Workgroup: Network Working Group
Internet-Draft:
draft-dong-6man-enhanced-vpn-vtn-id-05
Published: 9 September 2021
Intended Status: Standards Track
Expires: 13 March 2022
Authors: J. Dong
Huawei Technologies
Z. Li
Huawei Technologies
C. Xie
China Telecom
C. Ma
China Telecom
G. Mishra
Verizon Inc.

Carrying Virtual Transport Network Identifier in IPv6 Extension Header

Abstract

A Virtual Transport Network (VTN) is a virtual network which has a customized network topology and a set of dedicated or shared network resources allocated from the physical network. A VTN can be used as the underlay for one or a group of overlay VPNs to provide enhanced VPN (VPN+) services. In packet forwarding, some fields in the data packet needs to be used to identify the VTN the packet belongs to, so that the VTN-specific processing can be performed on each node the packet traverses.

This document proposes a new Hop-by-Hop option of IPv6 extension header to carry the VTN Resource ID, which is used to identify the set of network resources allocated to a VTN for packet processing. The procedure for processing the VTN option is also specified.

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 13 March 2022.

Copyright Notice

Table of Contents

1. Introduction

Virtual Private Networks (VPNs) provide different customers with logically isolated connectivity over a common network infrastructure. With the introduction and evolvement of 5G, some existing or new services may require connectivity services with advanced characteristics comparing to traditional VPNs, such as resource isolation from other services or guaranteed performance. These services are refered to as "enhanced VPNs" (VPN+). [I-D.ietf-teas-enhanced-vpn] describes a framework and the candidate component technologies for providing VPN+ services.

The enhanced properties of VPN+ require tighter coordination and integration between the underlay and the overlay network. VPN+ service can be delivered using a Virtual Transport Network (VTN) as the underlay, which has a customized network topology and a set of dedicated or shared network resources allocated from the physical network. The overlay VPN together with the corresponding VTN in the underlay constitute the VPN+ service. In the network, traffic of different VPN+ services need to be processed separately based on the

topology and the network resources associated with the corresponding VTN.

[I-D.dong-teas-enhanced-vpn-vtn-scalability] describes the scalability considerations and the possible optimizations for providing a relatively large number of VTNs for VPN+ services, one approach to improve the data plane scalability is by introducing a dedicated VTN Resource Identifier (VTN Resource ID) in the data packet to identify the set of network resources allocated to a VTN, so that VTN-specific packet processing can be performed using that set of resources, which avoids the possible resource competition with services in other VTNs. This is called Resource Independent (RI) VTN.

This document proposes a mechanism to carry the VTN resource ID in a new Hop-by-Hop option of IPv6 extension header [RFC8200] of IPv6 packet, so that on each network node along the packet forwarding path, the VTN option in the packet is parsed, and the obtained VTN Resource ID instructs the network node to use the network resources allocated to the corresponding VTN to process and forward the packet. The procedure for processing the VTN Resource ID is also specified. This provides a scalable solution to support a relatively large number of VTNs in an IPv6 network.

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 BCP14 RFC 2119 [RFC2119] RFC 8174 [RFC8174] when, and only when, they appear in all capitals, as shown here.

2. New IPv6 Extension Header Option for VTN

A new Hop-by-Hop option type "VTN" is defined to carry the VTN related Identifier in an IPv6 packet. Its format is shown as below:

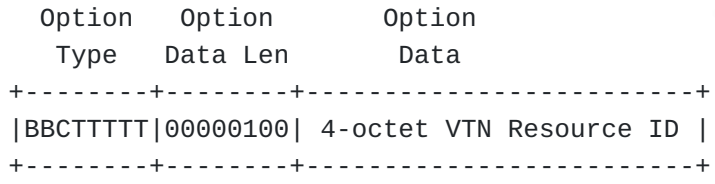

Figure 1. The format of VTN Option

Option Type: 8-bit identifier of the type of option. The type of VTN 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 VTN option SHOULD be set to 4.

VTN Resource ID: 4-octet identifier which uniquely identifies the set of network resources allocated to a VTN.

Editor's note: The length of the VTN Resource ID is defined as 4-octet in correspondence to the 4-octet Single Network Slice Selection Assistance Information (S-NSSAI) defined in 3GPP [TS23501].

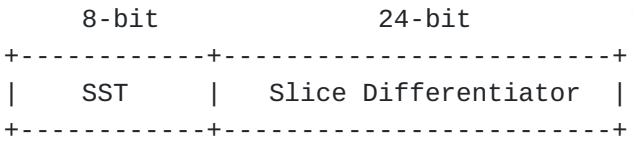

Figure 2. The format of S-NSSAI

3. Procedures

As the VTN option needs to be processed by each node along the path for VTN-specific forwarding, it SHOULD be carried in IPv6 Hop-by-Hop options header when the Hop-by-Hop options header can be either processed or ignored in forwarding plane by all the nodes along the path.

3.1. VTN Option Insertion

When an ingress node of an IPv6 domain receives a packet, according to the traffic classification or mapping policy, the packet is steered into one of the VTNs in the network, then the packet SHOULD be encapsulated in an outer IPv6 header, and the Resource ID of the VTN which the packet is mapped to SHOULD be carried in the VTN option of the Hop-by-Hop options header associated with the outer IPv6 header.

3.2. VTN based Packet Forwarding

On receipt of a packet with the VTN option, each network node which can process the VTN option in fast path SHOULD use the VTN Resource ID to determine the set of local network resources allocated to the VTN for packet processing. The packet forwarding behavior is based on both the destination IP address and the VTN Resource ID. More specifically, the destination IP address is used to determine the next-hop and the outgoing interface, and VTN Resource ID is used to determine the set of network resources on the outgoing interface which are reserved to the VTN for processing and sending the packet. The Traffic Class field of the outer IPv6 header MAY be used to provide Diffserv treatment for packets which belong to the same VTN. The egress node of the IPv6 domain SHOULD decapsulate the outer IPv6 header which includes the VTN option.

In the forwarding plane, there can be different approaches of partitioning the local network resources and allocating them to different VTNs. For example, on one physical interface, a subset of the forwarding plane resources (e.g. the bandwidth and the associated buffer and queuing resources) can be allocated to a particular VTN and represented as a virtual sub-interface with reserved bandwidth resource. In packet forwarding, the IPv6 destination address of the received packet is used to identify the next-hop and the outgoing layer-3 interface, and the VTN Resource ID is used to further identify the virtual sub-interface which is associated with the VTN on the outgoing interface.

Network nodes which do not support the processing of Hop-by-Hop options header SHOULD ignore the Hop-by-Hop options header and forward the packet only based on the destination IP address. Network nodes which support Hop-by-Hop Options header, but do not support the VTN option SHOULD ignore the VTN option and continue to forward the packet based on the destination IP address and MAY also based on the rest of the Hop-by-Hop Options.

4. Operational Considerations

As described in [RFC8200], network nodes may be configured to ignore the Hop-by-Hop Options header, and in some implementations a packet containing a Hop-by-Hop Options header may be dropped or assigned to a slow processing path. The proposed modification to the processing of IPv6 Hop-by-Hop options header is specified in [I-D.hinden-6man-hbh-processing]. Operator needs to make sure that all the network nodes involved in a VTN can either process Hop-by-Hop Options header in the fast path, or ignore the Hop-by-Hop Option header. In other word, packets steered into a VTN MUST NOT be dropped due to the existence of the Hop-by-Hop Options header. It is RECOMMENDED to configure all the network nodes involved in a VTN to process the

Hop-by-Hop Options header and the VTN option if there is a nob for this.

5. IANA Considerations

This document requests IANA to assign a new option type from "Destination Options and Hop-by-Hop Options" registry.

Value	Description	Reference
TBD	VTN Option	this document

6. Security Considerations

The security considerations with IPv6 Hop-by-Hop options header are described in [RFC8200], [RFC7045] and [I-D.hinden-6man-hbh-processing]. This document introduces a new IPv6 Hop-by-Hop option which is either processed in the fast path or ignored by network nodes, thus it does not introduce additional security issues.

7. Contributors

Zhibo Hu
Email: huzhibo@huawei.com

Lei Bao
Email: baolei7@huawei.com

8. Acknowledgements

The authors would like to thank Juhua Xu, James Guichard and Joel Halpern for their review and valuable comments.

9. References

9.1. Normative References

[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>.

[RFC8200] Deering, S. and R. Hinden, "Internet Protocol, Version 6 (IPv6) Specification", STD 86, RFC 8200, DOI 10.17487/RFC8200, July 2017, <https://www.rfc-editor.org/info/rfc8200>.

9.2. Informative References

[I-D.dong-teas-enhanced-vpn-vtn-scalability]
Dong, J., Li, Z., Gong, L., Yang, G., Guichard, J. N., Mishra, G., and F. Qin, "Scalability Considerations for Enhanced VPN (VPN+)", Work in Progress, Internet-Draft, draft-dong-teas-enhanced-vpn-vtn-scalability-03, 11 July 2021, <https://www.ietf.org/archive/id/draft-dong-teas-enhanced-vpn-vtn-scalability-03.txt>.

[I-D.hinden-6man-hbh-processing] Hinden, R. M. and G. Fairhurst, "IPv6 Hop-by-Hop Options Processing Procedures", Work in Progress, Internet-Draft, draft-hinden-6man-hbh-processing-01, 2 June 2021, <https://www.ietf.org/archive/id/draft-hinden-6man-hbh-processing-01.txt>.

[I-D.ietf-teas-enhanced-vpn] Dong, J., Bryant, S., Li, Z., Miyasaka, T., and Y. Lee, "A Framework for Enhanced Virtual Private Network (VPN+) Services", Work in Progress, Internet-Draft, draft-ietf-teas-enhanced-vpn-08, 12 July 2021, <https://www.ietf.org/archive/id/draft-ietf-teas-enhanced-vpn-08.txt>.

[RFC7045] Carpenter, B. and S. Jiang, "Transmission and Processing of IPv6 Extension Headers", RFC 7045, DOI 10.17487/RFC7045, December 2013, <https://www.rfc-editor.org/info/rfc7045>.

[TS23501] "3GPP TS23.501", 2016, <https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=3144>.

Authors' Addresses

Jie Dong
Huawei Technologies
Huawei Campus, No. 156 Beiqing Road
Beijing
100095
China

Email: jie.dong@huawei.com

Zhenbin Li
Huawei Technologies
Huawei Campus, No. 156 Beiqing Road
Beijing
100095
China

Email: lizhenbin@huawei.com

Chongfeng Xie
China Telecom
China Telecom Beijing Information Science & Technology, Beiqijia
Beijing
102209
China

Email: xiechf@chinatelecom.cn

Chenhao Ma
China Telecom
China Telecom Beijing Information Science & Technology, Beiqijia
Beijing
102209
China

Email: machh@chinatelecom.cn

Gyan Mishra
Verizon Inc.

Email: gyan.s.mishra@verizon.com