ICS 33.040.40
CCS L 78

NATIONAL STANDARD OF THE PEOPLE'S REPUBLIC OF CHINA

GB/T 44887.5-2024

IPv6 evolution technical requirements-Part 5: SRv6-based VPN

IPv6演进技术要求 第5部分：基于IPv6段路由（SRv6）的虚拟专用网（VPN）

Issued on: November 28, 2024 **Implemented on: March 1, 2025**

Issued by: State Administration for Market Regulation;
Standardization Administration of the PRC

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1 Scope

This document specifies the technical requirements for the architecture of the SRv6-based VPN network, for the SRv6 service TLV, for the layer 3 services over the SRv6 VPN network

and for the layer 2 services over the SRv6 VPN network.

This document applies to the development, testing and application of SRv6 VPN technology in network devices.

2 Normative references

The contents of the following documents constitute indispensable provisions of this document through normative reference in the text. For dated references, only the version corresponding to that date applies; for undated references, the latest version, including all amendments, applies.

IETF RFC 2545 Use of BGP-4 multiprotocol extensions for IPv6 inter-domain routing; IETF RFC 4659 BGP-MPLS IP virtual private network (VPN) extension for IPv6 VPN; IETF RFC 7432 BGP MPLS-based Ethernet VPN; IETF RFC 8950 Advertising IPv4 network layer reachability information (NLRI) with an IPv6 next hop; IETF RFC 8986 SRv6 network programming; IETF RFC 9136 IP prefix advertisement in EVPN; IETF RFC 9251 Internet group management protocol (IGMP) and multicast listener discovery (MLD) proxies for Ethernet VPN (EVPN); IETF RFC 9256 Segment routing policy architecture.

3 Terms and definitions

The following terms and definitions apply to this document.

3.1 segment routing: a source routing technique applied to MPLS networks or to IPv6 networks that customizes the service path. Note: in an MPLS network the segment is encoded as an MPLS label; in an IPv6 network the segment takes the form of an IPv6 address and the forwarding path is indicated by the segment routing header.

4 Abbreviations

The following abbreviations apply to this document. AFI: address family identifier. BGP: border gateway protocol. CE: customer edge. ES: Ethernet segment. ESI: Ethernet segment identifier. EVPN: Ethernet virtual private network. IANA: Internet Assigned Numbers Authority. IGMP: Internet group management protocol. IPv4: Internet protocol version 4. IPv6: Internet protocol version 6. L3VPN: layer 3 virtual private network. MAC: media access control. MPLS: multi-protocol label switching. NLRI: network layer reachability information. PE: provider edge. SAFI: subsequent address family identifier. SID: segment identifier. SLA: service-level agreement. SR: segment routing. SRH: segment routing header. SRv6: segment routing over IPv6. TLV: type, length and value. VLAN: virtual local area network. VPN: virtual private network. VPWS: virtual private wire service. VRF: virtual routing and forwarding.

5 Architecture of the SRv6-based VPN network

An SRv6-based VPN network is a layer 2 or layer 3 overlay network that uses BGP as the control plane and SRv6 as the data plane. An SRv6 service SID is an SRv6 segment identifier associated with a specific service behaviour, including but not limited to the End.DT behaviour (decapsulate and look up the VRF table) or the End.DX behaviour (decapsulate and cross-connect to the next hop) in an L3VPN service. The SRv6-based VPN network uses BGP to advertise the reachability of a specific service prefix from the egress device to the ingress device, uses the existing BGP messages to carry the information of the SRv6 service SID between edge devices, and takes this as a way of interconnecting edge devices and building the VPN. The architecture of the SRv6-based VPN network is shown in Figure 1.

When an SRv6 service with best-effort connectivity is provided, the egress edge device shall use the BGP overlay service route message to advertise an SRv6 service SID, and the ingress edge device shall encapsulate the data payload inside an outer IPv6 header and set the outer destination address to that service SID. The underlay network between the edge devices only needs to support ordinary IPv6 forwarding.

When an SRv6 service that meets an SLA from network ingress to network egress is provided, the egress edge device shall add the BGP Color extended community attribute to the overlay service route, and the ingress edge device shall encapsulate the payload packet in an outer IPv6 header carrying an SRH extension header; that SRH contains the SID list of the SR policy associated with the corresponding SLA, and the last hop of that list shall be the SRv6 service SID associated with the route. For an underlay network node, if its SRv6 SID is part of the SID list, that node shall support the SRv6 data plane.

The SRv6 SIDs of the layer 2 and layer 3 services of the SRv6-based VPN network shall be encapsulated in the SRv6 service TLV of the BGP Prefix-SID attribute.

6.1 SRv6 service TLV

The SRv6 service TLVs are defined as two new TLVs of the BGP Prefix-SID attribute, in order to advertise the SRv6 SIDs of layer 2 and layer 3 services. The content of the TLVs shall meet the following requirements.

The SRv6 layer 3 service TLV encodes the service SID information of the SRv6-based layer 3 services, corresponding to the MPLS label that provides the same function in layer 3 service routes. Some of the behaviours that can be encoded in this TLV include but are not limited to End.DX4, End.DT4, End.DX6, End.DT6 and End.DT46.

The SRv6 layer 2 service TLV encodes the service SID information of the SRv6-based layer 2 services, corresponding to the MPLS label that provides the same function for the various EVPN route messages. Some of the behaviours that can be encoded in this TLV include but

are not limited to End.DX2, End.DX2V, End.DT2U and End.DT2M.

The encoding format of the SRv6 service TLV in the BGP Prefix-SID attribute is shown in Figure 2. TLV type (1 byte): this field is a value allocated from the IANA registry BGP Prefix-SID TLV Types; the value corresponding to the SRv6 layer 3 service TLV is 5 and the value corresponding to the SRv6 layer 2 service TLV is 6. TLV length (2 bytes): it identifies the length of the data part of the TLV, in octets. Reserved (1 byte): this field is reserved; the sender shall set it to zero and the receiver ignores it. SRv6 service sub-TLVs (variable length): this field contains the information relevant to the SRv6 service, encoded as an unordered list of sub-TLVs.

When a BGP speaker receives a route carrying a BGP Prefix-SID attribute in which one or more SRv6 service TLVs are contained, and advertises that route to other peers, the following rules shall be complied with. If the next hop field is not changed when the route is advertised, the SRv6 service TLV continues to be propagated even if it contains unknown sub-TLVs and sub-sub-TLVs, and the reserved fields in the SRv6 service TLV, sub-TLVs and sub-sub-TLVs are propagated unaltered. If the next hop field is changed when the route is advertised, the SRv6 service TLV, sub-TLVs and sub-sub-TLVs shall be updated with the locally allocated SRv6 SID information, and any unknown sub-TLV or sub-sub-TLV shall be deleted.

6.2 SRv6 service sub-TLV

The encoding format of a single SRv6 service sub-TLV is shown in Figure 3, with the following format requirements.

SRv6 service sub-TLV type (1 byte): it identifies the type of SRv6 service information and is a value allocated from the IANA registry SRv6 Service Sub-TLV Types.

SRv6 service sub-TLV length (2 bytes): it identifies the length of the data part of the sub-TLV, in octets.

SRv6 service sub-TLV data part (variable length): it contains the data of the specific sub-TLV type. Besides the fixed-length data, this part also contains other SRv6 service attributes, encoded as a series of SRv6 service data sub-sub-TLVs.

6.3 SRv6 SID information sub-TLV

Type 1 of the SRv6 service sub-TLV is allocated to the SRv6 SID information sub-TLV, which contains an SRv6 SID and other attributes. The encoding format of the SRv6 SID information sub-TLV is shown in Figure 4, with the following format requirements.

SRv6 service sub-TLV type (1 byte): this field is set to 1, indicating the SRv6 SID information sub-TLV. SRv6 service sub-TLV length (2 bytes): this field identifies the total length of the data part, in octets. Reserved 1 (1 byte): the sender sets it to zero and the