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Intent-based Routing
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Abstract

This document defines the intent-based routing mechanism through which the packet can carry the intent information and the network node can enforce the policy according to the intent information (typically steering the packet into the SR policy or the underlay slice which can meet the intent). The intent-based routing mechanism provides a simple and scalable solution to meet the different service requirements for the inter-domain routing.

Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC 2119](#) [[RFC2119](#)].

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1. Introduction

Application-aware Networking (APN) is introduced in [[I-D.li-apn-framework](#)] and [[I-D.li-apn-problem-statement-usecases](#)]. APN conveys an attribute with data packets in the network and makes the network aware of fine-grain requirements at the user group and application group levels. This document defines the intent-based routing mechanism in which intent can be seen as the APN parameter to specify the service requirements.

[[I-D.hegde-spring-mpls-seamless-sr](#)] describes the requirements for end-to-end intent-based paths spanning multi-domain networks. [[I-D.kaliraj-idr-bgp-classful-transport-planes](#)] specifies the BGP based mechanisms to signal the packet paths which span multiple domains and provide different SLA characteristics. Since these SR paths need to setup according to the pair <color, endpoint>, it means more SR paths are introduced and this will cause more challenges on scalability.

In order to reduce the challenge of scalability introduced by the inter-domain routing with different service requirements, this document proposes the intent-based routing mechanism through which the packet can carry the intent information and the network node can steer the packet into the SR policy to satisfy the service requirement (that is, meet the specific intent). With the intent-based routing mechanism, network nodes do not need to maintain the fine-granularity connection state for each destination in the control plane, which can improve the scalability of the end-to-end routing significantly.

Besides steering the packet into the SR policy, the intent-based routing mechanism can also be used to steer the traffic into the underlay network slice to meet the specific intent or enforce policy for other intents such as network measurement, security, etc. Since the same intent can be satisfied by different solutions in the different network domain, the intent-based routing also improve the flexibility to satisfying the service requirement through the combined solutions for the same intent.

2. Terminologies

The following terminologies are used in this document.

SR: Segment Routing

SRv6: Segment Routing over IPv6

3. Intent-based Routing

The Intent-based routing mechanism introduces the concept of intent as the information carried in the data plane to represent the specific service requirement for the destination on the network. The intent can be associated with a series of service attributes, such as low latency and high bandwidth. The value can be allocated by the administrator. The allocation of values of the intent in the multiple domain must be consistent.

[I-D.ietf-spring-segment-routing-policy] defines the color used for the SR policy. The color is a 32-bit numerical value that associates the SR Policy with an intent (e.g. low-latency). There can be the mapping as follows between the color and the intent. If the intent and the color can be designed and allocated consistently, the value of the color can be the same as that of the intent and the mapping between the color and the intent can be saved in the data plane.

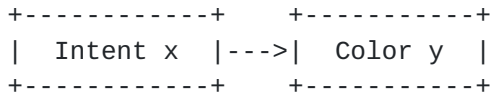


Figure 1 Mapping between Intent and Color

Figure 1: Figure 1: Reference Topology

In the scenario of the inter-domain routing, the SR policy group for a specific Endpoint shown in the Figure 2 can be set up in the data plane in the local network domain. That is, it is not necessary to advertise the pair <color, endpoint> to set up the end-to-end SR path. When the packet carrying the intent information arrives at the edge node of the network domain, the edge node can search the SR policy group according to the destination, then steer the packet into the corresponding SR policy according to the mapping between the color and the intent and the mapping between the color and the SR policy.



Figure 2: Figure 2: SR Policy Group

In the scenario of the inter-domain network slicing, the following mapping between the color and the local underlay network slice can be set up in the data plane in the local network domain. When the packet carrying the intent information arrives at the edge node of the network domain, the edge node can steer the packet into the local underlay network slice according to the mapping between the color and the intent and the mapping between the color and the local underlay network slice.

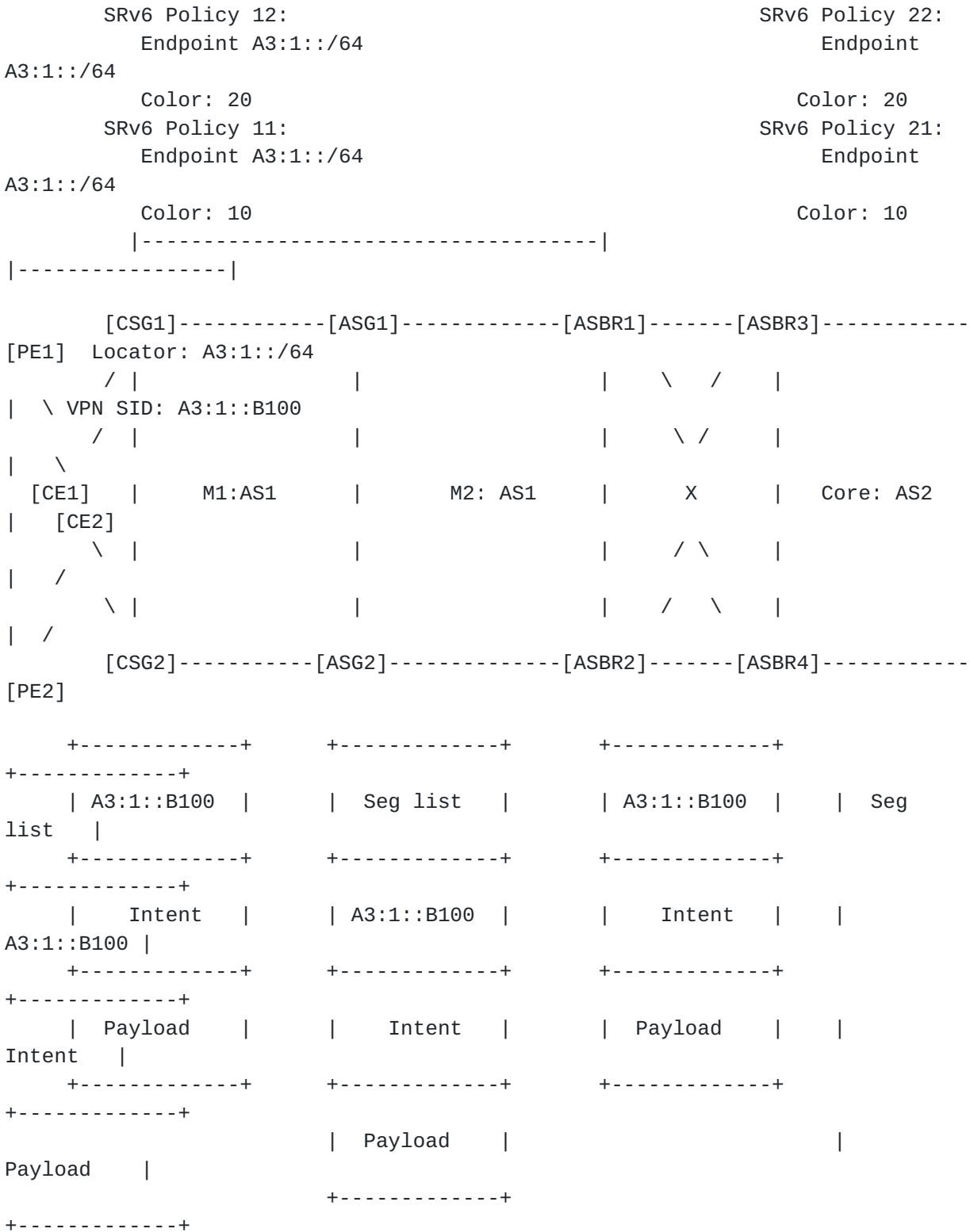


Figure 4: Figure 4: Illustration of Intent-based Inter-domain Routing

Figure 4 shows an example of a service provider network that

comprises of two Autonomous systems, AS1 and AS2. The customer requests a leased line that requires bandwidth guarantee from CSG1 to PE1. Assume that the following is applied in the network shown in the Figure 4:

- o Independent ISIS instance in core (C) region.
- o Independent ISIS instance in Metro1 (M1) region.
- o Independent ISIS instance in Metro2 (M2) region.
- o BGP between ASBRs
- o PE1`s locator is A3:1::/64, and VPN SID is A3:1::B100.
- o Core`s aggregated routes are redistributed from Core to M (M1 and M2).

- o SRv6 policy group is set up in the AS1 between the CSG1 and ASBR1. It includes two SRv6 policies with the same Endpoint A3:1::/64 and color 10 and 20 respectively.
- o SRv6 policy group is set up in the AS2 between the ASBR3 and PE1. It includes two SRv6 policies with the same Endpoint A3:1::/64 and color 10 and 20 respectively.

PE1 advertises the VPN route with color 10 to CSG1. After CSG1 receive the VPN route, it maps color to the Intent and installs the VPN route with VPN SID A3:1::B100 and the corresponding intent. When CSG1 receives a packet from CE1, assume that CE1 finds the VPN route and the forwarding process is as follows:

1. CE1 encapsulates a new IPv6 header to the packet with the destination IPv6 address set as VPN SID A3:1::B100 and the Intent in the packet.
2. CE1 can search the forwarding entry according to the destination IPv6 address A3:1::B100 and the Intent.
3. After CE1 finds the SRv6 Policy 11 with the color 10, it encapsulates the new IPv6 header with the corresponding segment list to the packet.
4. The packet is forwarded to ASBR1 and the segment list is decapsulated at ASBR1.
5. ASBR1 can send the packet to ASBR3 according to the destination address A3:1::B100 by IPv6 forwarding process.
6. ASBR3 searches the forwarding entry according to the destination IP address A3:1::B100 and the Intent.
7. ASBR3 finds the SRv6 policy 21 with the color 10 and encapsulates the new IPv6 header with the corresponding segment list to the packet.
8. The packet is forwarded to PE1 and the segment list is decapsulated at PE1.
9. The packet is forwarding in the corresponding VPN instance identified by the destination IPv6 address A3:1::B100.

5. IPv6 Encapsulation

The intent can be encapsulated in the different data plane. This document firstly define the IPv6 encapsulation for the intent.

In order to support the intent-based routing, one new option, the Intent option, is defined.

The Intent option has the following format:

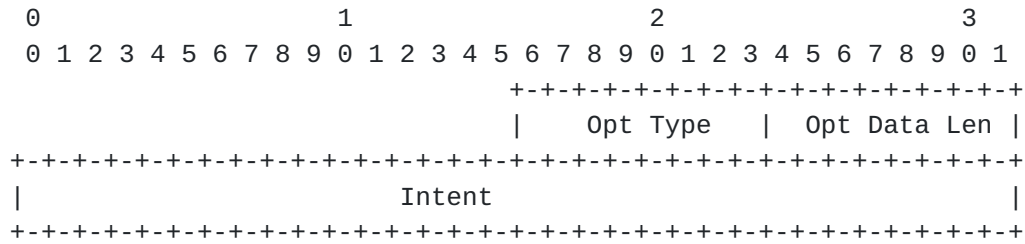


Figure 5. Intent Option

where:

- o Opt Type: Type value is TBD. 8-bit unsigned integer. Identifier of the type of this Intent Option.
- o Opt Data Len: 8-bit unsigned integer. Length of the Option Data field of this option, that is, length of the Intent.
- o Option Data: Option-Type-specific data. It carries the Intent. A 32-bit identifier.

The Intent option can be placed in several locations in the IPv6 packet header depending upon the scenarios and implementation requirements.

1. Hop-by-Hop Options Header (HBH)

The Intent option can be carried in the Hop-by-Hop Options Header as the new option. By using the HBH Options Header, the intent information carried can be read by every node along the path.

2. Destination Options Header (DOH)

The Intent option can be carried in the Destination Options Header as the new option. By using the DOH Options Header, the intent

information carried can be read by the destination node along the path.

Besides the Intent option, the intent can also be carried combining with Application-aware Networking ([I-D.li-apn-framework]). [I-D.li-apn-header] and [I-D.li-apn-ipv6-encap] defines that the intent can be carried in the APN header which is encapsulated in the APN option in the IPv6 data plane.

6. Security Considerations

TBD

7. IANA Considerations

This document requests IANA to assign a new option type from "Destination Options and Hop-by-Hop Options" registry.

Value Description Reference

TBD Intent Option this document

8. References

8.1. 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>>.

[RFC7356] Ginsberg, L., Previdi, S., and Y. Yang, "IS-IS Flooding Scope Link State PDUs (LSPs)", [RFC 7356](#), DOI 10.17487/RFC7356, September 2014, <<https://www.rfc-editor.org/info/rfc7356>>.

[RFC7490] Bryant, S., Filsfils, C., Previdi, S., Shand, M., and N. So, "Remote Loop-Free Alternate (LFA) Fast Reroute (FRR)", [RFC 7490](#), DOI 10.17487/RFC7490, April 2015, <<https://www.rfc-editor.org/info/rfc7490>>.

[RFC8400] Chen, H., Liu, A., Saad, T., Xu, F., and L. Huang, "Extensions to RSVP-TE for Label Switched Path (LSP) Egress Protection", [RFC 8400](#), DOI 10.17487/RFC8400, June 2018, <<https://www.rfc-editor.org/info/rfc8400>>.

- [RFC8402] Filsfils, C., Ed., Previdi, S., Ed., Ginsberg, L., Decraene, B., Litkowski, S., and R. Shakir, "Segment Routing Architecture", [RFC 8402](#), DOI 10.17487/RFC8402, July 2018, <<https://www.rfc-editor.org/info/rfc8402>>.
- [RFC8665] Psenak, P., Ed., Previdi, S., Ed., Filsfils, C., Gredler, H., Shakir, R., Henderickx, W., and J. Tantsura, "OSPF Extensions for Segment Routing", [RFC 8665](#), DOI 10.17487/RFC8665, December 2019, <<https://www.rfc-editor.org/info/rfc8665>>.
- [RFC8667] Previdi, S., Ed., Ginsberg, L., Ed., Filsfils, C., Bashandy, A., Gredler, H., and B. Decraene, "IS-IS Extensions for Segment Routing", [RFC 8667](#), DOI 10.17487/RFC8667, December 2019, <<https://www.rfc-editor.org/info/rfc8667>>.
- [RFC8679] Shen, Y., Jeganathan, M., Decraene, B., Gredler, H., Michel, C., and H. Chen, "MPLS Egress Protection Framework", [RFC 8679](#), DOI 10.17487/RFC8679, December 2019, <<https://www.rfc-editor.org/info/rfc8679>>.

8.2. Informative References

- [I-D.hegde-spring-mpls-seamless-sr]
Hegde, S., Bowers, C., Xu, X., Gulko, A., Bogdanov, A., Uttaro, J., Jalil, L., Khaddam, M., Alston, A., and L. M. Contreras, "Seamless SR Problem Statement", [draft-hegde-spring-mpls-seamless-sr-06](#) (work in progress), September 2021.
- [I-D.ietf-spring-segment-routing-policy]
Filsfils, C., Talaulikar, K., Voyer, D., Bogdanov, A., and P. Mattes, "Segment Routing Policy Architecture", [draft-ietf-spring-segment-routing-policy-19](#) (work in progress), March 2022.
- [I-D.kaliraj-idr-bgp-classful-transport-planes]
Vairavakkalai, K., Venkataraman, N., Rajagopalan, B., Mishra, G., Khaddam, M., Xu, X., Szarecki, R. J., and D. J. Gowda, "BGP Classful Transport Planes", [draft-kaliraj-idr-bgp-classful-transport-planes-13](#) (work in progress), January 2022.

[I-D.li-apn-framework]

Li, Z., Peng, S., Voyer, D., Li, C., Liu, P., Cao, C., Mishra, G., Ebisawa, K., Previdi, S., and J. N. Guichard, "Application-aware Networking (APN) Framework", [draft-li-apn-framework-04](#) (work in progress), October 2021.

[I-D.li-apn-header]

Li, Z. and S. Peng, "Application-aware Networking (APN) Header", [draft-li-apn-header-00](#) (work in progress), October 2021.

[I-D.li-apn-ipv6-encap]

Li, Z. and S. Peng, "Application-aware IPv6 Networking (APN6) Encapsulation", [draft-li-apn-ipv6-encap-00](#) (work in progress), October 2021.

[I-D.li-apn-problem-statement-usecases]

Li, Z., Peng, S., Voyer, D., Xie, C., Liu, P., Qin, Z., Mishra, G., Ebisawa, K., Previdi, S., and J. N. Guichard, "Problem Statement and Use Cases of Application-aware Networking (APN)", [draft-li-apn-problem-statement-usecases-05](#) (work in progress), December 2021.

[RFC5226] Narten, T. and H. Alvestrand, "Guidelines for Writing an IANA Considerations Section in RFCs", [RFC 5226](#), DOI 10.17487/RFC5226, May 2008, <<https://www.rfc-editor.org/info/rfc5226>>.

[RFC5462] Andersson, L. and R. Asati, "Multiprotocol Label Switching (MPLS) Label Stack Entry: "EXP" Field Renamed to "Traffic Class" Field", [RFC 5462](#), DOI 10.17487/RFC5462, February 2009, <<https://www.rfc-editor.org/info/rfc5462>>.

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