be popped at the node who
    receives a packet with the Source label as the stack top label.

3. Path Segment Application

3.1. Packet Loss Measurement for Real Traffic

Measuring packet loss of real traffic is called "direct mode" packet
loss measurement in [RFC6374], it is sometime called passive
measurement as well. To measure the packet loss of the real traffic
of an SR path, one fundamental condition is path identification at
the measuring points. For an SR path, the ingress node have the
complete information of the path, it can use those information for
packet counting. At the egress node, since the Path Segment label
(or combination with Source label) can be used to identify the path,
path based packet counting can be implemented as well. Then combined
with the mechanisms defined in [RFC6374], end-2-end packet loss
measurement of an SR path can be achieved.

3.2. End-2-end Path Protection

For end-2-end 1+1 path protection, the egress node of an path needs
to know the set of paths that constitute the primary and the
backup(s), in order to select the primary packet for onward
transmission, and to discard the packets from the backups.

To do this each path needs a path identifier that is unique at the
egress node. Depending on the design, this single unique label
chosen by the egress PE or the combination of the source node
identifier and a unique path identifier chosen by the source.

There then needs to be a method of binding this path identifiers into
equivalence groups such that the egress PE can determine the set of
packets that represent a single path and its backup.

It is obvious that this group can be instantiated in the network by
an SDN controller.

In a network that is using a distributed control plane the approach
will depend on the control protocol used, but the essence of the
solution is that which ever PE is responsible for creating the group
advertises then as a group of equivalent paths. Whether one of these
is advertised as primary and the others as secondary will or all are
advertised as of equal status will depend on the details of the
underlying protection mechanism.

3.3. Bi-directional SR Tunnel

With the current SR architecture, an SR path is an unidirectional
path. In some scenarios, for example, mobile backhaul transport
network, there are requirements to support bi-directional path, and

the path is normally treated as a single entity and both directions
of the path have the same fate, for example, failure in one direction
will result in switching at both directions.

MPLS supports this by introducing the concepts of co-routed
bidirectional LSP and associated bi-directional LSP. With SR, to
support bidirectional path, a straightforward way is to bind two
unidirectional SR paths to a single bi-directional path. Path
segments can be used to correlate the two unidirectional SR paths at
both ends of the paths.

4. IANA Considerations

This document makes no request of IANA.

Note to RFC Editor: this section may be removed on publication as an
RFC.

5. Security Considerations

6. Contributors

The following individuals also contribute to this document.

o   Shuangping Zhan, ZTE

o   Cheng Li, Huawei

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8. References

8.1. Normative References

[I-D.ietf-6man-segment-routing-header]
          Previdi, S., Filsfils, C., Raza, K., Dukes, D., Leddy, J.,
          Field, B., daniel.voyer@bell.ca, d.,
          daniel.bernier@bell.ca, d., Matsushima, S., Leung, I.,
          Linkova, J., Aries, E., Kosugi, T., Vyncke, E., Lebrun,
          D., Steinberg, D., and R. Raszuk, "IPv6 Segment Routing
          Header (SRH)", draft-ietf-6man-segment-routing-header-08
          (work in progress), January 2018.

[RFC2119]   Bradner, S., "Key words for use in RFCs to Indicate
            Requirement Levels", BCP 14, RFC 2119,
            DOI 10.17487/RFC2119, March 1997,
            <https://www.rfc-editor.org/info/rfc2119>.

8.2. Informative References

[I-D.ietf-spring-segment-routing]
            Filsfils, C., Previdi, S., Ginsberg, L., Decraene, B.,
            Litkowski, S., and R. Shakir, "Segment Routing
            Architecture", draft-ietf-spring-segment-routing-15 (work
            in progress), January 2018.

[I-D.ietf-spring-segment-routing-mpls]
            Bashandy, A., Filsfils, C., Previdi, S., Decraene, B.,
            Litkowski, S., and R. Shakir, "Segment Routing with MPLS
            data plane", draft-ietf-spring-segment-routing-mpls-12
            (work in progress), February 2018.

[RFC6374]   Frost, D. and S. Bryant, "Packet Loss and Delay
            Measurement for MPLS Networks", RFC 6374,
            DOI 10.17487/RFC6374, September 2011,
            <https://www.rfc-editor.org/info/rfc6374>.

Authors' Addresses

   Weiqiang Cheng
   China Mobile

   Email: chengweiqiang@chinamobile.com

   Lei Wang
   China Mobile

   Email: wangleiyj@chinamobile.com

   Han Li
   China Mobile

   Email: lihan@chinamobile.com

   Mach(Guoyi) Chen
   Huawei

   Email: mach.chen@huawei.com

Royi Zigler
Broadcom

Email: royi.zigler@broadcom.com

Shuangping Zhan
ZTE

Email: zhan.shuangping@zte.com.cn