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BGP-LS with Flex-Algo for Segment Routing based Virtual Transport
Networks
draft-zhu-idr-bgpls-sr-vtn-flexalgo-01

Abstract

Enhanced VPN (VPN+) aims to provide enhanced VPN service to support some application's needs of enhanced isolation and stringent performance requirements. VPN+ requires integration between the overlay VPN and a particular set of resources in the underlay network. A Virtual Transport Network (VTN) is a virtual underlay network which has a customized network topology and a set of network resources allocated from the physical network. A VTN could be used to support one or a group of VPN+ services.

When Segment Routing is used as the data plane to provide VTNs, each VTN can be allocated with a group of SIDs to identify the topology and resource attributes of network segments in the VTN. The association between the network topology, the network resource attributes and the SR SIDs may need to be distributed to a centralized network controller. For network scenarios where each VTN can be identified by a unique Flex-Algo ID, this document describes a mechanism to distribute the information of SR based VTNs using BGP-LS with Flex-Algo.

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[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 overlay VPN and the underlay 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 can be used for 5G network slicing, and will also be of use in other generic scenarios.

To meet the requirement of enhanced VPN services, a number of virtual underlay networks need to be created, each with a subset of the underlay network topology and a set of network resources allocated to meet the requirement of a specific VPN+ service or a group of VPN+ services. Such a virtual underlay network is called Virtual Transport Network (VTN) in [[I-D.ietf-teas-enhanced-vpn](#)].

[[I-D.ietf-spring-resource-aware-segments](#)] introduces resource-awareness to Segment Routing (SR) [[RFC8402](#)] by associating existing type of SIDs with network resource attributes (e.g. bandwidth, processing or storage resources). These resource-aware SIDs retain their original functionality, with the additional semantics of identifying the set of network resources available for the packet processing action. [[I-D.ietf-spring-sr-for-enhanced-vpn](#)] describes the use of resource-aware segments to build SR based VTNs. To allow the network controller and network nodes to perform VTN-specific explicit path computation and/or shortest path computation, the group of resource-aware SIDs allocated by network nodes to each VTN and the associated topology and resource attributes need to be distributed in the control plane. When a centralized network controller is used for VTN-specific path computation, especially when a VTN spans multiple IGP areas or multiple Autonomous Systems (ASes), BGP-LS [[I-D.ietf-idr-rfc7752bis](#)] is needed to advertise the VTN information in each IGP area or AS to the network controller, so that the controller could use the collected information to build the view of inter-area or inter-AS SR VTNs.

In some network scenarios, each VTN can be identified by a unique Flex-Algo ID [[I-D.ietf-lsr-flex-algo](#)].

[[I-D.zhu-lsr-isis-sr-vtn-flexalgo](#)] describes an IGP mechanism to advertise the association between the Flex-Algo and the resource attributes and the SR SIDs associated with each VTN. This document describes a mechanism to distribute the information of SR based VTNs to the network controller using BGP-LS with Flex-Algo.

[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](#)] [[RFC8174](#)] when, and only when, they appear in all capitals, as shown here.

2. Advertisement of VTN Topology Attribute

[I-D.zhu-lsr-isis-sr-vtn-flexalgo] describes the mechanism of using ISIS Flex-Algo to distribute the topological constraints of SR based VTNs. This section describes the corresponding BGP-LS mechanism to

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distribute both the intra-domain and inter-domain topology attributes of SR based VTNs.

2.1. Intra-domain Topology Advertisement

[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 is the combination of calculation-type, metric-type and the topological constraints used for path computation. As specified in [[I-D.zhu-lsr-isis-sr-vtn-flexalgo](#)], the topology attribute of a VTN can be described by applying Flex-Algo constraints on a particular topology. If each VTN is associated with a unique Flex-Algo, the Flex-Algo ID could be reused as the identifier of the VTN in the control plane.

BGP-LS extensions for Flex-Algo [[I-D.ietf-idr-bgp-ls-flex-algo](#)] provide the mechanisms to advertise the Flex-Algo definition information. BGP-LS extensions for SR-MPLS [[I-D.ietf-idr-bgp-ls-segment-routing-ext](#)] and SRv6 [[I-D.ietf-idr-bgpls-srv6-ext](#)] provide the mechanism to advertise the algorithm-specific segment routing information.

In [[I-D.ietf-idr-bgp-ls-segment-routing-ext](#)], algorithm-specific prefix-SIDs can be advertised in BGP-LS attribute associated with Prefix NLRI.

In [[I-D.ietf-idr-bgpls-srv6-ext](#)], algorithm-specific SRv6 Locators

can be advertised in the Prefix NLRI with the SRv6 Locator TLV carried in the associated BGP-LS Attribute, and algorithm-specific End.X SID can be advertised in BGP-LS Attribute associated with the corresponding Link NLRI. Other types of SRv6 SIDs can also be algorithm-specific and are advertised using the SRv6 SID NLRI .

[2.2.](#) Inter-Domain Topology Advertisement

In some network scenarios, a VTNs which span multiple areas or ASes needs to be created. The multi-domain VTN could have different inter-domain connectivity, and may be associated with different set of network resources in each domain and also on the inter-domain links. In order to build the multi-domain VTNs using segment routing, it is necessary to advertise the topology and resource attribute of VTN on the inter-domain links and the associated BGP Peering SIDs.

[[I-D.ietf-idr-bgpls-segment-routing-epe](#)] and [[I-D.ietf-idr-bgpls-srv6-ext](#)] defines the BGP-LS extensions for

advertisement of BGP topology information between ASes and the BGP Peering Segment Identifiers. Such information could be used by a network controller for the computation and instantiation of inter-AS traffic engineering SR paths.

Depending on the network scenarios and the requirement of inter-domain VTNs, different mechanisms can be used to specify the inter-domain connections of VTNs.

- o One EBGP session between two ASes can be established over multiple underlying links. In this case, different underlying links can be used for different inter-domain VTNs which requires link isolation between each other. In another similar case, the EBGP session is established over a single link, while the network resource (e.g. bandwidth) on this link can be partitioned into several pieces, each of which can be considered as a virtual member link. In both cases, different BGP Peer-Adj-SIDs SHOULD be allocated to each underlying physical or virtual member link, and ASBRs SHOULD advertise the VTN identifier associated with each BGP Peer-Adj-SID.
- o For inter-domain connection between two ASes, multiple EBGP

sessions can be established between different set of peering ASBRs. It is possible that some of these BGP sessions are used for one multi-domain VTN, while some other BGP sessions are used for another multi-domain VTN. In this case, different BGP peer-node-SIDs are allocated to each BGP session, and ASBRs SHOULD advertise the VTN identifier associated with each BGP Peer-node-SIDs.

- o At the AS-level topology, different multi-domain VTNs may have different inter-domain connectivity. Different BGP Peer-Set-SIDs can be allocated to represent the groups of BGP peers which can be used for load-balancing in each multi-domain VTN.

When Flex-Algo is used consistently in multiple ASes covered by a VTN, the topology-specific BGP peering SIDs can be advertised together with the admin-group (color) of the corresponding Flex-Algo in the BGP-LS attribute.

In network scenarios where consistent usage of Flex-Algo among multiple ASes can not be expected, a global-significant VTN-ID can be used to define the AS level VTN topologies. Within each domain, the Flex-Algo based mechanism could be used for intra-domain topology advertisement. The detailed mechanism is specified in [\[I-D.dong-idr-bgpls-sr-enhanced-vpn\]](#).

[3.](#) Advertisement of VTN Resource Attribute

[I-D.zhu-lsr-isis-sr-vtn-flexalgo] specifies the mechanism to advertise the resource information associated with each VTN. It is based on the extensions to the advertisement of L2 bundle member links information[RFC8668]. This section defines the corresponding BGP-LS extensions.

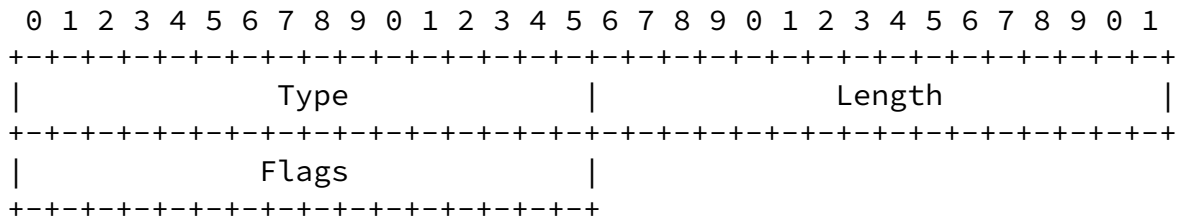
A new TLVs is defined to specify the attribute flags of either a Layer-3 link or a L2 bundle member link. It can be carried in BGP-LS attribute which is associated with a Link NLRI, or it could be carried as a sub-TLV in the L2 Bundle Member Attribute TLV. The format of the sub-TLV is as below:

0

1

2

3



Where:

Type: TBD

Length: 4 octets.

Flags: 16-bit flags. This field is consistent with the Flag field in IS-IS Link Attribute sub-TLV in [RFC5029]. In addition to the flags defined in [RFC5029], A new Flag V is defined in this document. When the V flag is set, it indicates this link is a virtual link.

In order to correlate the virtual or physical member links with the Flex-Algo used to identify the VTN, each VTN SHOULD be assigned with a unique Admin Group (AG) or Extended Admin Group (EAG), and the virtual or physical member link associated with this VTN SHOULD be configured with the AG or EAG assigned to the VTN. The AG or EAG of the Layer-3 link SHOULD be set to the union of all the AGs or EAGs of its virtual or physical member links. In the definition of the Flex-Algo corresponding to the VTN, It MUST use the Include-Any Admin Group rule with only the AG or EAG assigned to the VTN as the link constraints, the Include-All Admin Group rule or the Exclude Admin Group rule MUST NOT be used. This ensures that the Layer-3 link is included in the Flex-Algo specific constraint path computation for each VTN it participates in.

The TE attributes of each Layer-3 link or Layer 2 bundle member link, such as the bandwidth, the Adj-SIDs or the SRv6 End.X SIDs, can be advertised using the mechanism as defined in [I-D.ietf-idr-bgp-ls-segment-routing-ext] [I-D.ietf-idr-bgpls-segment-routing-epe] and [I-D.ietf-idr-bgpls-srv6-ext].

4. Scalability Considerations

The mechanism described in this document assumes that each VTN is associated with a unique Flex-Algorithm, so that the Flex-Algorithm IDs can be reused to identify the VTNs in the control plane. While this brings the benefit of simplicity, it also has some limitations. For example, it means that even if multiple VTNs share the same topological constraints, they would still need to be identified using different Flex-Algorithm IDs in the control plane, then independent path computation needs to be executed for each VTN. The number of VTNs supported in a network may be dependent on the number of Flex-Algorithms 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-Algorithms can be used in a network.

Based on the above considerations, this mechanism is suitable for networks where a relatively small number of VTNs are needed.

[5. Security Considerations](#)

This document introduces no additional security vulnerabilities to BGP-LS.

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

[6. IANA Considerations](#)

TBD

[7. Acknowledgments](#)

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