Compressed SRv6 SID List Requirements
draft-srcompdt-spring-compression-requirement-03

Abstract

   This document specifies requirements for solutions to compress SRv6
   SID lists.

Status of This Memo

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

   Internet-Drafts are working documents of the Internet Engineering
   Task Force (IETF). Note that other groups may also distribute
   working documents as Internet-Drafts. The list of current Internet-
   Drafts is at https://datatracker.ietf.org/drafts/current/.

   Internet-Drafts are draft documents valid for a maximum of six months
   and may be updated, replaced, or obsoleted by other documents at any
   time. It is inappropriate to use Internet-Drafts as reference
   material or to cite them other than as "work in progress."

   This Internet-Draft will expire on July 16, 2021.

Table of Contents

1. Introduction

   The SPRING working group defined SRv6, with [RFC8402] describing how
   the Segment Routing (SR) architecture is instantiated on two data-
   planes: SR over MPLS (SR-MPLS) and SR over IPv6 (SRv6). SRv6 uses a
   routing header called the SR Header (SRH) [RFC8754] and defines SRv6
   SID behaviors and a registry for identifying them in
   [I-D.ietf-spring-srv6-network-programming]. SRv6 is a proposed
   standard and is deployed today.

   The SPRING working group has observed that some use cases, such as
   strict path TE, may require long SRv6 SID lists. There are several

proposed methods to reduce the resulting SRv6 encapsulation size by
compressing the SID list.

The SPRING working group formed a design team to define requirements
for, and analyze proposals to, compress SRv6 SID lists.

It is a goal of the design team to identify solutions to SRv6 SID
list compression that are based on the SRv6 standards. As such, this
document provides requirements for SRv6 SID list compression
solutions that utilize the existing SRv6 data plane and control
plane.

It is also a goal of the design team to consider proposals that are
not based on the SRv6 data plane and control plane. As such, this
document includes requirements to evaluate whether a compression
proposal provides all the functionality of SRv6 (section "SRv6
Functionality") in addition to satisfying compression specific
requirements.

For each requirement, a description, rationale and metrics are
described.

The design team will produce a separate document to analyze the
proposals.

This document is a draft; additional requirements are under review,
additional requirements will be added, and current requirements may
change. Appendix A contains a subset of requirements without
unanimous consensus. Additional requirements without unanimous
consensus are not in the appendix.

2. Conventions used in this document

2.1. Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT",
"SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and
"OPTIONAL" in this document are to be interpreted as described in BCP
14 [RFC2119] [RFC8174] when, and only when, they appear in all
capitals, as shown here.

2.2. Terminology

SR: Segment Routing

SRH: Segment Routing Header

MPLS: Multiprotocol Label Switching

SR-MPLS: Segment Routing over MPLS data plane

SID: Segment Identifier

SRv6: Segment Routing over IPv6

SRv6 SID List: A list of SRv6 SIDs

Compression proposal: A proposal to compress SRv6 SID lists

SRv6 base: SRv6 as defined in [RFC8402], [RFC8754],
[I-D.ietf-spring-srv6-network-programming]

SID numbering space: may be implemented as

o a single IGP instance

o a single IGP level or area

o two or more autonomous systems that coordinate SID numbering space

o two or more IGP instances that coordinate SID numbering space

SRv6 Encapsulation Header: The IPv6 header, and any extension headers
preceding a payload, used to implement a SRv6 base or compression
proposal.

3. SRv6 SID List Compression Requirements

3.1. Dataplane Efficiency and Performance Requirements

3.1.1. Encapsulation Header Size

Description: The compression proposal MUST reduce the size of the
SRv6 encapsulation header.

Rationale: A smaller SRv6 encapsulation results in better MTU
efficiency.

Metric: Compression is the ratio of the IPv6 encapsulation size of
SRv6 as defined in [RFC8402], [RFC8754],
[I-D.ietf-spring-srv6-network-programming] vs the IPv6 encapsulation
size of a given proposal. The encapsulation savings of a compression
proposal vs the SRv6 base is a useful measurement to compare
proposals.

The encapsulation metric (E) records the number of bytes required for
a proposal to encapsulate a packet given a specific segment list.

o E(proposal, segment list).

The encapsulation savings(ES)records the encapsulation savings for a
proposal to encapsulate a packet given a specific segment list.

o ES(proposal, segment list) = 1 - E(proposal, segment list)/E(SRv6
   base, segment list).

3.1.2. Forwarding Efficiency

Description: The compression proposal SHOULD minimize the number of
required hardware resources accessed to process a segment.

Rationale: Efficiency in bits on the wire and processing efficiency
are both important. Optimizing one at the expense of the other may
lead to significant performance impact.

Metric: The data plane efficiency metric (D) records the data plane
forwarding efficiency of the proposed solution. Two metrics are used
and recorded at each segment endpoint:

o D.PRS(segment list): number of headers parsed during processing of
   the segment list, starting from and including the IPv6 header.

o D.LKU(segment list): number of FIB lookups during processing of
   the segment list. The type of lookup is also recorded as longest
   prefix match (LPM) or exact match (EM)

3.1.3. State Efficiency

Description: The compression proposal SHOULD minimize the amount of
additional forwarding state stored at a node.

Rationale: Additional state increases the complexity of the control
plane and data plane. It can also result in an increase in memory
usage.

Metric: The state efficiency metric (S) records the amount of
additional forwarding state required by the proposed solution.

o S(node parameters): the number of additional forwarding states
   that need to be stored at a node, given a set of node parameters
   consisting of the number of nodes in the network, number of local
   interfaces, number of adjacencies. The forwarding state is
   counted as entries required in a Forwarding Information Base (FIB)
   at a node.

[4](#). SRv6 Specific Requirements

[4.1](#). SRv6 Based

   Description: A solution to compress SRv6 SID Lists SHOULD be based on
   the SRv6 architecture, control plane and data plane. The compression
   solution MAY be based on a different data plane and control plane,
   provided that it derives sufficient benefit.

   Rationale: A compression proposal built on existing IETF standards is
   preferable to creating new standards with equivalent functionality
   and performance.

   Metric: The utilization metric (U) records whether a proposal
   utilizes the SRv6 specifications.

   Utilization is recorded in a table, with a column per proposal and
   rows consisting of the following metrics:

   o U.[RFC8402](#): utilizes [[RFC8402](#)].

   o U.[RFC8754](#): utilizes [[RFC8754](#)].

   o U.PGM: utilizes [[I-D.ietf-spring-srv6-network-programming](#)].

   o U.IGP: utilizes [[I-D.ietf-lsr-isis-srv6-extensions](#)].

   o U.BGP: utilizes [[I-D.ietf-bess-srv6-services](#)].

   o U.POL: utilizes [[I-D.ietf-spring-segment-routing-policy](#)].

   o U.BLS: utilizes [[I-D.ietf-idr-bgpls-srv6-ext](#)].

   o U.SVC: utilizes [[I-D.ietf-spring-sr-service-programming](#)].

   o U.OAM: utilizes [[I-D.ietf-6man-spring-srv6-oam](#)].

   o U.ALG: utilizes [[I-D.ietf-lsr-flex-algo](#)].

   Each cell contains "yes" for utilizes, or "no" for does not utilize.

[4.2](#). Functional Requirements

[4.2.1](#). SRv6 Functionality

   Description: A solution to compress an SRv6 SID list MUST support the
   functionality of SRv6. This requirement ensures no SRv6
   functionality is lost. It is particularly important to understand

how a proposal, as evaluated in section "SRv6 Based", provides this
functionality.

Rationale: Operators require SRv6 functionality. Evaluating the
extent to which a proposal supports SRv6 functionality is important
for operators and implementors to understand the impact on network
operations.

Metric: The Functionality metric (F) records whether a proposal
supports SRv6 functionality and how the functionality is provided.

Functionality is recorded in a table with columns for each proposal
and rows consisting of the following metrics:

o F.SID: Supports SRv6 SID functionality as described in [RFC8402]

o F.SCOPE: Supports globally and locally scoped SID functionality as
   described in [RFC8402]

o F.PFX: Supports prefix SID functionality as described in [RFC8402]
   and [I-D.ietf-spring-srv6-network-programming]

o F.ADJ: Supports adjacency SID functionality as described in
   [RFC8402] and [I-D.ietf-spring-srv6-network-programming]

o F.BIND: Supports binding SID functionality as described in
   [RFC8402] and [I-D.ietf-spring-srv6-network-programming]

o F.PEER: Supports BGP peering SID functionality as described in
   [RFC8402] and [I-D.ietf-spring-srv6-network-programming]

o F.SVC: Supports L3 and L2 VPN service SID functionality as
   described in [I-D.ietf-spring-srv6-network-programming]

o F.ALG: Supports flexible algorithms functionality as described in
   [I-D.ietf-lsr-flex-algo]

o F.TILFA: Supports TI-LFA functionality as described in
   [I-D.ietf-rtgwg-segment-routing-ti-lfa]

o F.SEC: Supports securing an SR domain with ingress filtering as
   functionally defined in [RFC8754]

o F.IGP: Supports distributing topological SIDs and behaviors via
   ISIS as functionally described in
   [I-D.ietf-lsr-isis-srv6-extensions]

   o F.BGP: Supports BGP VPNs as functionally described in
      [I-D.ietf-bess-srv6-services]

   o F.POL: Supports SR policies and steering traffic over those
      policies as funcitonally described in
      [I-D.ietf-spring-segment-routing-policy]

   o F.BLS: Supports Link State distribution via BGP as functionally
      described in [I-D.ietf-idr-bgpls-srv6-ext]

   o F.SFC: Supports stateless service programming as functionally
      described in [I-D.ietf-spring-sr-service-programming]

   o F.PING: Supports pinging a SID to verify the SID is implemented as
      functionally described in [I-D.ietf-6man-spring-srv6-oam]

   Each cell contains the specification name documenting the
   functionality.

4.2.2. Heterogeneous SID lists

   Description: The compression proposal SHOULD support a combination of
   compressed and non-compressed segments in a single path. As an
   example, a solution may satisfy this requirement without being SRv6
   based by using a binding SID to impose an additional SRv6 header
   (IPv6 header plus optional SRH) with non-compressed SID.

   Rationale: Support of SID lists with compressed and non-compressed
   SIDs reduces encapsulation size when not all SRv6 nodes deploy the
   compression proposal or 128-bit SIDs are required.

   Metric: A compliant compression proposal supports both:

   o classic 128-bit SRv6 SIDs in the IPv6 Destination Address field

   o segment lists (i.e., paths) with both compressed and 128-bit SRv6
      SIDs.

4.2.3. SID list length

   Description: The compression proposal MUST be able to represent SR
   paths that contain up to 16 segments.

   Rationale: Strict TE paths require SID list lengths proportional to
   the diameter of the SR domain.

   Metric: The compression proposal must be able to steer a packet
   through an SR path that contains up to sixteen segments.

4.2.4. SID summarization

   Description: The solution MUST be compatible with segment
   summarization.

   Rationale: Summarization of segments is a key benefit of SRv6 vs SR
   MPLS. In interdomain deployments, any node can reach any other node
   via a single prefix segment. Without summarization, border router
   SIDs must be leaked, and an additional global prefix segment is
   required for each domain border to be traversed.

   Metric: A solution supports summarization when segments can be
   summarized for advertisement into other IGP domains or levels.

4.3. Operational Requirements

4.3.1. Lossless Compression

   Description: A path traversed using a compessed SID list MUST always
   be the same as the path traversed using the uncompressed SID list if
   no compression was applied.

   Rationale: In SRv6, we can represent a path to meet certain
   objectives. A compression proposal needs to support the objectives
   with the same path.

   Metric: Information present in the pre-compression segment list MUST
   also be present in the post-compression SID list.

4.4. Scalability Requirements

4.4.1. Adjacency segment scale

   Description: The compression proposal MUST be capable of representing
   65000 adjacency segments per node

   Rationale: Typically, network operators deploy networks with tens or
   hundreds of adjacency segments per node, but some network operators
   may deploy networks that use more adjacency segments per node.

   Metric: A proposal that allows 65000 adjacency segments per node
   satisfies this requirement.

4.4.2. Prefix segment scale

   Description: The compression proposal MUST be capable of representing
   1 million prefix segments per SID numbering space.

Rationale: Typically, network operators deploy networks with
thousands of prefix segments per SID numbering space, but some
network operators may deploy networks that use more prefix segments
per SID numbering space.

Metric: A proposal that allows 1 million prefix segments per SID
numbering space satisfies this requirement.

4.4.3. Service Scale

Description: The compression proposal MUST be capable of representing
1 million services per node.

Rationale: Typically, network operators deploy networks with tens to
hundreds of thousands of services per node, but some network
operators may deploy networks that use more services per node.

Metric: A proposal that allows 1 million services per node satisfies
this requirement.

5. Protocol Design Requirements

5.1. SRv6 Base Coexistence

Description: The compression proposal MUST support deployment in
existing SRv6 networks.

Rationale: SRv6 is deployed today. A compression proposal that
interoperates well with SRv6, as deployed, will reduce the overhead
and simplify operations. For Network operators who would migrate to
compressed SRv6 SID lists, the migration is expected to gradually
occur over a period of time as they upgrade networks, domains, device
families and software instances.

Metric: A compliant compression proposal provides the following

o Supports simultaneous deployment at a node with current SRv6 SIDs.

o Supports simultaneous deployment at a node with current SRv6
   control plane.

o Supports simultaneous operation of current SRv6 paths with
   compressed paths.

o Supports the behaviors in
   [I-D.ietf-spring-srv6-network-programming].

o Does not require removal of existing IPv6 address planning.

6. Security Requirements

6.1. Security Mechanisms

   Description: The compression solution SHOULD be able to address
   security issues that it introduces, using existing security
   mechanisms.

   Rationale: It is important to identify security issues and how to
   address them in any specification.

   Metric: A compression solution that does not introduce unresolved
   security issues meets this requirement.

6.2. SR Domain Protection

   Description: A compression solution must not require nodes outside
   the SR domain to know SID values within the SR domain, and it must
   provide the ability to block nodes outside an SR domain from
   accessing SIDS.

   Rationale: The unauthorized use of SIDs within the SR domain by nodes
   outside the domain can disrupt an operators' network.

   Metric: A compliant solution describes how access to SIDs within the
   SR domain is denied to nodes outside the SR domain.

7. IANA Considerations

   This document has no requests to IANA.

8. Security Considerations

   TBD

9. Contributors

   The following individuals contributed to this draft

   Chongfeng Xie, China Telecom, xiechf@chinatelecom.cn

   Ron Bonica, Juniper Networks, rbonica@juniper.net

   Darren Dukes, Cisco Systems, ddukes@cisco.com

   Cheng Li, Huawei, c.l@huawei.com

   Peng Shaofu, ZTE, peng.shaofu@zte.com.cn

Wim Henderickx, Nokia, wim.henderickx@nokia.com

Sanders Steffann, SJM Steffann Consultancy, sander@steffann.nl

[10](#). Normative References

[I-D.ietf-6man-spring-srv6-oam]
           Ali, Z., Filsfils, C., Matsushima, S., Voyer, D., and M.
           Chen, "Operations, Administration, and Maintenance (OAM)
           in Segment Routing Networks with IPv6 Data plane (SRv6)",
           draft-ietf-6man-spring-srv6-oam-08 (work in progress),
           October 2020.

[I-D.ietf-bess-srv6-services]
           Dawra, G., Filsfils, C., Talaulikar, K., Raszuk, R.,
           Decraene, B., Zhuang, S., and J. Rabadan, "SRv6 BGP based
           Overlay services", draft-ietf-bess-srv6-services-05 (work
           in progress), November 2020.

[I-D.ietf-idr-bgpls-srv6-ext]
           Dawra, G., Filsfils, C., Talaulikar, K., Chen, M.,
           daniel.bernier@bell.ca, d., and B. Decraene, "BGP Link
           State Extensions for SRv6", draft-ietf-idr-bgpls-
           srv6-ext-05 (work in progress), November 2020.

[I-D.ietf-lsr-flex-algo]
           Psenak, P., Hegde, S., Filsfils, C., Talaulikar, K., and
           A. Gulko, "IGP Flexible Algorithm", draft-ietf-lsr-flex-
           algo-13 (work in progress), October 2020.

[I-D.ietf-lsr-isis-srv6-extensions]
           Psenak, P., Filsfils, C., Bashandy, A., Decraene, B., and
           Z. Hu, "IS-IS Extension to Support Segment Routing over
           IPv6 Dataplane", draft-ietf-lsr-isis-srv6-extensions-11
           (work in progress), October 2020.

[I-D.ietf-rtgwg-segment-routing-ti-lfa]
           Litkowski, S., Bashandy, A., Filsfils, C., Decraene, B.,
           and D. Voyer, "Topology Independent Fast Reroute using
           Segment Routing", draft-ietf-rtgwg-segment-routing-ti-
           lfa-05 (work in progress), November 2020.

[I-D.ietf-spring-segment-routing-policy]
           Filsfils, C., Talaulikar, K., Voyer, D., Bogdanov, A., and
           P. Mattes, "Segment Routing Policy Architecture", draft-
           ietf-spring-segment-routing-policy-09 (work in progress),
           November 2020.

[I-D.ietf-spring-sr-service-programming]
            Clad, F., Xu, X., Filsfils, C., daniel.bernier@bell.ca,
            d., Li, C., Decraene, B., Ma, S., Yadlapalli, C.,
            Henderickx, W., and S. Salsano, "Service Programming with
            Segment Routing", draft-ietf-spring-sr-service-
            programming-03 (work in progress), September 2020.

[I-D.ietf-spring-srv6-network-programming]
            Filsfils, C., Camarillo, P., Leddy, J., Voyer, D.,
            Matsushima, S., and Z. Li, "SRv6 Network Programming",
            draft-ietf-spring-srv6-network-programming-28 (work in
            progress), December 2020.

[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>.

[RFC8174]   Leiba, B., "Ambiguity of Uppercase vs Lowercase in RFC
            2119 Key Words", BCP 14, RFC 8174, DOI 10.17487/RFC8174,
            May 2017, <https://www.rfc-editor.org/info/rfc8174>.

[RFC8402]   Filsfils, C., Ed., Previdi, S., Ed., Ginsberg, L.,
            Decraene, B., Litkowski, S., and R. Shakir, "Segment
            Routing Architecture", RFC 8402, DOI 10.17487/RFC8402,
            July 2018, <https://www.rfc-editor.org/info/rfc8402>.

[RFC8754]   Filsfils, C., Ed., Dukes, D., Ed., Previdi, S., Leddy, J.,
            Matsushima, S., and D. Voyer, "IPv6 Segment Routing Header
            (SRH)", RFC 8754, DOI 10.17487/RFC8754, March 2020,
            <https://www.rfc-editor.org/info/rfc8754>.

Author's Address

   Weiqiang Cheng
   China Mobile

   Email: chengweiqiang@chinamobile.com