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Advertising Exclusive Links for Flex-Algorithm in IGP
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Abstract

This document proposes the method to advertise exclusive links for Flex-Algorithm in IGP.

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1. Introduction

Flexible Algorithm (Flex-Algorithm) allows IGP to compute constraint-based paths. [I-D.ietf-lsr-flex-algo] specifies the usage of Flex-Algorithm in Segment Routing (SR) data planes - SR MPLS and SRv6. [I-D.ietf-lsr-ip-flexalgo] extends the Flex-Algorithm for native IPv4 and IPv6 data planes.

In some scenarios, exclusive links may be deployed for Flex-Algorithm, but not for best-effort service. However, these links

cannot be pruned in normal SPF calculation, and unexpected flows may be steered into these links.

This document proposes the method to advertise exclusive links for Flex-Algorithm in IGP.

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 BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

2. Problem Statement

Flex-Algorithm allows IGP to compute the best paths along the constrained topology.

A network topology is shown in Figure 1. Node A, B, C and D have an extra link between each other. These links have EAG attribute of "red" color.

Flex-Algorithm 128 are enable on Node A, B, C and D, with metric type of IGP cost and EAG rule of including "red". The topology used by Flex-Algorithm 128 is shown in Figure 2.

Flex-Algorithm 128 are used to transmit particular flows, such as network slice. The links used by Flex-Algorithm 128 are sub-interfaces with dedicated queues for bandwidth guarantee. So it is expected that only the particular flows are transmitted on these links using Flex-Algorithm 128. However, these links are also contained in the default topology used by normal SPF calculation, and unexpected flows of best-effort service may be steered into these links. Therefore, it is a problem that exclusive links for Flex-Algorithm cannot be pruned in normal SPF calculation.

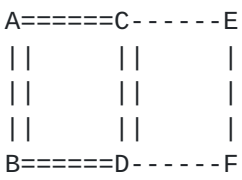


Figure 1

Figure 2

3. Solution A: Maximum Link Metric

3.1. Advertising Maximum Link Metric in IS-IS

As specified in [RFC5305], if a link is advertised with the maximum link metric (2^24 - 1), this link MUST NOT be considered during the normal SPF computation in IS-IS.

The exclusive links for Flex-Algorithm may be advertised with the maximum link metric, so that they will be the pruned in normal SPF computation.

3.2. Advertising Maximum Link Metric in OSPF

In OSPF protocol, if a link is advertised with the maximum link metric (2^16 - 1), it may be still reachable. [RFC1247] specifies that, if the cost of the link is (2^16 - 1), the link should not be used for data traffic. However, if a router performs an intra-area Dijkstra calculation as specified in [RFC1583] and higher, it do not treat links with maximum link metric as unreachable.

If an exclusive link for Flex-Algorithm is advertised with the maximum link metric, OSPF routers will prefer alternate paths in the network, rather than the path through that link. However, if there is no alternate path, the path through the exclusive link will still be used.

3.3. Considerations for Flex-Algorithm Using IGP Metric

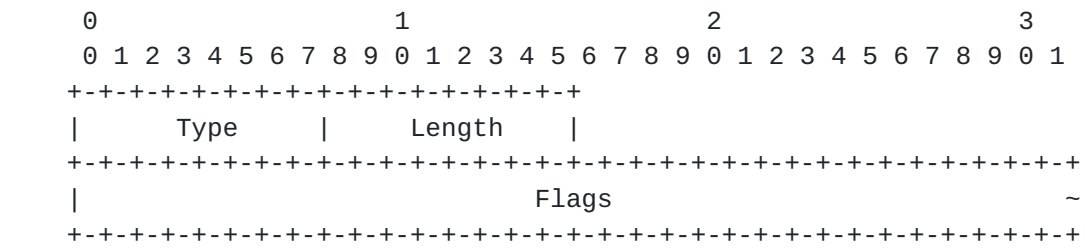
If the associated Flex-Algorithm needs to use IGP Metric in path calculation, a user defined metric type (128-255) may be assigned to substitute IGP Metric, and the Generic Metric sub-TLV may be

advertised to carry the metric value, as specified in [I-D.ietf-lsr-flex-algo-bw-con].

4. Solution B: Unreachable Link Flag

4.1. Advertising Unreachable Link Flag in IS-IS

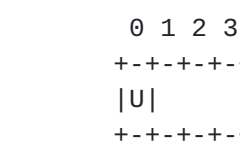
A new ISIS Link Flags sub-TLV is defined in IS-IS. The format is as the following:



o Type: TBD.

o Length: Variable, dependent on the size of the Flags field. MUST be a multiple of 4 octets.

o Flags: Following flags are currently defined.



  o U-Flag: Unreachable Link Flag. The associated link MUST be treated as unreachable during SPF calculation.

The ISIS Link Flags sub-TLV is advertised in the TLVs/sub-TLVs below:

o TLV-22 (Extended IS reachability) [RFC5305]

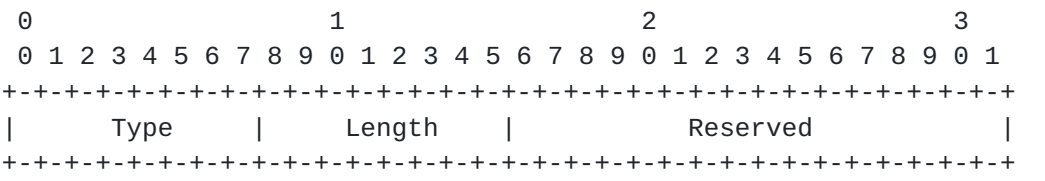
o TLV-222 (MT-ISN) [RFC5120]

o TLV-23 (IS Neighbor Attribute) [RFC5311]

o TLV-223 (MT IS Neighbor Attribute) [RFC5311]

The ISIS Link Flags sub-TLV with U-Flag can be advertised for the exclusive links used by Flex-Algorithm, so that these links will be pruned during normal SPF calculation.

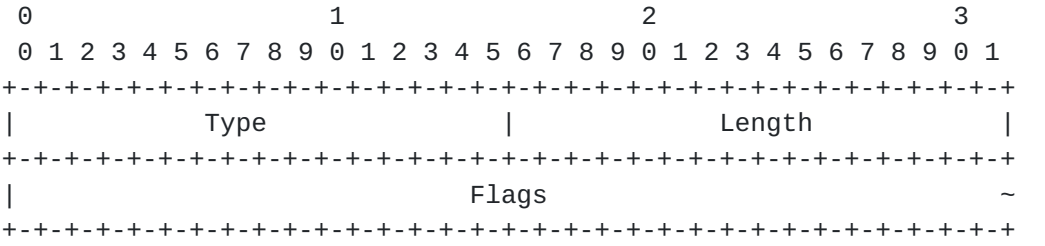
Due to the change of procedures in the SPF calculation, all routers in a level must support the changes specified in this section. To ensure that, if a level is provisioned to support Unreachable Link Flag, all routers supporting this capability must advertise an IS-IS Router Capability TLV-242 that includes the following Unreachable Link Flag Sub-TLV:



Upon detecting the presence of a reachable TLV-242 without an Unreachable Link Flag Sub-TLV, all routers MUST recalculate routes without considering any Unreachable Link Flag.

4.2. Advertising Unreachable Link Flag in OSPF

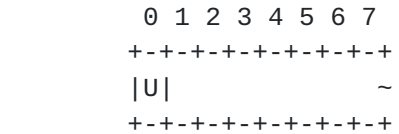
A new OSPF Link Flags sub-TLV is defined in OSPF. The format is as the following:



o Type: TBD.

o Length: Variable, dependent on the size of the Flags field. MUST be a multiple of 4 octets.

o Flags: Following flags are currently defined.



  o U-Flag: Unreachable Link Flag. The associated link MUST be treated as unreachable during SPF calculation.

The OSPF Link Flags sub-TLV is advertised in the TLVs/sub-TLVs below:

- OSPFv2 Extended Link TLV of OSPFv2 Extended Link Opaque LSA [RFC7684]

- Router-Link TLV of OSPFv3 E-Router-LSA [RFC8362]

The OSPF Link Flags sub-TLV with U-Flag can be advertised for the exclusive links used by Flex-Algorithm, so that these links will be pruned during normal SPF calculation.

Due to the change of procedures in the SPF calculation, all routers in an area must support the changes specified in this section. To ensure that, if an area is provisioned to support Unreachable Link Flag, all routers supporting this capability must advertise a Router Information (RI) LSA with a Router Functional Capabilities TLV [RFC7770] that includes the following Router Functional Capability Bit:

Bit	Capabilities
TBD	Unreachable Link Flag support

Upon detecting the presence of a reachable Router-LSA without a companion RI LSA that has the bit set, all routers MUST recalculate routes without considering any Unreachable Link Flag.

5. Backward Compatibility

An obvious benefit of solution A is that using maximum link metric is backward compatible. However, in OSPF, it may not work as well as in ISIS, since the links with maximum link metric are not always treated as unreachable by OSPF routers. Besides, additional mechanisms are required for the Flex-Algorithm using IGP Metric in path calculation.

When using the Link Flags sub-TLV with U-Flag in solution B, all nodes in the same area or level must support this feature. To avoid topology inconsistence and achieve backward compatibility, routers supporting the Unreachable Link Flag MUST advertise that capability. Upon detecting the absence of that capability from any router in the same area or level, all routers MUST recalculate routes without considering any Unreachable Link Flag. The backward-compatibility procedures described in [RFC8042] should be followed to ensure loop-free routing.

6. Security Considerations

TBD

7. IANA Considerations

Link Flags sub-TLV (TBD)

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TBD

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