Chapter 10

Internet Group Management Protocol (IGMP)
CONTENTS

• GROUP MANAGEMENT
• IGMP MESSAGES
• IGMP OPERATION
• ENCAPSULATION
• IGMP PACKAGE
• IGMP helps build up multicasting groups and maintain membership lists.
  – Members may be Hosts or Routers.
• Multicast Routers are needed to route Multicast traffic
  – Their routing tables are updated using special multicasting routing protocols (which do NOT include IGMP)
• Multicast Routers maintain a list of groups for each interface (network) they are connected.
  – Each list contains only the groups for which there is at least one member.
10.2 IGMP MESSAGES

- IGMP Messages
  - Query
    - General
    - Special
  - Membership Report
  - Leave Report
### IGMP message format

The IGMP message format consists of four fields:

- **Type**: A 8-bit field indicating the type of message.
- **Maximum Response Time**: A 8-bit field indicating the maximum response time.
- **Checksum**: A 8-bit field used for error checking.
- **Group address**: A variable-length field used for membership report and leave report; all 0s in general query.

#### Type and Value

<table>
<thead>
<tr>
<th>Type</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>General or Special Query</td>
<td>0x11 or 0001 0001</td>
</tr>
<tr>
<td>Membership Report</td>
<td>0x16 or 0001 0110</td>
</tr>
<tr>
<td>Leave Report</td>
<td>0x17 or 0001 0111</td>
</tr>
</tbody>
</table>

In the diagram, the group address is highlighted as "tenths of a second."
10.3 IGMP OPERATION

- If multiple Multicast Routers exist in one network, then their Group Lists are mutually-exclusive.
- Member routers: one or more other network receives the multicast
- Host Members: one or more local process receives the multicast
Joining a Group: The Membership Report

Each host (or router) may join a group by sending a Membership Report (MR) message.

A Host maintains a list of group IDs it subscribes to. If a new group ID is received, the Host sends an MR.

Routers maintain one list of group IDs per interface. If a new (i.e., to the router) group ID is received, the MR is sent out of all interfaces, except the one from which the new interest came from.

In IGMP, a membership report is sent twice, one after the other.
Leave report

Host or Router

Leave Report

<table>
<thead>
<tr>
<th>0x17</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group address</td>
<td></td>
</tr>
</tbody>
</table>

Router

Host or Router

Special Query

<table>
<thead>
<tr>
<th>0x11</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group address</td>
<td></td>
</tr>
</tbody>
</table>

Router

Host or Router

Membership Report

<table>
<thead>
<tr>
<th>0x16</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group address</td>
<td></td>
</tr>
</tbody>
</table>

Router

Host or Router

No Response

Or


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Monitoring Membership: The *General Query* message

- Distributing routers periodically query each node on an interface for *ALL* the groups they are interested in.
- Nodes must respond in 10 seconds by sending a membership report for each such groupid.
Delayed Response

- To prevent a burst of, and sometimes unnecessary, membership reports in response to a Query, the responding node (hosts or other routers) delay the response for each group by a random time.
- During the waiting period, if some other node responds to the same groupid, the waiting node simply cancels its own timer for that groupid.
**Example 1**

Imagine there are three hosts in a network as shown:

<table>
<thead>
<tr>
<th>Group Address</th>
<th>Timer (in tenths of seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>225.14.0.0</td>
<td>30</td>
</tr>
<tr>
<td>228.42.0.0</td>
<td>48</td>
</tr>
<tr>
<td>230.43.0.0</td>
<td>62</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group Address</th>
<th>Timer (in tenths of seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>228.42.0.0</td>
<td>12</td>
</tr>
<tr>
<td>251.71.0.0</td>
<td>50</td>
</tr>
<tr>
<td>230.43.0.0</td>
<td>70</td>
</tr>
</tbody>
</table>

A query message was received at time 0; the random delay time (in tenths of seconds) for each group is shown next to the group address. Show the sequence of report messages.
Solution

The events occur in this sequence:

**Time 12:** The timer for 228.42.0.0 in host A expires and a membership report is sent, which is received by the router and every host including host B which cancels its timer for 228.42.0.0.

**Time 30:** The timer for 225.14.0.0 in host A expires and a membership report is sent, which is received by the router and every host including host C which cancels its timer for 225.14.0.0.

**Time 50:** The timer for 251.70.0.0 in host B expires and a membership report is sent, which is received by the router and every host.

**Time 70:** The timer for 230.43.0.0 in host C expires and a membership report is sent, which is received by the router and every host including host A which cancels its timer for 230.43.0.0.

Note that if each host had sent a report for every group in its list, there would have been seven reports; with this strategy only four reports are sent.
## The IP Datagram

<table>
<thead>
<tr>
<th>Type</th>
<th>Destination IP address</th>
</tr>
</thead>
<tbody>
<tr>
<td>General or Special Query</td>
<td>224.0.0.1</td>
</tr>
<tr>
<td></td>
<td>All systems on this subnet</td>
</tr>
<tr>
<td>Membership Report</td>
<td>The multicast address of the group</td>
</tr>
<tr>
<td>Leave Report</td>
<td>224.0.0.2</td>
</tr>
<tr>
<td></td>
<td>All routers on this subnet</td>
</tr>
</tbody>
</table>

The IP packet that carries an IGMP packet has a value of **2** in its protocol field.

The IP packet that carries an IGMP packet has a value of **1** in its TTL field.
Mapping class D to Ethernet physical address

32-bit class D address

1110  23 bits of multicast address

5 bits unused

00000001000000000010111100  23 bits of physical address

48-bit Ethernet address
10.5 Host IGMP Package

Application layer

A request to join a group

Group-joining module

A request to leave a group

Group-leaving module

Timers

Input module

Output module

IGMP packet (query or report)

IP layer

Group table

IGMP packet (report)
# Group table

<table>
<thead>
<tr>
<th>State</th>
<th>Interface No.</th>
<th>Group Address</th>
<th>Reference Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>..........</td>
<td>............</td>
<td>.............</td>
<td>...............</td>
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<td>...............</td>
</tr>
</tbody>
</table>

**State:** Free, Delaying, Idle

**Reference Count:** Number of processes interested