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BGP SPF for Network Resource Partitions

Abstract

A VTN is a virtual underlay network which has customized network topology and a set of dedicated or shared network resources. Network Resource Partition (NRP) refers to a set of network resources that are available to carry traffic and meet the SLOs and SLEs. Multiple NRPs can be created in a network to provide different Virtual Transport Networks (VTN) to meet the requirements of different services or different service groups. In the context of network slicing, a VTN can be instantiated as a Network Resource Partition (NRP).

As the number of NRP increases, there can be scalability concerns about using Interial Gateway Protocols (IGP) to distribute the NRP information in the network. In networks where BGP Shortest Path First (SPF) can used as the underlay routing mechanism to distribute the link-state information among network nodes, the information of NRPs needs to be distributed along with the basic network information. This document specifies the BGP SPF mechanisms with necessary extensions to distribute the NRP information and perform NRP-specific path computation.

Status of This Memo

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1. Introduction

The concept of Virtual Transport Network (VTN) is introduced in [I-D.ietf-teas-enhanced-vpn]. A VTN is a virtual underlay network which has customized network topology and a set of dedicated or shared network resources. In a network, different VTNs may be created to meet different service requirements, and services can be mapped to the same or different VTNs.

[I-D.ietf-teas-ietf-network-slices] introduces the concept Network Resource Partition (NRP) as a set of network resources that are available to carry traffic and meet the SLOs and SLEs. In the context of network slicing, an NRP can be used to instantiate a VTN for one or a group of IETF network slice services.

[I-D.ietf-spring-sr-for-enhanced-vpn] describes the use of resource-aware segments [I-D.ietf-spring-resource-aware-segments] to build SR based NRPs. The SIDs of each NRP and the associated topology and resource attributes need to be distributed using the control plane.

[I-D.dong-lsr-sr-enhanced-vpn] specifies the IGP mechanism and extensions to build a relatively large number of SR based NRPs. [I-D.dong-idr-bgpls-sr-enhanced-vpn] further specifies the BGP-LS mechanisms and extensions to advertise the NRP information within each domain and the NRP information on the inter-domain links to the network controller, so that the controller could use the collected information to obtain the view of the inter-domain SR NRPs .

As the number of NRP increases, there can be scalability concerns about using IGP to distribute the NRP information in the network. In networks where BGP SPF is used to distribute the link-state information among network nodes, the NRP information needs to be distributed along with the basic network link state and TE information. Comparing with the Internal Gateway Protocols (IGPs), BGP SPF may have some advantage in supporting a relatively large number of NRPs. This document specifies the BGP SPF mechanisms with necessary extensions to advertise the information of NRPs. The proposed mechanism is applicable to segment routing with MPLS data plane (SR-MPLS), segment routing with IPv6 data plane (SRv6), and native IPv6 data plane.

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

2. Applicability of NRP related BGP-LS Extensions to BGP SPF

2.1. Reuse of BGP-LS TLVs for BGP SPF VTN

As described in [I-D.ietf-lsvr-bgp-spf], the NLRI and TLVs of BGP-LS can be reused by BGP SPF, this section describes the TLVs which are defined in BGP-LS and can be reused in BGP SPF for the distribution of NRP related information.

According to [I-D.ietf-teas-enhanced-vpn], a virtual transport network (VTN) has a customized network topology and a set of dedicated or shared network resources. Thus a VTN can be defined as the combination of a set of network attributes, including the topology attribute and the network resource attribute. As the instantiation of VTN, an NRP is associated with a Multi-Topology ID (MT-ID) and/or an Algorithm ID which are used to define the NRP topology and path computation constraints. In some cases, each NRP can be associated with a separate MT-ID or a Flex-Algo ID. When the amount of NRPs in a network is large, as described in [I-D.ietf-teas-nrp-scalability], multiple NRPs may be associated

with the same topology and/or algorithm, so that the amount of topology-specific path computation can be shared by a group of NRPs, this could help to reduce the computation overhead in the control plane.

[I-D.ietf-lsvr-bgp-spf] does not cover the usage of Multi-Topology or Flex-Algo with BGP SPF. This document proposes to use Multi-Topology [RFC4915][RFC5120] or Flex-Algo [I-D.ietf-lsr-flex-algo] with BGP SPF for topology and/or algorithm -specific link-state information distribution and path computation. For this purpose, the Multi-topology TLV as defined in [I-D.ietf-idr-rfc7752bis], the SR Algorithm TLV as defined [RFC9085], and the Flex-Algo Definition TLV as defined in [I-D.ietf-idr-bgp-ls-flex-algo] are reused for BGP SPF.

[I-D.ietf-lsvr-bgp-spf] does not explicitly describe the usage with Segment Routing data plane. To build SR based NRPs, the SR-MPLS and SRv6 TLVs as defined in [RFC9085] and [I-D.ietf-idr-bgpls-srv6-ext] are reused for BGP SPF.

The NRP extensions to BGP-LS as defined in [I-D.dong-idr-bgpls-sr-enhanced-vpn] applies to BGP SPF as well. This section lists the TLVs which are reused by BGP SPF, the detailed format of the TLVs are described in [I-D.dong-idr-bgpls-sr-enhanced-vpn].

The BGP-LS Attribute TLVs which are defined in [I-D.dong-idr-bgpls-sr-enhanced-vpn] and reused with BGP-LS-SPF SAFI are listed as below:

* NRP Definition (NRPD) TLV: This is used to advertise the association between the NRP and the topology ID and/or algorithm ID. It can be carried in BGP-LS attribute associated with a Node NLRI.

* NRP IDs TLV: This is used to describe the identifiers of one or more NRPs which are associated with a specific set of network resources. 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 or the NRP-specific TE attribute TLV.

* Link Attribute Flags TLV: This is used to specify the characteristics of a link, its functionality is similar to the IS-IS Link Attribute sub-TLV defined in [RFC5029]. 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.

*NRP-specific prefix-SID TLV: This is used to advertise the prefix-SID and its associated NRP. It can be carried in BGP-LS attribute which is associated with a Prefix NLRI.

*NRP-specific Adj-SID TLV: This is used to advertise the adj-SID and its associated NRP. It can be carried in BGP-LS attribute of the associated Link NLRI.

*NRP Locator-block sub-TLV: This is used to advertise the SRv6 locator block and its associated NRP. It can be carried in the SRv6 Locator TLV of the associated Prefix NLRI.

*NRP ID Sub-TLV. This is used to advertise the relationship between SRv6 End.X SIDs and its associated NRP.

Further BGP-LS TLVs may be defined in [I-D.dong-idr-bgpls-sr-enhanced-vpn], their usage with BGP SPF will be specified in a future version of this document.

2.2. NRP Topology and Resource Distribution

In network scenarios where each NRP is associated with a unique MT-ID, The BGP-LS mechanisms used to distribute the NRP topology and resource information to the network controller are described in [I-D.ietf-idr-bgpls-sr-vtn-mt]. Such mechanism can be reused for the distribution of NRP information with BGP SPF.

In network scenarios where each NRP is associated with a unique Flex-Algo ID, The BGP-LS mechanisms used to distribute the NRP topology and resource information to the network controller are described in [I-D.zhu-idr-bgpls-sr-vtn-flexalgo]. Such mechanism can be reused for the distribution of NRP information with BGP SPF.

In network scenarios where multiple NRPs are associated with the same <topology, algorithm> tuple, while each NRP has different resource attributes, the BGP-LS mechanisms which can be used to distribute the NRP topology and resource information to the network controller are described in [I-D.dong-idr-bgpls-sr-enhanced-vpn]. Such mechanism can be reused for the distribution of NRP information with BGP SPF.

The Sequence Number TLV as defined in [I-D.ietf-lsvr-bgp-spf] MUST be carried in the BGP-LS attribute associated with the BGP-LS-SPF NLRI. If the Sequence-Number TLV is not received then the corresponding Link NLRI is considered as malformed and MUST be handled as 'Treat-as-withdraw'. An implementation MAY log an error for further analysis.

3. SPF Calculation for NRPs

[I-D.ietf-lsvr-bgp-spf] describes the mechanisms of using the BGP-LS-SPF Node, Link, and Prefix NLRIs for shortest path computation. With the introduction of NRP, the same mechanism is used for the shortest path computation of each NRP. The path computation for a NRP is based on the topology attributes and the constraints specified with the MT-ID and/or Algorithm ID associated with the NRP. When multiple NRPs are associated with the same <topology, algorithm> tuple, the result of the shortest path computation based on that <topology, algorithm> could be shared by these NRPs.

4. Security Considerations

This document introduces no additional security vulnerabilities to BGP SPF.

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

5. IANA Considerations

This document request no IANA actions.

6. Acknowledgments

TBD

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