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W. Cheng
China Mobile
P. Ma
China Telecom
F. Ren
China Unicom
C. Lin
New H3C Technologies
L. Gong
China Mobile
S. Zadok
Broadcom
M.Wu
CentecNetworks
X. Wang
Ruijie Networks Co., Ltd.
January 10, 2024

Encoding Network Slice Identification for SRv6
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Abstract

This document describes a method to encode network slicing identifier within SRv6 domain.

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1. Introduction

SRv6 Network Programming [RFC8986] enables the creation of overlays with underlay optimization to be deployed in an SR domain [RFC8402].

As defined in [RFC8754], all inter-domain packets are encapsulated for the part of the packet journey that is within the SR domain. The outer IPv6 header [RFC8200] is originated by a node of the SR domain and is destined to a node of the SR domain.

This document describes a novel method to encode slice identifier in the outer IPv6 header of an SR domain. Unlike other proposed methods before, which will bring side effects on existed functions, by encoding network slicing identifier in the source IPv6 address of the outer header, this method avoids the drawbacks which previous proposals incur.

1.1. 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. Slice Identifier

The Slice identifier (SLID) is a network slicing identifier encoded within the IPv6 packet that allows transit routers to apply the proper forwarding treatment with associated network resources.

[I-D.ietf-teas-ietf-network-slices] defines the network resource mapped to the network slice as NRP (Network Resource Partition). A NRP may be associated with a unique IETF network slice or a group of slices. In this document, SLID also refers to NRP-ID, which is used to identify the network resource used in the forwarding process.

3. SLID Assignment

When an SR domain enables network slicing, the ingress PE should reserve least significant bits in a local IPv6 address for slicing use. The number of bits used to encode SLID is governed by local policy and uniform within the SR domain.

When a packet enters the SR domain from an ingress PE, the ingress PE encapsulates the packet in an outer IPv6 header and optional SRH as defined in [RFC8754]. The ingress PE MAY also classify the packet into a slice and set the slice identifier as follows:

o Write this SLID in the least significant bits of source address of the outer IPv6 header.

o Set the SLID Presence Indicator (SPI) in the outer IPv6 header.

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|Version| SPI (Option A)|           Flow Label                  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|         Payload Length        |  Next Header  |   Hop Limit   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|         SPI (Option B)        ~                               |
++-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-                               +
|                                                               |
+                         Source Address                        +
|                                                               |
+                               +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                               ~             SLID              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
+                                                               +
|                                                               |
+                      Destination Address                      +
|                                                               |
+                                                               +
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 1: Encoding of SLID and SPI

The SPI is used to inform transit routers that a SLID is encoded in the packet. There are two possible places in the outer IPv6 header that may be used to encode SPI:

o SPI Option A - Traffic Class: The SPI is encoded as a specific bit in the Traffic Class field. The choice of the SPI bit is governed by local policy and uniform within the SR domain.

```
Traffic Class
+---------------+
| .....SPI Bit. |
+---------------+
```

o SPI Option B - Source Address: The SPI is encoded as a specific prefix covering the Source Address. The assignment of the SPI prefix is governed by local policy and uniform within the SR domain. Furthermore, some bits in the SPI prefix can be masked, which provides greater flexibility for network administrators to plan IPv6 addresses.

```
Source Address
+------------+---------+---------+------+
| SPI Prefix | Node ID | Padding | SLID |
+------------+---------+---------+------+
```

4. Per-Slice Forwarding

Any router within the SR domain that forwards a packet with SPI set uses the SLID to select a slice and apply per-slice policies.

The most significant bit of SLID may be used to carry an S-flag, which is used to indicate whether the packet MUST be forwarded strictly using the network resource associated with the SLID. When the network resource associated with the SLID does not exist or is not available, if the S-flag is set to 1, the packet MUST be discarded, otherwise the packet SHOULD be forwarded using the default network resource or ignoring the SLID.

```
+------------+
|S|   SLID   |
+------------+
```

5. Example

Figure 2 shows an example of network slice packet forwarding using the proposed encoding method. Assume the SPI is encoded using option B as the SPI prefix in Source Address.

```
                       SPI prefix: AA::/64
                  +--------------+--------------+
                  |              |              |
                  v              v              v
     +---+      +---+          +---+          +---+     +---+
     |CE1|------|PE1|----------|P1 |----------|PE2|-----|CE2|
     +---+      +---+          +---+          +---+     +---+
                  ^
                  |
         IPv6 Addr: AA::1:0:0 (Lowest 32 bits reserved for SLID)


                 +------------+     +------------+
                 |    IPv6    |     |    IPv6    |
                 |SA=AA::1:0:5|     |SA=AA::1:0:5|
                 +------------+     +------------+
                 |     SRH    |     |     SRH    |
   +-------+     +------------+     +------------+     +-------+
   |Payload| --> |   Payload  | --> |   Payload  | --> |Payload|
   +-------+ PE1 +------------+ P1  +------------+ PE2 +-------+
```

Figure 2: Packet Forwarding for Network Slice

The PE and P routers are configured to use the prefix AA::/64 as SPI. The IPv6 address AA::1:0:0 is assigned to PE1 as the source address used for network slicing. And the lowest 32 bits of the address is reserved for SLID.

PE1 encapsulates the network slice packet with an outer IPv6 header along with an SRH. The Source Address in the outer header is AA::1:0:5, in which the lowest 32 bits carries the SLID 5. P1 checks the Source Address and finds it matching the SPI prefix AA::/64. So, P1 parses SLID 5 from the Source Address, and uses the network resources associated with SLID 5 to forward the packet. PE2 decapsulates the outer IPv6 header and SRH.

6. Backward Compatibility

PE routers that do not set the SPI do not enable the SLID semantic of the IPv6 source address bits. Hence, SLID-aware routers would not attempt to classify these packets into a slice.

Any router that does not process the SPI nor the SLID forwards packets as usual.

7. Acknowledgements

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8. Security Considerations

TBD

9. IANA Considerations

TBD

10. References

10.1. Normative References

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Authors' Addresses

Weiqiang Cheng
China Mobile
Beijing
China
Email: chengweiqiang@chinamobile.com

Peiyong Ma
China Telecom
Guangzhou
China
Email: mapeiy@chinatelecom.cn

Fenghua Ren
China Unicom
Beijing
China
Email: renfh3@chinaunicom.cn

Changwang Lin
New H3C Technologies
Beijing
China
Email: linchangwang.04414@h3c.com

Liyan Gong
China Mobile
Beijing
China
Email: gongliyan@chinamobile.com

Shay Zadok
Broadcom
Israel
Email: shay.zadok@broadcom.com

Mingyu Wu
CentecNetworks
Suzhou Industrial Park
China
Email: wumy@centec.com

Xuewei Wang
Ruijie Networks Co., Ltd.
Beijing
China
Email: wangxuewei1@ruijie.com.cn