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IGMP/MLD Extension for Multicast Source Management
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Abstract

This document describes extensions to Internet Group Management Protocol (IGMP) and Multicast Listener Discover (MLD) protocols for supporting interaction between multicast sources and routers, accomplishing multicast source management.

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[1.](#) Introduction

Among protocols for Internet Protocol (IP) multicast, there is no protocol specification for the source registration so far. The current protocol focuses more on data control. This document specifies some new messages to extend IGMPv3 [[RFC3376](#)] and MLDv2 [[RFC3810](#)] for exchanging source registration information and data transmission control information between sources and routers.

In addition, combined with the multicast management process based on SDN architecture described in [[I-D.li-pce-based-bier](#)], the transmission of multicast source data can be effectively controlled, enhancing the security and controllability of the multicast service.

[2.](#) Conventions used in this document

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.

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[3.](#) Terminology

The following terms are used in this document:

- * BIER: Bit Index Explicit Replication
- * ICMPv6: Internet Control Message Protocol version 6
- * IGMP: Internet Group Management Protocol
- * IP: Internet Protocol
- * MDN: Multicast Data Notification
- * MLD: Multicast Listener Discover
- * MRS: Multicast Receiver Statistics
- * MSR: Multicast Source Registration
- * PCE: Path Computation Element
- * RP: Rendezvous Point
- * SDN: Software Defined Network

[4.](#) Overview of Multicast Source Management

Multicast source management includes multicast source registration and authorization, multicast data transmission and termination, and receiver information statistics. Currently, multicast source management is mainly used in Source Specific Multicast (SSM) scenario. If multicast source management is to be applied to Any-Source Multicast (ASM) scenarios, other mechanisms are needed. ASM scenario is not discussed in this document.

This document specifies IGMP and MLD protocol extensions for multicast source management, including Multicast Source Registration (MSR) described in [Section 5.1](#), Multicast Data Notification (MDN) described in [Section 5.2](#) and Multicast Receiver Statistics (MRS) described in [Section 5.3](#).

[4.1](#). Multicast Source Registration and Authorization

Source systems send Multicast Source Registration messages to routers informing them that there are multicast sources available to provide services. The Multicast Source Registration message must contain the multicast source address, service start time and validity period of the request. In some scenarios, The Multicast Source Registration message also needs to contain credential for controlling multicast source access.

After receiving the registration message from the source system and authenticating, the routers send Multicast Source Registration messages with valid registration status response to the source systems and inform the source systems that the requests are approved. The routers will trigger a timer and maintain the registration status for the source systems until the timer expires.

In contrast, the source systems can also send Multicast Source Registration messages to routers to withdraw the registration requests. Then the routers will revoke the registration status and reply to the source systems.

The source systems need periodically send registration messages to the routers to inform the router that the multicast source is alive. Then routers will refresh the timer of the registration status. If routers receive multicast data from multicast sources, they will refresh the timer. During data delivery, the source systems does not have to send registration messages periodically.

When the timer expires or the registration validity period expires, the router will release the registration status and send a Multicast Source Registration message with invalid registration status to the source system to inform it.

[4.2.](#) Multicast Data Transmission and Termination

Within the service validity of registration, when the first receiver joins a multicast group with SSM address and requests to receive data from a specific multicast source, the first hop router will send Multicast Data Notification message carrying multicast group address to inform the source system that the source can send data to this multicast group.

For a specific (S, G) tuple, when the last receiver leaves the multicast group, the first hop router will send Multicast Data Notification message carrying multicast group address to inform the source system that the source should stop sending data to this multicast group.

[4.3.](#) Receiver Information Statistics

For certain scenarios, a first hop router can learn receiver statistics for a specific (S, G) tuple. For example, in SDN scenario, the receiver statistics of each egress router can be centrally managed by the controller. The controller then aggregates these statistics and informs the first-hop router.

In this case, if the first hop router has sent Multicast Data Notification message to the source system to inform the source system sending data, the first-hop router should periodically send Multicast Receiver Statistics messages to the source system synchronizing the receiver statistics. In this way, the source system can perform analysis based on the receiver statistics, facilitating further optimization and scaling.

[5.](#) Message Formats

There are three types of IGMP and MLD messages associated with multicast source advertisement described in this document.

[5.1.](#) Multicast Source Registration Message

MSR message is sent by multicast source to request multicast data transmission service activation or by router responding to the request from the multicast source.

MSR message has the following format:

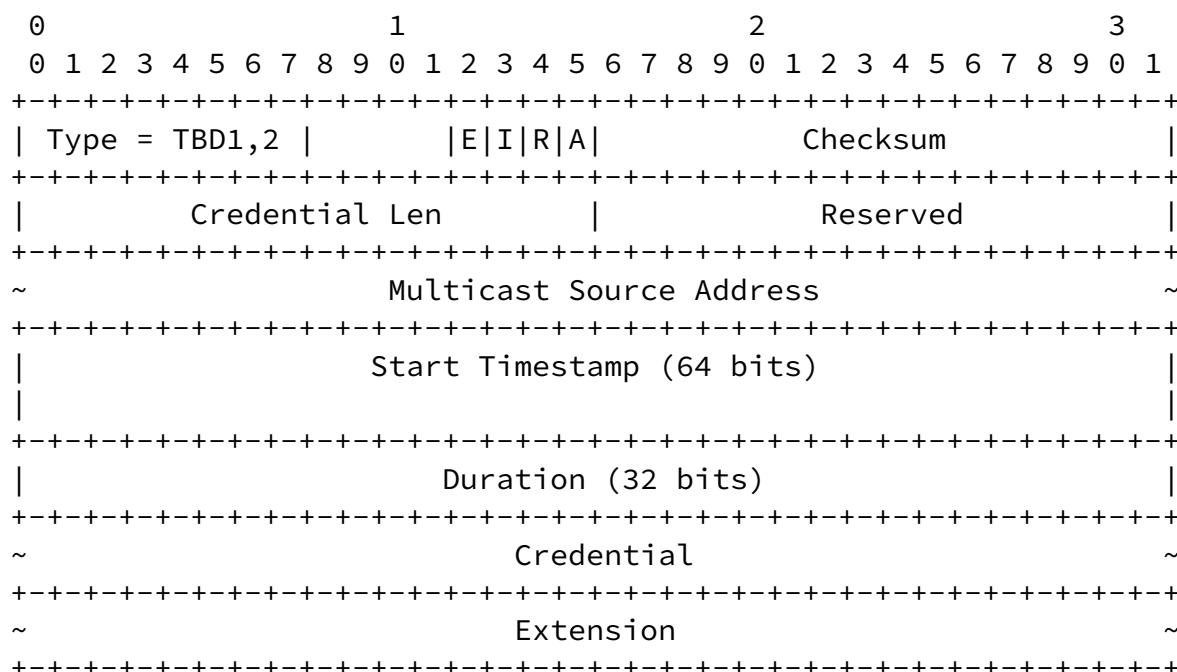


Figure 1: MSR Message Format

Type (8 bits): IGMP and MLD messages types, they need to be registered by the IANA.

E(E-bit): E-bit set to 1 to indicate that extension is present in the message. E-bit set to 0 to indicate that extension is not present in the message. The E-bit MUST be set to 1 to indicate that the extension is present. Otherwise, it MUST be 0.

I (Identity flag, 1 bit): The I flag set to 1 indicates that the message is sent by multicast source. The I flag set to 0 indicates that the message is sent by router.

R (Request flag, 1 bit): The R flag set to 1 indicates the request to activate transmission service. The R flag set to 0 indicates revocation of the request.

A (Authentication flag, 1 bit): The A flag set to 1 indicates success of request. The A flag set to 0 indicates failure of request or revocation of the request.

Checksum (16 bits): The Checksum is the 16-bit one's complement of the one's complement sum of the whole IGMP or MLD message (the entire IP payload). For computing the checksum, the Checksum field is set to zero. When receiving packets, the checksum MUST be verified before processing a message.

Multicast Source Address (Variable length): contains IPv4 or IPv6 address of the multicast source requested. If the MSR Message is used in IGMP, the length of the address is 32 bits. If the MSR Message is used in MLD, the length of the address is 128 bits.

Start Timestamp (8 bytes): indicates the start time when the multicast source can provide data services. Before this time, the multicast source cannot send data to multicast groups.

Duration (1 byte): indicates the maximum duration that the multicast source can provide data services in a valid registration request.

Credential (Variable length): is used for authorization of multicast sources.

Extension: It is defined and described in [\[I-D.ietf-pim-igmp-ml-d-extension\]](#). It may contain a variable number of TLVs for flexible extension.

[5.2.](#) Multicast Data Notification Message

MDN message is sent by router to notify multicast source to start or stop sending multicast packets. For different (S, G) tuples, the router needs to send multiple MDN messages.

MDN message has the following format:

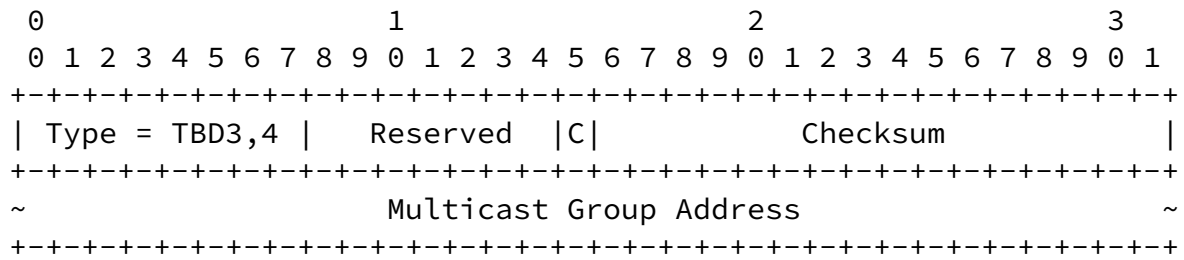


Figure 2: MDN Message Format

Type (8 bits): IGMP and MLD messages types, they need to be registered by the IANA.

C (Control flag, 1 bit): The C flag set to 1 indicates starting sending multicast packets. The C flag set to 0 indicates stopping sending multicast packets.

Checksum (16 bits): The Checksum is the 16-bit one's complement of the one's complement sum of the whole IGMP/MLD message (the entire IP payload). For computing the checksum, the Checksum field is set to zero. When receiving packets, the checksum MUST be verified before processing a message.

Multicast Group Address (Variable length): contains IPv4 or IPv6 address of the multicast group requested. If the MDN message is used in IGMP, the length of the address is 32 bits. If the MDN message is used in MLD, the length of the address is 128 bits.

5.3. Multicast Receiver Statistics Message

MRS message is sent by router to multicast source to synchronize receiver statistics of a group. For different (S, G) tuples, the router needs to send multiple MRS messages.

MRS message has the following format:

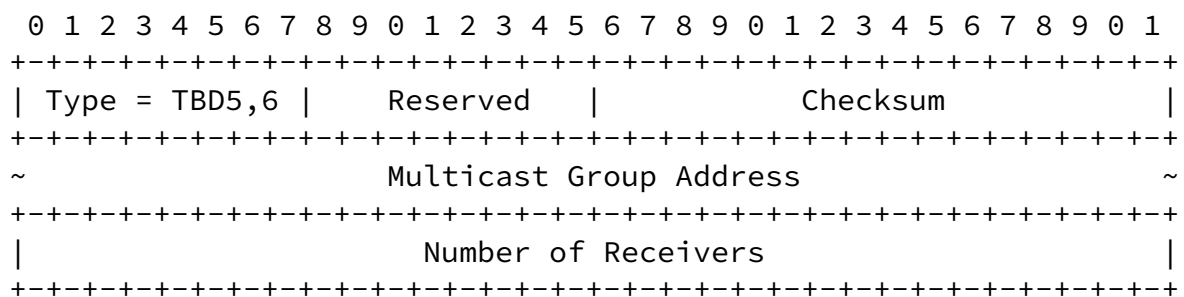


Figure 3: MRS Message Format

Type (8 bits): IGMP and MLD messages types, they need to be registered by the IANA.

Checksum (16 bits): The Checksum is the 16-bit one's complement of the one's complement sum of the whole IGMP/MLD message (the entire IP payload). For computing the checksum, the Checksum field is set to zero. When receiving packets, the checksum MUST be verified before processing a message.

Multicast Group Address (Variable length): contains IPv4 or IPv6 address of the multicast group requested. If the MRS message is used in IGMP, the length of the address is 32 bits. If the MRS message is used in MLD, the length of the address is 128 bits.

Number of Receivers (32 bits): indicates the number of receivers for a particular (S,G) tuple.

6. Use Case

6.1. Multicast Source Management for PCE based BIER

This section briefly describes procedures of multicast source management through a simple example of Path Computation Element(PCE) based Bit Index Explicit Replication(BIER) described in extended in [I-D.li-pce-based-bier].

The specific implementation process is as follows:

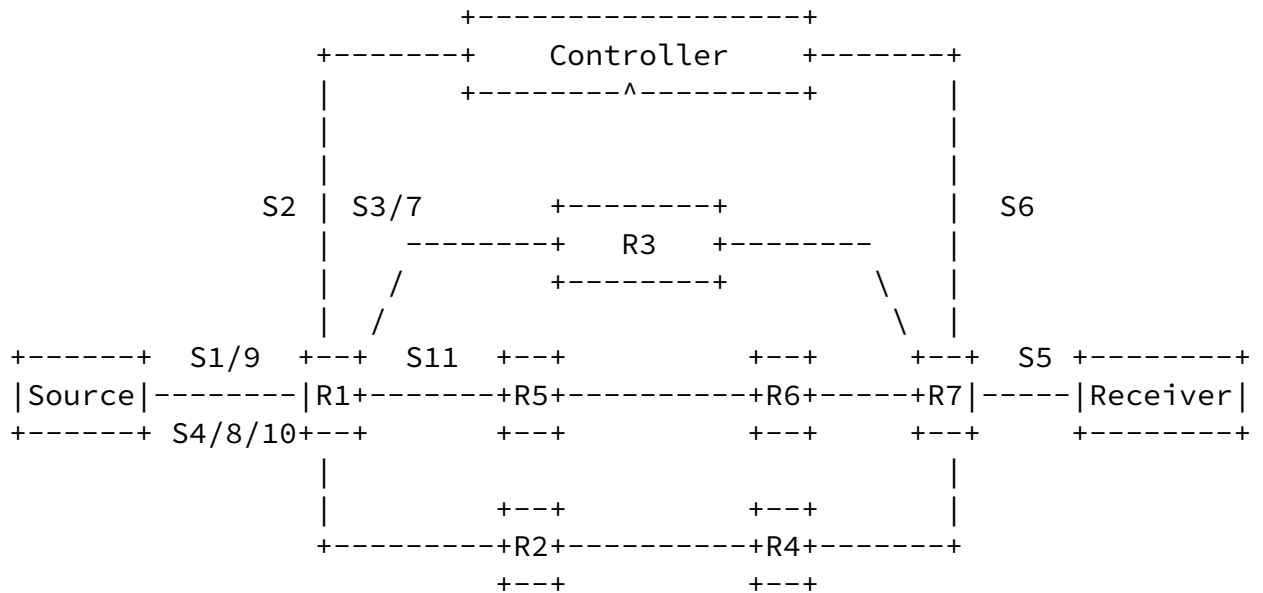


Figure 4: Topology of multicast source management for PCE based BIER

For PCE based BIER, the transmission of multicast source registration and authorization and receiver information statistics depends on the PCRpt message and PCUpd message, defined in [RFC8231] and extended in [I-D.li-pce-based-bier], between the router and the controller.

S1, S4, S8 and S10 in the figure are multicast source advertisement related processes. S1 is the process by which multicast sources send messages and data to router. S4, S8 and S10 are the process by which router send messages to multicast sources. The other steps are beyond the scope of this document.

Step 1(S1): Source sends IGMP or MLD MSR message to R1 requesting to activate the multicast data transmission service.

Step 2(S2): R1 sends multicast information registration to controller via PCRpt message.

Step 3(S3): The controller sends PCUpd message to the R1, carrying authentication result.

Step 4(S4): R1 sends authentication result to the source via IGMP or MLD MSR message. Source will conduct subsequent processing based on the authentication result, such as reapplying after the failure of authentication.

Step 5(S5): Receivers send IGMP or MLD messages to R7 requesting to join or leave a multicast group.

Step 6(S6): R7 converts the IGMP or MLD messages of receivers into PCRpt message and send it to the controller.

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Step 7(S7): The controller sends PCUpd message to R1 to start or stop forwarding, carrying BitString.

Step 8(S8): R1 sends IGMP or MLD MDN message to the source to notify the source sending multicast packets to the specific multicast group.

Step 9(S9): Source sends multicast data to R1.

Step 10(S10): R1 sends IGMP or MLD MSR messages with multicast receivers' statistics to the source periodically.

[7.](#) Deployment Considerations

[8.](#) Security Considerations

[9.](#) IANA Considerations

[9.1.](#) IGMP Type Numbers

IANA is requested to allocate a new code point within registry "IGMP Type Numbers" under "Internet Group Management Protocol (IGMP) Type Numbers" as follows:

Type Number	Message Name
-----	-----
TBD1	Multicast Source Activation
TBD3	Multicast Data Notification
TBD5	Multicast Receiver Statistics

[9.2.](#) ICMPv6 Parameters

IANA is requested to allocate a new code point within registry "ICMPv6 "type" Numbers" under "Internet Control Message Protocol version 6 (ICMPv6) Parameters" as follows:

Type Number	Message Name
-------------	--------------

TBD2	Multicast Source Activation
TBD4	Multicast Data Notification
TBD6	Multicast Receiver Statistics

[10.](#) Contributor

[11.](#) Acknowledgement

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