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Using Flex-Algo for Segment Routing based VTN
draft-zhu-lsr-isis-sr-vtn-flexalgo-01

Abstract

As defined in I-D.ietf-teas-enhanced-vpn, enhanced VPN (VPN+) aims to provide enhanced VPN service to support the needs of enhanced isolation and stringent performance requirements. VPN+ requires integration between the overlay VPN and the underlay network. A Virtual Transport Network (VTN) is a virtual network which consists of a subset of network topology and network resources allocated from the underlay network. A VTN could be used as the underlay for one or a group of VPN+ services.

I-D.dong-lsr-sr-enhanced-vpn defines the IGP mechanisms with necessary extensions to build a set of Segment Routing (SR) based VTNs. This document describes a simplified mechanism to build the SR based VTNs using SR Flex-Algo together with minor extensions to IGP L2 bundle.

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 will expire on March 15, 2021.

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Table of Contents

1. Introduction 2
2. Advertisement of SR VTN Topology Attribute 3
3. Advertisement of SR VTN Resource Attribute 4
4. Forwarding Plane Operations 5
5. Scalability Considerations 5
6. Security Considerations 6
7. IANA Considerations 6
8. Acknowledgments 6
9. References 6
   9.1. Normative References 6
   9.2. Informative References 7
Authors' Addresses 8

1. Introduction

Enhanced VPN (VPN+) is an enhancement to VPN services to support the needs of new applications, particularly including the applications that are associated with 5G services. These applications require enhanced isolation and have more stringent performance requirements than that can be provided with traditional overlay VPNs. Thus these properties require integration between the underlay and the overlay networks. [I-D.ietf-teas-enhanced-vpn] specifies the framework of enhanced VPN and describes the candidate component technologies in different network planes and layers. An enhanced VPN may be used for

5G transport network slicing, and will also be of use in other generic scenarios.

To meet the requirement of enhanced VPN services, a number of virtual transport networks (VTN) can be created, each with a subset of the

underlay network topology and a set of network resources allocated from the underlay network to meet the requirement of a specific VPN+ service or a group of VPN+ services. Another possible approach is to create a set of point-to-point paths, each with a set of network resource reserved along the path, such paths are called Virtual Transport Paths (VTPs). Although using a set of dedicated VTPs can provide similar characteristics as VTN, it has some scalability issues due to the per-path state in the network.

[I-D.ietf-spring-resource-aware-segments] introduces resource awareness to Segment Routing (SR) [RFC8402]. As described in [I-D.dong-spring-sr-for-enhanced-vpn], the resource-aware SIDs can be used to build virtual transport networks (VTNs) with the required network topology and network resource attributes to support enhanced VPN services. With segment routing based data plane, Segment Identifiers (SIDs) can be used to represent both the topology and the set of network resources allocated by network nodes to a virtual network. The SIDs of each VTN and the associated topology and resource attributes need to be distributed using control plane.

[I-D.dong-lsr-sr-enhanced-vpn] defines the IGP mechanisms with necessary extensions to build a set of Segment Routing (SR) based VTNs. The VTNs could be used as the underlay of the enhanced VPN service. The mechanism described in [I-D.dong-lsr-sr-enhanced-vpn] allows flexible combination of the topology and resource attribute to build customized VTNs. In some network scenarios, it is assumed that each VTN can have an independent topology and a set of dedicated network resources, and the number of the VTNs required is limited. This document describes a simplified mechanism to build the SR based VTNs in those scenarios.

2. Advertisement of SR VTN Topology Attribute

[I-D.ietf-lsr-flex-algo] specifies the mechanism to provide distributed constraint-path computation, and the usage of SR-MPLS prefix-SIDs and SRv6 locators for steering traffic along the

constrained paths.

The Flex-Algo definition consists of the topological constraints for path computation. According to the network nodes' participation of a Flex-Algo, and the rules of including or excluding Admin Groups (i.e. colors) and Shared Risk Link Groups (SRLGs), thus the topology attribute of a VTN can be described using the associated Flex-Algo. And when each VTN has an independent set of network topology constraints, the Flex-Algo identifier could be reused as the identifier of the VTN in control plane.

With the mechanisms defined in[RFC8667] [I-D.ietf-lsr-flex-algo], SR-MPLS prefix-SID advertisement can be associated with a specific topology and a specific algorithm, which can be a Flex-Algo. This allows the nodes to use the prefix-SIDs to steer traffic along distributed computed constraint paths according to the identified Flex-Algo in the associated topology.

[I-D.ietf-lsr-isis-srv6-extensions] specifies the IS-IS extensions to support SRv6 data plane, in which the SRv6 locators advertisement can be associated with a specific topology and a specific algorithm, which can be a Flex-Algo. This allows the nodes to used the SRv6 locators to steer traffic along distributed computed constraint paths according to the identified Flex-Algo in the associated topology. In addition, topology/algorithm specific SRv6 End SIDs and End.X SIDs can be used to enforce traffic over the Loop-Free Alternatives (LFA) computed backup paths.

3. Advertisement of SR VTN Resource Attribute

Each VTN may have customized network resource attributes. In order to perform constraint based path computation for each VTN on network controller and the ingress nodes, the resource attribute of each VTN also needs to be advertised.

[RFC8668] was defined to advertise the link attributes of the Layer 2 bundle member links. In this section, it is extended to advertise the network resource attributes associated with different VTNs on a Layer 3 link.

The Layer 3 link may or may not be a Layer 2 link bundle, as long as it has the capability of allocating different subsets of link resources to different VTNs it participates in. A subset of the link resource can be considered as a virtual Layer 2 member link (or sub-interface) of the Layer 3 link. If the Layer 3 interface is a Layer 2 link bundle, it is possible that the subset of link resource allocated to a specific VTN is provided by one of the physical Layer 2 member links.

A new flag "V" (Virtual) is defined in the flag field of the Parent L3 Neighbor Descriptor in the L2 Bundle Member Attributes TLV (25).

```
 0 1 2 3 4 5 6 7
+-+-+-+-+-+-+-+-+
|P|V|           |
+-+-+-+-+-+-+-+-+
```

V flag: When the V flag is set, it indicates the advertised member links under the Parent L3 link are virtual Layer 2 member links.

When the V flag is clear, it indicates the member links are physical member links.

For each virtual or physical member link, the TE attributes defined in [RFC5305] such as the Maximum Link Bandwidth and Admin Groups SHOULD be advertised using the mechanism as defined in [RFC8668]. The Adj-SIDs or SRv6 End.X SIDs associated with each of the virtual or physical member links of an L2 bundle SHOULD also be advertised.

In order to correlate the virtual or physical member links with the corresponding VTNs, each member link SHOULD be assigned with a dedicated Admin Group or Extended Admin Group, which is included in the definition of the Flex-Algo of the corresponding VTN. Note that in this case the Admin Group or Extended Admin Group of the Layer 3 link SHOULD be set to the union of all the Admin Groups or Extended Admin Groups of its virtual or physical member links. This is to ensure that the Layer 3 link is always included in the Flex-Algo specific constraint path computation of the VTNs it participates in.

4. Forwarding Plane Operations

For SR-MPLS data plane, a prefix SID is associated with the paths

calculated using the corresponding Flex-Algo of a VTN. An outgoing Layer 3 interface is determined for each path. In addition, the prefix-SID also steers the traffic to use the virtual or physical member link which is associated with the VTN on the outgoing Layer 3 interface for packet forwarding. The Adj-SIDs associated with the virtual or physical member links of a VTN MAY be used with the prefix-SIDs of the same VTN together to build SR-MPLS paths with the topological and resource constraints of the VTN.

For SRv6 data plane, an SRv6 Locator is a prefix which is associated with the paths calculated using the corresponding Flex-Algo of a VTN. An outgoing Layer 3 interface is determined for each path. In addition, the SRv6 Locator prefix also steers the traffic to use the virtual or physical member link which is associated with the VTN on the outgoing Layer 3 interface for packet forwarding. The End.X SIDs associated with the virtual or physical member links of a VTN MAY be used with the SRv6 Locator prefix of the same VTN together to build SRv6 paths with the topological and resource constraints of the VTN.

5. Scalability Considerations

The mechanism described in this document requires that each VTN associated with an independent Flex-Algo, so that the VTNs can be identified using the corresponding Flex-Algo ID. While this brings the benefits of simplicity, it also has some limitations. For example, it means that even if multiple VTNs share the same topology

constraints, they would still need to be identified using different Flex-Algos in the control plane. This means independent path computation would be executed for each VTN. The number of VTNs supported in a network may be dependent on the number of Flex-Algos supported, which is related to the control plane computation overhead.

Another aspect which may impact the number of VTNs supported with this mechanism is that at most 128 Flex-Algos can be used in a network.

6. Security Considerations

This document introduces no additional security vulnerabilities to IS-IS.

The mechanism proposed in this document is subject to the same vulnerabilities as any other protocol that relies on IGPs.

7. IANA Considerations

This document does not request any IANA actions.

8. Acknowledgments

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