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Encapsulation of End-to-End IETF Network Slice Information in IPv6
draft-li-6man-e2e-ietf-network-slicing-00

Abstract

Network slicing can be used to meet the connectivity and performance requirement of different services or customers in a shared network. An IETF network slice may span multiple network domains. In the context of 5G, the 5G end-to-end network slices consist of three major types of network segments: Radio Access Network (RAN), Transport Network (TN) and Core Network (CN).

In order to facilitate the mapping between network slices in different network segments and network domains, it is beneficial to carry the identifiers of the 5G end-to-end network slice, the multi-domain IETF network slice together with the intra-domain network slice identifier in the data packet.

This document defines the mechanism of encapsulating the end-to-end network slice related information in IPv6 data plane.

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

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1. Introduction

The definition and the characteristics of IETF are introduced in [I-D.ietf-teas-ietf-network-slice-definition], and [I-D.ietf-teas-ietf-network-slice-framework] describes a general framework of IETF network slice.

[I-D.ietf-teas-enhanced-vpn] describes the framework and the candidate component technologies for providing enhanced VPN services. VPN+ can be built from a VPN overlay and an underlying Virtual Transport Network (VTN) which has a customized network topology and a set of dedicated or shared resources in the underlay network. Enhanced VPN (VPN+) can be used for the realization of IETF network slices.

[I-D.dong-teas-enhanced-vpn-vtn-scalability] describes the scalability considerations in the control plane and data plane to enable VPN+ services, and provides several suggestions to improve the scalability of VTN. In the control plane, It proposes the approach of decoupling the topology and resource attributes of VTN, so that multiple VTNs may share the same topology and the result of topology based path computation. In the data plane, it proposes to carry a VTN-ID in the data packet to determine the set of resources reserved for the corresponding VTN.

An IETF network slice may span multiple network domains. Further in the context of 5G, there can be end-to-end network slices which consists of three major types of network segments: Radio Access Network (RAN), Transport Network (TN) and Core Network (CN). In order to facilitate the mapping between network slices in different network segments and network domains, it may be beneficial to carry the identifiers of the 5G end-to-end network slice and the multi-domain IETF network slice together with the intra-domain network slice identifier in the data packet.

[I-D.li-teas-e2e-ietf-network-slicing] describes the framework of carrying end-to-end network slice related identifiers in the data plane, each of the identifiers may span a different network scope.

With IPv6 data plane, [I-D.dong-6man-enhanced-vpn-vtn-id] specifies the extensions and mechanisms to carry the VTN-ID of a single network domain in IPv6 extension header, so as to improve the scalability of VTN [I-D.dong-teas-enhanced-vpn-vtn-scalability]. This document further specifies the extensions and mechanisms of encapsulating the identifiers of the 5G end-to-end network slice and the multi-domain IETF network slice in IPv6 data plane to support the end-to-end network slicing.

2. End-to-End Network Slice Identifiers in IPv6

This section describes the approach of encapsulating the end-to-end network slice identifiers in IPv6 data plane. Two new IPv6 options are defined for the global VTN-ID and the 5G end-to-end network slice ID (i.e. S-NSSAI) respectively. This way, the network slice identifiers with different network scopes are carried in separate IPv6 options.

The Global VTN-ID and the 5G network slice ID are optional in the data packet, depending on whether a IETF network slice spans multiple domains and whether it is used as part of the 5G end-to-end network slice.

Editor's note: Another option is to define a new network slice option to carry all the network slicing related information, each network slice related identifier can be defined as a separate TLV in the new option. Since the end-to-end network slice related identifiers are optional information, it is more practical to define them as separate options of IPv6 extension header for better incremental evolution.

2.1. IPv6 Global VTN-ID Option

The format of the Global VTN-ID option is shown as below:

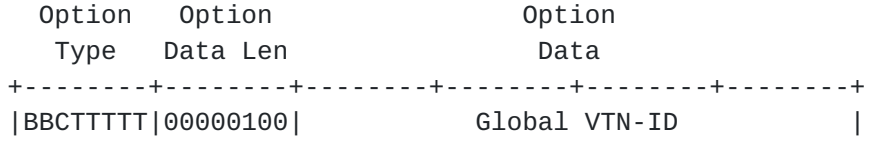

Figure 1. The format of Global VTN-ID Option

Option Type: 8-bit identifier of the type of option. The type of Global VTN-ID option is to be assigned by IANA. The highest-order bits of the type field are defined as below:

- BB 00 The highest-order 2 bits are set to 00 to indicate that a node which does not recognize this type will skip over it and continue processing the header.

- C 0 The third highest-order bit are set to 0 to indicate this option does not change en route.

Opt Data Len: 8-bit unsigned integer indicates the length of the option Data field of this option, in octets. The value of Opt Data Len of the Global VTN-ID option SHOULD be set to 4.

Option Data: 4-octet identifier which uniquely identifies a global VTN.

2.2. IPv6 5G Network Slice ID Option

The format of the 5G network slice ID option is shown as below:

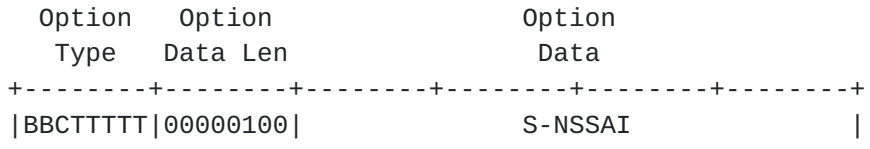

Figure 2. The format of 5G network slice ID Option

Option Type: 8-bit identifier of the type of option. The type of 5G network slice ID option is to be assigned by IANA. The highest-order bits of the type field are defined as below:

- BB 00 The highest-order 2 bits are set to 00 to indicate that a node which does not recognize this type will skip over it and continue processing the header.

- C 0 The third highest-order bit are set to 0 to indicate this option does not change en route.

Opt Data Len: 8-bit unsigned integer indicates the length of the option Data field of this option, in octets. The value of Opt Data Len of the 5G network slice ID option SHOULD be set to 4. This aligns with the length of the S-NSSAI defined in 3GPP.

Option Data: 4-octet identifier which uniquely identifies a 5G end-to-end network slice.

3. Procedures

The ingress node of a multi-domain IETF network slice SHOULD encapsulate the received packet in an outer IPv6 header, the Global VTN-ID the packet mapped to MAY be carried in the IPv6 HBH options header of the outer IPv6 header.

The edge nodes of each domain MAY parse the Global VTN-ID in the IPv6 HBH options header and maps it to a local VTN. When the mechanism as defined in [I-D.dong-6man-enhanced-vpn-vtn-id] is used in the local domain, the Local VTN-ID is obtained from the mapping relationship between the Global VTN-ID and Local VTN-ID maintained on the edge node, and the Local VTN-ID SHOULD be encapsulated in the HBH header of the outer IPv6 header. The Local VTN-ID is used to identify the local network resources reserved for the VTN in the local domain. The local VTN-ID in the packet MAY be updated on the edge nodes of each domain.

When the multi-domain IETF network slice is part of a 5G end-to-end network slice, the 5G Network Slice ID option MAY be carried in the IPv6 HBH options header of the outer IPv6 header. The S-NSSAI MAY be used for the collection and report of the performance information of the 5G end-to-end network slice based on the mechanism defined in [I-D.ietf-6man-ipv6-alt-mark].

4. IANA Considerations

IANA is requested to allocate two new option types from "Destination Options and Hop-by-Hop Options" registry.

Value	Description	Reference
TBD1	Global VTN-ID Option	this document
TBD2	5G Network Slice ID Option	this document

5. Security Considerations

TBD

6. Acknowledgements

TBD

7. References

7.1. Normative References

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Gray, E. and J. Drake, "Framework for IETF Network Slices", March 2021, <https://tools.ietf.org/html/draft-ietf-teas-ietf-network-slice-framework>.

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7.2. Informative References

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