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IGMP Multicast Router Discovery
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Abstract

Companies have been proposing "IGMP snooping" type schemes for layer-2 bridging devices. A method for discovery multicast capable routers is necessary for these schemes. An IGMP query message is inadequate for discovering multicast routers as one querier is elected. In order to "discover" multicast routers, we introduce two new types of IGMP messages: Multicast Router Advertisement and Multicast Router Solicitation. These two messages can be used by any device which listens to IGMP to discovery multicast routers.

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1. Introduction

Multicast router discovery messages are useful for discovering multicast capable routers. This capability is useful in a layer-2 bridging domain with "IGMP snooping" type of schemes. By listening to multicast router discovery messages, layer-2 devices can determine where to send multicast source data and IGMP Host Membership Reports [[RFC1112](#)] [[IGMPv2](#)]. Multicast source data and IGMP Host Membership Reports must be received by all multicast routers on a segment. Using IGMP Host Membership Queries to discover multicast routers is not useful because of query suppression in IGMP.

Unlike ICMP router discovery messages [[RFC1256](#)], multicast router discovery advertisements should not be listened to by hosts. Hosts need not know the identity of multicast routers.

The use of the multicast router advertisement is not precluded from being used for other purposes. Extensible options have been included in the advertisement message for future enhancements.

The following are justifications for inventing another router discovery protocol:

1. Using ICMP router discovery is not an appropriate solution for multicast router discovery because: 1.) It may confuse hosts listening to ICMP router advertisements; unicast and multicast topologies may not be congruent. 2.) It is desirable to have advertisements sent to the all-multicast routers group address. 3.) There is no way to tell from a ICMP router advertisement if a router is running a multicast routing protocol.
2. By making multicast router discovery messages extensible and sending messages to the all-routers group, future enhancements can be made.
3. By inventing a generic IP layer message, multiple type of messages per link layer are not needed (i.e. including this functionality as part of IP is better than inventing N discovery protocols for N layer-2 technologies).

1.1 Protocol Overview

IGMP Multicast Router Discovery consists of two messages for discovering multicast routers. The Multicast Router Advertisement is sent by routers to advertise IP multicast forwarding enabled on an interface. The Multicast Router Solicitation is used by routers to solicit Multicast Router Advertisements.

Multicast routers send Multicast Router Advertisements (hereafter called advertisements) periodically on all interfaces on which multicast forwarding is enabled. These messages are sent to the All-Routers multicast group.

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Multicast Router Advertisements are also sent in response to Multicast Router Solicitations (hereafter called solicitations). These are sent to solicit a response of Multicast Router Advertisements from all multicast routers. Solicitations are sent to the All-Routers multicast group.

Multicast Router Solicitations are sent whenever a router wishes to discover multicast routers on a directly attached subnet. Solicitations are sent to the All-Routers multicast group.

All IGMP Multicast Router Discovery messages are sent with an IP TLL of 1 and contain the IP Router Alert Option [[RFC2113](#)] in their IP header.

[2.](#) Multicast Router Advertisement

[2.1](#) Overview

Multicast Router Advertisements are sent periodically on all router interfaces on which multicast forwarding is enabled. They are also sent in response to Multicast Router Solicitations.

Router advertisements are sent upon expiration of a periodic timer, when a router starts up, and when a router interface (that has IP multicast forwarding enabled) initializes/restarts. Advertisements are sent as IGMP messages to the All-Routers multicast address (224.0.0.2) and should be rate-limited.

Router advertisements may contain any number of options. Two options are defined in this document and MUST be supported by any implementation of IGMP multicast router discovery. These options are described in [Section 5](#). Additional options may be defined as

needed by future work.

2.2 IP Header Fields

2.2.1 Source Address

An IP address belonging to the interface from which this message is sent. If multiple source addresses are configured on an interface, then the one chosen is implementation dependent.

2.2.1 Destination Address

Router Advertisements are sent to the All-Routers multicast address (224.0.0.2).

2.2.2 Time-to-Live

The Time-to-Live field MUST be 1.

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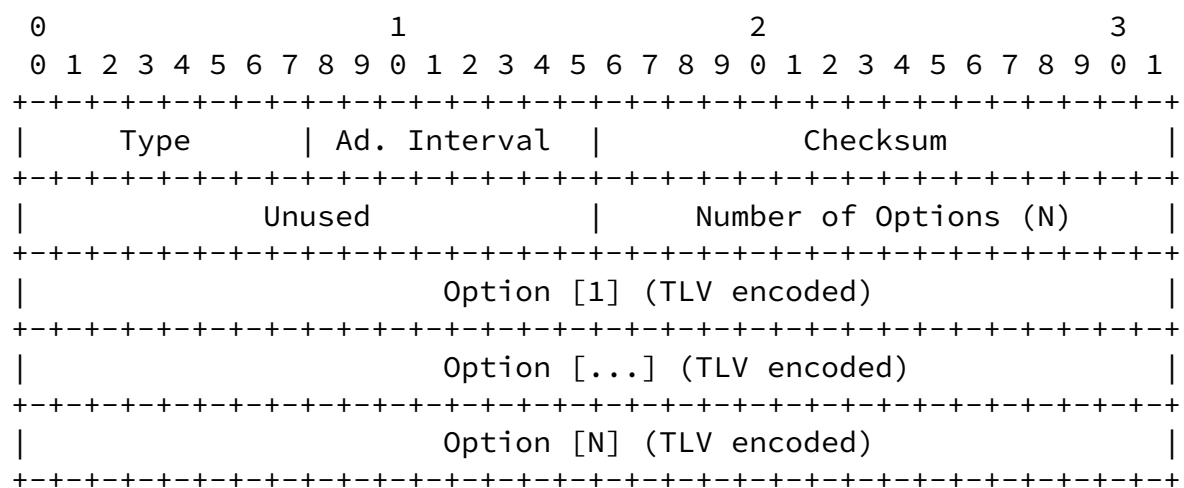
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2.2.3 Protocol

The protocol field is set to IGMP (2).

2.3 Multicast Router Advertisement Message Format



2.3.1 Type Field

The type field is set to 0x24.

2.3.2 Advertisement Interval

This specifies the periodic time interval at which Multicast Router Advertisements are sent in units of seconds. This value is set to the configured MaxAdvertisementInterval variable.

2.3.3 Checksum

The 16-bit one's complement of the one's complement sum of the IGMP message, starting with the IGMP type. For computing the checksum, the Checksum field is set to 0.

2.3.4 Number of Options (N)

The number of options contained in the router advertisement. If no options are sent this field **MUST** be set to 0.

2.3.5 Option[1..N]

Options are encoded as TLV in the following manner:

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If the Number of Options field is not zero, all options MUST be examined by a receiver. No strict ordering of options is enforced.

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Type: Set to option type being advertised

Length: Length in bytes of Value field

Value: Option dependent value

2.4 Sending Multicast Router Advertisements

Router Advertisements are sent when the following events occur:

1. When the a periodic advertisement interval timer expires. Note that it is not strictly periodic because the advertisement interval is a random number between `MaxAdvertisementInterval` and `MinAdvertisementInterval`. (Default Value: 7-10 seconds).
2. After waiting for a random delay less than

MaxInitialAdvertisementInterval when an interface first comes up, is (re)initialized, or IGMP Multicast Router Discovery is enabled. A router may send up to a maximum of MaxInitialAdvertisements advertisements, waiting for a random delay less than MaxInitialAdvertisementInterval between each successive advertisement.

This is to prevent an implosion of router advertisements. An example of this occurring would be when many routers are powered on at the same time.

3. When a solicitation is received, a router advertisement is sent in response with a random delay less than MAX_RESPONSE_DELAY. If a solicitation is received while an advertisement is pending (because of a recent solicitation), that solicitation will be ignored.

Whenever an advertisement is sent, the periodic advertisement interval timer may be reset.

[2.5](#) Receiving Multicast Router Advertisements

Upon receiving a router advertisement, routers will validate the message by the following criteria:

1. Verifying that the IGMP type is 0x24
2. Verifying the IGMP checksum
3. IP Destination Address = All-Routers multicast address

A router advertisement not meeting the validity requirements will be silently discarded. Routers MUST process all options, discarding options that are not recognized.

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If a router advertisement is not received for a particular neighbor within NeighborDeadInterval time interval, then the neighbor is considered to be unreachable.

[2.6](#) Multicast Router Advertisement Configuration Variables

A router that implements multicast router discovery MUST allow for the following variables to be configured by system management; default values are specified so as to make it unnecessary to configure any of these variables in many cases.

For each interface the following configurable variables are defined:

[2.6.1](#) MaxAdvertisementInterval

The maximum time allowed between sending router advertisements from the interface, in seconds. Must be no less than 4 seconds and no greater than 1800 seconds.

Default: 600 seconds.

[2.6.2](#) MinAdvertisementInterval

The minimum time allowed between sending unsolicited router advertisements from the interface, in seconds. Must be no less than 3 seconds and no greater than MaxAdvertisementInterval.

Default: $0.75 * \text{MaxAdvertisementInterval}$

Note: The default value will cause the periodic interval to be set to a period of 450-600 seconds.

[2.6.3](#) MaxInitialAdvertisementInterval

The first router advertisement out of an interface is sent after waiting for a random interval less than this variable. This will prevent a flood of router advertisements when many routers start up at the same time.

Default: 10 seconds

[2.6.4](#) MaxInitialAdvertisement

The maximum number of router advertisements that will be sent per event sending event.

Default: 3

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[2.6.5](#) NeighborDeadInterval

The maximum time allowed before declaring that a neighbor can be declared "dead". This variable is defined in seconds. In order for all routers to have a consistent state, it is necessary for the MaxAdvertisementInterval to be configured the

same on all routers per subnet.

Default: $3 * \text{MaxAdvertisementInterval}$

[3.](#) Multicast Router Solicitation

[3.1](#) Overview

Multicast Router Solicitations are used to solicit Multicast Router Advertisements. These messages are used when a router (or other device) wishes to discover multicast routers. Upon receiving a solicitation on an interface with IP multicast forwarding enabled, router will respond with an advertisement.

Router solicitations may be sent when a router starts up, when a router interface (re)initializes, or when IGMP Multicast Router Discovery is enabled. Solicitations are sent as IGMP messages to the All-Routers multicast address (224.0.0.2) and should be rate-limited.

[3.2](#) IP Header Fields

[3.2.1](#) Source Address

An IP address belonging to the interface from which this message is sent. If multiple source addresses are configured on an interface, then the one chosen is implementation dependent.

[3.2.2](#) Destination Address

Solicitation messages are sent to the All-Routers multicast address (224.0.0.2).

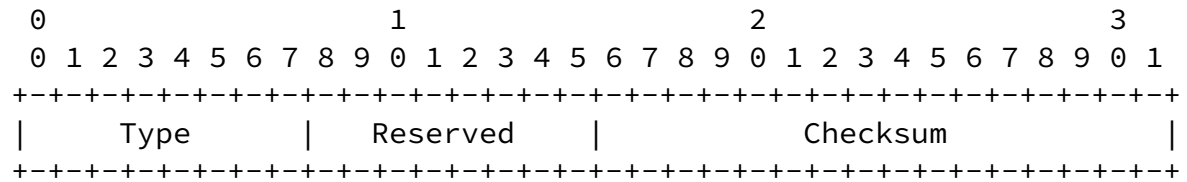
[3.2.3](#) Time-to-Live

The time-to-live field MUST be 1.

[3.2.4](#) Protocol

The protocol field is set to IGMP (2).

3.3 Multicast Router Solicitation Message Format



3.3.1 Type Field

The type field is set to 0x25.

3.3.2 Reserved Field

Sent as 0; ignored on reception.

3.3.3 Checksum

The 16-bit one's complement of the one's complement sum of the IGMP message, starting with the IGMP type. For computing the checksum, the Checksum field is set to 0.

3.4 Sending Multicast Router Solicitations

Router solicitations are sent when the following events occur:

1. After waiting for a random delay less than SOLICITATION_INTERVAL when an interface first comes up, is (re)initialized, or IGMP Multicast Router Discovery is enabled. A router may send up to a maximum of MAX_SOLICITATIONS, waiting for a random delay less than SOLICITATION_INTERVAL between each successive solicitation.
2. Optionally, for an implementation specific event. Solicitations MUST be rate-limited; no more than MAX_SOLICITATIONS MUST be sent in SOLICITATION_INTERVAL seconds.

3.5 Receiving Multicast Router Solicitations

Upon receiving a router solicitation, routers will validate the message by:

1. Verifying that the IGMP type is 0x25
2. Verifying the IGMP checksum
3. IP Destination Address = All-Routers multicast address

A router solicitation not meeting the validity requirements will be silently discarded.

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[3.6](#) Multicast Router Solicitation Configuration Variables

There are no configurable variables with respect to router solicitations.

[4.](#) Multicast Router Discovery Protocol Constants

MAX_INITIAL_ADVERT_INTERVAL	10 seconds
MAX_INITIAL_ADVERTISEMENTS	3 transmissions
MAX_RESPONSE_DELAY	2 seconds
MAX_SOLICITATION_DELAY	1 second
SOLICITATION_INTERVAL	3 seconds
MAX_SOLICITATIONS	3 transmissions

[5.](#) Mandatory Advertisement Options

[5.1](#) Overview of Options

The following options MUST be supported by an implementation of IGMP Multicast Router Discovery: Query Interval Advertisement Option and Robustness Variable Advertisement Option. These options advertise specific IGMP variables and are sent in an advertisement depending on the version of IGMP enabled on an interface. Although no requirements exist for multicast routers at this time, it is assumed that all multicast routers support the IGMP protocol.

[5.1](#) Query Interval Advertisement Option

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=1										Length=2										IGMP Query Interval																			
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+																																							

If a multicast router has any version of IGMP [[RFC1112](#)] enabled on an interface on which IGMP Multicast Router Discovery is also enabled, it MUST send all advertisements with the Query Interval

Advertisement Option. This option contains the IGMP "Query Interval" configured on the interface on which advertisements are sent.

This option is sent regardless of whether the router is currently the IGMP querier for the subnet. This option is sent regardless of what version of IGMP the router is running.

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IGMP Query Interval field is equal (in seconds) to the configured IGMP "query interval" on the interface from which the advertisement was sent.

5.2 Robustness Variable Advertisement Option

[illegible]

If a multicast router has IGMPv2 [[IGMPv2](#)] or IGMPv3 [[IGMPv3](#)] enabled on an interface on which IGMP Multicast Router Discovery is also enabled, it MUST send all advertisements with the Robustness Variable Advertisement Option. This option contains the IGMP "Robustness Variable" configured on the interface on which advertisements are sent.

This option is sent regardless of whether the router is currently the IGMP querier for the subnet. This option may be omitted if IGMPv1 is enabled on the interface.

Robustness Variable is an integer which MUST not be zero [[IGMPv2](#)] and is equal to the IGMPv2 robustness variable.

6. Acknowledgements

ICMP Router Discovery [[RFC1256](#)] was used as a general model for IGMP Multicast Router Discovery.

7. References

- [RFC1256] Deering, S., "ICMP Router Discovery Messages", [RFC 1256](#), September 1991.

- [RFC1112] Deering, S., "Host Extensions for IP Multicasting", [RFC 1112](#), August 1989.
- [IGMPv2] Fenner, W., "Internet Group Management Protocol, Version 2", Internet-Draft, November 1997.
- [IGMPv3] Cain, B., Deering, S., Thyagarajan, A., "Internet Group Management Protocol, Version 3", Internet-Draft, November 1997.
- [RFC2113] Katz, D., "IP Router Alert Option," [RFC 2113](#), April 1996.

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