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Color Operation with BGP Label Unicast
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Abstract

This document specifies how to carry colored path advertisement via an extension to the existing protocol BGP Label Unicast. It would allow backward compatibility with [RFC8277](#).

The targeted solution is to use stack of labels advertised via BGP Label Unicast 2.0 for end to end traffic steering across multiple IGP domains. The operation is similar to Segment Routing.

This proposed protocol will convey the necessary reachability information from ingress PE node to construct an end to end path.

There is a major change of protocol format starting from this updated draft.

Status of this Memo

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1. Introduction

The proposed protocol is aimed to solve interdomain traffic steering, with different transport services in mind. One application is low latency service across multiple IGP domains, which could scale up to 100k or more routers network wide.

BGP is a flexible protocol. With additional of color attribute to BGP Labeled Unicast, a path with specific color would be given a meaning in application: a latency path, a fully protected path, or a path for diversity.

The stack of labels would mean an end to end path across domains through

or ASBR. Each ABR or ASBR will take one label from the stack, and hence p forwarding path to next ABR, ASBR, or the final destination.

And the label in the stack may be derived from any of the below

- Prefix SID
- Binding SID for RSVP LSP
- Binding SID for SR-TE LSP
- Local assigned label

The enhancement to the original [RFC8277](#) is to add color extended communit multiple advertisement allowed. The result is similar to multi-topology B different colors.

With Add-path [[RFC7911](#)] feature, non color RIB and colored RIB could be a to the BGP neighbors without new additional attributes. Add-path capabili required advertise multiple paths with same prefix but different colors.

A new [[BGP-CAP](#)] should be required to enforce such slicing operation duri negotiation.

On the other hand, to enable the service prefixes to be mapped accordingl L3VPN, L2VPN, EVPN and IP prefix with BGP signaling, the color extended c is also added there. In the PE node, the service prefixes with color will matched to a transport tunnel with the same color.

The following is an example. Between PE1 and PE2, there is a VPN service with label 16, which is associated with color 100.

PE1----ABR1-----ABR2-----PE2

PE1 will send the following labels with a color 100 path plus VPN label

[2001 13001 801 16], where

2001 - SR label to reach ABR1

13001 - a Binding-SID label for ABR1-ABR2 tunnel. Underlying tunnel type

801 - a Binding-SID label for ABR2-PE2 tunnel. Underlying tunnel type is

16 - a VPN label, which is signaled via other means

[2001 13001 801] - denotes the label stack for this color 100 path to rea

The document here is going to describe how PE1 gains enough information to reach PE2 with this label stack across routing domains.

If PE1 wants to reach PE2 with another colored path, say color 200, the label stack could be different.

At the same time, this architecture is also controller friendly, since all notation is Segment Routing compatible, like use of Binding-SID.

2. Conventions used in this document

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](#)].

In this document, these words will appear with that interpretation only when in CAPS. Lower case uses of these words are not to be interpreted as carrying the significance described in [RFC 2119](#).

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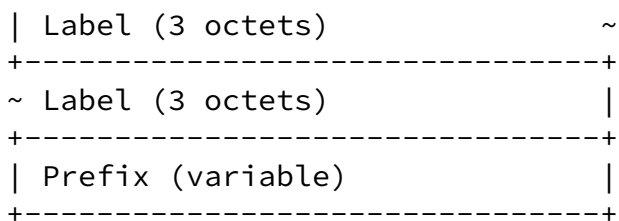
3. Carrying Label Mapping Information with Color and Label Stack

3.1. Use of Add-path to advertise multiple color paths

The use of Path Identifier is to allow multiple advertisement of the same NLRI but with different colors or null color.

The extended NLRI format would be like this

```
+-----+
| Path Identifier (4 octets) |
+-----+
| Length (1 octet)         |
+-----+
```



3.2. Color extended community for BGP Labeled Unicast

The addition of Color Extended Community is an opaque extended community [RFC4360](#) and [RFC5512](#). The draft allows multiple color values advertisement

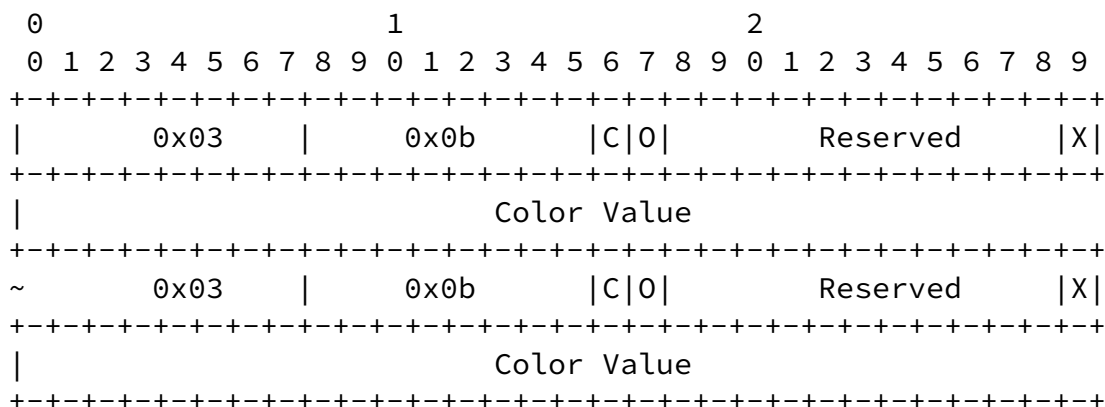


Figure 1: Color value advertisement format

Both in BGP update and MP_UNREACH_NLRI message, multiple color extended community could be included. It means that multiple colors, indicating different kinds of services, could share the same label stack. With the use of Path-ID, the colors are considered as one bundled update. Any subsequent update is based on Path-ID.

If color extended community is not present in a BGP update message, it will be treated as normal BGP-LU without any color.

3 bits of XXX is reserved here for the draft.

The meaning for XXX is interpreted as sub-slice of color, with 0 to 7 in decimal or 000b and 111b in binary. These sub-slice could be used in either of the following case.

- a) Primary path and fallback paths in order of preference
 - 0 - primary path
 - 1 - first and most preferred backup path
 - ...

7 - least preferred backup path

b) ECMP paths up to 8, since all paths should be active in forwarding plane

Color value 0 is reserved for future interoperability purpose.

Color value 1 - 31 are not recommended to use, and this range is reserved for future use.

3.3. Color extended community for service prefixes

The same format of color extended community is advertised with service prefixes which could be VPN prefixes or IP prefixes. The order of the color extended community could be interpreted as

- Order of primary and fallback colors
- Or, ECMP of equal split between color paths

The above would be interpreted by the receiving PE upon its local configuration

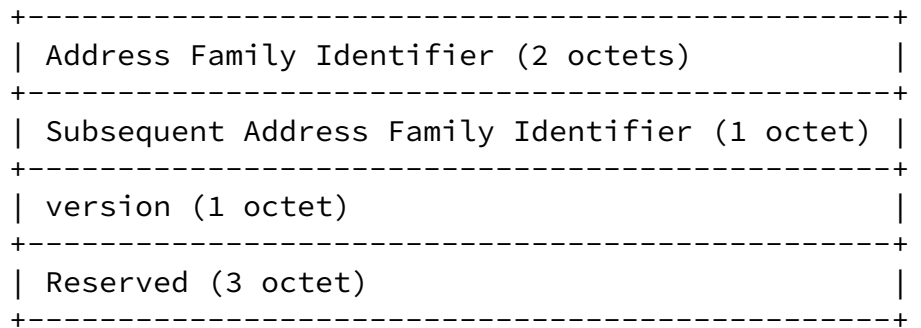
It is optional to enable sub-slice notation.

But if sub-slice bits are used, it will be used to map directly to each sub-slice path. If sub-slice path is not available for mapping, it should just resolve by color.

3.4. Color Slicing Capability

The Color Slicing Capability is a BGP capability [RFC5492], with Capability Length field of this capability is variable. The Capability Length field of this capability is variable. The Capability Length field of this capability is variable.

Value field consists of one or more of the following tuples:



The meaning and use of the fields are as follows:

Address Family Identifier (AFI):

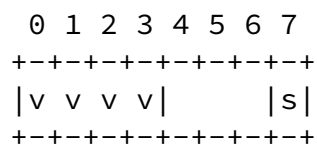
This field is the same as the one used in [[RFC4760](#)].

Subsequent Address Family Identifier (SAFI):

This field is the same as the one used in [[RFC4760](#)].

Version:

This field is for capability negotiation.



Each of 4 bits of v represents a flag of version from 0 to 4, where 0 denotes support of version 1, and MSB denotes version 4. Version 0 is the mode of operation, which is described in this document. To determine the capability between the two BGP PEER, logical AND function to use determine highest denominator of protocol version.

For example, if BGP receive 0b0110 from its peer and perform AND function on own capability 0b0010, the result is 0b0010. Version 2 is selected.

The other examples are

- 0b0110 AND 0b0110, version 3 is selected
- 0b0100 AND 0b0010, version 0 is selected

Version 1 (0b0001) is reserved.

S-flag is the indication of use of sub-slice. Set to 1 if sub-slice not enforced. If either side is set to 0 for S-flag, sub-slice is not in use.

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Reserved:

This field is reserved for future use.

4. Uniqueness of path entries

a) Use of color can be considered to slice into multiple BGP Label Unicas. Therefore, it should be treated as unique entries for the <path-id, color prefix>.

e.g. <path-id, color(s), prefix>, [labels]

<123, 100, 10.1.1.1/32>, [1000 2000]

<124, 200, 10.1.1.1/32>, [1000 2000]

<222, {300,400}, 10.1.1.1/32>, [1000 2000]

<223, null, 10.1.1.1/32>, [1000 2000]

All these 4 NLRI are considered different but valid entries for different instances.

b) With sub-slice notation

<path-id, color-sub, prefix>, [labels]

<901, 100-0, 10.1.1.1/32>, [1000 2000]

<902, 100-1, 10.1.1.1/32>, [1001 3000]

<903, 100-7, 10.1.1.1/32>, [1002 4000]

These 3 NLRI are distinct, and the second and third NLRI could be used backup or ECMP purpose.

5. AIGP consideration

AIGP ([RFC7311](#)) would be also used in here to embed certain metric across.

6. Explicit Withdraw of a <path-id, color(s), prefix>

According to [RFC8277](#), MP_UNREACH_NLRI can be used to remove binding of a <path-id, color(s), prefix>.

If a path-id is associated with a prefix with multiple colors, the withdrawal should be applied to all associated colors.

To withdraw color(s) partially from the same path-id advertisement, BGP unreachability should be used instead.

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7. Error Handling Procedure

If BGP receiver could not handle the NLRI, it should silently discard with logging.

8. Controller Compatibility

The proposed architecture is compatible with controller for end to end provisioning. Persistent label, like Binding-SID is recommended to be used. Controller could learn these labels from the network, and program specific end path.

In this case, BGP-LU2 will provide a second best path to an ingress PE node. A controller, with more external information, could provide a best path from an overall perspective.

Controller could also be deployed based on domain by domain perspective. Optimizing latency of a RSVP LSP, or maintain the bandwidth and loading of TE LSPs.

9. Security Considerations

10. IANA Considerations

TBD. It will require a new BGP capability code to enable such color operation.

New SAFI might be required as well.

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