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BGP SR Policy Extensions for State Report
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Abstract

This document extends BGP SR Policy, the same protocol used to configure SR Policies, to report operational state information of SR Policies, Candidate Paths, and Segment Lists.

Optional State sub-TLVs, carried within the BGP Tunnel Encapsulation attribute, are introduced in this document to report the operational states (e.g., Down, Inactive, or Invalid) along with their associated reasons of the SR Policies from network elements to controller.

These extensions are restricted to operational state reporting and do not alter SR Policy computation, path selection procedures, or the operations of the base BGP protocol.

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1. Introduction

In practice, BGP SR Policy [RFC9830] is usually used by controller to configure SR Policies [RFC9256] on the relevant network elements, i.e., the headends of the SR Policies. Deployments of SR Policies [RFC9256] require the controller to obtain accurate operational state information for instantiated policies. Such information is critical to policy lifecycle management, troubleshooting, and service assurance.

Existing mechanisms for conveying SR Policy state include YANG notifications as defined in [I-D.ietf-spring-sr-policy-yang] and SR Policy State TLVs carried in BGP-LS, as specified in [RFC9857]. These approaches typically require additional protocol sessions between network elements and controllers, which increases operational complexity.

This document extends BGP SR Policy [RFC9830], the same protocol used to configure SR Policies, to report the operational states (e.g., Down, Inactive, or Invalid) along with their associated reasons of the SR Policies from network elements to controller, thereby reducing the number of protocols that need to be run between network elements and controller, lowering the requirements for network elements and controller, and simplifying network configuration and network operation and maintenance.

This document does not update or obsolete [RFC9256], [RFC9830], [RFC9857], or [RFC4271]. The extensions defined here are restricted to operational state reporting and do not alter existing protocol procedures or protocol semantics.

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. Extensions to BGP SR Policy

This document defines optional State sub-TLVs carried within the BGP Tunnel Encapsulation Attribute (see section 2.1) to report the operational states (e.g., Down, Inactive, or Invalid) along with their associated reasons of the SR Policies from network elements to controller. The operational states and the associated reasons include those for SR Policies (see section 2.2), Candidate Paths (see section 2.3), and Segment Lists (see section 2.4).

2.1. Encoding of SR Policy State Information

The extended BGP SR Policy encoding is as follows:

```

SR Policy SAFI NLRI: <Distinguisher, Color, Endpoint>
Attributes:
  Tunnel Encapsulation Attribute(23)
    Tunnel Type: SR Policy(15)
      Binding SID
      Preference
      Priority
      SR Policy Name
      SR Policy State
      SR Policy Candidate Path Name
      SR Policy Candidate Path State
      Explicit NULL Label Policy (ENLP)
      Segment List
        State
        Weight
        Segment
        Segment
        ...
        ...

```

Figure 1: Extended BGP SR Policy Encoding

The state sub-TLVs defined in this document follow a hierarchical model where Segment List state may influence Candidate Path state, and Candidate Path state may influence overall SR Policy state. The exact derivation procedures are implementation-specific.

2.2. Policy State sub-TLV

The Policy State sub-TLV is used to report the operational state of an SR Policy. The format of Policy State sub-TLV is as follows:

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										RESERVED									
State(4 octets)																																							
sub-TLVs(optional)																																							

Figure 2: Policy State sub-TLV

Type (1 octet): Indicates this sub-TLV is Policy State, specific values need to be assigned by IANA.

Length (1 octet): Length in octets of the Value field.

Flags (1 octet): Reserved bits MUST be set to 0 on transmission and ignored on receipt.

RESERVED (1 octet): Reserved bits MUST be set to 0 on transmission and ignored on receipt.

State (4 octets): Indicates the operational state of the SR Policy. The format is as follows:

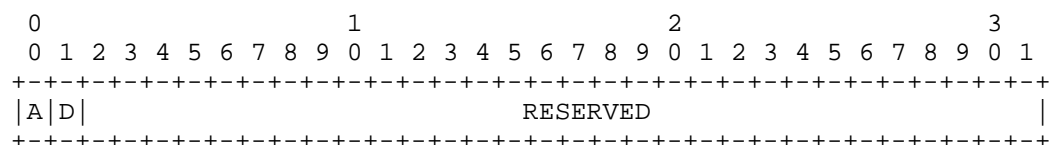


Figure 3: State Field for Policy State sub-TLV

A flag:

- * If A = 0: The SR Policy is in the administrative up state.
- * If A = 1: The SR Policy is administratively disabled.

D flag:

- * If D = 0: The SR Policy is in the up state.
- * If D = 1: The SR Policy is in the down state.

RESERVED: Reserved bits MUST be set to 0 on transmission and ignored on receipt.

The Policy State sub-TLV may optionally carry the following sub-TLVs: the Active Candidate Path sub-TLV and the Policy Down Reason sub-TLV.

2.2.1. Active Candidate Path sub-TLV

The Active Candidate Path sub-TLV is used, when an active Candidate Path exists for the SR Policy, to carry the candidate path that is currently active. Its format is as follows:

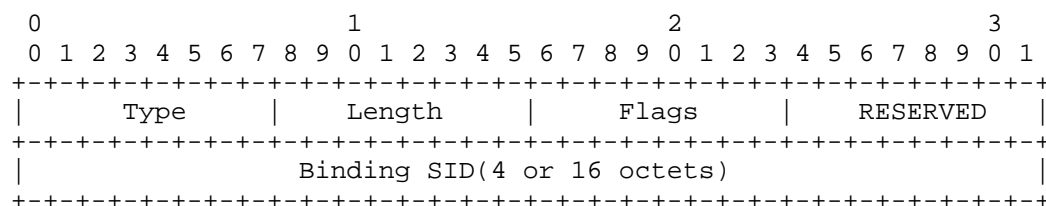


Figure 4: Active Candidate Path sub-TLV

Type (1 octet): Indicates this sub-TLV is Active Candidate Path, specific values need to be assigned by IANA.

Length (1 octet): Indicates the length of the Active Candidate Path sub-TLV in octets.

Flags (1 octet): Indicates the type of Binding SID, its format is as follows:

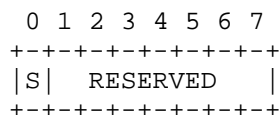


Figure 5: Flags Field for Active Candidate Path Sub-TLV

Where:

- * If S = 0: Indicates the Binding SID is a 4-byte SR-MPLS BSID.
- * If S = 1: Indicates the Binding SID is a 16-byte SRv6 BSID.

RESERVED (1 octet): Reserved bits MUST be set to 0 on transmission and ignored on receipt.

Binding SID (4 or 16 octets): The Binding SID of the active candidate path. The length is determined by the S bit in the Flags field.

2.2.2. Policy Down Reason Sub-TLV

The Policy Down Reason sub-TLV is used, when the SR Policy is in the down state, to carry the reason for the failure. Its format is as follows:

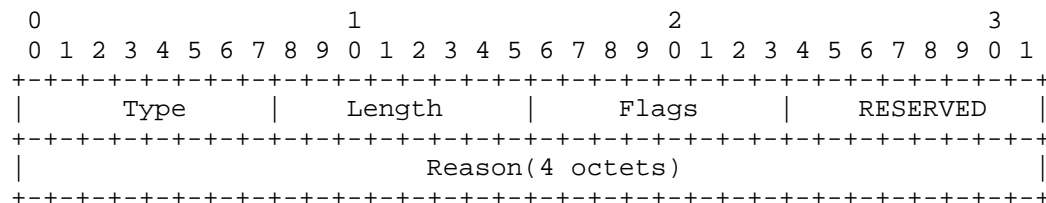


Figure 6: Policy Down Reason sub-TLV

Type (1 octet): Indicates this sub-TLV is Policy Down Reason, specific values need to be assigned by IANA.

Length (1 octet): Indicates the length of the Policy Down Reason sub-TLV in octets.

Flags (1 octet): Reserved bits MUST be set to 0 on transmission and ignored on receipt.

RESERVED (1 octet): Reserved bits MUST be set to 0 on transmission and ignored on receipt.

Reason (4 octet): Indicates the specific reason for the SR Policy failure. Its format is as follows:

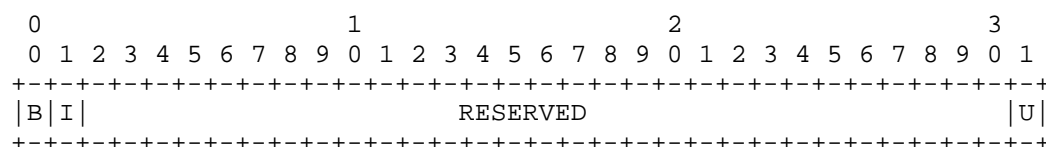


Figure 7: Reason Field for Policy Down Reason sub-TLV

B flag:

- * If B = 0: Indicates the failure is not detected by BFD.
- * If B = 1: Indicates the SR Policy failure is due to BFD detecting the policy as unavailable.

I flag:

- * If I = 0: Indicates the failure is not detected after IGP convergence.

- * If I = 1: Indicates the SR Policy failure is due to the IGP detecting the policy as unavailable after convergence (e.g., the SID used by the SR Policy becomes unavailable following IGP convergence).

U flag:

- * If U = 0: The failure reason is known.
- * If U = 1: The failure reason is unknown.

RESERVED: Reserved bits MUST be set to 0 on transmission and ignored on receipt.

2.3. Candidate Path State Sub-TLV

The Candidate Path State sub-TLV reports the operational state of an SR Policy Candidate Path. The format of the Candidate Path State sub-TLV is as follows:

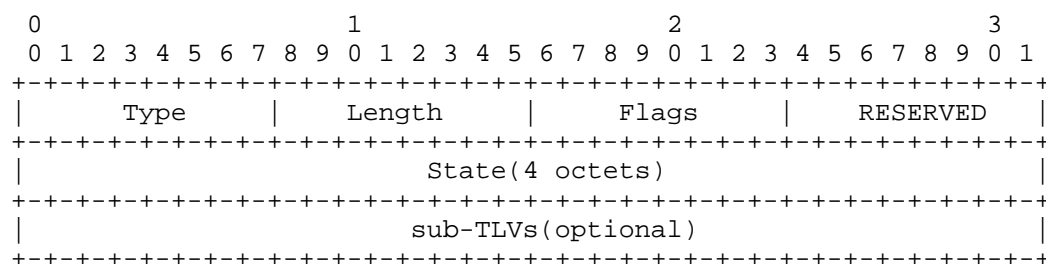


Figure 8: Candidate Path State sub-TLV

Type (1 octet): Indicates this sub-TLV is Candidate Path State, specific values need to be assigned by IANA.

Length (1 octet): Indicates the length of the Candidate Path State sub-TLV in octets.

Flags (1 octet): Reserved bits MUST be set to 0 on transmission and ignored on receipt.

RESERVED (1 octet): Reserved bits MUST be set to 0 on transmission and ignored on receipt.

State (4 octets): Indicates the operational state of the Candidate Path. The format is as follows:

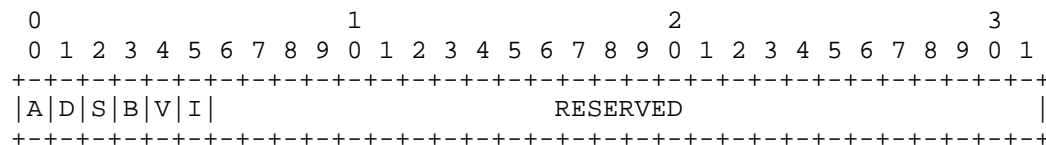


Figure 9: State Field for Candidate Path State sub-TLV

A flag:

- * If A = 0: The candidate path is in the administrative up state.
- * If A = 1: The candidate path is in the administrative down state, meaning the path has been administratively configured as unavailable.

D flag:

- ```
* If D = 0: The candidate path is in the up state.
* If D = 1: The candidate path is in the down state.
```

S flag:

- \* If  $S = 0$ : The candidate path is not the active path.
- \* If  $S = 1$ : The candidate path is the active path selected by the SR Policy.

B flag:

- \* If  $B = 0$ : The candidate path is not a backup path.
- \* If  $B = 1$ : The candidate path is selected as a backup path.

A candidate path SHOULD NOT have both S=1 and B=1.

V flag: Indicates configuration or structural validity.

- \* If  $V = 0$ : The candidate path is considered invalid due to configuration or structural inconsistencies.
- \* If  $V = 1$ : The candidate path has passed configuration and structural validity checks.

I flag: Indicates runtime operational invalidity.

- \* If I = 0: No operational condition currently invalidates the candidate path.
- \* If I = 1: The candidate path is considered operationally invalid due to runtime conditions (e.g., detected packet loss, liveness failure, or other operational impairments).

RESERVED: Reserved bits MUST be set to 0 on transmission and ignored on receipt.

The Candidate Path State sub-TLV may optionally carry the following sub-TLVs: the Candidate Path Down Reason sub-TLV, the Candidate Path Inactive Reason sub-TLV and the Candidate Path Invalid Reason sub-TLV.

### 2.3.1. Candidate Path Down Reason sub-TLV

The Candidate Path Down Reason sub-TLV is used, when the candidate path is in the down state, to carry the reason for the failure. Its format is as follows:

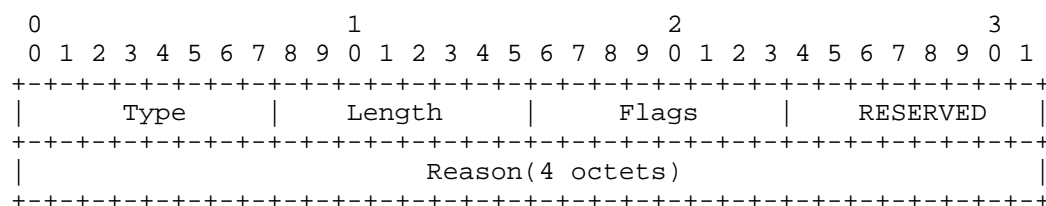


Figure 10: Candidate Path Down Reason sub-TLV

Type (1 octet): Indicates this sub-TLV is Candidate Path Down Reason, specific values need to be assigned by IANA.

Length (1 octet): Indicates the length of the Candidate Path Down Reason sub-TLV in octets.

Flags (1 octet): Reserved bits MUST be set to 0 on transmission and ignored on receipt.

RESERVED (1 octet): Reserved bits MUST be set to 0 on transmission and ignored on receipt.

Reason (4 octet): Indicates the specific reason for the candidate path failure. The format is as follows:

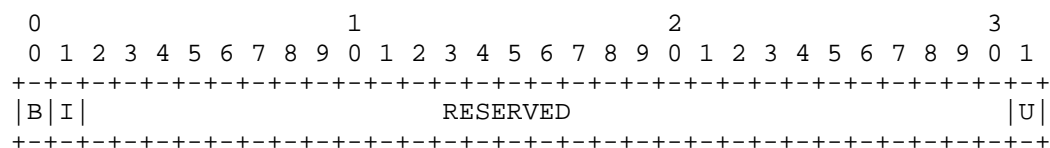


Figure 11: Reason Field for Candidate Path Down Reason sub-TLV

B flag:

- \* If B = 0: The failure is not detected by BFD.
- \* If B = 1: The candidate path failure is due to BFD detecting the path as unavailable.

I flag:

- \* If I = 0: The failure is not detected after IGP convergence.
- \* If I = 1: The candidate path failure is due to the IGP detecting the path as unavailable after convergence (e.g., the SID used by the candidate path becomes unavailable following IGP convergence).

U flag:

- \* If U = 0: The failure reason is known.
- \* If U = 1: The failure reason is unknown.

RESERVED: Reserved bits MUST be set to 0 on transmission and ignored on receipt.

### 2.3.2. Candidate Path Inactive Reason sub-TLV

The Candidate Path Inactive Reason sub-TLV is used, when the candidate path is not selected by the SR Policy and is in the inactive state, to carry the reason for being inactive. Its format is as follows:

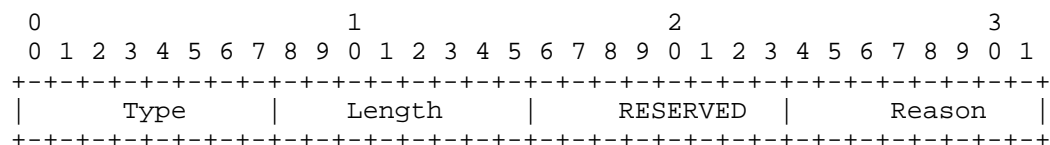


Figure 12: Candidate Path Inactive Reason sub-TLV

Type (1 octet): Indicates this sub-TLV is Candidate Path Inactive Reason, specific values need to be assigned by IANA.

Length (1 octet): Indicates the length of the Candidate Path Inactive Reason sub-TLV in octets, excluding the Type and Length fields. The value is fixed to 2.

RESERVED (1 octet): Reserved bits MUST be set to 0 on transmission and ignored on receipt.

Reason (1 octet): Indicates the reason why the candidate path is not selected. Values defined by this document are listed below. Additional values may be assigned by IANA.

| Reason | Description               |
|--------|---------------------------|
| 0      | Reserved                  |
| 1      | Lower priority            |
| 2      | Lower protocol origin     |
| 3      | Configuration-related     |
| 4      | Lower Discriminator value |
| 5-255  | Reserved                  |

Figure 13: Reason for Candidate Path Inactive Reason Sub-TLV

### 2.3.3. Candidate Path Invalid Reason sub-TLV

The Candidate Path Invalid Reason sub-TLV is used, when the candidate path fails validity check and is invalid, to carry the reason for being invalid. Its format is as follows:

| 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 | RESERVED | Reason |

Figure 14: Candidate Path Invalid Reason sub-TLV

Type (1 octet): Indicates this sub-TLV is Candidate Path Invalid Reason, specific values need to be assigned by IANA.

Length (1 octet): Indicates the length of the Candidate Path Invalid Reason sub-TLV in octets, excluding the Type and Length fields. The value is fixed to 2.

RESERVED (1 octet): Reserved bits MUST be set to 0 on transmission and ignored on receipt.

Reason (1 octet): Indicates the reason why the candidate path is invalid. Values defined by this document are listed below. Additional values may be assigned by IANA.

| Reason | Description                                                                       |
|--------|-----------------------------------------------------------------------------------|
| 0      | Reserved                                                                          |
| 1      | Explicit Candidate Path has no valid segment list                                 |
| 2      | Explicit Candidate Path contains a segment list with mixed forwarding plane types |
| 3      | Dynamic Candidate Path cannot compute a path that satisfies the constraints       |
| 4      | Composite Candidate Path has no valid constituent SR Policy                       |
| 5-255  | Reserved                                                                          |

Figure 15: Reason for Candidate Path Invalid Reason Sub-TLV

#### 2.4. Segment List State sub-TLV

The Segment List State sub-TLV reports the operational state of a Segment List. The format of Segment List State sub-TLV is as follows:

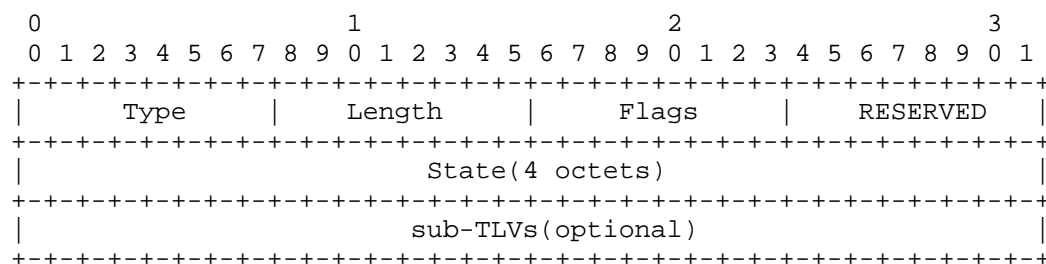


Figure 16: Segment List State sub-TLV

Type (1 octet): Indicates this sub-TLV is Segment List State, specific values need to be assigned by IANA.

Length (1 octet): Indicates the length of the Segment List State sub-TLV in octets.

Flags (1 octet): Reserved bits MUST be set to 0 on transmission and ignored on receipt.

RESERVED (1 octet): Reserved bits MUST be set to 0 on transmission and ignored on receipt.

State (4 octets): Indicates the operational state of the segment list. The format is as follows:

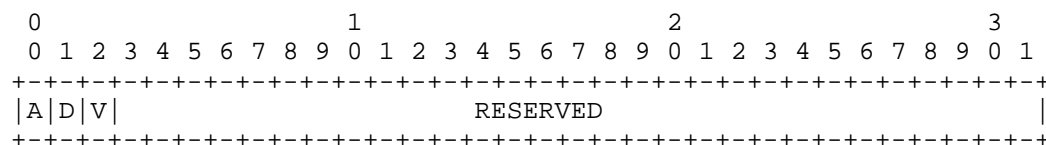


Figure 17: State Field for Segment List State sub-TLV

A flag:

- \* If A = 0: The segment list is in the administrative up state.
- \* If A = 1: The segment list is in the administrative down state, meaning it has been administratively configured as unavailable.

D flag:

- \* If D = 0: The segment list is in the up state.
- \* If D = 1: The segment list is in the down state.



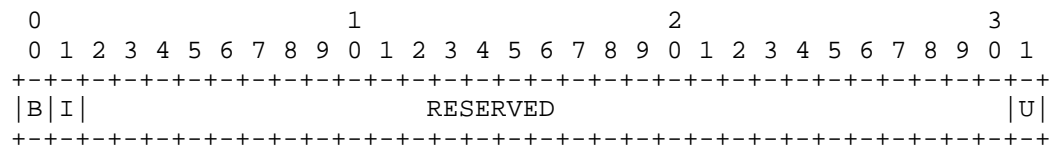


Figure 19: Reason Field for Segment List Down Reason sub-TLV

B flag:

- \* If B = 0: The failure is not detected by BFD.
- \* If B = 1: The segment list failure is due to BFD detecting the segment list as unavailable.

I flag:

- \* If I = 0: The failure is not detected after IGP convergence.
- \* If I = 1: The segment list failure is due to the IGP detecting the segment list as unavailable after convergence (e.g., the SID used in the segment list becomes unavailable following IGP convergence).

U flag:

- \* If U = 0: The failure reason is known.
- \* If U = 1: The failure reason is unknown.

RESERVED: Reserved bits MUST be set to 0 on transmission and ignored on receipt.

#### 2.4.2. Segment List Invalid Reason sub-TLV

The Segment List Invalid Reason sub-TLV is used, when the segment list fails validity check and is invalid, to carry the reason for being invalid. Its format is as follows:

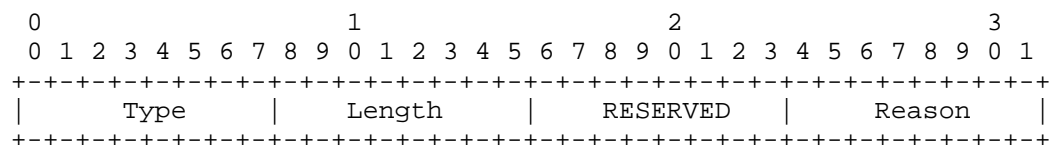


Figure 20: Segment List Invalid Reason sub-TLV



Type (1 octet): Indicates this sub-TLV is Segment List Invalid Reason, specific values need to be assigned by IANA.

Length (1 octet): Indicates the length of the Segment List Invalid Reason sub-TLV in octets, excluding the Type and Length fields. The value is fixed to 2.

RESERVED (1 octet): Reserved bits MUST be set to 0 on transmission and ignored on receipt.

Reason (1 octet): Indicates the reason why the segment list is invalid. Values defined by this document are listed below. Additional values may be assigned by IANA.

| Reason | Description                                             |
|--------|---------------------------------------------------------|
| 0      | Reserved                                                |
| 1      | Segment list is empty                                   |
| 2      | Segment list has a weight of 0                          |
| 3      | Segment list contains a mix of SR-MPLS and SRv6 SIDs    |
| 4      | Resolution of the first SID failed                      |
| 5      | Segment list contains a SID not present in the SRDB     |
| 6      | Segment list contains inconsistent or incompatible SIDs |
| 7-255  | Reserved                                                |

Figure 21: Reason for Segment List Invalid Reason Sub-TLV

### 3. SR Policy State Originator Behavior

A SR Policy State Originator, such as a network element acting as the headend node of a SR Policy, is a BGP SR Policy speaker that originates SR Policies state together with associated state information.

The originator SHOULD determine the operational state of Segment Lists, Candidate Paths, and SR Policies based on local operational data.

A change in Segment List state that affects the usability or validity of a Candidate Path SHOULD result in an update to the corresponding Candidate Path State sub-TLV.

Similarly, when the state of one or more Candidate Paths affects SR Policy path selection or operational availability, the originator SHOULD update the Policy State sub-TLV accordingly.

A change of the active Candidate Path for an SR Policy SHOULD be reflected in the Active Candidate Path sub-TLV.

State changes MAY trigger BGP UPDATE messages, subject to local policy and report procedures.

#### 4. SR Policy State Consumer Behavior

An SR Policy State Consumer, such as a controller, is an entity that receives SR Policy state information via BGP SR Policy.

A consumer:

- \* MUST be capable of parsing Policy, Candidate Path, and Segment List State sub-TLVs.
- \* MAY use the received state information according to local policy or operational objectives.

This document does not specify how the received state information is to be used by the consumer.

#### 5. IANA Considerations

IANA is requested to assign new code points from the "BGP Tunnel Encapsulation Attribute Sub-TLVs" registry for the following sub-TLVs defined in this document:

| Code Point | Description                            | Reference     |
|------------|----------------------------------------|---------------|
| TBD1       | Policy State sub-TLV                   | This document |
| TBD2       | Active Candidate Path sub-TLV          | This document |
| TBD3       | Policy Down Reason Sub-TLV             | This document |
| TBD4       | Candidate Path State Sub-TLV           | This document |
| TBD5       | Candidate Path Down Reason Sub-TLV     | This document |
| TBD6       | Candidate Path Inactive Reason sub-TLV | This document |
| TBD7       | Candidate Path Invalid Reason sub-TLV  | This document |
| TBD8       | Segment List State sub-TLV             | This document |
| TBD9       | Segment List Down Reason sub-TLV       | This document |
| TBD10      | Segment List Invalid Reason sub-TLV    | This document |

Table 1: New BGP Tunnel Encapsulation Sub-TLV Code Points for SR Policy State

## 6. Security Considerations

This document introduces no new security considerations beyond those already described for BGP [RFC4271] and BGP SR Policy [RFC9830].

## 7. References

### 7.1. Normative References

- [RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <<https://www.rfc-editor.org/info/rfc2119>>.
- [RFC8174] Leiba, B., "Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words", BCP 14, RFC 8174, DOI 10.17487/RFC8174, May 2017, <<https://www.rfc-editor.org/info/rfc8174>>.

- [RFC9256] Filsfils, C., Talaulikar, K., Ed., Voyer, D., Bogdanov, A., and P. Mattes, "Segment Routing Policy Architecture", RFC 9256, DOI 10.17487/RFC9256, July 2022, <<https://www.rfc-editor.org/info/rfc9256>>.
- [RFC9830] Previdi, S., Filsfils, C., Talaulikar, K., Ed., Mattes, P., and D. Jain, "Advertising Segment Routing Policies in BGP", RFC 9830, DOI 10.17487/RFC9830, September 2025, <<https://www.rfc-editor.org/info/rfc9830>>.

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- [I-D.ietf-spring-sr-policy-yang] Saleh, T., Raza, S. K., Zhuang, S., Matsushima, S., and V. P. Beeram, "YANG Data Model for Segment Routing Policy", Work in Progress, Internet-Draft, draft-ietf-spring-sr-policy-yang-06, 20 October 2025, <<https://datatracker.ietf.org/doc/html/draft-ietf-spring-sr-policy-yang-06>>.
- [RFC4271] Rekhter, Y., Ed., Li, T., Ed., and S. Hares, Ed., "A Border Gateway Protocol 4 (BGP-4)", RFC 4271, DOI 10.17487/RFC4271, January 2006, <<https://www.rfc-editor.org/info/rfc4271>>.
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