The Internet Group Management Protocol (IGMP) is used by routers and hosts to manage multicast group membership. This protocol flow describes the following IGMP operations:

- IGMP query handling
- Hosts joining multicast groups
- Hosts leaving multicast groups

You can click on individual message titles in the sequence diagram to see the complete contents on the message. The messages are also shown with a timestamp to give you an idea of the timer intervals involved in the message exchanges.

**Preconditions**

The router periodically sends an IGMP Membership Query to all hosts in the network. The hosts with active multicasts respond back with an IGMP Membership Response. Note that the hosts add a random delay before responding. This is done to avoid a sudden surge in query responses in large networks.

**IGMP Membership Query Handling**

The router periodically sends a IGMP Membership Query to all hosts in the network. The hosts with active multicasts respond back with an IGMP Membership Response. Note that the hosts add a random delay before responding. This is done to avoid a sudden surge in query responses in large networks.

05:21:47.698870: The router sends out a membership query addressed to all hosts in the network. Note that the message is sent with a TTL of 1 so that the message does not get multicast to other networks. Also note that the maximum response time is set to 10 seconds. Thus the responding nodes have 10 seconds to respond back.

A query has been received and a report delaying timer is running for the multicast group.

All hosts receive the membership query and start a random timer so that they can reply within the allocated 10 second maximum response time.

05:21:48.627293: Host 1 responds to the membership query with an IGMP Membership Report multicast. The multicast is sent on the 239.255.255.250 address.

The main advantage of this scheme is that the router will not be flooded with query responses for the same multicast group. The router just needs to know if there is any active listener for a multicast on a network.
IGMP Query, Join and Leave Sequence Diagram

IGMP Query, Join and Leave Sequence Diagram

Router

All Hosts

Multicast

All Routers

Multicast

Host 1

Multicasts

Host 1

Host 2

Host 2

Multicast

[225.10.10.10]

[192.168.1.2]

[224.0.0.1]

[224.0.0.2]

[225.10.10.10]

[192.168.1.64]

[225.1.1.3]

[225.10.10.10]

[10.10.12.201]

1. IGMP Membership Report (0x16) [225.10.10.10]

05:21:54.761748: Host 2 responds to the membership query with 225.10.10.10 multicast address.

2. IGMP Membership Report (0x16) [225.1.1.3]

05:21:56.111610: Host 2 responds to the membership query with 225.1.1.3 multicast address.

3. Query Response Timer (10 sec)

IGMP Leave Group message is used to reduce the time it takes for the multicast router to stop forwarding multicast traffic after the last listener leaves the multicast group. In this scenario, Host 2 leaves the multicast group 225.1.1.3. The router then sends out a group specific multicast query to confirm if there are any more listeners for the 225.1.1.3 group.

4. IGMP Leave Group (0x17) [225.1.1.3]

05:22:07.221561: Host 2 leaves the 225.1.1.3 multicast group.

5. IGMP Membership Query (0x11) [225.1.1.3]

Max Response Time = 1 sec, Multicast Address = 225.1.1.3

05:22:07.231083: The multicast router initiates a membership query to check if there are any other hosts in the network that are still listening to multicasts on 225.1.1.3. It gives the hosts 1 second to respond.

6. Query Response Timer (1 sec)

No host responded to the query

7. Query Response Timer (1 sec)

The router stops forwarding multicasts for 225.1.1.3.

8. Host 2 joins 225.1.1.4 multicast group

An application on Host 2 joins a new multicast group 225.1.1.4. The networking stack of the OS performs the following actions:

1. Prepare to receive multicasts from the 225.1.1.4 class D address.
2. Map the 225.1.1.4 multicast group to MAC address 01:00:5e:01:01:04.
3. Program the NIC to receive Ethernet frames to 01:00:5e:01:01:04 MAC address.
4. Send an IGMP Membership Report (aka IGMP Join) to register as an interested listener.
5. Periodically send The IGMP Membership Report until a general query is received.

* Multicast address to MAC address mapping

Multicast MAC addresses have been assigned a standard 24-bit prefix of 01:00:5e. Out of the remaining 24 bits, only 23 bits are available for assignment to multicast groups. The lower 23 bits of the multicast IP address are copied into the lower 23 bits of the multicast MAC address. Thus, multiple multicast addresses map to the a single multicast MAC address.

9. IGMP Membership Report [225.1.1.4]

26:IGMP Membership Report [225.1.1.4]

The destination MAC address 01:00:5e:01:01:04 is associated with the 225.1.1.4 multicast group.

Program the NIC to forward packets destination MAC address 01:00:5e:01:01:04.

10. Delaying Member

The new multicast starts in the "Delaying Member" state (RFC 2236). Note that the application has started sending and receiving multicast data at this point.

11. IGMP Leave Group Handling: Host 2 leaves 225.1.1.3 multicast group

12. IGMP Membership Report [225.1.1.4]

The new multicast group 225.1.1.4 starts in the "Delaying Member" state (RFC 2236).

13. 225.1.1.4 multicast on the network

24:Calculate the destination MAC address associated with the 225.1.1.4 multicast group

Program the NIC to forward packets destination MAC address 01:00:5e:01:01:04.

14. IGMP Membership Report [225.1.1.4]

26:IGMP Membership Report [225.1.1.4]

The destination MAC address 01:00:5e:01:01:04 is associated with the 225.1.1.4 multicast group.

Program the NIC to forward packets destination MAC address 01:00:5e:01:01:04.

15. IGMP Membership Report [225.1.1.4]

26:IGMP Membership Report [225.1.1.4]
Host 2 leaves 225.1.1.4 multicast group

34: IGMP Leave Group (0x17) [225.1.1.4]
Destination MAC Address = 01:00:5e:01:01:04, Multicast Address = 225.1.1.4

05:22:18.681377:
Host 2 is leaving the 225.1.1.4 multicast group, so ask the NIC to stop forwarding packets with the associated destination MAC address.

No longer awaiting confirmation of multicast start

35: Non-Member
Change the multicast group state to "Non-Member"

36: report delaying timer
No longer awaiting confirmation of multicast start

37: Forwarding packets with destination MAC address 01:00:5e:01:01:04 to the upper layers

Host 2 joins 225.1.1.5 multicast group

Another example of Host 2 joining a multicast group (225.1.1.5).

44: IGMP Membership Report (0x16) [225.1.1.5]
Destination MAC Address = 01:00:5e:01:01:04, Multicast Address = 225.1.1.5

05:22:18.821288
05:22:24.791096
05:22:28.461112

45: IGMP Membership Report (0x16) [225.1.1.5]
Destination MAC Address = 01:00:5e:01:01:04, Multicast Address = 225.1.1.5

46: IGMP Membership Report (0x16) [225.1.1.5]
Destination MAC Address = 01:00:5e:01:01:04, Multicast Address = 225.1.1.5

Postconditions
The router sends another periodic IGMP query. The router receives the multicast reports from 225.10.10.10, 239.255.255.250 and 225.1.1.5.

47: IGMP Membership Query (0x11)
Destination MAC Address = 01:00:5e:01:01:04, Multicast Address = 225.1.1.5

48: IGMP Membership Report (0x16) [225.10.10.10]
Destination MAC Address = 01:00:5e:01:01:04, Multicast Address = 225.1.1.5

49: IGMP Membership Report (0x16) [239.255.255.250]
Destination MAC Address = 01:00:5e:01:01:04, Multicast Address = 225.1.1.5

50: IGMP Membership Report (0x16) [225.1.1.5]
Destination MAC Address = 01:00:5e:01:01:04, Multicast Address = 225.1.1.5

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3-23-17