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Extensions for SRv6 traversing IPv4 network
draft-li-spring-srv6-traverse-ipv4-00

Abstract

As the development of cloud computing, increasing services have been migrated from enterprise sites to clouds, so the connections between sites and clouds are critical for enterprises.

SRv6 provides a sourcing routing mechanism to connect the enterprise sites and clouds by programming the end-to-end path at the ingress node. In this scenario, the SRv6 packets may traverse multiple network domains and some of them may not be SRv6-capable.

In order to support SRv6 end-to-end path programming, this document proposes the mechanism of SRv6 traversing IPv4 network.

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1. Introduction

When segment routing (SR) [RFC8402] is deployed on the IPv6 data plane, it is called SRv6 [RFC8754]. For support of SR, a new routing header called Segment Routing Header (SRH), which contains a list of SIDs and other information, has been defined in [RFC8754].

When deploying SRv6, the SRv6 network may need to interwork with exiting networks, such as MPLS netwoks and IPv4 networks.

With the development of cloud computing, increasing services have been migrated from enterprises to cloud data centers. Compared with interconnections between branches and headquarters, new connections between enterprise sites to cloud data centers and inter-cloud are added, which bring new requirements and challenges for existing networks. [I-D.li-rtgwg-ipv6-based-con] describes the requirements and candidate technologies in IPv6-based Cloud-oriented Networking (CON). In IPv6-based CON, SRv6 can be used to connect enterprise sites and clouds. In this scenario, an SRv6 packet may be forwarded traversing IPv4 domains.

The Tunnel Segment is defined in [I-D.li-spring-tunnel-segment] to associate a tunnel to a segment in SRv6 and SR-MPLS, therefore, its dataplane is IPv6 or MPLS. The document defines the a new types of tunnel segment to associate an IPv4 tunnel to an SRv6 SID for supporting end-to-end path programming traversing IPv4 domains. Furthermore, this document also defines the mechanism of encoding the IPv4 tunnel information in the SRH at the source node to provide better source routing programming.

2. Terminology

This document makes use of the terms defined in [RFC8986], and the reader is assumed to be familiar with that terminology.

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.

3. IPv4 Path Programming in SRv6

This document defines the following mechanisms for SRv6 traversing IPv4 networks.

3.1. End.B4

This document defines a new End.B4 (End bound to an IPv4 tunnel) behavior for an SRv6 SID bound to an IPv4 tunnel.

End.B4 SID MUST NOT be the last SID in the segment list. When the node receives a packet with End.B4 SID, the packet is steered into the bound IPv4 tunnel.

When node N receives a packet whose IPv6 DA is S and S is a local End.B4 SID, the line S15 - S16 from the End processing [RFC8986] is replaced by the following:

```
S15.   Encapsulates the SRv6 packet with a new IPv4 tunnel
       encapsulation bound to the End.B4 SID S.
S16.   Submit the packet to the IPv4 module for transmission

S17. }
```

3.2. End.4

Another option is to carry the IPv4 tunnel information in the SRH. The IPv4 tunnel information can be encoded in another 128-bit value following the SID or SRH TLVs.

In this revision, this section defines an End.4 (End function with IPv4 tunnel instantiation) behavior for an SRv6 SID to indicate a 128-bit IPv4 tunnel information is encoded following the SID.

An End.4 SID MUST be encoded preceding the IPv4 tunnel information encapsulation, thus it can not be the last SID in the SID list. In addition, the IPv6 address is needed to be updated by the next SRv6 SID, therefore the IPv4 tunnel information encapsulation MUST NOT be the last SID as well.

The SRv6 path of crossing IPv4 domain is called IPv4 sub-path. An IPv4 sub-path is encoded by an END.4 SID and the following IPv4 tunnel information encapsulation as shown in the following figure.

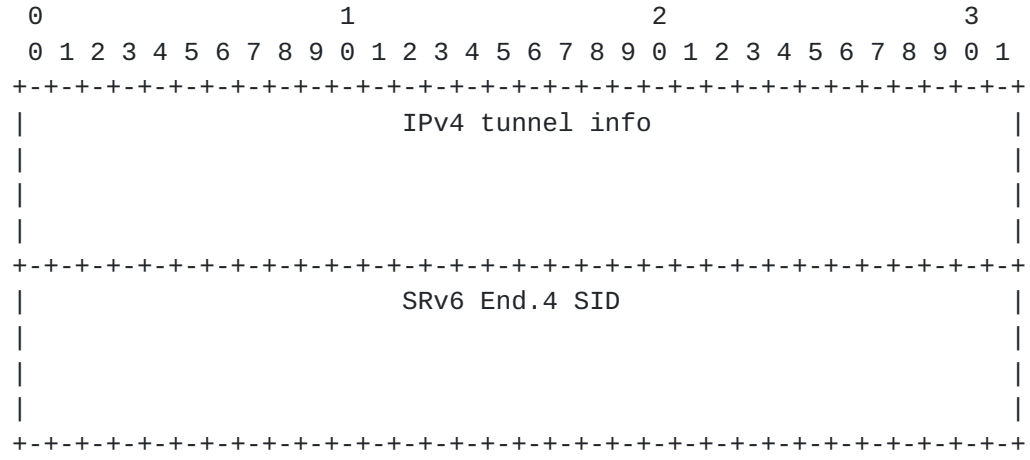

Figure 1. IPv4 Tunnel Sub-path Encoding in SRH

When encoding the end-to-end forwarding path, the ingress encodes the End.4 SID and related IPv4 tunnel info into the SID list, the encoding of IPv4 tunnel information is shown in section 3.2.1.

When a node processes an End.4 SID, it encapsulates the SRv6 packet with an IPv4 tunnel header using the information carried by the IPv4 tunnel information, decreases the SL accordingly and then sends the packet by looking up the IPv4 destination address in the IPv4 header.

When node N receives a packet whose IPv6 DA is S and S is a local End.B4 SID, the line S02 from the End processing [RFC8986] is replaced by the following:

```
   S02.   If (Segments Left == 0 or 1)
```

The lines S13-S16 are replaced by the following pseudo code.

```
   S13.   Decrement SL by 2
   S14.   Update IPv6 DA with Segment List[Segments Left]
   S15.   Encapsulates the SRv6 packet with a new IPv4 tunnel
               by using the IPv4 tunnel information
   S16.   Submit the packet to the IPv4 module for transmission
   S17. }
```

3.2.1. IPv4 Tunnel Information Encapsulation

An IPv4 Tunnel Information Encapsulation contains 128 bits IPv4 tunnel related information. The format is shown below.

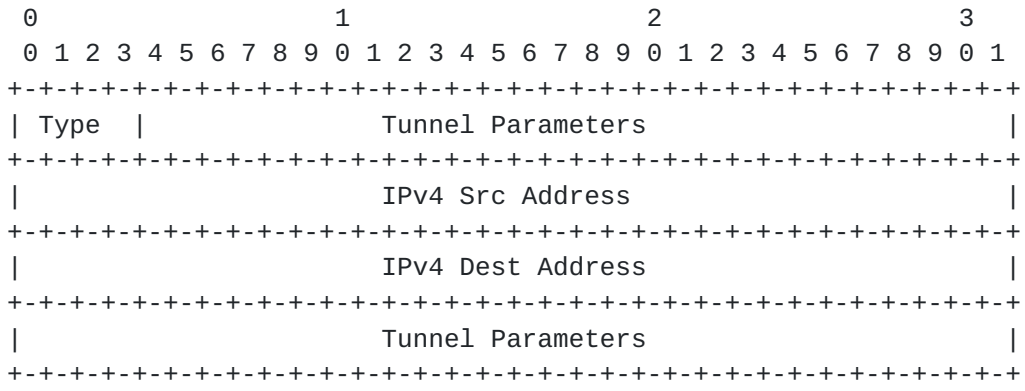

Figure 1. IPv4 Tunnel Information

3.2.1.1. IPv4 Tunnel Information Encoding

The IPv4 tunnel information includes tunnel type, source IPv4 address, destination IPv4 address and tunnel parameters. Different types of IPv4 tunnels have specific parameters:

- IPv4 UDP tunnel: the tunnel parameters includes source port and destination port.

- IPv4 VXLAN tunnel: the tunnel parameters includes source port, destination port and VN ID.

The detailed encapsulation formats for different types of IPv4 tunnel is out of scope of the document.

3.2.2. IPv4 Tunnel Information in SRH TLV

The IPv4 tunnel information MAY be carried in SRH TLV as well.

A TLV Carrying (TC) Flavor is defined to indicate the SID related information is carried within the SRH TLV.

Therefore, an End.4(TC) SID indicates to read the IPv4 tunnel information in the SRH TLV.

A mechanism of specifying which SRH TLV to be processed by which SID in the SID list is defined in [I-D.li-spring-srh-tlv-processing-programming], and it can be used for indicating the node to processing IPv4 tunnel information in SRH TLV. More details will be described in the future.

4. Illustration

For easy understanding, this section illustrates how to use End.4 SID for SRv6 traversing IPv4 networks.

Assuming that

- A::1:200 is the End.4 SID for traversing an IPv4 domain.
- 192.168.0.1 is the source address of the IPv4 tunnel.
- 192.168.0.2 is the destination address of the IPv4 tunnel.

The programmed SRv6 path is shown in Figure 3:

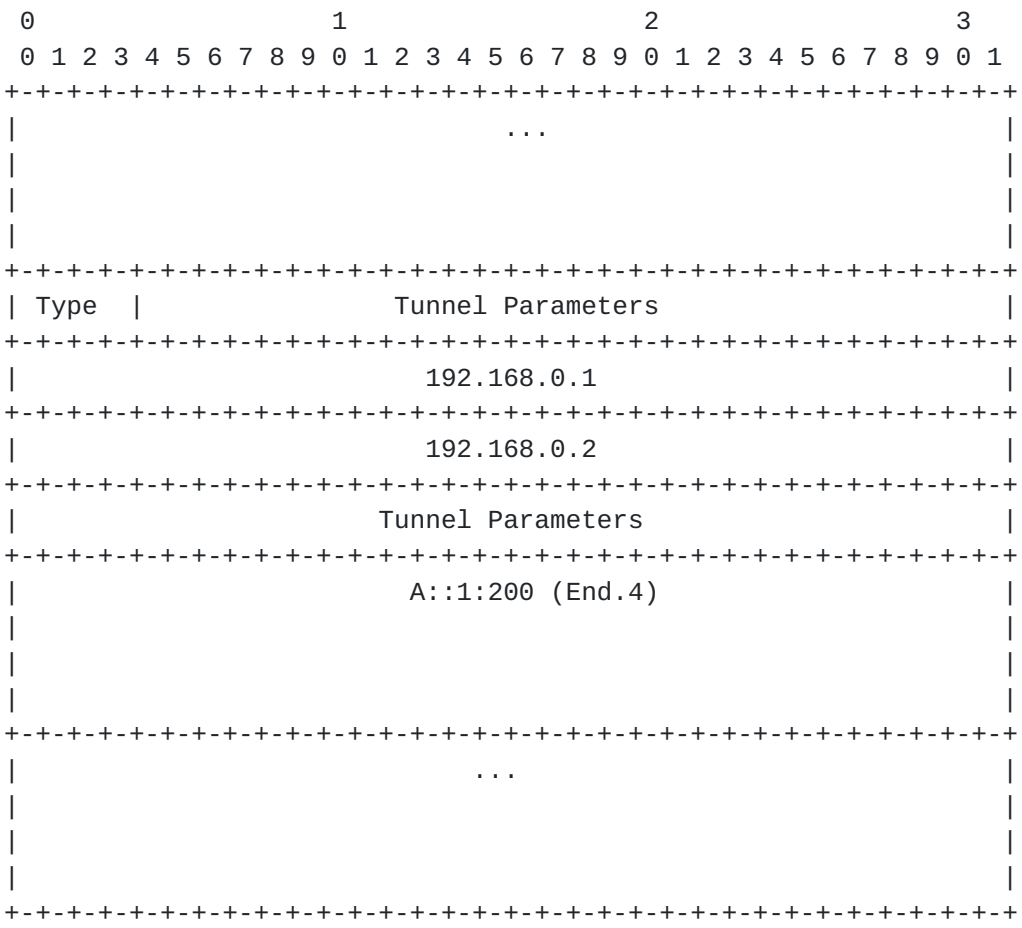

Figure 3. Illustration of using End.4 SID

When the node processes the End.4 SID A::1:200, it encapsulates a new IPv4 header for the SRv6 packet, setting source IPv4 address as 192.168.0.1, and destination address as 192.168.0.2, and parameters accordingly. Also, the inner IPv6 DA is updated by the next SID following the IPv4 tunnel information. The node looks up the IPv4 destination address and forward the packet.

5. IANA Considerations

TBD

6. Security Considerations

TBD

7. Acknowledgements

8. References

8.1. Normative References

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8.2. Informative References

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