Network Working Group A. Gupta
Internet-Draft S. Venaas
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# PIM Encoding and Procedures for Unicast IPv4 prefixes with IPV6 next-hop

draft-pim-with-ipv4-prefix-over-ipv6-nh-00.txt

## Abstract

Multiprotocol BGP (MP-BGP) has support for distributing next-hop information for multiple address families using one AFI/SAFI Network Layer Reachability Information (NLRI). [RFC5549] specifies the extensions necessary to allow advertising IPv4 NLRI or VPN-IPv4 NLRI with a Next Hop address that belongs to the IPv6 protocol. While the next-hop info is learnt via MP-BGP, certain procedures are needed to enable traffic forwarding. This document describes PIM extentions and the use-cases for multicast forwarding in various scenarios.

## Status of This Memo



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## 1. Introduction

Figure 1: Example Topology

```
             +-------------+                   +-------------+
             |             |                   |             |
             | Router1   1::1/64         1::2/64 Router2     |
10.1.1.1/32--+             +--------Intf1------|             +--+PIM receiver
             |         1.1.1.1/24        1.1.1.2/24          |
             |             +                   +             |
             |             |                   |             |
             +-------------+                   +-------------+
```

While use of MP-BGP along with [RFC5549] enables one routing protocol session to exchange next-hop info for both IPv4 and IPv6 prefixes, forwarding plane needs additional procedures to enable forwarding in data-plane. For example, when a IPv4 prefix is learnt over IPv6 next-hop, forwarding plane resolves the MAC-Address (L2-Adjacency) for IPv6 next-hop and uses it as destination-mac while doing inter-subnet forwarding. While it's simple to find the required information for unicast forwarding, multicast forwarding in same scenario poses additional requirements.

Multicast traffic is forwarding on a tree build by multicast routing protocols such as PIM. Multicast routing protocols are address family dependent and hence a system enabled with IPv4 and IPv6 multicast routing will have two PIM sessions one for each of the AF. Also, Multicast routing protocol uses Unicast reachability information to find unique Reverse Path Forwarding Neighbor. Further it sends control messages such as PIM Join to form the tree. Now when a PIMv4 session needs to initiate new multicast tree in event of discovering new receiver It consults Unicast control plane to find next-hop information. While this multicast tree can be Shared or Shortest Path tree, PIMv4 will need a PIMv4 neighbor to send join. However, the Unicast control plane can provide IPv6 next-hop as explained earlier and hence we need certain procedures to find corresponding PIMv4 neighbor address. This address is vital for correct prorogation of join and furthermore to build multicast tree. This document describes various approaches along with their use-cases and pros-cons.

In example topology, Router1 and Router2 can have PIMv4 and PIMv4 neighbors. Router2 learns prefix 10.1.1.1/32 has next-hop as 1::1/64 on Intf1 as advertised by Router1 using BGP IPV6 NLRI. But in order to send (10.1.1.1/32, mcast-group) PIMv4 join on Intf1, Router1 needs to find corrosponding PIMv4 neighbor.

### 1.1. Terminology

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].

## 2. Solution

### 2.1. Networks with both PIMv4 and PIMv6 sessions

[RFC6395] introduces a new PIM hello option called interface identifier. The Interface Identifier consists of 64 bits. The lower 32 bits form a Local Interface Identifier, and the high 32 bits form a Router Identifier. When a PIM router is enabled with said option

it would include an optional router ID, like an IPv4 loopback address that is unique in the network and can uniquely identify said PIM router and an interface ID unique to the router, e.g. ifindex which can uniquely identify interface within the said router. PIMv4 and PIMv6 would use the same IDs while generating hello messages on same interface on said router.

Furthermore, downstream router can make use of this as following. When PIMv4 have found the IPv6 Next-hop for a given prefix, it can consult with PIMv6 and find out the interface Identifier for the PIMv6 neighbor. Then it can check which PIMv4 neighbor has the same router ID + interface ID. A match would give the PIMv4 neighbor on required interface, and PIMv4 join should include it as upstream-neighbor since It found as the same interface on the same router.

Optionally if for some reason, the complete interface Identifier does not match, PIMv4 can try to look for a router ID match. That would mean that the IPv4 interface is a different interface than PIMv6 neighbor but on the same router, and in this case PIMv4 join should be sent to different interface since there is no PIMv4 neighbor ship on given Interface but with a different interface on same router.

## 2.2. Networks with Either PIMv4 or PIMv6 session

### 2.2.1. Using secondary neighbor list option

PIM router can advertise its locally configured IPv6 addresses on the interface in PIMv4 Hello messages as per RFC4601 section 4.3.4. PIM will keep this info for each neighbor in Neighbor-cache along with DR-priority, hold-time etc. Once IPv6 Next-hop is notified to PIMv4, it will look into neighbors on the notified RPF-interface and find PIMv4 neighbor advertising same IPv6 local address in secondary Neighbor-list. Once found this neighbor will be used as IPv4 RPF-Neighbor for initiating upstream routers. This method does not need network to be enabled with PIMv4 and PIMv6.

### 2.2.2. Using MAC-Address option

In some cases where PIM-Neighbor ship can't be established with IPv6 Next-Hop [For example recursive Next-Hop case]. PIMv4 routers can advertise their local router-mac address in PIM Hello. This info should be maintained per neighbor by PIMv4 in neighbor-cache, along with hold-time, DR-Priority etc. Once IPv6 Next-hop is known to PIMv4, it can first resolve its L2-Address (Mac-Address) using known/ existing methods such as ARP/IPv6 Neighbor Discovery. Once MAC-address is resolved, PIMv4 should look into neighbor cache with RPF-interface and MAC-Address as key. If a matching PIMv4 neighbor is found, it should be included in Upstream-neighbor field of Join-

message.  The above-said new option to include local MAC-Address in PIM hello message should be registered in IANA and TBD as of now. The proposed new Hello option is structured below.

Option Type: MAC address identifier

```
 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 = TBD          |         Length = 8            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                        MAC-Address-1                          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                        MAC-Address-2                          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Length: In bytes for the value part of the Type/Length/Value encoding.  The MAC-Address identifier will be 8 bytes long.

MAC-Address-1: The MAC-Address-1 is a 4-byte identifier made up of Low order 4 bytes of Router MAC Address.  The field MUST contain a valid value which is Non-zero.

MAC-Address-2: The MAC-Address-2 Identifier is a 4-byte identifier that contains the 2-high-order bytes value of Router MAC Address in its 2 high-order bytes.

## 3.  Security Considerations

TBD

## 4.  IANA Considerations

TBD

## 5.  Acknowledgements

none

## 6.  References

### 6.1.  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, <http://www.rfc-editor.org/info/rfc2119>.

### 6.2. Informative References

[RFC4601] Fenner, B., Handley, M., Holbrook, H., and I. Kouvelas, "Protocol Independent Multicast - Sparse Mode (PIM-SM): Protocol Specification (Revised)", RFC 4601, DOI 10.17487/RFC4601, August 2006, <http://www.rfc-editor.org/info/rfc4601>.

[RFC5549] Le Faucheur, F. and E. Rosen, "Advertising IPv4 Network Layer Reachability Information with an IPv6 Next Hop", RFC 5549, DOI 10.17487/RFC5549, May 2009, <http://www.rfc-editor.org/info/rfc5549>.

[RFC6395] Gulrajani, S. and S. Venaas, "An Interface Identifier (ID) Hello Option for PIM", RFC 6395, DOI 10.17487/RFC6395, October 2011, <http://www.rfc-editor.org/info/rfc6395>.

Authors' Addresses

Ashutosh Gupta
Cisco Systems
821 Alder Drive
San Jose, CA  95035
USA

Email: ashugupt@cisco.com

Stig Venaas
Cisco Systems
821 Alder Drive
San Jose, CA  95035
USA

Email: stig@cisco.com