LSR Shaofu. Peng
Internet-Draft Ran. Chen
Intended status: Standards Track ZTE Corporation
Expires: January 26, 2023 Ketan. Talaulikar
Arrcus, Inc
Peter. Psenak
Cisco Systems
July 25, 2022

Algorithm Related IGP-Adjacency SID Advertisement
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Abstract

Segment Routing architecture supports the use of multiple routing algorithms, i.e., different constraint-based shortest-path calculations can be supported. There are two standard algorithms: SPF and Strict-SPF, defined in Segment Routing architecture. There are also other user defined algorithms according to Flex-algo applicaiton. However, an algorithm identifier is often included as part of a Prefix-SID advertisement, that maybe not satisfy some scenarios where multiple algorithm share the same link resource. This document complement that the algorithm identifier can be also included as part of a Adjacency-SID advertisement

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1. Introduction

Segment Routing architecture [RFC8402] supports the use of multiple routing algorithms, i.e., different constraint-based shortest-path calculations can be supported. There are two standard algorithms, i.e., SPF and Strict-SPF, that defined in Segment Routing architecture. For SPF, the packet is forwarded along the well known ECMP-aware Shortest Path First (SPF) algorithm employed by the IGPs. However, it is explicitly allowed for a midpoint to implement another

forwarding based on local policy. For Strict Shortest Path First (Strict-SPF), it mandates that the packet be forwarded according to the ECMP-aware SPF algorithm and instructs any router in the path to ignore any possible local policy overriding the SPF decision.

There are also other user defined algorithms according to IGP Flex Algorithm [I-D.ietf-lsr-flex-algo]. IGP Flex Algorithm proposes a solution that allows IGPs themselves to compute constraint based paths over the network, and it also specifies a way of using Segment Routing (SR) Prefix-SIDs and SRv6 locators to steer packets along the constraint-based paths. It specifies a set of extensions to ISIS, OSPFv2 and OSPFv3 that enable a router to send TLVs that identify (a) calculation-type, (b) specify a metric-type, and (c)describe a set of constraints on the topology, that are to be used to compute the best paths along the constrained topology. A given combination of calculation-type, metric-type, and constraints is known as an FAD (Flexible Algorithm Definition).

However, an algorithm identifier is often included as part of a Prefix-SID advertisement, that maybe not satisfy some scenarios where multiple algorithm share the same link resource. This document complement that the algorithm identifier can be also included as part of an Adjacency-SID advertisement for SR-MPLS. Note that SRv6 already has this function.

2. 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.

3. Use-cases

The main use-case is that a TI-LFA backup path computed in Flex-algo plane may contain Adjacency Segments and require to contain an algorithm-aware Adjacency-SID, which can not only steer the traffic towards the link, but also distinguish traffic between different algorithms. Benefit from this, for the protected Adjacency-SID which belongs to a TI-LFA path within specific Flex-algo plane, the backup path of such Adjacency-SID can continue to follow the algorithm specific constraints that is consistent with the primary path. And, more enhancement treatments related with specific algorithm, such as statistics of traffic of different algorithms on the same link, etc, will be possible.

4. Adjacency Segment Identifier per Algorithm

4.1. ISIS Adjacency Segment Identifier per Algorithm

[RFC8667] describes the IS-IS extensions that need to be introduced for Segment Routing operating on an MPLS data plane. It defined Adjacency Segment Identifier (Adj-SID) sub-TLV advertised with TLV-22/222/23/223/141, and Adjacency Segment Identifier (LAN-Adj-SID) Sub-TLV advetised with TLV-22/222/23/223. Accordingly, this document defines two new optional Sub-TLVs, "ISIS Adjacency Segment Identifier (Adj-SID) per Algorithm Sub-TLV" and "ISIS Adjacency Segment Identifier (LAN-Adj-SID) per Algorithm Sub-TLV".

4.1.1. ISIS Adjacency Segment Identifier (Adj-SID) per Algorithm Sub-TLV

ISIS Adjacency Segment Identifier (Adj-SID) per Algorithm Sub-TLV has the following format:

```
     0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |   Type        |     Length    |     Flags     |     Weight    |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |   Algorithm   |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                        SID/Label/Index (variable)             |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 1: ISIS Adjacency Segment Identifier (Adj-SID) per Algorithm Format

where:

Type: TBA1.

Length: 6 or 7 depending on size of the SID.

Flags: Refer to Adjacency Segment Identifier (Adj-SID) sub-TLV.

Weight: Refer to Adjacency Segment Identifier (Adj-SID) sub-TLV.

Algorithm: The Algorithm field contains the identifier of the algorithm the router uses to apply algorithm specific treatment configured on the adjacency.

SID/Label/Index: Refer to Adjacency Segment Identifier (Adj-SID) sub-TLV.

For a P2P link, an SR-capable router MAY allocate different Adj-SIDs for different algorithms, if this link participates in the plane related to different algorithms.

4.1.2. ISIS Adjacency Segment Identifier (LAN-Adj-SID) per Algorithm Sub-TLV

ISIS Adjacency Segment Identifier (LAN-Adj-SID) per Algorithm Sub-TLV has the following format:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Type      |     Length    |      Flags    |    Weight     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   Algorithm   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                  Neighbor System-ID (ID length octets)        |
+                               +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                   SID/Label/Index (variable)                  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 2: ISIS Adjacency Segment Identifier (LAN-Adj-SID) per Algorithm Format

where:

Type: TBA2.

Length: Variable.

Flags: Refer to Adjacency Segment Identifier (LAN-Adj-SID) Sub-TLV.

Weight: Refer to Adjacency Segment Identifier (LAN-Adj-SID) Sub-TLV.

Algorithm: The Algorithm field contains the identifier of the algorithm the router uses to apply algorithm specific treatment configured on the adjacency.

SID/Label/Index: Refer to Adjacency Segment Identifier (LAN-Adj-SID) Sub-TLV.

For a broadcast link, an SR-capable router MAY allocate different Adj-SIDs for different algorithms, if this link participates in the plane related to different algorithms.

4.2. OSPFv2 Adjacency Segment Identifier per Algorithm

[RFC8665] describes the OSPFv2 extensions that need to be introduced for Segment Routing operating on an MPLS data plane. It defined Adj-SID Sub-TLV and LAN Adj-SID Sub-TLV advertised with Extended Link TLV defined in [RFC7684]. Accordingly, this document defines two new optional Sub-TLVs, "OSPFv2 Adj-SID per Algorithm Sub-TLV" and "OSPFv2 LAN Adj-SID per Algorithm Sub-TLV".

4.2.1. OSPFv2 Adj-SID per Algorithm Sub-TLV

OSPFv2 Adj-SID per Algorithm Sub-TLV has the following format:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|              Type             |            Length             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Flags     |   Algorithm   |     MT-ID     |  Weight       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                   SID/Label/Index (variable)                  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 3: OSPFv2 Adj-SID per Algorithm Format

where:

Type: TBA3

Length: 7 or 8 octets, depending on the V-Flag.

Flags: Refer to OSPFv2 Adj-SID Sub-TLV.

Algorithm: The Algorithm field contains the identifier of the algorithm the router uses to apply algorithm specific treatment configured on the adjacency.

MT-ID: Refer to OSPFv2 Adj-SID Sub-TLV.

Weight: Refer to OSPFv2 Adj-SID Sub-TLV.

SID/Index/Label: Refer to OSPFv2 Adj-SID Sub-TLV.

For a P2P link, an SR-capable router MAY allocate different Adj-SIDs for different algorithms, if this link participates in the plane related to different algorithms.

4.2.2. OSPFv2 LAN Adj-SID per Algorithm Sub-TLV

OSPFv2 LAN Adj-SID per Algorithm Sub-TLV has the following format:

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |              Type             |            Length             |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |     Flags     |   Algorithm   |     MT-ID     |    Weight     |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                          Neighbor ID                          |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                    SID/Label/Index (variable)                 |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 4: OSPFv2 LAN Adj-SID per Algorithm Format

where:

Type: TBA4

Length: 11 or 12 octets, depending on the V-Flag.

Flags: Refer to OSPFv2 LAN Adj-SID Sub-TLV.

Algorithm: The Algorithm field contains the identifier of the algorithm the router uses to apply algorithm specific treatment configured on the adjacency.

MT-ID: Refer to OSPFv2 LAN Adj-SID Sub-TLV.

Weight: Refer to OSPFv2 LAN Adj-SID Sub-TLV.

Neighbor ID: Refer to OSPFv2 LAN Adj-SID Sub-TLV.

SID/Index/Label: Refer to OSPFv2 LAN Adj-SID Sub-TLV.

For a broadcast link, an SR-capable router MAY allocate different Adj-SIDs for different algorithms, if this link participates in the plane related to different algorithms.

4.3. OSPFv3 Adjacency Segment Identifier per Algorithm

[RFC8666] describes the OSPFv3 extensions that need to be introduced for Segment Routing operating on an MPLS data plane. It defined Adj-SID Sub-TLV and LAN Adj-SID Sub-TLV advertised with Router-Link TLV as defined in [RFC8362]. Accordingly, this document defines two new optional Sub-TLVs, "OSPFv3 Adj-SID per Algorithm Sub-TLV" and "OSPFv3 LAN Adj-SID per Algorithm Sub-TLV".

4.3.1. OSPFv3 Adj-SID per Algorithm Sub-TLV

OSPFv3 Adj-SID per Algorithm Sub-TLV has the following format:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|               Type            |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Flags     |     Weight    |   Algorithm   |   Reserved    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                   SID/Label/Index (variable)                  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 5: OSPFv3 Adj-SID per Algorithm Format

where:

Type: TBA5

Length: 7 or 8 octets, depending on the V-Flag.

Flags: Refer to OSPFv3 Adj-SID Sub-TLV.

Weight: Refer to OSPFv3 Adj-SID Sub-TLV.

Algorithm: The Algorithm field contains the identifier of the algorithm the router uses to apply algorithm specific treatment configured on the adjacency.

Reserved: SHOULD be set to 0 on transmission and MUST be ignored on reception.

SID/Index/Label: Refer to OSPFv3 Adj-SID Sub-TLV.

For a P2P link, an SR-capable router MAY allocate different Adj-SIDs for different algorithms, if this link participates in the plane related to different algorithms.

4.3.2. OSPFv3 LAN Adj-SID per Algorithm Sub-TLV

OSPFv3 LAN Adj-SID per Algorithm Sub-TLV has the following format:

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |              Type             |            Length             |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |     Flags     |     Weight    |   Algorithm   |   Reserved    |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                          Neighbor ID                          |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                   SID/Label/Index (variable)                  |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 6: OSPFv3 LAN Adj-SID per Algorithm Format

where:

Type: TBA6

Length: 11 or 12 octets, depending on the V-Flag.

Flags: Refer to OSPFv3 LAN Adj-SID Sub-TLV.

Weight: Refer to OSPFv3 LAN Adj-SID Sub-TLV.

Algorithm: The Algorithm field contains the identifier of the algorithm the router uses to apply algorithm specific treatment configured on the adjacency.

Reserved: SHOULD be set to 0 on transmission and MUST be ignored on reception.

Neighbor ID: Refer to OSPFv3 LAN Adj-SID Sub-TLV.

SID/Index/Label: Refer to OSPFv3 LAN Adj-SID Sub-TLV.

For a broadcast link, an SR-capable router MAY allocate different Adj-SIDs for different algorithms, if this link participates in the plane related to different algorithms.

5. Operations

The method introduced in this document enables the traffic of different flex-algo plane to be distinguished on the same link, so that these traffic can be applied with different local treatment

(such as providing different repair path, traffic statistics, etc) per algorithm.

Depending on the implementation, operators can configure multiple Adacency-SIDs each for different algorithm on the same link. One of the difficulties is that during this configuration phase it is not straightforward for a link to be included in an Flex-algo plane, as this can only be determined after all nodes in the network have negotiated the FAD. A simple way is that as long as an IGP instance enable an algorithm for a level/area, all links joined to that level/ area should allocate Adjacency-SIDs for that algorithm statically, however, this will waste SID resources.

It is RECOMMENDEDED to allocate and withdraw Adjacency-SID per algorithm dynamically according to the result of FAD negotiation, i.e., Adjacency-SID per algorithm is assigned only to those links that have joined the Flex-algo plane.

The following figure shows an example of Adjacency-SID per algorithm.

```
        [S1]--------[D]--------[S2]
         |           |          |
         |           |          |
         |           |          |
        [A]---------[B]--------[C]
```

Figure 7: Flex-algo LFA Path with Adjacency-SID per Algorithm

Suppose that node S1, A, B, D and their inter-connected links belongs to FA-id 128 plane, and S2, B, C, D and their inter-connected links belongs to FA-id 129 plane. The IGP metric of link B-D is 100, and all other links have IGP metric 1. Both FA-id 128 and 129 use IGP default metric type for path calculation. In FA-id 128 plane, from S1 to destination D, the primary path is S1-D, and the TI-LFA backup path is segment list {node(B), adjacency(B-D)}. Similarly, In FA-id 129 plane, from S2 to destination D, the primary path is S2-D, and the TI-LFA backup path is segment list {node(B), adjacency(B-D)}. The above TI-LFA path of FA-id 128 plane can be translated to {node-SID(B)@FA-id128, adjacency-SID(B-D)@FA-id128}, and TI-LFA path of FA-id 129 plane will be translate to {node-SID(B)@FA-id129, adjacency-SID(B-D)@FA-id129}. So that node B can distinguish the flow of FA-id 128 and FA-id 129 based on different adjacency-SID(B-D), and take different treatments of them when they are send to the same outgoing link B-D.

6. Deployment Considerations

When multiple flex-algos are deployed in the network and they share the same link, multiple algorithm specific Adjacency-SIDs may need to be allocated on such a link, to distinguish the traffic of different algorithms and provide possible different treatment.

Even if a link is only used by a single flex-algo, because the link always belongs to algorithm 0 by default, both the traditional Adjacency-SID (termd as adj-sid@algo-0) and the algorithm specific Adjacency-SID (termd as adj-sid@algo-x) may need to be allocated on that link, so that the potentional repair paths of the two Adjacency-SIDs can be distinguished.

If the topology of multiple flex-algo planes, and physical topology, are isomorphic, that is, they contain the same nodes and same inter-connected links, but due to the differences between these FADs (such as different metric types), different repair paths will also be calculated on the same topology. Therefore, multiple algorithm specific Adjacency-SIDs may still need to be provided on the same link.

It is not recommended to bind a link to algorithm 1 (Strict SPF) and allocate adj-sid@algo-1. Such Adjacency-SID is no useful.

The operator may configure the policy on the node to turn off the algorithm specific processing capability for each algorithm, and the node will not allocate algorithm specific Adjacency-SIDs on the links those joined to the flex-algo plane, this is a local behavior. As mentioned before, the algorithm specific processing capability can be further subdivided into repair path per algorithm, statistics per algorithm, etc. Assuming that a node only wants to support the capability of repair path per algorithm, in this case, for an individual link, it is also controlled by the adjacency backup capability. When adjacency backup is disabled, it will let the capablitiy of repair path per algorithm be also invalid, so the link does not need to allocate algorithm specific Adjacency-SIDs.

In any case, when instantiate a segment list (such as a TI-LFA path) within a specific flex-algo plane, for each Adjacency Segment of that list, if it has a corresponding algorithm specific Adjacency-SID, the algorithm specific Adjacency-SID MUST be used to construct SID list; if it has not, traditional Adjacency-SID can be used.

7. IANA Considerations

7.1. IANA ISIS Considerations

This document makes the following registrations in the "Sub-TLVs for TLV 22, 23, 25, 141, 222, and 223" registry.

Type	Description	22	23	25	141	222	223
TBA1	Adjacency Segment Identifier per Algorithm	y	y	n	y	y	y
TBA2	LAN Adjacency Segment Identifier per Algorithm	y	y	n	y	y	y

7.2. IANA OSPFv2 Considerations

This document makes the following registrations in the OSPFv2 Extended Link TLV Sub-TLVs Registry.

Value	Description	Reference
TBA3	OSPFv2 Adj-SID per Algorithm Sub-TLV	This document
TBA4	OSPFv2 LAN Adj-SID per Algorithm Sub-TLV	This document

7.3. IANA OSPFv3 Considerations

This document makes the following registrations in the "OSPFv3 Extended-LSA Sub-TLVs" Registry.

Value	Description	Reference
TBA5	OSPFv3 Adj-SID per Algorithm Sub-TLV	This document
TBA6	OSPFv3 LAN Adj-SID per Algorithm Sub-TLV	This document

8. Security Considerations

There are no new security issues introduced by the extensions in this document. Refer to [RFC8665], [RFC8666], [RFC8667] for other security considerations.

9. Acknowledgements

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10. Contributors

The following people gave a substantial contribution to the content of this document.

Les Ginsberg
Cisco Systems, Inc.
United States of America
Email: ginsberg@cisco.com

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Authors' Addresses

Shaofu Peng
ZTE Corporation
China

Email: peng.shaofu@zte.com.cn

Ran Chen
ZTE Corporation
China

Email: chen.ran@zte.com.cn

Ketan Talaulikar
Arrcus, Inc
India

Email: ketant.ietf@gmail.com

Peter Psenak
Cisco Systems
Slovakia

Email: ppsenak@cisco.com