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IGP Color-Aware Shortcut
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Abstract

IGP shortcut mechanism allows calculating routes to forward traffic over Traffic Engineering tunnels. This document specifies the enhancement of IGP shortcut which can steer routes onto TE-tunnels based on colors.

Status of this Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

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This Internet-Draft will expire on April 17, 2026.

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1. Introduction

[RFC3906] describes how IGP calculate routes to forward traffic over Traffic Engineering tunnels. Such mechanism is also referred to as IGP shortcut.

The granularity of IGP shortcut is based on nodes. If the first-hop of a node is determined to be a TE-tunnel during the SPF computation, all routes to IP prefixes advertised by that node will be over that TE-tunnel. For example, in the following topology, X1 and X2 are IP prefixes advertised by rtrC, and Y1 and Y2 are IP prefixes advertised by rtrD. Using IGP shortcut, all routes to X1, X2, Y1 and Y2 will be steered onto T1 and T2.

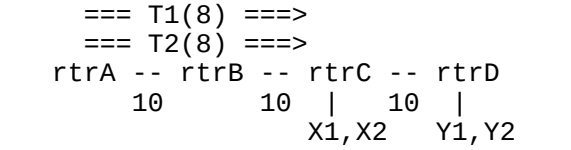


Figure 1: IGP shortcut Topology

However, in some scenarios, there may be requirements to steer the routes to different prefixes of the same node onto different TE-tunnels. For example, the traffic flows to X1 and Y1 need to be

forwarded over low delay tunnel T1, but the traffic flows to X2 and Y2 need to be forwarded over high bandwidth tunnel T2.

In the BGP-based service, "color" is often used to indicate the intent of forwarding [RFC9012] [RFC9252]. The Color Extended Community can be attached to BGP routes, and the associated flows will be steered into tunnels with the same color.

This document specifies the enhancement of IGP shortcut which can steer routes onto TE-tunnels based on colors.

In [RFC3906], the term "TE-tunnel" mainly refers to Label Switched Path, such as MPLS RSVP-TE tunnel. With the development of Segment Routing (SR) technology, SR Policy [RFC9256] becomes a useful tool for Traffic Engineering. In the context of this document, SR Policies are also included as TE-tunnels.

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. Colors of IGP Prefixes

A prefix can be associated with one or more colors. Administrative tags are used to advertising the colors for IGP prefixes.

For IS-IS, the 32-bit Administrative Tag Sub-TLV defined in [RFC5130] can be used to associate one or more 32-bit tags with a prefix. For OSPFv2 and OSPFv3, the 32-bit Administrative Tag Sub-TLV defined in [RFC9825] provides the similar function.

Since multiple tags for different applications may be attached to one prefix, there has to be a mechanism for a receiver to know which tags are used as colors. For example, the tag space can be split and some of it can be used to signal colors.

The value of a tag and the value of color indicated by that tag can simply be equal. Alternatively, there can be a mapping relationship between them. For example, the value of color can be calculated from the value of tag by applying a mask over it.

How to obtain the color(s) of a prefix from the associated tags, is governed by local policy and uniform within the same IGP domain.

3. Colors of TE-Tunnels

The main idea of this document is to steer the flows to colored prefixes into tunnels with the same color.

Some kinds of TE-tunnels, such as SR Policy [RFC9256], have inherent color values which can be directly used to match the colors of prefixes. For the TE-tunnels which have no inherent color, the color values may be determined by local configurations.

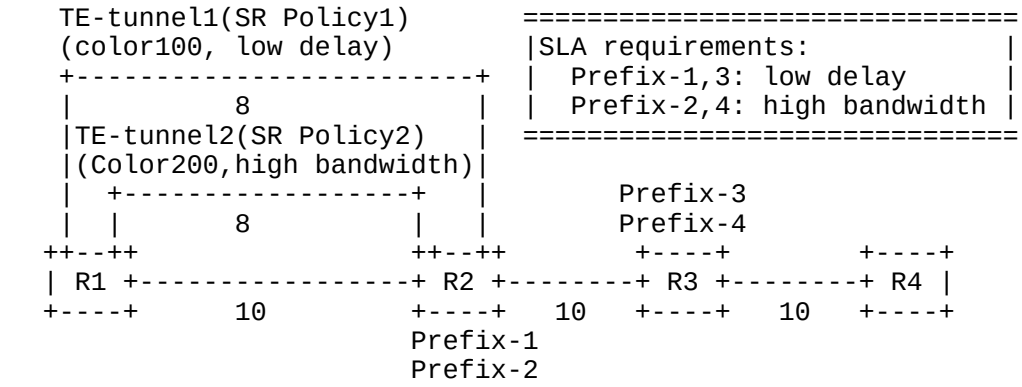
4. IGP Color-Aware Shortcut

The SPF computation for IGP shortcuts is described in Section 2 of [RFC3906], and the metric adjustment for IGP shortcuts is described in Section 4 of [RFC3906].

This document does not modify the SPF calculation for IGP shortcuts. Instead, it introduces the following additional steps when calculating next hops for prefixes advertised by a node:

- If a prefix is colored, we look up the first-hop information of the advertiser node for TE-tunnels with the same color.
  - If there are eligible TE-tunnels, we compare the costs of paths over those TE-tunnels, and use the next-hop of the TE-tunnel with the lowest path cost.
  - If there is no eligible TE-tunnel, we use the native adjacency next-hop.
- If a prefix has no color, we use the next-hop with the lowest path cost.

5. Use Case



Routing calculation on R1:

Traditional Shortcut:

Prefix-1,2,3,4

Next-hop1: SR Policy 1

Next-hop2: SR Policy 2

Color Aware Shortcut:

Prefix-1,3

Next-hop: SR Policy 1

Prefix-2,4

Next-hop: SR Policy 2

Figure 2: IGP Color Aware Shortcut

Between R1 and R3, there are two SP policies: SR Policy 1, which has a color of 100 and corresponds to a low-latency SLA (Service-level Agreement) required path, and SR Policy 2, which has a color of 200 and corresponds to a high-bandwidth SLA-required path.

In the case of a traditional TE Shortcut, after R1’s route calculation, the next hops for Prefix-1, Prefix-2, Prefix-3, and Prefix-4 all point to SR Policy 1 and SR Policy 2.

In the case of a Color-aware TE Shortcut, the next hops for Prefix-1 and Prefix-3 point to SR Policy 1, while the next hops for Prefix-2 and Prefix-4 point to SR Policy 2.

This approach ensures that traffic is routed according to the specific SLA requirements, improving network efficiency and performance.

6. Management Considerations

Implementations MAY allow configuration of policies that:

- Assign color values to prefixes.
- Map these colors to prefix tags for advertisement [RFC5130][RFC9825].

During prefix calculation, implementations MAY support local conversion of prefix tags to colors through configuration.

When a TE tunnel is not associated with a color, implementations MAY permit manual configuration of the color attribute.

Furthermore, implementations MAY support:

- Color-based TE tunnel matching during IGP shortcut computation.
- Policy-based control over which prefixes are included in the computation.

7. Security Considerations

This document does not change the security aspects of IS-IS or OSPF. Security considerations specific to each protocol still apply.

8. IANA Considerations

This document has no IANA actions.

9. References

9.1. Normative References

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.

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[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>

[RFC9825] Lindem, A., Psenak, P., and Y. Qu, "Extensions to OSPF for Advertising Prefix Administrative Tags", RFC9825, DOI 10.17487/RFC9825, July 2025, < https://www.rfc-editor.org/info/rfc9825>.

9.2. Informational References

[RFC9012] Patel, K., Van de Velde, G., Sangli, S., and J. Scudder, "The BGP Tunnel Encapsulation Attribute", RFC 9012, DOI 10.17487/RFC9012, April 2021, <https://www.rfc-editor.org/info/rfc9012>.

[RFC9252] Dawra, G., Ed., Talaulikar, K., Ed., Raszuk, R., Decraene, B., Zhuang, S., and J. Rabadan, "BGP Overlay Services Based on Segment Routing over IPv6 (SRv6)", RFC 9252, DOI 10.17487/RFC9252, July 2022, <https://www.rfc-editor.org/info/rfc9252>.

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