IPv6 Multicast

Intro

- Multicast is inherent to the IPv6 protocol
- No broadcasts
  - Multicast used instead
- But some parts need to be configured
  - for building the multicast trees
  - for topology information (routing)

IPv6 multicast

Multicast addressing

MLD & MLDv2

PIM SM/SSM

Interdomain multicast

Multicast addressing

- **Multicast addresses format: (RFC 3513)**

8 bits		4 bits	4 bits	112 bits
1111	1111	flags	scope	group ID
F	F			

- 8 high order bits set to 1 → Addresses derived from FF00::/8 prefix
- **flag** field(4 bits) :

  `0RPT` values

  T = 0 for permanent addresses (Defined by IANA)

  T = 1 for transient addresses

  Bits P and R discussed later
- **scope** field → Makes it possible to limit the scope of the multicasting

  0 - Reserved

  1 – Node-local

  2 – Link-local

  3 – Subnet-local

  4 - Admin-local

  5 - Site-local

  8 - Organization-local

  E - Global (Internet)

Multicast addressing

- Scopes must be configured on routers!
- Examples of IANA allocated addresses
  - Flag bits T=P=R=0
    - Flag = 0
  - Group ID 101 → NTP servers
    - FF01:0:0:0:0:0:0:101 : All the NTP servers on the sender's host
    - FF02:0:0:0:0:0:0:101 : All the NTP servers on the sender's link
    - FF05:0:0:0:0:0:0:101 : All the NTP servers on the sender's site
    - FF0E:0:0:0:0:0:0:101 : All the NTP servers on the Internet

Reserved multicast addresses: examples (RFC 2375)

- Addresses available only for a given scope
  - FF02:0:0:0:0:0:0:1 : All the nodes of the link
  - FF02 :0:0:0:0:0:0: 2 : All the routers of the link
  - FF05 :0:0:0:0:0:0: 2 : All the routers of the site
  - FF02 :0:0:0:0:0:0: D : All the PIM routers of the link
  - ...
- Addresses available for all scopes
  - FF0X :0:0:0:0:0:0: 101 : Network Time Protocol (NTP)
  - FF0X :0:0:0:0:0:0: 109 : MTP Multicast Transport Protocol
  - ...

IPv6 multicast and Ethernet

- Ethernet is multicast capable (not always implemented)
- Requires 8th bit of MAC address to be set to 1
- For IPv6 : @MAC = 33-33-xx-yy-zz-kk
- xx-yy-zz-kk are 32 lower bits of the IPv6 address
- Example:
  - **IPv6@ = FF3E:40:2001:660:3007:123:1234:5678**
  - **MAC@ = 33-33-12-34-56-78**

Solicited node multicast addresses (for NDP)

- Multicast address built from unicast address
- Concatenation of
  - FF02::1:FF00:0/104
  - 24 low order bits of the unicast address
- Nodes build their own IPv6 solicited node multicast address
- Nodes that know the IPv6 address of a host but not its MAC address can use the solicited node multicast address
  - NDP protocol (Neighbor Discovery Protocol)
  - Protocol for DAD management
- Avoids sending MAC broadcasts (FF-FF-FF-FF-FF-FF)
- Example:

```
2001:0660:010a:4002:4421:21FF:FE24:87c1
FF02:0000:0000:0000:0000:0001:FF00:0000/104
FF02:0000:0000:0000:0000:0001:FF24:87c1
33-33-FF-24-87-C1  -> MULTICAST MAC ADDRESS
```

Multicast addresses derived from unicast prefixes (RFC 3306)

- **Flag : 0RPT**

11111111	flag	scop	reserved	Plen	Network prefix	Group ID
8 bits	4	4	8 bits	8	64 bits	32 bits

Flag : 0RPT

P=0 → Address not based on the unicast prefix

P=1 → Address based on the unicast prefix

If P=1 → T=1 → FF30::/12 prefix

(T=1 because not allocated by IANA)

Reserved : 0

Plen: Prefix length

Network prefix

Example: prefix 2001:660::/32 (RENATER)

address FF3E:20:2001:660:0:0:1234:abcd

SSM addresses

- Are also RFC3306 addresses
- SSM addresses range: FF3X::/32
- Only addresses in FF3X::/96 should be used now. These are RFC3306 addresses with:
  - Plen = 0
  - Prefix = 0
- Example:
  - FF3x::1234:abcd /96
  - 1234:abcd being the Group ID

Multicast addresses allocation

- « Manual » choice of multicast address and port
- Dynamic
  - Session Announcement Protocol, (SAP), ID
    - SDR implements SAP (not scalable for a global scope)
  - MADCAP, RFC 2730
    - Multicast Address Dynamic Client Allocation Protocol (too much complex, very few implementations and no deployment)
  - GLOP, RFC 2770
    - Useless as we have RFC 3306
- Multicast addresses derived from unicast prefixes (RFC 3306)
  - Any host can derive a multicast address from the network prefix where it is connected
  - Makes allocation easier
  - How to assign addresses to end user remains a problem

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MLDv1 & MLDv2

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Interdomain multicast

Multicast Listener Discovery (MLD)

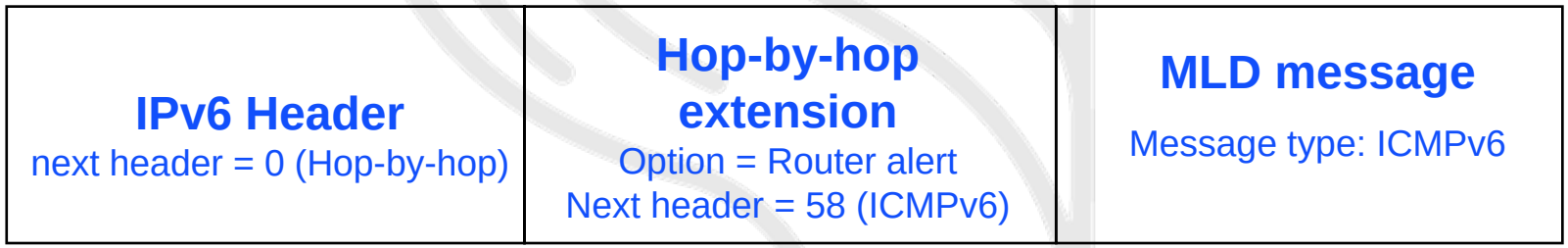
RFC 2710 (MLD version 1)

RFC 3810 (MLD version 2)

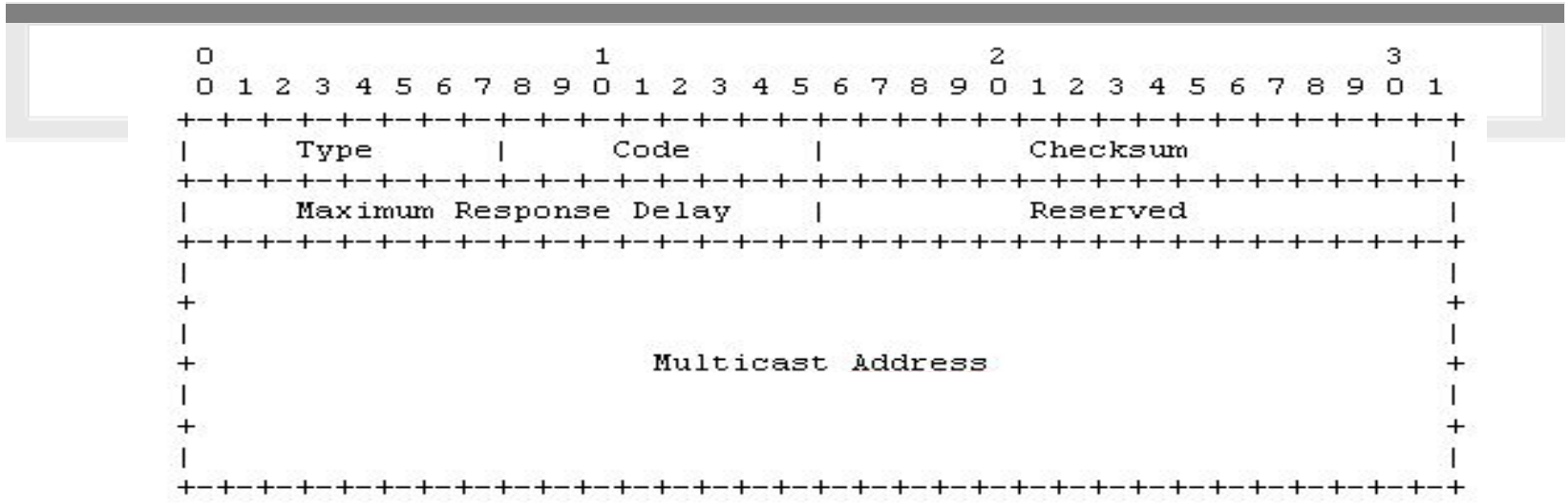
MLD

- Interaction protocol between
  - Multicast router on the link-local
  - Multicast hosts on the link-local
- Host can say: « I want to join group *FF0E::1234* and receive the related flow »
- MLD <-> IGMPv2 <-> ASM only
- MLDv2 <-> IGMPv3 <-> SSM + ASM
- MLD messages are sent in ICMPv6 packets

MLD packet

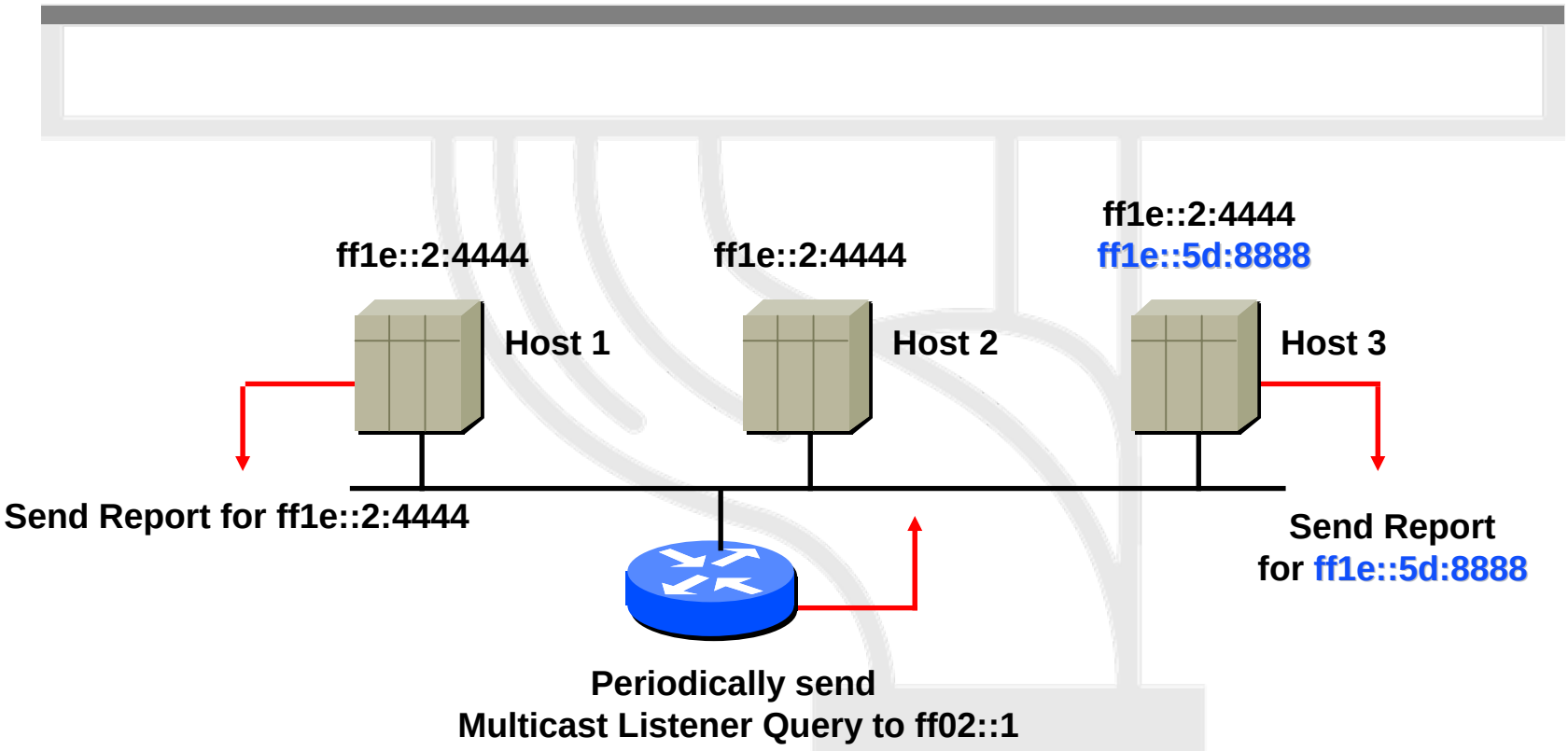

IPv6 Header
next header = 0 (Hop-by-hop)
Hop-by-hop extension
Option = Router alert
Next header = 58 (ICMPv6)
MLD message
Message type: ICMPv6

MLDv1 message

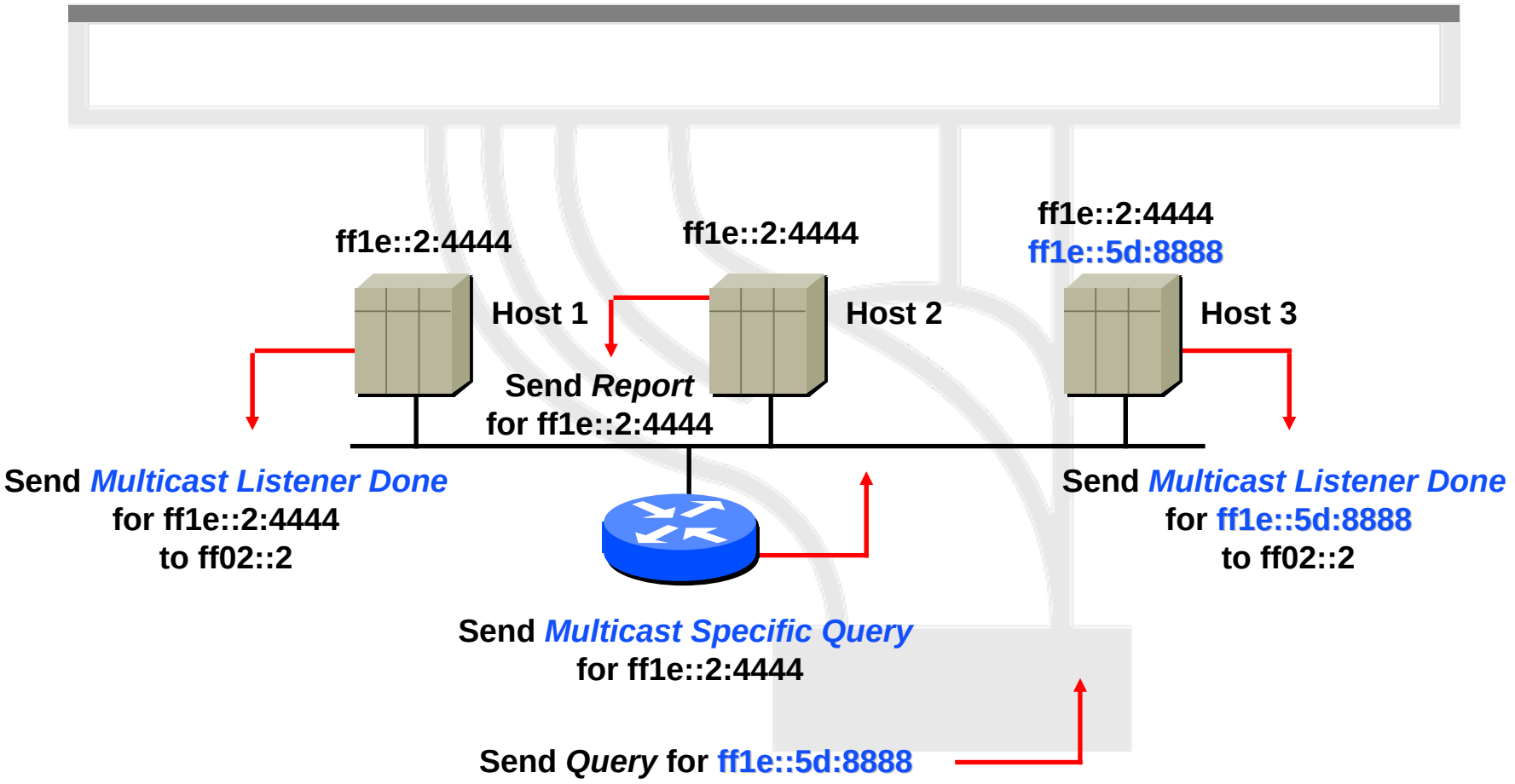


- Type : Messages types
  - General Query et Multicast-Address-Specific Query (130)
  - Multicast Listener Report (131)
  - Multicast Listener Done (132)
- Code : Set to 0 by sender and ignored then
- Checksum : for the complete packet (headers+MLD message)
- Maximum Response Delay : For query messages, time by which hosts must respond
- Reserved : Not used: set to 0 and ignored then
- Multicast Address : IPv6 multicast address or 0 according to the type of MLD message

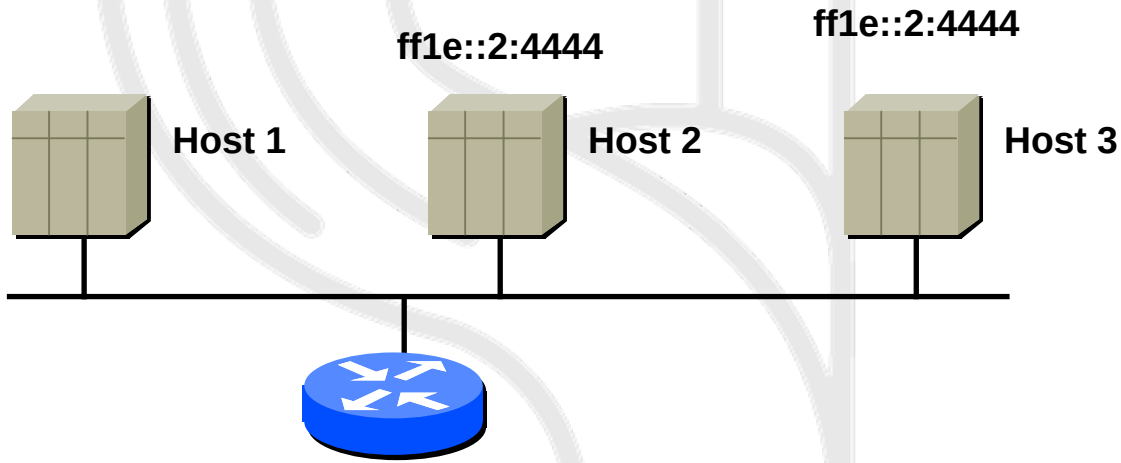
MLDv1 : Join a group



MLDv1 : Leave a group



MLDv1 : Leave a group



MLDv2 (RFC 3810)

- Management of group **& sources**
  - INCLUDE : to receive packets from sources specified in the MLDv2 message
  - EXCLUDE : to receive packets from all sources except the ones sepecified in the MLDv2 message
- 2 types of messages
  - Multicast listener query messages
  - Multicast listener report messages
- Interoperable with MLDv1

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PIM SM/SSM

- Protocol Independant Multicast
- No difference with PIM for IPv4
  - Except PIM messages are sent with link-local IPv6 address
- Creates multicast trees between senders and receivers (Diffusion trees)
- Not a routing protocol
- Relies on other routing protocols (MBGP, static…)

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Multicast addressing

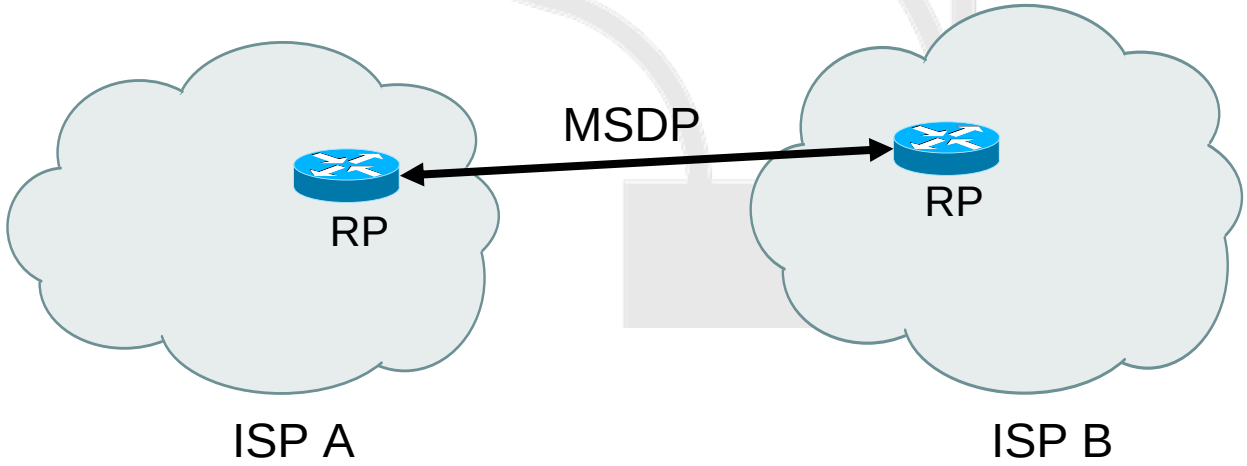
MLDv1 & MLDv2

PIM SM/SSM

Interdomain multicast

Interdomain multicast

- Not an SSM problem. Source specific trees created from senders to receivers accross domains
- ASM problem: was solved in the IPv4 world with MSDP (Multicast Source Discovery Protocol)



Interdomain multicast

- No one wants MSDP for IPv6, not manageable/scalable
- SSM IETF lobby
  - Some SSM apps already developed
- How to solve N -> M multicast ?
  - Application / Middleware ?
  - Not there yet (work ongoing)
- Embedded-RP – RFC 3956
  - One unique PIM domain with shared RPs
  - Embedded is a solution for group-to-RP mapping
  - Requires support in all PIM routers

Embedded-RP

- **Flag : 0RPT**

11111111	flag	scop	res	rpad	Plen	Network prefix	Group ID
8 bits	4	4	4	4	8	64 bits	32 bits

Flag : 0RPT

R=1 → Embedded-RP address

If R=1 → P=1 → T=1

FF7x::/16 addresses

Res : 0

Rpad : last 4 bits of the RP address

Plen: Prefix length

Network prefix

E.g. RP address 2001:660:3001:104::8

Multicast adress FF7E:0820:2001:660:3001:104:1234:abcd

Embedded RP